Department of Fish and Game

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Attn: Records Office
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Re: Request for information, 90-Day Finding on a Petition to List Gulf of Alaska Chinook Salmon as Threatened or Endangered Under the Endangered Species Act. NOAA-NMFS-2024-0042

Dear Dr. Eich:

The State of Alaska, through the Alaska Department of Fish and Game (ADF&G), submits this letter in response to the request for information from the National Marine Fisheries Service (NMFS or Service) as it initiates a status review of Gulf of Alaska (GOA) Chinook salmon (*Oncorhynchus tshawytscha*). The status review was triggered by a January 2024 petition from Wild Fish Conservancy (WFC) requesting that NMFS list the species, or any evolutionarily significant unit (ESU) that may be present in the petitioned area, as threatened or endangered under the Endangered Species Act (ESA; 16 U.S.C. 1531 *et seq*.), and to concurrently designate critical habitat for any listed population segments. The petition requested review of Chinook in the "southern Alaska" area, including all rivers supporting Chinook salmon that flow into the Gulf of Alaska, from the southern side of the Aleutian Peninsula south and east to the southern border of Alaska and British Columbia.

The petition cites several factors that it asserts may be contributing to declines in GOA Chinook numbers and concludes that the population is impacted by all five of the ESA section 4(a)(1) threat factors. As we demonstrate in the following sections and appendices, the petition provides minimal information to support its assertions, and much of what it does present is easily demonstrated to be erroneous. Through our review of the purported threat factors, as well as an overview of the status and trends of Alaska Chinook populations in a historical context, we show that GOA Chinook continue to be well-managed on a sustained yield basis by the State of Alaska. The best available scientific and commercial information makes it clear that GOA

Chinook salmon do not meet the definition of a threatened or endangered species, so there is no reason to list any GOA Chinook population segment under the ESA.

Alaska is troubled by many of the assertions in the petition and in NMFS's positive 90-day finding.[1] NMFS states in the finding that the agency "identified numerous factual errors, omissions, incomplete references, and unsupported assertions and conclusions within the petition."[2] This is a gross understatement of the substantial inaccuracies presented by the petition, which provided minimal, generalized, and vague information on population status and trends, specious information on threats facing the GOA Chinook populations, and incorrect information on regulatory protections, among other deficits. As NMFS noted, "[b]road statements about generalized threats to the species, or identification of factors that could negatively impact the species, do not constitute substantial information indicating that listing may be warranted."[3] Yet "generalized threats to the species" is precisely the level of information provided by the petition, which also fell far short of providing a "complete, balanced representation of the relevant facts, including information that may contradict claims in the petition," as required by the ESA regulations.[4]

Notwithstanding the "low statutory standard at the 90-day stage" referenced by NMFS in the 90-day finding,[5] the agency had a duty to reject conclusions in the petition that failed to meet even that low bar—assertions the agency could readily confirm were not supported by credible scientific information and thus do not constitute "substantial scientific or commercial information" that warranted a positive 90-day finding. Nevertheless, NMFS seized upon two factors mentioned in the petition—missed escapement goals and evidence of decreasing size at maturity—the agency felt may warrant further examination. However, a positive 90-day finding on this extremely information-deficient petition was not necessary for NMFS to pursue clarifying information—readily available in both NMFS's files and from ADF&G—to ascertain the validity of the concern expressed in the petition about these two factors.

As NMFS stated, "[p]otential overharvest of some populations of Chinook salmon and missed escapement targets are not necessarily sufficient to indicate that the species may warrant listing under the ESA."[6] We agree. If this was the standard used by NMFS to commence species status reviews, then NMFS should have initiated species status reviews on the very long list of federally managed fisheries that are overfished under NMFS's responsibility. But, of course, NMFS has not used overfished stocks as a benchmark for initiating status reviews in the past,

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[1] 89 Fed. Reg. 45815 (May 24, 2024).
[2] 90-day finding at 45817.
[3] *Id.* at 45816.
[4] 50 C.F.R. §424.14(d).
[5] 89 Fed. Reg. 45818.
[6] 90-day finding at 45818.

indicative of a double standard being applied here. NMFS should rescind the positive-90 day finding, because the agency made considerable mistakes in accepting and evaluating the petition.

In the face of a severely deficient petition, there was no statutory requirement for NMFS to proceed with a status review of GOA Chinook salmon. To date, at the information-gathering stage caused by this unwarranted positive 90-day finding, this review has demanded a substantial outlay of time and funding by the State of Alaska at an extremely busy time for salmon management. More importantly, this review has caused economic impacts by throwing doubt on the sustainability of Alaska salmon fisheries.

The ESA also does not require the Service to proceed at this stage with an evaluation of whether one or more segments of the GOA Chinook population may meet the definition of an ESU. For NMFS to pursue identification of ESUs based on a petition with limited and questionable information without proper scientific evidence flies in the face of Congressional direction to use distinct population segments (DPSs, and by extension, ESUs) "sparingly."[7]

This letter will enumerate and refute the shortcomings and numerous flawed assertions in the petition and NMFS's evaluation thereof, particularly with respect to inconsistencies in three categories:

- statutory and regulatory requirements for content of petitions;
- appropriate identification of ESUs, including the Congressional requirement that distinct population segments (DPSs), of which ESUs are a subset, should be used "sparingly;" and
- evaluation of the status of GOA Chinook stocks and potential impacts of the five threat factors that form the core of a listing determination.

In addition, we provide scientific and other information in Appendix A, which contains the evidence to support the assertions we make in this letter. We include an overview of the status and trends for Alaska Chinook salmon in a historical context, followed by scientific information in the categories requested by NMFS, as well as information relevant to the purported threats to the population as asserted by the petition.

I. NMFS should not have accepted or made a positive 90-day finding on the WFC's petition

NMFS erred by disregarding ESA regulatory requirements and agency guidance on responding to petitions in evaluating the WFC petition and making a positive 90-day finding that listing of

[7] S. REP. No. 96-151 (May 15, 1979).

Chinook salmon may be warranted. This error by the Service has started an expensive review that is costing the State of Alaska considerable financial and personnel resources to respond to, while giving Alaska's salmon fisheries an undeserved black eye. NMFS should withdraw their positive 90-day finding based on the egregious errors the Service made.

The process by which the ESA directs the Services to respond to petitions is complex but is laid out clearly in the regulations[8] and in joint regulatory guidance.[9] For the WFC petition, however, NMFS did not closely follow several elements of the regulations or guidance, particularly regarding whether the petition provided "substantial information," as well as in the agency's approach to determining whether the petitioned population of Chinook salmon includes one or more ESUs—which, if they exist, would be evaluated separately in the status assessment and listing review. In this section, we address these shortcomings in NMFS's approach to the WFC petition.

The process NMFS followed in issuing a positive 90-day finding on the WFC petition to list Alaska Chinook was flawed from the outset. In issuing a positive finding that the petition "presents substantial . . . information indicating the petitioned action may be warranted,"[10] NMFS ignored the "numerous factual errors, omissions, incomplete references, and unsupported assertions and conclusions within the petition"[11] the agency itself identified, in favor of pursuing a review of two unsupported assertions made by the petition. With minimal effort, using information readily available in their own files, NMFS could have confirmed that the two assertions in the petition—i.e., missed escapement goals and evidence of decreasing size at maturity—were misguided reasons to consider GOA Chinook salmon for listing. That NMFS was able to identify the multiple errors and omissions in the petition suggests that information to refute the many faulty assertions was "readily available" to the agency—including in NMFS's own files.[12] This begs the question as to why NMFS chose to disregard agency guidance indicating that a petition lacking substantial information should warrant a negative 90-day

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[8] *See, e.g.*, 50 C.F.R. § 424.14.
[9] *Guidance on Responding to Petitions and Conducting Status Reviews Under the Endangered Species Act*, Updated February 1, 2021 (Hereafter "Service Guidance").
[10] 50 C.F.R. § 414.24(h)(1).
[11] 90-day finding at 45817.
[12] In fact, the Petition points out (page 8)—including citations to the Alaska Department of Fish & Game web site—that repeated missed escapement goals constitute a "Stock of Management Concern," which is less severe than a "Stock of Conservation Concern." These "Special Status" stocks are conservatively managed and include a built-in buffer whereby management measures are implemented to halt a potential decline well before the level of a conservation concern is reached. However, beyond this introductory language, the petition focuses on the stocks of management concern, as does NMFS in issuing its positive 90-day finding. Thus, information showing that the petition's concern for these stocks of management concern is overblown is readily available in the petition, NMFS's own files, as well as to NMFS through a simple search of the ADF&G website, yet NMFS proceeded to issue a positive 90-day finding on the petition, in large part because of this faulty assertion.

finding rather than the free pass to a status review that NMFS provided by issuing a positive finding.

In its 90-day review, NMFS failed to closely adhere to the statutory requirement that a petition present "substantial information indicating that the petitioned action may be warranted."[13] NMFS also ignored and misapplied substantive provisions of the regulatory requirements regarding the type and quality of information to be included for petitions.[14] In so doing, NMFS effectively lowered the established "low bar" for the quality and quantity of information a petition is required to contain. Although NMFS does "retain discretion to process a petition where the [agency] determines there has been substantial compliance with the relevant requirements," [15] that discretion is not unbounded where, as here, the petition did not provide substantial information. Instead, the petition provided wholly inadequate support for its assertions, as we show below and in Appendix A. More of the petition content was wrong, overstated, cherry picked, or generalized without supporting evidence than was accurately portrayed with supporting evidence.

NMFS's decision to issue a positive 90-day finding on WFC's petition is all the more shocking to us after the agency rejected the well-reasoned petition to delist ringed seals, submitted by the State of Alaska and others, which was built on substantial scientific and other information.[16]

A. Required Content for Petitions

The WFC petition presents only conclusory statements not supported by scientific information, thus failing to meet the requirements listed in the regulations at ESA section 424.14. As noted in the Service Guidance, "conclusory statements lacking credible supporting information will not be considered 'substantial information.'"[17] In many sections, the petition misses the mark for the requirements at 424.14(c), which indicates that it does not "substantially compl[y] with the requirements for petitions," and should have been rejected.[18]

Section 424.14(c)(2) provides that "[o]nly one species may be the subject of a petition, which may include . . . any subspecies. . .or (for vertebrates) any potential distinct population segment**s**

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[13] 16 U.S.C. § 1533(b)(3)(A).
[14] 50 C.F.R. §424.14(c-d). https://www.ecfr.gov/current/title-50/chapter-IV/subchapter-A/part-424/subpart-B/section-424.14
[15] *Id.* at § 424.14(f)(1).
[16] 90-Day Finding on a Petition to Delist the Arctic Subspecies of Ringed Seal Under the Endangered Species Act. 85 Fed. Reg. 76018 (November 27, 2020).
[17] Service Guidance at 6.
[18] *Id.* at 3. *See also* 50 C.F.R § 424.14(f)(1): "If a request does not meet the requirements set forth at paragraph (c) of this section, the Services will generally reject the request without making a finding, and will, within a reasonable timeframe, notify the sender and provide an explanation of the rejection" (emphasis added).

of that species." Next, section (c)(3) requires "[a] clear indication of the administrative action the petitioner seeks (*e.g.*, listing a species as threatened or endangered). In turn, section (c)(4) requires "[a] detailed narrative justifying the recommended administrative action that contains an analysis of the information presented.

The WFC petition does indicate that the administrative action it seeks is for NMFS to list Chinook salmon across a vast geographic area in Alaska. However, the petition provides no "detailed narrative . . . containing an analysis of information." Instead, the petition presents little more than vague assertions supported by extremely limited data, in most cases, and no data in others. In the Executive Summary, the petition merely states, "[t]he Wild Fish Conservancy petitions to list one or more 'evolutionary[sic] significant units' of Chinook salmon in the State of Alaska as a threatened or endangered species under the [ESA]."[19] The petition later refines that request slightly, asking that "NOAA-NMFS initiate a status review of Chinook in southern Alaska, which encompasses all Chinook populations that enter the marine environment of the Gulf of Alaska." [20]

Although the petition refers to only one taxonomic species (i.e., Chinook salmon), the question of how many ESUs of Chinook—each of which would be treated as a separate listing entity or "species" for a listing review—may occur within the GOA is wholly left for NMFS to determine. The petition provides no hypothetical list of ESUs or data applying the relevant criteria in NMFS's ESU Policy to any Chinook stock groupings. The closest the petition comes to providing a "detailed narrative" justifying its requested action is one short paragraph: "[b]est available science supports listing of at least one or more Distinct ESUs," followed by "Southern Alaska Chinook constitute one or more Distinct ESUs."[21] The "analysis" of this information is limited to the following:

> Since no Alaska Chinook populations have previously been petitioned for listing under the ESA, Alaskan Chinook population structure has not been characterized in terms of ESUs. Designation of Chinook ESUs is therefore a first step in the development of a status review on the basis of which the merits of listing one or more ESUs under the ESA can be evaluated. Basic life-history and differences in the spatial structure of Alaska's numerous Chinook populations suggests that populations in southern Alaska are likely to form one or more ESUs distinct from Bering Sea populations . . ..[22]

Indeed, WFC's broad assertion that "southern Alaska" contains one or more ESUs without providing any supporting scientific evidence that there is at least one ESU should have led NMFS to reject the WFC petition.

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[19] Petition at 3.
[20] *Id*. at 20.
[21] *Id.* at 22.
[22] *Id.* at 22-23.

In essence, the WFC petition "double dips" by requesting that NMFS determine whether the "southern Alaska" Chinook population consists of "one or more" ESUs—each of which would be considered a listable entity or "species" under the ESA in a listing review. But because the petition failed to provide substantial information on potential ESUs within its arbitrarily defined "southern Alaska" region, it is not appropriate for NMFS to accept the petition's direction to identify multiple ESUs. To do so would be contrary to Congressional direction to use the DPS/ESU concept "sparingly"[23] and should not be the primary purpose of a listing review.

Service Guidance[24] provides highly relevant direction for the circumstances presented by the WFC petition, i.e., requesting that NMFS list a taxonomic species within a huge region or "any [ESUs] that may exist."

> [W]here the petition requests that we list the taxonomic species (or subspecies) or any distinct population segments (DPSs) that may exist, the lead office will first determine whether the petition or information readily available in NMFS files indicates that the *taxonomic species or subspecies* may be in danger of extinction . . .. If it does, the analysis will end there and a status review will be initiated on the taxonomic species or subspecies (though the lead office may decide to consider whether there are DPSs after considering whether the potential to list as DPSs might provide an overriding conservation benefit to the species . . .. If it does not, and the petition includes a request to list *specified DPSs* (as opposed to generally requesting that we list any DPSs we may identify), the lead office will determine whether the petition or information readily available in NMFS' files indicates that the petitioned population(s) may meet the DPS Policy criteria . . . and that listing, delisting, or reclassifying the population(s) may be warranted under the reasonable person standard. . . . In evaluating whether the petition or information readily available in NMFS' files indicates that the petitioned population(s) may meet the DPS Policy criteria, the lead office will not do a full DPS analysis, but will just determine whether the petitioned population(s) *may* meet the DPS Policy criteria . . .. In all cases, it is the petitioner's responsibility to provide some information to indicate that there may be a listable entity (a "species") that may warrant listing. . . . Where the petitioner fails to present any information that would indicate that a particular population may satisfy the DPS Policy criteria (such as where the petitioner merely asks that NMFS list "any DPS that may exist"), such petition will generally not lead to a positive finding and in some cases could lead to rejecting the request as a petition (emphases added).

The WFC petition "generally request[ed] that [NMFS] list any DPSs [the agency] may identify," rather than "specified DPSs." This vague request should not have led to a positive 90-day finding absent credible "information that would indicate that a particular population may satisfy the DPS

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[23] S. REP. No. 96-151 (May 15, 1979).
[24] Service Guidance at 6-7.

Policy criteria." The petition provided no such credible information. Nor did NMFS give any indication that the agency "consider[ed] whether the potential to list as DPSs might provide an overriding conservation benefit to the species," which might otherwise warrant consideration of multiple DPSs.[25]

Further, notwithstanding NMFS's presumption, without evidence, in the 90-day finding that "it is likely that more than one ESU exists within the petitioned area,"[26] the petition's lack of provided evidence in fact argues for NMFS to have never accepted the petition, much less made a positive 90-day finding. Given that NMFS did make a positive 90-day finding, the lack of evidence by the petitioner should have led NMFS to evaluate only one ESU: the entire Gulf of Alaska population, which the petition points out—through an unsupported assertion—would "likely" qualify as an ESU distinct from Chinook populations in the Bering Sea.[27]

B. Petition Standard

The standard by which the Service is to evaluate a petition is "whether [it] presents substantial scientific or commercial information indicating that the petitioned action may be warranted."[28] Whether the information provided in the petition meets the "substantial" standard will depend in part on the degree to which the petition includes the following types of information: [29]

(1) Information on current population status and trends and estimates of current population sizes and distributions, both in captivity and the wild, if available;
(2) Identification of the factors under section 4(a)(1) of the Act that may affect the species and where these factors are acting upon the species;
(3) Whether and to what extent any or all of the [section 4] factors alone or in combination . . . may cause the species to be an endangered species or threatened species . . . and, if so, how high in magnitude and how imminent the threats to the species and its habitat are;
(4) Information on adequacy of regulatory protections and effectiveness of conservation activities by States . . . that have been initiated or that are ongoing, that may protect the species or its habitat; and
(5) A complete, balanced representation of the relevant facts, including information that may contradict claims in the petition.

[25] Service Guidance at 6.
[26] 90-day finding at 45818.
[27] Petition at 23.
[28] 50 C.F.R. § 424.14(h)(1).
[29] 50 C.F.R. § 414.24(d).

The petition falls short in providing substantial information for each of these factors, as described below.

(1) Current Population Status and Trends

Although the petition does present some escapement data for some stocks (accessed from ADF&G reports), NMFS points out that "the petition only presents escapement data through 2021, but in 2022 and 2023, some GOA Chinook salmon populations have shown improvements toward meeting their escapement goals."[30] This statement also acknowledges that NMFS was able to readily access the publicly available information about 2022 and 2023 Chinook escapement levels.

(2) Identification and Magnitude of ESA Threat Factors Acting on the Species and

(3) Magnitude and Imminence of Identified Threat Factors

This section of the WFC petition stands out for its failure to provide adequate information regarding the ESA Section 4 threat factors. As NMFS stated in the 90-day finding, "the petition also makes vague references to threats from logging, road building, mining, overharvest, and competition from hatchery salmon without providing specific examples."[31] Although the petition does list several factors that could potentially be acting on a given population of Chinook salmon, it completely fails to identify specific threats, whether they are acting on the Alaska Chinook population, or how "high in magnitude" and "how imminent" the possible threats may be, much less how and to what extent the population may be responding to those potential threats.

To this point, in the 90-day finding background section explaining the process the agency intends to follow, NMFS directed that:

> "Information presented on impacts or threats should be specific to the species and should reasonably suggest that one or more of these factors may be operative threats that act or have acted on the species to the point that it may warrant protection under the ESA. We look for information indicating that not only is the species exposed to a factor, but that the species may be *responding* in a negative fashion; then we assess the potential significance of that negative response."

However, the petition fails to provide any local, watershed-level, or regional data to support its claim that the development activities are a current threat to Chinook habitat in Alaska. Instead, the description of "threats" is generic and imprecise and reads like it was cut and pasted from

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[30] 90-day finding at 45817. Also, for some stocks, the petition presented data only through 2019, despite the data being easily accessible to the public.
[31] *Id.* at 45817-45828.

report on threats to salmon habitat—in the Pacific Northwest, not Alaska. Although these development activities do occur in Alaska, their impact to Chinook habitat is minimal compared with the scale and magnitude of the impact of these activities to Chinook in the Pacific Northwest (See Appendix A – *Subsection 2.3.3 Habitat*).

Regarding overutilization, another of the five threat factors specified in ESA Section 4, the petition asserts that overharvest of Chinook is having a detrimental impact on the population without providing evidence of overfishing. Missed escapement goals are not evidence of overfishing, as they can be the result of many different factors. NMFS also counters the petition's assertion by stating that "potential overharvest of some populations of Chinook salmon and missed escapement targets are not necessarily sufficient to indicate that the species may warrant listing under the ESA."[32] Indeed, when there is a status determination that overfishing is occurring in a federal fishery and one or more stocks are overfished, NMFS does not directly move to conduct a species status review under the ESA.

Nevertheless, NMFS went on to issue a positive 90-day finding and is proceeding with a status review. Again, the 90-day finding assures the reader that "[b]road statements about generalized threats to the species, or identification of factors that could negatively affect a species, do not constitute substantial information indicating that listing may be warranted." But by issuing a positive 90-day finding, NMFS implicitly accepts these broad statements and faulty assertions as credible.

(4) Adequacy of Regulatory Protections

In its attempt to address section 424.14(d)(4), the petition's discussion of regulatory protections and conservation activities by states and other entities is genuinely laughable. It consists of a cursory listing of statutes and measures those statutes may or may not contain. This section demonstrates a disturbing lack of effort on the part of the petitioners to identify and evaluate the contents, much less the adequacy, of existing regulatory provisions, including the State of Alaska's constitutional, statutory, and regulatory management of salmon fisheries. For example, in the petition's purported assessment of the contributions of the ESA to Alaska Chinook, the petition states:[33]

> Alaskan Chinook salmon are not currently protected under the federal Endangered Species Act.
>
> The Act offers potential protections through Habitat Conservation Plans (HCP) which cover nonlisted species. Several Habitat Conservation Plans exist in Alaska under the

[32] 90-day finding at 45818.
[33] WFC Petition at 47.

> U.S. Endangered Species Act that may provide benefits to Alaskan Chinook salmon. A few examples of these include:
>
> - Tongass Land Management Plan HCP
> - Alaska Department of Transportation and Public Facilities HCP
> - Kensington Gold Mine HCP

If NMFS had consulted its own web page, it would find that there are no HCPs in Alaska, for any species. The petition invented these supposed existing HCPs. The petition then lists—and incorrectly spells—the names of other ESA-listed species in Alaska, with no mention aside from "co-occurrence" of how the ESA might protect those species, such as through designated critical habitat and Section 7 consultations:

> Another potential Endangered Species Act protection could be through co-occurrence with other listed species. As of 2021, Stellar[sic] Sea Lion (western population), Northern Sea Otter (Southwest Alaska Population), Spectacled Eider, Steller's Eider, North Pacific [sic] Humpback Whale, North Pacific Right Whale, and Cook Inlet Beluga Whales are species found in the State of Alaska which are listed as threatened or endangered.

The petition then summarizes its "assessment" of ESA contributions with an unsupported, conclusory statement:[34]

> "While Chinook could benefit somewhat from protection of these species and indirect benefits to Chinook habitat may occur, none of these listings appear to have slowed the decline of Chinook salmon in Alaska. Existing state and federal programs and regulations have failed to prevent continued high rates of habitat loss, and many threats to Chinook continue unabated."

It is clear that the petitioners did less than even a cursory examination of any of the myriad state regulatory protections currently in place. For contrast, we provide an overview of State of Alaska-implemented regulatory protections in Appendix A.

(5) Complete and Balanced Representation of Facts

For the fifth and final factor in section 424.14(d), the petition falls completely flat. It is difficult to imagine how NMFS concluded that the petition presented "[a] complete, balanced representation of the relevant facts, including information that may contradict claims in the petition." Given the direction in 424.14(d) that NMFS's conclusion as to whether the information provided by the petition meets the "substantial" standard will depend in part on the degree to which the petition includes" these five categories of information, the overall lack of unsupported

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[34] *Id.*

and therefore not credible information presented in the petition should have resulted in a negative 90-day finding. Although conclusive evidence that the action requested in a petition may be warranted is not required to receive a positive 90-day finding, no reasonable person would find that the WFC petition "substantially complied with the relevant regulatory requirements;" instead, it fell far short of that standard.

C. Limitations on Service Access to Information

Service Guidance directs that the Services "should not solicit additional information"[35] at the petition finding stage, stating that "[t]he question at the 90-day finding stage of petition review is whether *the petition* presents substantial scientific or commercial information indicating that the petitioned action may be warranted" (emphasis in original).[36] The Service Guidance continues:

> The lead office is to "evaluate the petitioner's request based on the information in the petition, including its references . . . and information readily available in NMFS's files. The lead office should not conduct additional research at this stage and may not solicit information from parties outside the agency to help evaluate the petition.[37]

A footnote in the guidance[38] contains a detailed discussion of three court cases from the early 2000s, all of which held that information considered during review "must either be provided in the petition (or cited in it) or available within agency files," and that "consultation with states and other federal agencies must await the 12-month review process." To the contrary, examination of the opinions cited makes clear that the issue being challenged in each of the cases was that the Service actively solicited information from outside sources, such as by requesting information on a species being petitioned, a process that delayed the "90-day finding" for many months.

As the Service Guidance indicates, that level of outreach is clearly out of bounds for the Services. However, the footnote also states that "[r]evisions made in 2016 to the petition[] regulations interpret the Services' ability to consider readily available information in their files to extend to information that is 'readily available; electronically if it is of a type routinely consulted by the Services."[39] For the WFC petition, this means that in many instances NMFS could easily have confirmed, refuted, or evaluated the completeness of statements in the petition by consulting its own or other agency websites as well as considering the unsolicited information the State of Alaska provided (see Appendix B).

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[35] Service Guidance at 4.
[36] Guidance at 5, citing 16 U.S.C. § 1533(b)(3)(A).
[37] *Id.*
[38] *Id.*, footnote #3 (internal citations omitted).
[39] *Id.*

Moreover, the State of Alaska provided considerable information to the Alaska Region before the petition was filed, (see Appendix C), which NMFS should have considered "readily available in its files." Consulting the ADF&G website or the information we provided would have allowed NMFS to avoid engaging in the unwarranted review process it has embarked upon at the request of a wholly inadequate petition.

D. The WFC Petition Did Not Meet the "Substantial Information" Standard

It is difficult to square NMFS's finding that the petition provides substantial information, or that it substantially complied with the relevant regulatory requirements, with the minimal content of the petition. It may have had the correct headings, but it was severely lacking in substantive information and in some cases, was absurdly incorrect, as we pointed out to NMFS in an unsolicited letter prior to the 90-day finding (see Appendix B).

A review of the regulatory definition of "substantial scientific or commercial information"[40] illustrates how NMFS failed to correctly construe whether the limited information provided by the petition was "substantial:"

> "Substantial scientific or commercial information" refers to credible scientific or commercial information in support of the petition's claims such that a reasonable person conducting an impartial scientific review would conclude that the action proposed in the petition may be warranted. Conclusions drawn in the petition without the support of credible scientific or commercial information will not be considered "substantial information."

Given the paucity of scientifically defensible information provided by the petition in support of its assertions, it is a far stretch to characterize that information as "substantial" or "credible" for most of the required information categories. NMFS nevertheless found it so, despite identifying "numerous factual errors, omissions, incomplete references, and unsupported assertions within the petition."[41] It is unclear how NMFS went from noting "numerous errors and omissions" to concluding the petition provides "substantial information."

In sum, NMFS came to the wrong conclusion regarding whether the petition provided "substantial information." The agency's error is highlighted by the following statement in the 90-day finding:

> "Nonetheless, we find that some of the information in the petition, in particular the missed escapement goals in recent years for many stocks in the petitioned area, and

[40] 50 C.F.R. §424.14(h)(1)(i).
[41] 90-day finding at 45817.

> evidence of decreasing size and age at maturity, would lead a reasonable person to believe that the petitioned action may be warranted."

In crediting this information, NMFS failed to meet its responsibility to not mislead the "reasonable person" who might review the petition by not refuting easily corrected statements in the petition, such as "missed escapement goals"—when the petition itself clarified that missed escapement goals for stocks of management concern were less severe than for stocks of conservation concern. In addition, it is hard to square how NMFS considers missed escapement goals as a signal that ESA listing may be warranted. Many federal fisheries, which NMFS manages, often fail to meet similar fishery management benchmarks on a regular basis and yet NMFS does not use that status as an impetus for conducting ESA status reviews on those fished species.

If NMFS had accurately portrayed the escapement goal issue, instead of continuing to credit WFC's incorrect assertions, then, contrary to NMFS's reasoning,[42] a "reasonable person conducting an impartial scientific review" would likely not be convinced that the petition supported its assertions with "substantial information" suggesting the petitioned action may be warranted. NMFS should acknowledge the serious errors it made in reviewing the petition and rescind the positive 90-day finding on the WFC petition.

II. NMFS should focus on determining if one ESU for the GOA is appropriate rather than presuming without evidence that there are likely multiple ESUs in the GOA.

A. Determination of Listable Entities

The WFC petition requests that NMFS list under the ESA the "Alaska Chinook" population, consisting of all Chinook-supporting rivers and streams that flow into the Gulf of Alaska, along with any ESUs that may occur within that vast area. The Service's first step in reviewing the petition is for "the lead office . . . to evaluate whether the information presented in the petition . . . indicates that the petitioned entity may constitute a "species" eligible for listing."[43]

As defined in section 3 of the ESA, "[t]he term "species" includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature."[44] The Act does not further define "distinct population segment," or DPS, but in 1996, the Services adopted a joint policy on the criteria that should be

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[42] 90-day finding at 45818.
[43] Service Guidance at at 6.
[44] 16 U.S.C. § 1532(16).

used to determine DPSs.[45] The 1996 DPS Policy criteria are based on, but not identical to, the criteria earlier established for ESUs, which is a conceptual framework developed and used exclusively for Pacific salmon populations.[46] The ESU policy "explains that Pacific salmon populations will be considered a DPS, and hence a "species" under the ESA.[47] In turn, when the DPS Policy was issued, "the Services indicated that the ESU Policy for Pacific salmon was consistent with the DPS Policy and that NMFS would continue to use the ESU Policy for Pacific salmon."[48]

B. Limitations of DPSs and ESUs

An ESU is a DPS applied specifically and solely to Pacific salmon stocks in the context of ESA listing reviews. The allowable use by the Services of DPSs and, by extension, ESUs, is not unlimited, however. The phrase "distinct population segment" was added to the ESA definition of "species" in 1978. There is little discussion specific to this addition at the time[49] but a Senate Report discussed concerns about the addition, stating that "there may be instances in which [the Services] should provide for different levels of protection for populations of the same species."[50] However, the report went on to caution that "the committee is aware of the great potential for abuse of this authority and expects the [Services to] use the ability to list [distinct] populations sparingly and only when the biological evidence indicates that such action is warranted."[51]

Accordingly, unless the biological evidence suggests a need to provide different levels of protection—through ESA listing—to distinct populations of a species (i.e., DPSs or ESUs, in the case of Pacific salmon), there is no statutory direction or other need for the Services to seek out opportunities to designate multiple ESUs. To do so, as it appears NMFS is inclined to do for GOA Chinook, would violate the direction from Congress to use this designation "sparingly."

Although the phrase "distinct population segment" does appear in the statute as a listable entity, the ESU concept does not appear in the statute or regulations and is therefore strictly a creature of policy. Further, the criteria the Services developed to guide designation of ESUs and DPSs are policies, not regulations, and therefore potentially more subject to change under different

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[45] DPS Policy, 61 Fed. Reg. 4722 (February 7, 1996).
[46] Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon, 56 Fed. Reg. 58612 (November 20, 1991).
[47] 88 Fed. Reg. 85179 (December 7, 2023).
[48] *Id.* at 81579.
[49] M-37018, Solicitor's Memo to the Director of the U.S. Fish and Wildlife Service, re: U.S. Fish and Wildlife Service Authority under Section 4(c)(1) of the Endangered Species Act to Revise Lists of Endangered and Threatened Species to "Reflect Recent Determinations," December 12, 2008.
[50] S. REP. No. 96-151 (May 15, 1979).
[51] *Id.*

administrations. If there is any doubt in how the concept should be applied, the Services should defer to the statute, Congressional intent, and regulations, not agency-created policies.

C. ESU Criteria May Not Be Fully Applicable to Alaska Chinook Stocks

The ESU criteria were developed for Chinook stocks in the Pacific Northwest in 1991 with no regard to potential future application in Alaska. The Pacific Northwest and Alaska have been subject to quite different geological histories and geophysical forces, a difference that likely influences the degree of reproductive isolation among stocks between the two regions. For example, the Pacific Northwest region is and has been largely deglaciated for 10,000 or more years, whereas the GOA region contains numerous glaciers and icefields that have expanded and contracted frequently over the last several millennia (see Appendix A). The Pacific Northwest was ice free far earlier than currently ice-free areas in Alaska, allowing for more differentiation among salmon stocks in the Pacific Northwest. Alaska is also more geologically active, with a high frequency of earthquakes, volcanism, tsunamis, and catastrophic landslides, and continues to demonstrate patterns of glacial advancement and recession. Combined, these frequent disturbances and environmental changes influence patterns of salmon recolonization and straying. As a result, spawning salmon stocks in Alaska are less differentiated than in the Pacific Northwest and exhibit more uniform life history patterns. Consequently, it is entirely possible, given the regional differences between the Pacific Northwest and GOA stocks, that a strict interpretation of the ESU criteria as applied to the highly differentiated stocks in the Pacific Northwest may not be directly applicable to spawning stocks in Alaska systems.

D. NMFS Should Evaluate Only the Single ESU Described in the Petition

There is no need for NMFS to pre-emptively designate ESUs for GOA populations as part of this review using an untested model that may not be appropriate for stocks in this region. Multiple other, well-established means exist by which to manage individual salmon populations, such as designation of stocks. The Service may designate a population as an ESU without listing it even if the newly designated ESU does not meet the definition of a threatened or endangered species under the ESA. But for NMFS to take the path of designating one or more ESUs in the GOA—simply because a poorly supported petition requests it—for a population that is not currently in danger of extinction and does not warrant listing, would be a misapplication of the ESA.

As discussed in more detail below, the regulations require petitioners to a) specify which “species” they seek the Service to list and b) to provide evidence demonstrating that the population they want listed would qualify as a listable entity under the ESA.[52] Although the petition clearly requests listing of GOA Chinook salmon, any portion of the population that

[52] *See* 50 C.F.R. § 414.24(c).

meets the ESU criteria would be treated separately in a listing review. Regarding whether the population they want listed would qualify as a listable entity, the "evidence" provided by the petition falls far short of the "substantial information" standard required by the regulations for a positive 90-day finding, although NMFS disregarded that major shortcoming.

Importantly, with respect to potential ESUs, the petition only specified one ESU of Alaska Chinook in their petition and only provided an unsupported assertion for that ESU. Therefore, NMFS should not have accepted the petition in the first place, as outlined above. Since NMFS has incorrectly come to a positive 90-day finding, the agency should only consider whether that single proposed ESU indeed meets the ESU criteria. One line of reasoning as to why GOA Chinook may not constitute an ESU is that the GOA region has only relatively recently become deglaciated, with evidence that Chinook salmon colonized the region from both the north and the south. In terms of evolutionary history, the region may not contain significant evolutionary differences. Rather, the genetic makeup of the region may simply be the heritage of colonization, combined with genetic isolation by distance. If the ESU the WFC proposed is not in fact a listable entity, then the status review for GOA Chinook should end there. If the weight of evidence indicates that the GOA Chinook ESU proposed by WFC meets the criteria for a listable entity, then NMFS should only proceed with a status review of the single GOA Chinook ESU.

Since the WFC petition did not specify any other ESUs, NMFS should not proceed with analyses to identify additional ESUs. To do otherwise would run counter to both the petition regulations and Congressional direction to use DPSs sparingly. However, if NMFS were to proceed with an inappropriate analysis of multiple ESUs, then it should use the best available scientific information—which ADF&G has provided in Appendix A, as well as directly to the Status Review Team.

E. It is likely that only one ESU, if any, exists in the GOA

Waples (1991)[53] and the NMFS ESU Policy[54] defined an ESU as a population or group of populations that 1) is substantially reproductively isolated from conspecific populations, and 2) represents an important component in the evolutionary legacy of the species. The former is typically quantified using data from putatively neutral genetic markers, but the latter is more difficult to evaluate directly, and typically relies on information such as morphology, behavior, life history, or ecological features of habitats to serve as proxies for adaptive differences. In some cases, genomic data are available to examine adaptive variation; however, genomic data and data from adaptive loci are rare in Alaska or limited in geographic scope. Because of the need to rely on proxies when evaluating evolutionary legacy, this definition is more difficult to

[53] Waples, R.S. 1991. Pacific salmon, *Oncorhynchus* spp., and the definition of "species" under the Endangered Species Act Mar. Fish. Rev., 53 (1991), pp. 11-22.
[54] Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon, 56 Fed. Reg. 58612 (November 20, 1991).

delineate. There is no definition for what constitutes an “important component” of an evolutionary legacy that we are aware of. Further, in many cases, proxy information is missing, making it difficult to reach objective decisions. Where data are available, it may be difficult to interpret how these differences relate to the evolutionary significance of a species. Where clear evidence on evolutionarily important differences between groups is lacking, Waples (1991) suggests that the size of ESUs should be defined more comprehensively broad.

No clear and objective methodology exists to define an ESU, and the inherent flexibility of the definition lends itself to ambiguity. Previous ESU designations in the Pacific Northwest relied heavily on life history and run timing diversity to help define units. Chinook salmon in Alaska are less likely to display large temporal differences in run timing that may act as barriers to gene flow. In the GOA, appellations like “early run” and “late run” are used to describe spawning components of the same population (e.g., tributary and mainstem spawners), with the peak river entry of each component less than a month apart and with considerable overlap. Similarly, reliance on life history is less definitive in GOA populations. In addition, many designations have used sharp genetic transitions associated with geographic features to define ESUs[55]. While there are geographic components to the structure of Chinook salmon in the GOA, it is not clear how this reflects historical conditions or future evolutionary potential. Lastly, because the GOA has been more recently deglaciated and colonized than most of the species’ range, the landscape is active and unsettled, and physical barriers to gene flow come and go (sometimes catastrophically) on short timescales. As a result, the genetic structure is more shallow and less complex compared to the Pacific Northwest.

Considering (1) the limited life history, ecological, and genetic diversity of GOA stocks, and (2) that geologic history, active disturbance regimes, and the climate limit the opportunity for population diversification through episodic displacement and recolonization, it is likely that only one ESU, if any, exists in the GOA. Given the lack of cogent reasons to consider GOA Chinook populations to be at risk, the potential downstream effects on continued sustainable management, and the existing congressional direction to use the ESU concept sparingly, if the Service continues to pursue the designation of ESUs, at most, a single ESU encompassing all GOA Chinook salmon is all that may be appropriate.

The notion that more than one ESU exists in the GOA simply because the area is geographically broader than the area that encompasses an ESU in the Pacific Northwest is presumptive and inappropriate. Additional ESU designations may meet the genetic reproductive isolation criteria for designating an ESU, but it is not clear that these units contribute substantially to the ecological and genetic diversity of the species. While conclusions could be drawn to support

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[55] Waples, R. S. 1995. Evolutionarily significant units and the conservation of biological diversity under the Endangered Species Act. Pages 8–27 in J. L. Nielsen, editor. Evolution and the aquatic ecosystem: defining unique units in population conservation. Symposium 17. American Fisheries Society, Bethesda, Maryland. Waples, R. S., R. G. Gustafson, L. A. Weitkamp, J. M. Myers, O. W. Johnson, P. J. Busby, J. J. Hard, G. J. Bryant, F. W. Waknitz, K. Nelly, and D. Teel. 2001. Characterizing diversity in salmon from the Pacific Northwest. Journal of Fish Biology, 59, pp.1-41.

additional ESU designations given the inherent subjectivity of NMFS policy guidance, the uncertainty of how these units are evolutionarily significant begs the question of whether they should be ESUs.

If NMFS does ultimately issue a proposed listing for any Alaska ESUs the agency might designate, we request a detailed explanation of the biological and conservation rationale for a proposal that differs from a single GOA ESU. Specifically, we request that NMFS document the "overriding conservation benefit to the species" that warranted an ESU analysis, as provided by agency guidance.[56]

III. GOA Chinook salmon are not threatened or endangered with extinction

While there has been a downturn in the productivity of many of the GOA Chinook stocks, the abundance of those stocks is not at a level where their long-term viability is at all compromised, much less the entire population of GOA Chinook salmon. None of the five threat factors considered in a listing determination is a significant threat to GOA Chinook salmon.

A. Productivity of Chinook stocks is cyclical; the downturn in productivity is not indicative of GOA Chinook being threatened or endangered with extinction

The ESA is an inappropriate tool to address a downturn in Chinook productivity. This is because a downturn in productivity is not indicative of a stock or a broader ESU being below an abundance threshold where the ability of the stock or an ESU to sustain itself is compromised. The mistaken idea that the current downturn in Chinook productivity is a threat to the conservation of GOA Chinook has been focused on missed escapement goals in ADF&G salmon management. As both NMFS and the WFC inappropriately utilized missed escapement goals in State of Alaska fisheries management as an indicator that the GOA Chinook population may be in jeopardy, it is necessary for us to provide information on and explain our fisheries management and why missed escapement goals are not an indicator of jeopardy for GOA Chinook. This issue should be obvious to NMFS, because NMFS manages many fisheries using a similar construct. That NMFS missed this would be ludicrous if it were not for the fact that the mistake would likely cause considerable economic impacts and costs to fishermen, conservation, and the State of Alaska.

Sustainable management is a bedrock concept enshrined in the State of Alaska Constitution. When Alaska assumed management authority of its salmon fisheries in 1960, one year after statehood, many of the state's salmon runs were depressed and its salmon fisheries were in

[56] Service Guidance at 6.

desperate shape. Alaska's first Governor, William Egan, stated in 1960 that the newly created Department of Fish and Game "was handed the depleted remnant of what was once a rich and prolific fishery." Alaska rebuilt salmon runs from abundances that were far lower than they are today, which is a profound example of the resilience of these stocks and the sustainable management practices that have been praised around the world.

ADF&G management is designed to protect the long-term productivity of salmon stocks when productivity is low. It is important not to confuse Alaska's salmon escapement goals with limit reference points or missing an escapement goal as an indication of a stock reaching a point of conservation concern. Alaska prioritized spawning escapement as the central tenet of sustained-yield salmon fisheries management and decision making. Escapement goals are based on the maximum sustained yield (MSY) concept and are not a metric of abundance to maintain a viable population. Failing to meet escapement goals is not evidence that stocks are at risk of extinction. In contrast to that notion, the escapement goals, paired with painful restrictions in fisheries that are implemented when an escapement is not met regularly, are the results of robust and responsive fishery management that provides for long-term sustained yield. Alaska's salmon management was designed, and is carried out, to avoid the health of stocks ever being jeopardized again like they were under pre-statehood federal management.

Alaska's salmon escapement goal-based management framework is precautionary by design because escapement goals are set based on providing for sustainable yield, well above levels of escapement at which reproductive capacity would be impaired. Thus, escapement goals based on an MSY management approach are not an appropriate metric for assessing extinction risk. Escapement goal management is designed to avoid the situation of very low escapements. We do not currently have the empirical information needed to develop a critical stock threshold, below which the ability of the salmon stock to sustain itself is compromised, because we do not drive stock abundance low enough to identify that threshold level. We provide considerable evidence in Appendix A on GOA Chinook stocks to demonstrate that GOA Chinook are not at the low levels where the potential for extinction becomes a concern.

GOA Chinook stock escapements have been declining, which ADF&G has monitored and documented as a part of good management. The declines are consistent with ocean regime shifts and are similar to past observations in the 1960's and early 1970's, which stocks rebounded from. Recruits produced per spawner is an appropriate indicator of productivity and population viability, where a value less than 1 in a given year would indicate that brood year abundance failed to replace itself with successfully returning offspring. Persistent, prolonged periods of failures of a stock to replace itself, despite management intervention to reduce or eliminate harvest, would indicate potential issues with population viability. Collecting recruits per spawner data is labor intensive and not available for all stocks. Based on the information available, while productivity has declined to levels where harvest is restricted in some stocks, there is little to no evidence to support the contention that decreases in productivity are sufficient to threaten GOA Chinook with extinction now or in the foreseeable future (see Appendix A).

We are surprised and disappointed NMFS would use MSY-based escapement goals as a metric for assessing extinction risk because NMFS manages federal fisheries under the Magnuson Stevens Act (MSA) using MSY based goals (i.e., status determination criteria). When fisheries managed by NMFS miss MSY goals, which are analogous to Alaska's salmon escapement goals, NMFS does not consider those stocks at risk of extinction and does not proceed with a species status review under the ESA. For example, NMFS identified nearly 50 stocks in 2023 that were considered overfished. NMFS defines an overfished stock as "[a] stock having a population size that is too low and that jeopardizes the stock's ability to produce its MSY," and NMFS recognizes that population sizes can be reduced by factors other than overfishing.[57] NMFS does not use missing these MSY goals as the impetus to conduct ESA status reviews.

Further and even more baffling, applying NMFS's metrics under the MSA, GOA Chinook salmon fisheries are not even considered overfished. The Salmon Fishery Management Plan (FMP) for the Economic Exclusive Zone off Alaska,[58] that NMFS is party to, identifies a minimum stock size threshold (MSST) for salmon that determines whether a stock is overfished and provides measures for southeast Alaska and Cook Inlet Chinook stock groups. Both assessed groups are above MSST and are therefore not considered overfished by NMFS. The Salmon FMP also incorporates escapement-based management goals with the recognition that missed escapement goals do not equate to an overfished stock. Either NMFS is using a double standard, or it should recognize that it made a mistake in using missed MSY goals as a metric for assessing extinction risk and withdraw the positive 90-day finding on the GOA Chinook salmon petition.

B. Size-at-age is not an extinction risk indicator for GOA Chinook

The second line of evidence NMFS used as justification for issuing a positive 90-day finding was decreasing size and age at maturity, though neither the petition nor the 90-day finding present a clear rationale for how a decline in size at age at maturity would cause GOA Chinook to be threatened or endangered now or in the foreseeable future. Declines in size and age at maturity do not indicate extinction risk. GOA Chinook populations with the greatest declines in age and size at maturity are not those with the greatest declines in productivity, and declines in body size do not necessarily mean a reduction in reproductive output of a stock (see Appendix A).

There have been observed declines in size and age at maturity in Chinook stocks, though these declines are widely variable among stocks. The state has adequate regulatory mechanisms in

[57] https://www.fisheries.noaa.gov/national/sustainable-fisheries/status-stocks-2023 *accessed 9/3/2024*
[58] NPFMC. 2021. Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska. North Pacific Fishery Management Council, Anchorage, Alaska. 67 p. https://www.npfmc.org/wp-content/PDFdocuments/fmp/Salmon/SalmonFMP.pdf.

place to provide for the continued viability of these stocks. Alaska's precautionary policies dictate that the state take actions to provide for sustained yield such as increasing escapement goals, decreasing mesh size in gillnet fisheries, and adjusting slot limits for sport fisheries.

C. Information pertinent to the ESA Section 4 five threat factors

(1) GOA Chinook habitat is abundant, healthy, and largely undeveloped.

Freshwater habitat is relatively pristine for most major GOA Chinook-producing watersheds. This is contrary to assertions in the WFC petition and in striking contrast to the considerable habitat degradation in the Pacific Northwest. Alaska's freshwater and marine habitats remain largely intact.

Unlike lower latitudes where dams blocking fish passage, water diversions, pollution, and large-scale urbanization have played a major role in the viability of salmonid populations, human alteration of habitat is much less pervasive and widespread in Alaska owing to the remoteness and ruggedness of the Alaskan landscape, the low population density, and the expansive network of state and federal parks, preserves, and refuges. The Anchorage watershed is the only GOA Chinook watershed that has relatively high levels of development. While there are Chinook that spawn and rear within the Anchorage watershed, there are no major Chinook bearing rivers within it.

(2) GOA Chinook salmon stocks are not being overharvested and are not overfished

Most of the GOA Chinook harvest occurs in directed commercial fisheries, with sport fisheries accounting for most of the remaining harvest. Subsistence fisheries and bycatch in state and federally managed fisheries account for only a small fraction of the total GOA Chinook harvest. The vast majority of the directed Chinook catch occurs in southeast Alaska, which is managed consistent with the terms and conditions of the Pacific Salmon Treaty.

Chinook harvests in GOA fisheries are far lower than they were historically. Harvests under federal management were generally high from the 1920s through early 1950s, with a peak at nearly 1 million Chinook harvested in 1937. Harvests have generally been lower since the state assumed management in 1960, with total Chinook harvest ranging from 800,000 in 2004 to just under 300,000 in 2018 for all GOA fisheries. Marine salmon fisheries in the GOA are diverse and encounter a mixture of stocks, with some that spawn within the GOA and some that originate outside of GOA. Therefore, this total harvest information is a combination of harvest of fish from within and outside of the GOA region. It is not an estimate of total harvest of GOA origin stocks.

Individual GOA Chinook stocks have only been below proxies for conservation limit reference points occasionally in the past 50 years (see Appendix A). While as explained above as well as in Appendix A, ADF&G has not established sustained escapement thresholds (SETs)[59] below which the ability of the salmon stock to sustain itself are compromised. However, using proxies for such limit reference points that other agencies and organizations have proposed demonstrate that GOA Chinook are not overfished. A potential proxy is the MSST as defined in the Salmon FMP,[60] which identifies that neither southeast Alaska Chinook nor Cook Inlet stocks should be considered overfished.[61]

The Marine Stewardship Council (MSC) has identified a proxy value for sustainability as 50% of the lower bound of the escapement goal range.[62] Unlike NMFS, MSC recognized that the level of escapement that results in significant reproductive impairment is substantially lower than Alaska salmon escapement goal ranges. Only a small portion of GOA Chinook stocks have been below this proxy threshold, and individual stocks that have dipped below that threshold have typically only done so for a single year or two consecutive years (see Appendix A). Our use of this metric is conservative for an ESA evaluation, because the evaluation was at the individual stock scale rather than at an ESU level that will combines multiple, many, or all GOA Chinook stocks. Using proxies for SETs, overfishing is not occurring on GOA Chinook salmon, and they are not overfished.

The WFC petition's assertion that "reduced recreational harvest in 2021 relative to harvest levels in 2005 and 2006 indicates overharvest by the recreational sector" amounts to a cherry-picking of evidence to support a forgone conclusion and is not a balanced representation of the relevant facts as required by regulation and NMFS guidance.[63] The general trend of decreased harvest in the sport fishery in recent years reflects the decline in Chinook productivity and management actions to restrict harvest. Additionally, non-resident sport harvest levels in 2020 and 2021 were heavily impacted by travel restrictions from the COVID pandemic.

(3) Disease is not threatening GOA Chinook salmon

Alaska has a world-class fish health and pathology program along with the regulatory and monitoring structures to identify threats and prevent disease transmission. WFC's assertion that "diseases originating in hatcheries (e.g., furunculosis, piscine reovirus, bacterial gill disease and kidney disease) have been transmitted to wild populations, driving mortality of all life stages of

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[59] 5 AAC 39.222. Policy for the management of sustainable salmon fisheries

[60] NPFMC. 2021. Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska. North Pacific Fishery Management Council, Anchorage, Alaska. 67 p. https://www.npfmc.org/wp-content/PDFdocuments/fmp/Salmon/SalmonFMP.pdf.

[61] https://www.fisheries.noaa.gov/national/sustainable-fisheries/status-stocks-2023 *accessed 9/3/2024*

[62] MRAG Americas, Inc. 2019. Marine Stewardship Council 3rd Reassessment Report for the Alaska Salmon Fishery. Public Certification Report. St. Petersburg, FL.

[63] 50 CFR § 424.14(d)

GOA Chinook salmon" is false. This statement appears to be written from a Pacific Northwest lens as most of the practices listed as concerning do not occur in Alaska. There has been no evidence that disease has negatively affected the sustainability of any wild or cultured Chinook salmon stocks in the GOA (see Appendix A).

(4) Predation on salmon occurs naturally but there is not evidence of predation being a threat to the sustainability of GOA Chinook salmon

Predation on salmon at all life stages naturally occurs in both freshwater and marine environments, because salmon are an integral part of the food web. The primary concern for GOA Chinook stocks in freshwater is invasive northern pike, which affect two tributaries of the Susitna River. There is no evidence of conservation concerns to GOA Chinook stocks caused by marine predation.

Northern Cook Inlet (NCI) is the only location in the GOA where the agents of freshwater predation have changed for Chinook salmon in historical times. Among the many factors influencing Chinook salmon abundance in northern Cook Inlet drainages is the presence of northern pike, which are an invasive species to Southcentral Alaska. Predation pressure from northern pike on juvenile Chinook is a driving factor of spawning populations in Alexander Creek and the Deshka River, tributaries of the Susitna River. ADF&G initiated an invasive northern pike suppression program in 2011 to reduce impacts, which has removed 10s of thousands of pike from these tributaries. Predation by invasive pike is being managed and is only a conservation issue for Chinook spawning populations within these two Susitna River drainages (see Appendix A).

There is no direct evidence that marine predatory impacts on salmon are acting outside of normal ecosystem dynamics and imperiling the long-term existence of GOA Chinook salmon populations. Predation is a known natural cause of mortality for salmon in marine waters and includes predation by marine mammals, fish, and sea birds. Marine predation can occur on all marine life stages. Unfortunately, direct measurements of predator-prey interactions at sea are practically impossible, and quantifying predator-prey interactions through modeling will always have some uncertainty and depend on the validity of assumptions. However, the assertions by WFC of marine mammal predation-driven conservation concerns for GOA Chinook salmon are largely unsupported and unlikely to be true (see Appendix A). For example, WFC raised concerns about humpback whale predation on hatchery fish releases, but that has no bearing on the humpback whale feeding on wild juvenile Chinook salmon which have a diffuse distribution at that life stage.

WFC bases their assumption of increased marine mammal predation pressure on Chinook salmon by asserting that marine mammal abundances are increasing. However, current range-wide estimates of marine mammals are not available as NMFS has not dedicated the funding to obtain consistent counts. Based on localized surveys, numbers for humpback whales have declined, as have localized counts of Steller sea lions and harbor seals (which have the biggest impact to Chinook biomass). For killer whales in the GOA, attempts to model predation effects by killer whales can only explore the potential for size-selective predation on Chinook salmon age and size at maturity. Caution is warranted when interpreting such models, given the large uncertainties from lack of data and untested assumptions. With the limited data available, localized regional counts from Alaska, and the lack of environmental inputs, pointing to marine mammals in Alaska as a driver of Chinook declines cannot be supported.

(5) Chinook salmon in Alaska are managed under a complex and comprehensive regulatory framework that has never led to a GOA Chinook salmon stock being categorized as a Stock of Conservation Concern

The State of Alaska manages all salmon stocks based on the sustained yield principle as promulgated in Article VIII, Section 4 of the Alaska Constitution and in state statute.[64] Policies are in place for the management of fisheries, hatcheries, habitat, and water quality.

i. World renowned fishery management

Chief among the policies guiding salmon management are the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP)[65] and the *Policy for Statewide Salmon Escapement Goals*[66] which specify the processes for setting escapement goals and the conservation actions to be taken when yield expectations and escapement goals are not met. When a stock is not projected to meet its escapement goal, management actions are taken to reduce fisheries as required under the SSFP.

Many fisheries have been reduced or closed altogether in response to declines in Chinook abundance, and in some cases, non-target fisheries have been restricted (e.g., sockeye) to protect wild Chinook stocks. The Board of Fisheries and ADF&G have reduced Chinook exploitation rates substantially in recent years. These actions have resulted in fishery closures, reduced fishing time and effort, and have impacted fisheries targeting other species that incidentally catch Chinook. Alaskans endure cultural and economic impacts during productivity downturns to ensure the long-term health and productivity of salmon stocks. Timely reductions in fishing pressure in response to downturns in productivity are indicators of Alaska's strong and responsive management approach to ensure the long-term health of subsistence, commercial, and recreational fisheries, rather than evidence of salmon stocks potentially going extinct. ADF&G is concerned about the decline in escapements; we are empathetic to the considerable social and

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[64] AS 16.05.020
[65] 5 AAC 39.222
[66] 5 AAC 39.223

economic impacts of fishery closures that come from good management. But we implement good management, because it protects the health of fish stocks and is less socially and economically impactful in the long run.

The status of each GOA Chinook stock is assessed triennially. When harvests are consistently below expectations, the Alaska Board of Fisheries is required to designate the stock as having "yield concern" and the board establishes an action plan with protective management measures to rebuild the stock to achieve sustainable levels of maximum yield. If the stock consistently fails to meet escapement goals over a 4 to 5-year period, it is designated as a "management concern" and a rebuilding plan is put in place.

If a Chinook stock's returns were to fall to levels where there was a concern about extirpation it would be designated a "conservation concern," defined in the SSFP as a stock for which there is "a concern arising from a chronic inability, despite the use of specific management measures, to maintain escapements for a stock above a sustained escapement threshold (SET)."[67] As strong conservation measures are mandated by the SSFP well before conservation concerns arise, no SETs – a threshold level of escapement below which the ability of the salmon stock to sustain itself is jeopardized – have been established. The sustainability of Alaska's salmon management has been recognized by others. For example, Alaska salmon was one of the first fisheries the Marine Stewardship Council certified as being sustainable,[68] which some in retrospect considered as "low hanging fruit"[69] because the fisheries were clearly sustainable.

As provided above and in Appendix A, Alaska Chinook stocks are not at risk of extinction when they are listed as a Stock of Concern under the SSFP. A failure to provide for <u>yield</u> does not mean a stock is at risk of extinction now or in the foreseeable future. While there has been a general downward trend in Chinook salmon population abundances throughout most systems that enter the Gulf of Alaska (and range wide) beginning around 2007, the trend has not continued in all populations as asserted in the WFC petition. Twenty-one Alaska Chinook populations have been listed as stocks of concern. Of these, 6 have been delisted and another 3 of the remaining 15 stocks of management concern have met the criteria for delisting as of this writing and may be recommended for delisting in the upcoming 2024/2025 Board cycle.[70] The delisting of stocks that have been rebuilt is strong evidence that Alaska's policies and salmon management framework are effective at conserving wild salmon stocks and listing as threatened or endangered under the ESA is unwarranted.

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[67] 5 AAC 39.222.
[68] Chaffee, C. 2000. Certification report on commercial salmon fisheries in Alaska. Project Number SCS-MFCP-F-0003. Scientific Certification Systems, Inc., Oakland.
[69] Cheney, J. 2022. The MSC standard under review – where did it start and where is it going? Sustainable Fisheries UW. https://sustainablefisheries-uw.org/msc-standard-under-review/ *accessed 9/3/2024*
[70] ADF&G 2024 *In prep*

ii. Alaska's fisheries enhancement program prioritizes minimal impacts on wild stocks.

Alaska's fisheries enhancement program has been designed since its inception in the 1970s to protect wild salmon stocks (see Appendix A). The program is based on a review of the practices and results of salmon enhancement programs that existed in the Pacific Northwest, taking lessons from these to ensure the Alaska fisheries enhancement program minimizes risk to wild populations. A framework of statutes, regulations, policies, plans, and permits has been developed to guide the growth of the Alaska hatchery program with the intent to minimize risk to wild stocks. The SSFP requires a precautionary approach to artificial propagation of salmon.[71] ADF&G has adopted a genetic policy that sets restrictions and guidelines on hatcheries to protect wild stocks.[72] ADF&G also uses the *Alaska Fish Health and Disease Control Policy*[73] to review hatchery plans and permits to control and prevent the spread of infectious diseases in fish.

iii. Alaska Chinook salmon freshwater habitats are minimally impacted and extensively protected by state and federal regulations and cooperation with other entities.

As described above, freshwater GOA Chinook habitat is healthy and largely pristine. There is an array of State and Federal statutes and regulations that protect and maintain the quality of water bodies that support salmon and other species (see Appendix A). These statutes and regulations are strong protections to maintain the health of GOA Chinook freshwater habitat. They include protections to protect salmon spawning and rearing habitats, ensure fish passage, avoid impacts to anadromous waters from industrial activities, ensure adequate stream flow, maintain water quality, and prevent oil spills and other pollution in fish habitat.

(6) Chinook salmon are resilient to climate change

Accurately assessing whether a species is likely to become in danger of extinction within the foreseeable future requires accounting for uncertainty about what may happen in the future. To address issues like climate change in ESA decisions, the U.S. Fish and Wildlife Service (USFWS) uses an approach that identifies and considers the full plausible range of future factors affecting a species population size.[74] USFWS bases their approach on the fact that there is limited confidence in any single projection of a species' future condition. In contrast, NMFS deals with climate change by only using what the agency believes is the most likely climate

[71] 5 AAC 39.222(c)(5)
[72] Davis, B., B. Allee, D. Amend, B. Bachen, B. Davidson, T. Gharrett, S. Marshall, and A. Wertheimer. 1985. Genetic policy. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement, and Development, Juneau. https://www.adfg.alaska.gov/static/fishing/PDFs/research/genetics_finfish_policy.pdf
[73] 5 AAC 41.080
[74] USFWS. 2023. Guidance for developing future scenarios in species status assessments (SSAs). U.S. Fish and Wildlife Service, Ecological Services.

scenario for ESA decision making.[75] NMFS's approach is clearly flawed, because it neglects the considerable uncertainty in the assumptions it makes in identifying the most probable climate scenario. NMFS does not have data on whether its chosen climate scenario is more likely to occur than not, because there are not data available on the relative likelihood of each climate scenario. The GOA Chinook Status Review Team should utilize the more robust USFWS approach when considering climate change impacts. Regardless of the approach taken, all assumptions concerning the projected outcome of a species should be fully evaluated.

Climate change is affecting Alaska and the Gulf of Alaska, which will in turn affect the Chinook salmon that spawn within the region. Predicting how climate change will affect Chinook salmon is complex, because there are multiple pathways through which it can occur. Those pathways may be beneficial, neutral, or unfavorable to GOA Chinook, and may also vary across the broad expanse of the Gulf of Alaska as well as through time. Two of the primary ways we anticipate GOA Chinook will be impacted by climate change are through glacial retreat and fluctuations in ocean productivity (see Appendix A). Glacial retreat can provide benefits to GOA Chinook salmon by opening up habitat and increasing productivity. However, glacial retreat can also have negative impacts due to decreased water flow and increased water temperatures.[76]

Chinook within the GOA have considerable resilience and adaptive potential, which needs to be factored in when considering how climate change will affect populations over multiple generations of fish (see Appendix A). GOA Chinook salmon have thrived in and continue to thrive in a dynamic environment, indicating population resilience that needs to be considered when assessing potential climate change impacts. The GOA region has been and continues to be a highly dynamic environment, with large fluctuations in glaciation and marine productivity that Chinook salmon have weathered for centuries and millennia. GOA Chinook salmon have high adaptive potential with intraspecific variation in spawning areas, age at maturity, and other phenotypic traits that buffer their populations by spreading risk from impacts across space and time.

(7) Chinook salmon hatchery production in GOA minimizes risks to wild Chinook stocks

Alaska's salmon hatchery program was developed and designed to supplement—not replace—sustainable natural production (see Appendix A). Hatchery programs must operate without adversely affecting natural stocks of fish in the state[77] and under a policy of management which

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[75] NMFS. 2023. Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions. National Marine Fisheries Service Procedure 02-110-18, Protected Resources Management. Conservation of Threatened and Endangered Species 02-110.

[76] Pitman, K. J., J. W. Moore, M. R. Sloat, A. H. Beaudreau, A. L. Bidlack, R. E. Brenner, E. W. Hood, G. R. Pess, N. J. Mantua, A. M. Milner, V. Radic, G. H. Reeves, D. E. Schindler, and D. C. Whited. 2020. Glacier Retreat and Pacific Salmon. BioScience 70: 220-236.

[77] AS 16.05.730

allows reasonable segregation of returning hatchery-reared salmon from naturally occurring stocks.[78] Per state policy, hatcheries generally use stocks taken close to the hatchery so that any straying of hatchery returns will have similar genetic makeup as the stocks from nearby streams. Also, per state policy, Alaska hatcheries do not selectively breed stocks. Large numbers of broodstock are used for gamete collection to maintain genetic diversity, without regard to size or other characteristics. Chinook salmon hatchery production levels are relatively small in Alaska (compared to the Pacific Northwest), with less than 10 million smolt released annually on average for the purpose of augmenting fishing opportunity. Most of that production is released as smolt in saltwater (76%) with limited freshwater releases (24%).

Southeast Alaska hatchery sites, remote release sites, and broodstock sources were carefully selected to minimize the potential for returning hatchery stocks to mix with wild stocks. All southeast Alaska Chinook salmon broodstock has been locally sourced. With few exceptions, Chinook salmon hatcheries are located on islands at or near tidewater and away from any endemic stock. Comprehensive enhancement plans document enhancement efforts, set production goals, identify potential for new projects, and are required by law.[79] The Southeast Alaska Chinook Salmon Plan delineates sensitive and nonsensitive zones for stock selection and transport considerations based on the potential to affect wild stocks. Studies estimating straying of hatchery fish indicate that it is generally low with under 1% of all rivers and years except for one river.[80]

Whereas southeast Alaska hatchery production is designed to augment both commercial and sport fishing opportunities, hatchery production outside of southeast Alaska is focused on enhancing sport fishing opportunity in both fresh and salt water in selected areas of Prince William Sound, Resurrection Bay, Kachemak Bay, Cook Inlet, and Kodiak. Like southeast Alaska, most of these hatcheries are in areas far from wild stocks. However, there are a few important exceptions to this in Cook Inlet where extra precautions are taken to protect wild stocks (see Appendix A).

(8) It is unlikely marine competition is threatening the existence of GOA Chinook salmon stocks now or into the foreseeable future.

Competition for food is a normal part of ecosystem dynamics and some competition among generalist pelagic fish species, like salmon, is expected in a healthy and functioning ecosystem. The general concern raised by WFC is that hatchery releases, especially of pink and chum

[78] AS 16.10.420
[79] AS 16.10.375
[80] *See* Evenson, D. F., C. Habicht, M. Stopha, A. R. Munro, T. R. Meyers, and W. D. Templin. 2018. Salmon hatcheries in Alaska – A review of the implementation of plans, permits, and policies designed to provide protection for wild stocks. Alaska Department of Fish and Game, Special Publication No. 18-12, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/SP18-12.pdf.

salmon, are depleting prey resources for Chinook salmon. There is considerable debate in the scientific literature on the issue, because competition among salmonids at sea is a topic where no definitive scientific measurement is available (reviewed in Appendix A). However, the argument that interspecific salmonid competition at sea is a threat to GOA Chinook salmon is tenuous, because even with what WFC describes as "massive release of hatchery pink and chum salmon," salmonids only makeup a relatively small portion of the biomass of predatory fish in the GOA marine ecosystem. While salmon are very important to humans, their importance as predators in the marine food webs is relatively small when considering other species with similar diets such as pollock, cod, and herring, which have far larger biomasses.[81] As salmon have low biomass in the system, their potential for exerting strong competitive interactions is limited. The effects of bottom-up factors (e.g., temperature) in the marine environment are more consistently demonstrated to be important to the marine distribution and productivity of Pacific salmon than top-down factors like competition and predation.

Competition between salmonids is commonly proposed but is rarely resolved as a causative factor, because the dynamics of nearshore and pelagic marine food webs are complex due to the vast area and number of species involved. If competition among predatory fish is important and of equal impact among species, this would imply a relatively smaller contribution by competing salmonids. This makes salmonid abundance and fluctuations in that abundance unlikely drivers of changes in GOA Chinook salmon abundance and mature individual size. Contrasting correlations in population sizes between potential salmonid competitors and Chinook salmon may merely indicate differing adaption to changes in environmental conditions. Most studies asserting marine salmon competition use modeling and post hoc reasoning based on observed associations but do not take the additional necessary steps to test assumptions and apply causal model approaches.

IV. Conclusion

The information we provide here and in the accompanying Appendices demonstrates unequivocally that there is no need to list GOA Chinook, which are and will continue to be managed sustainably by ADF&G. No Alaska Chinook population segment meets the definition of a threatened or endangered species, now or in the foreseeable future. In addition, we have clearly documented that NMFS made substantial mistakes in coming to a positive 90-day finding on the WFC petition seeking to list GOA Chinook under the ESA. NMFS failed to follow the

[81] Aydin, K., Gaichas, S., Ortiz, I., Kinzey, D., and Friday, N. 2007. A comparison of the Bering Sea, Gulf of Alaska, and Aleutian Islands large marine ecosystems through food web modeling. U.S. Department of Commerce, Washington, D.C., NOAA Tech. Memo. NMFS-AFSC-178.

ESA regulations, as well as its own policies and guidance, in its review and evaluation of the WFC petition. Therefore, NMFS should withdraw this inappropriate positive 90-day finding.

Thank you for the opportunity to provide information for this status review. Concerns about the petition aside, we are committed to ensuring that NMFS has the best available scientific information as the agency proceeds with the status review. Even if NMFS is unwilling to withdraw their positive 90-day finding, we will continue to provide data and work with the agency to ensure NMFS has and uses the best available scientific and commercial information in the status review. Please let me know if you require further information or have any questions.

Sincerely,

Doug Vincent-Lang
Commissioner

Cc:
Honorable Lisa Murkowski–U.S. Senator for Alaska
Honorable Dan Sullivan–U.S. Senator for Alaska
Honorable Mary Sattler Peltola–House Representative for Alaska
Jerry Moses– Director of State & Federal Relations, Office of the Governor
Dani Evenson–Policy Advisor & Extended Jurisdiction Program Manager, Division of Commercial Fisheries
Bill Templin– Chief Fisheries Scientist, Division of Commercial Fisheries
Andrew Munro– Fisheries Scientist, Division of Commercial Fisheries
Chris Krenz–Wildlife Science Coordinator, Division of Wildlife Conservation
Moira Ingle–ESA Response Coordinator, Threatened, Endangered, and Diversity Program
Congressional Delegation

APPENDIX A

The State of Alaska, through the Alaska Department of Fish and Game (ADF&G), provides the following in response to the request for information in the National Marine Fisheries Services' (NMFS) 90-day finding on a Petition to List Gulf of Alaska Chinook Salmon as Threatened or Endangered Under the Endangered Species Act. To ensure that the Service has access to the best available scientific information on which to base its status assessment, we provide a summary of new, historical, and relevant information, presented in three sections: demographics, the five threats listed in ESA section 4(a)(1), and an analysis and proposed delineation of evolutionary significant units.

1.0 DEMOGRAPHICS

1.1 ESCAPEMENT

1.1.1 Escapement Assessment

Alaska Department of Fish and Game (ADF&G) uses indicator stocks to represent populations in proximate areas which reflect a minimum escapement for the general area. Alaska Chinook salmon spawn and rear in numerous rivers throughout southcentral and southeast Alaska (i.e., systems that drain into the Gulf of Alaska). Chinook have been recorded spawning (adults), rearing (juvenile), present, or in combination in nearly every hydrologic unit (HUC8) that drains into the Gulf of Alaska (Figure 1). Chinook have been recorded either spawning and/or rearing in over 700 unique water bodies (i.e. rivers, tributaries, etc.) or 86 river systems that drain into the Gulf of Alaska (Giefer 2024a, 2024b, 2024c). Rivers that support Chinook populations are widely distributed and vary in size and number of spawners. For example, the Copper River watershed is over 62,000 km^2 and averages 28,500 spawners (1999–2023) while in contrast the King Salmon River watershed drains an area of about 108 km^2, of which only 11 rkm is designated anadromous habitat, and supports an average 159 large spawners (1975–2023).

Since assuming management authority of Alaska's depleted salmon stocks from the federal government in 1960, Alaska adopted an escapement-based approach to management that stipulated the development and use of spawning escapement goals as the primary management targets for major stocks of salmon. Given the number and distribution of systems it is not possible to assess escapement to all river systems; therefore, a subset of systems is monitored and assessed for escapement. This subset of systems is used to not only manage salmon fisheries and assess the status of the system being monitored, but also as "indicator stocks" of the status of other populations in the same general area. Therefore, Chinook escapement estimates are a minimum for a larger geographic area. For example, there are 34 systems in Southeast Alaska (SEAK) that are known to support spawning populations of Chinook salmon and 11 are designated indicator stocks with escapement goals and are annually assessed (Figure 2).

It is important to note that escapement estimates **cannot** be directly compared to the harvest information provided in Section 2.1 Utilization. The reason for this is that escapement estimates for each system are stock-specific but, as noted above, are a minimum for a given area, whereas the harvest estimates are not stock-specific; several of the fisheries are mixed-stock fisheries and many contain a significant and unknown number of fish from outside the area of interest (i.e., outside the GOA, principally from Canada and the Pacific Northwest).

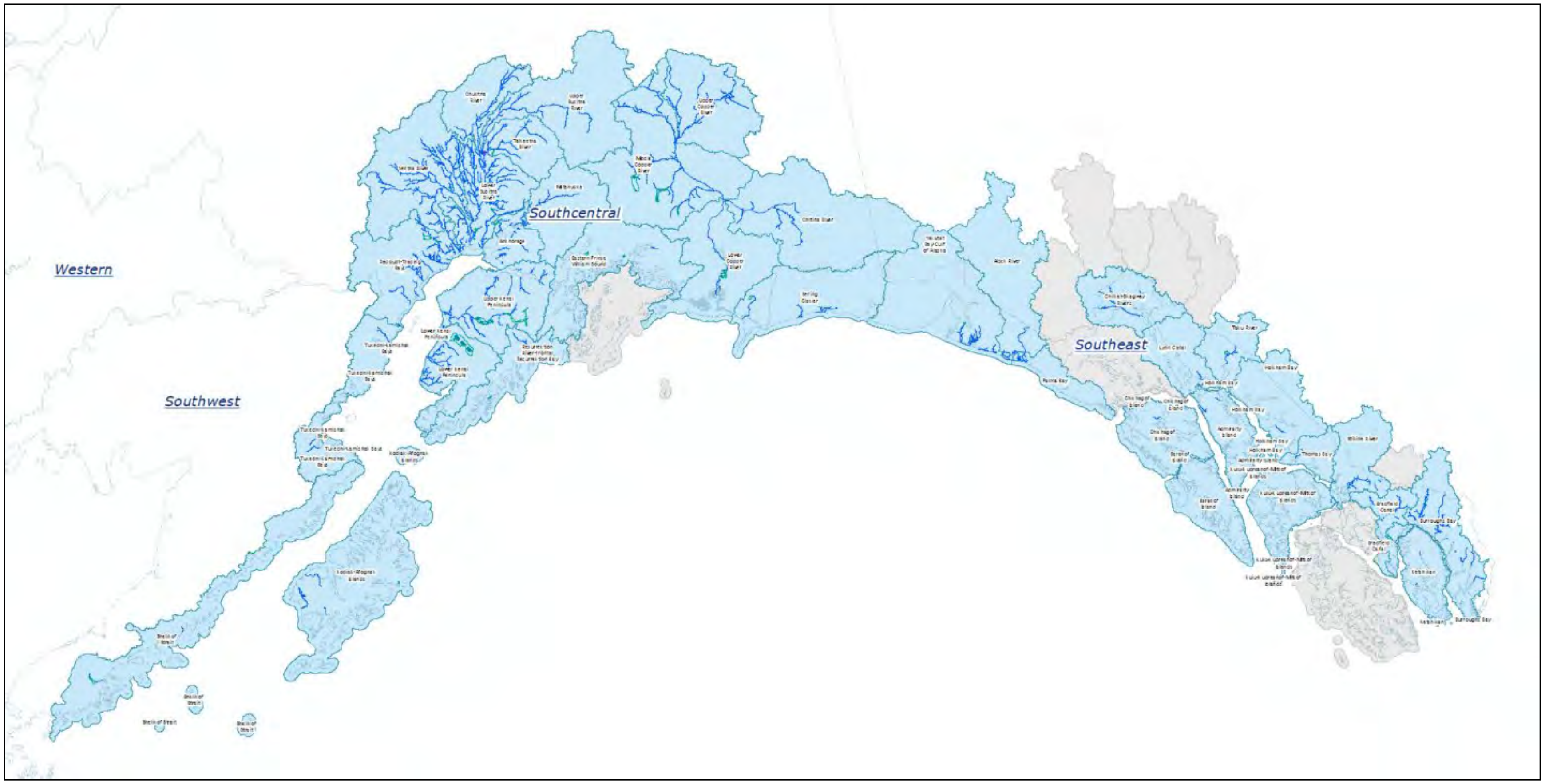

Figure 1.– *Hydrologic units (HUC8) with records of Chinook salmon present, spawning and/or rearing shaded in blue. Subbasins shaded grey do not have any reported Chinook salmon records (source: Anadromous Waters Catalog 2024).*

APPENDIX A

Figure 2.– *Identification of known Chinook salmon systems in Southeast Alaska. From Schultz et al., 2024 (Source: Kissner and Hubartt, 1986).*

Escapements of Chinook salmon are monitored and assessed in systems throughout the GOA. Escapement is usually estimated directly from run abundance in freshwater unless there are harvests upstream of where run abundance is measured. Escapement or inriver run may be enumerated directly with weirs (e.g., Karluk) or estimated from expanded tower or sonar counts (e.g., Kenai), expanded aerial survey counts (e.g., Chickamin, Blossom Keta, King Salmon), unexpanded aerial or foot survey index counts (e.g. Alexander, Campbell), mark-recapture experiments using external tags (e.g., Taku), or reconstructed using a statistical model of an index or indices of run size and formulations of how the index or indices relate to the total escapement or inriver run (e.g., Susitna River sub-basins). Age compositions (an important component for estimating run size) are estimated from scales taken from individual fish as samples during the run. While the State has used escapement-based management since assuming management of its salmon fisheries, the systems assessed and assessment methods have changed and evolved over time. Therefore, the lengths of continuous comparable time series of escapements vary from 11 to 50 years, with over 70% extending back to the late 1970s/early 1980s. It should be noted that these times series begin around the time, or shortly after, the last major North Pacific Ocean regime shift in 1977 where there was a shift from a period of low productivity to a period of higher productivity. Supplemental tables provided to NMFS contain continuous escapement estimates for each system based on the current assessment method. Currently, 31 systems or stock aggregates (e.g. Eastside Susitna River) are assessed regularly and have escapement goals that are used to manage and assess the status of Chinook salmon in this area (Table 1, Munro 2023).

1.1.2 Escapement Goals

Scientifically defensible escapement goals are set for yield and are well above abundances that would risk stock viability. Pacific salmon escapement goals are a central tenet of fisheries management in Alaska. Escapement goals for Alaska salmon stocks are founded in the **sustained yield** principle in the State of Alaska Constitution (Article VIII, Section 4) and in state statute (AS 16.05.730). More details on the policies, definitions, and responsibilities that pertain to escapement goals are provided in *Subsection 2.1.1.2 Escapement Goals*.

A variety of methods are used to develop escapement goals in Alaska, and brief descriptions of each are summarized in Munro (2023). For Chinook stocks that enter the GOA, spawner-recruit analyses based on the Ricker curve are the most common method used for developing escapement goals, followed by the percentile approach (Clark et al. 2014, 2017). The Little Susitna River has two escapement goals that use different escapement assessment methods (weir count vs. aerial survey) and the weir-based escapement goal is the primary escapement goal to be used if an escapement estimate is available. These two escapement goals use different units (count vs. index) so the time series are not interchangeable.

The Wild Fish Conservancy's petition is correct in noting that escapements have declined for most GOA Chinook populations assessed, but this is true throughout the entirety of their range (see NPAFC 2023). Since 2010, the Department has produced an annual report documenting the current salmon escapement goals, escapements and escapement performance throughout the state dating back to 2001, which is when the current Sustainable Salmon Fisheries and Escapement Goal policies were implemented (see Munro 2023, 2019, 2018, Munro and Brenner 2022, 2021, Munro and Volk 2017, 2016, 2015, 2014, 2013, 2012, 2011, 2010).

Table 1.– *List of current Gulf of Alaska Chinook salmon systems including escapement enumeration methods, escapement goal methods, escapement goal type, year that current goal was established or updated and escapement goal range. Adapted from Munro (2023).*

			2023 Escapement Goals				
Management Area	System	Enumeration Method	Goal Method	Goal Type	Initial Year	Lower	Upper
Southeast	Alsek River (age 4+)	Weir Count (Expanded)	SRA	BEG	2013	3,500	5,300
	Andrew Creek (lg. fish)	PAS (Expanded)[a]	SRA	BEG	1998	650	1,500
	Blossom River (lg. fish)	PAS (Expanded)	SRA	BEG	2018	500	1,400
	Chickamin River (lg. fish)	PAS (Expanded)	SRA	BEG	2018	2,150	4,300
	Chilkat River (age 5+)	Mark-Recapture	Theoretical SRA	BEG	2003	1,750	3,500
	Keta River (lg. fish)	PAS (Expanded)	SRA	BEG	2018	550	1,300
	King Salmon River (lg. fish)	PAS (Expanded)	SRA	BEG	1997	120	240
	Situk River (lg. fish)	Weir Count	SRA	BEG	2003	450	1,050
	Stikine River (lg. fish)	Mark-Recapture	SRA	BEG	2000	14,000	28,000
	Taku River (lg. fish)	Mark-Recapture	SRA	BEG	2009	19,000	36,000
	Unuk River (lg. fish)	PAS (Expanded)	SRA	BEG	2009	1,800	3,800
Upper Cook Inlet	Alexander Creek	Single Aerial Survey[b]	Percentile	SEG	2020	1,900	3,700
	Campbell Creek[c]	Single Foot Survey	Risk Analysis	LB SEG	2011	380	
	Chuitna River	Single Aerial Survey	Percentile	SEG	2020	1,000	1,500
	Chulitna River	Single Aerial Survey	Percentile	SEG	2020	1,200	2,900
	Crooked Creek	Weir Count	Percentile	SEG	2020	700	1,400
	Deshka River	Run Reconstruction	SRA	BEG	2020	9,000	18,000
	Eastside Susitna River	Run Reconstruction	SRA	BEG	2020	13,000	25,000
	Kenai R. - Early Run (lg. fish)	Sonar	SRA	SEG	2017	2,800	5,600
	Kenai R. - Late Run (lg. fish)	Sonar	SRA	SEG	2017	13,500	27,000
	Little Susitna River[d]	Single Aerial Survey	Percentile	SEG	2020	700	1,500
		Weir Count	Percentile	SEG	2017	2,100	4,300
	Talkeetna River	Run Reconstruction	SRA	SEG	2020	9,000	17,500
	Theodore River	Single Aerial Survey	Percentile	SEG	2020	500	1,000
	Yentna River	Run Reconstruction	SRA	SEG	2020	13,000	22,000
Lower Cook Inlet	Anchor River[e]	Sonar, Weir Count	SRA	SEG	2017	3,800	7,600
	Deep Creek	Single Aerial Survey	Percentile	LB SEG	2017	350	
	Ninilchik River[f]	Weir Count	Percentile	SEG	2017	750	1,300

Table 1.– *Page 2 of 2.*

			2023 Escapement Goals				
Management Area	System	Enumeration Method	Goal Method	Goal Type	Initial Year	Lower	Upper
Prince William Sound	Copper River	Mark-Recapture	SRA	SEG	2022	21,000	31,000
Chignik	Chignik River	Weir Count	SRA	BEG	2002	1,300	2,700
Kodiak	Ayakulik River	Weir Count	SRA	BEG	2017	4,800	8,400
	Karluk River	Weir Count	SRA	BEG	2011	3,000	6,000

Note: SRA = spawner-recruit analysis; PAS = peak aerial survey; BEG = biological escapement goal; SEG = sustainable escapement goal; LB SEG = lower-bound SEG.

[a] One or more aerial surveys are attempted during the peak of the run. Peak count is used to index the escapement.

[b] Single survey done around the time of presumed peak of the run with no expansion of counts.

[c] Campbell Creek escapement goal updated to LB SEG = 340 fish based on percentile approach for 2024 season.

[d] Little Susitna River Chinook salmon aerial survey goal is only used to assess escapement if weir count is not available.

[e] Anchor River escapement goal updated to SEG = 3,200-6,400 fish based on SRA for 2024 season.

[f] Ninilchik River escapement goal updated to SEG = 900-1,600 fish based on percentile approach for 2024 season.

The petition only provided escapement performance for select stocks and did not adequately characterize the variability among stocks in meeting their respective escapement goals. Supplementary tables with escapement estimates for all 31 GOA Chinook systems with escapement goals have been provided to NMFS. A standard metric for evaluating the performance of escapements for a species within a given management area or region is to examine the annual percentage of escapement goals met or exceeded (i.e. achieved). For GOA Chinook stocks, the percentage of escapement goals achieved declined from an average of 87% (2001–2007; range: 70–95%) to an average of 49% (2008–2023; range: 26–79%) after the downturn in productivity of Chinook salmon across their range (Figure 3). The patterns for GOA stocks reflect the broader pattern observed for all Alaska Chinook stocks (see Munro 2024).

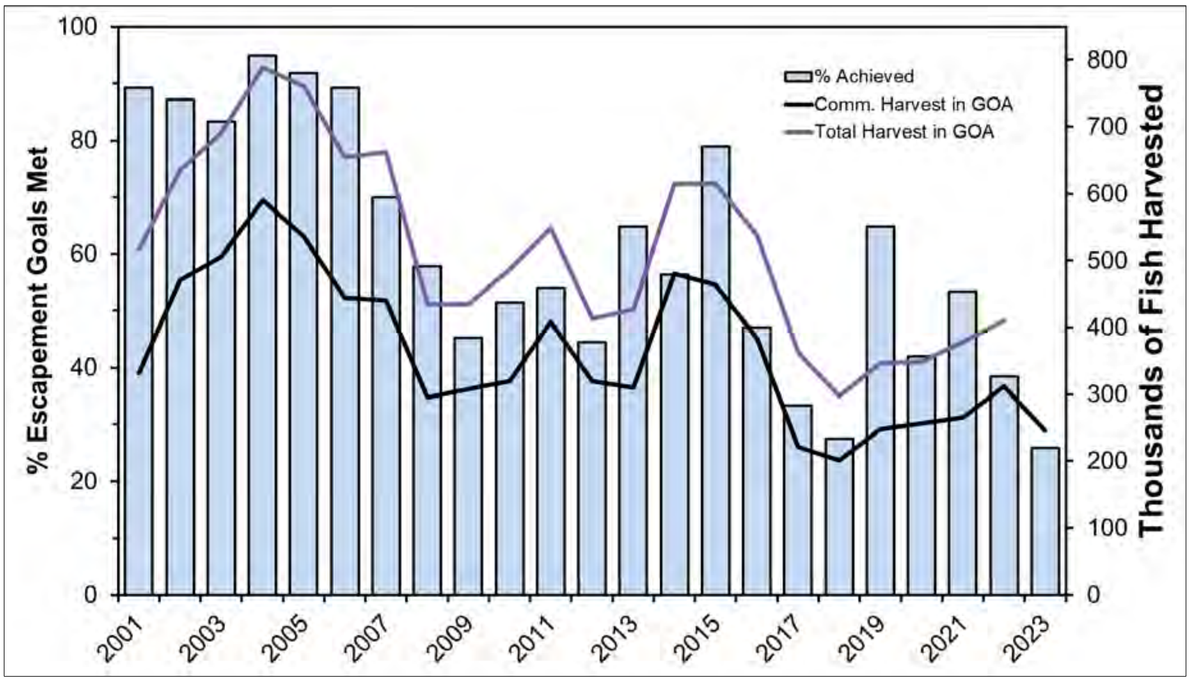

Figure 3.– *Percentage of escapement goals met for GOA Chinook stocks from 2001 (establishment of SSFP) to 2023 and trends in commercial and total Chinook (including bycatch) harvest in the Gulf of Alaska (includes unknown portion of non- Gulf of Alaska stocks). Note: 2023 sport, subsistence and personal use estimates are not available.*

The Department responded to this downturn in productivity with a commensurate and precautionary reduction in harvest of Chinook salmon (Figure 3; see *Subsection 2.1.1.5 Summary of Management Conservation Measures* and *Section 2.2.1 Harvest* for additional details). Harvest levels closely follow escapement goal performance (i.e. years with lower achievement of escapement goals also generally have lower harvest) with no discernable lag, which demonstrates the responsive management of commercial, sport, subsistence and personal use fisheries through the state and Treaty process.

An important difference between the Endangered Species Act (ESA) and the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP) that guides ADF&G's salmon management is the scale at which each is implemented. While the ESA concerns itself with species and Distinct Population Segments (DPS), of which clusters of many salmon stocks can be designated a DPS (i.e. evolutionarily significant units; ESU[1])

[1] 56 FR 58612; November 20, 1991.

the SSFP focuses on individual salmon stocks. Another important difference is the threshold for which management changes are implemented. A listing under the ESA, with associated management measures, is triggered when a species becomes endangered with extinction now or in the foreseeable future. In contrast, the SSFP requires management action when escapement goals are not being met. Escapement goals are designed to produce maximum sustained yield and are well above abundances that would result in a risk to the viability of that stock, much less a risk of extinction of a species or ESU. Further, the policy requires management action designed to increase escapements when yields are below optimal levels, which is the strong management that not only protects the long-term yield of stocks but helps ensure stocks do not further decline to the level where their viability becomes compromised (see *Section 2.1.1 Fishery Management Policies & Regulatory Framework*).

Through regular review of escapement performance and the status of stocks, a number of Chinook salmon stocks have been identified as Stocks of Management Concern since the downturn in productivity of Chinook salmon and action plans (analogous to Federal rebuilding plans but implemented with a more conservative management threshold) have been developed (see detailed description in *Subsection 2.1.1.3 Stock of Concern* for more details). Through time, 21 Alaska Chinook populations have been listed as stocks of concern. Of these, six have been delisted, and another two of the remaining 15 Stocks of Management Concern have met the criteria for delisting as of this writing (ADF&G 2024 *In prep*). The delisting of stocks that have been rebuilt is strong evidence that Alaska's policies and salmon management framework are effective at conserving wild salmon stocks.

1.1.3 Target Reference Points vs Limit Reference Points

It is important not to confuse Alaska's salmon escapement goals with limit reference points or missing an escapement goal as an indication of a stock reaching a point of conservation concern. Alaska's salmon escapement goals are based on the sustained yield principle and are MSY-based. That is, they are designed to provide, on average, escapement levels that will provide sustained yield, or more specifically at least a certain percentage of MSY, over the long-term. Alaska's escapement goals are most correctly referred to as target reference points. Target reference points are defined as numerical management objectives intended to bring some fishery benefit (e.g. provide sustainable yield). This contrasts with limit reference points, which are defined as a state at which fishery management has reached overfishing or some other regulatory or conservation point of concern and are often considered the beginning of the "danger zone".

Limit reference points for salmon are challenging to define and there currently is no consensus on appropriate approaches to derive reference points from the usual stock-recruit models (Portley and Geiger 2014). The sustained escapement threshold (SET), as defined in Alaska's SSFP, can be considered a limit reference point (i.e. "a threshold level of escapement, below which the ability of the salmon stock to sustain itself is jeopardized"), and it is formally adopted in the definition of a stock of "conservation concern" (i.e. as the inability to maintain escapements above the sustained escapement threshold). However, SETs have not been developed for Alaska salmon stocks for several reasons including the fact that Alaska's management framework, which prioritizes meeting escapement goals (i.e. target reference points), functions effectively to reduce harvest and avoid low escapements before overfishing or conservation thresholds occur. Further, SETs pertain to individual stocks rather than a species or ESU that is made up of multiple stocks, so one stock being below a SET level in a group of many stocks would not necessarily indicate a conservation concern at the broader ESU or species level (see *Section 2.1.1 Fishery Management Policies & Regulatory Framework*).

Alaska's salmon escapement goals (i.e. target reference points) and escapement-based management is inherently precautionary because lower bounds of escapement goals are set well above levels of escapement at which reproductive capacity would be impaired (i.e. a limit reference point). Further, because fisheries and harvests are restricted when escapements are at (or projected to be at) the lower end of the biological or sustainable escapement goals, weak stocks are protected at levels well above an otherwise undefined limit reference point.

1.1.4 Proxys for Limit Reference Points

GOA Chinook stocks have only been below proxies for limit reference points occasionally in the past 50 years. Other agencies and organizations have proposed or defined different limit reference points, and it might be informative to consider these alternative metrics for Alaska salmon fisheries. For example, Portley and Geiger (2014) noted that minimum stock size threshold (MSST) as defined in the North Pacific Fisheries Management Council's Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska (Salmon FMP) could be a proxy for Alaska's SETs (see *Section 2.2.2 Status Determination*).

The Marine Stewardship Council does not define limit reference points specifically, but proxy values are identified as 50% of the lower bound of the escapement goal range (MRAG Americas, Inc. 2019). The rationale for this proxy was that the level of escapement that results in significant reproductive impairment is substantially lower than Alaska salmon escapement goal ranges, which bracket escapements that produce sustained or maximum sustained yields. Further, 50% of the lower range goal was selected because an alternative value based on the midpoint of the goal range was often similar to the lower end of the goal range. If we apply this proxy to GOA Chinook stocks, the number and percentage of stocks with escapements that were below 50% of the lower bound of the current escapement goals for each stock has varied since 1974 (Figure 4). In the 1970s and early 1980s, shortly after the major North Pacific Ocean regime shift, the percent of escapements below current escapement goals averaged 5% (range: 0–23%), between 1985 and 2006 the average was 1% (range: 0–5%), and since 2007 the average is 10% (range 1–43%). Examining individual systems, escapements below 50% of the lower bound of the current escapement goal occurred sporadically and typically no more than for a single year or two consecutive years, except for Alexander Creek and Theodore River where predation by invasive Northern pike has been an issue that ADF&G has been actively managing (see *Section 2.4.2 Freshwater Predation*).

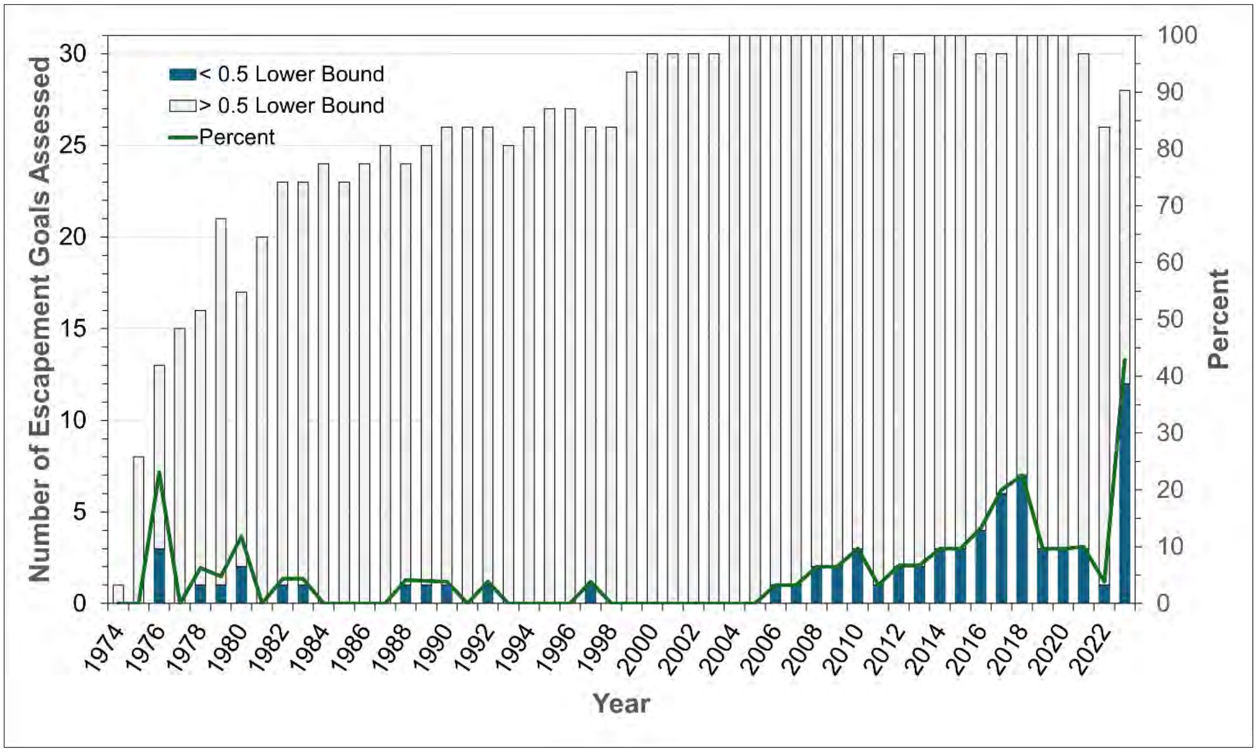

Figure 4.– *Summary of annual number (bars) and percent (line) of Gulf of Alaska Chinook salmon escapements less than 50% of current escapement goals as a proxy for undefined limit reference points per the Marine Stewardship Council.*

Canada's policy for Conservation of Wild Pacific salmon (WSP) provides several benchmarks to describe the status of salmon conservation units (CU; DFO 2005). The lower status benchmark is defined as the "level of abundance high enough to ensure there is a substantial buffer between it and any level of abundance that could lead to a CU being considered at risk of extinction." For stocks with sufficient data, this lower benchmark is set at S_{gen}, which is the number of spawners required to recover to S_{MSY} (spawners at MSY) within one generation, under equilibrium conditions in the absence of fishing (Holt et al. 2009). However, in their assessment of limit reference points for Pacific salmon, Portley and Geiger (2014) noted that at that time S_{gen} was still a theoretical value and whether escapements at that level would allow for a stock to return to S_{MSY} in one generation in a real-world situation had yet to be demonstrated. This metric has yet to be adopted and applied by the Department of Fisheries and Oceans Canada.

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1.2 SIZE AND AGE AT MATURITY

While NOAA presents declining size at age as one of two reasons for a positive 90-day finding based on a reasonable person performing an unbiased scientific review, neither the petition nor the 90-day finding present a clear rationale for how a decline in size at age at maturity would be a factor threatening GOA Chinook with being threatened or endangered now or in the foreseeable future. Using general statements and minimal scientific support, the Service can only conclude that changes to escapement goals might be necessary, effectively admitting that trends in size and age at maturity are insufficient to present substantial scientific or commercial information indicating that listing may be warranted. Below we provide information and concepts to understand changes in the size and age of Chinook salmon and what they might mean for the health of the species in the GOA. We also provide potential management actions that can be taken to maintain the sustainability of Chinook salmon in the presence of declining size and age.

1.2.1 Understanding declines in size of Chinook salmon

Demographic changes in Chinook are not evidence that population viability is at risk. Declining size and age of Chinook salmon in the GOA is unlikely to be a factor threatening or endangering GOA Chinook now or in the foreseeable future. Declines in average size of spawning Chinook salmon (as well as other species) have been a long-standing concern throughout their range, and these declines have also been widespread in Alaska (e.g., Ricker 1981; Bigler et al. 1996; Losee et al. 2019; Ohlberger et al. 2018; 2020; Malick et al. 2023). However, these trends are not uniform nor are they consistently negative. For example, a similar trend in declining size of Chinook was observed in British Columbia from 1951 to 1970 with a loss of 3 kg over the 20-year period (Jeffrey et al. 2017) after which the trend reversed, and sizes increased during the 1980s and 1990s to the former mean. Similar periodic reversals were also present in other salmon species.

Declines in the average size of spawners can occur in two ways: a decline in the average age of spawners (younger fish tend to be smaller), or a decline in the size of fish of a given age (Lewis et al. 2015). Although both mechanisms have been demonstrated in Chinook salmon, declines in the average age of spawners appears to have been the biggest contributor to the trends in Alaska (Oke et al. 2020).

Temporal variation in mean size at age of Chinook salmon is not directly related to risk of extinction of a species. Chinook salmon are the largest of the salmon species with a wide range of adult sizes both within and among populations. Populations of Chinook with smaller average size at maturity than those found in Alaska are not imperiled. Mean size at maturity of Alaska Chinook, which is within the normal range of sizes for the species and is not near the lower end of species range, is not evidence that populations are at risk. To highlight the conceptual error in assuming that temporal variation in mean size at age for any salmon is related to risk of extinction, one can simply look to Bristol Bay sockeye salmon as an example of populations that have also seen declines in size and age at maturity, yet have experienced record-breaking productivity despite these demographic changes.

1.2.2 Potential impacts of declines in Chinook spawner size

Declining size and age at maturity does not indicate extinction risk for Chinook salmon. *Declines in the* average spawner size have the potential to reduce the average reproductive output per spawner, which would reduce the potential recruitment resulting from a given number of spawners (Ohlberger et al. 2024). This can occur in several ways. First, as females tend to return as older, larger fish than males, a reduction in average size could indicate a reduction in the fraction of females in the spawning population. Second, egg numbers, total egg mass, and average egg size all tend to increase with the size of the female Chinook salmon (Healy and Heard 1984). Smaller females may produce fewer offspring, both because of the reduced number of eggs and because smaller eggs produce offspring less likely to survive (Einum and Fleming 1999; Quinn et al. 2011). Third, larger females contain more energy reserves, and are thus more capable of managing long migrations and arriving at distant spawning locations capable of effectively reproducing (Beacham and Murray 1993; Bromaghin et al. 2011). Larger females also can dig deeper nests that are less susceptible to disturbance.

ADF&G's extensive program of sampling spawners for age, sex, and length characteristics is sufficient to identify trends, and these data have been the basis for studies both by ADF&G personnel and outside investigators (e.g., Bromaghin et al. 2011; Lewis et al. 2015; Oke et al. 2020; Staton et al. 2021). While weights are not always available, body mass predicts fecundity better than length (e.g., Healey 2001) and better indicates energy reserves in spawning salmon, which is important for reproductive effectiveness of spawners; e.g., for spawning migration. Additional information about fish weight and fecundity among populations and over time would further inform potential impacts of changing body size on productivity.

Declines in size and age at maturity may be largely explained by warming temperatures (Angilletta Jr et al. 2004; Atkinson 1994; Atkinson 1996). Greater juvenile growth rate favors early reproduction (*e.g*. brook trout *Salvelinus fontinalis;* Hutchings 1993). Salmon are ectothermic and grow faster with warming temperatures. Alaska's freshwater environment is warming (Wolken et al. 2011), a phenomenon linked to younger age at maturity through increased growth (Tattam et al. 2015; Vøllestad et al. 2004) and irrespective of growth (Harstad et al. 2018). Warmer sea surface temperatures were linked to greater growth for Chinook salmon populations in Southeast Alaska (Wells et al. 2008) and to greater growth, younger age at maturity, and smaller size at adult age for populations in Western Alaska (Siegel et al. 2017; Siegel et al. 2018; McPhee et al. 2019).

Declines in body size do not necessarily mean a reduction in reproductive output. For Chinook salmon in Washington state that historically mature at younger ages than Alaska Chinook salmon (Ohlberger et al. 2018), fecundity strongly positively varied with length (Malick et al. 2023); however, the relationship between length and fecundity for Washington state populations may not apply in Alaska. There is substantial interannual variability in length-adjusted fecundity in other locations including Alaska (Bromaghin et al. 2011; Healey 2001; Jasper and Evenson 2006). Rapid early-life growth is associated with higher fecundity and small eggs (i.e., younger-maturing Chinook salmon had smaller but more numerous eggs than older maturing Chinook salmon of the same size; Quinn et al. 2004). Data reported by Alaska Private Non-Profit Corporations for the Andrew Creek Chinook salmon ancestral stock reared at four separate hatcheries indicate that while average body length (mid-eye to fork of tail) of female broodstock declined over time at all 4 locations (Figure 5), the number of eggs collected per viable female declined over time at only one of the four (Figure 6), and the number of eggs collected per viable female was positively related to the average body length of female at only two of the four locations (Figure 7 Thus, the body size-fecundity relationship is not always simply positive. If Chinook salmon are maturing earlier due to rapid early-life growth, the impacts on productivity are unknown without a better understanding of fecundity and the factors that influence fecundity beyond fish length, such as age at maturity, rearing environment, population, and temperature.

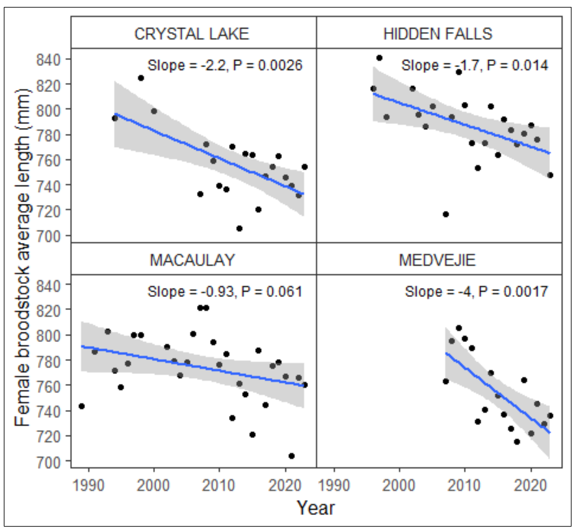

Figure 5.– *Andrew Creek Chinook salmon ancestral stock female brood average length (mid-eye to fork of tail) at four hatcheries in Southeast Alaska over time, from data collected by hatcheries. Simple linear regression summaries added for descriptive purposes only.*

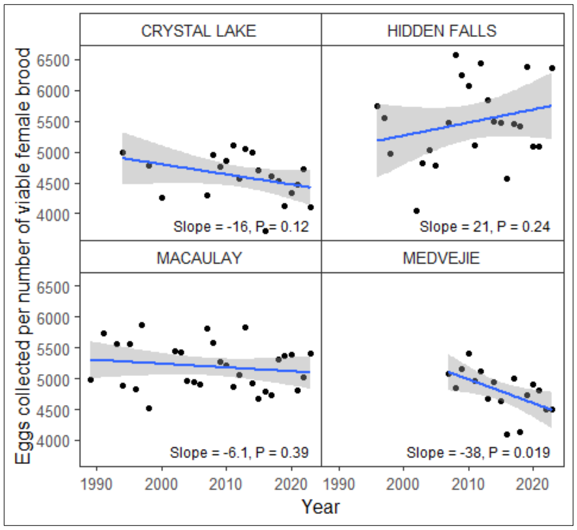

Figure 6.– *Number of eggs collected per number of viable female Andrew Creek ancestral stock Chinook salmon brood at four Alaska hatcheries over time, from data collected by hatcheries. Simple linear regression summaries added for descriptive purposes only.*

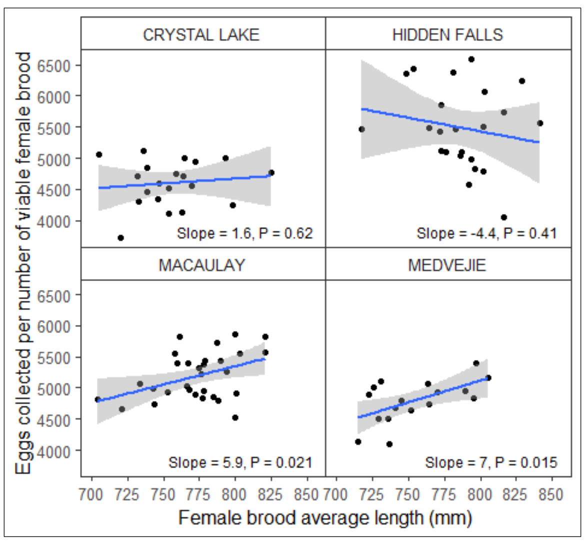

Figure 7.– *Number of eggs collected per number of viable female Andrew Creek ancestral stock Chinook salmon brood plotted against average length (mid-eye to fork of tail, mm) at four Alaska hatcheries, from sampling at hatcheries. Simple linear regression summaries added for descriptive purposes only.*

Populations with the greatest declines in age and size at maturity are not those with the greatest declines in productivity. Among 10 Alaska populations, Lewis et al. (2015) reported that during 1983–2013, Chinook salmon in the Kuskokwim and Copper Rivers had the greatest declines in age at maturity (*i.e.*, greatest declines in proportion of age-6 fish) and the Deshka and Unuk Rivers had the greatest declines in length at age (i.e., declines in length of age 4-ocean fish). These are not the populations showing the greatest declines in productivity. Declines in age at maturity does not necessarily mean that the older fish have higher mortality rates; rather, a larger fraction of younger fish appear to be maturing (Lewis et al. 2015; Oke et al. 2020).

Suggestions that declining size (i.e., age at maturity) could indicate declining productivity is possible if size declines are due to resource limitation, such as caused by top-down effects on the marine ecosystem of other abundant species such as pink salmon; however, this is contrary to life history theory. Life history theory predicts slower growth and later age at maturity in prey limited situations, such as found for Japanese chum salmon in the North Pacific (Morita et al. 2005), the opposite of the observation that Chinook salmon are maturing at younger ages. Increased abundance of pink salmon is a commonly-posited mechanism for reduced growth and productivity in salmon (*e.g.*, Buckner et al. 2023; Ruggerone and Goetz 2004). However, in the Gulf of Alaska, juvenile, immature, and maturing salmon growth and condition have been shown to be driven by bottom-up forces in the ocean, meaning that fluctuations in the primary productivity, not the abundance of other salmon species, would limit juvenile fish growth (Daly et al. 2019b). During 2012 and 2013, there was no bottleneck in the prey resource for pink, chum, and sockeye salmon (Daly et al. 2019a), demonstrating that these species were not competing for resources with Chinook salmon. During 2015–2016 when top-down pressures were thought to have controlled forage fish abundance in the northern Gulf of Alaska, the rearing area for many Alaska Chinook salmon populations (Larson et al. 2014), salmon (including pink salmon) were not the suspected cause (Arimitsu et al. 2021).

Estimates vary among Alaskan populations, but Oke et al. (2020) used length declines from many populations and fecundity data from two time points (1986 and 2005) from one river (Yukon; Jasper and Evenson 2006) to estimate the median reduction over the last 30 years in eggs-per-female for Chinook salmon at 15%, statewide. Even if egg deposition declined 15%, escapement goals designed to ensure high fisheries yields would be ample to maintain reproductive output well above levels that might threaten population viability.

1.2.3 ADF&G's Approach to Declines in Average Spawner Size

ADF&G's adaptive management framework is robust to changes in size at age. Changes in size and age at return have happened previously in all five species of Pacific salmon and many non-salmon species. While many of the demographic changes in Alaska Chinook salmon populations may be responses to warmer climate, which is unlikely to ameliorate in the near future (Wolken et al. 2011), some Chinook and coho salmon stocks in British Columbia show that a decline in average size can reverse itself (Jeffrey et al. 2017). Size decline may be a temporary, albeit widespread, phenomenon.

ADF&G's approach to managing for declines in average spawner age and size is best characterized as responsive but measured. For example, forecasting models have been adapted to accommodate for changes in age at maturity and more uncertainty was built into many sibling models. Similar approaches have been incorporated into Pacific Salmon Treaty abundance models. ADF&G researchers and managers are focused on ensuring that sex ratios in escapement do not decline through inadvertent targeting of females which are now smaller, but still generally larger than the male fish. Mesh size regulations and fishing openings are based on this awareness, and ASL samples of catch and escapement are analyzed for any concerning trends. Escapement goals expressed in terms of large fish, though originally implemented to facilitate differentiation of Chinook salmon from smaller salmon species for inseason management, is receiving increasing attention with ADF&G.

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1.3 Productivity

In the 90-day positive finding, NOAA cites recent failures to meet escapement goals for some GOA Chinook stocks as evidence that would lead a reasonable person performing a scientific review to believe that populations of GOA Chinook are vulnerable to extinction now or in the foreseeable future. However, this is a misunderstanding of what escapement goals signify. Escapement goals are not measures of population viability; rather, they are developed as levels of escapement that will provide for sustained surplus production (yield) with the intent to provide fisheries harvest, and in many cases to maximize that sustained yield. Thus, these goals are set well above levels of concern for population viability. Consequently, failure to meet escapement goals is not a useful metric of population viability and it is erroneous to apply it for this purpose.

There is little evidence from recruits per spawner data indicating decreases in productivity are threatening Chinook stocks. For the scientific review and analysis there are more appropriate indicators of the productivity and viability of a population, though these measures are data-intensive and are not available for all stocks. Typically, productivity can be thought of as the number of recruits produced per spawner (R/S), where a value less than 1 in a given year would indicate that brood year abundance failed to replace itself with successfully returning offspring. In practice, recruits per spawner abundance can fluctuate greatly across time, for example in the Copper River (Figure 8). When one or just a few brood years experience an R/S < 1 it may be a concern for harvest, but not for population viability for the long term. Persistent, prolonged periods of failures of a stock to replace itself, despite management intervention to reduce or eliminate harvest, would need to be seen to indicate potential issues with population viability.

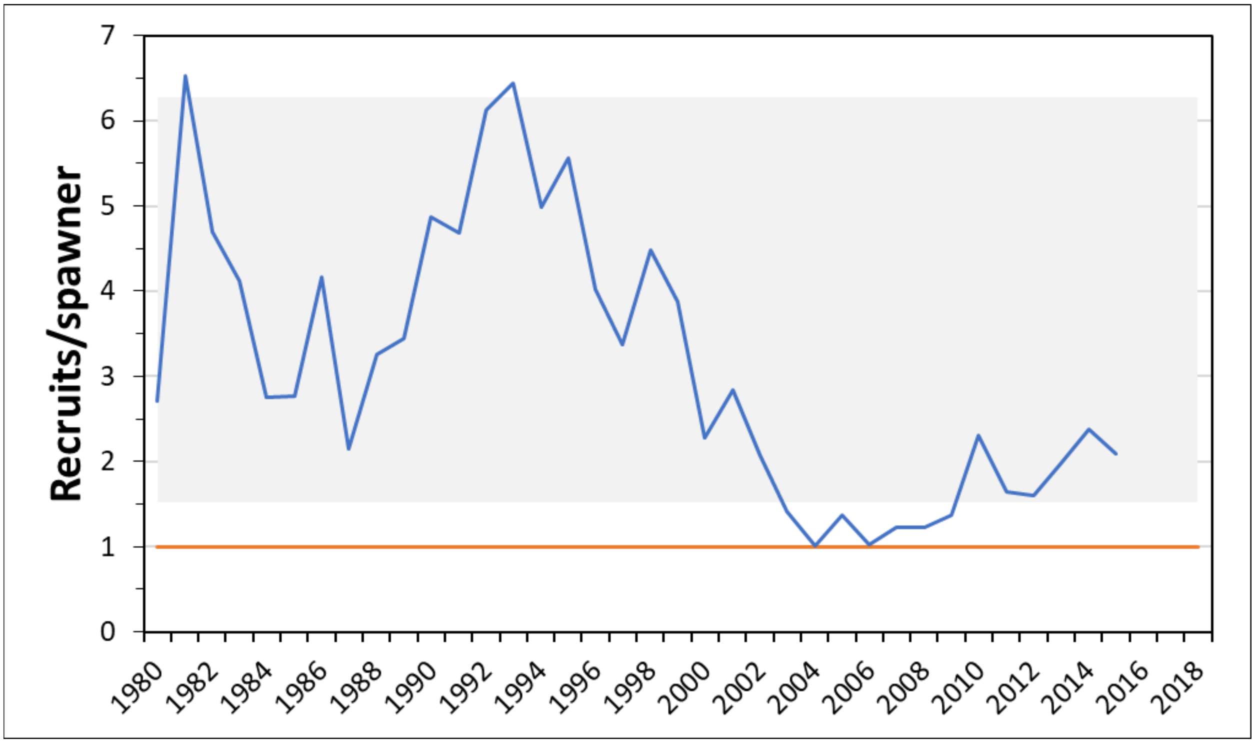

Figure 8.– Estimated recruits-per-spawner for Copper River Chinook salmon for the brood years from 1980 to 2015 (Joy et al. 2021). The shaded grey area is ± 1 standard deviation from the mean and the horizontal line at 1 recruit-per-spawner is where spawners just replace themselves.

While the productivity of GOA Chinook salmon has declined to levels where harvest is restricted on some populations, there is little evidence or rationale provided in either the 90-day finding or the petition to support the contention that decreases in productivity are sufficient to threaten GOA Chinook with being threatened or endangered now or in the foreseeable future.

1.3.1 Marine Productivity

While studies are ongoing, it appears Chinook productivity is driven by survival during the early marine life stage. The effect of marine environmental conditions on the productivity of GOA Chinook salmon is best understood using the critical size/critical period hypothesis first coined by Beamish and Mahnken (2001). This hypothesis posits that the first year at sea is an important bottleneck for survival, and it functionally drives productivity patterns for the cohort. In this hypothesis, mortality mechanisms differ between 2 critical periods in the very early marine life. In the first critical period (the first weeks to months at sea), this hypothesis predicts that survival will be primarily driven by size-selective predation, and variability in survival will be related to variability in salmon size. The second critical period (the first winter at sea) is expected to be starvation-driven, which may be size-related, but also strongly environmentally mediated.

Data collected on marine survival for GOA Chinook are limited to Southeast Alaska where long-term programs of tagging smolt and juvenile marine surveys provide the ability to estimate marine survival rates since the 1980s and '90s (ADF&G Unpublished data, Murphy et al. 2022). Data from these tagging programs indicate that productivity patterns are heavily influenced by marine survival rather than freshwater survival (CTC 2016), most likely during the second period implicated by Beamish and Mahnken (2001). Growth through the first winter at sea was positively related to marine survival for Southeast-area populations Taku and Unuk (Graham et al. 2019). Growth rates, commonly thought to be related to survival, for Taku (generally stream type) and Situk (generally ocean type) populations were better explained with winter seasonal temperature data (Wells et al. 2008). Therefore, the critical size-critical period hypothesis is understood to inform SEAK Chinook productivity patterns (Riddell et al. 2018).

Marine juvenile Chinook salmon datasets are currently being developed for western Gulf of Alaska stocks (Western Gulf of Alaska Survey, ADF&G Salmon Ocean Ecology Program), and for Southeast Alaska stocks (Southeast Alaska Coastal Monitoring Program; NOAA and ADF&G) to understand when, where, and how bottlenecks in survival and productivity may be occurring in marine waters. This is part of considerable recent investments by ADF&G and federal partners, particularly NOAA Fisheries and USFWS, to improve our understanding of Alaskan salmon in marine waters, improve our understanding of Alaskan salmon across their life cycle (from gravel to gravel), and to develop forward-looking management tools (e.g., juvenile-based forecasts) to better respond to changing conditions. With about 20 years of data in the Northern Bering Sea, researchers have concluded that marine juvenile survey data demonstrate that bottlenecks in productivity for Yukon River Chinook salmon occur before September of their first year at sea, implicating very early life experiences and not later marine life stages in determining stock productivity (Murphy et al. 2022). With additional years of data, GOA marine survey programs should be able to provide similar insights for GOA Chinook salmon stocks.

While marine drivers of GOA Chinook salmon productivity are frequently cited, freshwater contributors to Chinook productivity should also be considered. Variability in the Cook Inlet-area freshwater environment, although generally considered pristine, was associated with reduced productivity (Jones et al. 2020). Specifically, productivity was negatively associated with increased precipitation during fall spawning and early incubation period and below-average precipitation during juvenile rearing (Jones et al. 2020), matching general climate patterns observed in Southeast, Southcentral, and Southwest Alaska (Markon et al. 2012). Warmer freshwater environments may have carry-over effects on marine growth and maturity trajectories, with unexplored effects on population productivity (Hecht et al. 2015; Sloat and Reeves 2014).

Given the petitioner's emphasis on marine productivity driving threats to GOA Chinook salmon, and with this background understanding of when and how marine productivity is believed to be determined for GOA Chinook salmon, it is difficult to understand how many of the purported causes outlined in the petition would lead to a significant threat towards extinction for GOA Chinook salmon.

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1.4 Diversity

1.4.1 Life History Diversity

Alaska Chinook stocks exhibit less variability in life-history than more southerly stocks. Much of what is known about the general life history of Chinook salmon in Alaska has been summarized by Healey (1991) and Morrow (1980) and was briefly summarized by ADF&G as part of the Chinook Salmon Research Initiative (ADF&G Chinook Research Team 2013). Gulf of Alaska Chinook stocks have similar life history and run timing. With rare exceptions, they exhibit a stream-type life history, with the majority of juveniles spending two winters in freshwater before becoming smolt to make extensive ocean migrations to feed and mature before returning in spring and early summer as "spring" run adults, and most GOA Chinook stocks are confined to a single distinct run in each river. Thus, Alaska populations lack the life-history diversity of their Pacific Northwest cousins, which exhibit a mixture of stream-type and ocean-type life history, vary much more greatly in run timing, and more often exhibit multiple distinct runs returning to each river.

Run timing of GOA Chinook adults does vary somewhat among drainages, with migrations into freshwater beginning as early as April or as late as July. In contrast, peak spawning for some Pacific Northwest stocks may be as early as April or as late as November. Chinook salmon in large river systems may have protracted runs due to wide variation in distances fish must migrate to disparate spawning areas and/or the temperature of the water their embryos experience. In a few cases, there are two distinct run timings of GOA Chinook salmon in a large drainage. For example, fish that spawn in the far upper reaches of the drainage with lengthy freshwater migrations may enter the mouth of the river early whereas fish that spawn in larger mainstem habitats with shorter migrations may enter later. As an example, the Kenai River in Southcentral Alaska supports such multiple runs of Chinook salmon, similar to rivers in Southern BC and the Pacific Northwest including the Fraser River, Puget Sound, Washington Coast, Columbia River and Oregon coast, which have two or more distinct runs of Chinook (i.e., spring, summer and fall run).

Spawning of GOA Chinook salmon primarily occurs between late July and early September, with capacity of spawning populations limited by factors related to watershed area (Parken et al. 2006). Unlike the protracted run timing often observed in many southern populations, timing of spawning appears to be highly synchronized and compressed in most Chinook salmon populations in Alaska. Chinook salmon can spawn in a wide variety of habitats in terms of water depths, substrate type, and water velocities, although they prefer areas of high subgravel flow, specifically found at the heads of riffles, in pools below log jams, and alluvial fans in valley floors. This preference for high subgravel flow limits available Chinook spawning area in most rivers of Alaska.

Fecundity of female stream-type Chinook salmon varies by size and is also thought to vary by population along a latitudinal gradient. For example, fecundity of fish in the Salcha River tributary of the Yukon drainage ranged from 7,400 to 13,400 eggs per female depending on length (Skaugstad and McCracken 1991), which is somewhat higher fecundity than that reported in the general literature for Chinook salmon populations further south (Healy and Heard 1984). As with other Pacific salmon, female Chinook salmon deposit eggs into redds dug into the streambed. Within the redd, Chinook salmon eggs are susceptible to drying as river levels drop in fall and winter, freezing during winter, and mechanical abrasion due to floods and other spawning salmon. The timing of when eggs hatch varies with stream temperature and generally taking 12 or more weeks in Alaska. Fry hatch and spend 2 to 3 weeks in the gravel before emerging.

After hatching and emergence, fry disperse from spawning areas to feed in mainstem or tributary habitats of large watersheds. Juvenile Chinook salmon favor areas of moderate current and instream cover for feeding during summer. Some populations exhibit migrations from tributaries into mainstem areas for overwintering. Understanding of overwinter survival rates for juvenile Chinook salmon in freshwater is very limited. Unlike Chinook stocks in the Pacific Northwest and Fraser River stocks in British Columbia, most Chinook salmon in Alaska are stream-type fish that spend one winter in the gravel as eggs, another winter in the freshwater as fry, and then emigrate to sea as 2-year-old fish. In some instances, Alaska stocks can exhibit a combination of stream-type and ocean-type behavior with a portion of the fish spending one winter in the gravel as eggs and then emigrating to sea as 1-year-old fish. Situk River are one such example wherein the Chinook are predominately ocean-type fish (McPherson et al. 2005; Thedinga et al. 1998); scale age analysis since 1978 indicates 40%–95% of the returning adults are ocean-type fish (Ed Jones, ADF&G Southeast Chinook Research Coordinator, pers. comm.); though the mixture of ocean-type and stream-type fish are still considered a single stock. Seaward emigration of smolt generally occurs between May and July (King and Breakfield 2002), with smolt ranging in length from approximately 50-100 mm (Pahlke et al. 2010).

Very little is known about habitats occupied by juvenile Chinook salmon as they first enter nearshore marine waters of Alaska. As with other populations of stream-type Chinook salmon, it is thought that juveniles from GOA systems spend little time in their natal river estuary and rapidly move into the coastal currents along the shoreline, where very little biological sampling has been done to date. It has been hypothesized that the first year at sea is a critical period of growth and survival for juvenile Chinook salmon, a period that is modulated by climatic conditions (Beamish and Mahnkin 2001).

After leaving their freshwater environments, Chinook salmon stocks in Alaska typically migrate farther offshore into the shelf areas of the Gulf of Alaska and Bering Sea. These fish spend from one to five years in the marine environment feeding predominately on fish, squid, and euphausids. Maturation rate tends to be sex- and population-specific, with males maturing earlier than females, and more northern populations maturing later than more southerly populations. Chinook salmon in Alaska return primarily at age three to six years (ocean-age-1 to ocean-age-4 fish) and 7-year-olds (ocean-age-5 fish) are rare for most stocks. What is known about stock distribution is based on genetic and coded-wire tag analyses of samples gathered from catches in various research cruises and in bycatch from federal groundfish fisheries. These data indicate that most Chinook salmon originating in the Gulf of Alaska migrate north and west from their natal streams in Southeast and Southcentral Alaska along the Alaska Current, with some populations migrating as far as the Bering Sea (Larson et al. 2012). Some stocks in Southeast Alaska exhibit a mix of offshore and nearshore rearing strategies with some stocks rearing within the confines of Southeast Alaska. Chinook salmon in the Gulf of Alaska represent a complex and highly variable mixture of Alaska populations primarily originating in Southcentral and Southeast Alaska, interspersed with wild populations and hatchery releases originating in British Columbia and the Lower 48.

1.4.2 Genetic Diversity

While genetic diversity does exist among GOA Chinook populations, it is shallower and less complex than more southerly populations. Chinook salmon genetic diversity and population structure in Alaska has been highly influenced by frequent disturbances and environmental changes that have been occurring since the last glacial maximum (approx. 10,000 years ago). In general, genetic structure in Alaska is hierarchically organized in relation to major geographic features (coastlines, embayments, waterways). Most likely, this derives from geographically influenced patterns of recolonization and straying among spawning areas. The most common pattern is higher levels of gene flow among proximate populations leading to signals of isolation by distance. However, these patterns are commonly punctuated by discontinuities that can be caused by features like the intersection of major water bodies (e.g., rivers entering along a coast), barriers or resistance to gene flow (e.g., waterfalls), extinction and colonization events (e.g., glacial advance and retreat), among other geographic and temporal events. The GOA region is relatively newly available to Chinook salmon and remains one of the most geologically active areas in the world. When compared to the older and more stable western U.S. Chinook salmon populations, genetic structure is generally shallower and less complex. However, genetic differentiation does exist among populations on various scales.

On the largest scale, two major groups of Chinook salmon in Alaska are most readily apparent: 1) a western group (Russia to Cape Fairweather, near Yakutat), and 2) an eastern group (south of Cape Fairweather). Several studies have noted this split (Gharrett et al. 1987, Myers et al. 1998, Beacham et al. 2006, Martin et al. 2010, Templin et al. 2011, Moran et al. 2013) and have hypothesized that Chinook salmon survived late Pleistocene glaciation in two separate refugial areas (Bering and Pacific; McPhail and Lindsey 1970, but see discussion in Moran et al. 2013). Data suggests that Chinook salmon spread into the Bering refugium during an interglacial period late in the Pleistocene, where they survived subsequent glaciations and diverged from southern populations; the presence of elevated diversity in the central and southern portions of the range of Chinook salmon supports this hypothesis (Martin et al. 2010). It is informative that the two sets of northern latitude spawners in Moran et al. (2013), Alsek/Situk and the upper Yukon, form a single group in the context of 20+ distinct groups in BC and western U.S. The Alsek and upper Yukon populations are separated by about 3400 river km and thousands of km of coastline, yet are similar enough that they were not divided into two groups when compared to southern populations. While possible, watershed capture is not a likely mechanism given evidence that these groups are some of the most genetically distinct among Alaska Chinook populations (Templin et al. 2011). In Moran et al. (2013) and Beacham et al. (2006), these geographically separated groups are assumed to be representative of all Alaska Chinook salmon populations outside of Southeast Alaska (which are not represented in those data sets).

Within the western group, genetic structure is generally shallower than the eastern group though differentiation is present and generally based on geography. Several studies have noted that the amount of genetic differentiation between Alaskan populations in this region is smaller than for other regions (Gharrett et al. 1987, Myers et al. 1998, Templin et al. 2011) and this is corroborated by contemporary data (ADF&G unpublished data; Figure 9 and Figure 10). Within this group, middle and upper Yukon River populations are highly diverged and show significant isolation by distance (e.g. Smith et al. 2005, Templin et al. 2005, Beacham et al. 2008), while other populations in western Alaska display low levels of differentiation. Populations in the north Alaska Peninsula region are more structured compared to coastal western Alaska, similar to observations for chum salmon in this region (Seeb et al. 2011, Barclay et al. 2024). From the south Alaska Peninsula east to the Alsek River, genetic structure is consistent with isolation by distance, with additional structure present when including upper river populations (e.g., the upper Kenai, Copper, and Alsek). The Chignik River population is small and appears relatively isolated, but the pattern of genetic structure from Chignik and Kodiak to Cook Inlet is consistent with a pattern of isolation by distance, and it does not have lower within-population genetic diversity as might be expected from long isolation (ADF&G unpublished data).

Chinook salmon populations in this region show shallower structure among coastal systems with most of the diversity associated with large river systems. For example, in Cook Inlet there is deeper structure within the larger Susitna, Kenai, and Kasilof Rivers than the proximate coastal systems (Templin et al. 2011, Barclay et al. 2019, ADF&G unpublished data). Within the Kenai River, the Russian River population is genetically distinct, which has been attributed to run timing differences in this system (Burger et al. 1985), but could also be due to some portion of the population spawning above the falls (ADF&G unpublished) which forms a semi-permeable barrier. Similar to the Yukon River, Copper River populations display a high degree of isolation by distance, and upper river populations are more genetically distinct than those in lower river tributaries (Seeb et al. 2009) and have decreased within-population diversity that could be due to a combination of contemporary and historical demographic processes (Ackerman et al. 2013). Chinook salmon populations in the Alsek River are genetically similar to the lower Copper River populations though separated by nearly 400 km, while the nearby Situk River population is intermediate between Copper, Alsek, and Cook Inlet genetic groups despite its unique life history of primarily ocean-type fish (Thedinga et al. 1998). This relationship is an indication of both the strength of the geographic signal and the lack of utility of stream/ocean life history categories for differentiating populations in Alaska. These relationships are likely due to the highly dynamic geomorphology in this area, where active glacial and tectonic influences frequently change the landscape and access to habitat (Mann et al. 1998).

Populations of Chinook salmon in Southeast Alaska represent the northern extent of the eastern group of Chinook salmon. Similar to the western group, there is a general pattern of isolation by distance within Southeast Alaska, with populations organized hierarchically by river systems (Figure 8; Guthrie and Wilmot 2003, Beacham et al. 2006, Seeb et al. 2007, Templin et al. 2011, ADF&G unpublished data). Chinook salmon in Southeast Alaska are found both in more than 20 shorter coastal rivers and in large river systems including the Chilkat, Taku, and Stikine rivers. In the north, the Chilkat River populations form a group separate from nearest large populations in the Taku River. The Taku and Stikine River populations have shallow genetic structure and are genetically similar to each other (Guthrie and Wilmot 2003, Beacham et al. 2006, Seeb et al. 2007, Templin et al. 2011). Interestingly, populations in these rivers do not show higher genetic differentiation in upper river locales as might be expected, but rather lower Stikine River populations are more diverged from neighboring populations (i.e. Andrew Creek, Verrett River, Alpine Creek). This pattern could be due to the dynamic geomorphology of the region, which may include a history of stream capture between these systems in the Stikine Plateau (Kerr 1948, Guthrie and Wilmot 2003). It might also be due to the observed straying between these two systems confirmed by recoveries of coded wire tags (ADF&G unpublished data). On Admiralty Island, the geographically isolated King Salmon River population is distinct from all other Southeast Alaska populations, which may be a function of its unique habitat, relative isolation, and drift/bottlenecks arising from its small population size. This population is small, and subsequently has lower within-population genetic diversity than other Southeast Alaska populations (H_O = 0.24 compared to average H_O = 0.29 for other southeast Alaska populations; ADF&G unpublished data). In southern Southeast Alaska, Chinook salmon populations are primarily found in shorter coastal rivers concentrated in Behm Canal and Portland Inlet. There are low levels of differentiation between these populations, which is indicative of gene flow among these proximate locales (Guthrie and Wilmot 2003, Beacham et al. 2006, Seeb et al. 2007).

It is important to note that the genetic diversity of Chinook salmon populations in the Gulf of Alaska are reflective of unique and dynamic landscapes that are undergoing significant and sometimes abrupt changes. This area is characterized by a variety of landscapes, including rugged coastal mountains, glacial fjords, coastal tributaries and short rivers, and large river systems crossing into interior habitats. There are sections of coastline that do not support large Chinook salmon populations (e.g. Chignik River to Cook Inlet, Cook Inlet to Copper River, Copper River to Situk River), likely due to landscapes highly impacted by geologic forces in relatively recent time periods. However, much of this area is remote and observations of Chinook presence, spawning, or rearing are opportunistic and intermittent. Spawners and juveniles have been recorded in several coastal locations (Figure 1; e.g. east of the Bering River; Giefer and Graziano 2024a, 2024b, and 2024c) which likely form connections between more hospitable areas, but very few have been sampled for genetic analysis and are not represented in the data set. Much of the Gulf of Alaska was deglaciated much more recently than the late Pleistocene, and active glacial areas, particularly in the lower Copper, Alsek, Taku, and Stikine rivers, can result in dramatic barriers to gene flow and subsequent colonizations (e.g. Loso et al. 2021, Gubernick and Paustian 2007). In addition, the area is tectonically active due to the subduction of the Pacific Plate along the Aleutian trench in the central Gulf of Alaska, and the presence of the Queen Charlotte-Fairweather Fault system in the eastern Gulf of Alaska (Taber et al. 1991, Plafker et al. 1994). As a result, the entire area is highly influenced by earthquakes, tsunamis, and volcanic eruptions. On average, this region has had one magnitude (M) 8+ earthquake every 13 years, one M 7–8 earthquake every two years, and six M 6–7 earthquakes per year (Alaska Seismic Hazards Safety Commission 2012), and there is ample evidence of coastline changes due to seismic land level shifts and tsunamis (Mann et al. 1998). Patterns of genetic differentiation can be made more complex by the continuing geologic dynamism of the region and its effect on salmon distribution.

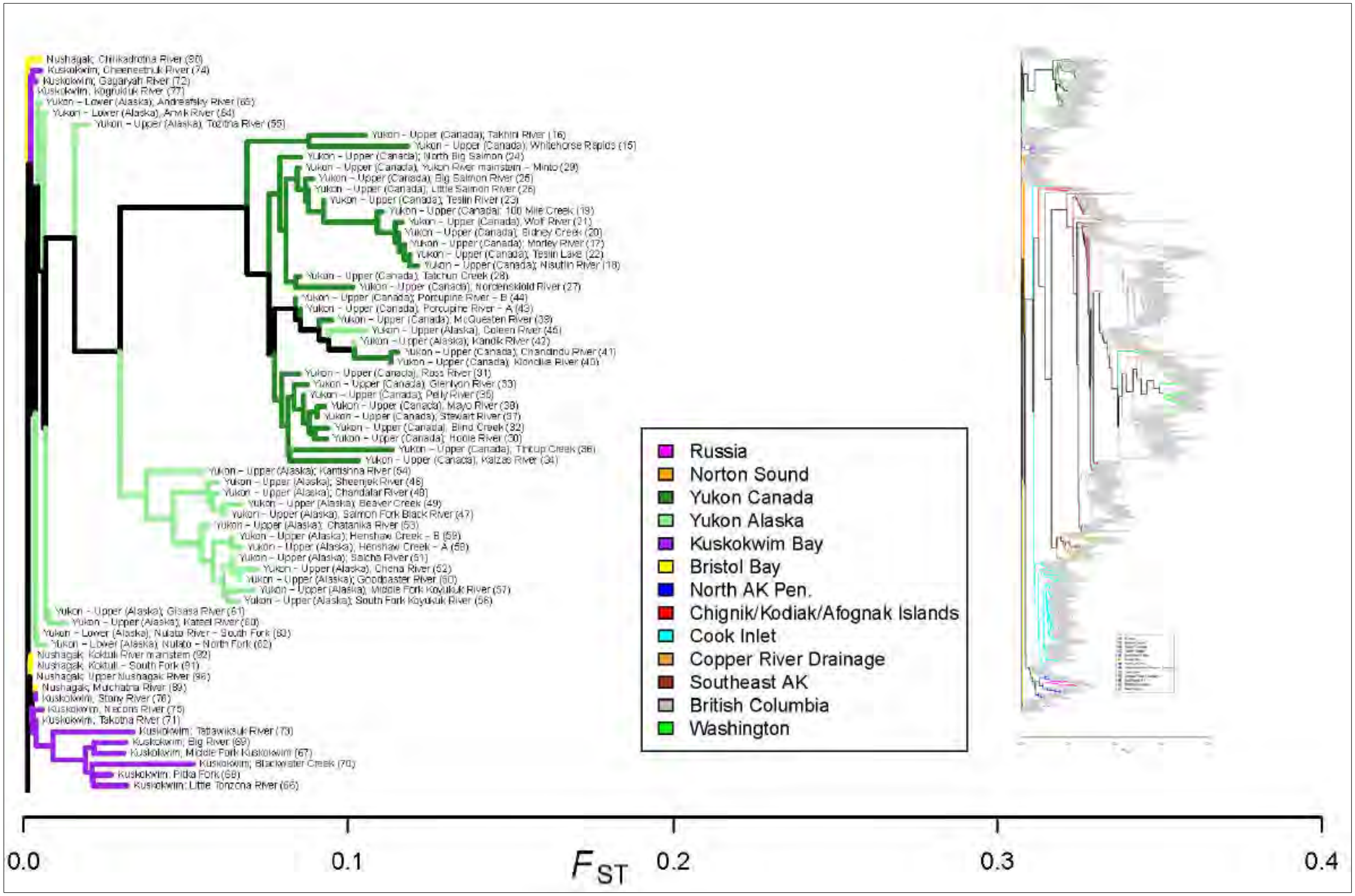
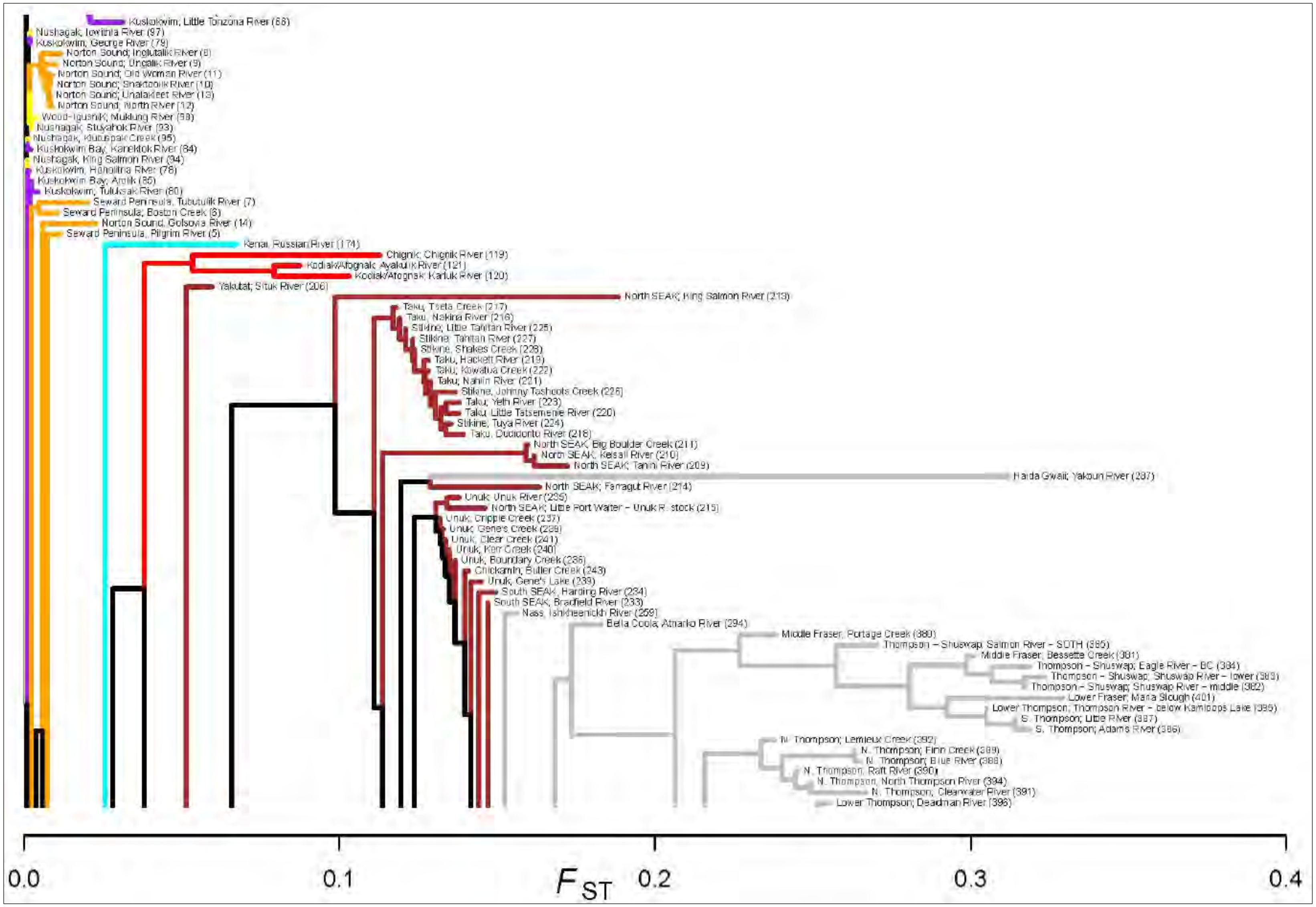


Figure 9.– *Neighbor-joining tree based on pairwise F_{ST} between 424 Chinook salmon populations ranging from Russia to Washington using 120 SNP markers. Colors indicate regional groupings. (ADF&G unpublished data).*



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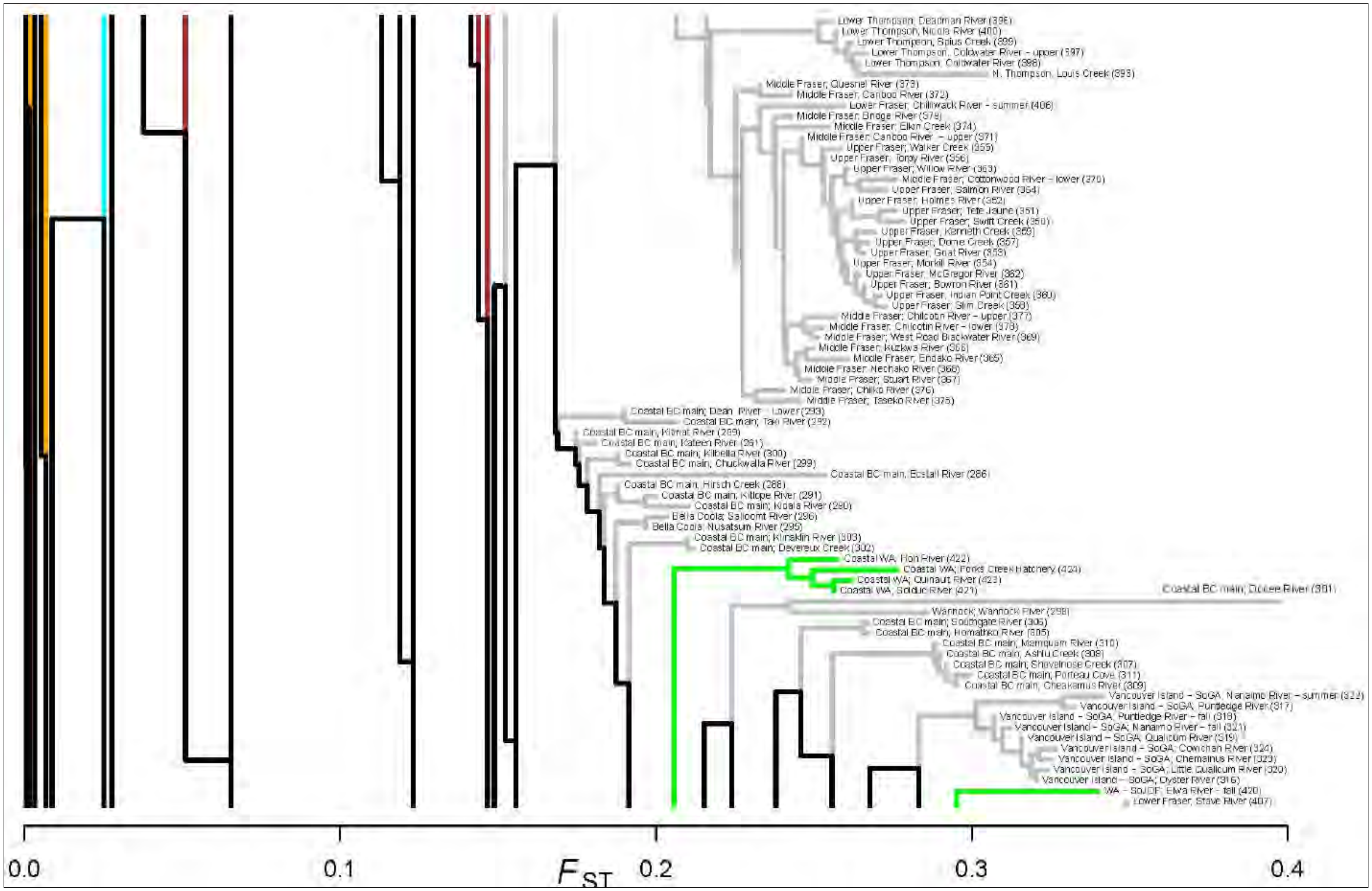

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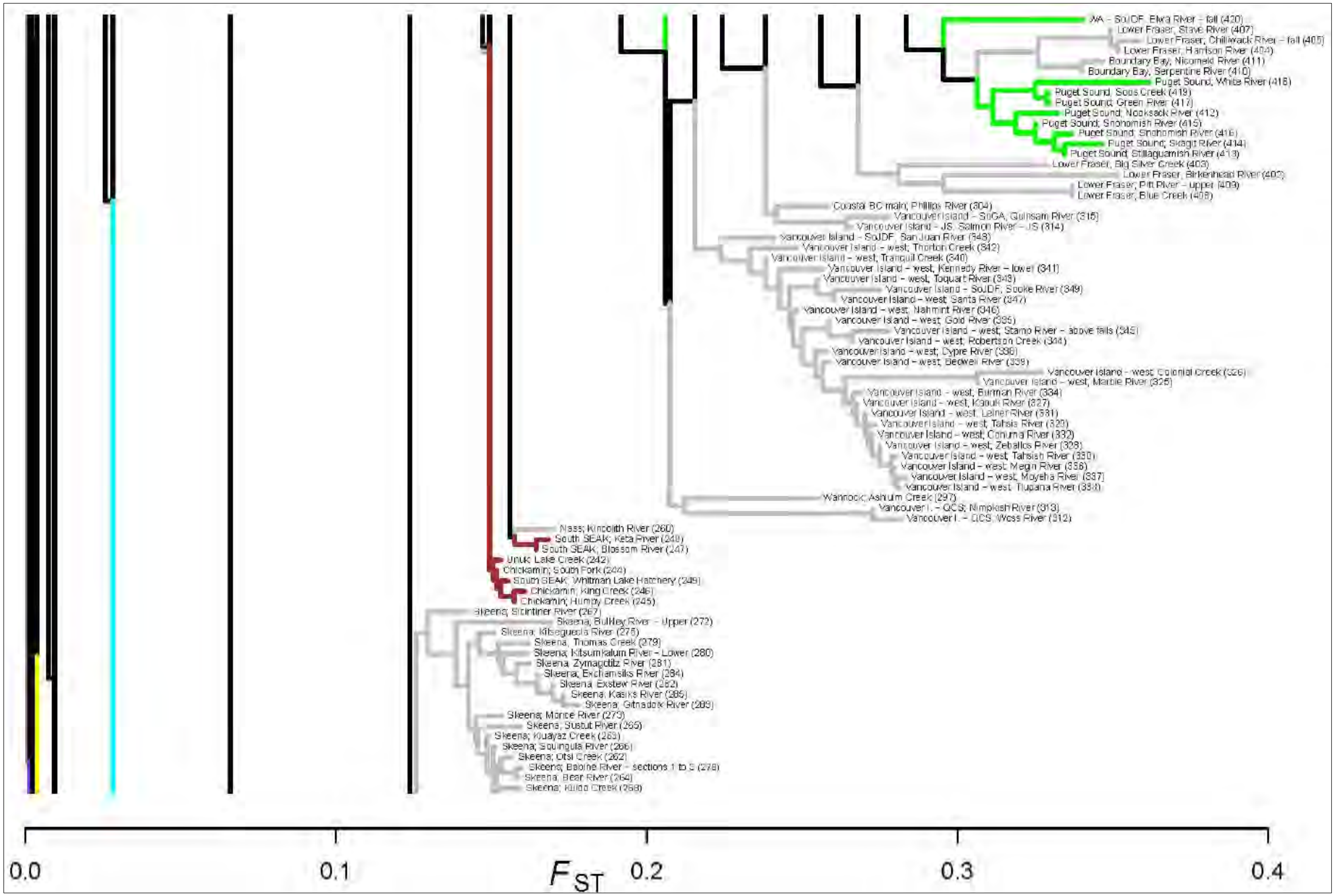

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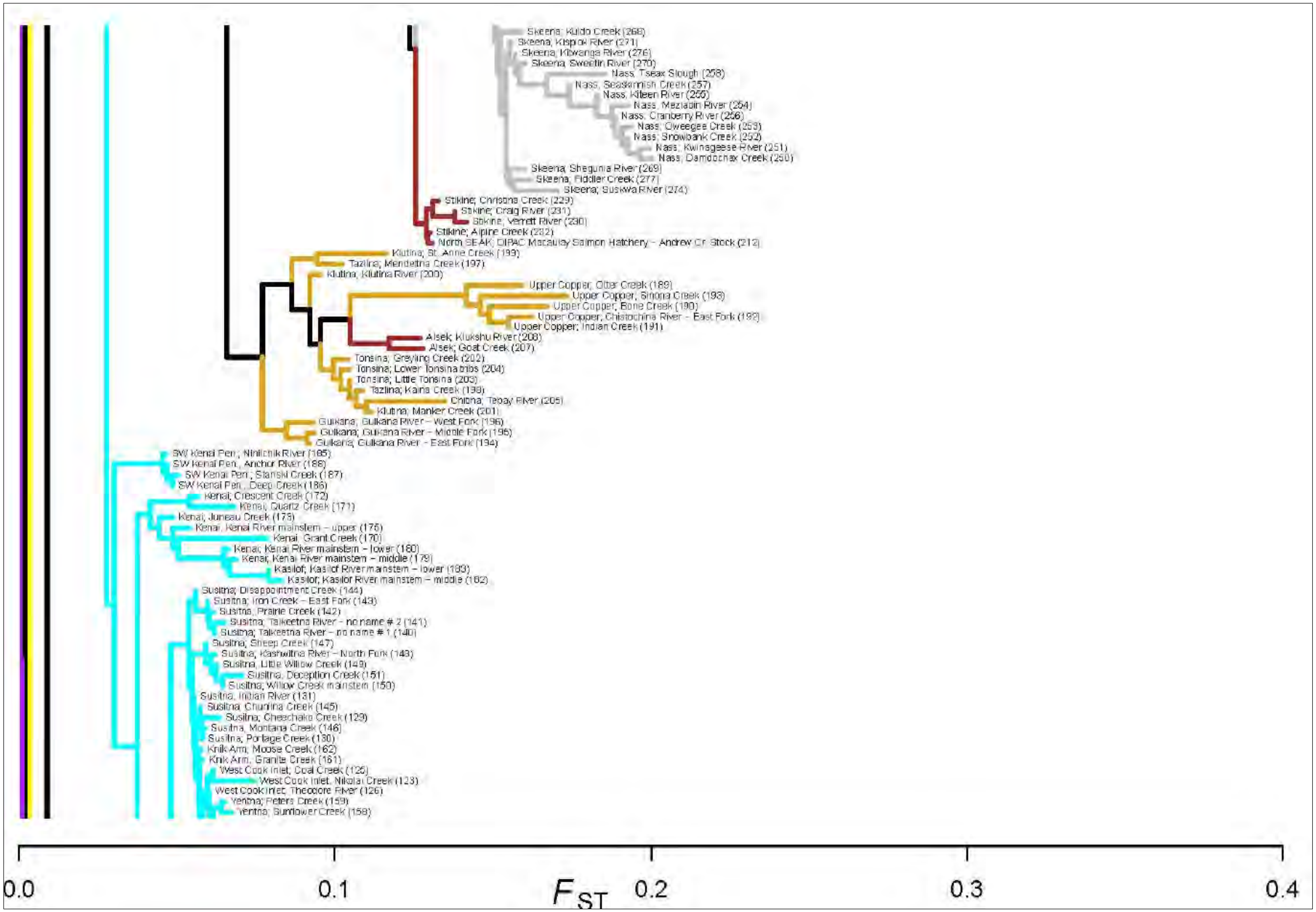

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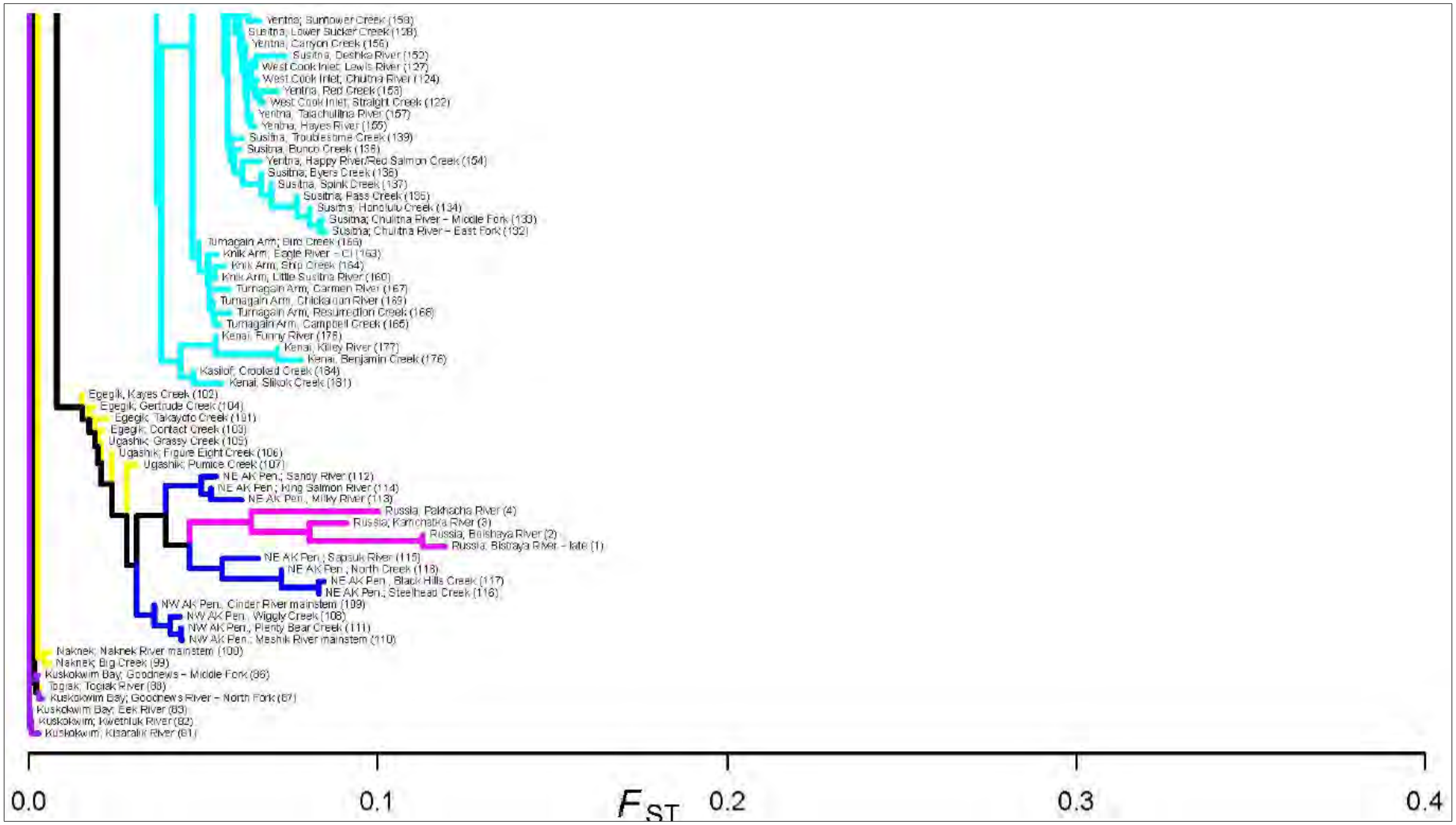

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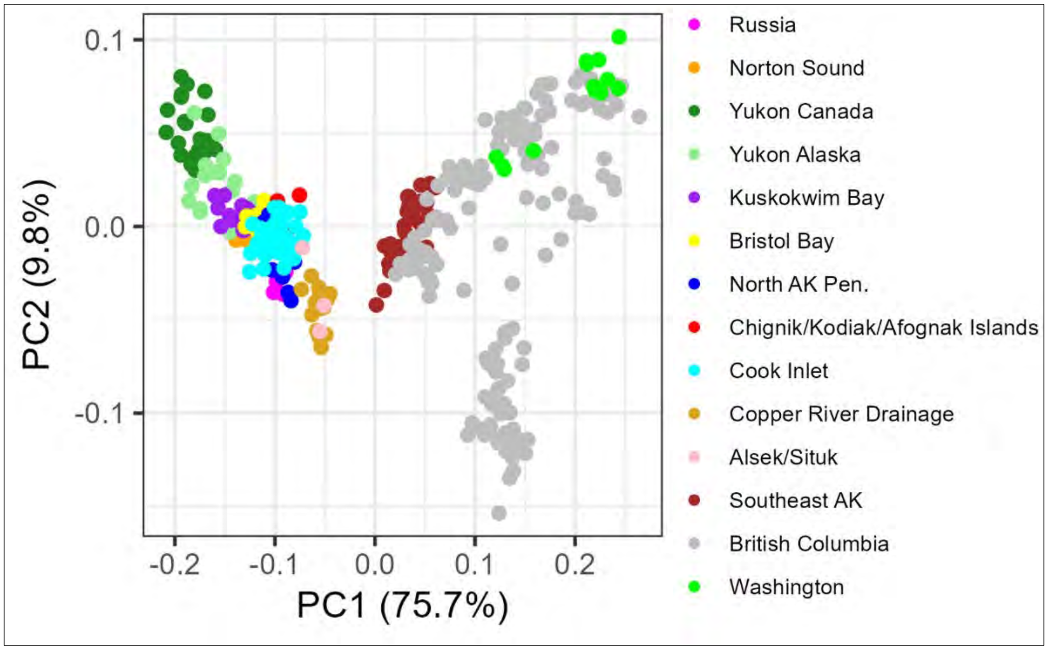

Figure 10.-Principal coordinates 1 (PC1) and 2 (PC2) based on F_{ST} between 424 Chinook salmon populations in a baseline ranging from Russia to Washington using 120 SNP markers. The percentage of variation explained by each principal component is in parentheses; the first two components explain 85.5% of the variation. Colors correspond to regional groupings. (ADF&G unpublished data).

1.4.3 Habitat Diversity

GOA Chinook salmon are adapted to marine and freshwater habitats that are dynamic and diverse.

1.4.3.1 Landscape Shaping Processes

Geologic "disturbances both create selective pressures for adaptive responses by salmon and inhibit long-term divergence by periodically extirpating local populations and creating episodic dispersal events that erode emerging differences" (Waples et al. 2008). Chinook salmon habitat in the GOA is shaped by active geological processes including glaciation and glacial retreat, volcanoes, earthquakes, and tsunamis that occurred in the past and continue to occur today. When combined with climatic and oceanographic cycles, these processes can dramatically affect salmon productivity, abundance, distribution, and diversity (Waples et al. 2008), and yet Chinook salmon, as a species, continue to persist. To understand why this is so, it is important to realize that the autotetraploid event creating the Salmonidae between 65–95 million years ago, gives these fish duplicated genes that allow for evolutionary flexibility and buffers against inbreeding depression (Waples et al. 2008). This allows Chinooks salmon to respond to landscape-level changes occurring in their environment. Waples et al. (2008) identified two primary modes of landscape-level dynamics shaping salmon habitats: 1) long-term processes as a result of glacial advancement and retreat causing sea level change and isostatic rebound after glacial recession and 2) periodic geologic disturbances of varying frequency and magnitude.

Glacial Dynamics. Over evolutionary time, the GOA region has been glacially dynamic, with glaciers advancing and retreating and Chinook salmon responding to those changes. As recently as 16-17,000 years ago, which was shortly after the last glacial maximum, the entire GOA region was covered in ice

(Briner et al. 2017; Pitman et al. 2020). Significant warming occurred after the Last Glacial Maximum, which included the Hypsithermal interval in the early Holocene, wherein glaciers within the GOA region receded beyond their present-day limits (Mann et al. 1998). Neoglaciation has occurred in the last 5-6,000 years, which have been appreciably cooler than the Hypsithermal interval. The Neoglaciation period has been marked by alternating cold and warm intervals with glaciers advancing and retreating multiple times (Mann et al. 1998), including the Medieval Warm Period (900–1350), the Little Ice Age (1350–1900), and recent climate change amplified warming .Outside the two major ice sheets that cover most of Greenland and Antarctica, glaciers in Alaska (and shared ice-fields with Canada) currently represent about 13 percent of the mountain glaciers and ice cap areas on Earth[2].

At this point in time, Alaska's glaciers are generally in decline. Glacial retreat poses benefits and risks to salmon as the habitat changes. Summer stream flows can become lower and warmer due to reduced glacial meltwater and increased stream temperatures, which can either be beneficial or stressful to salmon depending on initial stream temperature (Pitman et al. 2021). On the other hand, glacial retreat is creating new rivers and opening up new spawning and rearing habitat. Pitman et al. (2021) project that gains in salmon habitat are substantial enough (on the order of hundreds to thousands of miles) that they could lead to sizable increases in salmon production in some locations. Isostatic rebound from glacial retreat can also have both positive and negative effects on salmon as some rivers shift, flow patterns change, and salmon accessibility is altered. For example, salmon have demonstrated an ability to rapidly colonize streams near receding glaciers (Milner 1987), whereas episodic inundation events in low-lying areas during the early stages of glacial recession allow for mixing of populations from drainages that are currently geographically isolated (e.g., the Alsek River and Yukon River Chinook salmon populations).

Chinook salmon habitat in the GOA is shaped by active geological processes including glaciation and glacial retreat, volcanoes, earthquakes, and tsunamis that occurred in the past and continue to occur today. When combined with climatic and oceanographic cycles, these processes can dramatically affect salmon productivity, abundance, distribution, and diversity (Waples et al. 2008), and yet Chinook salmon, as a species, continue to persist. To understand why this is so, it is important to realize that the autotetraploid event creating the Salmonidae between 65–95 million years ago, gives these fish duplicated genes that allow for evolutionary flexibility and buffers against inbreeding depression (Waples et al. 2008). This allows Chinooks salmon to respond to landscape-level changes occurring in their environment. Waples et al. (2008) identified two primary modes of landscape-level dynamics shaping salmon habitats: 1) long-term processes as a result of glacial advancement and retreat causing sea level change and isostatic rebound after glacial recession and 2) periodic geologic disturbances of varying frequency and magnitude.

Geological Disturbances. The Gulf of Alaska is the most seismically active region in the country; it has had multiple "great" (magnitude [M] 8 or larger) historic earthquakes, and it has the potential to generate the largest earthquakes in the world. On average, this region has had one M 8+ earthquake every 13 years, one M 7–8 earthquake every two years, and six M 6–7 earthquakes per year (ASHSC 2012).

The southern edge of Alaska is an active tectonic plate boundary where the Pacific plate subducts (i.e., dives beneath) the North American plate along the great Alaska–Aleutian Megathrust. The plate boundary encompasses about 2,500 miles of the Pacific "ring of fire" where ongoing subduction gives rise to arcs of active volcanoes and the largest earthquakes in the world. In Alaska, the Pacific plate, relative to the North American plate, moves at a rate of about 5.5+ cm/yr (Figure 11). The general pattern of seismicity follows the Pacific plate as it subducts beneath Alaska (Figure 12). The Fairweather fault system in southeast

[2] https://dggs.alaska.gov/popular-geology/volcanoes-glaciers.html

Alaska (over 620 miles long) is the primary strike-slip structure that accommodates ongoing subduction. Plate convergence at the southern margin of the state drives distributed deformation on secondary faults over 400 miles northward into the continental interior. These secondary faults have also generated several significant historic earthquakes (such as the 200+ mile-long 2002 M 7.9 Denali fault rupture), and scientists are still discovering faults that are capable of large earthquake displacements.

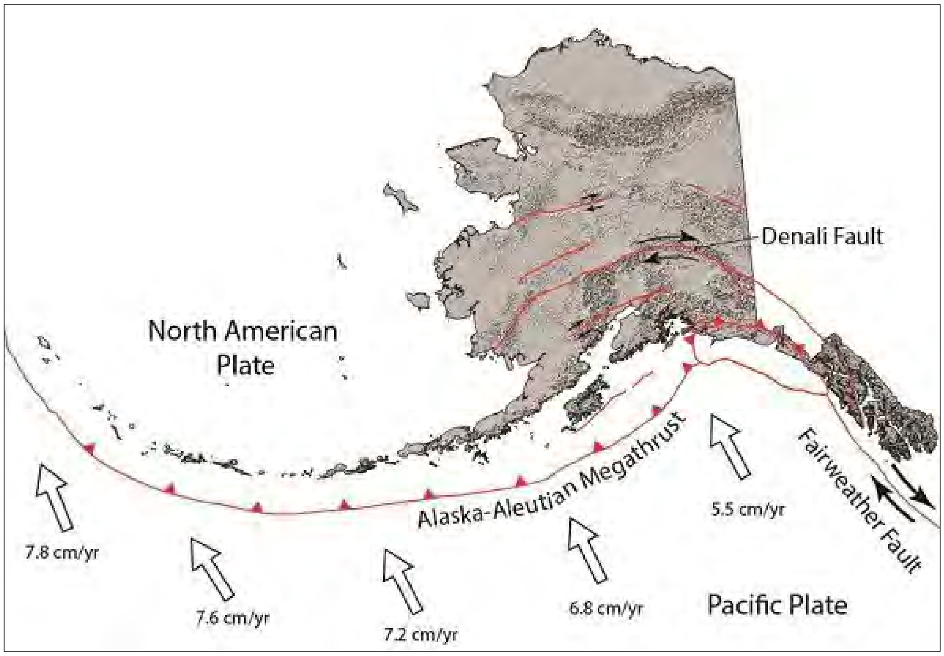

Figure 11.– Map showing major fault lines in Alaska. Source: Alaska Department of Natural Resources

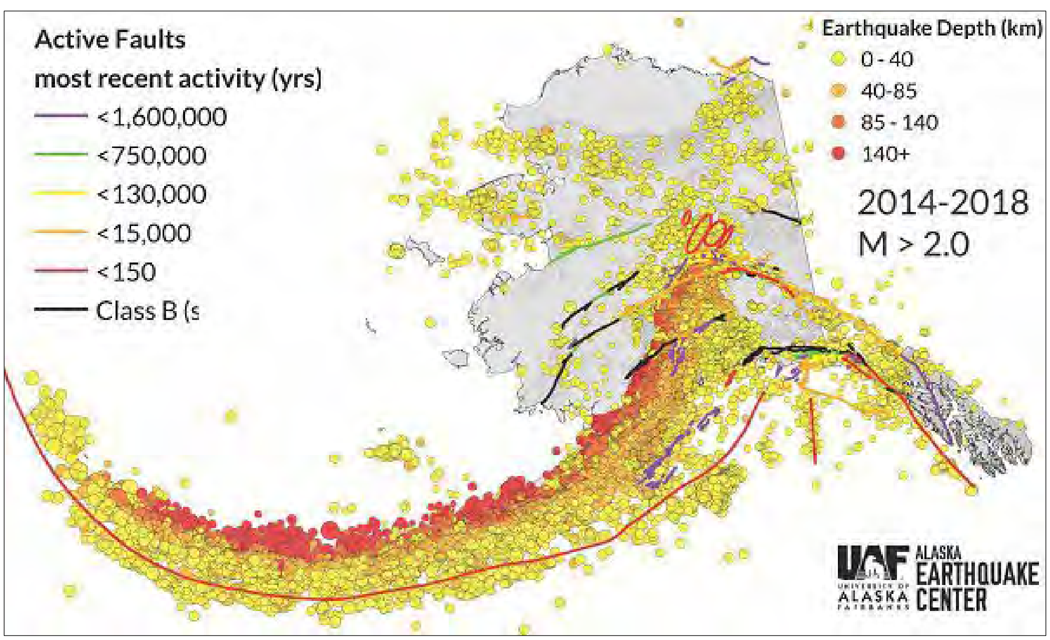

Figure 12.– Earthquakes greater than magnitude (M) 2.0 in Alaska, 2014–2018. Source: UAF Alaska Earthquake Center

Evidence that large earthquakes can affect the abundance of salmon in seismically active areas comes from an archeological record of Native American occupation on the Olympic Peninsula in Washington State. In comparing excavated evidence of fish use before and after a large seismic event, Mohlenhoff and Butler (2016) found a decline in salmon use, consistent with earthquake-related habitat loss. However, other evidence from the Good Friday Earthquake indicates that earthquakes are not always bad for salmon. On Good Friday, March 28, 1964, southcentral Alaska was struck by the second-largest earthquake ever recorded. The M 9.2 earthquake ruptured a patch of the subduction zone that was approximately 500 miles long and 100–175 miles wide, producing vertical displacements over an area of about 110,039 square miles in Southcentral Alaska (Plafker 1969). Widespread areas south of the Alaska coastline were raised up as much as 18 feet whereas other areas dropped as much as six feet. Portions of the overriding crust moved seaward as much as 50 feet in a matter of minutes, and the earthquake generated multiple submarine landslides and tsunamis (Mann 2000). In a study of the Martin–Bering Rivers, Tuthill and Laird (1966) found that following this historic earthquake, sockeye salmon migrating to Tokun Lake arrived at their spawning grounds earlier, stating “This shorter migration time gave the fish more time for the spawn and should have insured the optimum chance of a successful spawn.” Tuthill and Laird (1966) suggest that the clearing of the water of the outlet streams by the downcutting of the Martin River in response to the earthquake resulted in this more rapid progress of migrating fish.

Clearly, earthquakes can have widespread effects on coastal ecology by affecting tidal regimes in lagoons and marshes (Mann 2000) and causing a wide variety of geomorphic changes (Tuthill and Laird 1966), but such effects, like those of advancing and retreating glaciers, can have either positive or negative effects on salmon depending on circumstance. The most significant source earthquake-related fish mortality is probably earthquake-triggered submarine landslides (Zimmerman et al. 2008). A submarine landslides from the “Good Friday” earthquake resurfaced more than 90 km^2 of the sea floor in the Port of Valdez and deposited material up to 13 km from the source (Haeussler et al. 2007). Witnesses observed large numbers of dead fish following this event, though most were rockfish, indicating either groundfish were most likely impacted by this event or swim bladders made these fish most likely to float, meaning impacts to other fish species cannot be disproved (Zimmerman et al. 2008).

Like earthquakes, volcanos result from Alaska’s association with the "ring of fire," an area bordering the Pacific Ocean that contains numerous volcanoes, resulting from partial melting of the earth's crust caused by active plate tectonics. Alaska's Aleutian Arc volcanoes have formed by the subduction of the Pacific Plate under the North American Plate at the Aleutian Trench. In total, the state has over 130 volcanoes (more than any other state) with 54 considered to be historically active (active within the last 300 years). Volcanoes such as Aniakchak, Katmai, Redoubt, and Chiginagak can affect salmon habitat by several modes, including sedimentation from ash fall, release of acidic or toxic gases, volcanic debris deposition in rivers, and generation of tsunamis (Zimmerman et al. 2008). In Cook Inlet, the initial consequence of the eruption of Redoubt Volcano during 1989–1990 was an interruption of the juvenile rearing stage in the Drift River with hot lahars that boiled the water and eliminated of the riparian zone (Dorava and Milner 1999). In subsequent years, returning salmon encountered migratory impediments and unstable streambeds, and there was evidence this eruption was detrimental to the set net fishery near the mouth of the Drift River (Dorava and Milner 199). However, Dorava and Milner (1999) found that after only five years, the macroinvertebrate community, crucial to juvenile salmon, had essentially recovered, though it is unknown to when and to what extent the salmon will.

Alaska continues to have a dynamic environment with on-going disturbance regimes. Because of the subduction of the Pacific tectonic plate and subsequent melting of earth materials beneath the state, earthquakes, volcanoes, mountain building, glacial retreat, and other deformation events will continue to affect a wide area, altering fish distributions and abundance. ***The geologic history, active disturbance regimes, and the climate limit the opportunity for population diversification through episodic displacement and recolonization***.

1.4.3.2 Marine Habitat Diversity

The Gulf of Alaska biogeographic region is a relatively open marine system encompassing approximately 592,000 square miles (within U.S. Territorial waters) and includes all shoreline, marine waters, and ocean floor to the south between the Canadian border in the east to Unimak Pass to the west. The area includes the marine waters of the Alexander Archipelago, Prince William Sound, Cook Inlet, Kodiak Island, and the southern shoreline of the Alaska Peninsula. The coastline of the region is approximately 24,700 miles long and includes many glacially carved fjords and estuaries (ADF&G 2006). The following marine and marine-adjacent state conservation areas provide additional protections for Chinook salmon habitat.

McNeil River State Game Sanctuary and Refuge	Anchorage Coastal Wildlife Refuge
Goose Bay State Game Refuge	Mendenhall Wetlands State Game Refuge
Palmer Hay Flats State Game Refuge	Susitna Flats State Game Refuge
Trading Bay State Game Refuge	Yakataga State Game Refuge
Tugidak Island Critical Habitat Area	Kachemak Bay and Fox River Flats Critical Habitat Areas
Kalgin Island Critical Habitat Area	Anchor River Critical Habitat Area
Chilkat River Critical Habitat Area	Clam Gulch Critical Habitat Area
Copper River Delta Critical Habitat Area	Dude Creek Critical Habitat Area
Redoubt Bay Critical Habitat Area	Willow Mountain Critical Habitat Area
Ft. Abercrombie State Historical Park	Buskin River State Recreation Site
Pasagshak River State Recreation Site	Shuyak Island State Park
Afognak Island State Park	Kachemak Bay State Park
Kachemak Bay State Wilderness Park	Kenai River Special Management Area
Resurrection Bay, Prince William Sound, and North Gulf Coast State Marine Parks	Chugach State Park
Denali State Park	Alaska Chilkat Bald Eagle Preserve
Chilkat Islands State Marine Park	Chilkat State Park
Funter Bay State Marine Park	Juneau Channel Island State Marine Park
Oliver Inlet State Marine Park	Pavlof Harbor State Marine Park
Point Bridget State Park	St. James Bay State Marine Park
Taku Harbor State Marine Park	Betton Island State Marine Park
Dall Bay State Marine Park	Grant Island State Marine Park
Grindall Island State Marine Park	Big Bear/Baby Bear State Marine Park
Magoun Island State Marine Park	Sealion Cove State Marine Park
Security Bay State Marine Park	Beecher Pass State Marine Park
Hole in the Wall State Marine Park	Joe Mace Island State Marine Park
Thom's Place State Marine Park	

The Gulf of Alaska consists primarily of deep ocean basins, with a narrow continental shelf that makes up only 10% of the total area (approximately 62,000 square miles). The region is strongly influenced by the Alaska Current, which is part of a huge counter-clockwise gyre in the Gulf of Alaska. Almost all of the area is ice-free year-round, and nearshore surface water temperatures range between 32° and 57°F. Offshore surface temperatures tend to be slightly warmer, ranging from 39° to 57°F. Weather is wind-dominated, and the region is well known for generating significant storm events, driving precipitation patterns for much of Alaska, the west coast of Canada, and the Lower 48.

The marine environments in Southcentral Alaska vary from exposed coastlines to sandy barrier islands to deep fjords. In Prince William Sound, water depths reach greater than 2,500 feet and icebergs float at the base of tidewater glaciers. Tides here are large, and a large amount of freshwater flows into the ocean from the land. The rugged Gulf Coast has intertidal and subtidal algal forests, characterized by kelp attached to rocky substrates.

Utilization of marine habitat has been documented by Courtney et al. (2021), who used pop-up satellite archival tags on Chinook salmon caught in the marine waters of Cook Inlet. These tags provided valuable information on migratory characteristics and occupied depths and temperatures while these fish utilized Cook Inlet and the Gulf of Alaska.

1.4.3.3 Freshwater Habitat Diversity

Thousands of rivers and streams enter the GOA from southcentral to southeastern Alaska, laced with a rich mosaic of freshwater habitats including rainforests, glacial fjords, rivers and streams, estuaries, wetland complexes, mountains, broad U-shaped valleys, and glaciers. The complexity and connectivity of this nearly pristine habitat provides for the resiliency of Chinook stocks. The region's habitat, including distinctive features, terrain, vegetation, soil types, and land use have been described by USGS in the Ecoregions of Alaska (Gallant et al. 1995) and 2005 ADF&G Wildlife Action Plan (ADF&G 2006).

Southeast Alaska

The Southeast region (SEAK) has more than 1,000 islands and more than 18,000 mi (29,000 km) of coastline, which is about 20% of the coastline of the entire United States (Audubon Alaska 2016). It is defined by rainforests, glacial fjords, rivers and streams, estuaries, mountains, and glaciers and ranks as one of the largest, most complex, and intact estuarine and temperate rainforest systems on earth (Audubon Alaska 2016).

The Northern Coast Mountains straddle the border between Alaska and British Columbia, with elevations ranging from sea level to 9,840 feet (ADF&G 2006). During the Pleistocene, massive ice sheets covered these mountains. Today heavy winter snows still feed ice fields and glaciers in this ecoregion, but steep, rugged peaks are exposed and retreating glaciers have left U-shaped valleys. During the summer, melting ice feeds swift streams and rivers to the coast. Several interior rivers pass through these mountains—including the Alsek, Taku, Stikine, and Unuk. The subarctic climate in the headwaters of these rivers tends to be drier and colder than the temperate maritime climate. Southeast Alaska includes the southernmost extent of tidewater glaciers (LeConte Glacier, near Wrangell) on the North American continent (Audubon 2016). The Alexander Archipelago consists of thousands of islands, including Prince of Wales, the third largest island in the U.S. Past glaciers carved deep, U-shaped valleys, which filled with seawater when the glaciers retreated. Elevations in the archipelago range from sea level to over 3,280 feet (1,000 meters). Rolling moraine landforms dominate the hills and valley bottoms (ADF&G 2006; Audubon 2016). Tectonic movement and the forces of rebound after glacier retreat have raised and lowered marine terraces, forming rich coastal lowlands and estuaries. Glacial inputs of nutrients and minerals strongly influence the nearshore marine environment, particularly where glaciers flow into bays and fjords (ADF&G 2006). Limestone underlies parts of the ecoregion, and karst topography of sinkholes, caves, underground streams, and fractured bedrock fosters high levels of endemism in plants (ADF&G 2006). With many narrow passages for tidewaters to transit, tidal range and currents can be extreme. The primarily maritime climate results in large amounts of precipitation and surprisingly warm temperatures, given the extent of ice present. The average annual temperature ranges from about 33° to 46°F, though frost is possible at any time of year (ADF&G 2006). Precipitation averages about 30–220 inches per year. The northern part of the ecoregion experiences drier and colder weather. Much of the land not under glaciers is barren rock or alpine tundra consisting of sedges, grasses, and low shrubs. Dwarf and low scrub communities also occur, and Western hemlock, alpine fir, and Sitka spruce inhabit river valleys.

The Audubon Ecological Atlas of Southeast Alaska (Audubon Alaska 2016) describes SEAK watersheds as follows:

> "Most coastal streams are short and, owing to the region's high precipitation, their watersheds contain large expanses of wetlands and riparian zones. Therefore, interactions between land and water are more intense here than elsewhere on Earth. Southeast Alaskan rivers discharge about 90 cubic mi (370 cubic km) of freshwater annually, similar to the discharge of the Mississippi River. Glaciers constantly release fresh phosphorus as they grind bedrock into glacial flour. Many streams in the area also have high concentrations of iron. Coastal waters that carry freshwater runoff and nutrients from the land are entrained within marine currents that drift northward. These marine eddies, which contain unusually high concentrations of nutrients, are hotspots of primary productivity that are primary feeding areas for fish, marine mammals, and birds. "

Glacial fjords and major river systems cut through the mountainous mainland region of Southeast Alaska, bordered to the east by the Coast Mountains and in the northwest by the Wrangell-St. Elias Range The complex, high-relief topography of this region is a product of intense mountain building generated at the suture zone of the North American and Pacific crustal plates. Wrangell–St. Elias Range rises over 15,000 ft (5,400 m) in elevation and forms a substantial barrier to fish colonization into interior regions in this area.

Southcentral Alaska

The Southcentral Alaska biogeographic region encompasses 29,384 square miles and spans from Kodiak Island in the southwest to the Malaspina Forelands in the east (ADF&G 2006). This region includes Cook Inlet, Kenai Peninsula and Prince William Sound, as well as the northern portion of the Aleutian Range, southern drainages of the Alaska Range and the Chugach, Talkeetna, Kenai and St. Elias mountain ranges. Elevation in Southcentral Alaska spans from sea level to the peak of Denali, the tallest mountain in North America (20,320 feet). Gently sloping lowlands were extensively glaciated during the Pleistocene epoch. Hundreds of small lakes and wetland complexes occur in this region. Spruce and hardwood forests dominate the landscape, but varying climatic influences, sporadic permafrost, and rolling topography supports diverse vegetation. Lowlands with wet, organic soils support black spruce stands, and ericaceous shrubs are dominant in open bogs. Uplands contain mixed forests of white and Sitka spruce, aspen and birch. Tall scrub communities, dominated by willow, alder and cottonwood occur in floodplains. A mixture of wetland habitats occurs, from low scrub bog communities to freshwater wet graminoid communities. In the upper elevations of this area, vegetation is sparse, with dwarf scrub communities commonly occurring. Shrub communities of willow, birch, and alder occupy more protected lower slopes and valley bottoms.

The mountains in this area contain the largest area of ice fields and glaciers outside of the polar region. Fjords and archipelagos are common and small lakes occur high in glacier-carved valleys. Several large rivers, including the Susitna, Matanuska, Knik, Kenai, and Copper Rivers, drain from the surrounding mountains. During the summer, meltwater from the snow and ice flows along the base of the glaciers and eventually forms swift, short streams in valleys or inundates coastal flats. Nutrient and mineral contributions from ice-melt into glacial fjords make them some of the most productive marine habitats in the world.

The climate in Southcentral Alaska is a mix of continental and maritime, with continental climate found primarily in the mountain ranges (ADF&G 2006). Continental temperatures range from a winter average minimum of 5°F to a summer average maximum of 64°F. Annual precipitation varies widely by location from about 12 to 30 inches. In contrast, the maritime climate has little seasonal temperature variation, ranging from about 30° to 42°F annually. Clouds and fog are common, and precipitation is heavy, ranging from 50 to 160 inches annually.

The interior Copper River basin consists of many lakes and wetlands and was the site of a large lake during the late Pleistocene (ADF&G 2006). This historic lake was located in the Copper River plateau in an area that now exhibits a nearly level to rolling plain topography. Much of this area has a shallow permafrost table and soils are poorly drained. Black spruce forests and tall scrub are the major vegetation communities in this area. Wetlands, which occupy about 36% of this ecoregion, include low scrub bog communities dominated by sedges. Well drained sites contain coniferous forests dominated by white spruce or broadleaf forests dominated by black cottonwood and quaking aspen. Stream and river corridors are lined with cottonwood, willow, and alder. Spring floods are common along drainages.

The Copper River Delta constitutes the largest contiguous wetland complex on the Pacific Coast of North America at 700,000 acres (ADF&G 2006). The rugged, ice-covered Chugach and St. Elias mountains serve as the backdrop for these lowlands, forming a crescent behind the Gulf of Alaska coastline and reaching from the southern tip of the Kenai Peninsula around to the Fairweather Range in Southeast Alaska. Glacial outburst floods, land subsidence, isostatic rebound, landslides, and localized high-wind events continue to dominate and influence landscape patterns.

Alaska Peninsula

The Alaska Peninsula separates the Gulf of Alaska from the Bering Sea, and its dominant feature is the Aleutian Range, a volcanic spine reaching elevations of 8,580 feet above sea level (ADF&G 2006). This area was historically covered by extensive glaciers, and because glaciers remain on some high peaks, many lakes and rivers contain suspended glacial flour. The lowlands of the peninsula contain many lakes and river basins, some of which terminate in broad estuarine areas. The protected bays and lagoons often have eelgrass beds, which support the food base for many fish and waterfowl. Due to topography, past glaciation, and climate, tundra vegetation characterizes this area below barren and ice-covered peaks. The alpine tundra is a semiarid habitat that supports low shrubs, lichens, mosses, and grasses. Moist tussock tundra of mosses, lichens, and tufted hair grass occurs in mountain valleys and along plateaus. Ponds, lakes, and wetland complexes are also found in this area. Black spruce occurs primarily in interior lowlands and on poorly drained areas. Mixed forests of black or white spruce, balsam poplar, black cottonwood. Paper birch and quaking aspen are also present. Coastal spawning habitats are influenced by tectonic activities and abrupt changes in sea level.

A maritime climate dominates the Alaska Peninsula, with average annual precipitation ranging from about 24 to 82 inches and average annual temperature ranging from about 34° to 39°F. Rain, fog, and persistent winds are common and sea ice does not form, except in a few protected bays and inlets.

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2.0 THREATS

2.1 ADEQUACY OF EXISTING REGULATORY MECHANISMS

2.1.1 Fishery Management Policies & Regulatory Framework

Chinook salmon in Alaska are managed under a complex and comprehensive regulatory framework. Authority for the management of salmon fisheries in Alaska was granted to the state at statehood and was vested with the Alaska Department of Fish and Game (ADF&G, department). The State of Alaska manages all salmon stocks based on the sustained yield principle as promulgated in Article VIII, Section 4 of the Alaska Constitution and in state statute (AS 16.05.730). Also inherent to Alaska's management of salmon is the constitutional objective of developing natural resources to maximize long term and sustainable benefits for Alaskans.

After statehood, Alaska adopted an escapement-based approach to salmon fishery management that stipulated the development and use of spawning escapement goals as the primary management targets for major stocks of salmon. Scientifically defensible Pacific salmon escapement goals are founded on the sustained yield principle. This approach prioritizes the achievement of salmon spawning escapements that will sustain yields into the future over all other uses of salmon, including harvests. Management of salmon stocks for escapement goals, while central to sustaining yields in the long term, at times does require actions that greatly curtail and sometimes prohibit all harvesting activities, especially during times of low salmon productivity and abundance.

Formally adopted in 2000, the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222) includes in regulation the principles and practices already in place. It calls for a precautionary approach in the face of uncertainty such that salmon stocks, fisheries, artificial propagation, and essential habitats are managed conservatively (5 AAC 39.222(c)(5)). Other policies in the Alaska Administrative Code also provide guidance for establishing escapement goals and management decisions, including the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223), the *Policy for the Management of Mixed Stock Fisheries* (5 AAC 39.220), and local fishery management plans (5 AAC 39.200).

An overview and history of the development of the existing management structures for salmon fishing in Alaska can be found in Clark et al. (2006). An overview of escapement goal development and processes can be found in the oral presentations to the Alaska Board of Fisheries (Templin and Hasbrouck 2017; Templin et al. 2021). A synopsis of habitat-related policies and protections can be found in Section 2.1.5.

2.1.1.1 Alaska Board of Fisheries

The Alaska Board of Fisheries (Board) is the state's regulatory authority that passes regulations to conserve and develop Alaska's fisheries resources and is charged with making allocative and regulatory decisions. The Board consists of seven members serving three-year terms. Members are appointed by the governor and confirmed by the legislature. Members are appointed on the basis of interest in public affairs, good judgment, knowledge, and ability in the field of action of the Board, with a view to providing diversity of interest and points of view in the membership (see Alaska Statute 16.05.221).

The Board of Fisheries' responsibilities involve setting seasons, bag limits, methods and means for the state's subsistence, commercial, sport, guided sport, and personal use fisheries, and it also involves setting policy and direction for the management of the state's fishery resources. The Board is charged with making allocative decisions, and the department is responsible for management based on those decisions.

The Board has a three-year meeting cycle and generally holds meetings from October through March—meeting four to six times per year in communities around the state to consider proposed changes to fisheries regulations. The Board uses biological and socioeconomic information provided by ADF&G, public comment received from people inside and outside of the state, and guidance from the Alaska Department of Public Safety and Alaska Department of Law when creating regulations that are sound and enforceable. More information on this process is available on the Board of Fisheries webpage[3].

2.1.1.2 Escapement Goals

The fisheries management policies provide detailed definitions of specific escapement goal types, outline the responsibilities of ADF&G and the Alaska Board of Fisheries in establishing escapement goals, and provide general direction for development and application of escapement goals in Alaska. Currently, there are 264 active salmon stock escapement goals throughout the State of Alaska (Munro 2023).

Formal definitions of escapement goal types can be found in the *Policy for the Management of Sustainable Salmon Fisheries*. The biological escapement goal (BEG) is the escapement that provides the greatest potential for maximum sustained yield (MSY) and is used primarily when estimates of spawners and recruits can be obtained with statistical confidence. The BEG is the primary fishery management objective in the absence of any allocative factors and is developed from and scientifically defensible based on the best available biological information. The BEG is always specified as a range. The sustainable escapement goal (SEG) is the escapement known to provide for sustained yield over a five to ten-year period and is used in situations where a BEG cannot be estimated or managed for. The SEG is the primary fishery management objective in the absence of any allocative factors and is developed from and scientifically defensible based on the best available biological information. The SEG can be a range or a lower bound. In addition, the Board may establish an optimal escapement goal (OEG) or inriver run goal for a given stock. These are allocative in nature to meet specific management objectives determined by the Board.

The SSFP also defines the sustained escapement threshold (SET) as a threshold level of escapement, below which the ability of the salmon stock to sustain itself is jeopardized. Because escapement goals are set to provide for sustainable harvest, the SET, therefore, does not represent any kind of escapement goal and is by definition lower than the lower bound of the BEG or SEG. **No SET has been set for any salmon stock in Alaska** (see Clark and Volk [2013] for an explanation)**,** but if determined to be necessary, SETs are established by ADF&G in consultation with the Board as needed for stocks of management or conservation concern.

It is the responsibility of ADF&G to document, establish, and review escapement goals; prepare scientific analyses in support of escapement goals; notify the public when escapement goals are established or modified; and notify the Board of allocative implications associated with escapement goals. The foundation for this effort are the regional or area escapement goal review teams that are assembled every three years to review goals and recommend changes, establishing new goals or eliminating goals as deemed necessary. These teams have broad expertise in the biological characteristics of salmon stocks

[3] A handout explaining the process is available at http://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/forms/bof_process.pdf

and the technical approaches for establishing escapement goals. A detailed regional report of escapement goal recommendations is presented to the Board and the public at triennial board meetings for that region or area. Following the Board meeting, recommended goals are presented to the directors of the Divisions of Commercial Fisheries and Sport Fish for approval.

A statewide summary report is assembled each year to compile escapement goals and stock performance into a single document as a resource for ADF&G staff, stakeholders, and the public. Included in this report is an overview of the escapement goals as well as the following for each stock: a numerical description of the escapement goal, the type of escapement goal, the year in which the current escapement goal was first implemented, and recent years' escapement data. In addition, statistics documenting achievement of escapement goals are summarized and presented, and a statewide summary of stocks of concern, as recommended by ADF&G and established by the Board, is included. Information on specific methods used to enumerate and develop escapement goals, and associated references with detailed information for each escapement goal, are also provided.

Escapement goals are developed to sustain abundance of salmon stocks at levels that provide both escapement for future production and a surplus of salmon that is available for harvest. Thus, escapement goals, which guide fisheries management, are based on a time series of historical data and represent "average" production over a number of years. These historical data include escapements and in many cases include information on production (the total number of fish that return from a given escapement or brood year). Because of the large number of salmon-bearing rivers across Alaska, the department cannot monitor escapements for all salmon stocks in the state and therefore uses an indicator stock program to provide an ongoing statewide index of Chinook salmon productivity and abundance trends across a diversity of drainage types and sizes, representing a wide range of ecological and genetic attributes. Thus, not all salmon stocks have defined escapement goals.

When sufficient data are available (e.g., the intensively monitored Chinook populations in Southeast Alaska), escapement goals are set at levels estimated to produce the maximum surplus for harvest (S_{MSY}). When data are insufficient for estimating this value, various validated approaches are used (Munro 2023) to select an escapement level that in the past has maintained a stable population as well as a fishery (a sustainable escapement goal or SEG). Thus, for salmon stocks in the State of Alaska, escapement goals are set at levels of escapement that support sustained yield, well above levels for which a stock has consistently demonstrated its ability to sustain itself.

Escapement goals are often expressed as ranges encompassing S_{MSY} to facilitate management and provide for sustained yield over the long term. At the large drainage level, the upper bound of these ranges for Chinook salmon stocks can be as high as 120,000 adults. At the small drainage level, Alaska Chinook escapement goals can have lower bounds as small as 100 adults. In terms of population viability analysis (PVA), these smaller numbers can be misleading when compared to PVA rules of thumb for abundance (e.g., 500–1,000). Chinook salmon have overlapping generations, so the extant adult-equivalent abundance at any one time is more properly the sum of five years of returns. Furthermore, Evolutionarily Significant Units (ESUs), the unit the ESA evaluates for viability, are much larger than a single stock that ADF&G manages for. Rather, a large stretch of a major watershed (e.g., Lower Columbia River Chinook salmon) or an ensemble of proximate smaller watersheds (e.g., Puget Sound Chinook salmon) have been designated as ESUs. Because ADF&G's escapement goals are set to maintain a large harvestable surplus, which requires a healthy abundance, and because of the precautionary management reaction to population declines, the goals are generally far above levels where extirpation of an ESU is a concern.

2.1.1.3 Stock of Concern

Average production implies variability in annual productivity exists, but situations arise when stock production declines for a series of years. Because the department's first priority is to achieve escapement goals, these situations may lead to fisheries restrictions— reducing fishing opportunity in space and/or time, and sometimes through gear via either emergency orders or "trigger points" set in regulation. In some cases, escapement goals are not met despite fishery restrictions and closures. Given the variability in annual production, this is expected to happen periodically, but when it happens consistently over a period of years, it may lead the department to recommend the Board consider a stock be designated a stock of concern. Upon Board designation as a stock of concern, actions are taken to reduce harvest of the stock, improve stock assessment of escapement if not total production, and/or rehabilitate freshwater habitats. The *Policy for the management of sustainable salmon fisheries* (5 AAC 39.222) and the *Policy for statewide salmon escapement goals* (5 AAC 39.223) outline roles, responsibilities, principles and criteria to guide management and regulatory actions for salmon fisheries, including the designation ofsalmon stocks of concern.

Where escapements chronically (over a 4 to 5-year period, approximating the generation time of most salmon) fail to meet expectations for harvestable yield or spawning escapements, ADF&G may recommend—and the Board may adopt—a stock of concern (SOC) designation for those underperforming salmon stocks. The *Policy for the Management of Sustainable Salmon Fisheries* provides definitions for types of stock of concern designation as well as a definition for "chronic inability." Yield concerns arise from a chronic inability to maintain expected yields or harvestable surpluses above a stock's escapement needs. Management concerns, which are more severe that yield concerns, are precipitated by a chronic inability, despite the use of specific management measures, to maintain escapements within the bounds, or above the lower bound, of the established escapement goal. A conservation concern may arise from a failure to maintain escapements above an SET (see 2.1.1.2 *Escapement Goals* above). **To date, the Board has not established any stocks of conservation concern.** A list of current Chinook salmon SOCs can be found in Table 1. A history and review of the SOC process was provided to the Board at the October 2017 Work Session as both an oral presentation (Hasbrouck and Templin 2017) and a written memo (ADF&G 2017).

The Board and ADF&G work together in a defined process to determine if a salmon stock meets criteria as a stock of concern. As part of the escapement goal review that occurs for a regulatory area during a Board meeting cycle, the department reviews escapements, annual harvests, and other data relative to stock of concern designation. The department presents a memo at the Board Work Session held annually in October to inform the Board of any stocks within the regulatory area that appear to meet criteria for stock of concern designation, with a recommendation that the Board discuss this designation at their regulatory meeting. Upon request, ADF&G will draft an action plan for the Board to consider at their regulatory meeting. An action plan generally describes stock status, trends in escapement and harvest, and other factors that potentially impact stock production and/or harvest levels (e.g., changes to fish habitat, expanding and/or new fisheries). The plan also outlines options the Board may consider to implement regulatory action and the impacts of these options on management of the fisheries. The plan also includes options the department could or will undertake to improve stock assessment and/or freshwater habitat. In addition, the action plan provides criteria that should be met before the department recommends delisting a stock to the Board. After a stock is designated a stock of concern and actions are implemented, the department reviews the status of the stock of concern during their triennial review. If actions proved successful and a stock no longer meets the criteria for a stock of concern designation, the department will recommend delisting of that stock; otherwise, the department will recommend continued listing or a change in level of concern.

Table 2.–Chinook salmon stocks of concern in the Gulf of Alaska. (A) Current stocks of concern, and (B) stocks previously designated a stock of concern and later removed because they no longer fit the criteria for listing.

Status	Area	System	Level of Concern	Year Designated	Last Year Reviewed
A	Southeast	Chilkat River	Management	2018	2020[a]
A	Southeast	King Salmon River	Management	2018	2020[a]
A	Southeast	Unuk River	Management	2018	2020[a]
A	Southeast	Stikine River	Management	2022	2020[a]
A	Southeast	Andrew Creek	Management	2022	2020[a]
A	Southeast	Chickamin River	Management	2022	2020[a]
A	Southeast	Taku River	Management	2022	2020[a]
A	Cook Inlet	Chuitna River	Management	2011	2023
A	Cook Inlet	Theodore River	Management	2011	2023
A	Cook Inlet	Alexander Creek	Management	2011	2023
A	Cook Inlet	East Susitna River	Management	2020	2023
A	Cook Inlet	Kenai River (late run)	Management	2023	2023
A	Kodiak	Karluk River	Management	2011	2023
A	Kodiak	Ayakulik River	Management	2020	2023
A	Chignik	Chignik River	Management	2023	2022
B	Cook Inlet	Anchor River	Management	2001	2004
B	Cook Inlet	Lewis River	Management	2011	2019
B	Cook Inlet	Sheep Creek	Management	2014	2020
B	Cook Inlet	Goose Creek	Management	2014	2020
B	Cook Inlet	Goose Creek	Yield	2011	2014
B	Cook Inlet	Willow Creek	Yield	2011	2020

Note: Sheep, Goose, and Willow Creeks are included in the current Eastside Susitna River Chinook salmon designation.

[a] Currently under review. Chilkat, Unuk, and Chickamin stocks may be recommended for delisting (ADF&G 2024 *In prep*).

Since 2001, there have been 21 stock of concern designations for Chinook salmon in Alaska: 19 management concern and two yield concern designations (Table 1). No stocks of conservation concern have been designated. There are currently 15 stocks of management concern and no stocks of yield concern. Of these, Chilkat, Unuk, and Chickamin stocks are up for review during the October 2024 Board Work Session and may be recommended for delisting by ADF&G (ADF&G 2024 *In prep*). Most current stocks of management concern have been listed for six years or less. Four of these, including three from Cook Inlet and one from Kodiak, were designated a stock of concern in 2011, when runs of Chinook salmon stocks began to decrease statewide. No Chinook stocks from the Prince William Sound Management Area have been designated since the policies were adopted.

Most stocks that have been removed from stock of concern status were determined to have recovered in the first 6 years or two Board cycles after listing (10 of 11; 91%). In a few cases, stocks have had their stock of concern designation revised from one level of concern to another. One Chinook stock, Goose Creek, was initially designated as a stock of yield concern (2011) and subsequently redesignated a stock of management concern (2014).

2.1.1.4 Summary of Wild Stock Protections

No Alaska Chinook salmon stock has ever been categorized as a Stock of Conservation Concern. The *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223) specify the processes for setting escapement goals and the conservation actions to be taken when expected yields and escapement goals are not met. Although it is not possible to assess escapement for every Chinook salmon stream in the GOA, those that are assessed are used as indicators of other stocks in proximity. Management actions implemented to conserve assessed stocks, when necessary, provide protections for proximate unassessed stocks.

Chinook salmon escapement goals are reevaluated triennially, even when the escapement goals are met. If harvests are consistently below expectations, the Board designates the stock a "yield concern" and establishes an action plan with protective management measures to rebuild the stock to achieve sustainable levels of maximum yield. If the stock consistently fails to meet escapement goals over a 4 to 5-year period, it is designated as a stock of "management concern" and a rebuilding plan is submitted to the Board. If returns were to fall to levels where extirpation was a concern for any given stock, it would be designated a stock of "conservation concern," defined in the SSFP as "a concern arising from a chronic inability, despite the use of specific management measures, to maintain escapements for a stock above a sustained escapement threshold (SET); a Conservation Concern is more severe than a Management Concern." Because strong conservation measures are mandated by the SSFP well before conservation concerns arise, no SETs—a threshold level of escapement below which the ability of the salmon stock to sustain itself is jeopardized—have been established. **To date there have been no Chinook populations in Alaska designated as a Stock of Conservation Concern**.

Alaska Chinook stocks are not at risk of extinction when they are listed as a Stock of Concern under the SSFP. Again, ADF&G escapement goals are developed to attain maximum sustained yield from a stock over the long term. A failure to provide for *yield* does not mean a stock is at risk of extinction now or in the foreseeable future; it is a concern about the level of harvests. Even the late run Kenai River Chinook salmon stock, which is listed as a stock of management concern, is returning over 12,000 Chinook salmon annually, a level that does not put that stock at risk of becoming endangered or even threatened.

While we agree that there has been a general downward trend in Chinook salmon population abundances throughout most systems that enter the GOA (and range wide) beginning around 2007, the trend did not continue in all populations as asserted in the petition. Chinook abundance levels have not continued to decline for most stocks, and many stocks appear to have stabilized at lower levels of productivity. As such, a number of Alaska Chinook populations have been designated as stocks of concern. Of these, six have been delisted since, and another three of the remaining 15 stocks of management concern have met the criteria for delisting as of this writing and may be recommended for delisting in the upcoming 2024/2025 Board cycle (ADF&G 2024 *In prep*). The delisting of stocks that have been rebuilt is strong evidence that Alaska's policies and salmon management framework are effective at conserving wild salmon stocks; thus, listing these stocks as threatened or endangered under the ESA is unwarranted.

2.1.1.5 Summary of Management Conservation Measures

In multiple cases, stocks with below-goal escapements have responded positively to directed management measures. Regulations such as fishing seasons, fishing areas, fishing periods, methods, and means are established by the Board of Fisheries. These are the products of scientific knowledge regarding the timing of runs, historical catch data, forecasts of salmon abundance, and includes some economic and social considerations. These regulations are in place prior to the fishing season, allowing fishermen the ability to plan, somewhat, for the fishing season in advance.

However, unexpected deviations from preseason forecasts in salmon run timing and abundance can occur which necessitate readjustment of fishing time and area. Occasionally run timing and strength vary substantially from the norm. The department has a mandate to address this, as described by Edfelt (1973), *"[T]his requires immediate, on-the-spot correction to avoid overharvest with a subsequent reduction in the desired escapement. This check valve, supplied by statute, allows the department to summarily modify time and area regulations when the necessity arises to more precisely tailor fishing intensity to salmon run strength.*"

Thus, when a stock is not projected to meet its escapement goal, management actions in the form of emergency orders that adjust fishing time, area, methods, and/or means are taken to reduce fisheries as required under the SSFP. To provide responsive management, the department relies on preseason forecasts at the onset of each fishing season, then transitions to inseason indicators of run-strength (escapement enumeration, fishery catch per unit effort, etc.) as the season progresses. When salmon runs appear insufficient to support harvest opportunity and meet escapement goals within a season as indicated by inseason metrics of abundance, restrictions are typically applied in river and in the area of the river terminus (terminal area). A discrepancy between forecasted and realized run abundance in one year generally translates into more conservative management at the onset of the fishing season the following year until inseason metrics indicate there is enough fish to support a harvestable surplus in excess of escapement needs. If escapement goals are not met in successive years, this often entails fishery-specific restrictions in river, in terminal areas and in near-terminal areas. When a pattern of poor productivity develops, stocks can be designated stocks of concern (SOC) by the Board and an action plan is developed. This plan, in prescribing management actions to bolster spawning escapement to protect the wild stock of interest, takes into consideration harvest of other salmon species, allocation issues between fisheries, and socio-economic factors. Upon designating an SOC, all directed fisheries, including subsistence, are closed preseason and remain closed unless otherwise indicated by escapement counts of the SOC, and near-shore coastal mixed-stock fisheries are reduced or shaped in time and/or area to avoid the SOC. If the pattern of poor productivity persists, then offshore fisheries and fisheries targeting other species that intercept the SOC may also be subject to management action.

The department's responsiveness and the extent of management actions taken depends on the amount and timeliness of information available. Some stocks are data rich and can provide managers with preseason forecasts, inseason stock composition, inseason run size estimates, and accurate estimates of escapement. For these stocks, management actions are highly responsive, and actions can be taken before the season commences based on preseason forecasts and can be taken during the season based on inseason assessment of abundance. Like all other stocks managed across Alaska, management actions are assessed postseason by comparing harvests and escapement. Other stocks with enough information to make preseason forecasts, inseason assessments, and accurate estimates of escapements can be managed largely on preseason forecasts and inseason trends of escapement in relation to harvests.

However, some stocks may only have estimates of escapement available postseason. For these stocks, management actions are reactionary to escapements observed in prior years and do not consider increases or decreases in abundance inseason. The following provides examples of how the department and BOF responded to periods of low productivity in certain Chinook salmon stocks.

The Taku River has the largest Chinook salmon run in Southeast Alaska (SEAK). It is a transboundary river originating in Canada and subject to the provisions of the Pacific Salmon Treaty (Pacific Salmon Commission 2020). Harvests of Taku Chinook have occurred in directed fisheries and they are incidentally harvested in fisheries targeting other stocks or species (e.g., Taku River sockeye salmon) by both the U.S. and Canada. In 2016, after meeting escapements in 27 of the prior 30 years, productivity dramatically decreased. That year, the preseason forecast suggested the Taku River Chinook salmon run would meet the escapement goal. As a result, the inriver Chinook salmon assessment fishery in Canada, designed to operate as a recapture event for the stock assessment project, operated in statistical weeks (SW) 19–23. However, inseason mark–recapture (MR) results indicated the run would be insufficient to achieve the escapement goal so the last two weeks of the assessment fishery in SWs 24–25 were cancelled. In addition, area and gear restrictions were imposed in the first week of the District 11 directed sockeye salmon commercial drift gillnet fishery to conserve Taku River Chinook salmon. Then, from 2017 to 2021, preseason forecasts indicated the annual Taku River Chinook salmon runs would be below the escapement goal range, triggering management actions in U.S. and Canadian fisheries. For Alaska fisheries, management actions included time, area, and mesh size restrictions in the District 11 commercial drift gillnet fishery, nonretention of Chinook salmon in the sport fishery through the end of June, nonretention of Chinook salmon in commercial troll fisheries through mid-July, and delayed openings of the Taku River personal use sockeye salmon fishery by up to 2 weeks. In addition, winter and spring troll fisheries as well as the sport fishery were already restricted per the *Chilkat River and King Salmon River king salmon stock status and action plan, 2018* (Lum and Fair 2018a). If not already restricted under this plan, restrictions to these nonterminal fisheries would have been recommended. In 2021, after five years of failing to meet escapement goals (Hagerman et al. 2022), the Taku Chinook salmon stock was recommended by the department and adopted by the BOF as a stock of management concern. To increase escapement, the BOF recommended specific management actions outlined in the *Northern Southeast Alaska Chinook Salmon Stock Status and Action Plan, 2022* (Hagerman et al. 2022). The department has continued to evaluate the effectiveness of those actions prescribed by the action plan and has taken more conservative actions where appropriate.

The Chilkat Chinook salmon, another SEAK stock, was designated an SOC in 2018 after not meeting the escapement goal in 4 of the prior 5 years (Lum and Fair 2018a). The Chilkat River Chinook salmon run is also managed under the *5 AAC 33.384 Lynn Canal and Chilkat River King Salmon Fishery Management Plan.* The assessment program for the Chilkat River is not as comprehensive as for the Taku River but it does provide an indication of run size in season. Additional management actions in sport, commercial, and subsistence fisheries, above those actions prescribed by the regulatory management plan, began in 2012 when the preseason forecast indicated the run was likely to be below the escapement goal range. Management actions were focused on the terminal waters of District 15 near the mouth of Chilkat River. In 2013, the preseason forecast indicated the goal would be met; however, inseason information indicated the run would be below the preseason forecast and below the escapement goal. As a result, management actions in the sport and commercial drift gillnet fisheries were more restrictive than prior years' actions to reduce harvest of Chilkat River Chinook salmon. From 2014 through 2017, preseason forecasts indicated the escapement goal would not be met so increasingly restrictive management actions were taken to reduce harvests of Chilkat Chinook salmon each year through 2017. In 2017, management actions expanded to the commercial troll fishery within District 15 and to areas outside of the district not only in the summer troll fishery but also in the winter and spring fisheries in northern Southeast Alaska. In addition, the subsistence fishery in the Chilkat River was further restricted. From 2018 through 2021, sport, commercial, and subsistence fisheries were managed under the actions prescribed by the *Chilkat River and King Salmon River king salmon stock status and action plan, 2018* (Lum and Fair 2018). In addition to the actions prescribed by the plan, further actions were taken in the District 15 commercial drift gillnet fishery. Following these extensive efforts, the escapement goal was achieved in 3 consecutive years from 2019 through 2021, which met the criteria for removing Chilkat River Chinook salmon as stock of concern. However, the department did not recommend delisting the stock because the run in 2022 was anticipated to be poor and below goal. The Board continued the Chilkat River Chinook as an SOC and recommended many of the same management actions be continued. The escapement goal has now been met in 4 of the past 6 years, which meets the criteria for delisting. The department is recommending removal as a stock of a concern but because surplus production is still low, restrictive management actions are expected to continue.

The Chickamin River Chinook salmon stock was listed an SOC in 2021 after failing to meet the lower end of the BEG range in the previous four of five years (Meredith et al. 2022). The Chickamin River is data limited so there is no preseason forecast and no inseason assessment although escapements are available postseason. Management actions are predicated on escapements observed in prior years. The Chickamin River Chinook salmon stock benefited from the management actions taken for the neighboring Unuk River Chinook stock as prescribed by the *Unuk River King Salmon Stock status and Action Plan, 2018* (Lum and Fair 2018b) because the two stocks are in Behm Canal in SEAK and have similar run timing and migration routes. As a result, no additional management actions were recommended to reduce harvest of Chickamin River Chinook. Since listing, the Chickamin Chinook stock has met the escapement goal in 4 consecutive years, meeting the criteria for delisting as a stock of concern.

Stock of concern action plans have been made for Chinook stocks outside of SEAK. In Cook Inlet, the late-run Kenai River stock has failed to meet its escapement goal in five consecutive years since 2019. This was despite specific management measures taken by the department to reduce harvest in the sport, personal use, and commercial fisheries. Because of this, the late-run stock was identified as an SOC by the Board in 2024. Coincident with this determination, the Board adopted an Action Plan aimed at rebuilding this stock (Miller et al. 2023). Under this plan, the directed inriver Chinook salmon sport fishery is closed when the department projects the escapement goal will not be met. Retention of Chinook is prohibited in the personal use dip net fishery that occurs at the mouth of the Kenai River. Use of bait is also restricted in other inriver sport fisheries that could incidentally take Chinook salmon (e.g., the directed inriver coho salmon fishery). Finally, all marine sport fisheries for Chinook salmon north of Bluff Point are closed. The Eastside set net (ESSN) commercial fishery, which targets sockeye, is also closed under this plan when the department projects the escapement goal will not be met. To allow for some sockeye harvest opportunity, the Board authorized dip net gear in the ESSN fishery area in 2024, specifying a requirement that any Chinook or coho salmon taken incidentally must be released alive. Even if the escapement goal is projected to be met, time, area, and gear are still restricted in the ESSN fishery to assist in rebuilding harvestable surplus in the Kenai River late-run stock. As of 2023, management of the driftnet fishery in the Cook Inlet EEZ was transferred to NOAA Fisheries, and a Chinook salmon harvest cap was put in place in 2024 that closes the fishery if the cap is exceeded.

The harvest of Chignik River Chinook on the Alaska Peninsula is primarily incidental to targeted commercial fishing for sockeye salmon, although limited directed sport and subsistence fisheries also occur. In 2013, the run appeared unable to meet the escapement goal of 1,300–2,700 Chinook salmon and accordingly, the department restricted the terminal commercial fishery near the Chignik River to nonretention of large Chinook (greater than 28 inches), closed the inriver sport fishery, and prohibited the use of bait and treble hooks to reduce the occurrence of hooking-related injury and mortality. As escapement continued to lag in 2013, the nonretention restrictions were expanded to commercial fishing in the waters adjacent to the terminal fishing areas. The escapement goal was met in 2014–2016 and no restrictions with respect to Chinook salmon were enacted on the commercial or sport fishery in those years. Since 2017, Chinook escapement goals have not been achieved, except for 2019, and both commercial and sport fisheries have been restricted with similar management actions as in 2013. The department also restricted the state managed Chinook subsistence fishery beginning in 2018 and continuing each year since, except in 2019. In 2018 and 2020, commercial fishing for sockeye salmon was severely restricted or closed entirely, resulting in no incidental harvest of Chinook within the entire management area. In February of 2023, Chignik Chinook salmon were designated an SOC by the Board. Preseason regulatory nonretention of Chinook was instituted in the commercial sockeye salmon fishery in accordance with the action plan until the Chignik Chinook run appeared able to meet the escapement goal. In 2024, further restrictions beyond those outlined in the SOC action plan were enacted by the department to protect Chignik Chinook, wherein fishing periods in the terminal fishery were restricted to a maximum of 48 hours of fishing per week when sockeye salmon escapement objectives were being met and a maximum of 96 hours per week if sockeye salmon objectives were exceeded. Nonretention of large Chinook was expanded to the entire Chignik commercial fishing area. Additionally, a portion of the terminal fishing area known locally as the “King Hole” remained closed for the season, regardless other commercial openings. These additional restrictions have caused a foregone harvest of sockeye salmon in favor of Chinook salmon conservation.

2.1.2 Hatchery Policies, Plans, and Permitting

Alaska’s fisheries enhancement program prioritizes minimal impact on wild stocks. Alaska’s fisheries enhancement program has been designed since its inception in the 1970s to protect wild salmon stocks (McGee 2004). The program is based on a review of the practices and results of salmon enhancement programs that existed elsewhere, taking lessons from these to ensure the Alaska fisheries enhancement program minimizes risk to wild populations. Accordingly, ADF&G worked with a broad consortium of expertise at other regulatory agencies, veterans of Pacific Northwest hatcheries, the University of Alaska, and fishermen’s associations to formulate guidelines and policies for the hatchery programs in the mid-1970s–1980s (reviewed in McGee 2004). In Alaska, the state constitution requires natural resources to be managed sustainably (Article VIII, Section 4). A framework of statutes, regulations, and policies has been developed to guide the growth of the Alaska hatchery program with the intent to minimize risk to wild stocks (McGee 2004; Evenson et al. 2018). A good overview of the salmon hatchery program in Alaska statewide can be found in Wilson (2023) and for Southeast Alaska in Heard (2012).

ADF&G recognized the need to minimize the effects that enhancement could have on wild stocks and adopted standards with respect to hatchery location, genetic and disease policies, culture techniques, monitoring, data collection, and management. For example, hatcheries generally use stocks taken from close proximity so that any straying of hatchery returns will have similar genetic makeup as the stocks from nearby streams. Furthermore, Alaska hatcheries do not selectively breed salmon. Large numbers of broodstock are used for gamete collection to maintain genetic diversity, without regard to size or other characteristics.

Detailed planning and permitting processes for salmon hatcheries ensure adherence to sustainable fisheries management, genetic, and fish health and disease policies (AS 16.10-375–16.10.480; 5 AAC 40.005–40.990; Fish Transport permits 5 AAC 41.001–41.090). Additional guidance is provided by:

1. *Policy for the Management of Sustainable Salmon Fisheries.* (AAC 39.222). Formally adopted in 2000, the SSFP incorporates into regulation the principles and practices already in place. The regulation calls for a precautionary approach in the face of uncertainty such that salmon stocks, fisheries, artificial propagation, and essential habitats are managed conservatively (5 AAC 39.222(c)(5)).
2. *Genetic Policy.* The *ADF&G Genetic Policy* (Davis et al. 1985) sets restrictions and guidelines for stock transport, protection of wild stocks, and maintenance of genetic variance. This policy and other relevant information are used by ADF&G geneticists when they review requests for hatchery-related permits as well as the use and transportation of live fish within the State of Alaska.
3. *Fish Health and Disease Policy.* The *Alaska Fish Health and Disease Control Policy* (5 AAC 41.080) is designed to protect fish health and prevent spread of infectious disease in fish and shellfish. The policy is used by ADF&G fish pathologists to review hatchery plans and permits. The policy and associated guidelines are discussed in Policies and Guidelines for Alaska Fish and Shellfish Health and Disease Control (Meyers 2014), which includes policy guidelines for FTPs, broodstock screening, disease histories, and transfers between hatcheries. These regulations and guidelines are used by ADF&G fish pathologists when they review hatchery permits.

2.1.3 Habitat Policies, Plans, and Permitting

Alaska Chinook salmon freshwater habitats are minimally impacted and extensively protected by state and federal regulation and cooperation with other entities. The petition correctly notes that "freshwater spawning and juvenile rearing habitats in most Alaska Chinook rivers are in relatively healthy or minimally disturbed condition"[4]. Aside from that statement, however, the petition fails to describe the array of State and Federal statutes and regulations that protect and maintain the quality of water bodies that support salmon and other species.

As a territory and then a young state, Alaska observed the potential for the degradation of salmon populations as the Pacific Northwest grew in population and industry. Unlike other states, Alaska employed these observations and incorporated respect for its natural resources into the state constitution. This innovative document serves as the foundation for a comprehensive regulatory structure that is designed to ensure that Alaska streams would continue to sustain salmon—Chinook salmon, in particular—for the foreseeable future.

Article VIII, Section 4 of the Alaska Constitution provides "Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield of principle, subject to preferences among beneficial uses." The directives of the constitution were laid out in statute under Alaska Statute (AS) Title 16, Chapter 05, which includes laws to protect clean water and habitat important to salmon and other fish. These laws are implemented by ADF&G, which was created as a cabinet-level department run by a commissioner, who answers directly to the governor.

[4] Petition, p. 7.

Alaska's fish habitat protection statutes were adopted shortly after statehood and remain unchanged to this day. This reflects the longstanding Alaskan ideal that fishery resources and habitats are assets that improve our quality of life and merit protection from unnecessary human disturbance.

The primary Alaska statutes that provide comprehensive protections for fish habitat, fish passage, and adequate stream flow have been summarized by ADF&G as follows:

> Since statehood, ADF&G has been responsible for the protection of salmon habitat and for ensuring safe passage for all Alaska fish species. Strict laws and regulations govern industrial activities and development in or near fish-bearing water bodies, such as road building, logging, and mining.
>
> Four state laws work together to protect salmon spawning and rearing habitats: the *Anadromous Fish Act*, the *Fishway Act*, the *Alaska Forest Resources and Practices Act*, and the *Alaska Water Use Act*.
>
> The *Anadromous Fish Act*[5] has been the cornerstone of the state's salmon habitat protection programs for over half a century. It requires ADF&G to identify rivers and streams that are important for salmon rearing, spawning, or migration. These are included in an *Anadromous Waters Catalog*[6] that now includes almost 20,000 streams, rivers, and lakes in Alaska. For waters in the catalog, the *Anadromous Fish Act* requires that an individual or government agency get approval from ADF&G for projects that may be harmful to fish. These instream activities include building road crossings, filling or removing gravel, placer mining, withdrawing water, stabilizing the bank, or driving a vehicle across a waterway.
>
> The *Fishway Act*[7] complements the Anadromous Fish Act by requiring fish passage to be provided in streams frequented by all species of fish. It requires that dams or obstructions built across a fish stream allow effective fish passage; the state can seek compensation for any loss of habitat and fish production. Improperly designed or installed culverts can block or restrict movement of salmon and resident fish species such as rainbow or cutthroat trout. With Alaska's continued growth and improvements to roads and highways throughout the state, it is more important than ever to ensure culverts are designed and built so that salmon and other fish can move safely between spawning and rearing habitats.

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[5] Anadromous Fish Act (AS 16.05.871 – 901) requires notice and permitting by ADF&G of activities within "specified" anadromous waterbodies, i.e., waterbodies identified in the Anadromous Waters Catalog, the legal record of anadromous streams in Alaska, which is updated annually. *See* https://www.adfg.alaska.gov/index.cfm?adfg=habitatregulations.prohibited

[6] The *Anadromous Waters Catalog* and accompanying *Atlas* are governed by AS 16.05.871. *See* https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=intro.purpose

[7] The *Fishway* (or Fish Passage) *Act***,** governed by AS 16. 05.871, requires a permit from ADF&G for activities in fish-bearing streams that would block upstream passage of fish. *See* https://www.adfg.alaska.gov/index.cfm?adfg=habitatregulations.prohibited

The *Alaska Forest Resources and Practices Act*[8] governs how timber harvest activities occur on state, private, and city land. Forest management standards are designed to prevent adverse impacts to fish habitat and water quality. The act's standards include retention of trees as buffers along salmon streams to provide habitat, ensure bank stability, and protect water quality. Bioengineering bank stabilization techniques are now the preferred method to stabilizes eroding banks to protect infrastructure which provides an increase in riparian vegetation and promotes additional development of good salmon habitat.

The stream flow and water volume necessary for salmon passage, spawning, incubation, and rearing are protected under the *Alaska Water Use Act*[9]. In Alaska, water is a common property resource, so landowners do not have automatic rights to use groundwater or surface water. The Alaska Department of Natural Resources is responsible for reviewing and authorizing the temporary or permanent use of state water resources. Alaska is one of the states providing the opportunity for private individuals, in addition to state, federal, and local governments, to legally reserve water in rivers and lakes. Instream flow reservations will play an increasing role in salmon habitat protection, making certain salmon have enough clean water for their complete life cycle.

2.1.3.1 Culverts and Bridges in Fish Habitat

Fish passage and conveyance has been an important conservation priority in Alaska for more than 25 years. Much progress has been made toward evaluating the performance of existing culverts, correcting past problems, and setting new construction standards. In 1998, the U.S. Forest Service agreed to submit plans for roads crossing salmon streams to ADF&G biologists for their review and concurrence. As a result, fish passage along new roads in Alaska's National forests is greatly improved.

In 2001, ADF&G and the Alaska Department of Transportation and Public Facilities (ADOT&PF) signed a Memorandum of Agreement (MOA)[10] for the design, permitting, and construction of culverts for fish passage on state roads; the latest update of this MOA is currently under review. Although this document is not meant to serve as fish passage guidelines for the State of Alaska, it does serve as an acknowledgement of the importance of fish-passage culverts for maintaining healthy fish resources, and that a minimum set of standards is necessary for designing and permitting culverts along state roads to insure fish conveyance. The MOA also serves as evidence that Alaska has long recognized the impacts of undersized culverts on fish habitat and is actively pursuing ways to ensure no new fish passage barriers are installed on state roads.

In addition to the State requirements fish passage on state roads, the Matanuska-Susitna (Mat-Su) Borough, a rapidly developing area of the state, has recognized the benefits of culverts designed for fish

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[8] The Alaska Forest Resources and Practices Act (AS 41.17) and Regulations □ set standards for forest management along waterbodies, including buffers; prevent erosion from roads and harvest areas into waterbodies; and establishes roles for DEC and ADF&G to ensure protection of water quality and fish habitat. *See* https://forestry.alaska.gov/forestpractices#act

[9] The Alaska Water Use Act (AS 41.15.035). *See* https://dnr.alaska.gov/mlw/water/rights/

[10] *See* 2001 ADF&G/DOT MOA: https://dot.alaska.gov/stwddes/desenviron/assets/pdf/procedures/dot_adfg_fishpass080301.pdf

passage. The Mat-Su Borough Assembly adopted fish-passage standards for the Borough in their subdivision construction manual,[11] and annually allocates capital project funds for fish-passage projects.

The current ADF&G culvert database contains 2,330 known culverts in Southeast, Gulf of Alaska, and Cook Inlet drainages. Of these, 955 are rated as red, or most likely barriers to fish. Since 2004, ADF&G fish passage staff have worked with relevant parties to replace more than 330 poorly functioning culverts with stream-simulation design culverts or bridges. These numbers are not comprehensive because ADF&G and partner organization staff continue to locate new culverts as this is written, and the ADF&G Fish Passage Program staff are not involved in every fish passage project in the state, including most ADOT projects. ADF&G's current fish-passage work is driven by a "grassroots, bottom up approach" with local partners. These core partners include but are not limited to the following:

AKDOT & PF	US Forest Service	Eyak Tribe
US Fish and Wildlife Service	Tyonek Native Conservation District	Cooper River Watershed Project
NOAA/NMFS	Native Village of Chickaloon	Kenai Watershed Forum
NCRS	Knik Tribe	Southeast Alaska Watershed Coalition

2.1.3.2 Maintaining Water Quality and Preventing Pollution in Fish Habitat

Alaska has created regulatory provisions to maintain and implement high water quality standards in fish habitat, which is critical for maintaining sustainable populations of salmon. As described in its by ADF&G in its Alaska's Wild Salmon publication:[12]

> Salmon are particularly vulnerable to the effects of pollution during their life in fresh water. The Alaska Department of Environmental Conservation (DEC) administers the federal Clean Water Act in conjunction with the federal Environmental Protection Agency. Alaska's water quality standards are designed to protect aquatic life, including salmon and their food sources. DEC monitors and regulates pollutant discharges from direct sources, such as sewage treatment plants and industrial operations, and from indirect sources, such as community storm water controls and construction projects. Through this work, DEC ensures that projects meet high water quality standards in both marine and fresh waters and protect fish from the effects of toxic pollutants as well as sediments and the impact of elevated temperatures.
>
> The handling of oil and hazardous substances can pose a threat to water quality. The state has laws that prohibit the discharge of oil or hazardous substances, require prompt reporting when a spill does occur, and mandate containment and proper disposal of all waste materials. Alaska's oil spill response laws extend to all self-propelled ocean vessels over 400 gross tons. Alaska has a strong oil transportation system, thanks to strict state regulation and monitoring, industry investment, and the efforts of concerned citizens.

Following is a summary of Alaska's Department of Environmental Conservation (DEC) water quality programs and Federal obligations:

[11] See 2022 Mat-Su Borough Subdivision Construction Manual, p. 31: https://matsugov.us/document/2021-subdivision-construction-manual

[12] ADF&G. 2019 Alaska's Wild Salmon, Alaska Department of Fish & Game, Juneau, AK.

Oil Spill Prevention and Response

DEC's Spill Prevention and Response (SPAR) Division's activities are specifically focused on oil spill prevention and assurance of adequate oil spill response. It is the specific responsibility of DEC to ensure that the environmental consequences of an oil spill discharge can be mitigated to a degree protective of human health and the environment by requiring regulated owners and operators to be prepared to respond to and clean up oil spills under typical environmental conditions. Oil discharge prevention and contingency plans are required under Alaska Statute (AS) 46.04.030 and Alaska Administrative Code regulations 18 AAC 75.

The State of Alaska requires oil discharge prevention and contingency plans for the following facilities:

- Terminals and distributors of crude and refined oil products
- Marine tankers and barges that transport crude and refined oil products
- Crude oil pipelines
- Onshore and offshore oil exploration and production facilities
- Refineries
- Nontank vessels

The SPAR *Prevention, Preparedness and Response Program* requires regulated facilities and vessels to develop state-approved oil discharge prevention and contingency plans, to establish a facility-wide spill prevention program, and to ensure that personnel, equipment, and financial resources are available to respond to spills. DEC-approved contingency plans are available online[13]. In the event of an oil spill, the SPAR *Prevention, Preparedness and Response Program* also provides oversight of emergency responders to oil and hazardous substance spills and ensures that cleanup measures are adequate and timely. DEC, EPA, and the United States Coast Guard manage response operations in accordance with the *Alaska Regional Contingency Plan* and *Area Contingency Plans*. These plans include requirements for sensitive area protections, which can include anadromous fish streams.

Please also note that Alaska's oil discharge prevention and contingency plan requirements are more stringent than the federal oil spill standards through the Oil Pollution Act of 1990 (OPA 90). Alaska standards (18 AAC 75) require the operator produce a plan to "contain or control, and clean up within 72 hours," whereas the federal standards only require a plan to remove and control "to the maximum extent possible," with no specific time standards[14]. DEC keeps a database of spills and analyzes the database to prioritize protection of Alaska's resources. The DEC's annual reports[15] analyzing spill activity support the following conclusions:

- Oil (both crude and noncrude oil products) constitute most of the reported spills. In Fiscal Year 2022 oil spills constituted over 70% of the reported spills.
- Spills from unregulated vessels were most common for the coastal areas of Kodiak, Cook Inlet, and the Aleutians. These marine spills generally occurred during the commercial fishing season, typically from April through September.

Industrial Wastewater Discharges

[13] https://dec.alaska.gov/spar/ppr/contingency-plans/response-plans/
[14] 49 C.F.R. Part 130
[15] https://dec.alaska.gov/spar/reports/

The DEC issues seafood processing permits with strict standards for any wastewater discharges from land-based or vessel-based facilities. The DEC has a GIS database of seafood processing facilities and information is available online[16].

This database provides facility locations and discharge locations for Alaska seafood processing facilities, as well as existing sensitive areas. This GIS database includes separate layers for permit AKG523000, the Alaska Offshore Seafood Processor general permit, permit AKG520000, the Alaska Seafood Processor general permit, as well as several individual seafood processing facility permits.

The Alaska *Pollutant Discharge Elimination System* is based on the same water quality standards as the EPA's *National Pollutant Discharge Elimination System*. Given the importance to Alaska's world class fisheries, the DEC takes its responsibility for water quality very seriously and these permits ensure that Alaska waters are protected under strict environmental standards and regulatory authority. It should be clear that existing environmental protections are adequate without the endangered species listing.

Water Quality Protection

The Federal *Clean Water Act* (CWA) mandates that each state assess the quality of its surface and groundwaters and prepare a report describing the status of these waters. The U.S. Environmental Protection Agency (EPA) then compiles and summarizes the information from all the state reports and sends this information to Congress. For this effort, DEC compiles readily available data from multiple sources in addition to leading field monitoring efforts across Alaska. These data are then assessed against Alaska's water quality standards.

Alaska utilizes publicly reviewed methodologies for assessing water quality and solicits public input during a public notice period for draft assessments. Final assessments are submitted to the EPA as required by several sections of the CWA: Section 305(b) requires that the quality of all waterbodies be characterized; Section 303(d) requires that states list any waterbodies that do not meet water quality standards. DEC uses a data-driven approach for water quality assessments and has over 90 water body assessment units currently listed as impaired; this includes fresh and marine waters. Impaired waters are regulated in a number of ways. DEC develops Total Maximum Daily Loads (TMDLs) or alternative recovery plans; both have enforceable limits and identified actions.

The State of Alaska takes great pride in its water quality and is active in managing it for all uses. DEC recognizes that impaired waters routinely require collective action from multiple agencies and works cooperatively to address concerns. Several recent examples include partnerships with ADF&G to lower boat wakes and require updated outboard motors to address turbidity and petroleum concerns in freshwater rivers. This cooperation resulted in improved water quality and delisting of impaired waters. In the marine environment, DEC was awarded an Exxon Valdez Trustee grant in 2023 to re-evaluate beaches impacted during the 1989 Exxon Valdez oil spill. DEC had listed 34 beaches as impaired and is currently re-examining the status of all impacted beaches.

Prevention is the first approach that DEC takes to ensure waters are meeting Alaska water quality standards. Pollution prevention is achieved by working with communities to develop voluntary protections plans, addressing non-point pollution prevention across the state with community partnerships and grants, and regulating discharges through the *Alaska Permit Discharge Elimination System* (APDES). DEC was granted full primacy for the APDES program in 2012.

[16] https://www.arcgis.com/home/item.html?id=d686c1f3c1e54e7c910a55ca8c9f15b2

Additional Habitat Information
Alaska's Integrated Water Quality Monitoring and Assessment Report available at
https://dec.alaska.gov/water/water-quality/integrated-report
DEC Wastewater Permits Database, available at
https://dec.alaska.gov/Applications/Water/EDMS/nsite/map/help
DEC Environmental Data Management System (EDMS)
https://dec.alaska.gov/Applications/Water/EDMS/ncore/external/home
Ambient Water Quality Monitoring
https://dec.alaska.gov/water/water-quality/monitoring-and-assessment/watershed-health-and-data-analysis/ambient-marine-water-quality-monitoring
DEC-SPAR-PPR Approved Oil Discharge Prevention and Contingency Plans
https://dec.alaska.gov/Applications/SPAR/PublicMVC/IPP/ApprovedCPlans/
Alaska Regional Contingency Plan and Area Contingency Plans
https://dec.alaska.gov/spar/ppr/contingency-plans/response-plans/
DEC GIS Web Maps, available at
https://dec.alaska.gov/das/gis/apps/

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2.2 UTILIZATION

2.2.1 Harvest

Fishery data show that harvests of Alaska Chinook salmon are sustainable. Chinook salmon are harvested in the Gulf of Alaska (GOA) in state managed commercial, sport, subsistence, and personal use fisheries; federally managed subsistence fisheries; and Annette Islands Reserve fisheries managed by the Metlakatla Indian Community. Chinook are also caught incidentally in nontarget salmon fisheries (legal harvest and sale) and as bycatch[17] in state and federally managed commercial fisheries targeting non-salmon species such as rockfish and pollock (i.e. prohibited species catch).

Historically, commercial salmon fishing in Alaska was under federal management until 1960, one year after statehood, when the State of Alaska assumed management of a depleted resource with the goal of rebuilding salmon populations and managing them sustainably (Clark et al. 2006). As the newly formed ADF&G developed its salmon management framework, several noteworthy bills and policies were implemented that directly affected Alaska fisheries and harvests. Article 8, Section 15 of Alaska's Constitution was amended by popular vote in 1972 to provide critical tools for restoring and maintaining the state's fishing economy, including the ability to limit fishery entry and promote the efficient development of aquaculture. This amendment gave rise to Alaska's salmon hatchery program in an effort to relieve fishing impact on wild stocks (see Section 2.1.4 of this document), and the Alaska legislature passed a bill in 1973 creating the limited entry permitting system to stabilize the number of fishery participants and regulate allowable gear. In 2000, the *Policy for the Management of Sustainable Salmon Fisheries* and *Policy for Statewide Escapement Goals* were adopted into state regulation (Clark et al. 2006).

In addition to the state policies, several notable policies and agreements were promulgated nationally and internationally affecting harvest of Chinook salmon in Alaska. These include the International Convention for the High Seas Fisheries of the North Pacific Ocean (1952), the Convention for the Conservation of Anadromous Stock in the North Pacific Ocean (1992), and the Pacific Salmon Treaty (Pacific Salmon Commission 2020). The Pacific Salmon Treaty (PST; Treaty) was signed by the governments of the United States and Canada in 1985, recognizing that salmon spawned in the rivers of one country often mature in or migrate through the ocean waters of the other country. The fundamental goals of the Treaty are to conserve Pacific salmon and to provide for the optimum production and fair sharing of the harvest of salmon. Accordingly, the Treaty sets catch limits for the Southeast Alaska (SEAK) Chinook salmon fishery as well as Canadian and the Pacific Northwest U.S. fisheries. Treaty fishery management regimes are of limited duration and thus must be renegotiated from time to time as the status and condition of the resources change. Major amendments to the regimes occurred in 1999, 2009, and 2019, each of which successively reduced SEAK Chinook catch limits. Further, given the highly migratory nature of Chinook, several listings of Pacific Northwest Chinook stocks as threatened under the Endangered Species Act in 1991 and 1999 and Southern Resident killer whales listed as endangered in 2004 served to further reduce allowable catch levels to conserve these species.

Most Chinook harvest occurs in commercial salmon fisheries, followed by sport fisheries. Bycatch in state and federally managed commercial fisheries and directed subsistence fisheries account for only a small fraction of the harvest. From 1996 to 2022, total Chinook harvest in all GOA fisheries ranged from just under 300,000 fish in 2018 to 800,000 fish in 2005 (Figure 1). This contrasts greatly with the data

[17] For the purposes of these comments, we use the NOAA Fisheries definition of bycatch "discarded catch of marine species and unobserved mortality due to a direct encounter with fishing vessels and gear."

provided by the Wild Fish Conservancy in their petition, which features a purported harvest range from 600,000 to over 1.5 million Chinook salmon from only commercial harvest and sport catch (i.e. harvest plus catch and release) over the same period while excluding subsistence and personal use harvest and bycatch.

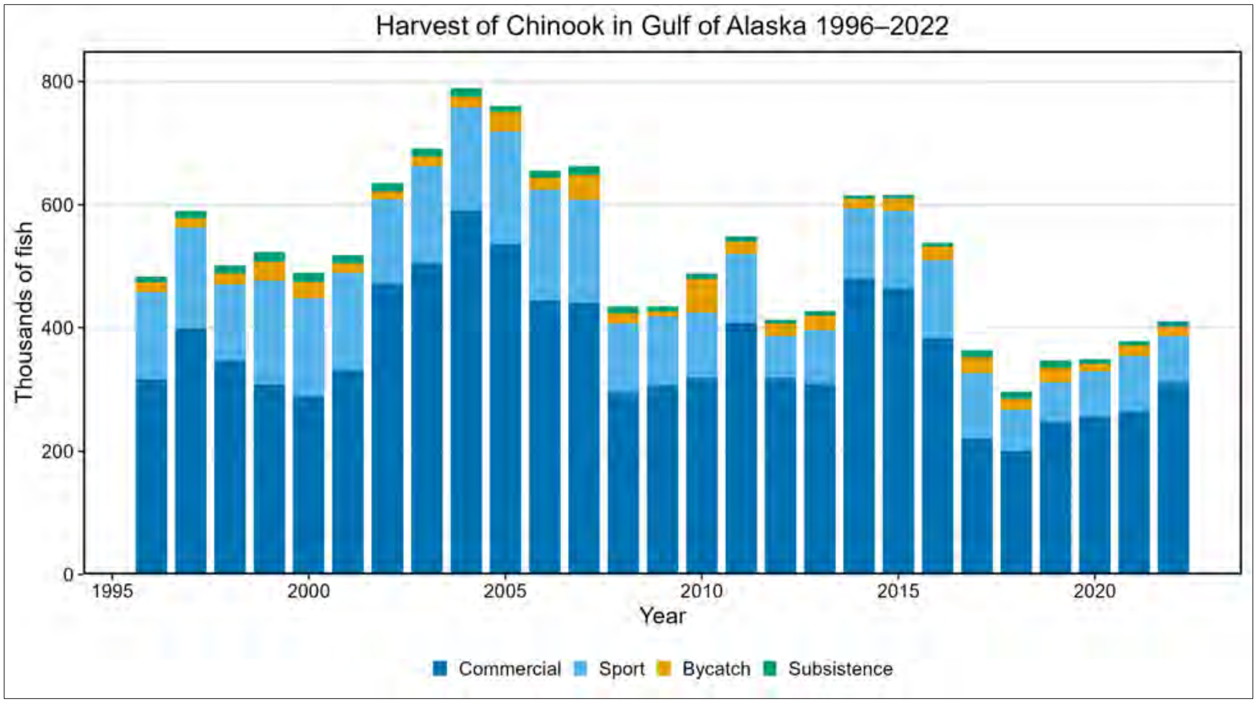

Figure 13.– Total Chinook harvest in the Gulf of Alaska including commercial, sport, subsistence and personal use fisheries, and bycatch in federal groundfish fisheries, 1996–2022.

Note: Data are available for all four types of fisheries beginning in 1996. State managed groundfish bycatch, which has harvested less than 1,000 Chinook annually since 2008 (275 Chinook on average), is not included.

Table 3.– List of fisheries included in harvest estimates of Chinook salmon in the Gulf of Alaska, by area, type, and management agency.[1]

Area	Type	Fishery	Management
Alaska Peninsula	C	Drift gillnet, set gillnet, purse seine	ADF&G
	R	Marine sport: Alaska Peninsula & Aleutian Islands	ADF&G
	S, PU	Alaska Peninsula general, Adak, Unalaska	ADF&G
Chignik	C	Purse seine	ADF&G
	S, PU	Chignik management area	ADF&G, FSB
Kodiak	C	Beach seine, drift gillnet, purse seine	ADF&G
	R	Marine sport	ADF&G
	R	Freshwater sport: Kodiak roadside	ADF&G
	S, PU	Kodiak Management Area - General	ADF&G, FSB
Cook Inlet	C	Drift gillnet, set gillnet, purse seine, beach seine	ADF&G, NOAA
	R	Freshwater Sport: Ship Cr, Eklutna, Ninilchik, Crooked Cr, Kasilof, Kenai, Susitna	ADF&G
	R	Marine: Nick Dudiak Lagoon, Seldovia Lagoon	ADF&G
	S, PU	Upper Yentna, Tyonek, West Cook Inlet, Seldovia, Kenai, Kasilof, Port Graham, Koyuktolik	ADF&G, FSB
	E	Cook Inlet educational	ADF&G
Prince William Sound	C	Drift gillnet, set gillnet, purse seine	ADF&G
	R	Marine sport: Chenega, Resurrection Bay, General	ADF&G
	R	Freshwater sport	ADF&G
	S	Marine: Southwest (Chenega), Eastern (Tatitlek), and Chugach districts	ADF&G, FSB
	S, PU	Freshwater: Copper River, Chitina, Glenallen	ADF&G, FSB
	E	Copper River	ADF&G
Southeast	C	Troll, drift gillnet, purse seine, and Yakutat set gillnet	ADF&G
	C	Drift gillnet	ADF&G
	C	Yakutat set gillnet	ADF&G
	C	Purse seine	ADF&G
	R	Marine Sport	ADF&G
	R	Freshwater Sport: Ketchikan, Petersburg, Wrangell, Stikine, Kake, Sitka, Juneau, Skagway, Yakutat	ADF&G
	S, PU	Southeast marine	ADF&G, FSB
	S, PU	Freshwater: Stikine River, Taku River	ADF&G, FSB
Annette Islands Reserve	C	Troll, drift gillnet, purse seine	MIC
	R	Marine sport	MIC
	S	Marine subsistence	MIC
GOA bycatch	C	Pollock trawl	NOAA
	C	Other groundfish fisheries	NOAA
	C	Prince William Sound Pollock trawl	ADF&G

Note: Fishery type: C= commercial, R= recreational, S= subsistence, PU= personal use, E=educational
[1]Includes harvests of hatchery fish in Special Harvest Areas.

It is important to note that marine fisheries in the GOA encounter a mixture of stocks, including some that originate from outside of the GOA. Therefore, the total harvest information presented above is not a true reflection of harvest of the GOA stocks; rather, it is an overestimate. To generate an estimate of the harvest of the stocks of interest—those originating from rivers flowing into the GOA ("GOA stocks")—genetic data on the stock composition of each source of harvest are needed. Additionally, to estimate the portion of the catch attributable to wild GOA-origin fish, coded wire tag (CWT) or otolith data are needed;

this is because Alaska hatcheries use local broodstock, and it is not possible to distinguish wild-origin fish from their hatchery counterparts using genetic techniques.

Although stock of origin analyses for all Chinook fisheries occurring in the GOA are not available, CWT and genetic mixed-stock analysis (MSA) data are available annually from SEAK troll and sport fisheries since 1985 and 2004, respectively, to meet obligations under the Treaty. Results from genetic MSA and CWT analyses of SEAK troll and sport harvest show that only a portion of the Chinook salmon harvested in SEAK is of SEAK origin, and even fewer are of wild SEAK origin. Peterson et al. (2017) first apportioned SEAK commercial troll and marine sport harvest from 2005 to 2017 into SEAK origin and non-GOA origin Chinook using genetic MSA and then apportioned the SEAK group into hatchery-SEAK and wild SEAK stocks using CWT information. This analysis was recently updated to include Chinook harvest information through 2023 (Peterson et al. *In prep*). Analyses from 2005 to 2023 showed that, on average, 22% of combined commercial troll and sport fishery harvests were SEAK-origin (range: 13% to 40%). The average annual combined troll and sport harvest was 264,171 for the same time period (range: 136,771 to 439,730), and of that, an average of 58,793 Chinook harvested were of SEAK origin (range: 25,785 to 115,316).

Stock composition data are also available for Copper River Chinook salmon caught in commercial fisheries since 2005 (Barclay et al. 2022) and in federally managed groundfish fisheries (Guthrie et al. 2022). Additionally, some fisheries were sampled in conjunction with the Chinook Salmon Research Initiative for Chinook harvested in the Chignik and South Alaska Peninsula commercial fishery, Homer sport fishery, and Kodiak commercial and sport fisheries (Shedd et al. 2016), though data are very limited. Unlike SEAK fisheries, MSA analysis shows that Chinook caught in the Copper River District commercial drift gillnet fishery are mostly Copper River fish (Barclay et al. 2022). However, bycatch from 2020 GOA trawl fisheries were mostly made up of British Columbia and West Coast U.S. stocks (Guthrie et al. 2022), and harvests from Westward commercial and Kodiak area marine sport fisheries were dominated by British Columbia and West Coast U.S. stocks as well (Shedd et al. 2016).

2.2.1.1 Commercial Harvest

Historical commercial salmon harvest information is available since 1878 and is summarized by Edfelt (1973) and Byerly et al. (1999). Since 1969, all salmon that are sold in Alaska must be reported on a fish ticket and catch statistics are generated from a fish ticket database. Statistics from years prior to 1969 were compiled by Edfelt (1973) and came from multiple sources that were deemed to be the most accurate by ADF&G consensus. Estimates prior to statehood should be interpreted judiciously. Harvests estimates from 1985 to present are available from the current State of Alaska commercial salmon fish ticket database.

Based on these sources, commercial harvests of Chinook salmon have fluctuated greatly across the 130-year period (Figure 2). Although harvests can used as be an indicator of abundance, they are not a direct measure nor necessarily correlated. Edfelt (1973) explains:

> *In the early years, prior to 1902, catches were generally increasing as the incipient industry expanded. However, total catches were small due to small fleet size, limited processing capabilities, and a limited market for salmon other than sockeye. As fishermen and processors became more efficient larger catches were recorded. Catches became indicative of abundance and fluctuations in catches became more conspicuous during the period of 1915 to 1930. When catches could not be maintained at a constant level fishery agents became concerned with the onset of depletion and began thinking of the resource in terms of variable maximum productivity. Salmon*

> *catches peaked during the period 1935-1945, followed by a drastic decline in certain major fisheries during the 1950's.*

In the early years of statehood (after 1959), both catches and escapements gradually increased through the mid-2000s. Since the early to mid-2010s, harvests and escapements have been declining. Harvests since statehood have fluctuated in response to abundance, fleet size, hatchery production, market conditions, regulatory and policy changes, innovations in fishing gear, and processing capacity. More recently, fisheries have also been limited by management actions taken to improve stock status.

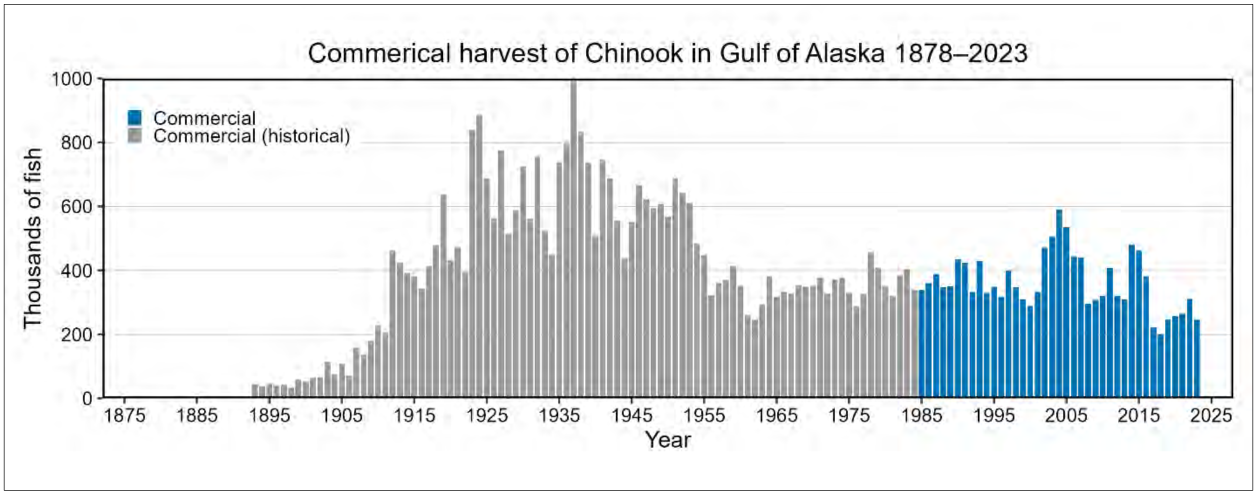

Figure 14.–Gulf of Alaska commercial harvests of Chinook salmon in directed and non-directed fisheries, 1878–2022.

Source: Commercial harvest data for 1878–1968 are from Edfelt (1973) and Byerly et al. (1999); 1969–1984 data are from Byerly et al. (1999); commercial harvest data since 1985 are from the State of Alaska fish ticket database.

Prior to statehood (1959), the combined commercial directed and non-directed salmon fishery harvest of Chinook in the GOA reached a high of nearly 1 million Chinook salmon in 1937 (Figure 2). Since the State of Alaska assumed management of commercial salmon fisheries in 1960, the highest recorded harvest of Chinook salmon in the GOA was in 2004, when 591,000 Chinook salmon were harvested. The average annual harvest since 1960 is 357,000 Chinook salmon and the average harvest since the productivity downturn in 2007 is 322,000.

The greatest harvest of Chinook has always occurred in SEAK. Initially (it is presumed), this was because of SEAK's proximity to Washington. Since 1985, this proportionately large harvest has been due to management under the Treaty, owing to its mixed-stock nature. SEAK is currently the only place in Alaska with directed commercial Chinook salmon fisheries. In 1937, during the year with the highest recorded Gulf of Alaska Chinook catch, 880,000 of the nearly 1 million Chinook salmon were harvested in SEAK. Since the Treaty was signed, SEAK commercial fisheries have harvested on average 78% of the total GOA harvest. The remainder of the GOA commercial harvest occurs in salmon fisheries near the mouth of the Copper River, in Prince William Sound and Cook Inlet, and in Kodiak, Chignik, and South Alaska Peninsula areas that primarily target other salmon species.

2.2.1.2 Sport Harvest

Sport fishery harvest estimates date back to 1996 and are available from the State of Alaska statewide harvest survey database through 2022. Fluctuations in harvest are largely attributable to species abundance, hatchery production levels (i.e., put and take fisheries), public access, tourism (i.e., fishing charters) and status of individual stocks. The decrease in freshwater sport fishery harvest since 2007 reflects conservative management actions in response to decreases in Chinook salmon productivity (Figure 3). Because freshwater fisheries tend to have the highest stock-specific impact and typically have daily escapement information to manage harvest relative to achieving escapement goals, they are often restricted or closed entirely when runs are not projected to meet escapement goals in season. In cases where escapement goals are not achieved in successive years, freshwater sport fisheries may be closed entirely before the season begins.

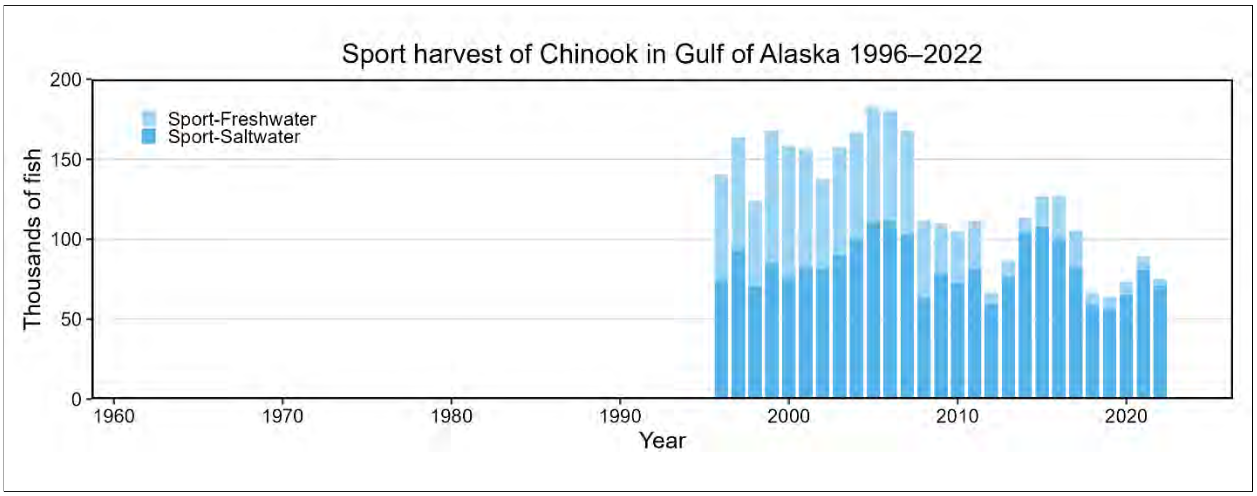

Figure 15.– Gulf of Alaska freshwater and marine sport harvests of Chinook salmon, 1996–2022.

Source: State of Alaska Statewide Harvest Survey database (https://www.adfg.alaska.gov/sf/sportfishingsurvey/) and Mark Tag and Age Laboratory database (for Southeast Alaska harvest estimates).

Freshwater sport harvest of Chinook salmon occurs primarily on the Kenai Peninsula, the Susitna River drainage, the streams around Anchorage and Knik Arm, and the Copper River drainage. Sport fishing for Chinook salmon also occurs to a lesser extent in the rivers of SEAK, Kodiak, and the Alaska Peninsula/Aleutian Islands. Between 1996 and 2022, the harvest of Chinook salmon in the GOA freshwater systems ranged from roughly 4,000 Chinook in 2022 to nearly 83,000 fish in 2000 and averaged 41,000 Chinook annually. Since 2007, as the abundances of Chinook salmon stocks have declined, freshwater sport fishing has been curtailed or closed entirely, with limited opportunity provided to harvest hatchery fish (put and take fisheries). Hatchery enhancement is specifically to provide freshwater sport fishing opportunities in SEAK, Anchorage, Northern Cook Inlet, Kachemak Bay, Ninilchik, Kasilof/Crooked Creek, Kodiak, Prince William Sound, and Resurrection Bay. These hatchery-produced Chinook salmon currently provide the only freshwater sport fishing opportunity in the GOA.

Marine sport fisheries targeting Chinook occur throughout SEAK, and in Prince William Sound, Cook Inlet, and Kodiak. Since 1996, the marine sport harvest of Chinook in the GOA has averaged 83,000 fish annually. The highest harvest recorded during that same period was 112,000 in 2006 and the lowest was 57,000 fish in 2019. Like the commercial Chinook harvest, most marine sport harvest occurs in SEAK, which is managed under the PST, and has averaged 74% of the marine sport harvest of GOA Chinook since 1996.

Other marine sport fisheries occur in Knik Arm, marine waters near Anchorage, and the Alaska Peninsula/Aleutian Islands areas. Marine sport fisheries encounter mixed stocks of Chinook salmon as in commercial fisheries (e.g., Shedd et al. 2016; Guthrie et al. 2022), and therefore the marine sport harvest estimates of GOA Chinook salmon most likely include stocks that are not of Alaska origin.

The Wild Fish Conservancy's petition asserts that "reduced recreational harvest in 2021 relative to harvest levels in 2005 and 2006 indicates overharvest by the recreational sector." Although we cannot replicate the data provided in the petition and find the selected dates for comparison perplexing, the general trend of declining sport fish harvest (Figure 3) does not indicate overharvest because this decline reflects management actions to restrict harvest to just hatchery Chinook (put and take fisheries). Note that the marine sport harvest levels have largely been dominated by SEAK fisheries which are managed under the Treaty, and have not been subject to the same restrictions, has not declined as precipitously and compares to pre-2000 levels. Additionally, because a growing sector of the sport fishery comes from tourism (i.e., charter fishing), harvests for 2020 and 2021 do not reflect the decline in effort of nonresident sport anglers due to travel restrictions during the COVID pandemic.

2.2.1.4 Subsistence and Personal Use Harvest

Subsistence and personal use fishing in Alaska is restricted to Alaska residents only. Both require a permit to legally harvest Chinook; however, personal use fishing also requires the purchase of a resident sport fishing license. Subsistence and personal use fisheries typically harvest lower amounts of Chinook salmon than other fisheries. Permitting and harvest reporting, however, is generally less consistent and accurate than in commercial and sport fisheries. Due to the small contribution to the total GOA Chinook harvest of these two sources of harvest, they are combined herein. Federal subsistence fisheries also occur in the GOA, regulated by the Federal Subsistence Board (FSB)and those harvest numbers are included here as well, as are the small number of fish harvested under educational permits. Although subsistence management has occurred since 1960, harvest information from personal use and subsistence fisheries became more accurate in 1980 when the state began tracking subsistence and personal use harvest information. Subsistence and personal use harvests from 1980 to 2022 ranged from 2,000 in 1980 to 16,000 in 1999, with an average of 8,400 Chinook salmon harvested annually (Figure 4). These fisheries occur throughout the region with the highest levels in Chitina, Cook Inlet, Glennallen, Copper River Flats, SEAK, and Tyonek fisheries. Limited harvests also occur in the Chignik, Kodiak, and Port Graham, and Koyuktolik subsistence fisheries.

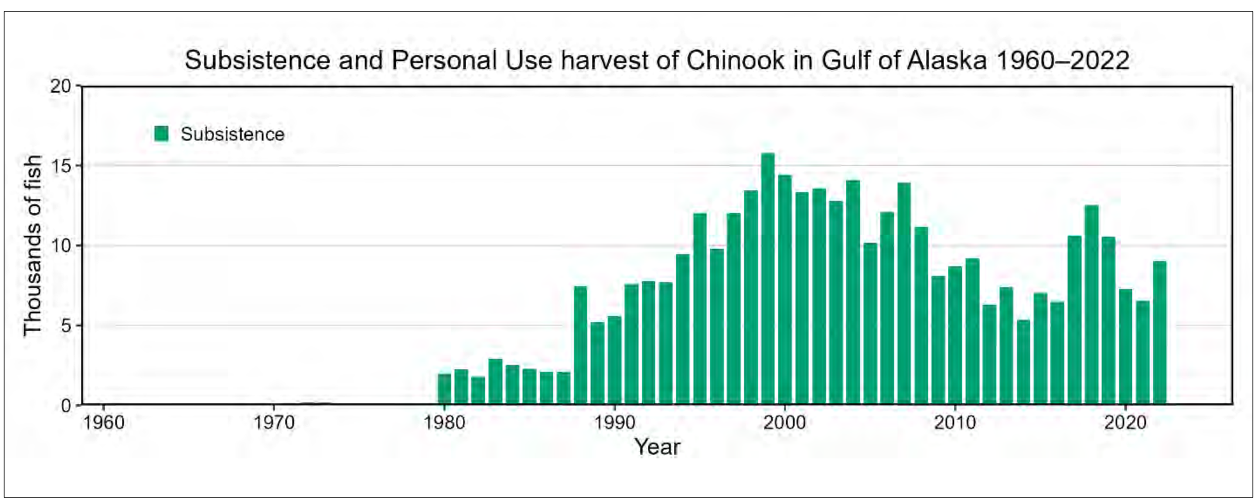

Figure 16.– Gulf of Alaska subsistence and personal use harvests of Chinook salmon, 1960–2022. Source: State of Alaska Subsistence Harvest database and includes state and federal subsistence, personal use and education permits.

2.2.1.5 Bycatch

Chinook salmon are also taken as bycatch in fisheries targeting non-salmon species. State and federally managed commercial groundfish fisheries occurring in the GOA are regulated to limit the amount of incidentally caught Chinook that is taken while targeting other species. The average annual bycatch in federally managed GOA groundfish fisheries was approximately 21,000 Chinook (Figure 5). The GOA bycatch in groundfish fisheries typically consists of a mixture of Chinook stocks with a high proportion originating outside of the region (Guthrie et al. 2022) because the harvest occurs further offshore. The total number of Chinook salmon caught as bycatch in the federally managed GOA fisheries between 1990 and 2022 has ranged from 8,500 Chinook salmon in 2009 to 54,000 Chinook in 2010. Chinook bycatch in State managed groundfish fisheries, primarily harvested in the Prince William Sound trawl fishery, ranged from 13 Chinook salmon in 2008 to 980 Chinook harvested in 2023, averaging 275 Chinook annually.

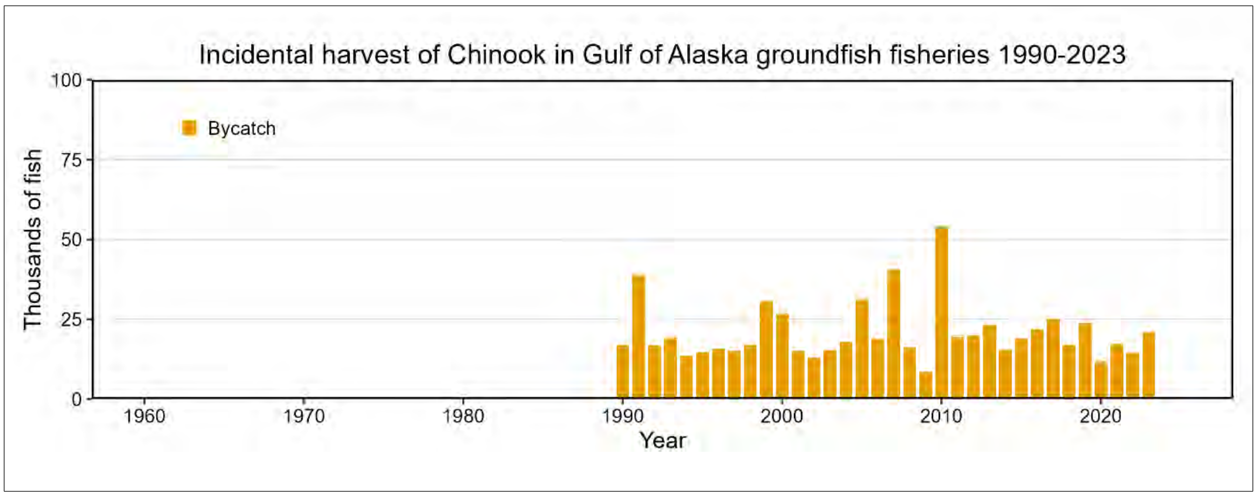

Figure 17.– Gulf of Alaska harvest of Chinook salmon as bycatch in federal groundfish fisheries, 1990–2023. State managed groundfish fishery bycatch is not included, which is <1,000 fish/yr (average = 275 fish). Source: https://www.fisheries.noaa.gov/sites/default/files/akro/goasalmonmort2024.html

2.2.2 Status Determination

Fishery and escapement data point to sustainable harvest of Alaska Chinook salmon. Owing to the mixed stock nature of some GOA fisheries, it is challenging to assess whether overutilization is occurring. Several approaches have been developed to meet objectives for different entities (e.g., North Pacific Fisheries Management Council [NPFMC], Pacific Salmon Treaty [PST]). One approach is to use a proxy developed under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) to ensure federally-managed fish stocks are harvested and managed at sustainable levels. This approach could be adapted to accommodate all GOA Chinook salmon stocks.

Each federal fishery management plan (FMP) includes criteria for managed stocks that are used to make stock status determinations, and these must be consistent with the MSA. Each salmon stock is annually assessed to determine its status and whether 1) overfishing is occurring or the rate or level of fishing mortality for the stock is approaching overfishing, 2) the stock is overfished, or the stock is approaching an overfished condition, and 3) the catch has exceeded the allowable catch limit (ACL; NOAA 2024). These assessments are required to achieve National Standard 1, which is to prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery (NPFMC 2021) and contain objective and measurable criteria for identifying when a fishery is overfished. If a stock or stock complex is declared overfished or if overfishing is occurring, management measures that comply with the MSA and national standard guidelines must be implemented to prevent overfishing and rebuild the fishery.

For salmon stocks in Southeast Alaska (East Area) and in the Cook Inlet EEZ, the Salmon FMP (NPFMC 2021) and amendment 16[18] outline these criteria as part of the management framework. It is important to note that the criteria are different for the East Area and the Cook Inlet EEZ because different mixtures of stocks are harvested in each fishery and because East Area fisheries are subject to the Pacific Salmon Treaty. ADF&G is required to submit an annual stock status determination report on salmon stocks subject to the Treaty, per the FMP, to the North Pacific Fishery Management Council (NPFMC).

Overfished status for each stock is determined using escapement estimates and using a limit reference point called a minimum stock size threshold (MSST). For stocks or stock complexes considered to have reliable estimates of escapements, MSST is defined. If the number of spawners drops below the MSST then the stock is considered overfished. For stocks without reliable estimates of escapement, MSST and overfished status are undefined.

For the East Area, the determination of whether any stocks are overfished is based on comparison of the productive capacity, which is the aggregate escapements across all 22 Treaty Chinook salmon indicator stocks for which escapement goals have been established and approved (including 3 Southeast Alaska stocks and 3 transboundary stocks) summed over the most recent 5 years, and the minimum stock size threshold ($MSST_t$), which is one half the sum of the indicator stock MSY escapement goals (mid-point if a range). If the productive capacity falls below the MSST in any year, it will be determined that the stock group is overfished. ***Productive capacities reported for the East Area since 2009 have been over 1.7 million and are well above $MSST_t$ (0.7 million) for the stocks indicating these stocks are not overfished***[19]**.**

For Cook Inlet, amendment 16 to the Salmon FMP uses MSST defined differently than the East Area and a rule for defining overfishing based on comparing the stock-specific fishing mortality rate in the EEZ (FEEZ) with MFMT (NOAA 2024). The Science and Statistical Committee of the NPFMC recommended an MSST=0.5*SMSY (summed over a generation) or half of the spawning abundance expected to produce MSY over the long term. In the first SAFE report for this area (NOAA 2024), this was applied to Tier 1 stocks (i.e., salmon stocks that have reliable estimates of annual spawning escapements and stock-specific harvests). Cook Inlet Chinook salmon were, however, designated a Tier 3 stock complex (i.e. salmon stocks without reliable estimates of escapement). Calculation of MSST for Tier 3 stocks was not explicitly defined in amendment 16, the Cook Inlet salmon SAFE report, or in the SSC recommendations. Examination of the SAFE report suggests the aggregate of the lower bounds of escapement goals were used in lieu of

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[18] Fisheries of the Exclusive Economic Zone off Alaska; Cook Inlet Salmon; Amendment 16. https://www.federalregister.gov/documents/2024/04/30/2024-08664/fisheries-of-the-exclusive-economic-zone-off-alaska-cook-inlet-salmon-amendment-16 [Accessed 8 August 2024].

[19] 2023 Status of Salmon Stocks Under the FMP (Fisheries Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska). Unpublished. Submitted to NOAA July 2024.

estimates of SMSY. However, for Cook Inlet Chinook, the lower bound of the Board-determined OEG for Kenai River late-run Chinook was used in the calculation of MSST for Cook Inlet Chinook salmon instead of the scientifically based SEG.

Herein, we adapted this approach to Chinook stocks across the GOA using the definition of MSST for the East Area (Figure 6). The rationale for using only the approach for the East Area and not the Cook Inlet EEZ as well is twofold: 1) there is a long-standing application of the calculation of MSST for the East Area and it is relatively easy to apply it across the GOA and to include all stocks assessed, and 2) the Cook Inlet calculation is new (established in 2024) and would require categorizing stocks into tier levels defined for Cook Inlet stocks to stocks outside of the Cook Inlet area and then whether to use either half of S_{MSY} or half of the lower-bound of the escapement goal as the metric for calculating MSST. Results from this approach show that ***productive capacity has declined since 2005 but remains above 732,000 fish and is well above the MSST of 546,000 fish for GOA Chinook, indicating these stocks are not overfished.***

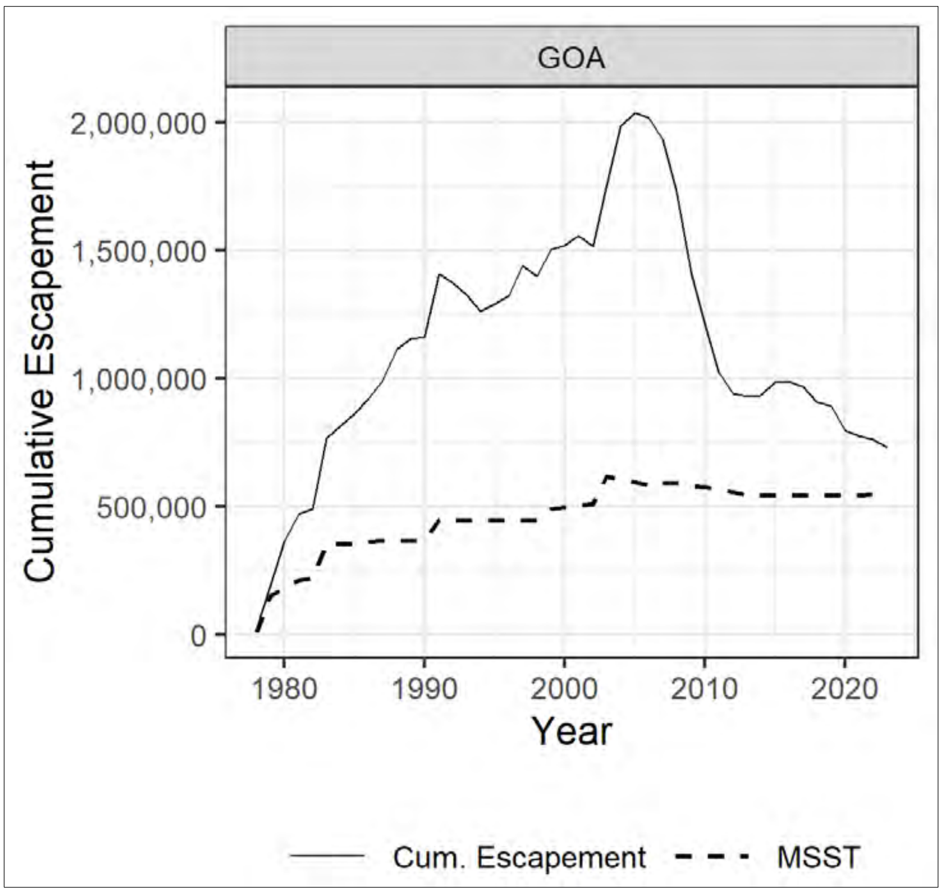

Figure 18.– Adaptation of East Area MSST applied to 31 assessed Gulf of Alaska Chinook salmon stocks (dashed line) and cumulative escapement (solid line), which can retrospectively be assessed against MSST.

Another useful way to evaluate stock status relative to exploitation employed by the Pacific Salmon Commission's Chinook Technical Committee for Chinook salmon stocks is through synoptic evaluation plots, also referred to as Garcia plots. These plots resemble those presented for groundfish in Garcia and De Leiva Moreno (2005). A general depiction of the plots is provided in Figure 7. The example plot shows the exploitation rate (*x*-axis) and escapement (*y*-axis) of each stock for available years of data. There are three reference lines, two horizontal lines for escapement benchmarks related to escapement goals that produce MSY (i.e., S_{MSY}) and one vertical line representing the exploitation rate associated with MSY (i.e., U_{MSY}). These lines divide the plot area into 5 color-coded status zones. The panels within Figure 8 provide these synoptic evaluations for the 22 GOA Chinook stocks with escapement goals based on spawner-recruit analysis. For the purposes of these comments only the lower-bound of the escapement goal (i.e. target reference point) is used for the horizontal escapement benchmark, thus dividing the plot area into 4 status zones.

Examining the figures shows that there are very few cases of harvest rates in the high risk zone (bottom right quadrant) of the figure (i.e., low escapements with harvest rates above U_{MSY}). Escapements are generally well distributed, reflecting the effectiveness of Alaska's escapement-based management system to provide for a range of escapements and not just the lower-bound of the escapement goal. Further, the annual calendar year harvest rates for many of the stocks are generally below U_{MSY} and are very low or zero when escapements are low. These plots clearly demonstrate that State of Alaska fisheries management has been responsive to changes in productivity of the stocks, as required under the SSFP, and this management strategy has proven effective.

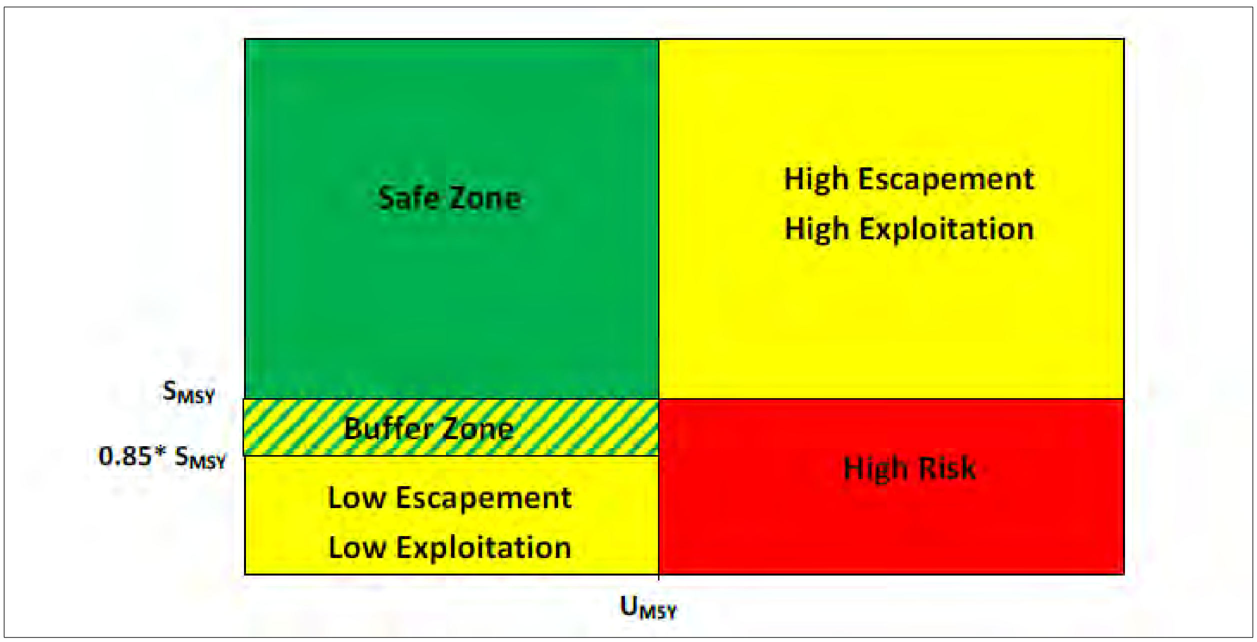

Figure 19.– Example plot for synoptic evaluations used for Pacific Salmon Treaty Chinook salmon stocks showing the three reference lines and five status zones (from CTC 2024).

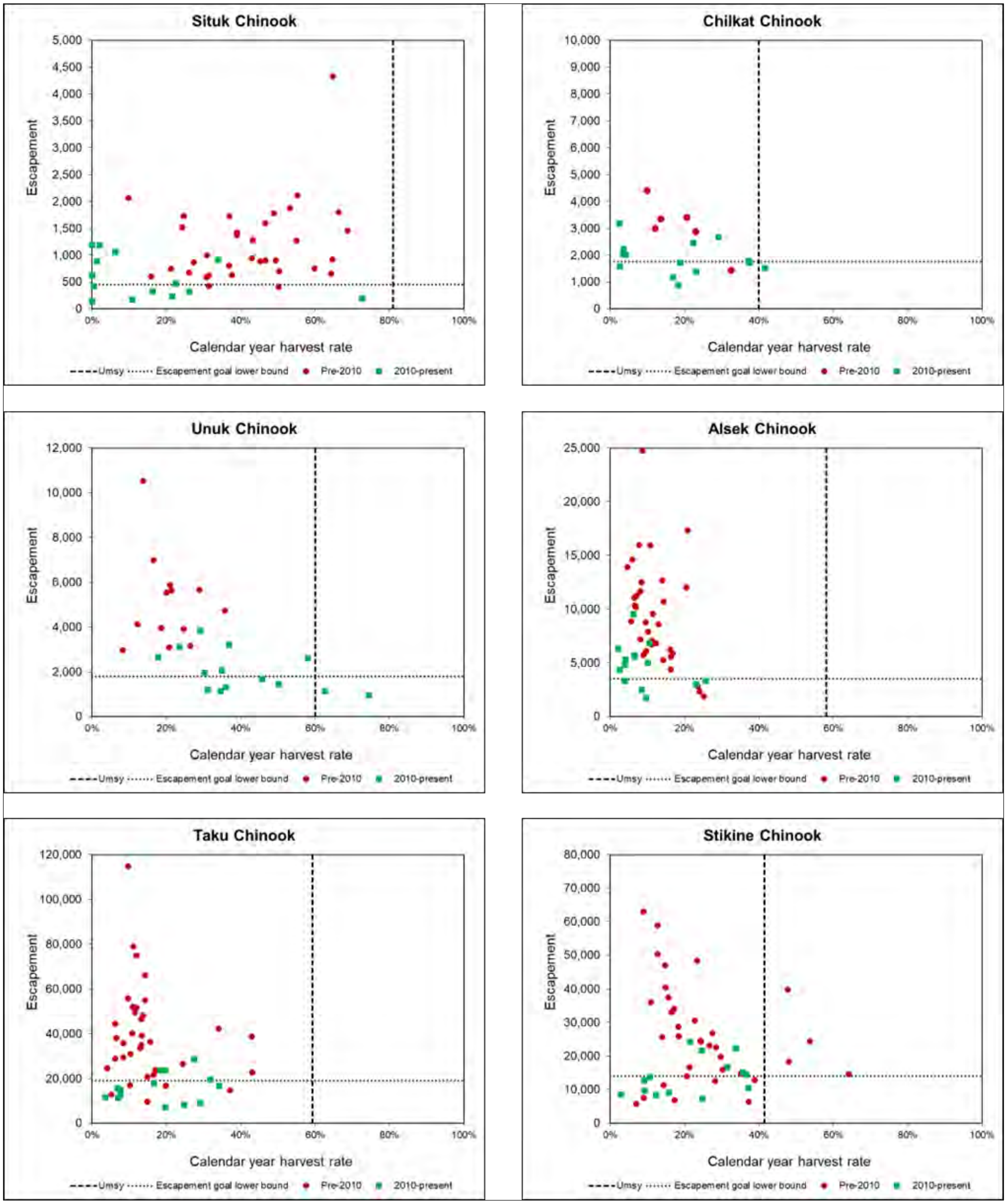

Figure 20.– Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement for 22 Gulf of Alaska Chinook salmon stocks.

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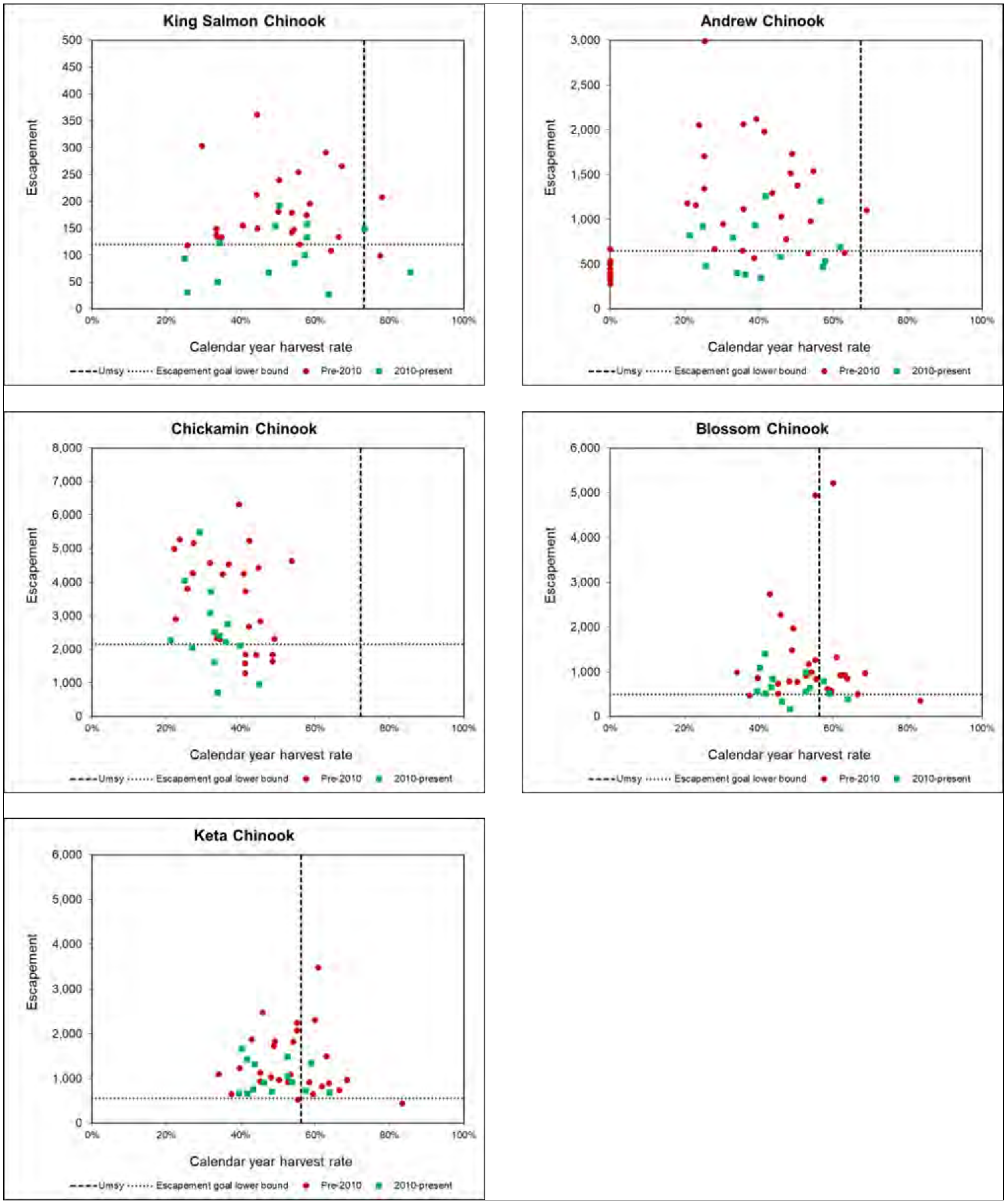

Figure 8. Page 2 of 4.

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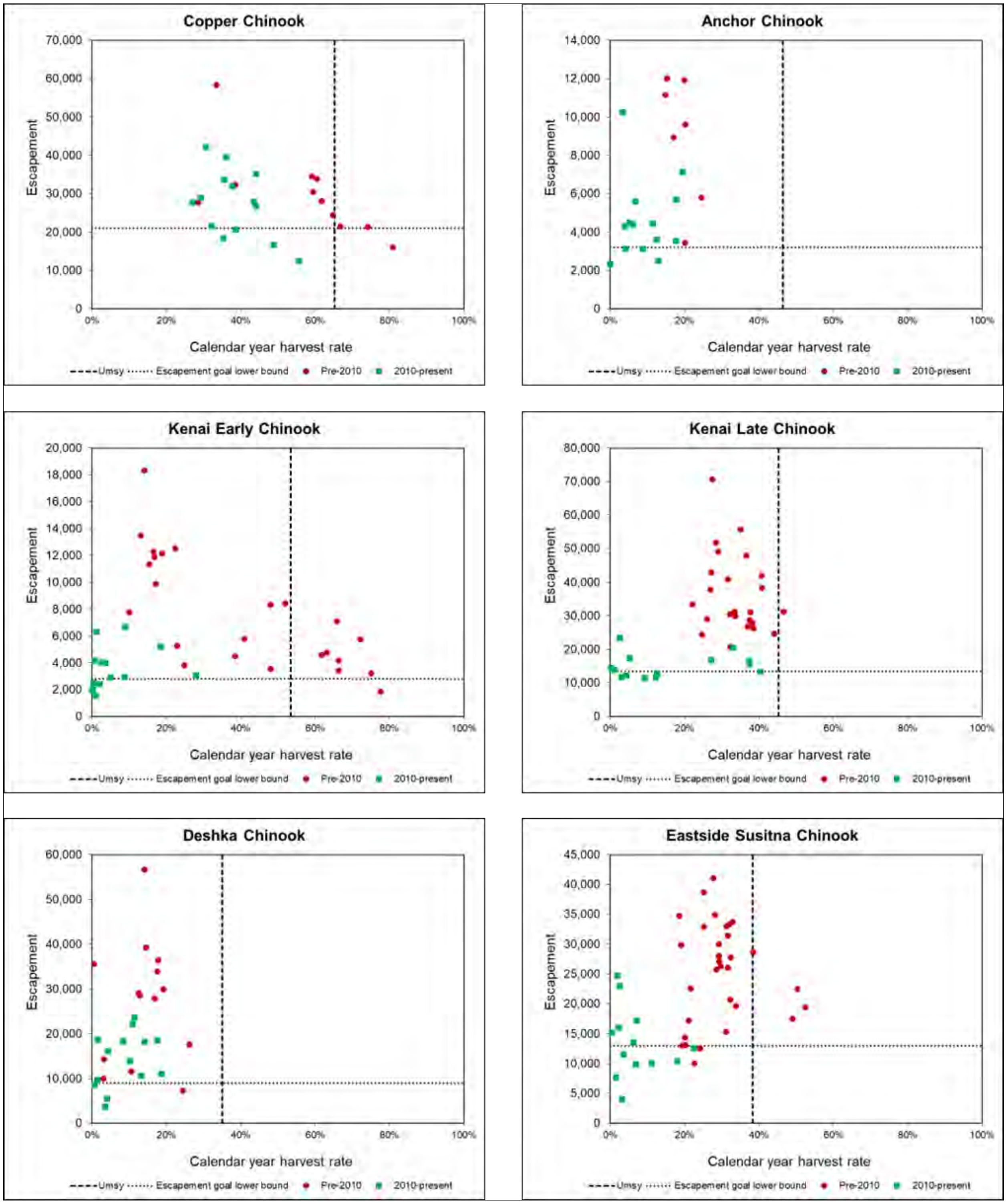

Figure 8. Page 3 of 4.

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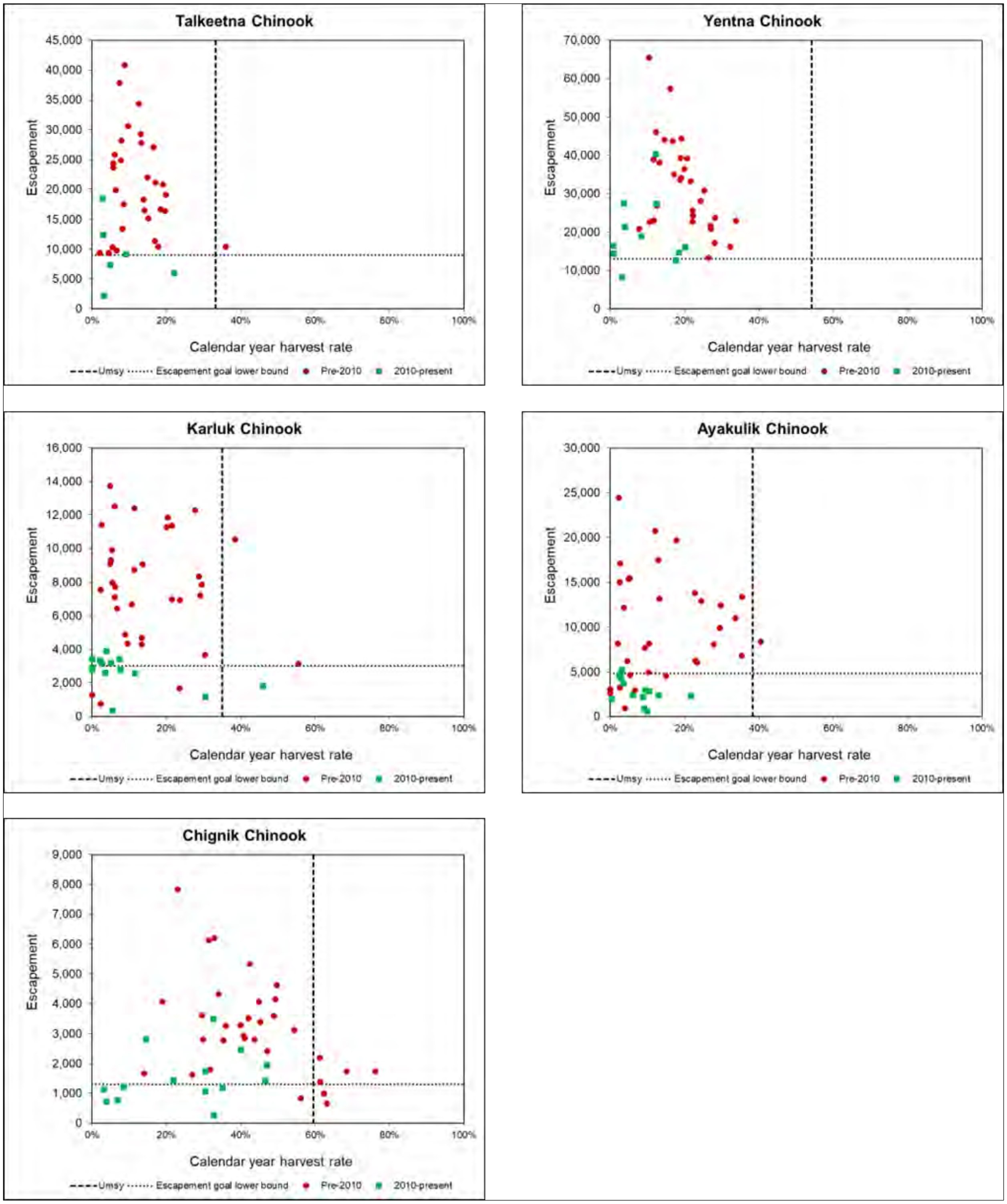

Figure 8. Page 4 of 4.

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2.3 Habitat

2.3.1 Petition Statements

Wild Fish Conservancy's petition does not represent Habitat threats to GOA Chinook accurately. As noted in the NOAA Fisheries (NMFS) 90-day finding, the listing petition for GOA Chinook salmon "makes vague references to threats from logging, road building, and mining . . . without providing specific examples"[20] that serve as "likely drivers or contributors to . . . declines [in Alaska Chinook populations]"[21]. The petition mentions these ill-defined and unsupported threats under the heading "present or threatened destruction, modification, or curtailment of habitat or range," corresponding to ESA section 4(a)(1) factor (1).

The petition fails to provide any local, watershed-level, or regional data to support its claim that these development activities are a current threat to GOA Chinook. Further, diligent implementation of the State's comprehensive regulatory framework, such as the *Alaska Forest Practices Act*, as well as cooperative efforts with the U.S. Forest Service, have substantially reduced the negative impacts of sedimentation caused by road building to access logging operations, and by "putting roads to bed" by removing crossing structures that may have blocked fish passage during logging operations.

The petition admits that "freshwater spawning and juvenile rearing habitats in most Alaska Chinook rivers are in relatively healthy or minimally disturbed condition"[22]. As noted previously, the people of the State of Alaska have had the opportunity to observed and learn from the problems created by degradation of freshwater salmon habitat in the U. S. Pacific Northwest and have responded with state statutes that provide comprehensive protections for fish habitat, fish passage, and adequate stream flow (see Section 2.1.5).

2.3.2 Chinook Salmon-Bearing Subbasin Habitat Quality

Impacts to GOA Chinook habitat are mitigated by limited population and development as well as regulations, policies, and programs. Salmon need particular freshwater habitat characteristics that allow successful spawning, egg survival, and juvenile growth during their freshwater residence. These habitat characteristics include adequate connection and accessibility to these waters during the spawning migration and subsequent juvenile dispersal. Much of Alaska's freshwater habitats are considered relatively pristine when compared to those in lower latitudes where dams blocking fish passage, water diversions, pollution, and large-scale urbanization have greatly impacted the viability of salmonid populations. Habitat degradation and fragmentation is much less pervasive and widespread in Alaska owing to the remoteness and ruggedness of the Alaskan landscape, the low population density, and the expansive network of state and federal parks, preserves, and refuges protecting these waterway from development (Figure 9). Additionally, the Northerly latitudes associated with the GOA afford an additional buffer to the compounding effects of climate driven changes to freshwater habitat quality (e.g., temperature, oxygen, etc.) when compared to areas further south.

[20] 90-day finding 45817-45818, under *Petition Finding*, p. 11/14
[21] Petition p. 41.
[22] Petition p. 7.

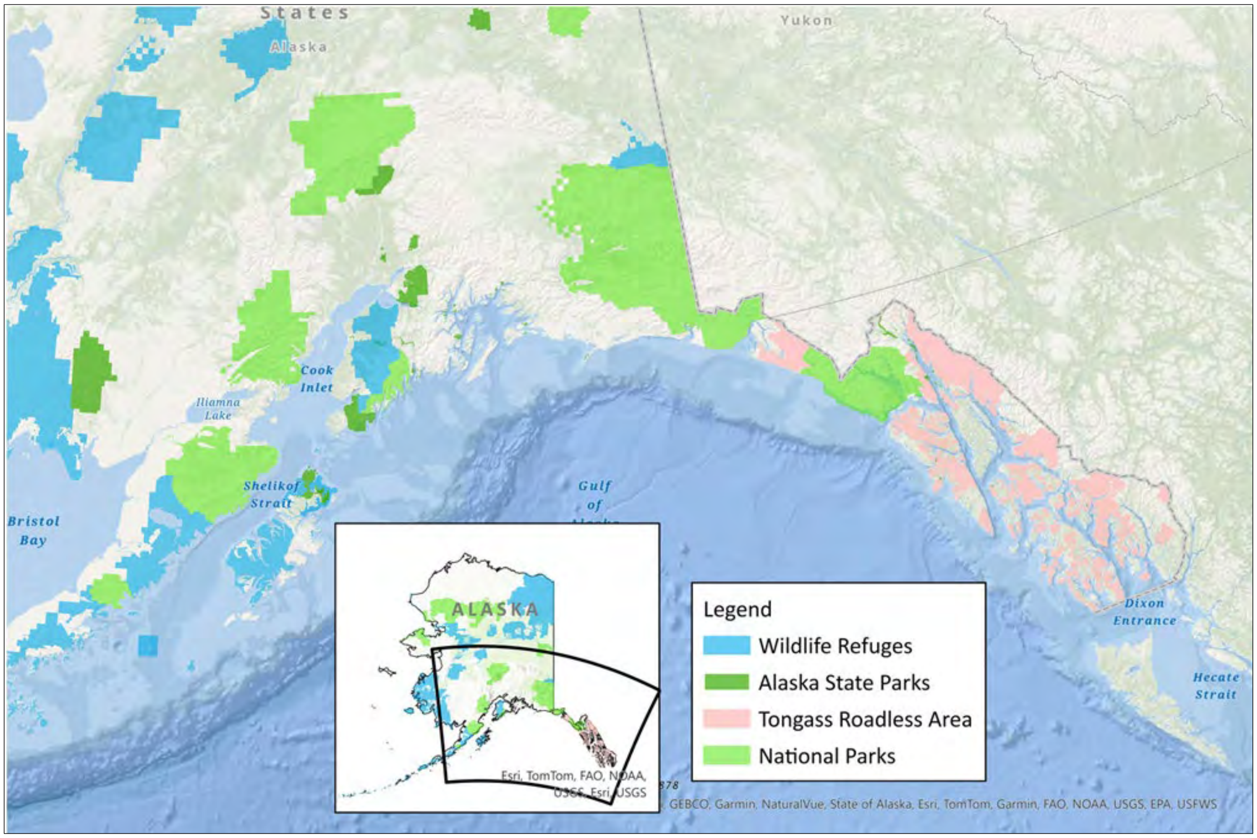

Figure 21.–Map of state and national parks, wildlife refuges, and roadless areas in Gulf of Alaska region.

The Wild Fish Conservancy's petition asserts that the primary threats to salmon habitat are from clear-cut logging and deforestation, which can lead to erosion and sedimentation in streams and rivers and elevated stream temperatures, road building, which can alter channels, increase sedimentation, and block salmon passage; and from mining activity, which can release pollutants and other contaminants such as heavy metals. Large human populations and anthropogenic activities and associated infrastructure such as dams, construction, timber harvest, agriculture, urbanization, and mining can and often do disrupt habitat function and impact survival of Pacific salmon. This list of threats may be common and widespread in the Pacific Northwest; however, these activities and impacts are limited in freshwater systems emptying into the Gulf of Alaska. Except the Chilkat River and some watersheds in Cook Inlet and the Copper River, the majority of freshwater spawning and rearing habitat in the GOA is found within roadless watersheds and considered intact. In places where this is an exception, road access and infrastructure including extractive forestry and petroleum and mining development have been limited. Comparisons of GOA and Puget Sound Chinook salmon-bearing watersheds bear this out (see *Section 2.3.3 Gulf of Alaska Subbasin Descriptions*).

State of Alaska forestry activities including timber harvest, reforestation, and forestry road/culvert construction on state, private, and municipal land follow guidelines and practices established in the *Alaska Forest Resources Practice Act* to minimize impacts on fish and their habitat. Timber harvest and sale only occurs in 11 of the 20 subbasins and active miles of forestry roads indicate the extent of activity (Table 3).

Table 4.–Acres of timber harvest (US Forest Service) and acres of timber sale (Alaska Department of Forestry) within each subbasin in Alaska along with miles of forestry roads and road status (Alaska Department of Forestry).

	Timber		Forestry roads (miles)					
Subbasin	**Harvest (acres)**	**Sale (acres)**	**Active**	**Inactive**	**Closed**	**Proposed**	**Non-FRPA**	**Unknown status**
Alsek River	0	0	0	0	0	0	0	0
Taku River	0	0	0	0	0	0	0	0
Chilkat - Skagway Rivers	0	16,225	14.1	63.4	30.9	0	13.6	0
Yakutat Bay-GOA	6,562	0	9.4	11.9	236.3	0	0	23.9
Stikine River	6,205	3	4.2	2.9	0	0	0	0
Burroughs Bay	609	0	0	0	0	0	0	0
Admiralty Island	31,960	0	0	3.8	59.6	0	0	139.3
Upper Kenai Peninsula	3,326	598	0	0	0	0	0	0
Lower Kenai Peninsula	0	20,161	4.8	256.3	28.6	0	0	0
Lower Copper River	359	0	1.1	0	0	0	0	0
Middle Copper River	0	89	15.2	5.2	1.7	21.8	0	0
Upper Copper River	0	0	0	0	0	0	0	0
Shelikof Strait	0	0	0	0	0	0	0	0
Lower Susitna River	0	13,445	22.1	11.8	4.6	128.3	0	0
Upper Susitna River	0	0	0	0	0	0	0	0
Yentna River	0	625	0	0	0	0	0	0
Talkeetna River	0	0	0	0	0	0	0	0
Redoubt-Trading Bays	0	0	0	127.7	0.5	0	0	0
Chitina River	0	0	0	0	0	0	0	0
Kodiak – Afognak Islands	0	0	0	0	0	0	0	0

Although the density of roads is dramatically less than occurs in the Pacific Northwest, roads and roadways do occur in nearly every GOA subbasin. The two exceptions are Taku and Burroughs Bay subbasins, which are entirely without roads. Road building for extractive industries and in service of population centers is most extensive in the Upper Kenai Peninsula (Table 4).

Table 5.–Miles of paved and unpaved road within each subbasin in Alaska, and miles of road in the Canadian portion of transboundary subbasins.

	Alaska[a]		Canada
Subbasin	**Paved road (mi)**	**Unpaved road (mi)**	**Road (mi)**
Alsek River	0	0	15.67
Taku River	0	0	0
Chilkat - Skagway Rivers	109.49	56.83	31.9
Yakutat Bay-GOA	8.72	60.89	0
Stikine River	5.73	4.41	0
Burroughs Bay	0	0	0
Admiralty Island	7.77	2.96	–
Upper Kenai Peninsula	424.97	775.88	–
Lower Kenai Peninsula	198.6	504.65	–
Lower Copper River	55.44	64.06	–
Middle Copper River	259.60	79.50	–
Upper Copper River	106.91	18.64	–
Shelikof Strait	0	13.21	–
Lower Susitna River	216.61	504.63	–
Upper Susitna River	5.56	58.38	–
Yentna River	0	36.00	–
Talkeetna River	0	8.10	–
Redoubt-Trading Bays	0	93.27	–
Chitina River	8.11	64.01	0
Kodiak – Afognak Islands	106.69	84.99	–

[a] Source: Alaska Department of Transportation.

Although roads can create barriers to fish passage when culverts are undersized and not properly maintained, culverts that are properly designed and maintained for fish passage can have minimal to no impact on salmon. ADF&G conducts assessments of culverts to determine the expected impact to fish passage using the following classification system based on juvenile and weak swimming fish: green (crossing assumed to be adequate), gray (crossing may be inadequate), red (crossing assumed to be inadequate), black (unable to rate or culvert has been replaced and not reassessed). Results of this assessment are given in Table 5. Once rated, ADF&G's Fish Passage Improvement Program works to replace or remove culverts that are identified as inadequate for fish passage.

Table 6.– Summary of ADF&G culvert passage assessments (juvenile and weak swimming fish) for salmon-bearing subbasins as of 2016, and number of structural culverts and drainage culverts in the Canadian portion of transboundary subbasins.

	Alaska culvert assessment[a]					**Canada[b]**	
Subbasin	**Green**	**Gray**	**Red**	**Black**	**Total**	**Structural culverts**	**Drainage culverts**
Alsek River	0	0	0	0	0	0	39
Taku River	0	0	0	0	0	0	0
Chilkat - Skagway Rivers	52	39	45	20	156	19	120
Yakutat Bay-GOA	0	0	0	0	0	0	0
Stikine River	0	1	6	1	8	0	0
Burroughs Bay	0	0	0	0	0	0	0
Admiralty Island	0	0	0	0	0	–	–
Upper Kenai Peninsula	40	55	78	37	210	–	–
Lower Kenai Peninsula	27	16	29	12	84	–	–
Lower Copper River	19	30	43	10	102	–	–
Middle Copper River	12	18	41	2	73	–	–
Upper Copper River	5	12	15	0	32	–	–
Shelikof Strait	0	0	0	0	0	–	–
Lower Susitna River	84	24	78	9	195	–	–
Upper Susitna River	7	7	48	3	65	–	–
Yentna River	4	4	11	1	20	–	–
Talkeetna River	0	0	1	0	1	–	–
Redoubt-Trading Bays	20	8	9	3	40	–	–
Chitina River	2	4	14	0	20	0	0
Kodiak – Afognak Islands	45	26	63	61	195	–	–

[a] Green = crossing assumed to be adequate; gray = crossing may be inadequate; red = crossing assumed to be inadequate; black = unable to rate or culvert has been replaced and not reassessed.
[b] Number of Canadian culverts for transboundary rivers; fish passage unknown (Government of Yukon).

In GOA Chinook-bearing systems, mining is limited to small scale operations in the Chilkat watershed and some larger-scale operations in the upper portions of transboundary rivers in Canada (Table 6). Placer mining in or near fish-bearing streams, rivers, etc. typically requires an ADF&G-approved Fish Habitat Permit to ensure low impact mining techniques are used. Large scale hardrock and surface mining requires extensive review, oversight, and permits by state and federal resource management agencies. Mining claims may also be present in watersheds, which are parcels of land in which the "claimant" has the right to develop and extract minerals, typically on a small scale or to conduct exploratory operations with minimal impact to habitat. Additional permits are required to move forward with mining activity that would result in significant disturbance to the environment.

Table 7.– Number of mine sites and prospective mine sites within subbasins in Alaska and in the Canada portion of transboundary subbasins, and area (mi^2) of active state and federal mining claims.

	Alaska						Canada	
	Mine sites[a]		Prospective mine sites[a]		State mining claims (mi^2)[b]	Federal mining claims (mi^2)[c]	Mine sites[d]	
Subbasin	Inactive	Active	Inactive	Active			Inactive	Active
Alsek River	0	0	1	0	0	0	0	0
Taku River	0	0	6	1	0.41	0.09	3	0
Chilkat – Skagway Rivers	4	4	19	13	34.77	10.35	2	0
Yakutat Bay-GOA	5	0	1	0	0	0	0	0
Stikine River	2	1	3	0	0	0.07	0	0
Burroughs Bay	9	0	39	1	0	20.65	2	0
Admiralty Island	1	1	24	3	0	14.43	NA	NA
Upper Kenai Peninsula	34	16	46	0	6.54	13.76	NA	NA
Lower Kenai Peninsula	4	0	2	0	0	0	NA	NA
Lower Copper River	9	0	23	0	0.19	0.22	NA	NA
Middle Copper River	7	1	77	1	47.79	0	NA	NA
Upper Copper River	19	2	37	9	149.35	0	NA	NA
Shelikof Strait	1	0	8	3	0	0	NA	NA
Lower Susitna River	17	5	43	2	30.96	0.44	NA	NA
Upper Susitna River	13	4	72	20	154.82	4.42	NA	NA
Yentna River	21	0	18	22	319.00	0.62	NA	NA
Talkeetna River	2	0	17	1	18.98	0	NA	NA
Redoubt-Trading Bays	0	0	5	0	3.25	0	NA	NA
Chitina River	18	0	77	1	0	0	0	0
Kodiak – Afognak Islands	13	2	15	1	7.88	0	NA	NA

[a] Source: USGS Alaska Resource Data File (ARDF). Sites that were indicated as active in the USGS ARDF dataset were counted as active, all other sites including those that were most likely inactive and those that did not have an official determination in the USGS ARDF data were counted towards inactive.

[b]Alaska Department of Natural Resources records.

[c]Bureau of Land Management records.

[d]Exploratory mining may be actively taking place at inactive mine sites.

Alaska is not without population centers, which tend to have airports, road networks, infrastructure, and development related to human habitation that could potentially disrupt freshwater habitat. However, Alaska is sparsely populated compared to the Pacific Northwest whereas the City of Seattle alone has a larger population than the entirety of Alaska (2022 U.S. census data). Where population centers exist in Alaska, there are policies and regulations in place to mitigate these impacts (see Section 2.1.5). Where areas are remote, airstrips (Table 7), and public use cabins and recreation structures (Table 8) can be markers of human presence within watersheds that otherwise have very little development and accessibility. Many cabins in Alaska are only accessible by boat or plane and are primarily used in summer months.

Table 8.– Number of airports/airstrips within each subbasin in Alaska.

Subbasin	**Airports / Airstrips**
Alsek River	2
Taku River	0
Chilkat - Skagway Rivers	4
Yakutat Bay-GOA	5
Stikine River	0
Burroughs Bay	0
Admiralty Island	1
Upper Kenai Peninsula	6
Lower Kenai Peninsula	8
Lower Copper River	3
Middle Copper River	5
Upper Copper River	1
Shelikof Strait	4
Lower Susitna River	2
Upper Susitna River	1
Yentna River	3
Talkeetna River	0
Redoubt-Trading Bays	1
Chitina River	2
Kodiak – Afognak Islands	10

Source: Alaska Department of Transportation.

Table 9.– Number of recreation structures within each subbasin in Alaska.

Subbasin	Campground	Trail-head	Cabin	Shelter	Picnic Area	Headquarters	Visitor Center	Ranger Station
Alsek River	0	0	2	0	0	0	0	1
Taku River	0	0	3	0	0	0	0	0
Chilkat - Skagway Rivers	6	9	2	8	5	0	1	3
Yakutat Bay - GOA	2	3	5	0	1	0	0	1
Stikine River	0	0	12	0	1	0	0	0
Burroughs Bay	0	0	13	0	0	0	0	0
Admiralty Island	0	0	12	0	0	0	0	0
Upper Kenai Peninsula	29	55	18	0	2	0	2	2
Lower Kenai Peninsula	0	5	0	0	0	0	1	0
Lower Copper River	1	11	6	0	3	0	1	0
Middle Copper River	5	10	0	0	0	2	1	0
Upper Copper River	1	13	0	0	1	0	0	1
Shelikof Strait	0	0	0	0	0	0	0	3
Lower Susitna River	0	0	0	0	0	0	0	1
Upper Susitna River	0	3	0	0	0	0	0	0
Yentna River	0	0	0	0	0	0	0	0
Talkeetna River	0	0	0	0	0	0	0	0
Redoubt - Trading Bays	0	0	0	0	0	0	0	0
Chitina River	0	9	0	2	1	0	2	1
Kodiak – Afognak Islands	0	1	0	0	0	0	1	0

Source: Esri US federal data.

The habitat for salmon populations in Alaska contrasts with Pacific Northwest Chinook habitat where fish must contend with dams, which impede passage and form reservoirs that increase water temperatures and alter natural flow patterns and river dynamics; land clearing and diking for agriculture; water withdrawal for irrigation; water diversions and migration barriers; and extensive road networks that straighten streams, alter floodplains, increase stream temperature, increase fine sediment, reduce levels of stream complexity, concentrate tire chemicals, and alter watershed hydrology. These habitat degrading factors are either not present or are present to a much lesser extent than they are in the Pacific Northwest. There are 11 of 20 GOA subbasins that are entirely without dams and the Kodiak subbasin is the only one with more than 5 dams (Table 9).

Table 10.–Number of dams within each subbasin in Alaska (US National Dam Inventory) and Canada (Government of British Columbia; Esri Canada).

Subbasin	Dams in Alaska	Dams in Canada
Alsek River	0	0
Taku River	2	0
Chilkat - Skagway Rivers	2	0
Yakutat Bay-GOA	0	0
Stikine River	0	–
Burroughs Bay	0	0
Admiralty Island	2	–
Upper Kenai Peninsula	3	–
Lower Kenai Peninsula	5	–
Lower Copper River	1	–
Middle Copper River	0	–
Upper Copper River	0	–
Shelikof Strait	1	–
Lower Susitna River	1	–
Upper Susitna River	0	–
Yentna River	0	–
Talkeetna River	0	–
Redoubt-Trading Bays	0	–
Chitina River	0	0
Kodiak – Afognak Islands	17	–

Despite having more limited population and development, the State of Alaska still takes on the challenges and opportunities to improve freshwater habitat for salmon in Alaska's waterways by improving fish passage, stabilizing adequate rearing habitat, and removing invasive species, among other activities. In cases where there is anthropogenic activity present in salmon-bearing systems, the State of Alaska has several policies, mitigation measures, and efforts to prevent or minimize habitat alteration and degradation (see Section 2.1.5), and ADF&G runs an Instream Flow Program, responsible for collecting water quality and hydrology data to inform development projects that may impact Alaska's fish and wildlife resources.

2.3.3 Comparison between GOA and Puget Sound Chinook-bearing Waters

A comprehensive compilation of data from major Chinook-bearing watersheds in Alaska along with comparisons of miles of road, number of culverts, and mines is presented in Section 2.3.2 where it is contrasted with a Chinook-bearing watershed in the Pacific Northwest (Puget Sound). This comparison makes clear that freshwater Chinook habitat in Alaska does not suffer the degradation found in in Puget Sound, where ESA listing of a Chinook population as threatened (1999 listing[23]) has been warranted.

[23] https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/puget-sound-chinook-salmon

2.3.3.1 Map Data

The scale of habitat impacts to GOA Chinook can be more clearly understood when compared with an area where Chinook salmon have been listed as threatened under the ESA. To illustrate the scale and impact of human activity on habitat quality, we compare density calculations of roads, culverts, and human populations between the heavily modified subbasins of Puget Sound with the relatively pristine subbasins in the GOA as indicators of the quantity of anthropogenic activity within watersheds. We also provide subbasin habitat descriptions for Chinook-bearing systems in the GOA as well as an analysis of habitat use, including presence and density of roads, culverts, mine sites, mining claims, airstrips, and recreation structures.

Watershed boundaries were determined using United States Geological Survey (USGS) hydrologic unit codes (HUCs) 8s for areas identified by ADF&G as Chinook salmon habitat, representing subbasins spanning an average of 700 square miles (Figure 9). GOA Chinook salmon-bearing subbasins were compared to subbasins in Puget Sound. GOA subbasins included in this analysis were Alsek River, Taku River, Chilkat–Skagway Rivers, Stikine River, Burroughs Bay, Admiralty Island, Upper Kenai Peninsula, Lower Kenai Peninsula, Lower Copper River, Upper Copper River, Shelikof Strait, Lower Susitna River, Upper Susitna River, Yentna River, Talkeetna River, Redoubt–Trading Bays, Chitina River, Anchorage, Matanuska, Chulitna River, Tuxedni-Kamishak Bays, and Kodiak–Afognak Islands. Chinook-bearing subbasins in Puget Sound included in this analysis were Lower Skagit, Lake Washington, Snohomish, Nooksack, Stillaguamish, and Duwamish (Figure 10). The Puget Sound subbasins all contain habitat for the Puget Sound ESU that is currently listed as threatened under the ESA[24]. ArcGIS data layers were compiled from publicly available sources including ADF&G, Alaska Department of Transportation and Public Facilities (AK DOT), Alaska Division of Forestry (AK DOF), USGS, United States Forest Service (USFS), Esri United States Federal Data, Esri Demographics, Province of British Columbia, and Yukon Government to determine presence of dams, culverts, mining, logging, roads, and urban development near and within GOA Chinook salmon watersheds (Table 10). The presence of anthropogenic activities and development (number, area, length, etc.) within each subbasin was determined using the Summarize Within ArcGIS function.

[24] https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/puget-sound-chinook-salmon

Figure 22.–Map of Gulf of Alaska Chinook salmon-bearing subbasins analyzed.

Figure 23– Map of Puget Sound, WA Chinook salmon-bearing subbasins analyzed

Table 11.–ArcGIS data layers used for subbasin habitat analysis.

Dataset Name	Source	Type of Data
AWC_stream	ADF&G	Chinook salmon identified streams
HU08	Esri Environment	HUC 8 subbasin boundaries
Road Surface	AK DOT	Public road location/length in Alaska
Forestry Roads Public View	AK DOF	Forestry road location/length/status in Alaska
Yukon Road Network	Government of Yukon	Road location/length in Yukon, Canada
Ministry of Transportation Road Features Inventory	Government of British Columbia	Road location/length in BC, Canada
Forest Service Roads – 50k	Government of Yukon	Forestry road location/length in Yukon, Canada
Forest Operations Map (FOM) – Road Sections	Government of British Columbia	Forestry road location/length in BC, Canada
Local Agency Public Road - Route	Washington DOT	Public road location/ length in Washington
Active Roads	Washington DNR	Forestry road location/length/status in Washington
U.S. Forest Service Timber Harvests	USFS Enterprise Content	US timber harvest
Timber Sales	AK DOF	AK DOF Timber sales
Alaska Resource Data File	USGS	Mines and prospective mines in Alaska
Culvert_1_22	ADF&G	Culvert locations and fish passage assessment in Alaska
Structural Culverts – 25 k	Government of Yukon	Structural culvert locations in Canada
Drainage Culverts – 25k	Government of Yukon	Drainage culvert locations in Canada
WSDOT Fish Passage Inventory Barrier Status	Washington DOT	Culvert locations and fish passage assessment in Washington
National Inventory of Dams	Esri US Federal Data	US inventory of dams
Recreation Structures	Esri US Federal Data	Recreation structure locations in US
BC Dams	Government of British Columbia	Dam locations in BC, Canada
Renewable Energy Power Plants, 1 MW or more	Esri Canada	Locations of renewable energy power plants throughout North America
AKDOT Public Airports March2018	AK DOT	Public airport/ airstrip locations in AK
USA_2020 Census Block Group	Esri Demographics	US 2020 census data
Roadless_NonNWA	GIS Help Audubon	Tongass roadless areas
ASP Park Boundary	DNR GIS Public Access Coordinator	Alaska state parks
Nps_fee_boundary	National Park Service	US National parks
FWSBoundaries	Federal User Community	US Wildlife refuges

2.3.3.2 Gulf of Alaska and Puget Sound Subbasin Comparisons

For each of the anthropogenic activities discussed in this section (road density, culvert density, dam density, population density), calculated densities were higher for most if not all of the Puget Sound subbasins compared to GOA subbasins.

Road density was calculated as the total kilometers of road within a subbasin divided by the total area of the subbasin in square kilometers (Table 11). Public road density (paved and unpaved) for GOA subbasins ranged from 0 – 1.8, with 20 out of 24 subbasins having a road density less than 0.10 km/km^2 (Table 11). Active forestry road density in Alaska ranged from 0 – 0.0065. Comparatively, public road density in Puget Sound was at least twice as dense (Figure 12), ranging from 0.41 to 4.70 km/km^2, with three out of six watersheds having a road density greater than 1.00 km/km^2 (Table 11). Active forestry road density in Puget Sound was at least an order of magnitude higher (Figure 12), ranging from 0.033 0.520 km/km^2 (Table 11).

Culvert density was calculated as the total number of culverts within a subbasin divided by the total area of the subbasin in square kilometers (Table 1). In the GOA, culvert density ranged from zero to 0.17/km^2, with the total number of culverts within a subbasin ranging from zero to 377. Culvert density in Puget Sound ranged from 0.068/km^2 to 0.190/km^2 or 106 to 301 culverts within a subbasin. Although the highest density of culverts in Alaska is comparable to the lowest density in Puget Sound, the density of culverts determined to be inadequate for fish passage ranges from zero to 0.03/km^2 in Alaska, which is nearly an order of magnitude less than the density of 0.026/km^2 to 0.076/km^2 in Puget Sound (Figure 13).

Dam density was calculated as the total number of dams within a subbasin divided by the total area of the subbasin in square kilometers (Table 11). Dam density for all Gulf of Alaska subbasins discussed in this document ranged from zero to 0.005/km^2, with many of the subbasins having zero dams (Figure 14). In Puget Sound, subbasin dam density was an order of magnitude higher and ranged from 0.0028/km^2 to 0.0270/km^2, with all subbasins having multiple dams (Figure 14). For the GOA, the 11 dams in the Anchorage was the largest number in a subbasin. In Puget Sound, Lake Washington had the highest number with 41 dams and Stillaguamish had the lowest number with five.

Block group census data collected in 2020 was used to estimate the average population density (number of people per square km) within each subbasin (Table 11). In the GOA, the mean population density within each subbasin ranged from 0 – 110 people / km^2, with 18 out of 24 subbasins having a mean population density less than 1 person / km^2. In Puget Sound, the mean population density within each subbasin ranged from 30 to 1,100 people/km^2. This 10 to 300-fold difference in population densities between the two areas demonstrates the vast difference in human impact and development in GOA versus Puget Sound (Figure 15).

Table 12.–Density comparisons of potential habitat threats between Gulf of Alaska subbasins and Puget Sound subbasins.

Subbasin	**Area (km^2)**	**Public road density (km/km^2)**	**Forestry road density (km/km^2)**	**Culvert density (number/km^2)**	**Dam density (number/km^2)**	**Mean population density (people/km^2)**
GOA						
Burroughs Bay	8,337	0.0000	0	0	0	0.0000042
Admiralty Island	5,545	0.0031	0	0	0.00036	0.20
Stikine River	2,595	0.0063	0.0026	0.0031	0	0.019
Chilkat - Skagway Rivers	5,196	0.052	0.0044	0.057	0.00038	0.63
Taku River	2,629	0	0	0	0.00076	0.13
Alsek River	2,111	0	0	0.018	0	0
Yakutat Bay-GOA	12,287	0.0091	0.0012	0	0	0
Upper Copper River	11,652	0.017	0	0.0027	0	0.0000028
Middle Copper River	21,119	0.026	0.0012	0.0035	0	0.0020
Chitina River	20,971	0.0055	0	0.00095	0	0.000045
Lower Copper River	14,123	0.014	0.00013	0.0072	0.00007	0.085
Lower Kenai Peninsula	7,006	0.16	0.0011	0.012	0.00071	2.9
Upper Kenai Peninsula	10,927	0.18	0	0.019	0.00027	3.6
Anchorage	2,155	1.8	0.0065	0.17	0.0051	110
Matanuska	9,068	0.070	0	0.0060	0.00011	2.2
Upper Susitna River	16,275	0.0063	0	0.0040	0.00000	0.014
Chulitna River	6,711	0.020	0	0.0061	0	0
Talkeetna River	5,273	0.0025	0	0.00019	0	0.047
Yentna River	15,895	0.0036	0	0.0013	0.00016	0
Lower Susitna River	9,578	0.12	0.0037	0.020	0.00010	1.2
Redoubt-Trading Bays	10,759	0.014	0	0.0037	0	0
Tuxdeni-Kamishak Bays	7,988	0.00041	0	0	0	0
Kodiak – Afognak Islands	23,144	0.013	0	0.0084	0.00073	1.0
Shelikof Strait	20,772	0.0010	0	0	0.00005	0.0000020
Puget Sound						
Nooksack	2,639	0.71	0.20	0.078	0.0076	81
Lower Skagit	1,173	0.85	0.29	0.090	0.0085	35
Stillaguamish	1,818	0.41	0.27	0.068	0.0028	30
Snohomish	756	2.6	0.16	0.16	0.015	340
Lake Washington	1,546	4.7	0.033	0.19	0.027	1,100
Duwamish	1,285	2.0	0.52	0.12	0.011	330

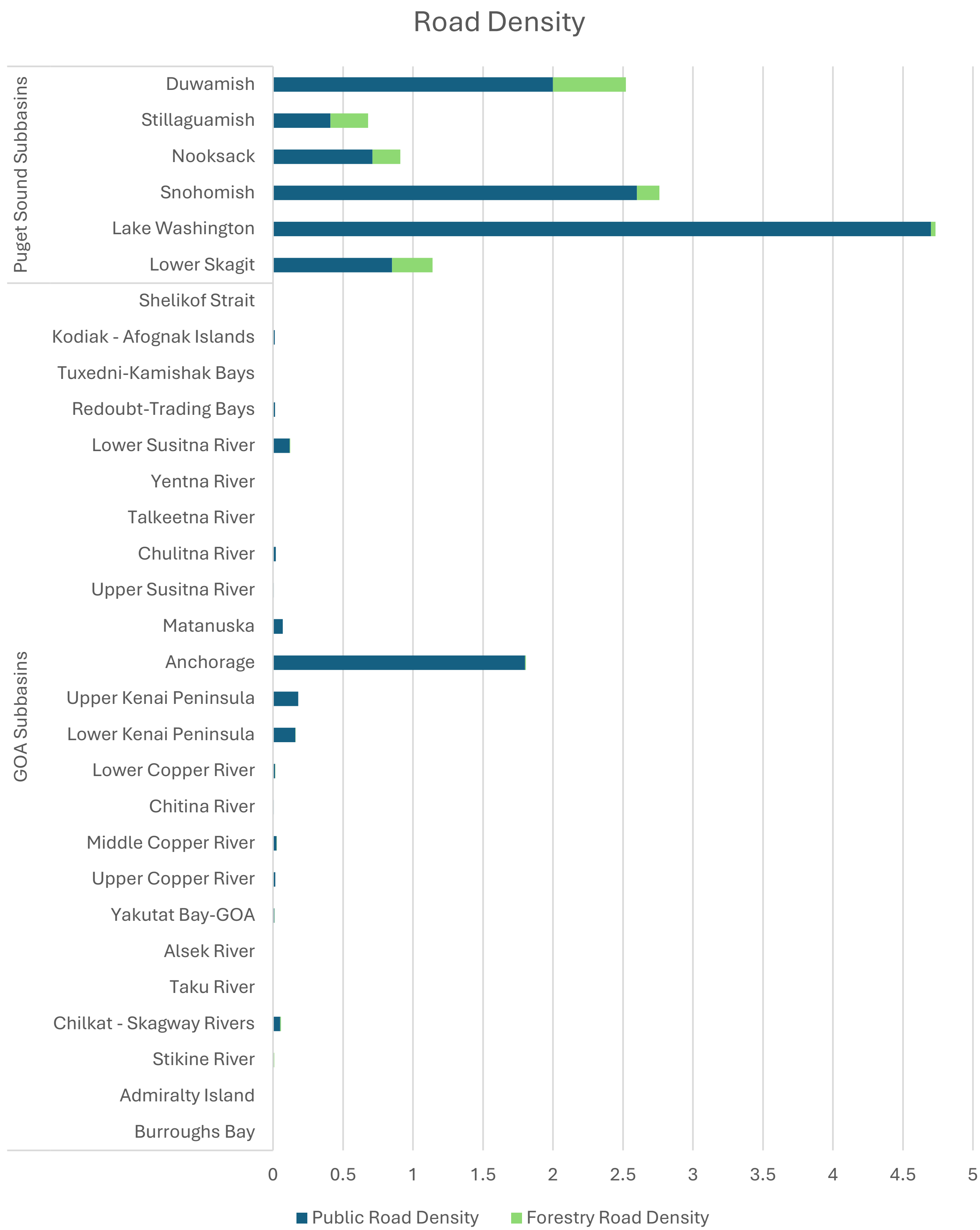

Figure 24.–Density (km/km^2) of public roads and forestry roads for Chinook salmon-bearing subbasins in Puget Sound and Gulf of Alaska.

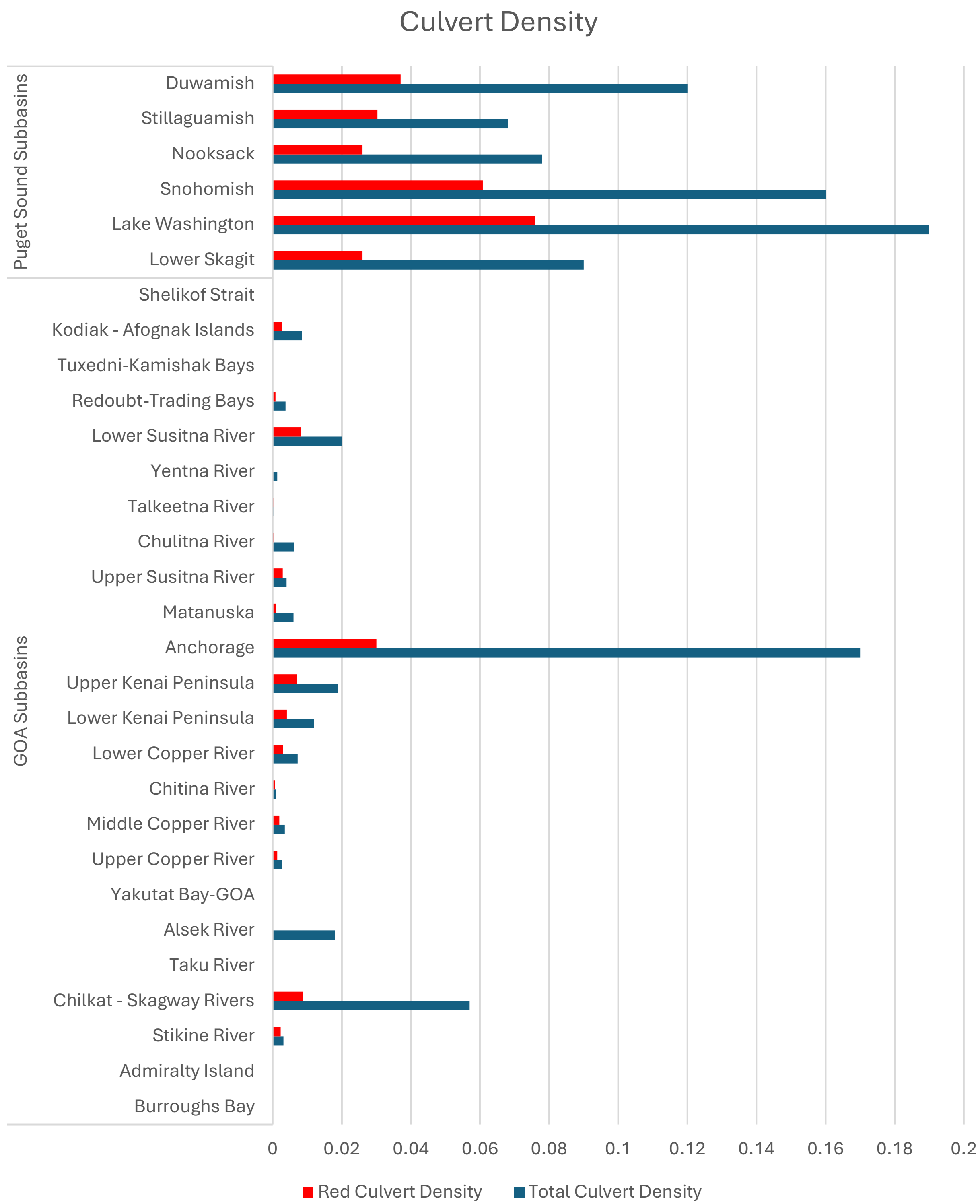

Figure 25.–Density (culverts/km^2) of total culverts and culverts with a red rating for Chinook salmon-bearing subbasins in Puget Sound and Gulf of Alaska. A red culvert rating indicates that Alaska Department of Fish and Game or Washington Department of Transportation assessments have indicated fish passage is likely blocked at the location of that culvert.

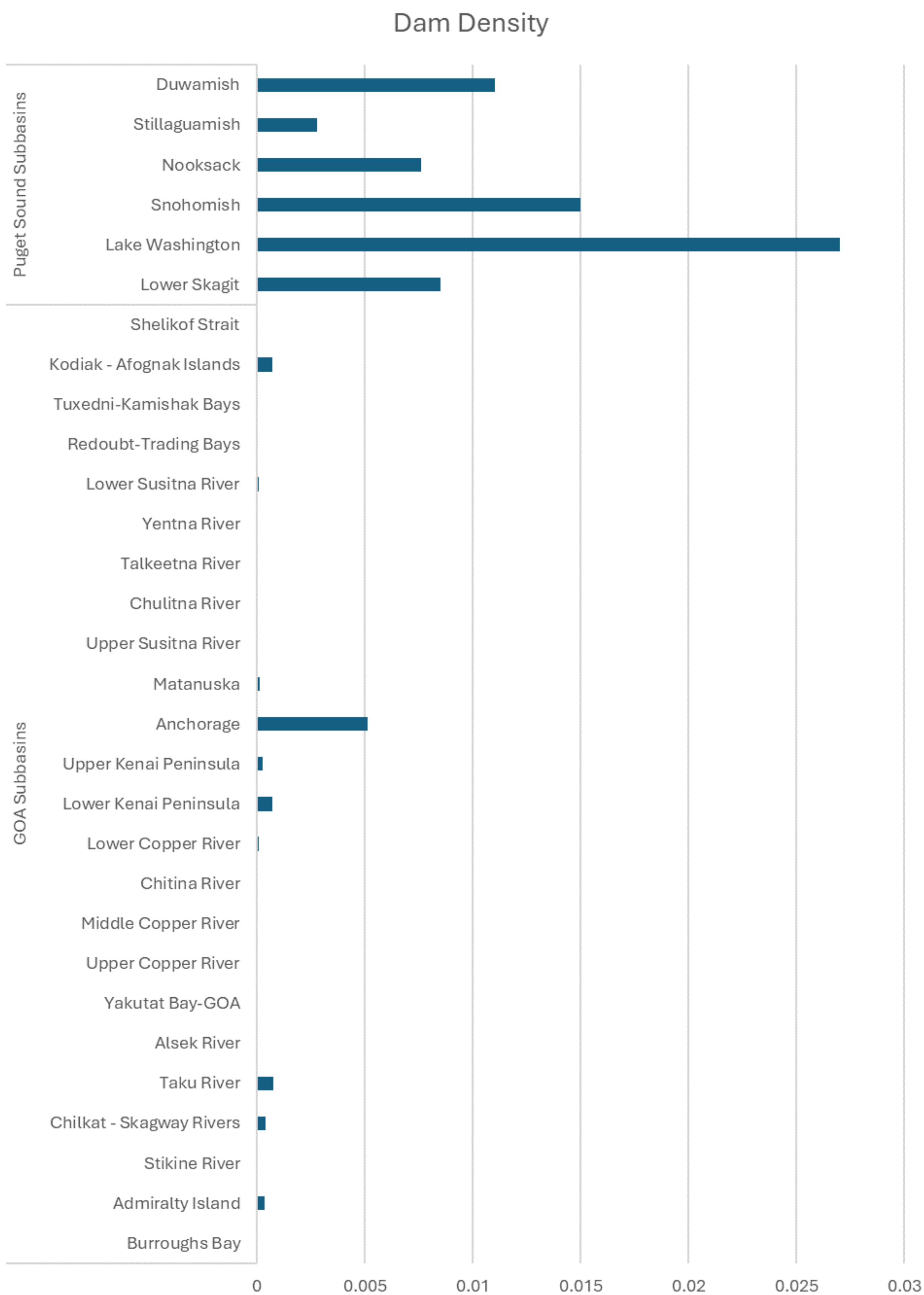

Figure 26.–Density of dams (dams/km^2) for Chinook salmon-bearing subbasins in Puget Sound and Gulf of Alaska.

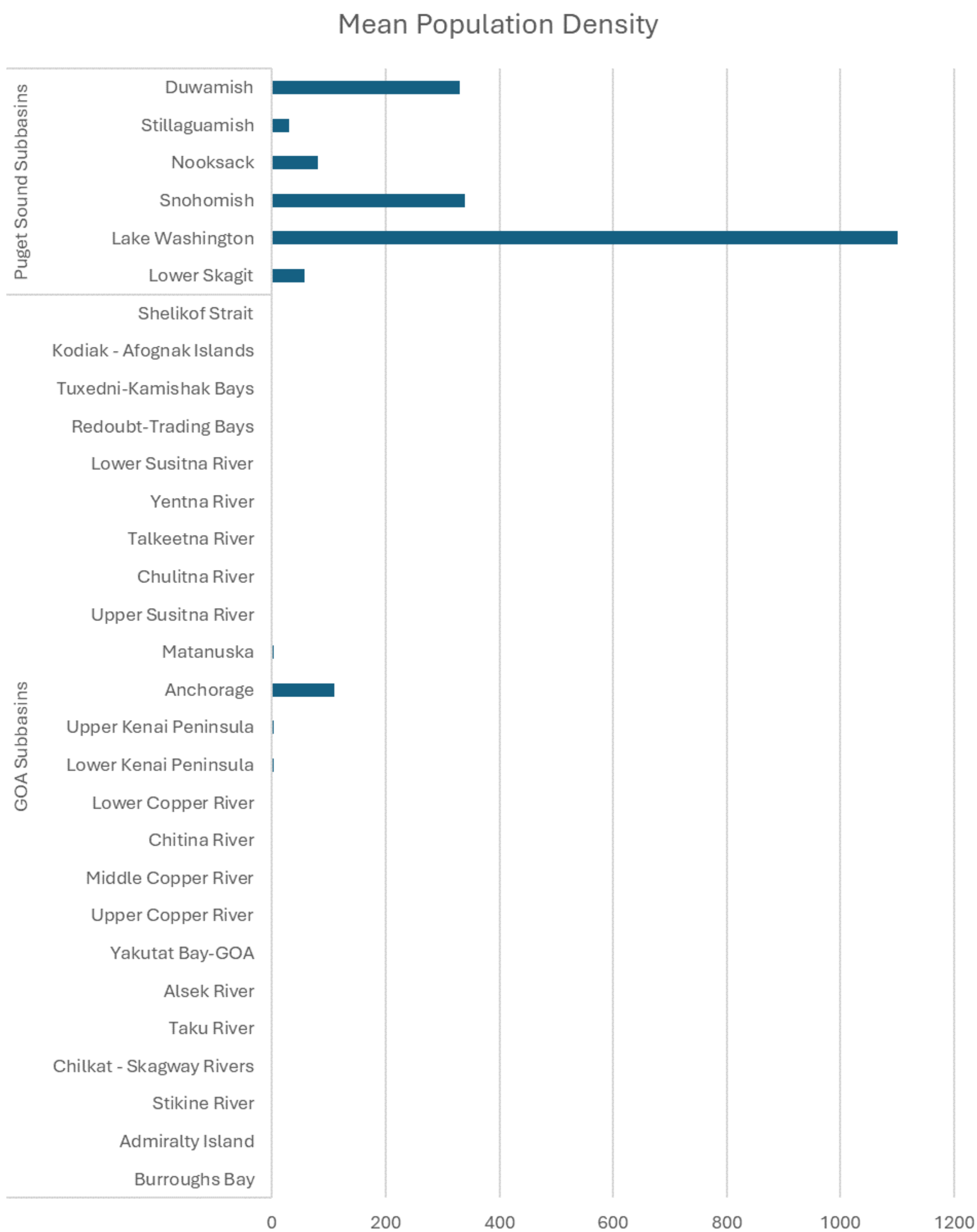

Figure 27.– Mean population density for Chinook salmon-bearing subbasins in Puget Sound and Gulf of Alaska.

Source: US census block group population densities (number of people per km^2) were obtained from Esri demographics 2020 Census Block Group data. The ArcGIS summarize within function was used to determine mean population density (people per km^2) within each subbasin boundary.

Appendix A

2.3.4 Gulf of Alaska Subbasin Descriptions

2.3.4.1 Alsek River Subbasin (HUC ID: 19010406)

The Alsek River subbasin (HUC ID: 19010404) covers 815 square miles and comprises numerous secondary and tertiary branches stemming from the Alsek River. The Alsek River itself is a transboundary glacial system that originates in southwestern Yukon and northwestern British Columbia and flows into the GOA approximately 80 km southeast of Yakutat. This river supports a single stock of Chinook salmon. The Alsek River drainage covers about 28,000 km^2 (Bigelow et al. 1995), but much of it, including the mainstem of the Alsek River, is inaccessible to anadromous salmonids due to velocity barriers. The largest tributaries are the Dezadeash and Tatshenshini Rivers. Significant spawning areas for Chinook salmon are found mostly in tributaries of the Tatshenshini River, including the Klukshu, Blanchard, and Takhanne Rivers and in headwater creeks in the upper Tatshenshini River (Pahlke and Waugh 2006). The Klukshu and upper Tatshenshini Rivers are accessible by road near Klukshu Village and Dalton Post, Yukon Territory.

The 250 km span of the transboundary Alsek River is considered pristine and lies entirely within the Kluane/Wrangell–St. Elias/Glacier Bay/Tatshenshini–Alsek UNESCO World Heritage Site, a vast internationally protected land-based ecosystem. Additionally, a 90 km stretch of the river within the Champagne and Aishihik First Nations and Kluane National Park and Reserve is a designated Canadian Heritage River (Parks Canada 2019).

In the Alaska portion of the Alsek River subbasin, there are no dams, culverts, record of USFS timber harvest, or record of AK DOF timber sales. According to USGS resource data, the only mining activity within the subbasin is one inactive prospective mine site. The only development within the subbasin consists of the following airstrips with associated public use cabins, and one ranger station: Tanis Mesa Airstrip (1,900 ft ×10 ft) and cabin near Gines Creek, Alsek River Airstrip (1,860ft × 12 ft) and cabin near Emile Creek, Dry Bay Airstrip (3,600 ft × 170 ft) and cabin, and the Dry Bay Ranger Station. The airstrips, cabins, and ranger station are not accessible by road. Outside of the Alsek River Watershed boundary, the East Alsek River Airstrip (1,500 ft × 10 ft) and cabin are located nearby in the adjacent watershed (Palma Bay watershed; HUC ID: 19010406) and there are a series of jeep trails in this area.

In Canada, most of the subbasin has no human development or activity except where the Alaska Highway crosses through near the northern boundary of the watershed for a stretch of approximately 22 km. There are 39 drainage culverts along this stretch of highway that are lacking fish passage assessments.

In Canada, there are also secondary and tertiary branches of the Alsek River that extend outside of the HUC ID: 19010406 watershed boundary that may influence habitat within the watershed. The Dezadeash River (Alsek River secondary tributary) meets the village of Haines Junction in Yukon, Canada, which has a population of 688 according to the 2021 Census. There are road systems in and around Haines Junction, including the Alaska Highway and Haines Highway, which have several structural and drainage culverts. In Haines Junction, there is a wastewater treatment facility that ultimately discharges into the Dezadeash wetlands and then into the Dezadeash River, approximately 22 km upstream of the Alsek River. Although discharges have historically occurred every four to five years, increased water use in recent years has resulted in discharges every one to two years since 2011 and an emergency discharge in 2015. Water quality parameters in the Alsek River watershed are being monitored by Parks Canada and are not of concern at this time (Parks Canada 2019). The Aishihik hydroelectric dam along the Aishihik River (tertiary tributary) is the only dam present on a secondary or tertiary tributary of the Alsek River; a fish ladder was built as part of the dam structure that allows fish to travel back and forth freely. Both seasonal and diurnal changes in flow rates of the Aishihik River have been observed as a result of the hydroelectric dam, although other factors may play a part as well. Changes in Aishihik River flow rates have downstream effects to the Dezadeash River and Alsek River, though at a much smaller magnitude than the Aishihik River (Baraer et al. 2019; Parks Canada 2019).

2.3.4.2 Taku River Subbasin (HUC ID: 19010304)

The Taku River subbasin (HUC ID: 19010304) covers 1,015 square miles including the Taku River and numerous tributaries. The Taku River is a transboundary glacial system that supports a single stock of Chinook salmon. The Taku River originates in British Columbia and drains over 17,000 km^2 before its terminus at Taku Inlet, approximately 40 km northeast of Juneau. The Taku River Chinook salmon run spawns entirely in Canada. The 2 main tributaries are the Nakina and Inklin Rivers. The Inklin River drains a larger area and comprises several large tributaries that provide Chinook salmon spawning and rearing habitat. Most of the tributaries are clear or slightly occluded by glacial flour, especially in the lower Nakina and Sheslay Rivers and Kowatua Creek.

In 2023, the Taku River Tlingit First Nation declared the Canada portion of the Taku watershed an Indigenous Protected Conserved Area (IPCA), protecting 60% of the watershed from mining and other extractive resource development. The Alaska portion of the subbasin is within the Tongass National Forest. No permanent cities or communities are located anywhere within the Taku River watershed, and most areas within the watershed can only be accessed by small planes. Outside of the subbasin boundary road, access once existed in the far upper reaches of the Sheslay River (Taku River tributary) to allow access to the Muddy Lake mine. However, that road has been decommissioned and the Taku River is the only major river on the Pacific coast of North America that lacks road access to any of its tributaries.

Overall, there is minimal human activity or impact to the U.S. portion of the Taku River watershed. There are two hydroelectric dams in the Alaska portion of the subbasin on secondary branches from Taku Inlet, Annex Creek and Lake Dorothy. However, neither stream is known to be used by Chinook salmon and both are located ‘downstream’ of where the Taku River empties into the estuary of Taku Inlet. However, neither stream (Annex Creek, Lake Dorothy) is known to be used by Chinook salmon. Development in the Alaska portion of the subbasin includes three public use cabins (Taku Glacier Cabin, West Turner Lake Cabin, and East Turner Lake Cabin), and one lodge (Taku Glacier Lodge). Nearly 100% of the Taku River watershed in Alaska is surrounded by “roadless areas”, a federal rule protecting land from timber harvest and road construction. USFS records (dating back to 1820) indicate there has been no timber harvest in the Taku River subbasin in Alaska and there are no AK DOF records of timber sale.

Development in the Alaska portion of the subbasin includes three public use cabins, Taku Glacier Cabin, West Turner Lake Cabin, and East Turner Lake Cabin, and one lodge, Taku Glacier Lodge. A small number of private cabins are located on the lower mainstem of the Taku River and are accessed for seasonal use. Nearly 100% of the Taku River watershed in Alaska is surrounded by “roadless areas”, a federal rule protecting land from timber harvest and road construction. US Forest Service records (dating back to 1820) indicate there has been no timber harvest in the Taku River subbasin in Alaska and there are no AK DOF records of timber sale.

In British Columbia, approximately 10 km north of the U.S. border, there are three inactive hardrock mine sites along the Tulsequah River (Taku River tributary), primarily for gold, silver, copper, and lead: Tulsequah Chief, Big Bull, and New Polaris. Although all hardrock mining was suspended in this area in the late 1950s, acid mine drainage continues to be released from the Tulsequah Chief site into the Tulsequah

River. An ADF&G Habitat Technical Report includes detailed information regarding the Taku River watershed and historic and current mining activity. [25]

In the Alaska portion of the subbasin, there are no mines (active or inactive); however, there are seven prospective mine sites, one of which is active (primarily gold and silver). Since the late 1980s, several mining companies have considered opening three of these sites, and multiple environmental assessments and hydrology studies have been conducted. Mining exploration is ongoing in the area and an airstrip has been constructed and local roads have been built to facilitate exploration. There are approximately 0.41 square miles of state of Alaska mining claims and 0.09 square miles of federal mining claims in the Alaska portion of the subbasin.

2.3.4.3 Chilkat-Skagway Rivers Subbasin (HUC ID: 19010303)

The Chilkat-Skagway River subbasin (HUC ID: 19010303) covers 2,006 square miles and contains two primary transboundary rivers separated by mountain ranges: the Chinook-bearing Chilkat River and the non-Chinook bearing Skagway River. This subbasin has more road access and development compared to other subbasins in Southeast Alaska, with approximately 200 miles of road and access to both the Chilkat and Skagway Rivers. AK DOF records indicate there have been approximately 16,225 acres of timber sale within the subbasin. There is mining activity present, with approximately 35 square miles of state mining claims and 10 square miles of federal mining claims within the subbasin. There are eight mine sites, but only four are active (primarily gold, silver, lead, zinc), two of which are placer mines and two of which are hardrock mines. There are also 19 active prospective mine sites (primarily gold, silver, barium, copper, lead, zinc, iron, and titanium) and 13 inactive prospective mine sites. There are two hydroelectric dams in the subbasin; however, they are located near the non-Chinook bearing Skagway River.

The Chilkat River is a mainland glacial system that originates in British Columbia and traverses rugged mountainous terrain before terminating in the Chilkat Inlet in northern Lynn Canal, near Haines. It supports the fifth largest stock of Chinook salmon in SEAK. The main channels and major tributaries comprise approximately 600 km of fluvial habitat in a watershed covering about 1,600 square kilometers (Bugliosi 1988). The Chilkat River originates from the Chilkat Glacier, and the watershed is fed by multiple glaciers. In Alaska, the Chilkat River Critical Habitat Area protects 4,800 acres of land on the lower area of the river and the Alaska Chilkat Bald Eagle Preserve (CBEP) protects 48,000 acres of land (Schoen and Dovichin 2007). The CBEP Management Plan (Alaska Department of Natural Resources, 2002), includes two purposes that are directly related to Chinook salmon: to protect and sustain the natural spawning and rearing areas of the Chilkat River system in perpetuity; and maintain water quality and necessary water quantity. Most of the river basin includes wild forests and mountainous terrain. Rafting and canoeing are common recreational activities in Chilkat River.

Haines, AK is located on the Chilkat Peninsula and has a population of about 2,080 people. A small Alaska Native village is also located on the Chilkat River about 22 miles north of Haines, known as Klukwan, with a population of about 67 people. Haines Airport is located near the edge of the Chilkat River and the Haines Sea Plane Base is located in Portage Cove; both airports serve regional air carriers but not large-scale commercial operations. In the Alaska portion of the Chilkat watershed area there are approximately 81 miles of paved road and 43 miles of unpaved road. In the Canadian portion of the Chilkat watershed there are an additional 32 miles of road. Multiple tributaries of the Chilkat River lie within the Haines State

[25] Taku-Tulsequah River mining activity, background environmental monitoring and potential mining effects (alaska.gov)

Forest, which covers 286,000 acres. About 42,000 acres of the state forest are allocated for timber harvest and the annual allowable harvest is 5.88 million board feet. There are approximately 14 miles of active forestry road, 63 miles of inactive forestry roads, 31 miles of closed forestry roads, and 13.6 miles of non-Forest and Range Practices Act roads. There are multiple culverts associated with the Haines Highway, secondary roads, and forestry roads with the following fish passage classifications for juvenile or weak swimming salmonid according to ADF&G assessments: 36 culverts assumed to be adequate, 36 culverts assumed to be inadequate, 28 culverts that may be inadequate, 13 culverts with unknown adequacy. In the Canada portion of the watershed there also 19 structural culverts and 119 drainage culverts that are lacking fish passage assessments.

There is ongoing construction within the watershed known as the Haines Highway Reconstruction project which is occurring between mileposts 3.9 and 25 and involves widening the highway. There are also plans to replace the Chilkat River Bridge to improve debris flow which has been an issue near mileposts 17, 19, and 23. The final revised environmental assessment for this project was released in 2016 and determined there would be no significant impact and any short-term impacts would be temporary and minimal due to the conservation measures included in the project proposal.

Historical mining as well as current mining prospects, exploration, and placer mines are located in the Porcupine Mining District near Porcupine Creek, which stems off of Klehini River. Advanced stage volcanic massive sulphide exploration and development known as the Palmer–Constantine Project is actively taking place in the area. Constantine Mining, LLC contracted the ADF&G Habitat Section to study aquatic resources and conditions in Glacier Creek, a small tributary to the Chilkat River. Since 2016, periphyton, benthic macroinvertebrates, fish, and sediment have been sampled annually in Glacier Creek at two sites to document baseline productivity and sediment conditions. The most recent data and analyses for this study can be found in Krull (2023). In Canada, near the Eastern boundary of Tatshenshini–Alsek Park there are two nonactive mines near Inspector Creek: Maid of Erin (operational 1911-1956) and State of Montana (operational 1908-1909) (Krull 2023).

2.3.4.4 Yakutat Bay-Gulf of Alaska Subbasin (HUC ID: 19010405)

The Yakutat Bay-Gulf of Alaska (HUC ID: 19010405) watershed covers 4,744 square miles. The Situk River and associated tributaries as well as multiple other rivers in the Yakutat Forelands located in the southeast portion of the Yakutat Bay-Gulf of Alaska watershed have been identified as Chinook salmon habitat. There are a total of five airports/airstrips, two campgrounds, three trailheads, five cabins, one picnic area, and one ranger station within the watershed as well as the community of Yakutat (population 657). A total of approximately 6,652 acres have historically been harvested in the watershed according to USFS records. There are no active mines or mining claims within the subbasin, however there are five inactive placer mines (primarily gold) and one inactive prospective mine site. There are no dams throughout the entire watershed and no assessment of culverts.

The Situk River is a clearwater system located near Yakutat, Alaska, that supports a single stock of Chinook salmon. The Situk River is located approximately 10 km east of Yakutat, a city of 657 people, and flows into the Gulf of Alaska. It is 35.2 km long and drains 3 lakes that have a combined surface area of 17,000 ha. The Situk, Ahrnklin, and Lost Rivers all flow into the Situk-Ahrnklin Inlet before entering the Gulf of Alaska. The Situk River supports sport fisheries for salmon *Oncorhynchus* spp., steelhead *O. mykiss* and Dolly Varden *Salvelinus malma* in addition to commercial and subsistence fisheries for salmonids. The majority of freshwater angling effort for Chinook salmon in the Yakutat vicinity occurs in the Situk River.

There are approximately 14 km of paved road and 98 km of unpaved road within the Yakutat Bay-Gulf of Alaska watershed, all of which are in the Yakutat area. The Situk River is accessible from Yakutat by Forest Highway No. 10 at the Nine Mile Bridge and at Strawberry Point near the mouth of the river, and both access points include boat launches; the remainder of the watershed is not road accessible. There are six designated campsites located at the Nine Mile Bridge and camping is allowed along the river. The Situk Airstrip (2,150 ft × 10 ft) is located approximately 540 m east of the Situk River with two nearby public use cabins (Raven Cabin and Eagle Cabin) that are not accessible by road. There is also a public use cabin on Situk Lake accessible by trail or float plane. There are approximately 9.5 miles of active forestry roads near the west fork Situk River as well as a series of inactive, closed, and unknown status forestry roads. Timber harvest has previously taken place near the origin of the Situk River in 1985, 1986, and 2005.

There are also a unnamed streams further east of the Situk River in the Yakutat Forelands, where Chinook salmon have been found present. The Forest Highway No. 10 crosses over some of these streams, all of which drain into Situk-Ahrnklin Inlet to the East or the Dangerous River to the West. There are two airstrips in the area: the Dangerous River Airstrip (1800 ft) and the Harlequin Lake Airstrip (2100 x 35 ft). The Middle Dangerous River Cabin is located within 5,000 m of the Harlequin Lake Airstrip, but is not nearby identified Chinook salmon habitat. The Italio River is located within 7 km east of the Harlequin Lake Airstrip and the only nearby development is one cabin (Italio River Cabin).

2.3.4.5 Stikine River Subbasin (HUC ID: 19010207)

The Stikine River subbasin (HUC ID: 19010207) covers 1,002 mi^2. The transboundary Stikine River is a glacial system that originates outside of the subbasin boundary in the Spatsizi Plateau in British Columbia and spans approximately 312 miles in Canada and 35 miles in Alaska where the river ultimately empties into the Pacific Ocean near Wrangell, AK. The Stikine River supports a single stock of Chinook salmon. The Stikine River drainage is the largest transboundary system in British Columbia and SEAK, covering an area of about 52,000 km^2; however, only around 15,000 km^2 are accessible to anadromous fish due to a large canyon that creates a natural barrier upstream of the confluence of the Tuya and Stikine Rivers. The Stikine River has many clear water tributaries, though the drainage is predominately glacially influenced. Major anadromous tributaries of the Stikine River include the Tahltan, Tuya, Chutine, Scud, Porcupine, and Iskut Rivers. Most of the accessible Chinook salmon spawning habitat in the Stikine River drainage is in the Tahltan River and its tributaries, though major spawning populations are present in the Chutine and Iskut Rivers. The upper portion of the Stikine River drainage is road accessible via the Telegraph Creek Road and the Stewart Cassiar Highway.

Multiple protected areas have been established in the Stikine watershed in Canada, including Spatsizi Plateau Wilderness Provincial Park, Mount Edziza Provincial Park, Stikine River Provincial Park, Great Glacier Provincial Park, Choquette Hot Springs Provincial Park, Chukachida Protected Area, Pitman River Protected Area, and Craig Headwaters Protected Area. In Alaska, the Stikine River lies within a portion of the Tongass National Forest designated as the Stikine-Lekonte Wilderness. In total, 60% of the Stikine River watershed is under conservation management through protected areas, parks, and Special Management Zones (SMZs) (Schoen and Dovichin, 2007). There are no airports or renewable energy plants anywhere in the Stikine River subbasin.

In Alaska, the Community of Wrangell (population about 2,100; 2020 U.S. census) is within 10 km of the mouth of the river just outside of the subbasin boundary and is not accessible by road. There are some forestry roads, culverts, and timber harvest present near the southern boundary of the Stikine River subbasin. However, this area is located south of the mouth of the Stikine River. The Stikine River is accessible by road via Highway 37 and Telegraph Creek Road (gravel road). Highway 37 is the only road/bridge to cross over the Stikine River at any point. Development near the Stikine River in Alaska includes public use cabins and campsites accessible by boat including Twin Lakes Cabin, Mount Rynda Cabin, Shakes Slough Cabins 1 and 2, Mount Flemer Cabin, Garnet Ledge Cabin, Sergief Island Cabin, Koknuk Cabin, Gutland Island Cabins 1 and 2, Little Dry Island Cabin, and Mallard Slough Cabin. The historic Wrangell Garnet Mine site is located near the Garnet Ledge Cabin and has unique rules only allowing children from Wrangell to mine and sell gems. There are two small, inactive placer mines (primarily gold), Buck Bar and an unnamed site, located on the Stikine River. There are also three inactive prospect mines and approximately 0.07 square miles of federal mining claims within the subbasin.

The Iskut River is the largest tributary of the Stikine River. There are a series of non-active mines within the adjacent subbasin (Lower Iskut; HUC ID: 19010205) in Canada including Snip Mine near Bronson Creek (active 1991–1999 but may reopen in the future; hardrock mine; gold, silver, copper), Johnny Mountain Mine near Jekill River (active 1988–1993). The McLymont Creek Hydroelectric Dam is also located within the Lower Iskut subbasin in addition to the Forest Kerr Hydroelectric Dam and Volcano Creek Hydroelectric Dam located on the Iskut River just outside of the Iskut River subbasin. The Forest Kerr Hydroelectric Dam includes a return channel for any fish that may get caught to return to the river (Hatch 2015).

In Canada, there is one active mine as well as current proposals, development, and exploration of mines in the Stikine River watershed outside of the Stikine River and Isur River subbasin boundaries: Red Chris Mine near Kluea Lake (active 2015–present; open-pit mine; copper, gold, silver), Galore Creek Mine (proposed open-pit mine; copper, gold, silver), Schaft Creek Mine Project (advanced exploration for proposal to open-pit mine; copper, gold, molybdenum, silver), Iskut Mine Project (advanced exploration; copper, gold).

In 2014, a landslide occurred on the lower Tahltan River, a major Stikine River tributary (outside of HUC ID: 19010207 boundary) supporting the largest population of Chinook salmon in the Canadian portion of the Stikine River drainage. The landslide created a partial impediment to fish movement during high flows but did not completely prevent upstream fish passage. The Canadian Department of Fisheries and Oceans took steps to modify the slide so that the obstruction might be cleared during a high-water event. Unfortunately, from 2017 to 2019, the region experienced a series of drier than usual conditions and low precipitation that did not provide enough flow to move the debris downriver; however, the low flows still allowed for unimpeded fish passage. In 2020, high water flows succeeded in moving a substantial portion of slide debris downriver, which improved conditions for fish passage.

2.3.4.6 Burroughs Bay Subbasin (HUC ID: 19010105)

The Burroughs Bay subbasin (HUC ID: 19010105) covers 3,219 square miles and includes multiple river systems that support Chinook salmon including the Unuk, Chickamin, Blossom, and Keta Rivers. There are no roads (including forestry roads), airports/airstrips, dams, or culverts in the Alaska portion of the subbasin, although there are 13 cabins. There are approximately 20.7 square miles of federal mining claims. There are several inactive mine sites (9) and inactive prospect sites (39) throughout the Alaska portion of the subbasin; however, there are no active mines sites and only one active prospect site (primarily molybdenum). Within the subbasin in Canada, there is one active mine (Brucejack Mine; active 2012–present; hardrock mine; gold, silver), one proposed mine (Kerr-Sulphurets-Mitchell mine), and one inactive mine (Eskay Creek Mine; active 1971–2007). There are also gravel airstrips associated with the Brucejack Mine (Brucejack Aerodrome) and Eskay Creek Mine (Bronson Strip; Bob Quinn Strip) within the Canadian portion of the watershed.

Unuk River

The transboundary Unuk River is a glacial system spanning 80 miles with approximately 56 miles of the river in British Columbia and the remaining 24 miles in Alaska. In Canada there are two parks within the watershed: Lava Forks Provincial Park and Border Lake Park (both only accessible via air or combination air transport/boat). The section of the Unuk River watershed in Alaska lies entirely within the Misty Fjords National Monument Wilderness. There is no road access to any part of the Unuk River watershed so the majority of the Unuk River and its tributaries are extremely remote and difficult to access.

The Anchor Pass Cabin is located near the mouth of the river and is only accessible via boat or float plane. ADF&G has a field camp located on the Unuk River to conduct an annual Chinook salmon stock assessment project. The closest city is Ketchikan (population approximately 8,000 people) about 53 miles southwest of the mouth of the river. There is one unnamed historic prospect mine site at Burrough. There are no culverts, road systems, dams, or USFS timber harvest record in the area.

In Canada, the proposed Kerr-Sulphurets-Mitchell mine (primarily copper and gold mining) could have impacts to the Unuk River watershed because plans include open-pit and underground mining techniques. The mine proposal includes plans to establish mine support facilities in the non-fish bearing Mitchell and McTagg Creek valleys and to store and treat contact water before discharging the effluent into Sulphurets Creek, which drains into the Unuk River. At this time, it is not possible to estimate the potential effects of this mining project on the Unik River Chinook salmon population; however, projects are currently being proposed to collect baseline water quality and quantity data, and to implement periodic monitoring in the watershed to assess impacts that might occur due to this mining project (Meredith et al. 2022).

Chickamin River

The Chickamin River is a transboundary glacial system spanning approximately 43 miles. Although the river originates from the Chickamin Glacier in British Columbia, the entirety of the river itself is in Alaska and is fully contained within the Misty Fjords National Monument Wilderness. The river is considered pristine as there are no roads, dams, culverts, mines, logging, or development on the river.

Blossom River

The Blossom River is a clearwater system located approximately 37 miles east of Ketchikan, AK and lies entirely within the Misty Fjords National Wilderness. The river is considered pristine as there are no roads, dams, culverts, mines, logging, or development on the river.

Keta River

The Keta River is a clearwater system located approximately 46 miles east of Ketchikan, AK and lies entirely within the Misty Fjords National Monument Wilderness. The river is considered pristine as there are no roads, dams, culverts, mines, logging, or development on the river.

2.3.4.7 Admiralty Island Subbasin (HUC ID: 19010204)

King Salmon River

The King Salmon River is a clearwater system located on Admiralty Island and lies within the Admiralty Island National Monument and the Kootznoowoo Wilderness Area. This supports a small population of Chinook salmon. The King Salmon River watershed contains approximately 59 miles of stream habitat of which 7 miles are designated as anadromous habitat. There are no roads, dams, culverts, mines, timber harvest or development on the King Salmon River. There are approximately 14.4 square miles of federal mining claims that come within five miles of the river as well as one active mine approximately four miles from the river. On Admiralty Island, there is one active mine, one inactive mine, 24 inactive prospective mine sites, three active prospective mine sites, and two dams; however, they are not on or near King Salmon River or other known Chinook-bearing streams.

2.3.4.8 Copper River (HUC ID: 19020104; HUC ID: 19020102; HUC ID: 19020101)

The Copper River is a glacial system spanning approximately 466 km and is split into three different subbasins according to USGS HUC 8 boundaries. The Copper River watershed includes areas under different land status and jurisdiction including the Wrangell-St. Elias National Park, Chugach National Forest, and Alaska Native lands. The entirety of the Copper River watershed is considered among the last remaining intact watersheds on the planet, as there are no dams or industrial logging in the area. There are multiple culverts within all three subbasins that will be discussed in more detail in the following sections. However, there is an ongoing effort known as the Copper River Watershed Project to replace culverts throughout the watershed to allow for fish passage; it is estimated this will restore 187.5 miles of streams and 527 acres of lake habitat.

Lower Copper River Subbasin (HUC ID: 19020104)

The Lower Copper River subbasin (HUC ID: 19020104) covers 5,453 square miles. Cordova is the closest city to the Copper River with a population of approximately 2,500 people and is partially located within the Lower Copper River Subbasin. Highway 10 (Copper River Highway) extends approximately 80 km (first 19 km are paved and the remainder is gravel) from Cordova and crosses over the Copper River Delta; however, the highway has been closed at mile 36 since 2011 due to a failed bridge. There is also a stretch of Highway 4 in the northwest area of the subbasin and a small stretch of Edgerton Highway to the town of Chitina (population approximately 70 people) near the northern boundary of the subbasin. In total, there are approximately 56 miles of paved road and 64 miles of unpaved road within this subbasin. There are a series of culverts along the highways as well as secondary roads, many of which were poorly designed and do not provide proper drainage or fish passage. The Lower Copper River subbasin contains the following culverts and fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: 19 culverts assumed to be adequate, 43 culverts assumed to be inadequate, 30 culverts that may be inadequate, and 10 culverts with unknown adequacy.

The Power Creek Hydroelectric Dam and Eyak Lake Dam near Cordova are the only dams in this subbasin and neither are on a known Chinook-bearing stream. There are three airports including the Cordova Municipal Airport, the Cordova Merle K "Mudhole" Smith Airport, and the Thompson Pass Airport. There are multiple recreational structures within the subbasin including one campground, 11 trailheads, six public use cabins, three picnic areas, and one visitor center. There are 0.19 square miles of state mining claims and 0.22 square miles of federal mining claims within the subbasin. There are nine mine sites and 23 prospect sites; however, none of these sites are currently active. According to USFS records, there have been approximately 359 acres of timber harvest in the subbasin, concentrated in one area, and one mile of active forestry road.

Middle Copper River Subbasin (HUC ID: 19020102)

The Middle Coper River subbasin covers 8,154 square miles. Highway 4 and Highway 1 cross through this subbasin and there is a total of approximately 260 miles of paved road and 80 miles of unpaved road. There are also a series of forestry roads including approximately 15.2 miles of active forestry road, 5.2 miles of inactive forestry road, 1.7 miles of closed forestry road, and 21.8 miles of proposed forestry road. There are multiple culverts within the subbasin, primarily along the main highways, with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: 12 culverts assumed to be adequate, 41 culverts assumed to be inadequate, 18 culverts that may be inadequate, and 2 culverts with unknown adequacy.

There are 5 airports/airstrips within the subbasin including Chitina Airport, Tonsina Airport, Copper Center No 2 Airport, Tazlina Airport, and Gulkana Airport. There are a series of road accessible recreational structures throughout the watershed including five campgrounds, 10 trailheads, two headquarters, and one visitor information center. According to AK DOF, there are historical records of approximately 89 acres of timber sale within the subbasin. There is active and historical mining activity in the subbasin, including approximately 48 square miles of State of Alaska mining claims, eight total mine sites (one active hardrock mine; primarily gold), and 78 prospect mine sites (one active site primarily mining copper, nickel, palladium, and platinum).

Upper Copper River Subbasin (HUC ID: 19020101)
The Upper Copper River subbasin covers 4,499 square miles. There are no USFS records of timber harvest or forestry roads within the subbasin. Throughout the watershed, there are 107 miles of paved road composed of Highway 1 and Nabesna Road in addition to 19 miles of unpaved road. There are multiple culverts associated with these roads with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: five culverts assumed to be adequate, 15 culverts assumed to be inadequate, and 12 culverts that may be inadequate. There is one airport (Chistochina Airport) within the subbasin. There are a series of road accessible recreational structures throughout the watershed including one campground (Porcupine Creek State Recreation Site), 13 trailheads, one picnic area (Kettle Lake Wayside), and one ranger station (Slana Ranger Station). There is active and historical mining activity in the subbasin including approximately 150 square miles of State of Alaska mining claims, 21 total mines (two active placer mines; primarily gold), and 46 prospect mine sites (nine active, primarily mining gold, silver, and copper).

2.3.4.9 Chitina River (HUC ID: 19020103)
The Chitina River subbasin (HUC ID: 19020103) covers 8,097 square miles. The Chitina River spans 170 miles and is a tributary of the Copper River. There are no USFS records of timber harvest or forestry roads in this subbasin. There are also no renewable energy projects.

Egerton Highway—McCarthy Road crosses through a portion of this subbasin, with approximately 8 miles of paved road and 64 miles of unpaved road. There are some culverts associated with roads in the subbasin with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: two culverts assumed to be adequate, 14 culverts assumed to be inadequate, and four culverts that may be inadequate. There are two airports/airstrips including the McCarthy No. 2 Airport and the May Creek Airport. There are nine trailheads, two shelters (Glacier Creek Emergency Shelter Cabin and Hubert's Landing Emergency Shelter Cabin; both are historic), one picnic area, two visitor information centers (Kennecott Visitor Center and McCarthy Road Visitor Center), and one ranger station (McCarthy Ranger Station). The historic Kennecott Mine site is located near the Kennecott Visitor Center in addition to other nearby historic mine sites. Within the subbasin there are a total of 18 mine sites and 78 prospect mine sites; however, no mines are currently active and only one prospective mine site is active and primarily mining for silver, copper, lead, and zinc.

2.3.4.10 Upper Kenai Peninsula Subbasin (HUC ID: 19020302)

The Upper Kenai Peninsula subbasin (HUC ID: 19020302) covers 4,219 square miles. Within this basin, the Kenai River stems from Kenai Lake and stretches west approximately 132 km where it empties into Cook Inlet. A large portion of the subbasin is within the Kenai National Wildlife Refuge. In addition, the Kenai River Special Management Area spans over 105 miles of rivers and lakes within the watershed.

Although there is no road access throughout most of the subbasin, there are highways that cross through the subbasin (with associated culverts) and a large portion of the Kenai River itself is road accessible. The lower Kenai River, near Cook Inlet, is located within a developed area with the cities of Kenai, Soldotna, and Sterling with additional road systems and culverts. In total, there are approximately 435 miles of paved road and 776 miles of unpaved road within the subbasin. There are culverts associated with roads in the subbasin with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: 40 culverts assumed to be adequate, 78 culverts assumed to be inadequate, 55 culverts that may be inadequate, and 37 culverts with unknown fish passage. There are three bridge crossings over the Kenai River: Warren Ames Memorial Bridge, Kenai River (Soldotna) Bridge, and Cooper Landing Bridge. The Alaska Railroad cuts through the watershed along a portion of the Kenai Lake, Lower Trail Lake, Upper Trail Lake, Trail Creek, and other smaller creeks. Overall, there is minimal logging history within the subbasin, with the majority of USFS logging records concentrated in the Chugach National Forest near the Sterling Highway, ranging from Mile 37 through 50, and near the Seward Highway, ranging from Mile 32 through 44. There has been a total of approximately 3,326 acres of timber harvest in the subbasin according to USFS records and there are 598 acres of timber sale according to AK DOF records. There are no dams on the Kenai River itself but there are three dams within the subbasin: the Roycroft Lake Hydroelectric Dam, Cooper Lake Hydroelectric Dam, and the Explorer Glacier Pond Dam. None of these dams occur on waters known to be Chinook-bearing. There is also a proposal for the Grant Lake Hydroelectric Project that would divert water from Grant Lake to a powerhouse located near the outlet of Grant Creek. Grant Creek is a Chinook-bearing stream.

Within the entire subbasin, there are 29 campgrounds, 55 trailheads, 18 public use cabins, two picnic areas, two visitor information centers, and two ranger stations. Many of the public use cabins are remote and are only accessible by boat, small plane, hiking, or skiing, depending on the location. There are six airports within the subbasin: Kenai Airport, Soldotna Airport, Quartz Creek Airport, Lawing Airport, Hope Airport, and Girdwood Airport.

Compared to other GOA Chinook salmon-bearing subbasins, the Upper Kenai Peninsula Subbasin has more historical and active mining activity. There are 50 mine sites (16 active) and 46 inactive prospect mine sites. The primary mineral for all active mine sites is gold, with one also mining for silver. Most of the active mine sites are placer mines; however, Case Grant Lake Mine and Primrose Mine are hardrock mines. There are approximately 6.5 square miles of State of Alaska mining claims and 13.8 square miles of federal mining claims.

2.3.4.11 Lower Kenai Peninsula Subbasin (HUC ID: 19020301)

The Lower Kenai Peninsula subbasin (HUC ID: 19020301) covers 2,705 square miles. This subbasin contains a variety of smaller rivers, streams, and creeks identified as Chinook salmon habitat. Like the Upper Kenai Peninsula subbasin, there is increased development in the subbasin near Cook Inlet. In total, there are approximately 199 miles of paved road and 505 miles of unpaved road in the subbasin. There are culverts associated with these roads with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: 27 culverts assumed to be adequate, 29 culverts assumed to be inadequate, 16 culverts that may be inadequate, and 12 culverts with unknown fish passage.

There are eight airports within the subbasin; Kasilof Airport and Ninilchik Airport are the only two close to identified Chinook salmon habitat. There are four dams within the subbasin, including the Bradley Lake Hydroelectric Dam, Bridge Creek Dam, Beluga Lake Dam, and Seldovia Upper Dam; none of these are one waters known to be Chinook-bearing. There are five trailheads and one visitor information center.

Within the subbasin there are approximately five miles of active forestry roads, 256 miles of inactive forestry roads, and 29 miles of closed forestry roads. According to AK DOF records there are 20,161 acres of timber sale within the subbasin.

There is relatively little mining activity within the subbasin. There are no state or federal mining claims and no active mines or prospective mine sites. There are four inactive mines including placer gold mines, a chromite hardrock mine, and two inactive prospect mine sites throughout the watershed.

2.3.4.12 Susitna River (HUC ID: 19020505; HUC ID: 19020501)

The Susitna River is a glacial system spanning over 300 miles and is split into two different subbasins according to USGS HUC 8 boundaries. The Susitna River drainage originates in the Alaska and Talkeetna Mountain ranges and flows south to Cook Inlet. Tributaries flowing into the Susitna River from the west generally originate in the Alaska Range with relatively low gradient and velocity, and can be accessed only by boat or airplane. Westside tributaries include the glacial Chulitna River and the Deshka River. The Deshka River is accessible by boat, and accounts for roughly 20 percent of total Chinook salmon returns to the Susitna River drainage. In times of adequate abundance, it supports a popular sport fishery. Tributaries flowing into the Susitna River from the east mostly drain from the Talkeetna Mountains with relatively high gradient and velocity, and there is easy access to these from the Parks Highway. Eastside tributaries between Willow and Talkeetna––including Sheep, Goose, Montana, and Willow creeks—support moderate sized runs of Chinook salmon.

Lower Susitna River Subbasin (HUC ID: 19020505)

The Lower Susitna River subbasin (HUC ID: 19020505) covers 3,698 square miles. The portion of the subbasin west of the Susitna River is largely undisturbed habitat with very little road access or development. The portion of the subbasin east of the Susitna River has more development and connectivity to nearby cities including Wasilla and Palmer via Parks Highway and the Alaska Railroad. Parks Highway continues north along the Susitna River, crosses the Susitna River at the Susitna River Bridge and continues north along the west side of the river until crossing back over to the east side near milepost 130. There are small communities within the subbasin including Willow (population approximately 2,000 people), Susitna North (population approximately 1,500 people) and Talkeetna (population approximately 1,000 people).

Throughout the subbasin, there are approximately 217 miles of paved road and 505 miles of unpaved road. The Alaska Railroad also runs through the watershed and crosses over various rivers and creeks. Within the subbasin there are approximately 22 miles of active forestry roads, 12 miles of inactive forestry roads, 4.6 miles of closed forestry roads, and 128 miles of proposed forestry roads. According to AK DOF records, there are approximately 13,445 acres of timber sale within the subbasin. There are culverts associated with roads and railroads in the subbasin with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: 84 culverts assumed to be adequate, 78 culverts assumed to be inadequate, 24 culverts that may be inadequate, and 9 culverts with unknown fish passage.

There are two airports within the subbasin, including Willow Airport and Talkeetna Airport. There are multiple recreation sites along the east side of the Susitna River, including Willow Creek Recreation Area, Nancy Lake Recreation Area, and Montana Creek State Recreation Site. There is one ranger station (Talkeetna Ranger Station). There is currently one dam in the entire subbasin (Caswell Lakes Road Embankment Dam), which is not located within a known Chinook-bearing water body. There is a proposed Susitna-Watana Dam project that would be located on the Susitna River as well as a proposed 100-mile West Susitna access road.

There are approximately 31 square miles of state mining claims and less than half a mile of federal mining claims within the subbasin. Throughout the subbasin there are a total of 22 mines (5 active) and 45 prospect mine sites (2 active). The active mines are all hardrock mines primarily mining gold, one active mine's main commodities also include arsenic, copper, and lead.

Upper Susitna River Subbasin (HUC ID: 19020501)

The Upper Susitna River subbasin (HUC ID: 19020501) covers 6,284 square miles and is mostly remote. There is much less development and road access compared to the Lower Susitna subbasin, with approximately 6 miles of paved road, 58 miles of unpaved road, and no towns or cities. There are culverts associated with roads in the subbasin with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: seven culverts assumed to be adequate, 48 culverts assumed to be inadequate, seven culverts that may be inadequate, and three culverts with unknown fish passage. There is one airport (Lake Louise Airport) near the southeast boundary of the subbasin. There are three trailheads. There is no USFS record of timber harvest or forestry roads and no DOF records of timber sale within the subbasin. There are approximately 154.8 square miles of state mining claims and 4.4 miles of federal mining claims. There are a total of 17 mines (four active) and 92 prospect mine sites (20 active). The active mines are all placer mines primarily mining for gold and one also mining silver.

2.3.4.13 Yentna River (HUC ID: 19020504)

The Yentna River subbasin (HUC ID: 19020504) covers approximately 6,137 square miles and is a major tributary of the Susitna River, with which it converges approximately 33 river miles from Cook Inlet. It supports multiple Chinook salmon spawning populations, the largest of which are on Lake Creek and the Talachulitna River (a tributary of the Skwentna River). These tributaries support substantial sport fisheries in times of adequate abundance. The Kahilitna River drainage also supports spawning populations in its tributaries Cache Creek and Peters Creek. The majority of the subbasin is extremely remote and has little human presence with no cities or permanent communities. There are no dams, public cabins, forestry roads, or USFS timber harvest records within the subbasin. There is a record of approximately 625 acres of timber sale. There are approximately 36 miles of unpaved road and culverts with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: four culverts assumed to be adequate, 11 culverts assumed to be inadequate, four culverts that may be inadequate, and one culvert with unknown fish passage. There are three airports within the subbasin including Trail Ridge Airport, Skwentna Airport, and Chelatna Airport. Although there are no active mine sites, there is mining activity present in the subbasin: approximately 319 mi^2 of state mining claims, 0.62 mi^2 of federal mining claims, 21 inactive mine sites, 18 inactive prospective mine sites, and 22 active prospective mine sites. Cache Creek has several active mining claims. When built, the proposed West Susitna access road would run parallel to the majority of the Skwenta River.

2.3.4.14 Talkeetna River Subbasin (HUC ID: 19020503)

The Talkeetna River subbasin (HUC ID: 19020503) covers approximately 2,036 square miles and is largely undisturbed habitat. The Talkeetna Rivers spans 85 miles and is a tributary of the Susitna River. There are approximately 8 miles of unpaved road in the entire subbasin and only one culvert, which is assumed to be inadequate for fish passage according to ADF&G assessments. Within the subbasin there are no renewable energy plants, airports, public use cabins, forestry roads, or USFS timber harvest records.

There are no active mines within the subbasin; however, there is mining activity. There are approximately 19 square miles of State of Alaska mining claims. There is only one active prospective mine site primarily mining gold and silver in addition to two small, inactive placer gold mines and 17 inactive prospective mine sites.

The Talkeetna subbasin supports several Chinook salmon spawning populations, the two most prominent being Clear and Prairie Creeks. Clear Creek supports a popular sport fishery in times of adequate abundance.

2.3.4.15 Redoubt-Trading Bays Subbasin (HUC ID: 19020601)

The Redoubt-Trading Bays subbasin (HUC ID: 19020601) covers approximately 4,154 square miles and contains a variety of smaller rivers, streams, and creeks identified as Chinook salmon habitat. There are approximately 93 miles of unpaved roads and 128 miles of inactive forestry roads. There are culverts associated with primarily inactive forestry roads with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: 20 culverts assumed to be adequate, nine culverts assumed to be inadequate, eight culverts that may be inadequate, and three culverts with unknown fish passage. The Tyonek Airport is the only airport present within the subbasin. Within the subbasin there are no mines, renewable energy plants, or public use cabins. There are no AK DOF timber sale records or USFS timber harvest records within this subbasin. There are five inactive prospective mine sites within the subbasin.

2.3.4.16 Kodiak – Afognak Islands (HUC ID: 19020701)

The Kodiak – Afognak Islands subbasin (HUC ID: 19020701) covers approximately 8,936 square miles and includes multiple river systems identified as Chinook salmon habitat including the Karluk and Ayakulik Rivers. There is development within the subbasin, primarily associated with the city of Kodiak (population approximately 5,500 people); however, Karluk River and Ayakulik River are both over 75 miles away. Salonie Creek near Kodiak has been identified in the Anadromous Waters Catalog as having Chinook salmon spawning and rearing habitat, but Chinook are rarely observed there. There are approximately 107 miles of paved road and 85 miles of unpaved road within the subbasin. Although there are no culverts on or near the Karluk or Ayakulik Rivers, there are culverts in the subbasin with the following fish passage classifications for juvenile or weak swimming fish according to ADF&G assessments: 45 culverts assumed to be adequate, 63 culverts assumed to be inadequate, 26 culverts that may be inadequate, and 61 culverts with unknown fish passage. There are a total of 10 airports/ airstrips, one trailhead, and one visitor center within the subbasin. There is mining activity within the subbasin including 13 inactive mines, two active mines, 15 inactive prospective mines, one active prospective mine, and 7.88 square miles of state mining claims. There are 17 dams within the subbasin, most of which are located in or near Kodiak. However, only one dam, the Monashka Creek dam located near the source of Monashka Creek, is located where Chinook have been known to be present (though not a spawning stream). There are no USFS records of timber harvest or forestry roads, and no AK DOF record of timber sale anywhere in the subbasin. There has been timber harvest by Native corporations in and near Chiniak, over 75 miles away from the Karluk and Ayakulik Rivers.

Karluk River
The Karluk River spans approximately 22 miles and is located within the Kodiak National Wildlife Refuge except for the lower 8 miles of the river, which extends outside of the refuge boundary. The lands adjacent to the lower 8 miles of the river as well as the majority of land surrounding Karluk Lagoon are privately owned by Koniaq Inc., Karluk Tribal Council, and other private parcels. The Karluk Airport is located near the lower river and has approximately one mile of associated unpaved road. There are no dams or culverts on the river or tributaries and no mining in the area. The Karluk River is considered pristine with no-habitat-related concerns identified for Chinook salmon.

Ayakulik River
The Ayakulik River spans approximately 40 miles and the majority of the drainage is located within the Kodiak National Wildlife Refuge. The lower 1.5 miles of lands adjacent to the Ayakulik River are owned by Ayakulik Inc. There are no dams or culverts on the river or tributaries and no mining in the area. The Ayakulik River is considered pristine with no-habitat-related concerns identified for Chinook salmon.

2.3.4.10 Shelikof Strait Subbasin (HUC ID: 19020702)

The Shelikof Strait subbasin (HUC ID: 19020702) covers 8,020 square miles and has very little human disturbance. There are no USFS timber harvest records, forestry roads, or culverts anywhere in the subbasin. There is very little human development, with only approximately 13 miles of unpaved road through the entire subbasin. There is little historical or present mining activity within the subbasin, with only one mine site that is inactive and 11 prospective mine sites, three of which are active.

The Chignik River is located in the southern portion of the Shelikof Strait subbasin and lies within the Alaska Peninsula National Wildlife Refuge, village corporations, native allotments, regional corporations. There is no road access or development along the Chignik River. The habitat is considered pristine with no habitat-related concerns identified for Chignik River Chinook salmon.

The only development near the Chignik River watershed are three remote villages that all have populations of less than 100 people: Chignik Bay, Chignik Lagoon, and Chignik Lake. Each village has an airstrip and a few miles of road which are mostly unpaved. In Chignik Bay, there is one small hydroelectric dam on a creek stemming from Chignik Bay called Indian Creek, which is not a known Chinook-bearing stream. There are two active prospective mine sites within the Chignik River watershed: Marshinlak Creek (primarily mining silver, gold, and copper) and Bee Creek/Dry Creek (primarily mining silver, gold, copper, and molybdenum). There is also one inactive prospective unnamed site on Braided Creek.

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2.4 DISEASE AND PREDATION

2.4.1 Disease

2.4.1.1 Overview

There has been NO evidence that disease has negatively affected the sustainability of any wild or cultured Chinook salmon or other finfish/shellfish stocks in the Gulf of Alaska. The Conservancy's assertion in the petition that "diseases originating in hatcheries (e.g., furunculosis, piscine reovirus, bacterial gill disease and kidney disease) have been transmitted to wild populations, driving mortality of all life stages of GOA Chinook salmon" is patently false for reasons described below.

First, background information is provided regarding the statewide ADF&G Fish/Shellfish Health Program which has been in place for over 40 years and was specifically legislated to manage and protect wild stocks from infectious disease agents that might also occur in cultured stocks of fish and shellfish.

The mission and objectives of the Fish Health Program are to provide pathology expertise and diagnostic services to fisheries managers, state and private salmon hatcheries, aquatic farmers, and sport fishers to protect the health of wild and cultured fish and shellfish resources. This includes regulatory oversight of finfish/shellfish pathogens, development of disease policies, and application of technical expertise to prevent, detect, and manage diseases in cultured/wild fish and shellfish in Alaska. The Statewide Fish Health Program is administered by certified fish health specialists by the Fish Health Section of the American Fisheries Society as required by state regulations (AS 16.05.733). Responsibilities include the following:

1. Provide diagnostic services for wild and cultured fish and shellfish for all state user groups.
2. Provide hatchery fish health support and oversight with hatchery inspections of the current 30 fish rearing facilities, collect diagnostic and surveillance samples (34,206 tests performed on 13,480 fish and shellfish in FY 23; Figure 16) and provide periodic fish health workshops to train hatchery personnel in basic disease recognition, particularly at remote hatchery sites.
3. The Program has regulatory authority (several stipulations in 5ACC 41) on subjects including health inspection, diagnostic reporting, control of fish diseases, hatchery inspections, destruction of diseased fish, fish and shellfish categories of pathogens, signatory on fish transport permits and certification of imported Pacific oyster seed.
4. Provision of a statewide Fish and Shellfish Disease Policy (Meyers 2014) where both pathogens and diseases are managed.
    a. Diseased animals cannot be released where the pathogen does occur (reduces amplification).
    b. Animals with history of a pathogen cannot be released where the pathogen is NOT known to occur (thisreduces new introductions).
    c. Sockeye Salmon Culture Policy (McDaniel et al. 1994) to control infectious haematopoietic necrosis (IHN) virus in hatcheries and to protect other susceptible salmonid species including rainbow trout, Chinook, and chum salmon.
5. Conduct applied research.
    a. Characterization of new/poorly described pathogens.
    b. Disease transmission studies.
    c. Evaluation of new detection technology.

   d. Document distribution of specific disease agents within the state fish stocks and watersheds by maintaining a disease history database.

6. Provide public education.
   a. Informing user groups with internet links to policies and documents, including field guides for Alaska fish and invertebrate diseases (Meyers and Burton 2009; Meyers et al. 2019) and a Fish/Shellfish Pathology Laboratory Procedures Manual (Meyers 2009) that has received over 3,000 reads online.
   b. Publishing research results in peer-reviewed journals with over 90 peer-reviewed studies.
7. Surveillance for indigenous, emerging, and exotic disease agents.
   a. Indigenous pathogens–native in wild fish and shellfish stocks used for hatchery brood stocks and present in hatchery water supplies having resident fish.
   b. Emergent pathogens–native in wild stocks but cryptic/undetectable until environmental change or more sensitive tests are developed.
   c. Exotic pathogens–introduced from outside Alaska.

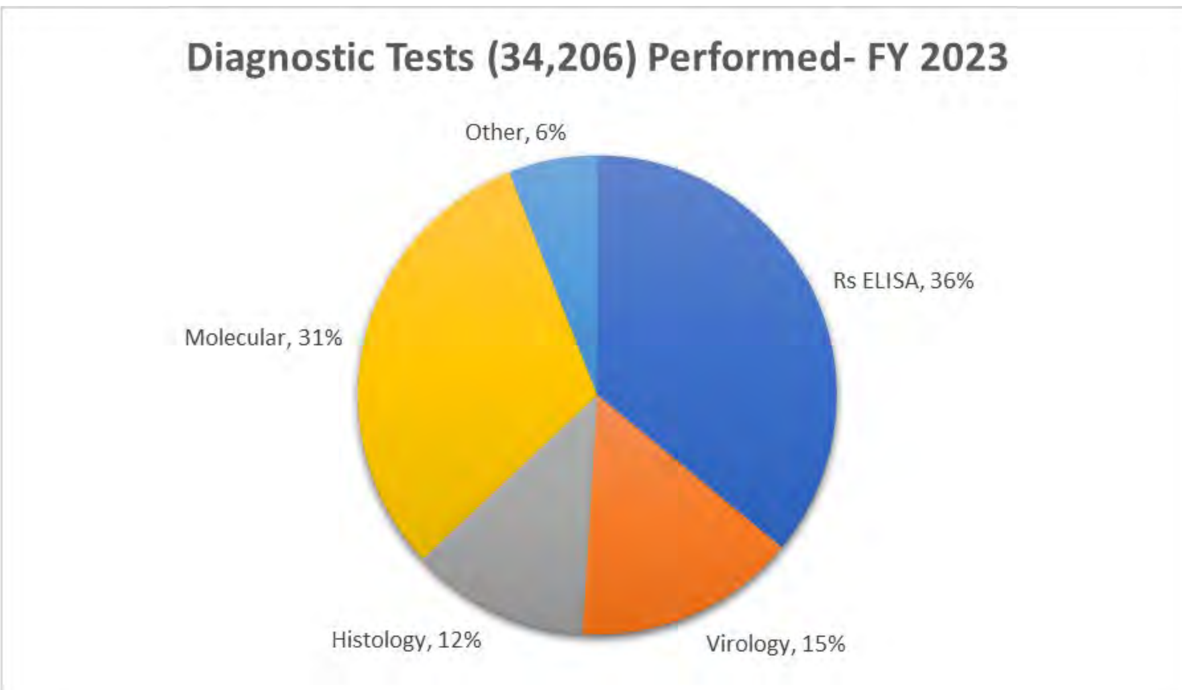

Figure 28.–Performance frequency of major diagnostic test categories for Statewide Fish Health Program FY 2023.

Note: "Other" includes necropsy examinations with microscopy of wet mounts and stained slides, bacterial/fungal testing and imaging of diagnostic results.

Below is a list of indigenous infectious agents detected in wild and cultured Alaska fish stocks, most from the GOA watersheds where over 90% of the fish hatcheries and aquaculture projects are located, including large active commercial and sport fisheries (see Meyers et al. [2019] for complete listing of disease agents, discussion and details on species affected, clinical signs, transmission, diagnosis and host prognosis).

I. Bacteria and Fungi

- *Aeromonas salmonicida*–Furunculosis–Occasional in most wild and hatchery salmonids.
- *Aeromonas/Pseudomonas*–Motile Bacterial Septicemia–Common opportunistic infections in most salmonids and other fish species worldwide.
- *Flavobacterium psychrophilum*–Coldwater Disease–Occurs in all cultured salmonids but occasionally in coho and Chinook salmon–Other Flavobacteria (Bacterial Gill Disease)–occasionally occurs in most salmonids as well as other fish species.
- *Tenacibaculum maritimum*–Marine external skin erosion (mouth-rot)–Occurs in many different marine species including salmonids (occasional in netpen reared salmonids).
- *Renibacterium salmoninarum* (Rs)–Bacterial Kidney Disease (BKD)–Common in wild and cultured Chinook and coho salmon 6-months old or older.
- *Vibrio anguillarum*–Vibriosis–Common in marine reared salmonids and many other fish species.
- *Yersinia ruckeri* Types 1 and 2–Enteric Redmouth (ERM)–occasional to uncommon in cultured salmonids and other fish species
- *Phoma* sp.–Fungal saprophyte of plants–Systemic occasionally in cultured salmonids in the Pacific Northwest

II. Protozoa

- *Saprolegnia*–Filamentous protozoan–Water Mold–Commonly infects all wild and cultured fish species and their eggs.
- *Ichthyophonus* sp.–Mesomycetozoea protozoan –Rare in most watersheds but common in Yukon River Chinook salmon and several marine forage species.
- *Ichthyobodo* (*Costia*) sp.–Flagellated protozoan–Common in many freshwater fishes, occasionally found in hatchery juvenile salmonids.
- *Trichodina* sp.–Ciliated protozoan–Common in both wild and captive marine and freshwater species of fish.
- *Tricophrya* (*Capriniana*) sp.–Suctorian protozoan–Common on the gills of many freshwater fishes in North America.
- *Cryptocaryon irritans* (marine) and *Ichthyophthirius multifilis* (freshwater)–Ciliated protozoa–Infrequently reported in Alaska. Causes white spot disease in many species of wild and cultured fish.

III. Cnidaria- Myxosporea

- *Ceratonova* (*Certomyxa*) *shasta*–Infrequently detected in a few watersheds in Alaska but not in hatchery Salmonids.
- *Henneguya* sp.–Tapioca Muscle Disease–Frequent in many adult species of marine, anadromous and freshwater fishes, but not in juvenile hatchery fish.
- *Kudoa thyrsites*–Soft Flesh Disease–Infrequent in adult Alaska coho, Chinook, and pink salmon including Pacific halibut, but can be common elsewhere in other fish species.
- *Myxobolus neurotropus*–new record in Alaska in wild rainbow trout–Frequency unknown; *M. squamalis*–common in adult returning coho salmon.
- *Tetracapsuloides bryosalmonae*–Proliferative Kidney Disease (PKD)–Rarely causing disease in Alaska salmonids but occasionally detected in adult returning salmon by qPCR.

IV. Copepods and Parasitic Worms- Various life stages of copepods, nematodes, tapeworms, digenean trematodes and monogenean flukes (common in various fish life stages and species; see Meyers et al. 2019)

V. <u>Viruses</u>

- Infectious Hematopoietic Necrosis Virus (Clade Up)–IHNV Disease–Rhabdovirus naturally infecting wild and cultured sockeye salmon only, with occasional spillover into resistant adult coho and pink salmon; other susceptible species include chum and Chinook salmon and rainbow trout.
- Viral Hemorrhagic Septicemia Virus (VHSV Type IVa)–Common rhabdovirus in Pacific herring and other marine forage fish and infrequently detected in asymptomatic adult pink salmon.
- *Aquareovirus*–Infrequently occurs in Chinook salmon adults (species B) and geoduck clams (species A).
- *Aquaparamyxovirus*–Pacific salmon paramyxovirus (PsaPV)–Infrequent in adult wild or returning Chinook salmon.
- Piscine orthoreovirus (Type 1a)–Infrequently detected in a few healthy Alaska adult Pacific salmon stocks by molecular methods.
- Erythrocytic Inclusion Body Syndrome Virus (EIBS)–Only one case in Alaska netpen reared juvenile Chinook salmon and likely related to PRV1a in the marine environment.
- Viral Erythrocytic Necrosis (VEN)–Iridovirus common infecting Pacific herring erythrocytes.

2.4.1.2 Assertions in the 90-day finding and petition

The Wild Fish Conservancy asserted in their petition

> *"It is probable that fish transferred between facilities, adult fish carcasses being outplanted into the watershed, and other fish released from hatcheries, have acted as disease vectors to wild fish and other aquatic organisms. These diseases, amplified within the fish hatchery environment, contribute to the mortality of fish at all life stages and can travel rapidly to areas well beyond where effluent pipes are discharged. The out planting of juvenile and adult fish can transfer disease upstream of the rearing site, and there is the potential for lateral infection through the travel of avian, mammalian, and other terrestrial predators which overlap with the distribution of artificially propagated fish. These dynamics contribute to disease driven mortality at all lifestages in wild Chinook populations."*

NOAA echoed these concerns in their 90-day finding. However, we emphasize that there is **NO evidence wild and hatchery fish interactions in Alaska produce disease driven mortality at all life stages of GOA Chinook salmon.** Rather, the assertions appear to be written from a Pacific Northwest lens, with limited to no research on diseases in Alaska, and little relevance to GOA Chinook salmon because most of the hatchery practices listed as concerning and contributing to disease transmission between hatchery and wild fish **do not occur** in Alaska.

Importation of fish used for aquaculture is prohibited by Alaska state legislation (5AAC 41.070), which has greatly reduced the potential for introduction of exotic infectious agents via this route. Consequently, Alaskan hatchery stocks originate from native salmonid stocks that are already exposed to or infected with various indigenous pathogens (see list above) that were present before the Alaska hatchery program began in the 1970s (for example, prevalence of Rs and IHNV can approach 90–100% in certain wild fish stocks that have not been exposed to hatchery fish or hatchery practices).

Use of native fish stocks is an important concept that emphasizes the very low risk of hatchery fish transmitting new pathogens to wild stocks, but the risk is even further reduced by by other Alaska management strategies, such as requiring the use of broodstocks obtained near the sited hatcheries so that hatchery fish would have similar disease histories. Secondly, hatcheries are generally built away from watersheds having significant wild salmon stocks, which reduces the possibility of disease transmission from adult fish returning to spawn. Spawning coincides with the weakening of the immune system when pathogen shedding/exposure is more likely than from healthy immature fish dispersed in the open ocean. Fish health policies also prevent the release of diseased fish that may require destruction (Meyers 2014) and restrict the transplant or release of fish known to be infected with a pathogen only to areas or watersheds with a similar disease history and occurrence of that pathogen(s).

Regarding the Petition, it is important to note that in Alaska, salmon aquaculture is described as ocean ranching and **not** netpen farming, where farmed fish are reared to adult size in a net pen, giving more opportunity to become infected with a pathogen and shed infectious material. Rather, cultured salmon in Alaska are released as juvenile smolt to forage in the open ocean for one to six years before returning to spawn at their release sites. Also of note, cultured pink and chum salmon are less likely to spread diseases to wild Chinook salmon because these species smolt quickly after emergence and therefore have only limited exposure to stress and potential infectious diseases while at the culture facilities. Petition concerns regarding avian and mammalian predators as vectors of hatchery diseases while fish are under culture is also not a significant threat in Alaska, where nearly all hatcheries have predator exclusion devices to prevent direct access to cultured fish or immediate water supplies. Finally, management criteria and regulations prioritize wild stocks with the marking of hatchery fish for recognition and the continuation of studies examining hatchery and wild stock interactions to determine whether disease (or genetic) issues have changed or have been introduced.

2.4.1.3 Indicator pathogens for hatchery-wild disease interaction

The Sockeye Salmon Culture Policy (McDaniel et al. 1994) has successfully managed IHNV in Alaska since 1981, allowing the state to become a world leader in successful sockeye salmon culture. During these many years, the virus, which infects all sockeye salmon stocks, has not been provided the selective pressure from hatchery culture that would be necessary for it to evolve beyond the single original Up genotype (Black et al. 2016; Paez et al. 2022). Hence, the virus is confined to sockeye salmon as the only carrier fish species in Alaska. The foundation of the Sockeye Salmon Culture Policy requires:

1. a virus-free water supply
2. rigorous disinfection of eggs, utensils, rearing containers, etc.
3. compartmentalization during incubation and rearing so that any lot of infected juvenile fish can be isolated to prevent transmission of the virus to the remaining fish inventory
4. immediate destruction of all virus-positive juvenile fish with proper disinfection and disposal.

Rs, the agent of BKD, is successfully managed in coho and Chinook salmon stocks (Meyers et al. 2003) by statewide culling of eggs from infected broodstocks using the enzyme-linked immunosorbent assay or ELISA (8,800 kidney tissues examined during 2023 and 9,162 in 2022). Research study results on indicator pathogens, IHNV, and Rs include the following:

1. NO increasing trend in prevalences or changes in clinical disease of the indicator pathogen *Renibacterium salmoninarum* in wild or cultured fish stocks (Meyers 2005).

2. Modest increase of IHNV prevalence (31% vs 38%) and high titers (30% vs 48%) during 20 years in both wild and cultured sockeye examined. There is NO correlation with hatchery practices because of the Sockeye Salmon Culture Policy. This is further supported by the following data:
    a. Low genetic diversity (42 isolates) of Up-clade IHNV with stasis over time based on genome finger-prints and nucleotide sequences (Emmenegger et al. 2000); therefore, NO selective pressure.

b. Up-clade IHNV remains restricted to sockeye salmon as a host species and is evolutionarily constrained in Alaska. This genetic homogeneity has continued with more recent virus samples examined periodically after this initial work.

Overall, the cyclical peaks and declines of these two pathogens do not show significant changes in prevalences (or homogeneity of IHNV) in wild fish stocks that can be attributed to hatchery practices and/or wild fish interactions with hatchery fish stocks.

2.4.1.4 Other diseases of concern listed in the petition

Furunculosis is caused by a bacterial obligate pathogen (*A. salmonicida*) present in carrier fish but is not transmitted vertically in the egg. This is one of the most encountered bacterial diseases in cultured salmonids and many other non-salmonid species of fish in both marine and freshwater reported in North America, Europe, Asia and Africa. Therefore, this bacterial organism is ubiquitous in other host species in both fresh and saltwater environments encountered by GOA Chinook salmon, so healthy hatchery released salmonids are unlikely to be a significant source of potential exposure. The bacterial organism is controlled in Alaska hatcheries by disinfecting eggs, reducing or eliminating native fish species in the hatchery water supplies, and recognizing the disease early for culling of dead and moribund fish followed by veterinary-prescribed antibiotic therapy before major epizootic outbreaks occur. Over the last 24 years, there have been approximately 45 cases of furunculosis in juvenile hatchery fish. These fish were only released into watersheds having the same pathogen history and only after the disease was effectively treated.

Bacterial gill disease is a nonspecific description for bacterial infection of the gills by various opportunistic bacteria but primarily includes various flavobacteria that commonly occur in the environment and infect fish when water quality is poor and/or fish are stressed. Occasionally the infection can become systemic as in Coldwater Disease caused by *F. psychrophilum,* which requires antibiotic therapy. When detected early, external treatments with various approved drugs such as formalin, chloramine-T, or hydrogen peroxide will generally resolve the infection. All salmonids are susceptible, but juveniles more so than adults, and the disease is found worldwide. Again, healthy juvenile salmonids released from Alaska hatcheries are not a significant source of exposure to this disease for stocks of GOA Chinook salmon.

Piscine orthoreovirus (PRV) the causative agent of heart and skeletal muscle inflammation (HSMI) has various strains that differ significantly in infectivity and pathogenicity for salmonids. PRV-1 in Norway, where HSMI was first described in 1999 (Kongtorp et al. 2004), has diverged into two genetic lineages based on mutations and/or genome segment reassortment (Dhamotharan et al. 2019). One lineage (PRV-1b) is associated with HSMI disease in farmed Atlantic Salmon. The second lineage (PRV-1a) was present in Norway as early as 1988, prior to HSMI disease emergence, and is hypothesized to be a lower virulence sub-genotype. Recent molecular surveillance testing in the Pacific Northwest established that PRV1a was endemic in several wild and hatchery stocks of Pacific salmon (Kibenge et al. 2013; Purcell et al. 2018). The PRV-1a strains from the North American Pacific coast and the Faroe Islands are more closely related to the hypothesized low-virulence PRV-1a sub-genotype not associated with clinical HSMI.

An archived sample from 1977 of wild steelhead in British Columbia (Marty et al. 2015) confirmed virus presence in the Pacific Northwest (PNW) prior to the expansion of aquaculture, and the PCR product was confirmed as PRV-1a by sequencing yielding 439-511 base pairs of genomic material that was deposited into Gen Bank (Acc numbers MT506522–MT506523; Siah et al. 2020). Subsequent laboratory studies indicated the virus was infectious for Pacific salmon but caused no mortality or significant harm that could affect fish on a population scale. Consequently, the overall scientific consensus was that the northeastern Pacific variant of PRV-1a is not a significant disease-causing agent in Pacific salmonids (Garver et al. 2016a, 2016b; Zhang et al. 2019; Purcell et al. 2020; Polinski et al. 2021), contrary to the media misinformation claiming that the virus is a threat to wild fish populations and resource sustainability (Noor 2021). The scientific information continues to support the conclusion that endemic PRV-1a in the PNW should be considered low risk (not zero) to Pacific salmon, thus requiring no significant changes to agency fish health policies (Meyers and Hickey 2022). However, evaluation of the risk for PRV1a is ongoing by fish health professionals. Also noteworthy, Studies in British Columbia have shown that freshwater hatcheries provide a minimal contribution to the prevalence and persistence of PRV1a in wild Pacific salmon and are not sources for non-endemic forms of the virus (Polinski et al 2023). These data confirm that seawater reservoirs are the primary source for PRV1a persistence in that region, and likely in Alaska as well. Consequently, released hatchery juvenile salmonids should be of negligible risk as a source of infection by PRV1a to GOA Chinook salmon stocks.

2.4.1.5 Surveillance for Emerging and Exotic Infectious Agents

Active surveillance for emerging and exotic pathogens in cooperation with the USDA/APHIS and USGS indicate that exotic pathogens such as infectious salmon anemia virus (ISAV), salmonid alphavirus (SAV) and piscine myocarditis virus (PMCV) do NOT occur in the PNW or Alaska (Gustafson et al. 2017); As previously indicated, piscine orthoreovirus (PRV-1a) was discovered as endemic in Alaska and the PNW and has been shown to be relatively benign to Pacific salmon (Purcell et al. 2020). The PRV public controversy effectively illustrates an important caveat regarding fish health evaluation—the detection of an infectious agent, especially by molecular methods, does not indicate that it is causing disease (Meyers and Hickey 2022). We should not be surprised that some infectious agents like PRV-1a may have very little negative impact while still infecting certain host species.

2.4.2 Predation

Because salmon are an integral part of the food web, predation on salmon at all life stages naturally occurs in both freshwater and marine environments. Predation naturally occurs from a variety of piscine, avian, mammalian, and marine mammal species. Limited data are available to quantify amounts and trends in Chinook consumption by predators. In the following sections, we describe what we know about human-caused changes to freshwater and marine predation on Chinook salmon and respond to the Wild Fish Conservancy's assertion that predation pressure on adult GOA Chinook salmon is increasing as a result of growing populations of killer whales (*Orcinus orca*), and that humpback whales (*Megaptera novaeangliae*) may be learning to target hatchery releases of Chinook salmon in Southeast Alaska.

2.4.2.1 Freshwater Predation

Northern Cook Inlet (NCI) is the only location in the GOA where the agents of freshwater predation have changed for Chinook salmon in historical times. The presence of invasive northern pike *Esox lucius* in waters where they -occur with Chinook salmon is one among many factors influencing recent Chinook abundance in NCI. Although Chinook and northern pike do occur together naturally in the same watershed (e.g., the Yukon River watershed; Stuby 2023) northern pike are an invasive species in Southcentral Alaska and pose a threat to salmon, especially where habitat conditions are relatively uniform and dominated by shallow, low-flow, vegetated waters (Dunker et al. 2018; Jalbert et al. 2021). Northern pike thrive in these habitats (Inskip 1982). Where northern pike are native in Alaska, they are the predominant species found in drainages with these habitat conditions (Stuby 2023). Northern pike are native to most of Alaska, essentially everywhere north and west (Figure 17). Northern pike are not native and are an invasive species in the northern Cook Inlet region of Southcentral Alaska.

Figure 29.–Map showing northern pike native (red hashed lines) and invasive (solid red) distribution in Alaska.

Northern pike are opportunistic predators. They will prey on anything that is available including fish, aquatic birds, rodents, and invertebrates, but studies have repeatedly shown that they select for soft-rayed fish like salmonids when they are available (Sepulveda et al. 2013; Sepulveda et al. 2014; Cathcart et al. 2019). As an apex predator, northern pike greatly influence the structure of fish communities in waters where they occur (Spens and Ball 2008; Persson et al. 2018). In Southcentral Alaska, wetland and shallow lake dominated drainages naturally function as Chinook and coho salmon and rainbow trout rearing areas. This was the case until northern pike were illegally introduced and subsequently spread beginning in the late 1950s (Dunker et al. 2018). ADF&G maintains an interactive map of all known invasive northern pike locations and their status in Southcentral Alaska[26].

Where northern pike are introduced or spread, they eventually restructure fish communities such that northern pike become the most numerous fish present and other native fish species are eventually extirpated (Haught and von Hippel 2011; Sepulveda et al. 2014). In the most severe cases, no native fish remain, and northern pike diets shift to aquatic macroinvertebrates (Cathcart et al. 2019).

With respect to Chinook salmon in the northern Cook Inlet, the most severely affected area includes Alexander Lake and Alexander Creek, a tributary of the Susitna River that was once highly productive for Chinook salmon (Bradley et al. 2022; Rutz et al. 2020). Today, northern pike are widespread throughout the system, which is shallow and densely vegetated with numerous sloughs and oxbows, making it ideal

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26 https://adfg.maps.arcgis.com/apps/webappviewer/index.html?id=ad27ebc052814b66a60d0e52701e64f7&_ga=2.134601268.433080285.1620951043-366266702.1609902335

northern pike habitat. Northern pike have been present in Alexander Lake since the 1960s, but they did not establish in the lower reach of Alexander Creek until the late 1990s (Rutz 1999). The lower reach of Alexander Creek, below the confluence with Sucker Creek, is historically where the majority of Chinook salmon production occurred. Soon after northern pike became prevalent in the lower reach, Chinook salmon abundance decreased to less than 185 returning adults, which is well below the sustainable escapement goal of 2,100–6,000 fish. To date, Chinook salmon abundance has remained far below the escapement goal (Oslund and Querin 2024).

Although declining Chinook salmon abundance has been prevalent throughout Cook Inlet, the driving factor in Alexander Creek is predation by northern pike on juvenile Chinook salmon. From the 1970s until the late 1990s when northern pike became established in Alexander Creek, Chinook salmon abundance for this system tracked closely with the Talachulitna River, a proximate drainage where northern pike do not occur (Figure 18). Within a few years of northern pike establishment in lower Alexander Creek, abundance patterns between the two systems shifted, with Alexander Creek Chinook abundances becoming substantially lower than in the Talachulitna River. ADF&G attributes an additional 77% reduction in Chinook salmon production in Alexander Creek since 2002 to northern pike predation (ADF&G, Unpublished). Currently, Chinook salmon fisheries in Alexander Creek are closed to harvest, and Alexander Creek Chinook salmon are an Alaska Board of Fisheries designated Stock of Concern (Oslund and Querin 2024).

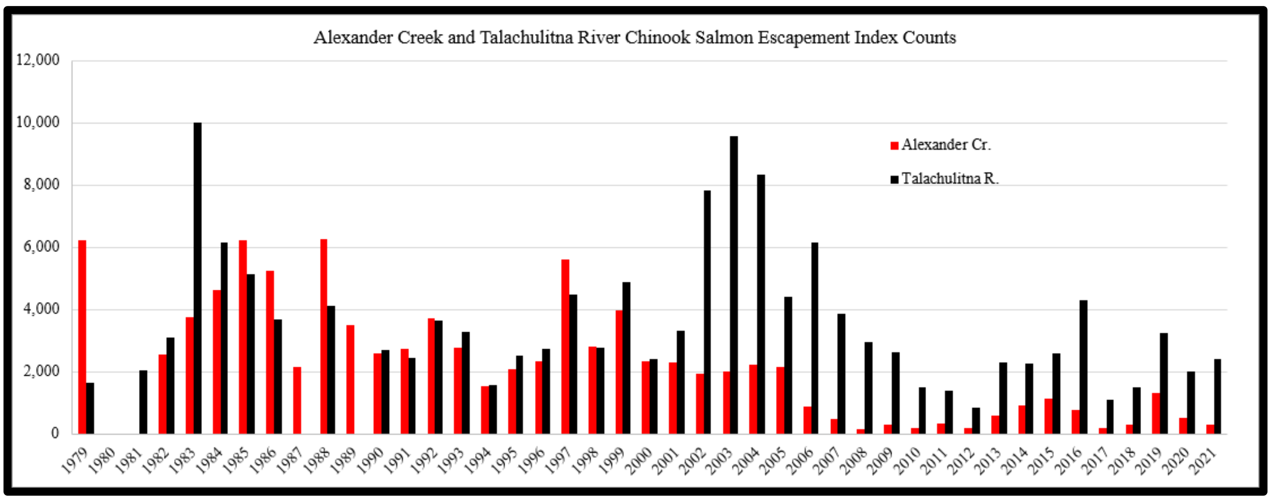

Figure 30.–Comparison of Chinook salmon escapement index counts in Alexander Creek (northern pike present) and Talachulitna River (no northern pike present), 1979–2021.

To restore salmon productivity within Alexander Creek, ADF&G initiated an invasive northern pike suppression program in 2011 (Dunker et al 2020; Rutz et al. 2020). This program has been funded though the Alaska State Legislature, the Alaska Sustainable Salmon Fund, and Federal Aid State Wildlife Grants and involves intensively gillnetting the side-channel sloughs of Alexander Creek annually during the northern pike spawning period in May. Since the inception of this project, more than 32,000 northern pike have been removed for suppression and dissected to study dietary changes over time. The presence of juvenile salmon in northern pike diets in Alexander Creek is actually a positive indicator of potential recovery in the system because northern pike diets reflect the prey species available, and because they prefer juvenile finfish, they are especially good at detecting them in a system. Although invasive northern pike abundances in Alexander Creek remain high, it is likely the Chinook salmon in the creek would have been extirpated without ADF&G's northern pike suppression efforts reducing predation pressure on juvenile Chinook. ADF&G intends to continue suppression efforts in Alexander Creek and is currently evaluating plans, costs, and feasibility of intensifying these efforts.

Declines of Chinook in the Deshka River, another Cook Inlet system, are being attributed in part to the presence of northern pike (Oslund and Querin 2024). Unlike Alexander Creek, the Deshka River is a much larger drainage with a greater mix of freshwater habitat and many small tributaries supporting salmon. It is thought that waters like this offer potential refugia from northern pike predation and experience ecosystem-level impacts from invasive northern pike more slowly (Dunker et al. 2018). Although some northern pike habitat exists in the Deskha drainage, it is not as extensive as that found throughout Alexander Creek. Over time, however, northern pike have now come to occupy almost all of the Deshka drainage, including most of the lakes within the drainage that historically supported salmon rearing. It is unknown exactly when northern pike first appeared in the Deshka drainage, but it was likely they arrived in the late 1970s or 1980s and because of the diversity of habitat with more refugia, impacts to Chinook salmon in the Deshka have been slower to occur than in Alexander Creek. However, because northern pike have now spread throughout the system, declines in Chinook salmon abundance are now being observed (Oslund and Querin 2024).

Even though the Deshka drainage is large and much of it is difficult to access, there are several sloughs in the lower part of the Deshka River that area readily accessible and contain some of the best northern pike habitat. ADF&G has been suppressing invasive northern pike in these Deshka River sloughs since 2012. To date, over 1,660 northern pike have been removed. The University of Alaska Fairbanks school of Fisheries and Ocean Sciences, in partnership with the U.S. Fish and Wildlife Service, has also been studying changes in northern pike diets in Deshka River sloughs (Rich 2024).

ADF&G is actively engaged in all aspects of invasive northern pike management in Southcentral Alaska. In this capacity, the Department chairs a northern pike-focused committee through the Alaska Invasive Species Partnership. This is an interagency and multi-partner group collectively focused on preventing northern pike from spreading in Southcentral Alaska and working collaboratively to eradicate invasive northern pike populations where feasible and suppress them where eradication is not currently possible. Outreach and research on invasive northern pike are interwoven throughout all management activities. In 2022, this committee, under ADF&G's leadership, completed an extensive technical guidance and management plan for invasive northern pike in Southcentral to coordinate and align interagency efforts and work toward minimizing impacts from invasive northern pike on salmon populations (Dunker et al. 2022). This plan is available online[27] and is intended to serve as an adaptive framework for all future invasive northern pike prevention, early detection, eradication, suppression, and research over the next decade (Dunker et al. 2022).

2.4.2.2 Marine Predation

Predation is a known natural cause of mortality for any salmon in marine waters; however, there is no direct evidence that predatory impacts are acting outside of normal ecosystem dynamics and imperiling the long-term existence of GOA Chinook salmon populations. Unfortunately, direct measurements of predator-prey interactions at sea are practically impossible, and quantifying predator-prey interactions through modeling will always have some uncertainty and depend on the validity of assumptions.

[27] https://www.adfg.alaska.gov/static/species/nonnative/invasive/pike/pdfs/2022_invasive_pike_management_plan.pdf

There is currently no quantified measure of marine predation on Chinook salmon, so it is not possible to compare the relative effect of predation (in all its forms) to the known effect of harvest. It may be possible to develop models using available data (e.g., satellite tagging of Chinook; Courtney et al. 2021) and well-considered assumptions to better understand the interactions between Chinook and their marine predators (e.g., Sobocinski et al. 2021). Ohlberger et al. (2019) attempted this kind of modeling effort to explore the potential for size-selective predation by resident killer whales on Chinook salmon age and size at maturity. However, caution is warranted when interpreting such models, given the large uncertainties (e.g., lack of data and untested assumptions) on marine predator abundance and marine predation of GOA Chinook salmon.

Marine Mammals

The Wild Fish Conservancy bases their assumption of increased predation pressure on Chinook salmon by asserting that marine mammal abundances are increasing. However, current range wide estimates of marine mammals are not available as NMFS has not dedicated the funding to obtain consistent counts. Based on localized surveys, numbers for humpback whales have declined, as have localized counts of Steller sea lions and harbor seals (with the biggest impact to biomass). With the limited data available, localized regional counts from Alaska, and the lack of environmental inputs, pointing to marine mammals in Alaska as a driver of Chinook declines cannot be supported. While marine mammal predation on Chinook salmon has received far more research interest in British Columbia and the lower 48 (e.g., Sobocinski et al. 2021), there has been far less attention paid to killer whale predation of GOA Chinook, which is probably due to lower marine mammal densities and estimated consumption rates (Adams et al. 2016; Chasco et al. 2017a).

Wild Fish Conservancy asserts that “humpback whales may be learning to target hatchery releases of Chinook salmon in Southeast Alaska” and cites Chenoweth et al. (2017). However, wild stocks are the main concern for this ESA petition. Because Chinook salmon are known for agonistic behaviors and diffuse distributions at this life stage (Chenoweth et al. 2017), hatchery releases are the only instances where humpback whales would target Chinook salmon, making this species atypical prey for filter feeding whales in a natural system. Wertheimer et al. (2014) have documented a negative correlation between humpback whale abundance and marine survival of Chinook salmon in Southeast Alaska. However, these authors note that this correlation may be a coincidence of unrelated population trajectories, particularly as it is unlikely that humpback whales are specifically targeting juvenile Chinook salmon due to their low density and distribution patterns relative to other prey species. Therefore, there should be little concern about humpback whale predation impacting wild stocks of Chinook salmon.

Other fish species

Direct observations of predation on Chinook salmon by other fish species are rare and alternative methods to assess predation (e.g., identifying predation attempts via wound and scars) provide limited information. Likely predators of Pacific salmon on the high seas consist of teleost fishes (long snouted lancetfish, daggertooth, and Pacific lamprey); sharks (salmon shark, spiny dogfish); and marine mammals including pinnipeds and cetaceans (Weitkamp and Garcia 2022). Direct observations of salmon shark predation indicate that the primary salmon species consumed by salmon sharks likely reflects availability, with mainly pink, sockeye, and chum salmon consumed in the western North Pacific Ocean (Sano 1962; Nagasawa 1998) and pink, chum, and coho salmon in the eastern North Pacific Ocean (Hulbert et al. 2005). Historically, Chinook salmon were rarely identified in salmon shark stomachs (Sano 1960, 1962). Recently, however, immature Chinook salmon carrying satellite transmitters were depredated by salmon sharks along the Aleutian Islands and southern Bering Sea shelf (Seitz et al. 2019). Information on salmon shark abundance would help determine if predation of Pacific salmon by salmon sharks has increased; such abundance estimates are currently not available for the North Pacific Ocean (Rigby et al. 2019).

Marine predation by age

While at sea, Chinook salmon have three distinct life stages—juvenile, immature, and maturing—that are characterized by their distribution and behavior, and consequently, each life stage has the potential to interact with different predators.

Juvenile. The juvenile life stage (the first year at sea) is generally identified as a critical bottleneck for salmon survival (Beamish and Mahnkin 2001). During their first summer at sea, juveniles of most salmon species tend to be concentrated nearshore before their offshore dispersal. Predation-based mortality immediately following ocean entry is hypothesized to be size-dependent, with smaller-sized salmon being more susceptible to predation events (critical size–critical period hypothesis; Beamish and Mahnken 2001). Because Alaska Chinook salmon have predominantly a stream-type life history (fry rear for one or more years in freshwater before ocean entry), they are generally larger than most juveniles of other species of salmon at marine entry, which is believed to provide some protection from predation, particularly for gape-limited predators like fishes. Likewise, the densities of juvenile Chinook salmon are much lower than for other species of salmon with different life history strategies, such as pink and chum salmon. It is speculated that outmigration of Chinook salmon at the same time as these high-density salmon species may allow for a predator-swamping effect, which could buffer juvenile Chinook salmon from predatory impacts (Riddell et al. 2018).

Immature. During the immature stage, most GOA Chinook salmon spend the next few years of their life distributed across the GOA and even into the Bering Sea, though a small proportion of Southeast Alaska Chinook remain coastally in inside waters (Larson et al. 2013, Heinl et al. 2017). During this time, Chinook salmon are exposed to numerous predators, though data are limited on predation rates and risk during this time. At this life stage, the most likely predators are teleost fishes (long snouted lancetfish, daggertooth, and Pacific lamprey); sharks (salmon shark, spiny dogfish); and marine mammals including pinnipeds and cetaceans (Weitkamp and Garcia 2022).

Mature/Adult. As Chinook salmon mature and re-enter coastal waters prior to river entry, their density becomes more concentrated compared to the immature life stage in the open ocean. At this life stage, hypothesized impacts of predators are largely focused on the potential for size-selective predation to contribute to reduced size at maturity, rather than direct impacts to population abundance (e.g., Ohlberger et al. 2018).

A recent analysis suggests that predation during the immature and maturing life stages could contribute to a decline in Yukon River Chinook salmon age at maturity (Manishin et al. 2021). While this analysis demonstrates that it is theoretically possible that predators like salmon sharks and killer whales could reduce the age at maturity for a Chinook salmon population, there is no evidence to validate the assertion that those predators are actually having that effect. In addition, the analysis did not include any GOA populations. Further, the authors also state that “It is implausible that all observed changes in Chinook salmon demographics are attributable to one agent of selection such as predation."

Regardless of life stage affected, hypotheses implicating size-selective predation as being responsible for reduced size/age at maturity of Chinook salmon fail to acknowledge documented concurrent declines in size-at-age for other, smaller salmon species and a variety of marine teleost species in northern oceans

(Morita and Fukuwaka 2007, Beamish 2008, Baudron et al. 2014). Rather than concluding these broadly observed demographic changes are due to size-selective predation, a more parsimonious explanation for this widespread phenomenon is changing environmental conditions that broadly impact diverse taxa of ectotherms.

Disease and Predation References

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2.5 Other Natural or Manmade Factors

2.5.1 Climate Change

Chinook salmon are resilient to climate change. Climate change is affecting Alaska and the Gulf of Alaska, which will in turn affect the Chinook salmon that spawn within the region. Predicting how climate change will affect Chinook salmon is complex, because there are multiple pathways through which it can occur. Those pathways may be beneficial, neutral, or unfavorable to GOA Chinook and may also vary across the broad expanse of the Gulf of Alaska as well as through time. In addition, the stocks of Chinook within the GOA have considerable resilience and adaptive potential, which needs to be factored in when considering how climate change will affect populations over multiple generations of fish.

2.5.1.1 Considerations for assessing climate change impacts to GOA Chinook

Accurately assessing whether a species is likely to become in danger of extinction within the foreseeable future requires accounting for uncertainty about what may happen in the future in addition to the uncertainty inherent in predicting how threats and conservation actions might affect a species. The U.S. Fish and Wildlife Service (USFWS) recently established guidelines for developing future scenarios that account for the uncertainty in future conditions when informing ESA decisions and species status assessments (SSA; USFWS 2023). The USFWS guidance emphasizes the importance of using scenarios to identify the plausible range of future factors affecting a species population size. This range is bounded by the best plausible scenario for the species and the worst plausible scenario for the species. It is necessary to consider this range between best and worst plausible scenarios because there is limited confidence in any single projection of a species' future condition. Using the USFWS framework would enable the Species Review Team to consider the full range of plausible variability in the future influences on Chinook salmon.

In contrast to USFWS's approach, NMFS's "Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions" focuses on only using one climate change scenario for ESA decision making (NMFS 2023). Thus, by basing decisions on only a relatively narrow range of future conditions, NMFS provides a false sense there is greater foresight than actually exists. NMFS justifies this approach by making numerous assumptions about socioeconomic and geopolitical drivers of energy use to identify what they believe is the most probable climate scenario. However, NMFS does not provide precise statements about the probability each of these assumptions are true now or into the future. This means the uncertainty in their prediction is unknown and possibly quite high. The NMFS's guidance is to use Intergovernmental Panel on Climate Change (IPCC)'s Shared Socioeconomic Pathway (SSP) 3-7.0, because it represents the status quo. While NMFS acknowledges that the IPCC has not identified any scenario as being more likely to occur than any other, NMFS cites various reports (NIC 2021; Riahi et al. 2017) indicating SSP3-7.0 may be more probable than other pathways. Yet it does not consider these other pathways, nor does it demonstrate this one scenario is more likely to occur than not (i.e., >50% chance). NMFS has even acknowledged that other sets of experts (IEA 2021; Pielke Jr et al. 2022; Burgess et al. 2023) "assert that a middle-of-the-road scenario similar to SSP2-4.5 is the most plausible" scenario (NMFS 2024 pg. 57), further supporting the notion that relying on a single scenario is fraught with uncertainty. A better approach is to bound that uncertainty by worst and best-case scenarios as is done by USFWS.

All assumptions concerning the projected outcome of a species should be fully evaluated. If NMFS has data on the precision or the likelihood of an assumption, then those data should be provided. In the absence of knowing the probability that an assumption is true, the assumption should be tested by projecting the future condition of the species with the assumption set at different values. Specifically, the full range of plausible values for each assumption should be tested.

2.5.1.2 Potential Pathways Climate Change May Affect GOA Chinook

There are many ways in which climate change may affect GOA Chinook. This subsection provides an overview of a few of the primary pathways that climate change is anticipated to affect GOA Chinook. However, this section is not intended to be an exhaustive treatment of the issue.

Glacial retreat

The rapid retreat of glaciers and shrinking of ice fields due to climate change may have large effects on GOA Chinook salmon populations (Pitman et al. 2020). But it is important to remember that on geological and evolutionary time scales GOA Chinook salmon have been responding to commensurate glacial changes. The GOA region has been glacially dynamic with glaciers advancing and retreating and Chinook salmon responding to those changes over the millions of years since speciation. As recently as 16-17,000 years ago, which was shortly after the last glacial maximum, the entire GOA region where Chinook salmon occur today was covered in ice (Brinner et al. 2017; Pitman et al. 2020). After the Last Glacial Maximum, significant warming occurred, including the Hypsithermal interval in the early Holocene, when glaciers within the GOA region receded beyond their present-day limits (Mann et al. 1998). Neoglaciation has occurred in the last 5-6,000 years, which have been appreciably cooler than the Hypsithermal interval. The Neoglaciation period has been marked by alternating cold and warm intervals, with glaciers advancing and retreating multiple times (Mann et al. 1998), including the Medieval Warm Period (900–1350 AD), the Little Ice Age (1350-1900 AD), and recent climate change amplified warming.

Pitman et al. (2020) recently synthesized the multiple ways retreating glaciers might affect GOA Chinook salmon. These effects were both positive or negative. For example, glacial retreat often creates new freshwater habitat, which can eventually lead to enhanced productivity that benefits smolt. However, the complete loss of glaciers within river systems can also decrease water flow and increase temperatures, which could have negative effects on Chinook salmon. Glacial retreat is predicted to affect habitat availability, hydrology, seasonal flow patterns, water temperature, and habitat productivity, and this will vary depending on the extent to which a watershed is still glaciated (Pitman et al. 2020).

With few exceptions, a portion of each major GOA Chinook salmon bearing watershed is still glaciated. The GOA region is predominated by watersheds and areas that have both significant (5–20%) and high (>20%) glacier coverage (Pitman et al. 2020). Within some GOA watersheds, especially larger watersheds, subwatersheds vary from having no glacier coverage to being completely glaciated. The high diversity of glaciation within GOA watersheds may make the region more resilient to impacts from glacial retreat because areas experiencing negative impacts to Chinook salmon will be mitigated by other areas experiencing positive impacts from glacial retreat (Pitman et al. 2020). Because GOA watersheds have significant glacial coverage, extreme warm events in the near future are less likely to result in freshwater temperature spikes and low flow events because such extreme warm events will result in high cold-water runoff from glacial melt (Pitman et al. 2020). In the worse case scenario, if all glaciers in the GOA were to disappear, Chinook populations would probably still exist, much as they do in more southern portions of their range.

Ocean Productivity

A number of environmental changes have been observed and are expected to continue in the North Pacific Ocean due to a changing climate, but the impacts of these changes on GOA Chinook salmon and their capacity for adaptive responses are largely unclear. GOA Chinook salmon utilize nearshore habitats of coastal waters in their first critical weeks to months in the ocean, but then disperse across a vast area of the North Pacific Ocean and into the southern Bering Sea in later stages of their marine life history (Larson et al. 2013). Several studies have observed and predicted a number of ecosystem changes for ocean habitats occupied by GOA Chinook salmon, including increased prevalence and duration of harmful algal blooms (Hu et al. 2024), and acidification of ocean waters (Hauri et al. 2021; Hauri et al. 2024), though the impacts of these changes on GOA Chinook salmon populations are currently speculative.

More notable marine ecosystem changes with observed links to salmon marine survival include the increased frequency, duration, and severity of large marine heatwaves (Litzow et al. 2020). The most notable recent marine heatwave that could have impacted GOA Chinook salmon occurred in 2014–2016 (“The Blob”) and again in 2019. These marine heatwaves were marked as impacting the age structure, size, growth, and energy content of forage fishes (capelin *Mallotus catervarius*, sand lance *Ammodytes personatus*, and herring *Clupea pallasii*), as well as causing shifts in distribution, mass mortalities, and reproductive failures in seabirds, marine mammals, and groundfish (Arimitsu et al. 2021). Marine heatwaves are expected to have the greatest impact on the juvenile life stage (first year at sea) of salmon, and stronger impacts on salmon species that are younger and smaller at ocean entry, like chum salmon (Farley et al 2023). Pacific sand lance *Ammodytes personatus*, a species consumed by Chinook salmon, were less nutritious during the 2014–2016 marine heatwave in the Gulf of Alaska, suggesting heatwaves could cause indirect energetic stress to Chinook salmon (Moss et al. 2016; von Biela et al. 2019). Moreover, as ecothermic animals, warmer ocean temperatures during marine heatwaves would be expected to increase metabolic rates and energetic consumption in salmon.

The physiological or behavioral adaptive capacity of GOA Chinook salmon in the face of these environmental changes is not yet well understood. Juvenile life stages are believed to be most vulnerable to changing ocean conditions due to their smaller size and limited energy reserves for enduring energetically stressful periods. Juvenile life stages are also more constrained to using surface waters (approximately the top 15 m of the water column) relative to immature Chinook salmon, which frequently utilize as much as the top couple hundred meters of the water column (Riddell et al. 2018, Emmett et al. 2004). Thus, immature Chinook salmon have a greater ability to use more of the water column to find energetically favorable temperature conditions. Consequently, immature life stages of Chinook salmon are expected to avoid unfavorable ocean conditions by either migrating to areas that are not under heatwave conditions and/or utilizing deeper parts of the water column where temperatures are more stable, even during heatwave conditions. The southern Bering Sea is already utilized by at least some GOA Chinook salmon stocks in their marine life stages, and it is hypothesized that, with the “borealization” of the normally Arctic Bering Sea (Litzow et al. 2024), there may be a northward movement of salmon to utilize this marine habitat (Langan et al. 2024).

Other Pathways

There are numerous other pathways through which climate change may affect GOA Chinook salmon. Ocean acidification is likely to alter the oceanic food web utilized by GOA Chinook salmon (Feely et al. 2016) and may have physiological effects on olfactory discrimination and homing in Chinook salmon (Munday et al. 2009) and may challenge their ability to modify phenotype to adapt to new conditions (Crozier et al. 2019). Changes in the amount and timing of rainfall and snowfall (including changes in the frequency of extreme precipitation events), along with changes in glacier melt, will alter the hydrology of many GOA Chinook bearing watersheds (Shanley et al. 2015). Warming of the land surface may lead to warmer river and stream temperatures on watersheds with little to no glacial coverage (Pitman et al. 2020). Climate change may affect GOA Chinook salmon distributions, migrations, and timing of key life cycle transitions (e.g., when eggs hatch; ADF&G 2022). However, the magnitude of effects on GOA

Chinook stocks is not well understood, requires additional research, and is largely speculative at this time (ADF&G 2022; AFSC 2024).

2.5.1.3 Sources of GOA Chinook Salmon Resilience

GOA Chinook salmon have thrived and continue to thrive in a dynamic environment, which indicates population resilience that needs to be considered when assessing potential climate change impacts. The GOA region has been and continues to be a highly dynamic environment. The GOA region has undergone enormous glaciation changes in the last 15,000 years (Briner et al. 2017; Mann et al. 1998). Even within the last thousand years, there have been considerable periods of both glaciation and deglaciation in the GOA region, as well as oceanographic oscillations affecting marine productivity, and large earthquakes and volcanic eruptions that have resulted in dramatic landscape changes (Mann et al. 1998).

Chinook salmon populations have responded to major changes in the GOA region. After the Last Glacial Maximum (ending c. 15,000 ya), which had covered nearly the entire GOA region, Chinook and other salmon recolonized the GOA from glacial refuges in other regions (Pitman et al. 2020). In contrast to the Last Glacial Maximum, during the Hypsithermal interval (between 9,000 and 6,000 ya) the GOA region was less glaciated than it is now (Mann et al. 1998). In the GOA, when glaciers expand, Chinook salmon habitat contracts, and as glaciers shrink, Chinook salmon colonize newly opened habitat (Mann et al. 1998). Chinook salmon thrive in watersheds with and without glaciers (Pitman et al. 2020), demonstrating considerable plasticity.

Significant changes are regularly occurring within Chinook salmon watersheds in the GOA region. The following are several recent examples.

- In the Alsek River watershed in 2016, the retreat of the Kaskawulsh Glacier resulted in shifting the glacial drainage from going into Kluane Lake and down the Yukon River to draining down the Kaskawulsh River and into the Alsek River (Shugar et al. 2017). This has resulted in altered flow and sediment discharges into the Alsek River, but this does not appear to have affected GOA Chinook escapement monitored in another branch of the Alsek River (Heinl et al. 2020). Shugar et al. (2017) hypothesize that Lake Kluane may also eventually drain down the Alsek River.
- The Hubbard Glacier periodically dams Russel Fjord (Gubernick and Paustian 2007). Although recent ice dams created by an advancing Hubbard Glacier in Russel Fjord in 1986 and 2002 were relatively short lived and did not result in major flow changes, prior to the mid-1800s, the ice dam caused flow to go out the Situk River, with a flow rate that was one to two orders of magnitude higher than currently. Despite the large shift in the mid-1800s, Chinook were part of the first weir counts on the Situk River in the late 1920s (Kissner 1977; Heinl et al. 2020) and almost certainly were present much earlier than that time.
- The Copper River delta is a 2,800 km^2 area created by the Copper River. The 1964 earthquake instantaneously uplifted the Copper River delta about two meters, which resulted in vast areas of the delta changing from a salt marsh to a freshwater wetland (Crow 1966). Such a large change could have impacted out-migrating Chinook salmon smolts from the Copper River. However, the Copper River basin remains a productive Chinook salmon watershed today with total runs ranging from 29,000 to 96,000 fish since they were first estimated in 1999 to 2018 when the most recent run reconstruction was conducted (Joy et al. 2021).
- The 1912 Novarupta eruption on the Alaska Peninsula was a highly explosive eruption that spread a thick layer of tephra across a large section of the Alaska Peninsula, Kodiak Island, and Cook Inlet.

Despite this perturbation, Chinook and other salmon have persisted within the region (Mann et al. 1998).

These examples demonstrate the resilience of Chinook salmon to large perturbations that are a regular part of the GOA region's volatile and dynamic nature.

In addition to the significant change in GOA region watersheds, the GOA also undergoes significant shifts in productivity over time (Mann et al. 1998). Fluctuations in Pacific salmon harvest and abundance, including Chinook salmon, have long been tied to multidecadal shifts in ocean productivity called the Pacific Decadal Oscillation (Mantua et al 1997; Mann et al. 1998; Yati et al. 2020). Large shifts in GOA productivity have occurred at least four times since 1900 (Francis et al. 1998), which have likely been responsible for cycles of relative salmon scarcity to stocks rebounding when productivity returns (e.g., Copper River commercial sockeye salmon harvests; Simeone et al. 2007).

Several attributes of the GOA Chinook salmon population provide resilience to perturbations, including potential effects from climate change. GOA Chinook salmon have intraspecific variation in spawning areas, age at maturity, and other phenotypic traits that provide an ecological portfolio effect, buffering the population by spreading risk across space and time (Tilman and Downing 1994; Schindler et al. 2010). For example, GOA Chinook salmon spawn in many discrete areas within and among watersheds (see AWC 2024). When one or more spawning areas are disturbed (e.g., a landslide), impacts are ameliorated across the broader metapopulation because most other spawning locations remain undisturbed (Schindler et al. 2010). In addition, the distribution of spawning areas across the landscape includes a high diversity of habitats (e.g., glaciated versus unglaciated watersheds, different levels of productivity and complexity, etc.; see AWC 2024), which demonstrates considerable genetic and phenotypic plasticity (Pitman et al. 2020). The ability to live in variable habitats is a source of resilience in a changing environment.

Like variability in spawning distribution, the variation in the age at maturity in GOA Chinook salmon stocks spreads risk across time (Shindler et al. 2010; Greene et al. 2010; Carvalho et al. 2023). If an impact, such as a glacial flood, wipes out a cohort of juveniles or adults, then other cohorts from a stock will replenish the impact over time (Pitman et al. 2020).

The propensity for a small portion of a salmon run to stray within and among watersheds is an important trait of GOA Chinook salmon. Such straying can provide both demographic and evolutionary rescue (Yeakel et al. 2018). Straying allows for individuals to colonize new habitats following glacial retreat (Pess et al. 2014; Pitman et al. 2020) and habitats that have been disturbed (Reeves et al. 1995). Straying may also allow for the dispersal of beneficial genes that promote adaptation (Yeakel et al. 2018).

Another source of resilience in GOA Chinook salmon is the relatively large population size and high fecundity. The large population size is spread across watersheds with considerable variability, indicating high levels of genetic and phenotypic variability that provides more potential to adapt to environmental changes than would a small population size. In addition, the high fecundity rates of salmon, enable beneficial traits to take hold and for the rapid colonization of open suitable habitat.

GOA Chinook salmon are adapted to living in a dynamic landscape (Waples et al. 2008, 2009), which will enable them to adapt to many of the impacts from climate change (Carvalho et al. 2023). Their multiple sources of resilience need to be incorporated into models of climate change impacts on GOA Chinook salmon for those models to be realistic. The GOA is a highly dynamic region that has experienced extreme climate swings in the past. Because Chinook salmon have persisted and thrived within these extremes, they are well adapted to take on the challenges of future climate change.

2.5.2 Hatchery Production

Chinook salmon hatchery production in GOA minimizes risks to wild Chinook stocks. When Alaska assumed management authority of its salmon fisheries in 1960, one year after statehood, many of the state's salmon runs were depressed and its salmon fisheries were in desperate shape. Due in part to historically low salmon harvests, Article 8, section 15 of Alaska's Constitution was amended by popular vote in 1972 to provide tools for restoring and maintaining the state's fishing economy:

> "No exclusive right or special privilege of fishery shall be created or authorized in the natural waters of the State. This section does not restrict the power of the State to limit entry into any fishery for purposes of resource conservation, to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of aquaculture in the State."

Alaska's salmon hatchery program was developed under this mandate and designed to supplement—not replace—sustainable natural production.

Alaska's modern salmon fisheries enhancement program began in 1971 when the Alaska Legislature established the Division of Fisheries Rehabilitation Enhancement and Development (FRED) within the Alaska Department of Fish and Game (ADF&G; FRED Division 1976). In 1974, the Alaska Legislature expanded the program, authorizing private nonprofit (PNP) corporations to operate salmon hatcheries:

> "It is the intent of this Act to authorize the private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing, by artificial means, to the rehabilitation of the state's depleted and depressed salmon fishery. The program shall be operated without adversely affecting natural stocks of fish in the state and under a policy of management which allows reasonable segregation of returning hatchery-reared salmon from naturally occurring stocks" (Alaska Legislature 1974).

Salmon fishery restoration efforts came in response to statewide annual salmon harvests of just 22 million fish in 1973 and 1974, among the lowest catches since 1900. The FRED Division and PNPs engaged in a variety of activities to increase salmon production. New hatcheries were built to raise salmon, fish ladders were constructed to provide adult salmon access to previously nonutilized spawning and rearing areas, lakes with waterfall outlets too high for adult salmon to ascend were stocked with salmon fry, log jams were removed in streams to enable returning adults to reach spawning areas, and nursery lakes were fertilized to increase the available feed for juvenile salmon (FRED 1975). A combination of favorable environmental conditions, limited fishing effort, abundance-based harvest management, habitat improvement and protection, and hatchery production gradually boosted salmon catches.

In Alaska, the purpose of salmon hatcheries is to supplement natural stock production for public benefit without adversely affecting natural stocks (Duckett et al. 2010). Hatcheries are efficient in improving survival from the egg to fry or smolt stage. Alaska hatcheries do not grow fish to adulthood, but incubate fertilized eggs and release resulting progeny as juveniles. Juvenile salmon imprint on the release site and return to the release location as mature adults. Per state policy, hatcheries generally use stocks taken close to the hatchery so that any straying of hatchery returns will have similar genetic makeup as the stocks from nearby streams. Also, per state policy, Alaska hatcheries do not selectively breed stocks. Large numbers of broodstock are used for gamete collection to maintain genetic diversity, without regard to size or other characteristics.

Hatchery production is limited by freshwater capacity and freshwater rearing space. Soon after emergence, all pink and chum salmon fry can be transferred from fresh water to salt water. Most Chinook, sockeye, and coho salmon must spend a year or more in fresh water before fry develop to the smolt stage and can tolerate salt water. These three species require a higher volume of fresh water, a holding area for freshwater rearing, and daily feeding. They also have a higher risk of disease mortality due to the extended rearing phase. There are economic tradeoffs between the costs of production versus the value of fish at harvest. Although Chinook, sockeye, and coho salmon usually garner higher prices per pound in the commercial harvest, chum and pink salmon are more economical to rear in the hatchery setting and generally provide a higher economic return.

2.5.2.1 Hatchery Production of Chinook Salmon

With respect to Chinook salmon, hatchery production levels are relatively small in Alaska, with less than 10 million smolt released annually on average for the purpose of augmenting fishing opportunity. Most of that production is released as smolt in saltwater (76%), mostly in Southeast Alaska (7.2 million), with limited freshwater releases (24%) in Cook Inlet and Prince William Sound (Table 12). In contrast, nearly 200 million salmon fry and smolts are released annually in Washington, Oregon, and British Columbia, with most releases occurring in freshwater and most for the purposes of conservation and mitigation (SFEC 2023).

Southeast Alaska Chinook Production

A comprehensive description and analysis of the hatchery program in Southeast Alaska can be found in Evenson et al. (2018). Chinook salmon hatchery production in the Southeast region was largely developed after the Pacific Salmon Treaty (PST) was signed in 1985. The PST includes funding for Chinook salmon hatchery production in SEAK to mitigate harvest concessions made in the treaty. Chinook salmon, wild and hatchery, are targeted year-round by the commercial troll and sport fleets and are harvested in the summer months by the net fleets. Harvest of Alaska hatchery-produced Chinook salmon is incentivized, as most do not count towards the PST all-gear harvest limit. Most hatchery production is saltwater releases intended for common property fisheries. Approximately 2.25 million of the 7.2 million smolt released annually are to increase Chinook salmon sport fishing opportunities, augmenting opportunity for marine boats and shoreside anglers, though a small proportion are released in freshwater at Ketchikan Creek (goal of 100,000 smolt) in Ketchikan and Fish Creek (goal of 250,000 smolt) near Juneau.

Eight facilities are currently producing Chinook salmon. Combined, these 8 facilities produce over 7 million juveniles annually. Of these 8 facilities, only one– Tamgas Creek Hatchery operated by the Metlakatla Indian Community–is not PNP operated and is not subject to PNP statutes and regulations. Crystal Lake Hatchery, located in Petersburg, is an ADF&G Sport Fish hatchery with operations contracted out to a PNP (Southern Southeast Regional Aquaculture Association).

Table 13.–Chinook salmon hatcheries, broodstocks, 2023 juvenile releases, and release sites by region.

Operator	Hatchery	Broodstock	Water	Release Site	Release
Southeast					
Southern Southeast Regional Aquaculture Association	Crystal Lake[a]	Andrew Cr	Salt	Anita Bay	403,586
		Andrew Cr	Fresh	Crystal Cr	652,104
	Whitman Lake	Chickamin R	Salt	Port St. Nicholas	99,342
		Chickamin R	Salt	Herring Cove	699,000
		Chickamin R	Salt	Carroll Inlet	626,000
		Chickamin R	Fresh	Ketchikan Cr	83,100
	Deer Mountain[b]	Chickamin R	Fresh	Ketchikan Cr	9,846
	Port St Nicholas[c]	Chickamin R	Salt	Port St. Nicholas	362,752
Northern Southeast Regional Aquaculture Association	Hidden Falls	Andrew Cr	Salt	Southeast Cove	347,658
		Andrew Cr	Salt	Gunnuk Creek	154,649
		Keta R	Salt	Little Port Walter	40,313
	Medvejie	Andrew Cr	Salt	Bear Cove	2,397,410
		Andrew Cr	Salt	Crecent Bay	298,223
		Andrew Cr	Salt	Crawfish Inlet	160,633
Armstrong-Keta, Inc.	Port Armstrong				
Douglas Island Pink and Chum	Macaulay	Andrew Cr	Fresh	Fish Creek	249,587
		Andrew Cr	Salt	Lena Cove	199,848
		Andrew Cr	Salt	Gastineau Channel	324,540
Metlakatla Indian Community	Tamgas Creek[d]	Unuk R, Chickamin R.	Salt	Tamgas Harbor	153,061
SEAK Subtotal					**7,261,652**
Prince William Sound					
Alaska Department of Fish & Game	William Hernandez	Ship Cr	Salt	Whittier	107,444
		Ship Cr	Salt	Fleming Spit, Cordova	109,739
		Crooked Cr	Salt	Seward Lagoon	332,346
Prince William Sound Regional Aquaculture Association	Wally Noerenberg	Ship Cr	Salt	Crab Bay	6,153
PWS Subtotal					**555,682**
Cook Inlet					
Alaska Department of Fish & Game	William Hernandez	Ship Cr	Fresh	Ekultna Tailrace	424,758
		Ship Cr	Fresh	Ship Cr	560,629
		Ninilchik R	Salt	Homer Spit	317,630
		Ninilchik R	Salt	Seldovia Harbor	91,983

		Ninilchik R	Fresh	Ninilchik R	118,615
		Crooked Cr	Fresh	Crooked Cr	91,801
Cook Inlet Subtotal					**1,605,416**
Kodiak					
	Pillar Creek	Salonie	Fresh	American, Olds, Salonie	19,502
Kodiak Regional Aquaculture Association		Monashka	Fresh	American, Olds, Salonie	27,001
Kodiak Subtotal					**46,503**
TOTAL					**9,469,253**

[a] Not a PNP permitted hatchery. Crystal Lake Hatchery egg takes and releases are regulated by ADF&G Division of Sport Fish.

[b] Egg take no longer occurs at Neets Bay or Deer Mountain hatcheries; eggs or fry are transferred from Whitman Lake Hatchery.

[c] No egg take occurs at Port Saint Nicholas; eggs or fry are transferred from Whitman Lake Hatchery.

[e] Tamgas Creek is operated by Metlakatla Indian Community and is not regulated by ADF&G.

Southeast Alaska hatchery sites, remote release sites, and broodstock sources were carefully selected to minimize the potential for returning hatchery stocks to mix with wild stocks (Holland et al. 1983; Farrington et al. 2004). All SEAK Chinook salmon broodstock has been locally sourced from SEAK. With few exceptions, Chinook salmon hatcheries are located on islands at or near tidewater and away from any endemic stock (Heard et al. 1995; Heard 1996). Comprehensive enhancement plans document enhancement efforts, set production goals, and identify potential for new projects, and are required by law (AS 16.10.375). The *SEAK Chinook Salmon Plan* delineates *sensitive* and *nonsensitive* zones for stock selection and transport considerations based on the potential to affect wild stocks (Holland et al. 1983). Sensitive zones contain wild spawning populations, whereas nonsensitive zones do not. In nonsensitive zones, enhancement stock needs may be met by any stock in the region approved through the ADF&G review process so more distant stocks are used; this is appropriate given the anticipated lack of interaction with or impact on wild populations. Within sensitive zones, movement of Chinook salmon stocks is limited, and enhancement stock needs must be met with the closest feasible stock.

A *Stock Appraisal Tool* modeled after one developed by the Hatchery Scientific Review Group (HSRG) for use in the Pacific Northwest (HSRG 2002), was developed to identify criteria to be used when evaluating the significance of a wild stock that may potentially interact with a hatchery release. Significance in this context is defined as “the importance of a stock in maintaining the overall viability and sustainability of the wild salmon resource as well as the importance of the stock in meeting fishery needs” (Duckett et al. 2010). The *Stock Appraisal Tool* attempts to be as objective as possible when determining the significance of a potentially impacted stock and identifies 6 characteristics for consideration: wildness, uniqueness, isolation, population size, population trend, and the stock’s economic and/or cultural significance. This tool essentially splits viability into population size and population trend and adds a criterion that addresses the human use pattern. Although no significant stocks were identified in SEAK comprehensive salmon plans (Duckett et al. 2010), the *Stock Appraisal Tool* is used each time a hatchery permit application comes up for review to evaluate risk to nearby stocks. In practice, when applying the *Genetic Policy*, all persistent wild spawning aggregates are considered significant stocks.

No wild stock sanctuaries are designated within SEAK preventing Chinook salmon hatchery enhancement. However, the sensitive zones identified in the *Chinook Salmon Plan* were delineated based on the presence or absence of wild spawning populations. Additionally, the National Park Service and U.S. Forest Service prohibit enhancement activities in lands/drainages classified as wilderness, therefore this land designation is considered a *de facto* sanctuary (Ducket et al. 2010).

Because Southeast Alaska Chinook are subject to the Pacific Salmon Treaty, hatchery releases are marked and tagged, allowing for evaluation. Consequently, several studies have documented variable hatchery proportions in wild systems. Hard and Heard (1999) examined hatchery straying from fish produced at the Little Port Walter facility from adult recoveries at 25 locations in Alaska and British Columbia between 1981 and 1989. Of the over 22,000 Little Port Walter-origin fish recovered, 98.8% were collected at Little Port Walter. Of 264 fish recovered elsewhere, 64.4% were within 25 km of the facility. No Little Port Walter-origin fish were recovered from the ancestral rivers, but 9 fish were recovered from rivers supporting wild Chinook salmon.

Following up on previous work (Heard et al. 1995), Heard (2011) summarized the incidence of hatchery strays in 10 wild stock rivers in SEAK from 1983 to 2007. Out of the 180,260 fish examined, only 493 were estimated to be hatchery fish from coded wire tag expansions[28] for an overall contribution of 0.3%. Hatchery proportions were generally under 1% across all rivers and years except the Farragut River where the portion of spawners that were hatchery strays was 8.5% over the 8 years (1983–1985; 1989; 1991–1993, 2007) for which data were available. More recent data are available through the ADF&G Mark, Tag, and Age Laboratory database (https://mtalab.adfg.alaska.gov/). These data, which do not include all the early years from Heard (2011), indicate that overall hatchery proportions in examined fish in more recent years was 0.5%. For more detail see Evenson et al. 2018.

Information from wild stock tagging programs in SEAK provide some context for the observed hatchery-to-wild stray proportions. Smolt from 4 wild stock rivers (Chilkat, Taku, Stikine and Unuk Rivers) were externally marked with an adipose fin clip and were coded-wire-tagged. Carcass recovery efforts in two of these rivers documented straying between wild rivers. In the Taku River, four out of 606 tags (0.7%) recovered over the period 1994 through 2013 were wild strays (Ed Jones, ADF&G, pers. comm.). Likewise, eight out of 872 tags (0.9%) recovered from the Unuk River between 1996 and 2014 were wild strays (Phillip Richards, ADF&G, pers comm.). It is difficult to compare stray rates between wild and hatchery Chinook salmon in SEAK because not all are coded-wire tagged and marked fractions vary.

Genetic impact of hatchery fish on wild fish occurs when hatchery-origin fish spawn with wild fish, introgressing genes into wild populations. Thus, straying is a prerequisite for genetic interaction and can act as an initial measure of its potential to occur. Genetic impacts include effects on fitness within wild populations and effects on genetic variation among wild populations. The potential for genetic introgression and impacts is tied to population structure of the species within the geographic area of interest. Although interaction is inherently difficult to demonstrate, given the hatchery proportions observed in most streams and the use of proximate broodstock for hatchery releases in SEAK, there is no clear evidence of genetic interaction, and furthermore, the effect of straying and introgression on fitness is not straightforward or predictable (reviewed in McClelland and Naish 2007).

Hatchery permits are reviewed by an ADF&G fish pathologist. Appropriate salmon culture techniques are implemented, and disease reporting and broodstock screening occur as required. Pathology records showed no inconsistencies with fish health and disease policies at any of the hatcheries. All hatcheries have been inspected regularly since at least the late 1980s, and no major health issues were reported. In general, the inspection reports have noted that most of the SEAK hatcheries are clean, well-organized, and well run.

Robust sampling programs are in place for all fisheries to determine hatchery contributions in mixed stock fisheries per Treaty requirements. Because all hatchery broodstock is locally sourced, hatchery fish have the same run timing and ocean rearing distributions as their wild stock counterparts and are indistinguishable genetically. Therefore, coded-wire-tag recoveries from fisheries have been used to estimate the hatchery contributions to the fisheries since 1985. This, in large part, is due to the SEAK hatchery add-on provision of the PST. Release and recovery data are publicly available from ADF&G Mark, Tag, and Age Laboratory database (https://mtalab.adfg.alaska.gov/), which includes recovery location, gear type, number of fish caught, and date, among other data. Because fisheries are generally sampled at rates greater than 20%, it is possible to assess hatchery contributions to fisheries both temporally and

[28] Coded-wire tag recoveries are expanded based on the proportion tagged of the total release group at the hatchery.

spatially with reasonable accuracy. The number of Alaska hatchery fish caught is estimated inseason providing fishery managers with information useful for regulation of SEAK fisheries.

Non-SEAK Chinook Production

Whereas SEAK hatchery production is designed to augment both commercial and sport fishing opportunities, hatchery production outside of SEAK is focused on enhancing sport fishing opportunity in both fresh and salt water in selected areas of Prince William Sound, Resurrection Bay, Kachemak Bay, Cook Inlet, and Kodiak. Additionally, approximately 95,000 adult fish are released into Susitna Lakes to increase sport fishing opportunity; these fish are triploid and sterile. See ADF&G Statewide Stocking Plans for additional details[29]

Prince William Sound. The purpose of the Prince William Sound hatchery program is to create terminal Chinook fisheries near communities where angling opportunities for Chinook are limited or nonexistent. There are no significant natural Chinook stocks in the Prince William Sound Area or in the Copper River Delta. ADF&G began Chinook salmon enhancement in the 1970s. For a variety of reasons, state involvement in these stocking activities was eliminated in the late 1980s and Prince William Sound Aquaculture Corporation (PWSAC) began Chinook salmon stocking projects at Whittier and Cordova. Due to production problems and cost considerations, PWSAC eliminated these stocking projects.

Currently, the program is focused on developing fisheries near three communities: Whittier, Cordova, and Chenega. Angler effort out of the port of Whittier has increased dramatically since modification of the Anton Anderson Memorial Tunnel in 2000 and is expected to continue to increase into the near future. In comparison to Whittier, the sport fisheries of Cordova are small. However, angler effort in the Cordova area has steadily increased throughout the last decade. The first release of Chinook salmon smolt at Chenega was in 2012. Ship Creek is the primary brood source for Chinook salmon released at these sites. Currently, these programs are designed to produce a return of approximately 200 adults each to the areas of Cordova, Whittier, and Chenega. A description of the programs and responsible parties is as follows:

- The Chenega stocking project is a cooperative project between the Village of Chenega, ADF&G and PWSAC. ADF&G supplies PWSAC with 50,000 eyed Chinook salmon eggs, and PWSAC completes incubation and rears the fish until they are released as smolt.
- The Whittier Chinook stocking program was terminated in 2005 due to a lack of rearing space at the ADF&G Fort Richardson Hatchery (old hatchery) but was resumed in 2010 after the William Jack Hernandez Sport Fish Hatchery (new hatchery) was built. Chinook salmon smolt are delivered to a net pen in Whittier and the local harbor master and residents feed and monitor these fish for two weeks while they imprint to the stocking location off the mouth of Cove Creek.
- The City of Valdez developed a release site in Old Town Valdez and stocking commenced in the spring of 2005. This particular stocking venture has not been productive and there is no evidence that it has produced any return. This project was terminated in 2013.
- The Fleming Spit site at Cordova is a brackish water lagoon that has supported a release since the 1980s. However, the success of this release, relative to the number of angler days supported and the number of returning adults diminished substantially with the loss of hot water at the old ADF&G hatchery. Chinook salmon smolt from the new hatchery were first stocked here in the spring of 2012. Coincidentally, the catch of Chinook salmon did pick up considerably off this beach site in 2013.

[29] https://www.adfg.alaska.gov/index.cfm?adfg=fishingSportStockingHatcheries.stockingPlan.

Resurrection Bay. The purpose of the Resurrection Bay enhancement program is to provide marine sport fishing opportunities in the area by returning 4,000 to 6,000 early-run Chinook. Resurrection Bay drainages do not support wild Chinook salmon runs. Two distinctive Chinook salmon runs have been developed in Resurrection Bay through hatchery enhancement. However, the late-run Chinook salmon program was canceled due to a lack of available broodstock. Sport fisheries occur in late May through early July for early-run Chinook salmon. In 2021, according to the SWHS estimates, 10,031 Chinook salmon were caught and 5,190 harvested inside Resurrection Bay by both shore-based and boat anglers.

Kachemak Bay. The Kachemak Bay program is designed to enhance sport fishing opportunities and to decrease harvest of lower Cook Inlet wild stocks by producing 2,000 adult returns to Nick Dudiak Fishing Lagoon (formerly known as the Homer Spit location) and 500 adults to Seldovia Lagoon. Boat anglers target Chinook salmon returning to the terminal areas and shore anglers primarily target Chinook salmon once they have arrived at the terminal areas and are more concentrated. Chinook salmon return to some tributaries but not in harvestable amounts. Hatchery-reared early-run Chinook salmon were stocked in Halibut Cove Lagoon from 1974 through 2017, the Homer Spit since 1984, and Seldovia Bay since 1987. In most years, the Ninilchik River Chinook salmon brood stock was used for these stockings. However, when broodstock from the Ninilchik River is insufficient, Crooked Creek and Ship Creek broodstock have also been used to support the Kachemak Bay stocking program.

Ninilchik. The primary purpose of the Ninilchik enhancement program is to increase sustainable Chinook salmon fishing opportunities on the Ninilchik River by supplementing the stream's wild run with hatchery-reared fish, without significantly altering historical Chinook salmon age and sex compositions. Chinook salmon smolt originating from egg takes conducted on the Ninilchik River then reared in ADF&G hatcheries have been stocked in Ninilchik River since 1988. The initial stocking level was 200,000 smolt, of which only 20% were adipose fin-clipped and tagged with coded wire tags (CWT). In 1995, due to wild stock concerns, the stocking level was reduced to 50,000 smolt, of which 100% were clipped and tagged. This reduction in enhancement level was thought to provide additional protection to wild stocks. The 100% marking provided for more accurate assessment of hatchery-reared versus wild-stock production and reduced genetic concerns by allowing the use of only wild fish for broodstock. Additionally, 100% marking provided a means of increasing exploitation of hatchery-reared fish while protecting wild stocks. The use of CWTs was discontinued in 2017 but fish are still marked with adipose fin clip to allow for hatchery-reared Chinook salmon to be identified in the Ninilchik River. A weir at an upstream location near the Brody Road bridge is used to monitor the Ninilchik River Chinook salmon escapement and used to collect broodstock for egg takes. The Ninilchik River Chinook salmon wild stock is managed to ensure the wild Chinook salmon escapement upstream of the Brody weir.

Northern Cook Inlet. The Northern Cook Inlet (NCI) urban area extends from Ingram Creek in Turnagain Arm north to the Eklutna River drainage. The primary purpose of this program is to maintain or increase Chinook salmon sport fishing opportunities in the region. In addition to opportunities, this enhancement program also reduces the fishing pressure on local wild stocks. The program provides alternative opportunities for anglers that might otherwise direct their efforts toward native fish that are vulnerable to overfishing. Increasing sport fishing pressure and overharvest of several native fish stocks (non-Chinook) resulted in more restrictive regulations in several NCI fisheries. As sport fishing pressure continues to increase in the Matanuska–Susitna Valley, hatchery fish are becoming a more important management tool to satisfy recreational demands. Although anglers have the opportunity to participate in salmon, trout, grayling, and char fisheries in this area, Chinook salmon sport fishing opportunities are limited to a few streams and rivers and currently are focused on hatchery fish.

By far the largest Chinook salmon fishery in the Anchorage Management Area is the enhanced Ship Creek fishery in downtown Anchorage. This program is designed to maintain or increase Chinook salmon sport fishing opportunities in Anchorage on a sustainable basis by supplementing Ship Creek's natural run with hatchery fish. Angling effort targeting all species in Ship Creek peaked at 62,101 angler-days in 2000. The 2021 Statewide Harvest Survey (SWHS) estimates of sport angler effort in the Anchorage and Turnagain Arm drainage areas totaled 60,984 angler-days, which is very similar to previous years. From 2011 to 2020, the Ship Creek sport fishery produced an annual average catch and harvest of 1,336 and 936 Chinook salmon, respectively. During 2021 anglers fishing Ship Creek caught an estimated 2,229 Chinook salmon, and they harvested 1,615 fish according to the SWHS. Hatchery fish are also stocked in the Eklutna tailrace, about 34 miles northeast of Anchorage, allowing harvest for the duration of the Chinook salmon return. In 2021, the Eklutna tailrace program generated 9,468 angler-days of effort.

Kodiak. The Kodiak enhancement program began in 2000 to provide sport harvest opportunity to anglers along the Kodiak road system. In 1999, the Karluk River Chinook salmon run was identified as a wild broodstock source to initiate hatchery production for annual smolt releases at designated road system streams. From 2004 to 2016, returns of hatchery-reared Chinook salmon to Monashka Creek were used as broodstock for continuation of this enhancement program. Now, since 2010, broodstock are collected from the Olds, American, and Salonie drainages. The current annual production goal is at least 200,000 15-gram smolt, which are released in the American and Olds Rivers and Salonie Creek. Returning adults are caught in marine and freshwater. This project is funded by ADF&G under a cooperative agreement with the Kodiak Regional Aquaculture Association.

2.5.3 Marine Competition

It is unlikely marine competition is threatening the existence of GOA Chinook salmon stocks now or into the foreseeable future. Competition between salmonids is commonly proposed, but is rarely resolved as a causative factor because the dynamics of nearshore and pelagic marine food webs are complex due to the vast area and number of species involved and it is difficult to obtain comprehensive measurements and identify all interactions. Furthermore, even if a source of competition is identified, complex food web dynamics (e.g., predation on competitors) can result in positive relationships between competing species when space is limiting, such as in intertidal areas (Paine 1966).

It is well understood that salmonids make up a relatively small proportion of the biomass of predatory pelagic fish (potential Chinook salmon competitors) in the GOA marine ecosystem. Additionally, many pelagic predatory fish in the NPO are generalists and use a diverse prey field. If competition among predatory fish is an important driver of Chinook productivity, this would imply a relatively smaller contribution by other competing salmonids. This makes salmonid abundance and fluctuations in that abundance unlikely drivers of changes in GOA Chinook salmon abundance and mature individual size. Contrasting correlations in population sizes between potential salmonid competitors and Chinook salmon may merely indicate differing adaptive responses to changes in environmental conditions. Most studies asserting marine salmon competition use modeling and *post hoc* reasoning based on observed associations but do not take the additional necessary steps to test assumptions and apply causal model approaches and are therefore less likely to be definitive (e.g., Buckner et al. 2022).

2.5.3.1 Debate over marine interspecific salmon competition

Competition among salmonids and between salmon and other species at sea is a topic where no definitive scientific measurement is available. Thus, it remains a topic of intense debate within the salmon scientific community. Although there are diverse perspectives in the scientific literature about this topic, there is no scientific consensus. For example, statements that pink salmon are responsible for a "resource vacuum" that has destabilized the ecosystem (e.g., Springer and van Vliet 2014) can be balanced by counterarguments showing these ideas are absurd (e.g., Shuntov et al. 2017).

This debate is fueled by regional differences in the availability of direct measurements of ecosystems. The marine ranges of salmon include four major basins (Okhotsk Sea, Bering Sea, Gulf of Alaska, and the western North Pacific Ocean), which cover vast areas and represent diverse ecosystem characteristics. Marine shipboard surveys require long term investments of significant resources to provide useful observations. Both Japan and Russia have datasets developed from long timeseries of comprehensive surveys in the western Bering Sea and portions of the western North Pacific Ocean (referenced in Dekshtain and Koval 1995). These data enable direct estimation of spatial and diet overlap, and prey consumption and availability. In many cases authors of these studies have concluded that prey resources are not limiting for salmon and that salmon consume a relatively small proportion of the available prey (Shuntov et al. 2017). As major ocean basins yield different ocean, salmon, and prey dynamics (Somov et al. 2024), it cannot be assumed that these studies necessarily represent conditions in the eastern North Pacific Ocean. Similar datasets are relatively sparse in North America and have shorter time series to draw from (e.g., Murphy et al. 2022; Riddell et al. 2018). This disparity in available data has led to the use of model-based approaches and assumptions dependent on information from returning adults.

Much of the literature on interspecific salmon competition at sea caricatures salmon ocean ecology and trophic interactions largely because expertise and data in ocean ecology is lacking or ignored. Most published papers do not directly investigate competitive interactions between salmon species but infer trophic competition and limited prey availability. Trophic ecologists consider units of energy (calories) or biomass (stored energy) as key measures in food web interactions (Barnes and Hughes 1999), yet many published papers use numerical abundance to investigate salmon competition (Ruggerone et al. 2023 and studies therein). Many salmon competition studies focus only on returning adults as a metric for presumed competition at sea (Ruggerone et al. 2023 and studies therein). However, species like chum, Chinook, and sockeye salmon remain in the ocean, and presumably compete for food, across multiple years of immature and maturing individuals, and this potential for interaction is largely ignored. Studies of competition should include all marine-resident members (adult and immature) of the species that might compete for food, not just a single maturation category. Furthermore, salmon ocean ecologists also recognize multiple rearing basins in the North Pacific Ocean and Bering Sea that various salmon stocks utilize; however, salmon competition studies often fail to distinguish the unique migratory and rearing distributions of the species and stocks they are investigating.

Competition for food is a normal part of ecosystem dynamics and some competition among generalist pelagic fish species, like salmon, is expected in a healthy and functioning ecosystem. The existence of competitive dynamics is not diagnostic of a problem or an existential threat to a species. Ecosystems are built around interactions among species and are self-correcting toward equilibrium state(s). It is only when there is some wildly abnormal ecological perturbation (e.g., an introduced and invasive species that is outside the bounds of how the food web evolved) where competition can become problematic (e.g., Ruiz et al. 1999).

Combined all Pacific salmon compose a relatively small proportion to the total biomass of consumers in the North Pacific and Bering Sea (e.g., Aydin et al. 2007). Based on a 35-year data set (1986-2020), Gorbatenko et al. (2022) estimated that the functional groups of the nekton (pollock, squid, salmon, and mesopelagic fish) accounted for 1.1% of total production in the Bering Sea. For this reason, studies that focus on a single species in that group are even less likely to detect an effect, and a relationship (if detected) is more likely to be caused to some extent by the larger, but unincluded, set of species consuming the same prey field. Recognizing the need to include a larger set of species in a competitor index, a multi-species competitor index was recently implemented in a study of the effects of competition on AYK Chinook salmon productivity (Feddern et al. in press).

The effects of bottom-up factors (e.g., temperature) in the marine environment are more consistently demonstrated to be important to the marine distribution and productivity of Pacific salmon than top-down factors like competition and predation. In a comprehensive modeling effort to describe species-specific marine distributions across the range, Langan et al. (2024) demonstrate the effect of temperature on the preferred ranges for each species within the Okhotsk Sea, Bering Sea, Gulf of Alaska, and the North Pacific. During 2002–2022, much of the variation in relative abundance and body condition of juvenile salmon, factors commonly thought to be drivers of productivity, corresponded with warm and cool periods in the Eastern Bering Sea (Somov et al. 2024). Climate indices, recently the North Pacific Gyre Oscillation, have been associated with shared changes in productivity of Chinook salmon populations from Oregon to western Alaska (Dorner et al. 2018).

Understanding the potential effects of competition on GOA Chinook salmon relies heavily on research on populations in other portions of the range. Most of the published studies on Chinook salmon productivity which include a marine competition component are focused on populations from either western Alaska or the coasts of BC and the western U.S. (Cunningham et al. 2018; Ruggerone and Nielsen 2004; Feddern et al. in press; Kendall et al. 2020; Buckner et al. 2023; Sobocinski et al. 2021). There is one productivity study that evaluated competition for a GOA population (Copper River; Ward et al. 2017) and a few studies on correlations between changes in size with abundance (Oke et al. 2020) or on diet overlap (Kaeriyama et al. 2004) to imply competition.

2.5.3.2 Considerations when interpreting interspecific salmon competition studies

Reproducibility of Central Data Set. Almost all studies implicating salmon competition at sea (For examples see Ruggerone et al. 2023) use the same time series of estimated abundance and biomass of wild and hatchery-origin salmon in the North Pacific (most recently published as Ruggerone and Irvine 2018) as the foundation for the analyses. While this dataset is currently the standard for studies of salmon competition, the estimates are not entirely reproducible and do not include measures of uncertainty. In addition, unknown errors and undescribed assumptions in the compilation of this data set can potentially be propagated across the published analyses. The need to improve the reliability and utility of the dataset was recognized by North Pacific Anadromous Fish Commission (NPAFC) and a collaborative effort is in process through its Working Group on Stock Assessment (A. Munro, WGSA Chair, pers. comm; The Science Sub-Committee (SSC), 2023).

Categories of Reasoning. In general, the scientific literature on competition between salmon species at sea falls into four categories: 1) studies focused on diet overlap and diet shifts, using various methods to investigate the similarity of the diets of various species to understand the *potential* for competition (e.g., Osgood et al. 2016); 2) papers that look at associations in the abundance, productivity or survival trends in species that *might* compete with one another; correspondence between one species in a poor phase and another species in a strong phase (Ruggerone and Connors 2015); 3) papers focused on growth, with the assumption that growth is directly related to survival, and lower growth occurring at the same time as high abundance of a potential competitor species is inferred to be a result of competition (Ruggerone and Nielsen 2004; Rand and Ruggerone 2024); and 4) papers that associate competitor abundance patterns with changes in a species age at maturity. For example, abundance of a competitor species was associated with declining body size of another species (Oke et al. 2020). Typically, the evidence that salmon diets overlap (Category 1) is presented as evidence that competition is possible, and studies that associate patterns and trends among covariates (Categories 2-4) are presented as evidence that competition is occurring between salmon species. In the absence of direct observation, much of the debate centers on the nature of analytical methods, unverified or tenuous assumptions, and deficiencies in causal linkages.

<u>Common Criticisms</u>. Some common criticisms of these types of analyses are:

1. Direct observations and collected data from the marine ecosystem are limited, so often analyses rely on indirect evidence and strong assumptions. In some cases, subsequent measurements from the system do not support the published relationships (e.g., Daly et al. 2019; Yasumiishi et al. 2024).
2. Most of the studies focus only upon salmon species ignoring the roles of non-salmon competitors in the marine ecosystem. While salmon are very important to humans, their importance as predators in the marine food webs is relatively small when considering other species with similar diets such as pollock, cod and herring, which have far larger biomasses. (e.g., Aydin et al. 2007; Gorbatenko et al. 2022)
3. When relying on observational data and indirect evidence, it is necessary to rule out alternative explanations for observed correlations. For example, across salmon competition studies, biennial patterns are assumed to relate to pink salmon abundance (Ruggerone et al. 2023), even though biennial patterns are also known to occur for important squid species (Arkhipkin et al. 1996), and some copepod species (Miller et al. 1984). Both of which occupy important roles in marine food webs (Aydin et al. 2007).
4. The many instances where a pattern is sought but not found are often ignored or unreported. Inherent in the literature for almost all scientific disciplines is a bias induced when a lack of relationships/associations are ignored by researchers or are not published. For example, for pink salmon competition to be supported as a causative agent for observed biennial patterns, the instances where biennial patterns are and are not found should be consistent with the most plausible mechanisms for competition for food. In other words, those species and stocks that are most likely to compete (greatest spatial and trophic overlap) with the densest biomasses of pink salmon should exhibit the strongest biennial patterns, and those with the least plausible mechanisms for competition should exhibit no to low biennial patterns.
5. For any pattern, there should be some evidence supporting whether the pattern itself is caused by depression in certain years or an enhancement in other years. For example, are odd/even year fluctuations a result of growth depression in odd years (due to competition for food or other factors), or growth enhancement in even years (due to predator swamping or pink salmon smolt as a prey source)? The literature pointing to biennial patterns as evidence of pink salmon influence almost universally assumes that any biennial patterns are negative and related to food competition without ruling out alternative explanations, or evaluating whether the spectrum of presence and absence of biennial patterns is consistent with pink salmon food competition as a

hypothesized mechanism. Yasumiishi et al. (2024) found that in the Bering Sea during summer, pink biomass positively correlated with sockeye salmon biomass and Somov et al. (2024), found that in the Western Bering Sea, pink salmon biomass positively related to the biomasses of sockeye and chum salmon, possibly indicating a positive effect on other species through schooling behavior, facilitating predator avoidance and finding food.

6. The majority of studies implicating interspecific salmon competition are focused on exploitation competition, which requires that the commonly utilized resource among species is limited. Typically this food limitation is assumed without analysis or evidence of food resource availability. In the Western Pacific Ocean and it's subbasins, research characterizing prey fields available to salmon and the consumption rates by salmon have generally concluded that the prey fields are not limiting given current salmon and prey abundances in those habitats (summarized in Shuntov et al. 2017).

Many studies that use observations from returns to evaluate competition as a potential cause for declines in demographic traits, such as for Alaska sockeye salmon length at age (Ohlberger et al. 2023) and pink salmon productivity (Ohlberger et al. 2022). When competition among juvenile salmon is evaluated using at-sea observations, often no competitive relationships are found (e.g., Daly et al. 2019; Yasumiishi et al. 2024). In the Eastern Bering Sea, much of the variance over time in abundance and body condition of pink, chum, and sockeye salmon, possible indicators of competition, could be attributed to temperature (i.e., warm and cool periods; Somov et al. 2024), suggesting demographic changes may be largely driven by temperature. Undoubtedly, temperature influences not only growth, but also maturation. Apparent delayed density-dependent growth, meaning growth or condition of one species negatively relates to growth or condition of another species in the following year (e.g., Morita and Fukuwaka 2020), may be caused by year-of-life and species (or stock) specific maturity responses to warming (i.e., maturing fish have higher energetic needs in warmer temperatures). Pink salmon may be a commonly suspected "culprit" because of being "winners" in a warming climate (Farley Jr et al. 2020; except the even-year lineage that is more cold adapted, Beacham and Murray 1988; Beacham and Murray 1990). Species that mature at larger size and older ages than pink salmon may have higher energetic needs than pink salmon for growth and maturation, which may result in statistically significant but ecologically unrelated relationships among their demographic traits. The one study of productivity of Gulf of Alaska Chinook salmon provided weak evidence for a positive effect of pink salmon hatchery releases on productivity (Ward et al. 2017). Clearly, at-sea surveys are needed to better understand the mechanisms causing statistically significant relationships suggestive of competition using information from returns.

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3.0 Evolutionarily Significant Units

To date, ESUs have not been defined for any salmonid species within the State of Alaska simply because there has been no impetus for doing so. Alaska salmon stocks are not at risk of extinction now nor in the foreseeable future. In the 90-day Finding, NMFS stated a pre-existing opinion that there is likely more than a single ESU among GOA Chinook and that "without knowing the boundaries of those ESUs, it is challenging to assess the status and trends of subpopulations." No evidence or reasons were provided to support this opinion. Designating ESUs in order to evaluate the merits of a petition is concerning for multiple reasons as outlined in the State's comment letter and serves no useful purpose for the sustainable management of Alaska's salmon resources. Simply because the petitioned area is geographically broad does not mean that a single or multiple ESUs exist. As stated in the State's comment letter, it is not necessary to categorize GOA Chinook into ESUs given the numerous deficiencies of the petition from the Wild Fish Conservancy, the lack of cogent reasons to consider GOA Chinook populations to be at risk, the potential downstream effects on continued sustainable management, and congressional direction to use the DPS concept sparingly. If the Service continues to pursue the designation of ESUs, then a single ESU encompassing all Gulf of Alaska Chinook salmon is all that may be required and even that should not be a foregone conclusion without the appropriate analyses.

In 1991, NMFS published a policy (56 FR 58612; November 20, 1991) on the application of the ESA definition of "species" to Pacific salmonid. The policy states:

> …that a Pacific salmon population (or group of populations) will be considered a DPS, and hence a "species" under the ESA, if it represents an ESU of the biological species. An ESU must be reproductively isolated from other conspecific population units, and it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation, need not be absolute, but must be strong enough to permit evolutionarily important differences to accrue in different population units… The second criterion is met if the population unit contributes substantially to the ecological and genetic diversity of the species.

This policy was expressly developed in response to petitions to list 5 salmon stocks in the Pacific Northwest with the recognition that potentially more salmon stocks may be petitioned for listing in the Pacific Northwest and a defined approach would be needed. Importantly, the policy and the guidance on its application (56 FR 58612 (November 20, 1991) and Waples 1991) was not developed with Alaska salmon stocks in mind. The Gulf of Alaska and the Chinook that populate it are, however, distinct from the regions and populations where ESUs have previously been defined in the Pacific Northwest. Where, on balance, this policy should be applied to GOA stocks in a commensurate manner as for Pacific Northwest stocks, its application should be preceded by careful consideration of the relevant policy guidance, underlying principles, and methods. It is possible, given the regional differences between the Pacific Northwest and GOA stocks, that the policy guidance may need to be adapted.

While distinct population segments (DPS) for Pacific salmon under the ESA have been defined as evolutionarily significant units (ESU) since the early 1990s, no clear and objective methodology exists to define an ESU, and the inherent flexibility of the definition lends itself to ambiguity. Waples (1991) and 56 FR 58612 (November 20, 1991) defines an ESU as a population or group of populations that 1) is substantially reproductively isolated from conspecific populations, and 2) represents an important component in the evolutionary legacy of the species. The former is typically quantified using data from putatively neutral genetic markers, but the latter is more difficult to evaluate directly and typically relies on information such as morphology, behavior, life history, or ecological features of habitats to serve as proxies for adaptive differences. In some cases, genomic data are available to examine adaptive variation; however, genomic data and data from adaptive loci are rare in Alaska or limited in geographic scope (e.g., Larson et al. 2014, McKinney et al. 2020, Hecht et al. 2015). Because of the need to rely on proxies when evaluating evolutionary legacy, this definition is more difficult to delineate. There is no definition for what constitutes an “important component” of an evolutionary legacy that we are aware of and in many cases, proxy information is missing, making it difficult to reach objective decisions. Where data are available, it may be difficult to interpret how these differences relate to the evolutionary significance of a species. Where clear evidence on evolutionarily important differences between groups is lacking, Waples (1991) suggests that the size of ESUs should be defined more comprehensively broad. This places the focus on designating units that are largely independent over evolutionary timescales, though this does not preclude preserving genetic diversity within an ESU (Waples 1995). While the definition of an ESU has allowed for flexibility in designations in other systems (Waples 1995), it could also lead to a tendency for decision makers to rely more heavily on cues and precedents from past designations instead of fully evaluating present circumstances and context.

While NMFS has designated ESUs for many Pacific Northwest Chinook salmon populations and NMFS policy was developed and applied for salmonid populations in the Pacific Northwest, it is not appropriate to apply the policy and precedents naively when designating units in GOA. For example, previous designations relied heavily on life history and run timing diversity to help define units. Chinook salmon in Alaska are less likely to display large temporal differences in run timing that may act as barriers to gene flow. In the GOA, appellations like “early run” and “late run” are used to describe spawning components of the same population (e.g., tributary and mainstem spawners), with the peak river entry of each component less than a month apart and with considerable overlap (e.g., Burger et al. 1985). Similarly, reliance on life history is less definitive in GOA populations; only one system is considered to comprise large proportions of ocean-type fish, the Situk River, which acts as a single population. In addition, many designations have used sharp genetic transitions associated with geographic features to define ESUs (Waples 1995; Waples et al. 2001). While there are geographic components to the structure of Chinook salmon in the Gulf of Alaska, it is not always clear how this reflects historical conditions or future evolutionary potential.

Among the available precedents for Chinook salmon, Washington and Oregon coastal ESUs may be the most appropriate for comparison to GOA systems rather than designations that reflect much older divergences (e.g. run-timing differences in the interior Columbia that predate the end of the Pleistocene). However, even these coastal reviews do not provide guidance for applying ESU designations for the aggregates of Chinook salmon spawning in the geologically dynamic landscapes in the GOA. The Pacific Northwest has experienced relatively geologically stable habitats for the past 5000 years (Waples et al. 2008). In contrast, the GOA has been more recently deglaciated and colonized than most of the species range, the landscape is active and unsettled, and physical barriers to gene flow come and go (sometimes catastrophically) on short timescales (e.g. McPhail and Lindsay 1970, Mann et al. 1998, Gubernick and Paustian 2007, Waples et al. 2008). As noted by Waples et al. (2008), geologic “disturbances both create selective pressures for adaptive responses by salmon and inhibit long-term divergence by periodically extirpating local populations and creating episodic dispersal events that erode emerging differences”. This is reflected in genetic structure that is more shallow and less complex compared to the Pacific Northwest (Meyers 1998, Gharrett et al. 1987, Templin et al. 2011, Moran et al. 2013).

Within the GOA, there is evidence that salmon can lose access to spawning habitat through various processes (e.g., Tarr and Martin 1912, Oslund et al. 2020) and colonize new habitat on short timescales (e.g., Milner et al. 2007, Milner et al. 2008, Pess et al. 2014). This continuous pattern of disruption, displacement, migration, and colonization is a driving force in the history of these populations and can reasonably be expected to continue into the future. The entire area is highly influenced by earthquakes, tsunamis, and volcanic eruptions. On average, this region has had one magnitude (M) 8+ earthquake every 13 years, one M 7–8 earthquake every two years, and six M 6–7 earthquakes per year (Alaska Seismic Hazards Safety Commission 2012), and there is ample evidence of coastline changes due to seismic land level shifts tsunamis, and subsurface landslides (Mann et al. 1998). It is highly probable that any geographical or genetic distinctions made among these populations could, in turn, be made irrelevant within the foreseeable future. Where genetic distinctions do arise in more stable locations, adaptation can happen on relatively short timescales (Waples et al. 2004), as is evidenced by introductions of Chinook salmon into novel habitats (Quinn et al. 2000, 2001; Narum et al. 2019).

In the GOA there is a genetic discontinuity at Cape Fairweather that is indicative of reproductive isolation or a pattern of active post-glaciation recolonization. Existing datasets consistently describe a deep separation between a "western" group, comprised of populations north and west of Cape Fairweather near the Alsek River (Western-Central GOA), and an "eastern" group, comprised of populations south and east of Cape Fairweather (Eastern GOA). Evidence for these groups is prominent in genetic data using allozymes (Gharrett et al. 1987), microsatellites (Beacham et al. 2006, Moran et al. 2013), and SNPs (Templin et al. 2011, ADF&G unpublished data). These groups are theoretically indicative of recolonization patterns post-glaciation in the Pleistocene. Though evidence for several refugia exists, two major refugia were likely: the Bering refuge in the north, and the Pacific refuge in the south (McPhail and Lindsey 1970, but see discussion in Moran et al. 2013). Martin et al. (2010) combined mitochondrial data with previously published patterns from microsatellite data and suggested that Chinook salmon spread into a northern refugium in the Bering Sea during an interglacial period late in the Pleistocene. Chinook salmon in the Bering refuge then survived subsequent glaciations and diverged from southern populations. This is the source of the Chinook that are in the process of resettling the western GOA.

The Eastern GOA group (Southeast Alaska; east of Cape Fairweather) includes populations from Chilkat River in northern Southeast Alaska south to the Keta and Blossom rivers in southern Southeast Alaska. This area is characterized by both large transmountain rivers (Taku and Stikine rivers) and shorter coastal systems. Though fish from this area are part of a lineage presumably recolonized from a southern refugia, the structure tends to be less hierarchical, and more shallow than other populations in the southern part of the range. This may be due to more recent colonization following deglaciation of the large ice fields in the mountainous headwaters of Southeast Alaska river systems and increased straying between proximate systems (ADF&G unpublished data). There appear to be genetic similarities with northern British Columbia populations, particularly in the Portland Canal area. One population, King Salmon River, stands out as genetically unique; this divergent population is small but heterozygosity and allelic richness measures indicate adequate diversity for population persistence (ADF&G unpublished data). While there are hatchery influences in this area, the influence on overall population structure is expected to be small; programs are designed to minimize impacts on wild stocks (McGee 2004; Heard 2012) and low stray rates have been detected (Pryor et al. 2009).

The Western-Central GOA group (west of Cape Fairweather) includes populations from the Chignik River in the east to the Alsek River. This area is characterized by a variety of habitat types, including large river systems and short coastal streams, and is influenced by rapidly changing geomorphology. These populations display a coastal continuum of isolation by distance and a hierarchical structure partitioned by major river systems. Within the Western-Central GOA group, there is divergence between populations (e.g., Chignik/Kodiak, Cook Inlet, Copper/Alsek), and diversity within regions (e.g., upper Copper River). However, it is unclear how these putative groups would individually contribute to the evolutionary legacy of the species.

Little information is available on morphology, behavior, or life history that distinguishes Chinook within the GOA. Habitat has similar patterns of structure and diversity across the GOA and potential groups share habitat types within this broad area. For example, within the entire GOA Chinook spawning occurs in both coastal rivers and large rivers that originate within or cross mountain ranges, in both glacially occluded and clear water, and in cool coastal forests and warm arid interior plains. Finally, as previously mentioned, the GOA landscape is very dynamic (e.g., Mann et al. 1998, Barclay et al. 2009), and has continued to experience the formation and removal of barriers to gene flow (via the active geological activity of earthquakes, tsunamis, volcanoes, and glacial advancement and retreat) and presumably much more recent subsequent colonization (e.g., Loso et al. 2021, Gubernick and Paustian 2007). Salmon abundances in the Gulf of Alaska have varied markedly even in the past century (e.g., Edfeldt 1973, Mann et al. 1998).

In summary, the geologically dynamic landscape with relatively recent deglaciation and colonization differentiates Alaska from the Pacific Northwest and a careful approach should be used to apply NMFS policy guidance developed for the Pacific Northwest, where the populations have far more life history diversity and deeper genetic diversity than the GOA. For example, the notion that likely more than one ESU exists in the GOA simply because the area is geographically broader than the size of ESUs in the Pacific Northwest presumes similarity between the two regions. Considering (1) the limited life history, ecological, and genetic diversity of GOA stocks, and (2) that geologic history, active disturbance regimes, and the climate limit the opportunity for population diversification through episodic displacement and recolonization, it is likely that only one ESU may exist, if any, in the GOA. One or no ESUs are consistent with congressional guidance to use DPSs sparingly (Senate Report 96-151). As we pointed out, there is a genetic discontinuity in the GOA with a Western-Central GOA group including populations in the Gulf of Alaska from the south Alaska Peninsula east to the Alsek River, and a second Eastern GOA group including populations in Southeast Alaska. While the genetic discontinuity between the groups is indicative of a level of reproductive isolation, it is not clear that these groups pass the second ESU criterion of contributing substantially to the ecological and genetic diversity of the species. While conclusions could be drawn to support additional ESU designations given the inherent subjectivity of NMFS policy guidance, the uncertainty of how these units are evolutionarily significant begs the question of whether they *should* be ESUs. Rather than focus on arguments leading to the designation of additional units, it may be more important to focus on conservation of a diverse array of populations within each comprehensive unit (Waples et al. 2001).

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APPENDIX B

February 13, 2024

Jon Kurland
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Re: Wild Fish Conservancy Petition to list wild Alaska Chinook Salmon under Endangered Species Act

Dear Mr. Kurland:

We have reviewed the Wild Fish Conservancy's January 11, 2024, *Petition to Designate Evolutionary Significant Units and List Alaskan Chinook Salmon under the Endangered Species Act* and have identified inconsistencies and factual errors. Accordingly, we provide the following comments.

The Conservancy's petition requests that NMFS initiate a status review of Chinook in "southern Alaska", a geographic region that they define as encompassing "all Chinook populations that enter the marine environment of the Gulf of Alaska (GOA)." The rationale for the petition is largely based on escapement performance of a limited suite of Chinook stocks and on perspectives from Pacific Northwest concepts of harvest, hatchery, and habitat management that have limited applicability to Alaska. Specifically, the Conservancy does not acknowledge or misrepresents Alaska's (1) escapement evaluation of Chinook stocks founded on the principles of sustained yield, (2) commercial and sport fishery harvest numbers, (3) hatchery practices, and (4) relatively pristine Chinook habitat throughout most of the population range.

Escapement Evaluation

The petition erroneously conflates stock performance relative to escapement goals with risk of extinction. Under the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP, 5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223), Alaska's policies for setting escapement goals and management objectives, escapement goals are set at levels of escapement that support sustained yield, well above levels for which a stock has consistently demonstrated its ability to sustain itself. This approach to management differs from that of the Pacific Northwest wherein a variety of methods and management objectives are used to set escapement targets including escapement floors, low abundance thresholds, upper management thresholds, management entity agreements (i.e., *U.S. v Oregon*), and sustained yield. Stocks listed as threatened under the ESA are managed under a ceiling exploitation rate relative to these escapement targets.

Alaska Chinook stocks are not at risk of extinction when they are listed as a Stock of Concern under the SSFP. ADF&G escapement goals are developed to attain maximum sustained yield from a stock. When a stock chronically fails to achieve these goals despite management action, the Board of Fisheries designates the stock as a stock of management concern and establishes an action plan to rebuild the stock to achieve sustainable levels of maximum yield. A failure to provide for yield does not mean a stock is at risk of extinction now or in the foreseeable future. Even the late run Kenai River Chinook salmon stock which is listed as a stock of management concern is returning over 12,000 chinook salmon annually, a level that does not put the stock at risk of becoming endangered.

While we agree that there was a general downward trend in Chinook salmon population abundances throughout most systems that enter the Gulf of Alaska (and range wide) beginning around 2007, the trend did not continue in all populations as asserted in the petition. Chinook population levels of most stocks have not continued to decline, and many appear to have stabilized at lower levels of productivity. As such, a number of Alaska Chinook populations have been listed as a Stock of Management Concern. A stock of Management Concern is defined as a stock which has demonstrated a "chronic inability, despite the use of specific management measures, to maintain escapements for a salmon stock within the bounds of the escapement goal or other specified management objectives for the fishery." To date there have been no Chinook populations in Alaska designated as a Stock of Conservation Concern, defined in the SSFP as a stock for which there is "a concern arising from a chronic inability, despite the use of specific management measures, to maintain escapements for a stock above a sustained escapement threshold (SET); a Conservation Concern is more severe than a Management Concern."

There are 31 Chinook salmon escapement goals currently monitored in Alaska in watersheds that drain into the Gulf of Alaska (Munro 2023)[1]. Yet the Conservancy chooses to focus on only 13 of these 31 Chinook stocks and portrays them as representative of all stocks in the petition's area of interest. In so doing, the petition omits the robust Copper River Chinook population s. Notably, the Conservancy omits any Chinook stocks that are not identified as a Stock of Management Concern as defined in the state's SSFP. It is unclear if those omissions were in error or deliberate because the abundance status and trends do not fit the narrative of declining Chinook populations which the petition is trying to assert.

As required by the SSFP, all Alaska Chinook populations designated as a Stock of Concern have an associated action plan with proscriptive management measures to address the low yields based on established escapement ranges. This is contrary to the Conservancy's claim that there are only action plans for "at least 7 of the 14" stocks of concern. If the Alaska Board of Fisheries designates a Stock of Concern, an action plan is adopted concurrently. The ADF&G is statutorily obligated to implement the action plans which typically involve a combination of fishery restrictions and new research.

Harvest

We reviewed the harvest information presented in Figures 1, 2, and 3 of the petition (note: there are two sets of figures in the report labeled Figures 1 to 3, here we refer to figures on pages 43-45). We were unable to reproduce these catch estimates using ADF&G catch databases. The commercial catch information in Figure 1 is inaccurate. Based on ADF&G data, commercial harvest of Chinook in the GOA from 2012-2021 ranged from 199,000 to 475,000 Chinook with an average harvest of 308,000 Chinook. By contrast, the Conservancy's commercial harvest

[1] Munro, A. R. 2023. Summary of Pacific salmon escapement goals in Alaska with a review of escapements from 2014 to 2022. Alaska Department of Fish and Game, Fishery Manuscript No. 23-01, Anchorage. https://www.adfg.alaska.gov/FedAidPDFs/FMS23-01.pdf

estimates, as interpolated from Figure 1, appear to range somewhere between 400,000 to well over a million fish for the same time period. Because the source data are not cited and the captions have scant detail relative to commercial catch, it was not possible to pinpoint the source of the discrepancies in the numbers provided. The only directed commercial Chinook fisheries in the area of interest are in SEAK and off the Copper River under prescribed management plans crafted to ensure sustainability. Though Chinook are also harvested commercially in fisheries targeting other salmon species, that harvest is minor in comparison to SEAK. If all commercial harvest of Chinook in Alaska are included, the number of fish would still not sum to the levels indicated in Figure 1.

The Conservancy's approach to catch accounting overestimates impacts. Sport harvest information presented in Figures 1 through 3 include catches from both kept and released fish. While this is noted in the figure captions, the inclusion of released fish inflates the estimates of "catch" and is therefore misleading; oddly, these numbers do not seem to account for released fish in commercial fisheries. The total impact, or what is commonly referred to as total mortality, associated with these catches would be significantly lower as a high proportion of released fish survive. The Chinook Technical Committee, per requirements under the 2019 Treaty Agreement was charged with recommending standards for estimating incidental mortality and uses 12.3% for fish greater than or equal to 33 cm and 32.2% for fish smaller than 33 cm for all sport fisheries (CTC 2022).[2] Total mortality, which is the sum of landed catch and incidental mortality, is the more appropriate metric to assess utilization where available. The Chinook Chapter of the Treaty is built upon a total mortality management framework and the Chinook Technical Committee is required to report annually on catches and incidental mortality for all Chinook fisheries and stocks harvested within the Treaty area. These are published in Appendix A of the Annual Report on Catches and Escapements (CTC 2023a)[3]. For the SEAK Chinook fishery, landed catch has averaged 240,000, incidental mortality has averaged 48,000, and total mortality has averaged 289,000 Treaty fish over the past decade (2012-2021; CTC 2023a Appendix A23-A25). Again, these fisheries account for the vast majority of Chinook caught in the area of interest (i.e., GOA), yet these estimates, which also include incidental mortality from commercial fisheries, represent less than half of the catches presented by the Conservancy in Figure 1.

It is also important to note that commercial and sport fisheries occurring in the marine waters of SEAK, Prince William Sound, Cook Inlet, and Kodiak are required to release any Chinook when escapement goals are not being met. Both sport and commercial fisheries are closed inriver and in the terminal areas in marine waters for any Chinook populations listed as a Stock of Concern.

Finally, ADF&G has the most robust assessment program for Chinook salmon harvest management on the Pacific coast. Our assessment program has annual operational plans and is reviewed annually. Our escapement goals are reviewed tri-annually in conjunction with the Board of Fisheries regulatory structure. Harvest management plans are also reviewed tri-annually and adjusted as needed by the Board of Fisheries. Finally, the Commissioner has Emergency Order authority to adjust or close fisheries to ensure for sustained yield as required under the State of Alaska Constitution.

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[2] Chinook Technical Committee. 2022. Review of the Uncertainty and Variance in Catch and Release Estimates of Chinook Salmon Fisheries. Pacific Salmon Commission, TCCHINOOK (22)-01. Vancouver BC.

[3] Chinook Technical Committee. 2023a. Annual Report on Catch and Escapement for 2022. Pacific Salmon Commission, Vancouver, BC. https://www.psc.org/publications/technical-reports/technical-committee-reports/chinook/

Hatchery Production

The Conservancy states that hatchery production in Alaska is having a negative effect on wild Chinook stocks based on studies in the Pacific Northwest showing impacts from increased competition and predation, transmission of disease, and reduction of the fitness and productivity of wild salmon populations through interbreeding and genetic introgression (HSRG 2014)[4]. In contrast, the Alaska salmon hatchery program was built upon lessons learned from the Pacific Northwest ensuring that precautionary plans, permits, and policies were in place to guide salmon enhancement in Alaska in a manner that protects wild stocks. These consist of rigorous permitting processes that include genetics, pathology, and fishery management reviews, policies that require hatcheries to be located away from significant wild stocks, use of local brood sources, laws that give priority to wild stocks in fisheries, provisions for marking of hatchery fish; and as necessary, requirements for special studies on hatchery/wild stock interactions. Over 157 million Chinook smolt are released annually in Washington, Oregon, and Idaho with many releases occurring in freshwater. In Alaska, Chinook hatchery production levels are relatively small, with roughly 10 million smolts released annually on average. The vast majority of Alaska's hatchery production is released in saltwater with limited freshwater releases in some Cook Inlet tributaries to provide sport fishing opportunities. This is counter to the petition's assertion on page 46 that Alaska's wild fish are at risk because "out planting of juvenile and adult fish can transfer disease upstream of the rearing site." Such practices are not permitted in Alaska salmon hatchery production. Alaska hatchery practices prohibit the introduction of diseases to salmon systems, or the amplification of existing diseases already present in streams.

Habitat

The Conservancy asserts that the primary threats are logging, roads, mining, pollutants, and other habitat degradation. While this list of threats may be common in the Pacific Northwest, habitat degradation is much less pervasive and widespread in Alaska owing to the remoteness and ruggedness of the Alaskan landscape and low population density. With the exception of the Chilkat River and some watersheds in Cook Inlet where there has been some limited road access and infrastructure development, the majority of freshwater spawning and rearing habitat for Chinook is roadless and considered intact. In most cases, habitat is pristine, with a large proportion protected within the boundaries of state and federal parks, preserves, and refuges. There are limited impacts from mining which mostly are small scale operations in the Chilkat watershed and some larger-scale operations in the upper portions of transboundary rivers in Canada. Logging is not a dominant land use practice except in parts of SEAK, though mainland watersheds are too mountainous to allow for logging, except some limited activity in the Chilkat River drainage. Despite having a level of natural resource development, the habitat in Chinook bearing river systems is generally high quality. This contrasts with Pacific Northwest Chinook populations which contend with dams impeding passage and forming reservoirs that increase water temperatures, land clearing and diking for agriculture, water withdrawal for irrigation, water diversions and migration barriers, and extensive road networks that straighten streams, alter floodplains, increase stream temperature, increase fine sediment, reduce levels of stream complexity, concentrate tire chemicals, and alter watershed hydrology. These habitat degrading factors are not present in Alaska to the extent that they are in the Pacific Northwest, and we are not aware of any studies documenting habitat degradation as a major negative pressure on Chinook salmon stocks in Alaska.

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[4] Hatchery Scientific Review Group (HSRG). 2014. On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest. A. Appleby, H.L. Blankenship, D. Campton, K. Currens, T. Evelyn, D. Fast, T. Flagg, J. Gislason, P. Kline, C. Mahnken, B. Missildine, L. Mobrand, G. Nandor, P. Paquet, S. Patterson, L. Seeb, S. Smith, and K. Warheit. June 2014; revised October 2014.

Miscellaneous Errors

Here we present a non-exhaustive list of errors and oversights.

- The petition asserts that fishery related incidental mortality (FRIM) is not accounted for in stock assessment of several SEAK rivers (Unuk, Stikine, Andrew, Chilkat, Alsek), when it is. These stocks are managed under the terms and provisions of the Pacific Salmon Treaty. While stock-specific total mortality is difficult to determine, each of the fisheries that are listed in the petition as not calculating FRIM have incidental mortality estimated by the Pacific Salmon Commission's Chinook Technical Committee that is reported in the annual Exploitation Rate Analysis report (CTC 2023b)[5].

- In the discussion of the Chickamin River, the petition wrongly cites McKinley et al. 2022 to discuss genetic baseline performance for Chinook in Alaska. This report is an escapement goal review report and is not listed in the references cited, though McKinley et al. 2019 is, which is a Kodiak escapement goal review report.

- The petition's reasoning that "the genetic identifiability of Chinook populations in the south-southeast region due to the source of local wild populations as hatchery broodstock significantly compounds the ability of managers to identify harvest impacts of southeast Alaska fisheries on population of management/conservation concern," is inaccurate. The genetic mixed stock analysis of Chinook in SEAK in Shedd et al. 2021[6], which is cited but also missing from references, is not the primary mechanism used to identify Chinook stocks in SEAK fisheries which are managed under the Pacific Salmon Treaty. Estimates of stock composition in Treaty fisheries are based on coded-wire tag (CWT) recoveries of indicator stocks. High sampling rates in Alaska, far in excess of the 20% coast-wide standard, provide precise harvest rate estimates, even for small Chinook stocks.

- In the petition's discussion of the Chilkat River, the river's name is incorrectly spelled "Chilcat" several times and is also confused with the Chignik River system which is on the opposite side of the GOA.

- The Chignik River system is referred to as a southern Aleutian Islands system. Chignik River is on the south side of the Alaska Peninsula and is several hundred miles from the Aleutian Islands. It is the furthest west known spawning stock of Chinook in the GOA. The petition also cites the Chignik Chinook escapement goal as pertaining to only large Chinook, however, that goal applies to Chinook salmon of all sizes. This is further evidence that they have conflated Chignik with Chilkat River escapement goal which is based on large fish.

- The petition duplicates several figures and uses date ranges that are inconsistent among figures. Figures 1, 4, and 6 are duplicated in the petition. The figures for Kenai River early- and late-run Chinook escapement are shown at the end of the petition without any supporting language in the text. Some figures go through 2022, while others only have information until 2019 often excluding recent years in which escapement goals were achieved. Table 1 lists escapement from 2014 to 2021.

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[5] Chinook Technical Committee. 2023b. 2023 Exploitation Rate Analysis. Pacific Salmon Commission Joint Technical Committee Report TCCHINOOK (23)-06. Vancouver, BC.

[6] Shedd, K. R., D. F. Evenson, and J. V. Nichols. 2021. Mixed stock analysis of Chinook salmon harvested in Southeast Alaska commercial troll and sport fisheries, 2017. Alaska Department of Fish and Game, Fishery Data Series No. 21-02, Anchorage.

In summary, the Conservancy's petition to list Alaska Chinook as threatened or endangered under the ESA and to designate critical habitat contains significant factual errors, omits important data that is widely available, and does not accurately describe the status of Chinook salmon in "southern Alaska." For additional detail about the status and management of Chinook salmon in this area, we refer you to the document ADF&G provided to NOAA Fisheries in July 2023 titled "Overview of Alaska Chinook Salmon Stock Status, Management, Policies, and Regulations."

The purpose of this letter is to provide NMFS the above factual information to ensure NMFS is aware of the errors and inconsistencies in the petition. While it is outside the purview of what NMFS will consider in reviewing the petition, the Department does not think the petition provides sufficient information to meet a positive 90-day finding under the ESA. In addition, the Department does not think the best available science justifies a listing of Chinook salmon in the Gulf of Alaska under the ESA.

Sincerely,

Doug Vincent-Lang
Commissioner

Cc: Anne Marie Eich—Assistant Regional Administrator for Protected Resources, NMFS Alaska Region
Robert Foy—Director, NMFS Alaska Fisheries Science Center

APPENDIX C

Overview of Alaska Chinook Salmon Stock Status, Management, Policies, and Regulations

Alaska Department of Fish and Game
July 10, 2023

INTRODUCTION

When Alaska assumed management authority of its salmon fisheries in 1960, one year after statehood, many of the state's salmon runs were depressed and its salmon fisheries were in desperate shape. The lack of self-rule in salmon management and the influence of the major lower-48 canning companies on federal management were primary driving forces in Alaska for statehood (Clark et al. 2006). Alaska's first Governor, William Egan, stated in 1960 that the newly created Department of Fish and Game "was handed the depleted remnant of what was once a rich and prolific fishery."

Upon statehood, conservative management actions were implemented across the state to bolster escapements and provide for the long-term sustainability of the resource. Among those actions, two of the most fundamental were 1) decentralizing management and placing fishery managers and biologists in the communities affected by their decisions; and 2) placing spawning escapement at the center of salmon fisheries management and decision making. Over the 63-year history of state management, these once depleted salmon fisheries have been rebuilt into one of the strongest and most sustainable fishery resources in the world.

After a period of higher productivity, Chinook salmon populations in Alaska and across the North Pacific have been declining. In Alaska this has resulted in conservative management actions that decreased harvest opportunity on some stocks when escapement fell below sustained-yield targets. Freshwater habitat is relatively pristine for most major Chinook-producing watersheds in Alaska, with most being roadless or having limited road access. In contrast to the Pacific Northwest where there are a myriad of anthropogenic habitat impacts ranging from road construction along all major rivers, dams, water withdrawals for agriculture and municipal use, intensive logging, industrial development, pollution, and toxins, Alaska's freshwater and marine habitats remain largely intact. Consequently, changing marine conditions are widely believed to be the primary driver behind reduced Chinook salmon productivity in recent years. Despite recent downward trends, Chinook salmon populations remain robust enough to provide for the long-term sustained yield of the resource and populations are expected to rebound once ocean conditions become more favorable.

In this document, we provide an overview of how Chinook salmon are managed across the state and focus on stocks in Southeast, Southwest, and Western Alaska. We review the policies, plans, and regulatory structure that provide a precautionary approach in the face of uncertainty such that salmon stocks, fisheries, artificial propagation, and essential habitats are managed conservatively.

In Section 1, we provide a statewide overview of salmon fishery management, the regulatory structure, salmon assessment, and the hatchery program.

In Sections 2 through 8, we provide regional summaries for Southeast Alaska, Copper River, Cook Inlet, Nushagak River, Kuskokwim River, Yukon River, and Norton Sound. These summaries include geographic overviews, stock and fishery assessment, stock status, fishery management, and regulatory changes.

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Statewide Salmon Fishery Policies, Procedures, and Programs

Salmon Fishery Management

Authority for the management of salmon fisheries in Alaska was granted to the state at statehood and was vested with the Alaska Department of Fish and Game (ADF&G, department). The State of Alaska manages all salmon stocks based on the sustained yield principle as promulgated in Article VIII, Section 4 of the Alaska Constitution and in state statute (AS 16.05.020). Also inherent to Alaska's management of salmon is the constitutional objective of developing natural resources to maximize long term and sustainable benefits for Alaskans.

After statehood, Alaska adopted an escapement-based approach to management that stipulated the development and use of spawning escapement goals as the primary management targets for major stocks of salmon. Scientifically defensible Pacific salmon escapement goals are founded on the sustained yield principle. This approach prioritizes the achievement of salmon spawning escapements that will sustain yields into the future over all other uses of salmon, including harvests. Management of salmon stocks for escapement goals, while central to sustaining yields in the long term, at times does require actions that greatly curtail and sometimes prohibit all harvesting activities, especially during times of low salmon productivity and abundance.

Formally adopted in 2000, the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222) includes in regulation the principles and practices already in place. It calls for a precautionary approach in the face of uncertainty such that salmon stocks, fisheries, artificial propagation, and essential habitats are managed conservatively (5 AAC 39.222(c)(5)). Other policies in the Alaska Administrative Code also provide guidance for establishing escapement goals and management decisions, including the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223), the *Policy for the Management of Mixed Stock Fisheries* (5 AAC 39.220), and local fishery management plans (5 AAC 39.200).

An overview and history of the development of the existing management structures for salmon fishing in Alaska can be found in Clark et al. (2006). An overview of escapement goal development and processes can be found in the oral presentations to the Alaska Board of Fisheries (Templin and Hasbrouck 2017; Templin et al. 2021).

Alaska Board of Fisheries

The Alaska Board of Fisheries (board) is the state's regulatory authority that passes regulations to conserve and develop Alaska's fisheries resources and is charged with making allocative and regulatory decisions. The board consists of seven members serving three-year terms. Members are appointed by the governor and confirmed by the legislature. Members are appointed on the basis of interest in public affairs, good judgment, knowledge, and ability in the field of action of the board, with a view to providing diversity of interest and points of view in the membership (see Alaska Statute 16.05.221).

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The Board of Fisheries' responsibilities involve setting seasons, bag limits, methods and means for the state's subsistence, commercial, sport, guided sport, and personal use fisheries, and it also involves setting policy and direction for the management of the state's fishery resources. The board is charged with making allocative decisions, and the department is responsible for management based on those decisions.

The board has a three-year meeting cycle (see below), and generally holds meetings from October through March – meeting four to six times per year in communities around the state to consider proposed changes to fisheries regulations. The board uses biological and socioeconomic information provided by ADF&G, public comment received from people inside and outside of the state, and guidance from the Alaska Department of Public Safety and Alaska Department of Law when creating regulations that are sound and enforceable. More information on this process is available on the Board of Fisheries webpage and in the handout (ADF&G BOF Process).

Salmon Assessment

Escapement goals

The fisheries management policies provide detailed definitions of specific escapement goal types, outline the responsibilities of ADF&G and the Alaska Board of Fisheries in establishing escapement goals, and provide general direction for development and application of escapement goals in Alaska. Currently, there are 264 active salmon stock escapement goals throughout the State of Alaska (Munro and Brenner 2022).

Formal definitions of escapement goal types can be found in the *Policy for the Management of Sustainable Salmon Fisheries*. The biological escapement goal (BEG) is the escapement that provides the greatest potential for maximum sustained yield (MSY). The BEG is the primary fishery management objective in the absence of any allocative factors and is developed from and scientifically defensible based on the best available biological information. The BEG is always specified as a range. The sustainable escapement goal (SEG) is the escapement known to provide for sustained yield over a 5 to 10-year period and is used in situations where a BEG cannot be estimated or managed for. The SEG is the primary fishery management objective in the absence of any allocative factors and is developed from and scientifically defensible based on the best available biological information. The SEG can be a range or a lower bound. In addition, the board may establish an optimal escapement goal (OEG) or inriver run goal for a given stock and are allocative in nature to meet specific management objectives determined by the board.

The policy also defines the sustained escapement threshold (SET) as a threshold level of escapement, below which the ability of the salmon stock to sustain itself is jeopardized. The SET, therefore, does not represent any kind of escapement goal. Because escapement goals are set to provide for sustainable harvest, the SET is by definition lower than the lower bound of the BEG or SEG. No SET has been set for any salmon stock in Alaska, but if determined to be necessary SETs are established by the department in consultation with the board as needed for stocks of management or conservation concern (Clark and Volk 2013).

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It is the responsibility of ADF&G to document, establish, and review escapement goals; prepare scientific analyses in support of escapement goals; notify the public when escapement goals are established or modified; and notify the board of allocative implications associated with escapement goals. The foundation for this effort is the regional or area escapement goal review teams that are assembled every 3 years for each area to review goals, recommend changes, establish new goals, or eliminate goals. These teams have broad expertise in biological characteristics of salmon stocks and technical approaches for establishing escapement goals. A detailed regional report of escapement goal recommendations is presented to the board and the public at triennial board meetings for that region or area. Following the board meeting, recommended goals are presented to the directors of the Divisions of Commercial Fisheries and Sport Fish for approval.

A statewide summary report is assembled each year to compile escapement goals and performance in a single document as a resource for ADF&G staff, stakeholders, and the public. It provides an overview of salmon stocks with escapement goals and includes the following for each: a numerical description of the escapement goal, the type of escapement goal, the year in which the current escapement goal was first implemented, and recent years' escapement data for each stock. In addition, statistics documenting achievement of escapement goals is summarized and presented, and a statewide summary of stocks of concern, as recommended by ADF&G and established by the board, is included. Information on specific methods used to enumerate and develop escapement goals, and associated references with detailed information for each escapement goal, are also provided. Data presented in this document are the most recently available at the time of publication and supersede data in previous annual statewide escapement reports. The most recent report is Munro and Brenner (2022).

Stocks of Concern

Where escapements chronically (over a 4 to 5-year period) fail to meet expectations for harvestable yield or spawning escapements, ADF&G may recommend–and the board may adopt–a stock of concern (SOC) designation for those underperforming salmon stocks. The *Policy for the Management of Sustainable Salmon Fisheries* provides definitions for types of stock of concern designation as well as a definition for "chronic inability". Yield concerns arise from a chronic inability to maintain expected yields or harvestable surpluses above escapement needs. Management concerns are precipitated by a chronic failure to maintain escapements within the bounds, or above the lower bound of the established goal. A conservation concern may arise from a failure to maintain escapements above an SET (see above). To date, the board has not established any stocks of conservation concern. A list of current SOCs can be found on the department's website and in Munro and Brenner (2022). A history and review of the SOC process was provided to the board at the October 2017 Work Session as both an oral presentation (Hasbrouck and Templin 2017) and a written memo (ADF&G 2017).

The board and department work together in a defined process to determine if a salmon stock meets criteria as a stock of concern. As part of the escapement goal review that occurs for a regulatory area during a board meeting cycle, the department reviews escapements, annual harvests, and other data relative to stock of concern designation. The department presents a memo at the board Work Session held annually in October to inform the board of any stocks within the regulatory area that appear to meet criteria for stock of concern designation, with a recommendation that the board discuss this designation at their regulatory meeting. Upon request, ADF&G will draft an action plan for the board to consider at their regulatory meeting. An action plan generally describes stock status, trends in escapement and harvest, and other factors that potentially impact stock production and/or harvest levels (e.g., changes to fish habitat, expanding and/or new fisheries). The plan also outlines options the board may wish to discuss to implement regulatory action – or action the department intends to take – that will affect management of fisheries, and options the department could or will undertake to improve stock assessment and/or habitat. In addition, the action plan provides criteria that should be met before the department recommends delisting of a stock to the board. After a stock is designated a stock of concern and actions are implemented, the department reviews the status of the stocks of concern during their triennial review. If actions proved successful and a stock no longer meets the criteria for a stock of concern designation, the department will recommend delisting of that particular stock; otherwise, the department will recommend continued listing or change in level of concern.

Hatchery program

From its inception in the 1970s, Alaska's enhancement program has been designed to protect wild salmon stocks (McGee 2004) based on review of the practices and results of salmon enhancement programs that existed elsewhere and the Alaska enhancement program is planned in a manner that minimizes risk to wild populations. Accordingly, ADF&G worked with a broad consortium of expertise at other regulatory agencies, veterans of Pacific Northwest hatcheries, the University of Alaska, and fishermen's associations to formulate guidelines and policies for the hatchery programs in the mid-1970s–1980s (reviewed in McGee 2004). In Alaska, the state constitution requires natural resources to be managed sustainably (Article VIII, Section 4). A framework of statutes, regulations, and policies has been developed to guide the growth of the Alaska hatchery program with the intent to minimize risk to wild stocks (McGee 2004, Evenson et al. 2018). A good overview of the salmon hatchery program in Alaska statewide can be found in Wilson (2023) and for Southeast Alaska in Heard (2011).

ADF&G recognized the need to minimize the effects that enhancement could have on wild stocks and adopted standards with respect to hatchery location, genetic and disease policies, culture techniques, monitoring, data collection, and management. For example, hatcheries generally use stocks taken from close proximity so that any straying of hatchery returns will have similar genetic makeup as the stocks from nearby streams. Alaska hatcheries do not selectively breed salmon. Large numbers of broodstock are used for gamete collection to maintain genetic diversity, without regard to size or other characteristics.

Detailed planning and permitting processes for salmon hatcheries ensure adherence to sustainable fisheries management, genetic, and fish health and disease policies (AS 16.10-375–16.10.480; 5 AAC 40.005–40.990; Fish Transport permits 5 AAC 41.001–41.090). Additional guidance is provided by:

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1. *Policy for the Management of Sustainable Salmon Fisheries. (*5 AAC 39.222). Formally adopted in 2000, the SSFP incorporates into regulation the principles and practices already in place. The regulation calls for a precautionary approach in the face of uncertainty such that salmon stocks, fisheries, artificial propagation, and essential habitats are managed conservatively (5 AAC 39.222(c)(5)).
2. *Genetic Policy*. The *ADF&G Genetic Policy* (Davis et al. 1985) sets out restrictions and guidelines for stock transport, protection of wild stocks, and maintenance of genetic variance. This policy and other relevant information are used by ADF&G geneticists when they review requests for hatchery-related permits as well as the use and transportation of live fish within the State of Alaska.
3. *Fish Health and Disease Policy*. The *Alaska Fish Health and Disease Control Policy* (5 AAC 41.080) is designed to protect fish health and prevent spread of infectious disease in fish and shellfish. The policy is used by ADF&G fish pathologists to review hatchery plans and permits. The policy and associated guidelines are discussed in Policies and Guidelines for Alaska Fish and Shellfish Health and Disease Control (Meyers 2014), which includes policy guidelines for FTPs, broodstock screening, disease histories, and transfers between hatcheries. These regulations and guidelines are used by ADF&G fish pathologists when they review hatchery permits.

Relative to Chinook salmon, hatchery production levels are relatively small in Alaska with 10 million smolts released annually on average. The vast majority of that production is released in saltwater in Southeast Alaska, with limited freshwater releases in some Cook Inlet tributaries to provide sport fishing opportunity. In contrast, over 170 million are released annually in Washington, Oregon, and British Columbia with the majority of releases occurring in freshwater and most for the purposes of conservation and mitigation.

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Policy for statewide salmon escapement goals, [EGP] 5 AAC 39.223
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Southeast Alaska Chinook Salmon

In Southeast Alaska (SEAK), there are 34 known stocks of Chinook salmon and escapement is estimated annually for 11 of these stocks (Situk, Alsek, Chilkat, Taku, King Salmon, Stikine, Unuk, Chickamin, Blossom, and Keta rivers and Andrew Creek) that serve as ADF&G escapement indicator stocks. These 11 escapement indicator stocks represent roughly 85% of the assumed total Chinook salmon production in SEAK and the transboundary rivers (TBR). Stock-specific information for these 11 stocks, including current and historical escapements, escapement goals, and stock status can be found in Appendix A of Heinl et al. 2021.

Most of these rivers are glacially influenced and have pristine or relatively pristine habitat owing to being both remote and roadless. The Situk River is surrounded by old growth spruce and hemlock with limited road access and is among the most productive steelhead habitat in Alaska. The Alsek River habitat is considered pristine it originates in Kluane National Park and Preserve in Yukon Territory and flows through the glaciated valleys of the St. Elias Mountains and empties into Glacier Bay National Park and Preserve. The entire length of the Alsek River falls within the Kluane / Wrangell–St. Elias / Glacier Bay / Tashenshini–Alsek UNESCO World Heritage Site. Similarly, the Unuk, Chickamin, Blossom and Keta rivers are within the Misty Fjords National Monument and the King Salmon River is within the Admiralty Island National Monument and the Kootznoowoo Wilderness Area, all of which provide habitat protection. In the Unuk River, there is some exploratory mining work in the British Columbia portion of the drainage, though terrestrial and aquatic habitat remains pristine at this point in time. In the Taku River, mining activities have occurred in various areas in the Canadian portions of the drainage and exploratory work is ongoing in some tributaries. The Tulsequah Chief, Big Bull, and Polaris mine operations near the U.S./Canada border appear dormant and abandoned; however, the Tulsequah Chief mine site continues releasing small amounts of acid mine drainage into the Tulsequah River about 10 km upstream of the confluence with the Taku River. The Stikine River is relatively pristine with road access at Telegraph Creek, though historical mining activities have occurred in the upper Canadian portion of the drainage and the Red Chris mine is currently active. The largest habitat impacts have resulted from naturally-occurring landslides in the Tahltan River, the Stikine River tributary with largest Chinook and sockeye production (Salomone et al. 2022).

Unlike most other large mainland watersheds in SEAK, the Chilkat River watershed has substantial road access and proximity to a population center with associated infrastructure. As such, the risk of negative anthropomorphic impacts is higher in the Chilkat River mainstem than in other remote salmon producing watersheds. The watershed contains over 300 km of roads, a large portion of which are near the Chilkat River mainstem, including some major tributaries used by Chinook salmon for spawning, rearing, or migration. The roads cross several anadromous tributaries of the Chilkat River, which have the potential to obstruct or hinder fish passage, although Chinook salmon are likely the least impacted salmonid given their preferred habitat and the location of such crossings. Iron, gold, copper, platinum, and palladium deposits exist within the Chilkat River watershed. Placer mining is ongoing in the Porcupine Creek mining district. Exploration of a volcanogenic massive sulfide deposit is underway in a tributary of the Klehini

River. The Haines State Forest includes the sub-basins of some of the major tributaries to the Chilkat River. About 15% of the state forest is dedicated to timber harvest, which has occurred since the 1960s. Timber operations on state lands follow *Standards and Guidelines* and *Best Management Practices* established in the Forest Resources Practices Act, which are designed to minimize impacts on fish habitat. While historical timber harvest in the watershed potentially occurred in less restrictive settings, all planned timber harvest in future years should have minimal impacts on anadromous fish. A portion of the Alaska Chilkat Bald Eagle Preserve surrounds the Chilkat River and its tributaries upstream of Haines Highway milepost 8 and contains the drainage's waterways and riparian lowlands which provide essential habitat for Chinook salmon juvenile rearing, emigrating smolt corridors, immigrating adult corridors, and spawning areas (Hagerman et al. 2022).

Southeast Stock and Fishery Assessment Overview

In 1981, ADF&G established a 15-year rebuilding program which included developing interim point escapement goals for the SEAK/TBR Chinook salmon indicator stocks based on the highest observed escapement count prior to 1981. Since then, more rigorous escapement goal analyses have been adopted and used for management, based on the State of Alaska *Policy for Statewide Salmon Escapement Goals* and *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222 and 39.223). Each of these stocks was also reviewed and accepted by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission and Fisheries and Oceans Canada Centre for Science Advice Pacific. Escapement goals for the three Transboundary River (TBR) stocks (Alsek, Taku, and Stikine rivers) were also reviewed by the TBR Technical Committee and accepted by the TBR Panel of the Pacific Salmon Commission.

Currently, 6 of the 11 ADF&G indicator stocks also serve as CTC escapement indicator stocks (Situk, Alsek, Chilkat, Taku, Stikine, and Unuk rivers). Information on the status of these stocks can be found in the CTC Annual Report on Catch and Escapement (e.g., CTC 2023).

The 11 ADF&G indicator stocks are monitored annually, and escapement is enumerated using weirs across the Klukshu River, which serves as an index of escapement for the Alsek River stock, and the Situk River. A mark–recapture study is also used to estimate the drainage-wide escapement for the Alsek River stock and mark–recapture studies are also used to estimate the drainage-wide escapement in the Chilkat, Taku, and Stikine rivers. Observer counts of escapement are undertaken for stocks from the Taku, King Salmon, Unuk, Chickamin, Blossom, and Keta rivers and Andrew Creek.

Escapement estimates are germane to large fish (i.e., Chinook salmon ≥660 mm mid-eye to fork of tail length) for all indicators except Alsek River, which in most systems include fish age-1.3 (i.e., 5-year-old)[1] and older. In SEAK, nearly all female Chinook salmon are age-1.3 and older, whereas younger Chinook salmon (age-1.1 and age-1.2 fish) are predominantly precocious males or

[1] European salmon age notation where number of years in freshwater precedes a decimal and the number years of marine growth follows a decimal (1.3 = one winter in fresh water and three winters in salt water). The total age of the fish is 5, due to the winter spent in the gravel prior to emergence as fry.

"jacks". To provide for quality escapement (i.e., females), escapement goals are based on older and larger fish.

Four of the indicator stocks (Chilkat, Taku, Stikine and Unuk rivers) have full stock assessment programs in place, which include juvenile marking with adipose fin-clips and tagging with coded-wire tags (CWT). These programs allow estimates of smolt abundance and marine harvest, respectively, by gear, area, and time in mixed-stock commercial and sport fisheries. These data, when paired with spawning abundance and age, sex, and length composition estimates, allow for estimates of marine (smolt-to-adult) survival, total return, and exploitation rates. These data are presented in the Chinook Technical Committee Annual Report on Catch and Escapement (i.e., CTC 2023).

Based on CWT recoveries, SEAK/TBR stocks are classified into two categories of ocean migration patterns: inside rearing and outside-rearing. Inside-rearing stocks include those vulnerable to SEAK fisheries as immature fish, as well as mature, migrating fish, and include stocks returning to the Chilkat, King Salmon, Unuk, Chickamin, Blossom, and Keta rivers and Andrew Creek. Outside-rearing stocks, sometimes referred to as "far north migrating stocks," have limited marine rearing time in SEAK and are harvested primarily during their spawning migrations through marine waters in the spring and summer, and includes stocks returning to the Situk, Alsek, Taku, and Stikine rivers.

Chinook salmon originating from SEAK rivers, TBR rivers, and SEAK hatcheries are harvested throughout SEAK in the commercial troll, net, and sport fisheries, along with stocks originating outside of Alaska (Peterson et al. 2021). Catch composition is assessed in commercial and sport fisheries via a port sampling program. The purpose of port sampling is to collect biological samples and fishery performance data from annual salmon harvests in the Southeast Alaska Management Area. Chinook salmon fisheries are sampled for coded wire tags at a minimum rate of 20% of the total harvest stratified by gear, fishing area, and statistical week. Information collected through port sampling is used by fishery managers and research biologists to manage fisheries, analyze stock contributions, create brood tables, generate run forecasts, determine migratory patterns and routes, determine size-at-age relationships, and fulfill international harvest sharing agreements outlined in the Pacific Salmon Treaty. Port samplers collect scale, otolith, and genetic stock identification (GSI) samples and coded wire tag (CWT) information, which are used to estimate stock composition and contribution. Fishery performance data are collected from troll permit holders weekly to estimate catch per unit of effort (CPUE) inseason. Sampling objectives for all salmon species and gear groups are reviewed for each fishery prior to the start of the summer season. Peterson et al. 2021 provides details on catch of SEAK and TBR wild stocks in Southeast Alaska fisheries.

Southeast Fisheries Management

The SEAK Chinook salmon fishery is managed to provide for the long-term sustainability of Southeast Alaska wild stocks and consistent with the terms and conditions of the Pacific Salmon Treaty (PST, Treaty). The Treaty requires that ADF&G stay within the annual catch limit established by the Pacific Salmon Commission, manage to achieve escapement goals for six SEAK and TBR river wild stocks, and to not exceed a 59,400 limit on incidental mortality. Management plans established by the Alaska Board of Fisheries allocate the Treaty catch limit among gear types and prescribe management measures for both commercial and sport fisheries [5AAC 29.060(b) and 47.055].

Under provisions of domestic regulatory action plans to conserve SEAK and TBR wild Chinook salmon stocks, ADF&G was given direction in 2022 by the board, through emergency order authority, to take management actions necessary to provide conservation for SEAK and TBR wild Chinook salmon stocks while continuing to identify harvest opportunities that maintain conservation of these stocks. These management actions are informed by data collected through various research projects and fisheries dependent information including inseason monitoring of Chinook returns, sampling harvest for the recovery of coded-wire tags and genetic stock identification (Peterson et al. 2021), and harvest accountability by fishery, time, and location. This allows the effectiveness of management actions to be monitored and adapted to conserve SEAK and TBR wild Chinook stocks by adjusting harvest opportunities in time and location.

The conservation measures for all gear types that were implemented during 2018–2022 are being continued for the 2023 season. Spring troll fisheries have been restricted to near terminal areas or areas on the outside coast, and summer troll fishery primary corridors and waters directly adjacent to the terminus of the Unuk, Chilkat, and Stikine rivers have been closed to the retention of Chinook salmon. Retention of Chinook salmon in the purse seine fishery outside designated terminal harvest areas has been delayed until July 24. Drift gillnet fisheries in Districts 106 and 108 (near the mouth of the Stikine River) have been delayed to the latter part of June. Drift gillnet fisheries in Districts 111 and 115 (near the mouths of the Taku and Chilkat rivers) have been subject to time, area, and gear restrictions through mid-July. Openings in terminal harvest areas were delayed until June. Similarly, sport fisheries throughout the inside waters of SEAK have been delayed until mid-June with longer periods of nonretention in terminal areas of the Unuk, Chilkat, Taku, and Stikine rivers. In addition to these conservation measures, all fisheries have been and continue to be managed conservatively and monitored closely inseason to avoid exceeding the harvest level defined in the 2019 PST Agreement. In concert, these restrictive management measures have reduced harvest rates on SEAK and TBR wild stocks considerably. Detail is provided in annual management plans (e.g., Hagerman and Vaughn 2022a and 2022b, Thynes et al. 2022a and 2022b, Hoffman 2022, and Sport Fish King Salmon Management Plan (5 AAC 47.055)), Annual Management Reports (Thynes et al. 2022c, Conrad and Thynes 2022, Hagerman et al. 2021 and Fowler et al. 2021) and actions plans (Hagerman et al. 2022, Salomone et al. 2022, and Meredith et al. 2022) for details.

Southeast Stock Status

Available run information indicates that substantial declines were first fully detected in 2007 from a decline in productivity that persists today. Similar long-term periods of poor production have happened historically and rebuilt through conservative management measures; available information suggests that the last significant period occurred in the 1970s and anecdotally the 1960s. Similar conservative management measures have been in place for at least the past five years to bolster escapements and provide for the long-term sustained yield of these stocks.

APPENDIX C

Situk River

The Situk River is a non-glacial system near Yakutat, Alaska that supports an outside-rearing stock. Most harvest of Situk-origin Chinook salmon occurs in a commercial fishery, which operates in the estuary and nearby marine waters, and in sport and subsistence fisheries located in-river, in the estuary, and in nearby marine waters. These fisheries are prosecuted under a State of Alaska management plan (Situk-Ahrnklin Inlet and Lost River King Salmon Management Plan (5 AAC 30.365)) to achieve escapements within the escapement goal range. Calendar year exploitation rates averaged 10%, ranging from 0% to 30% since 2012.

Chinook salmon begin entering the Situk River in early June and are mostly inriver by mid-August with peak spawning occurring in early August. Escapement of large spawners (> 659 mid-eye to fork of tail in length) is enumerated through a weir placed across the lower river just above tidal influence. The escapement estimate subtracts any sport and subsistence harvest that might occur above the weir. Sport harvest is estimated with an inseason creel survey and a postseason mail-out survey; subsistence harvest is enumerated using a subsistence permit reporting program. The weir was operated from 1928 to 1955 and continuously since 1976. An escapement goal was initially put in place in 1991 and the current escapement goal was established in 2003, with a range of 450 to 1,050 fish. Inseason management of this stock is based on weekly run estimates and projections of total run using historical run timing.

Productivity of the Situk River stock has generally been low since 2007 and escapements have been below the lower bound of the escapement goal range 8 of the most recent 16 years. However, escapements have improved recently, and the lower bound of the escapement goal has been attained in 4 out of the most recent 5 years. From 1990 to 2016, calendar year harvest rates averaged 41%. In response to poor production and escapement performance, conservative management actions have been in place since 2017 and harvest rates have dropped to an average of 2%.

Alsek River

The Alsek River is a large glacial system that originates in the southwestern Yukon Territory and northwestern British Columbia, Canada, and flows into the Gulf of Alaska about 50 miles east of Yakutat, Alaska. This river supports a run of outside-rearing Chinook salmon. Escapement estimates are germane to age-1.2 fish (4-year-old) and older and harvests occur predominantly in the Alaska commercial fishery in Dry Bay and in Aboriginal fisheries in the upper watershed in Canada. Some fish are also harvested in sport fisheries in each country.

Chinook salmon begin entering the Alsek River in early May and are mostly inriver by mid-July with peak spawning in early August. Since 1976, escapements have been monitored using a weir on the Klukshu River, one of 51 tributaries of the Tatshenshini River, the principal salmon-producing tributary of the Alsek River. Counts of returning age-1.2 (4-year-old) and older fish have been collected from 1976 to present. Concurrent with the weir counts, Alsek River drainage-wide mark-recapture escapement estimates were generated from 1998 to 2004 through a cooperative effort among the Champagne and Aishihik First Nations, Fisheries and Oceans

Canada (DFO), and ADF&G. Total drainage-wide inriver run is estimated by adding the above border inriver run plus any U.S. harvests. The mark-recapture program was reinstated in 2022 with a plan to run studies annually into the near future. Spawner-recruit analysis in 2010 resulted in a drainage-wide escapement goal of 3,500 to 5,300 age-1.2 and older fish. The previous goal was based solely on the Klukshu River stock. Inseason management of this stock is based on the weekly CPUE gathered in the Alaska Dry Bay commercial fishery and comparisons to historical CPUE and final estimates of inriver run.

Productivity of the Alsek River stock has generally been poor since 2007 though escapements have only been below the lower bound of the escapement goal range 5 of the most recent 16 years. Production has improved recently, and the escapement goal has been attained in 4 out of 5 recent years. From 1976 to 2017, calendar year harvest rates averaged 8%. In response to poor production and escapement performance, conservative management actions were enacted in 2018 and harvest rates were reduced to an average of 4% (see CTC 2023).

Chilkat River

The Chilkat River is a moderate-sized glacial system near Haines, Alaska, which supports an inside-rearing stock. Escapement estimates are germane to spawners that are ocean-age-3 and older. A juvenile tagging program occurs each fall and spring and wild fish have been tagged at relatively high rates (8–10%) beginning with the 1999 brood year. Relatively small terminal marine sport and subsistence fisheries target this stock and fish are also caught outside of the terminal area in SEAK commercial troll, commercial gillnet, and sport fisheries.

Chinook salmon begin entering the Chilkat River in mid-June and are mostly inriver by mid-July with peak spawning in late July, early August. Escapement of large spawners is estimated using a mark-recapture study that has occurred each year since 1991. An initial escapement goal was set in 1981, and since 2004 the current escapement goal is a range of 1,750 to 3,500 large spawners. Inseason management of this stock is based on the weekly CPUE gathered in the Chilkat River fish wheels and comparisons to historical CPUE and final mark–recapture estimates of escapement.

Productivity of the Chilkat River stock has generally been poor since 2007 and escapements have been below the lower bound of the escapement goal range 7 of the most recent 16 years. As a result, this stock was designated a Stock of Management Concern at the 2017 and 2021 Alaska Board of Fisheries fall work sessions and an action plan detailing conservative management measures was adopted and enacted beginning in 2018 (see Hagerman et al. 2022). From 2004 to 2017, calendar year harvest rates averaged 24%. Since the implementation of the action plan, harvest rates have averaged 6% and the lower bound of the escapement goal range has been achieved 3 out of the recent 5 years.

Taku River

The Taku River is a large glacial system that originates in northwestern British Columbia, flows into marine waters of SEAK near Juneau, Alaska, and supports a run of outside-rearing Chinook salmon. Escapement estimates are germane to large spawners (> 659 mid-eye to fork of tail in length) and beginning with the 1991 brood year, 2–3% of the juvenile outmigration has been tagged each year with CWTs. Most Taku River Chinook salmon are caught in terminal marine waters of SEAK and in the lower Taku River in Canada. Directed gillnet fisheries take place in terminal U.S. (District 111 of SEAK) and Canadian inriver fisheries when forecasted abundance or in-season assessments exceed predetermined levels as described in the Pacific Salmon Treaty. Taku River Chinook are incidentally harvested in terminal directed sockeye salmon gillnet fisheries, sport fisheries near Juneau, Alaska, and inriver in Aboriginal and sport fisheries in Canada, as well as in a U.S. personal use fishery just below the border. Taku Chinook salmon are also harvested outside of the terminal area, primarily in SEAK sport and troll fisheries.

Chinook salmon begin entering the Taku River in late-April and are mostly inriver by mid-July with peak spawning in early August. Escapement estimates of large Chinook salmon have been generated as part of a cooperative stock assessment program among the Taku River Tlingit First Nation, DFO, and ADF&G. Fish are captured using fish wheels and drift gillnets operated just below the U.S./Canada border and are later sampled for marks on the spawning grounds. In some years, when abundance is adequate, test and/or commercial fisheries are operated just above the border to sample fish for marks which allows inseason estimates of inriver abundance and projections based on historical run timing. Standardized observer survey counts have been performed by ADF&G since 1973. With the signing of the Pacific Salmon Treaty in 1985, an escapement goal range of 25,600 to 30,000 large spawners in the Canadian portion of the Taku River was established. Escapement Goals have periodically been revised and the current goal was updated in 2009 to a range of 19,000 to 36,000 large spawners. Inseason management of this stock is based on weekly CPUE gathered in the Taku River drift gillnet assessment program and comparisons to historical CPUE and final mark–recapture estimates of escapement. When abundance is adequate, weekly mark-recapture estimates are generated along with projections of total inriver run using samples gathered in fisheries operated just above the U.S./Canada border.

Productivity of the Taku River stock has been poor since 2007 and escapements have been below the lower bound of the escapement goal range 10 of the most recent 16 years. Production has not improved in recent years missing the lower bound of the escapement goal range in 7 straight years. This has precipitated a suite of agreed to conservative management actions by the TBR Panel of the Pacific Salmon Commission. Domestically, this stock was designated a Stock of Management Concern at the 2021 Alaska Board of Fisheries fall work session and an Action Plan detailing conservative management action was adopted and enacted beginning in 2022. From 2004 to 2017, calendar year harvest rates averaged 23%. Since the implementation of conservative management actions throughout the region in 2018, harvest rates were reduced to 9% (see CTC 2023).

Stikine River

The Stikine River is the largest river in SEAK; it originates in British Columbia, flows into the marine waters near the towns of Petersburg and Wrangell, and supports a run of outside-rearing Chinook salmon. Escapement estimates are germane to large spawners (> 659 mid-eye to fork of tail in length) and beginning with the 1991 brood year, 2–3% of the juvenile outmigration has been tagged each year with CWTs. Most Stikine River Chinook salmon are caught in terminal marine waters of SEAK and in the lower Stikine River. Directed gillnet fisheries take place in terminal U.S. (District 108 of SEAK) and Canadian inriver fisheries when forecasted abundance or in-season assessments exceed predetermined levels as described in the Pacific Salmon Treaty. Stikine River Chinook are incidentally caught in terminal directed sockeye salmon gillnet fisheries, sport fisheries near Wrangell and Petersburg, Alaska, and inriver in Aboriginal and sport fisheries in Canada and in a U.S. subsistence fishery just below the border. Stikine Chinook salmon are also harvested outside of the terminal area, primarily in SEAK sport and troll fisheries.

Chinook salmon begin entering the Stikine River in early May and are mostly inriver by mid-July with peak spawning in early August. Escapement estimates of large Chinook salmon have been generated as part of a cooperative stock assessment program among the Tahltan Central Government, DFO, and ADF&G. Although assessed by a variety of methods since 1975, beginning in 1996 mark-recapture estimates have been conducted each year to estimate total escapement. Fish are captured using drift gillnets operated just below the U.S./Canada border and are later sampled for marks on the spawning grounds and in fisheries in Canada. In some years, when abundance is adequate, test and/or commercial fisheries are operated just above the border to sample fish for marks which allows inseason estimates of inriver abundance and projections based on historical run timing. With the signing of the Pacific Salmon Treaty in 1985, an escapement goal range of 19,800 to 25,000 large spawners in the Canadian portion of the Stikine River was established. This goal was loosely based on observer counts of spawning fish in years believed to be free from overfishing and expansions based largely on professional judgment. A detailed spawner-recruit analysis in 1999 resulted in a revised goal range of 14,000 to 28,000 large Chinook salmon. Inseason management of this stock is based on weekly CPUE gathered in the Stikine River drift gillnet assessment program and comparisons to historical CPUE and final mark–recapture estimates of escapement. When abundance is adequate, weekly mark–recapture estimates are generated along with projections of total inriver run using samples gathered in fisheries operated just above the U.S./Canada border.

Productivity of the Stikine River stock has been poor since 2007 and escapements have been below the lower bound of the escapement goal range 8 of the most recent 16 years. Production has not improved in recent years, missing the lower bound of the escapement goal range in 7 consecutive years. This has precipitated a suite of agreed to conservative management actions by the TBR Panel of the Pacific Salmon Commission. Domestically, this stock was designated a Stock of Management Concern at the 2021 Alaska Board of Fisheries fall work session, and an action plan detailing specific conservative management measures was adopted and enacted beginning in 2022. See Salomone et al. 2022 for details. From 2004 to 2017, calendar year harvest rates averaged 26%. Since the implementation of conservative management actions throughout the region in 2018, harvest rates were reduced to 10%

Unuk River

The Unuk River is a moderate-sized glacial system that flows into Behm Canal northeast of Ketchikan, Alaska, and supports and inside-rearing stock. Escapement estimates are germane to large spawners (> 659 mid-eye to fork of tail in length) and a juvenile tagging program occurs each fall and spring. Wild fish have been tagged at relatively high rates (3–18%) beginning with the 1992 brood year. Harvest of immature and mature fish occurs predominately in SEAK commercial and sport fisheries, although some fish are also caught in northern British Columbia commercial net and troll fisheries.

Chinook salmon begin entering the Unuk River in late-June and are mostly inriver by the end of July with peak spawning in late August. The escapement of large spawners is estimated using expanded observer counts, a program that has been in place since 1977. In 2008, an extensive analysis was conducted and the current escapement goal of 1,800 to 3,800 large spawners was put in place. There is no inseason management of this stock; Chinook salmon fishing is closed in the near terminal marine area and inriver, as well as in known marine migratory corridors when Unuk fish historically have been present.

Productivity of the Unuk River stock has generally been poor since 2007 and escapements have been below the lower bound of the escapement goal range 7 of the most recent 16 years. As a result, this stock was designated a Stock of Management Concern at the 2017 and 2021 Alaska Board of Fisheries fall work sessions, and an action plan detailing specific conservative management measures was adopted and enacted beginning in 2018. See Meredith et al. 2022 for details. From 1997 to 2017, calendar year harvest rates averaged 31%. Since the implementation of the action plan, harvest rates have averaged 27% and the lower bound of the escapement goal range has been achieved 3 out of the recent 5 years.

Minor Stocks

Escapement of large spawners is also estimated using observer counts in the King Salmon, Chickamin, Blossom and Keta rivers and Andrew Creek, and counts are standardized and have occurred annually in each since 1975. Weirs were placed across the King Salmon River and Andrew Creek for several years to enumerate escapement and to ground truth and establish expansion factors for peak observer counts. For similar reasons, mark-recapture studies were conducted for several years on the Chickamin, Blossom, and Keta Rivers to estimate escapement. The King Salmon, Blossom, and Keta Rivers and Andrew Creek are small, clear water systems and the Chickamin River is a moderate-sized glacial system in which most fish spawn in several small clear water tributaries. The King Salmon River and Andrew Creek are in Central SEAK and the Chickamin, Blossom, and Keta Rivers are in Southern SEAK. These are all mainland systems except for the King Salmon River which is home to the only island stock of Chinook salmon in the region. Fish generally enter the King Salmon River and Andrew Creek in late June and are mostly inriver by the end of July with peak spawning around late July. Fish begin to migrate into the Chickamin, Blossom, and Keta Rivers in early July and are mostly inriver by mid-August with peak spawning around early September.

Historically, wild Chickamin River Chinook salmon were tagged with CWTs, and King Salmon River fish were once used as broodstock in the regional hatchery program. Andrew Creek and Chickamin River stocks, and most recently, the Keta River stock, all currently serve as key broodstock sources for the regional hatchery program. Information gleaned on recoveries of CWTs of wild Chickamin River fish and hatchery releases of King Salmon, Chickamin, and Keta

Rivers and Andrew Creek broodstocks, indicates these stocks are inside-rearing with harvests occurring in SEAK commercial and sport fisheries, and for the Southern SEAK stocks, in northern British Columbia commercial net and troll fisheries. By proximity, the Blossom River stock is assumed to have similar distribution and harvest patterns as the nearby Keta River stock.

Escapements of King Salmon and Andrew Creek stocks have been poor since 2007, being below the lower bound of the escapement goal range in 8 and 7 out of the most recent 16 years, respectively. As a result, the King Salmon stock was designated a Stock of Management Concern at the 2017 and 2021 Alaska Board of Fisheries fall work sessions and the Andrew Creek stock was similarly designated at the 2021 work session. Action plans were adopted for each detailing conservative management actions that initially began in 2018 for the King Salmon River stock and 2022 for the Andrew Creek stock. See Salomone et al. (2022) and Hagerman et al. (2022) for details.

Although production of Chickamin, Blossom, and Keta Rivers stocks also decreased since 2007, downturns were not as severe. The Chickamin River stock was below the lower bound of the escapement goal range in 5 of the most recent 16 years. As a result, this stock was designated a Stock of Management Concern at the 2021 Alaska Board of Fisheries fall work session and an Action Plan was adopted detailing conservative management actions for this stock beginning in 2022. See Meredith et al. 2022 for details. The Blossom River stock was below the lower bound of the escapement goal range in 4 of the most recent 16 years and the Keta River stock achieved the lower bound of the escapement goal in all years. These three stocks performed the best out of the 11 indicator stocks monitored annually by ADF&G. These stocks are also the southern-most stocks in the region and are the largest, most robust Chinook salmon in the region.

Southeast Regulatory Changes

In accordance with guidelines established in the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP), the ADF&G recommended that the Unuk, Chilkat, and King Salmon Rivers stocks of Chinook salmon be designated as stocks of “management concern” in October 2017 based on poor stock performance over the recent 5-year period. This recommendation was adopted by the Alaska Board of Fisheries (board) in January 2018. Then, in October 2020, ADF&G recommended continuing this designation for the aforementioned stocks and recommended that the Chickamin, Taku, and Stikine rivers, and Andrew Creek stocks be added as stocks of “management concern”. A “*management concern*” is defined as “a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for a salmon stock within the bounds of the SEG [sustainable escapement goal], BEG [biological escapement goal], OEG [optimum escapement goal], or other specified management objectives for the fishery.” “*Chronic inability*” is defined as “continuing or anticipated inability to meet escapement thresholds over a four-to-five-year period, which is approximately equivalent to the generation time of most salmon species.”

These designations were based on a review of escapements from 2016 to 2020. Escapement of Chinook salmon was below the lower bound of the existing escapement goal in 3 of the past 5 years for the Unuk (1,800 to 3,800 large Chinook), 4 of the past 5 years for the Chickamin River

(2,150 to 4,300), 3 of the past 5 years for the Chilkat River (1,750 to 3,500), 4 of the past 5 years for the King Salmon River (120 to 240), 4 of the past 5 years for Andrew Creek (650 to 1,500 fish), and 5 of the past 5 years for the Stikine River (14,000 to 28,000 fish) and Taku River (19,000 to 36,000)(Heinl et al 2020).

Since 2012, ADF&G has implemented conservative management measures to reduce the harvest of the Chilkat River stock of Chinook salmon and increase escapement. Through these measures, and from actions taken to reduce the harvest of the Taku River stock of Chinook salmon, by extension, harvest on the King Salmon River stock may likewise have been reduced. Similarly, ADF&G has implemented conservative management actions beginning in 2014 to reduce harvest of Unuk River Chinook salmon, and by extension and proximity to the Unuk River, it is assumed those actions have reduced harvests of Chickamin River Chinook salmon as well. Beginning in 2016, ADF&G implemented similar conservative management measures that have been effective in reducing the harvest of Stikine River Chinook salmon. Andrew Creek is a tributary to the Stikine River located entirely within Alaska. It is assumed actions that have reduced the harvest of Stikine River Chinook salmon have also reduced harvest of Andrew Creek Chinook salmon.

Southeast Hatcheries

Most of the state's Chinook salmon hatchery production occurs in SEAK. Chinook salmon hatchery production was largely developed after the Pacific Salmon Treaty was signed in 1985. The PST included funding for Chinook salmon hatchery production in SEAK to mitigate harvest concessions made in the treaty. Chinook salmon, wild and enhanced, are targeted year-round by the commercial troll and sport fleets and are harvested in the summer months by the net fleets. Harvest of Alaska hatchery-produced Chinook salmon is incentivized, as most do not count towards the PST all-gear harvest limit. Eleven facilities are currently producing Chinook salmon. Combined, these 11 facilities produce over 7 million juveniles annually (Evenson et al. 2018).

From 1990 to 2017, the cumulative contribution of the SEAK hatchery program to the all-gear harvest was 1.8 million Chinook salmon, accounting for 20% of the total harvest of Chinook salmon, on average. For the same time period, SEAK hatchery fish contributed an average of 24,500 fish annually (range: 8,600–38,400) to troll fisheries, accounting for 12% (range: 5–27%) of the total Chinook salmon harvest. In the net fisheries, SEAK hatchery fish have contributed an average of 22,140 fish annually (range: 8,700–39,700), accounting for 52% (range: 19–80%) of the Chinook salmon harvest. Chinook salmon released from SEAK hatcheries have contributed an average of 17,900 fish to the sport fishery (range: 8,300–30,900) accounting for 28% of the harvest (range: 15–43%).

Hatchery and remote release sites in SEAK, along with broodstock sources, were carefully selected to minimize the potential for returning hatchery stocks to mix with wild stocks (Evenson et al. 2018). All Chinook salmon broodstock has been locally sourced from SEAK. With few exceptions, Chinook salmon hatcheries are located on islands at or near tidewater and away from any endemic stock.

APPENDIX C

Southeast References

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APPENDIX C

Prince William Sound/Copper River

The Copper River is a glacially dominated system located in Southcentral Alaska. It flows south from the Alaska, Wrangell, and Chugach mountain ranges and empties into the Gulf of Alaska, east of Prince William Sound. The Copper River drainage (61,440 km^2) supports spawning populations of all 5 species of salmon as well as several resident fish species. The Copper River Chinook salmon stock is composed of 6 major spawning populations (Upper Copper, Gulkana, Tazlina, Klutina, Tonsina, and Chitina). Much of the watershed is sparsely populated and roadless; however, there is some development (i.e., the Trans Alaska Pipeline), road access, and infrastructure, particularly in the upper parts of the basin. There are many Chinook salmon spawning locations within the Copper River tributaries and assessment is resource intensive.

In the Prince William Sound/Copper River area there is 1 dominant wild Chinook salmon stock in the Copper River, and escapement is estimated annually by subtracting the inriver harvest from a mark-recapture experiment that estimates the number of Chinook salmon in the river before any inriver fisheries.

Copper River Stock Assessment Overview

Copper River Chinook salmon stocks have been monitored, studied, and actively managed since the 1960s. Except for the years 1993–1995, aerial escapement surveys have been conducted in 35 systems from 1966 through 2021. Chinook salmon spawning escapement was first estimated in 1999, and since 2003 by the mark–recapture fish wheel study conducted by the Native Village of Eyak (NVE). The objectives of the study are to estimate the annual drainagewide inriver passage of Chinook salmon in the Copper River and to further develop an ongoing, long-term monitoring program to ensure the continued involvement of NVE in the active management of Copper River fisheries. This program provides an estimate of the number of Chinook salmon greater than 500 mm (measured snout to tail fork) passing Baird Canyon located just upriver from Miles Lake and before any inriver fisheries.

The Miles Lake sonar project operates from mid-May to the end of July and passage counts (of all salmon species) is primarily used for inseason sockeye salmon management and estimating sockeye salmon run strength. Chinook salmon constitutes a minor portion of the total count. The department began measuring insonified fish at the Miles Lake sonars in 2018 and instituted a length threshold of 772 mm to differentiate sockeye and small Chinook salmon (below 772 mm) from known Chinook salmon (greater than 772 mm). The department's long-term goal of managing the fishery based on Miles Lake sonar counts of measured salmon is still under development. Multiple years of paired estimates with the NVE mark–recapture estimates, as well as other indices, will ultimately produce a stronger data set with improved precision of escapement estimates and more accurate estimates of inseason escapement. The goal of switching to sonar- based escapement goals will take time but promises further improvements in our understanding of stock dynamics and subsequent improved management.

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Since 2002, ADF&G and the Bureau of Land Management have jointly operated a counting tower on the Gulkana River above the West Fork to estimate the escapement of Chinook salmon. Counts at this location do not provide an enumeration of total inriver escapement but do provide a reliable estimate of fish escapement to the area upstream of the counting tower. Counts are conducted from late May to mid-August.

In 2021, a state-space model was updated to estimate sustainable yields of Chinook salmon using most recent Chinook salmon escapement data and mixed-stock analysis information from the commercial harvest. The time series of escapements (1980–2018) never failed to replace themselves, so there is little information to accurately understand the density-dependent effects of large escapements. In this situation, the Ricker model provided the best estimate of maximum sustained yield, but the estimates remain potentially sensitive to additional (large escapement) data. However, the optimum yield profiles suggest yields diminish as you approach 40,000 spawners, which justifies an upper boundary for an escapement goal. The results were robust across the different model scenarios and indicate escapements between 21,000 and 31,000 will produce sustained yields and are more likely to produce maximum sustained yield. Based on these results, the Alaska Board of Fisheries adopted an SEG of 21,000–31,000 Chinook salmon for the Copper River.

Copper River Fisheries Management

Salmon fisheries in the Copper River primarily harvest sockeye, Chinook, and coho salmon. Chinook salmon stocks are harvested in 4 fisheries: (1) a commercial gillnet fishery at the mouth of the Copper River; (2) a subsistence gillnet fishery at the mouth of the Copper River, a subsistence dipnet and fish wheel fishery in the Copper River between Chitina and the Slana River confluence, and a subsistence fish wheel, dip net and spear fishery in Tanada Creek and the Copper River near the traditional village site of Batzulnetas; (3) a personal use dip net fishery in the Copper River near Chitina; and (4) sport fisheries that occur in various tributaries. In addition, since 1999, federal subsistence fisheries have occurred in the Glennallen and Chitina Subdistricts and the Batzulnetas area.

The following management plans and policies have been adopted by the board and affect Chinook salmon:

> *Copper River District Salmon Management Plan* (5 AAC 24.360). This management plan sets the annual allocation of salmon for upriver users and contains spawning escapement goals for sockeye and other salmon; inriver apportionment goals for the subsistence, personal use, and sport fisheries in the drainage; and hatchery brood stock and hatchery surplus goals. The goals are met through regulation of the commercial fishery near the mouth of the river and are measured by the sonar counter at Miles Lake.
>
> *Copper River King Salmon Management Plan* (5 AAC 24.361). This management plan provides for a sustainable escapement goal (SEG) for Chinook salmon in the Copper River drainage of 21,000–31,000 Chinook salmon. To achieve this goal, during statistical weeks 20 and 21 (generally, the first 2 weeks of the commercial fishing season) the commissioner may

open no more than one 12-hour fishing period within the inside closure area of the Copper River District.

ADF&G will manage the sport fishery of the Upper Copper River drainage through an annual limit for Chinook salmon 20 inches or greater in length of 4 fish. The department also has authority to further restrict the sport fishery to achieve the escapement goals using the following management measures in the following priority order: a) reduction of the annual limit; b) modification of other methods and means not specified in the plan; c) catch- and-release only designation; and d) closure of specific waters to sport fishing for Chinook salmon.

In the Chitina Subdistrict personal use fishery, the annual limit for Chinook salmon is 1 fish and the department has authority to prohibit retention of Chinook salmon as needed.

The department also has authority to restrict the Glennallen Subdistrict subsistence fishery to achieve escapement goals using the following management measures in the following priority order: 1) establish a bag limit for Chinook salmon taken by fish wheel; b) reduce the bag limit for Chinook salmon taken by fish wheel and dip net; c) prohibit the taking of Chinook salmon by fish wheel and dip net; and d) modify methods and means for fish wheels.

The *Copper River Subsistence Salmon Fisheries Management Plan* (5 AAC 01.647) ensures that adequate escapement of salmon pass the Miles Lake sonar in the Lower Copper River and that subsistence needs are met. It also establishes the open area, gear, season, bag and possession limits, and permit requirements for a subsistence fishery near the traditional fishing village of Batzulnetas along a portion of Tanada Creek and its confluence with the Copper River.

The *Copper River Personal Use Dip Net Salmon Fishery Management Plan* (5 AAC 77.591) establishes fishing seasons, open area, gear, bag limits, and seasonal harvest level for the Chitina Subdistrict personal use fishery in the Upper Copper River. The harvest will be distributed throughout the season based on projected daily sonar counts from the Miles Lake sonar counter. Harvest will be adjusted, based on actual sonar counts, through reduction or increase of fishing times by emergency order.

Copper River Stock Status

Chinook salmon returning to the Copper River begin passing through the Copper River District and enter the Copper River in early May, headed for spawning locations in tributaries of the Upper Copper River. Run timing patterns vary among major spawning stocks, but the general run timing pattern is upriver stocks migrating up the river earlier than downriver stocks. Most of the Chinook salmon run (~85% on average) enters the river from mid-May through mid- June, and run entry into the river is essentially complete by July 1. Chinook salmon harvest timing in the commercial fishery, on average, is 50% complete by the end of May and 90% complete by mid-June.

Since 1999, the Copper River drainage has produced an average run of ~60,000 Chinook salmon; however, the recent 10-year average (2013–2022) is ~46,000 fish. This decline in production is partially due to the downward trend in Chinook salmon age-at-maturity and a decrease in age-specific size across Alaska. The average annual Chinook salmon harvest from 1999–2022 was

31,930 fish from these fisheries. Since 2000, based on the current escapement goal range of 21,000 to 31,000 fish, Chinook salmon escapements have achieved the lower end of the goal in all years except 2010, 2014, and 2021.

Copper River Regulatory Changes

The Copper River King Salmon Management Plan (CRKSMP; 5 AAC 24.361) was adopted during the 1996 board meeting. The original purpose of this plan was to ensure that the escapement of Chinook salmon into the Copper River drainage was provided for, at or above historic levels, by reducing the harvest potential of the commercial, sport, and personal use fisheries by 5%. This was done by allowing inside statistical area closures (effectively closing off most waters in the middle of the district inside the barrier islands) in the commercial fishery during statistical weeks 20 and 21 (14-day period with an annual start date as early as May 10 and end date as late as May 30), reducing the annual bag limit of Chinook salmon from 5 to 4 in the personal use fishery, and through a sport fish guiding closure on Tuesdays in the sport fishery.

In 1999, the board amended the plan. Commercial, personal use, and sport fisheries were managed to achieve a spawning escapement range of 28,000–55,000 Chinook salmon, sport fish annual limit was reduced from 5 to 4 Chinook salmon, and personal use language was removed because the Chitina Subdistrict personal use fishery was changed to a subsistence fishery.

In 2003, SEG was updated to 24,000 Chinook salmon or more.

In 2006, the management plan was revised to direct the commissioner to open no more than 1 period within the inside closure area during the combined statistical weeks 20 and 21. In addition, the Copper River Personal Use Dip Net Salmon Fishery Management Plan (5 AAC 77.591) was revised to delay the potential range of opening dates for the Chitina Subdistrict personal use dip net fishery from June 1–June 7 to June 7–June 15. Language was also added to the CRKSMP to provide management guidance for the Chitina Subdistrict personal use fishery and the Glennallen Subdistrict subsistence fishery if the commissioner determined that additional conservation measures were necessary to achieve the escapement goal.

In 2014 the CRKSMP was changed to provide additional management authority within the Glennallen Subdistrict subsistence salmon fishery to (in order of priority) 1) establish a bag limit for Chinook salmon taken by fish wheel, 2) reduce bag limits for Chinook salmon taken by fish wheel and dip net, 3) prohibit retention of Chinook salmon taken by fish wheel and dip net, and 4) modify methods and means if additional measures are necessary to achieve the escapement goal.

The CRKSMP was last revised in 2021 and a SEG of 21,000-31,000 Chinook salmon was established.

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Cook Inlet

The Cook Inlet Management Area is located in the Central Gulf of Alaska and comprised of all waters west of the longitude of Cape Fairfield and north of the latitude of Cape Douglas. Area marine waters vary from the numerous fjord-like bays along the north Gulf of Alaska coast to the moderately protected waters of Kachemak Bay and the high-energy shoreline of Kamishak Bay. All five species of Pacific salmon are commercially harvested in the Cook Inlet Area. Cook Inlet is divided into Upper Cook Inlet, managed out of Soldotna, and Lower Cook Inlet, managed from Homer.

The Upper Cook Inlet (UCI) Management Area consists of that portion of Cook Inlet north of the latitude of the Anchor Point Light and is divided into the Central and Northern districts. Central District is approximately 75 miles long, averaging 32 miles in width. Northern District is 50 miles long, averaging 20 miles in width. All 5 species of Pacific salmon are commercially harvested in UCI. Since the inception of a commercial salmon fishery in 1882, many salmon gear types, including fish traps, gillnets, and seines have been employed with varying degrees of success. More than 1,300 drift and set gillnet limited entry fishing permits have fished the UCI area, contributing about 10% of salmon permits issued statewide. Sockeye salmon are most important in terms of their economic value.

The Lower Cook Inlet (LCI) Management Area is comprised of all waters west of the longitude of Cape Fairfield, north of the latitude of Cape Douglas, and south of the latitude of Anchor Point. Area marine waters vary from the numerous fjord-like bays along the north Gulf of Alaska coast to the moderately protected waters of Kachemak Bay and the high-energy shoreline of Kamishak Bay. The majority of freshwater drainages are short, coastal streams dominated by pink salmon; however all five Pacific salmon species are present in LCI waters.

Cook Inlet Stock Assessment Overview

Cook Inlet has early run (roughly May-June river entry) Chinook salmon stocks in a few dozen tributaries. Late run (roughly July-August river entry) stocks are found in the Kenai and Kasilof Rivers, and a very small, unknown number in Crescent River on the west side of Cook Inlet. Methods to assess escapement vary but are extensive and include weirs, sonar, and aerial surveys via rotary wing aircraft.

While Cook Inlet is the most populous region of the state, more than half of the area surrounding the inlet is lightly populated, has minimal development (roads, buildings, etc.), and is inaccessible except by boat or plane. There are many Chinook salmon spawning locations within the surrounding tributaries. For this reason, assessment activities (e.g., test fishing, harvest monitoring and sampling, and estimating/enumerating escapement) are resource intensive. However, it is incumbent on the state that the resource be managed with the best information which requires a wide range of activities to provide comprehensive and trustworthy information. An overview of the stock assessment activities used in Cook Inlet, their history, the information provided, and the scientific/statistical rigor behind the actions can be found in the Cook Inlet References section below.

Cook Inlet Fisheries Management

North of Ninilchik sport fisheries are all inriver, while south of Ninilchik sport fisheries are primarily marine but include inriver fisheries in the primary Chinook producing streams. Assessment of harvest by sport anglers is primarily though the Statewide Harvest survey, Freshwater and Saltwater Guide logbooks, and an inseason creel survey on the Kenai River. Commercial fishery harvests are primarily in the May-June Northern District setnet fishery (NDSN), and the late June-August eastside setnet fishery (ESSN). Commercial harvest is assessed via the State of Alaska Fish Ticket system and age-sex-length data and genetic tissue analysis of stock composition. Subsistence harvest primarily occurs on the west side of Cook Inlet near the villages of Tyonek and Beluga. Personal Use harvest occurs primarily in fisheries in or adjacent to the Kenai and Kasilof Rivers. Genetic baseline and mixed stock analysis work has been substantial in many of these fisheries.

Information about these fisheries and their management through forecasts, plans, inseason actions through Emergency Orders, and history can be found in the Cook Inlet References section below.

Cook Inlet Chinook (King) Salmon Management Plans:

1. The *Northern District King Salmon Management Plan* (5 AAC 21.366) was created by the Alaska Board of Fisheries in 1986 and was most recently modified in 2017. This plan now contains paired restrictions for the Deshka River sport Chinook salmon fishery and the district's set gillnet Chinook salmon commercial fishery. Restrictions in the Deshka River sport Chinook salmon fishery result in time reductions in the commercial fishery, and Chinook salmon sport fishery closure of the Deshka River results in a complete closure of the commercial fishery. Closures in sport Chinook salmon fisheries in certain westside streams also will result in closures to nearby areas of the commercial Chinook salmon fishery.
2. Management of Chinook salmon harvests in the Eastside Set Net Fishery (ESSN) commercial fishery is largely predicated on the abundance of Chinook salmon in the Kenai River under stipulations of the *Kenai River Late-Run King Salmon Management Plan* (KRLKSMP; 5 AAC 21.359). The KRLKSMP has been changed incrementally since 2012 with the addition and modification of paired restrictions in the commercial and sport fisheries (Shields and Dupuis 2015, Shields and Frothingham 2018). In 2017, the SEG was changed to 13,500–27,000 large (>75 cm mid eye to tail fork) fish. In 2020, the board also added an optimal escapement goal (OEG) management target of 15,000–30,000 large fish. Kenai River Chinook salmon abundance is assessed inseason with acoustical methods at river mile 8 (Lipka et al. 2020).
3. The *Kenai River and Kasilof River Early Run King salmon Management plan* (5AAC 57.160). This plan sets a regulatory structure for the early run king salmon sport fishery. The plan directs the department to use broad general regulations for king salmon management on

the Kenai River (5AAC 57.120) at certain possible abundance scenarios, or it can also direct the department to specific management steps by emergency order at other abundance scenarios. Both preseason and inseason information is used as directed by this plan.

4. <u>*Upper Cook Inlet Salt Water Summer King Salmon Management Plan*</u> (5 AAC 58.055). The goal of this management plan is to stabilize the sport harvest of early-run king salmon in the mixed stock saltwater sport fishery in the Upper Cook Inlet Summer Salt Water King Salmon Management Area.

5. <u>*Cook Inlet Winter Salt Water Chinook Salmon Sport Fishery Management Plan*</u> (Winter King Plan; 5 AAC 58.060). The purpose of the management plan under this section is to meet the board's goal of slowing the growth in the sport harvest of king salmon originating from Cook Inlet spawning aggregations, in the salt waters of Lower Cook Inlet during the winter, which occurs from October 1 through March 31.

Cook Inlet Stock Status

Chinook salmon stocks throughout Cook Inlet have experienced declines from a period of higher productivity that was first recognized around 2007. In 2010 several stocks in northern Cook Inlet (Susitna River drainage) were designated stocks of management concern as a result of chronically not meeting the lower bound of the escapement goal. Depressed runs for many Chinook salmon stocks in Cook Inlet persist today. Similar long-term periods of poor production have happened historically and rebuilt through conservative management measures. Similarly, conservative management measures have been in place for at least the past decade-plus to bolster escapements and provide for the long-term sustained yield of these stocks. There are currently four Chinook salmon stocks of concern listed within Cook Inlet and brief overviews of their status are provided:

Eastside Susitna River

The Susitna River drainage originates in the Alaska and Talkeetna mountain ranges and flows south to Cook Inlet. The Susitna River drainage supports numerous Chinook salmon sport fisheries and is divided into 4 management units based on sub-drainages (Deshka River, Eastside Susitna River, Talkeetna River, and Yentna River). Recent run reconstruction efforts have enabled estimation of Chinook run sizes for these units and development of corresponding escapement goals (Reimer and DeCovich 2020). Tributaries flowing into the Susitna River from the west generally originate in the Alaska Range with relatively low gradient and velocity, and access is only by boat or airplane. Tributaries flowing into the Susitna River from the east mostly drain from the Talkeetna Mountains with relatively high gradient and velocity, and easy access from the Parks Highway. Eastside tributaries between Willow and Talkeetna – including Sheep, Goose and Willow creeks – support moderate sized runs of Chinook salmon, high sport fishing angler effort due to ease of access, and close proximity with each other.

Between 2011 and 2014, some of these Eastside tributaries were designated as stocks of concern. As of 2014, Sheep and Goose creeks were designated as stocks of management concern and Willow Creek was designated a stock of yield concern. In 2020, with the adoption of the Eastside

Susitna River escapement goal that replaced the individual tributary escapement goals, the board designated the aggregate Eastside Susitna River Chinook salmon stock as a stock of management concern, replacing the individual tributary designations for Sheep, Goose and Willow creeks.

The department has conducted post season single aerial surveys on Sheep, Goose, and Willow creeks since 1979 to index spawning escapement of Chinook salmon. Sheep and Goose creeks share a common channel created in 1971 by a flood that caused a breach in the Sheep Creek channel. Despite efforts to prevent Sheep Creek water flowing into this channel, it persists and is part of the Goose Creek aerial survey index area. Beaver progressively colonized this channel and, since 2009, a multigenerational beaver dam blocks fish passage some years upstream of the confluence of this channel with Goose Creek. Sheep, Goose, and Willow creek king salmon are harvested primarily in inriver sport fisheries. Sport harvests from 1977–2018 have been estimated from the Statewide Harvest Survey for each creek. These stocks may also be harvested in the Northern District commercial set gillnet Chinook salmon fishery, and a subsistence fishery that occurs in the Tyonek Subdistrict marine waters adjacent to the community of Tyonek. No estimates of harvest for Sheep Creek and Goose Creek Chinook salmon stocks in the marine fisheries are available because the stock contribution of these fisheries has never been fully determined.

The average escapement indexes for Sheep, Goose and Willow creeks from 1979 to 2018 were about 750, 350, and 2,100 fish respectively. More recent averages (2014-2018) were 350 Chinook for Sheep Creek, 160 Chinook for Goose Creek, and 1,400 Chinook for Willow Creek. Despite cautious incremental development of regulation since 1980; inseason emergency order (EO) closures of the sport fishery in some years; and regulatory and preseason EO actions since 2011 to restrict harvest of king salmon in both sport and commercial fisheries, the SEGs in place for these stocks were not consistently achieved prior to development of the Eastside Susitna River escapement goal in 2020. Since implementation of the Eastside Susitna River escapement goal, the goal has been achieved 2 out of the 3 years it has been in place. An action plan for the Eastside Susitna River has been developed and actions apply to all of the tributaries within the area (see ADF&G 2020, Eastside Susitna River Chinook salmon Action Plan).

Chuitna and Theodore Rivers

The Chuitna and Theordore rivers are located in the West Cook Inlet management area. The department has conducted annual single aerial surveys on the Chuitna and Theodore rivers since 1979 to index spawning escapement of Chinook salmon.

Chuitna and Theodore River Chinook salmon are harvested in the nearby subsistence fishery that occurs in the Tyonek Subdistrict marine waters adjacent to the community of Tyonek, and in the Northern District commercial set gillnet king salmon fishery. Prior to the closure of sport fisheries in these rivers, sport harvests have been estimated from the Statewide Harvest Survey for each river. Estimates of commercial and subsistence harvests are not available because the stock contribution of these fisheries has never been fully determined.

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The average escapement in the Chuitna River from 1979–2018 was 1,671 fish. Despite restrictive action since the mid-1990s, closure of the sport fishery in 2010, restrictions to time and area in the commercial fishery, and time restrictions to the subsistence fishery (2019 season), the sustainable escapement goal (SEG) has only been achieved five of the previous nine years (2011-2019). The recent average (2009–2018) escapement to the Theodore River is 238 fish. The Theodore River has failed to meet the SEG since 2006 despite a catch-and-release sport fishery for king salmon from 1999- 2009 and closure in 2010.

In 2011, the Board of Fisheries designated both the Chuitna and Theodore River Chinook salmon as stocks of management concern and an action plan was put in place and has been periodically reviewed (see ADF&G 2020, Chuitna and Theodore River Chinook salmon Action Plan).

Alexander Creek

Alexander Creek is located in the West Cook Inlet management area. The department has conducted annual single aerial surveys on Alexander Creek since 1974 to index spawning escapement of Chinook salmon. Until 2008, Alexander Creek king salmon were harvested by three user groups: a sport fishery, the Northern District commercial set gillnet king salmon fishery, and a subsistence fishery that occurs in the Tyonek Subdistrict marine waters adjacent to the village of Tyonek. Sport harvests from 1977–2019 have been estimated from the Statewide Harvest Survey. The sport fishery was closed in 2008 by the board. No estimates of harvest for Alexander Creek Chinook salmon to the marine fisheries are available because the stock contribution of these fisheries has never been fully determined, but it is suspected to be small. This stock has also been heavily impacted by the spread of invasive northern pike.

The average escapements from 1979–1999 were about 3,700 Chinook, but more recently (2010-2019) escapements have averaged 583 fish. Despite restrictive action since the mid-1990s, closure of the sport fishery in 2008, and concerted efforts to remove northern pike from the system Chinook salmon escapements to Alexander Creek have not met the SEG since 2005.

In 2011, the Board of Fisheries designated Alexander Creek Chinook salmon a stock of management concern and an action plan was put in place that has been periodically reviewed (see ADF&G 2020, Alexander Creek Chinook salmon Action Plan).

Other Stocks

The escapements and harvests on several other Chinook salmon stocks are assessed in Cook Inlet. This includes smaller coastal rivers, like the Anchor and Ninilchik Rivers, as well as larger more complex systems with both early and late runs like the Kenai and Kasilof Rivers. All stocks in the inlet have seen similar decreases in productivity over the past 15 years and escapement goals are not met in some years despite restrictions to harvest. Additional information for these stocks can be found in the references provided in the Cook Inlet References, such as area management and escapement goal review reports.

Cook Inlet Regulatory Changes

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The Cook Inlet Chinook salmon stocks are managed to provide for the long-term sustainability of Alaska wild stocks in the area. The management plans for each fishery are developed by the ADF&G and the Alaska Board of Fisheries in a public process that involves considerable public input. The amount of public interest, attention and expense involved it an incontrovertible indication of the cultural, social, and economical importance of these fisheries to the people of this region.

Some of the resources in the Cook Inlet References section below are exemplary of the information presented, discussed and deliberated upon at these board meetings. Included in the references is a section with information on stocks of concern and the action plans developed to restore the populations to levels that provide consistent harvest for the people of the state. It is important to consider that designation as a Stock of Concern does not indicate a concern for the stock's continued existence, but rather for its ability to produce sufficient surplus to allow consistent harvestable yield. Stocks discussed in these documents have abundances that still may provide yield, but are not fished to allow for escapements that have the potential to produce good future yield.

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Bristol Bay – Nushagak River

The Nushagak River flows into Nushagak Bay, an inlet of Bristol Bay, just east of the village of Dillingham in southwestern Alaska. The Nushagak River drains 13,400 square miles and has an average discharge of 35,315 cfs, making it the fifth largest river, by discharge, in Alaska. The Nushagak watershed has two main tributaries: the Nuyakuk River, which drains Tikchik Lakes and enters from the west; and the Mulchatna River, which flows into the Nushagak River from the east. The watershed is remote, with no roads except in local villages and towns; habitat is generally considered pristine, with little industrial development. The Wood River is a separate, smaller drainage (1,100 square miles), that also empties into Nushagak Bay, close to the mouth of the Nushagak River.

All five species of Pacific salmon in Alaska return to both the Nushagak and Wood rivers. Before reaching the river, returning adult salmon pass through the Nushagak District, where commercial gillnetters and setnetters may harvest a mixed run of fish bound for either the Nushagak or Wood Rivers. The Nushagak River has a spawning escapement goal for Chinook salmon. The presence of multiple stocks and escapement goals in the neighboring rivers adds to the complexity of managing harvests in the Nushagak District.

Nushagak Stock Assessment Overview

The Nushagak River is the largest Chinook salmon producer in Bristol Bay; from 2002 through 2021, average run size was 157,792 fish and average escapement was 105,192 fish. ADF&G has assessed Chinook salmon on the Nushagak River since the mid-1960s, using a variety of methods. From the mid-1960s to the late 1970s the department estimated escapement of Nushagak River Chinook salmon using various combinations of tower counts and aerial surveys (Nelson 1987). By the mid-1990s the department began assessing Chinook salmon escapement with a sonar project at Portage Creek. Aerial surveys were discontinued in 1995, and Chinook salmon passage was assessed only by Bendix sonar. In the early 2000s, Bendix sonar technology was increasingly less reliable and harder to service, and in 2005 the department began transitioning the Nushagak sonar project to Sound Metrics technology (i.e., DIDSON and ARIS). During this transition, ADF&G realized the estimates based on Bendix sonar were smaller than estimates based on DIDSON sonar. A Bendix-DIDSON conversion study was undertaken in 2011 to address this issue (Buck et al. 2012). Through this report the department converted all previous estimates of abundance into DIDSON-equivalent numbers.

Chinook salmon arrive at the Nushagak District earlier than sockeye salmon, but there is substantial overlap in their run timing from late June through mid-July. Chinook salmon pass through the district from early June to late July; the middle 50% of the run (i.e., the 25th-75th percentiles) is from June 19 through July 3. Sockeye salmon pass through from mid-June to late July; the middle 50% is from July 1 through July 10. The best run timing data come from Portage Creek sonar (Chinook and sockeye salmon) and from District harvests (sockeye salmon only). It takes salmon approximately two days to travel from the District to the sonar site at Portage Creek.

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A drainage-wide sustainable escapement goal (SEG) for Nushagak River Chinook salmon was established by the department in 2007 and revised in 2012 to the current SEG range of 55,000–120,000 fish (Fair et al. 2012). This SEG was based on the historical sonar counts and assumed that the annual Chinook salmon sonar count was a complete count (i.e., a census) of the entire run. However, we now know the Nushagak River sonar project only provides an index (i.e., a partial count) because the sonar only ensonifies part of the river channel. Results from two different studies (2011–2014 and 2014–2016) indicate the sonar currently undercounts fish by 19% to 65% (Maxwell et al. 2020).

In the mid-1990s, the board also established an inriver goal of 95,000 for Chinook salmon in the Nushagak-Mulchatna King Salmon Management Plan (5 AAC 06.361). This inriver goal is made up of the following components:

A. A biological escapement goal of 55,000 – 120,000 Chinook salmon;
B. A reasonable opportunity for subsistence harvest of Chinook salmon; and
C. A Chinook salmon sport fishery guideline harvest level of 5,000 fish, 20 inches or greater in length.

Nushagak Fisheries Management

Salmon fisheries in the Nushagak River watershed primarily harvest sockeye, Chinook, chum, and coho salmon. These fisheries are include subsistence (which takes place in both Nushagak Bay and upriver in fresh water), commercial (which takes place primarily in Nushagak Bay), and sport (which takes place primarily upriver in freshwater).

These various Nushagak River salmon fisheries are regulated by five different management plans that all can interact with each other across species in both the Nushagak and Wood Rivers. Notably, Chinook salmon can be harvested in the Nushagak District in both a directed Chinook salmon fishery and in a sockeye salmon fishery that incidentally harvests Chinook salmon due to overlapping run timing. Restrictions in the sockeye salmon fishery to reduce Chinook salmon harvest can therefore reduce harvest of sockeye salmon. Management is complicated by many factors, as summarized in the following list:

1. The *Nushagak-Mulchatna King Salmon Management Plan* (5 AAC 06.361). Among other things, this establishes the Inriver Goal, sets various triggers based on inseason run projections to the Nushagak and Wood Rivers, and affects management of sockeye and Chinook salmon;

2. The *Sockeye Salmon Management Plan* (5 AAC 06.367); This plan establishes the allocation of sockeye salmon between the commercial set and drift gillnet fisheries within the Nushagak Distract and establishes management measures for ADF&G to achieve the allocations.

3. The *Coho Salmon Management Plan* (5 AAC 06.368), which sets goals for Nushagak River coho salmon, and establishes triggers;

4. The *Wood River Special Harvest Area Plan* (5 AAC 06.358), which establishes criteria for opening the Wood River Special Harvest Area (WRSHA) based on inseason counts of Nushagak River coho and sockeye salmon, and Wood River sockeye salmon. Essentially, this plan allows excess sockeye salmon to be harvested in the WRSHA at times when the Nushagak District is restricted to conserve Nushagak River stocks of coho and sockeye salmon.
5. *Nushagak District King Salmon Stock of Concern Management Plan* (5 AAC 06.391). This is the newest plan, enacted in March 2023 after ADF&G proposed that Nushagak River Chinook salmon be designated a stock of management concern. While in stock of management concern status, this plan takes priority over 5 AAC.361.

Nushagak Stock Status

In 2022, a maximum likelihood model was developed (Head et al 2022) to estimate the 1968–2020 drainage- wide run size and escapement of Nushagak River Chinook salmon. The model simultaneously combined information by direct observations of escapement at 8 locations (1 tower and 7 aerial surveys); harvest of fish from commercial, subsistence, and sport fisheries; inriver abundance indices from the Nushagak River sonar project; and inriver abundance estimates from acoustic tag and mark–recapture studies. Results showed that reconstructed total run size ranged from 74,000 to 629,000 Chinook salmon with an average run size of 282,000 fish, and escapement ranged from 49,000 to 476,000 fish with an average of 210,000 fish. The model estimated total run and escapement appeared to be reasonable and tracked well with previous estimates.

From 1966 through 2022, Nushagak River Chinook salmon spawning escapement ranged from a low of 39,774 fish in 2022 to a high of 331,270 fish in 1983. During the six years from 2011 through 2016, annual escapements averaged 107,704 Chinook salmon. After 2016, there was a decline in productivity, as measured both by total harvest and escapement. During the next six years, from 2017–2022 (the recent period of reduced production), annual escapements decreased to an average of 52,742 fish. Conservative management actions were taken in response to the decline in escapement and total harvest (sport, subsistence, and commercial combined) decreased. Average total harvest decreased from 41,965 (2011–2016) to 35,533 fish (2017–2021). Nushagak River Chinook salmon failed to achieve the inriver goal of 95,000 Chinook salmon in five of the last six years and has likely failed to meet the SEG of 55,000–120,000 in three or more years in the last six.

Nushagak Regulatory Changes

The Nushagak-Mulchatna King Salmon Management Plan (NMKSMP; 5 AAC 06.361) was adopted during the 1992 board meeting. Since 1992 there have been changes in the subsistence, sport, and commercial fisheries. As a result of these changes, the Alaska Board of Fisheries has modified the plan numerous times.

1992 – Nushagak-Mulchatna King Salmon Plan was adopted

1994 – Adopted a 5,000-fish guideline harvest for sportfishing harvest

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1997 – Directed the department to schedule commercial openers that would provide pulses of Chinook salmon into the river and set escapement projection of 55,000 below which sport fishing would be restricted

2001 – Provided sport fishing opportunity when the inseason projection was less than 55,000 but greater than 40,00 fish

2003 – Directed the depart to reduce spurt fishing bag to 1 fish per day in in possession if the run was projected to be between 55,000 and 75,000 Chinook salmon

2003 – Allowed the department to close the commercial drift or set gillnet fishery if the harvest in the directed commercial fish of either group is more than 2 sockeye salmon for every one Chinook salmon.

2006 – A provision was added to require, during a directed commercial opening that drift and set gillnet fishing periods be of equal length, but do not have to be open concurrently.

2012 – Modified the biological escapement requirement, inriver goal, and management triggers to reflect changes in sonar technologies (Bendix to DIDSON conversion)

2018 – repealed the provision directing the department to restrict the sport fishery if the projection inriver return fell between 55,000 and 95,000 Chinook salmon.

2022-2023 – Declared Nushagak River Chinook salmon a stock of management concern. Developed an Action Plan, including new regulations, effective for the 2023 salmon management season.

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Kuskokwim River

The Kuskokwim River, located in Western Alaska, is the second largest river in the state and drains an area of approximately 130,000 km2 (11% of the total area of the state). The Kuskokwim River is the largest component of the Kuskokwim Management Area, which includes all waters of Alaska that flow into the Bering Sea between Cape Newenham and the Naskonat Peninsula, including Nunivak and St. Matthew Islands. The watershed is remote, with no roads except in local villages and towns; habitat is generally considered pristine, with no large-scale active industry operating within the drainage. There has been a history of industrial mining activity in tributaries of the Kuskokwim River. There is currently small-scale local timber harvesting and a large-scale mining project in the exploratory and permitting stages.

All five species of Pacific salmon are present in the Kuskokwim River and have historically supported subsistence, commercial, and sport fisheries. Chum salmon and sockeye salmon are the most abundant salmon species returning annually to the Kuskokwim River and co-migrate with Kuskokwim River Chinook salmon. The annual Chinook salmon run is one of the largest in Alaska and has historically supported one of the largest Chinook salmon subsistence salmon fisheries in the world (Brown et al. 2022).

Management of Kuskokwim River salmon fisheries is complex due to the large size of the drainage; multiple species with overlapping run timing; the vast distances between where fisheries and escapement monitoring occur; and State/Federal co-management obligations (Chythlook 2022; Smith and Grey 2022).

Kuskokwim Stock & Fishery Assessment Overview

Kuskokwim River Chinook salmon return to spawn in numerous tributaries and the annual total run is an aggregate of discrete spawning populations. There is a limited ability to genetically differentiate contributing populations in mixed fisheries. The current genetic baseline for Kuskokwim River Chinook can differentiate upper and lower Kuskokwim River populations (Prince et al. 2019); however, the lower Kuskokwim River populations are genetically indistinguishable from populations returning to Kuskokwim Bay, Togiak River, and Nushagak River in Bristol Bay (Templin et al. 2011). In-river harvest of Kuskokwim River Chinook salmon is managed as a single stock, but escapement projects are operated throughout the entire drainage to monitor abundance trends of the major contributing populations (see Smith and Grey 2022).
ADF&G has assessed Kuskokwim River Chinook salmon since statehood using a variety of methods. For simplicity, the assessment program can be summarized by projects designed to provide preseason, inseason, and post season information. Further, assessment methods can be broken into harvest and escapement monitoring.

Preseason run predictions are generated using two different methods (Larson 2023). Both methods assume the midpoint abundance expectation of the next year’s run is equal to the prior year run size. The difference between the methods is related to how forecast uncertainty is presented. Both methods have worked well for informing preseason management planning, due largely to the relative stability of the total annual runs from year to year.

Inseason projects include a mainstem test fishery, a mainstem sonar, and harvest reports. The Bethel Test Fishery (BTF) and Kuskokwim River sonar are operated in the lower portion of the Kuskokwim River mainstem. Both projects provide inseason information about run strength and timing of Chinook salmon and other co-migrating fish species. The BTF began in 1984 and has used a consistent methodology to generate a daily and cumulative index of drift gillnet catch-per-unit effort. The current Kuskokwim River Sonar project began as a feasibility study in 2014, and since 2017 has produced daily and cumulative total abundance estimates (Birchfield and Smith 2019). The information provided by the BTF and Kuskokwim Sonar is adequate for making inseason run projections of total abundance, allowing fishery managers to adjust harvest as needed to increase the likelihood that escapement objectives are met. A variety of projection methods exist, but the most advanced uses Bayesian updating procedures to integrate preseason forecasts and inseason run information to estimate the most likely range of end-of-season run sizes and associated probabilities that escapement goals will be met under different harvest scenarios (Staton and Catalano 2019). Inseason harvest of Chinook salmon is monitored using commercial fish tickets (when available) and community-based harvest survey programs focused on portions of the lower Kuskokwim River where most subsistence harvest occurs (Esquible and Tiernan 2021; Liller et al. 2019; Runfola and Koster 2019; Runfola et al. 2019).

Post season projects include aerial surveys, weirs, and subsistence harvest surveys. Aerial surveys provide a standardized index (i.e., raw unexpanded counts) of Chinook salmon spawning abundance. There are 14 priority Kuskokwim River tributaries, with long-term datasets, for which one-time peak abundance surveys are flown annually. Prior to the late 1990's, numerous ground-based assessment projects were attempted, but only the Kogrukluk River weir (in the headwaters of the Holitna River drainage) has operated continuously since 1976. Since the late 1990's, the number of weirs has expanded to include up to seven tributary locations spanning the lower, middle and headwater portions of the drainage (Dickerson et al. 2019). The expansion of the ground-based assessment efforts provided standardized estimates of total escapement and age-sex-length composition for representative tributary spawning populations (Berry and Larson 2021). Subsistence harvest is estimated annually postseason through a statistically robust stratified harvest survey design (McDevitt and Koster 2022; Brown et al. 2022).

Additional assessment projects include periodic drainagewide radiotelemetry mark-recapture studies. From 2002–2007 (Schaberg et al. 2012), Kuskokwim River Chinook salmon were tagged with radio transmitters in the middle portion of the Kuskokwim River and data were used to evaluate spawning distribution, migration patterns, and estimate abundance upstream of the tag site. From 2014-2017 telemetry studies were implemented to tag fish in the lower Kuskokwim River to produce drainagewide estimates of total abundance for the purpose of better informing the Kuskokwim River Chinook salmon run reconstruction model (Clark and Smith 2019).

The Kuskokwim River Chinook salmon run reconstruction model was published in 2012 (Bue et al. 2012) and revised in 2018 (Liller et al 2018). Estimates of annual inriver abundance and escapement are made using a maximum likelihood model developed for use in data-limited situations. The model provides an approach to combine and weight available harvest, escapement, and mark-recapture information about Kuskokwim River Chinook salmon abundance to arrive at a scientifically defensible estimate of total run size and escapement. Estimates produced by the model represent the most likely run size given the observed data back to 1976. Beginning in 2014, a multi-year effort to improve the run reconstruction model was initiated and incorporated additional drainagewide abundance estimates to improve model scaling, independent expert review, and an interagency approach to implement model improvements (Liller et al. 2018).

A drainagewide escapement goal of 65,000–120,000 was established by ADF&G in 2013 (Hamazaki et al. 2012) and re-confirmed in 2019 and 2023 (Liller and Savereide 2022). The escapement goal is based on results from a Bayesian state-space spawner recruitment model and brood table dating back to 1976. The escapement goal is designated a sustainable escapement goal (SEG) because the lower bound of the goal range was set higher than the theoretical range of escapements associated with maximum sustained yield. The Kuskokwim River Chinook salmon SEG has been heavily reviewed and confirmed to be appropriate for guiding sustainable harvest. Additional independent analyses suggest that escapements within the goal range are adequate to maintain population diversity (Connors et al. 2020) and appropriate to account for changes in sex and age structure, especially when small mesh fisheries are implemented or when escapements near the upper end of the goal range are realized (Staton et al. 2021). However, consistent escapements near or exceeding the upper end of the goal range are expected to be associated with reduced production (Hamazaki et al. 2012).

In addition to the drainagewide goal, SEGs are in place for four geographically diverse tributaries representing the lower, middle, and headwater portions of the drainage (Liller and Savereide 2022).

Kuskokwim Fisheries Management

The following summarizes information contained in Chythlook 2022; Smith and Gray 2022; and Smith et al. 2022).

Chinook salmon begin entry into the Kuskokwim River in late May, peak in late June, and decline in early July. The timing of the Chinook salmon upriver spawning migration overlaps broadly with chum, sockeye, and pink salmon and is separated temporally from the later migrating coho salmon. In addition, there are numerous non-salmon species (e.g., whitefish) that are harvested for subsistence at the same time Chinook salmon migration occurs.

The ADF&G manages the Kuskokwim River salmon fishery to meet escapement goals and subsistence use priority, following the guidelines set forth in the *Kuskokwim River Salmon Management Plan* (5 AAC 07.365). The management plan was last updated in 2013, after thorough public input through the Board of Fisheries (board) process.

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Harvest of Chinook salmon have historically occurred in commercial, subsistence, and sport fisheries. Directed commercial harvest of Chinook salmon using large mesh gillnets was discontinued in 1987; although, Chinook continued to be harvested incidentally in small mesh gillnet fisheries directed at chum and sockeye salmon. Prior to 1996, the Kuskokwim River commercial salmon fishery was relatively stable. Beginning in 1997, commercial salmon fisheries on the Kuskokwim River began to decline due to a combination of factors including poor salmon markets, limited processing capacity, and periods of poor salmon runs. From 2000–2015, commercial fishing within the Kuskokwim River occurred late in the season, to avoid Chinook, and focused primarily on the late portion chum and early coho salmon runs. In most years since 2000 (e.g., 2001–2003; 2007; 2011–2015) less than 1,000 Chinook salmon were harvested incidentally in commercial fisheries. Since 2016, there has been no commercial processor operating within the Kuskokwim Management Area, and commercial harvest has been limited to a few registered catcher-sellers during the coho season. The subsistence fishery operates throughout the entire Kuskokwim River drainage, with most effort occurring in the mainstem Kuskokwim River near communities. Subsistence harvest occurs primarily with set and drift gillnets, fish wheel, and rod and reel. There is no permit required to fish for subsistence; although, a limited harvest permit can be issued in the upper portion of the drainage during times of conservation (Runfola et al. 2018). Subsistence restrictions have been required annually since about 2012 due to limited harvestable surplus. The sport harvest of Kuskokwim River Chinook salmon is relatively small and has been closed in recent years due to concurrent subsistence harvest restrictions.

Management of Kuskokwim River Chinook salmon fisheries occurs through a cooperative process. The. Kuskokwim River Salmon Management Working Group (Working Group) was formed in 1988 by the board in response to requests from stakeholders in the Kuskokwim River that sought a more active role in the management of salmon fishery resources. The Working Group is the forum through which inseason management decisions regarding Kuskokwim River subsistence, commercial, and sport salmon fisheries are discussed. A substantial portion of the Kuskokwim River flows through the Yukon Delta National Wildlife Refuge, and fishery management actions are coordinated with the U.S. Fish and Wildlife Service who has a formal partnership with the Kuskokwim River Intertribal Fish Commission. See Kuskokwim River Salmon Management Working Group meeting materials and recommendations for details. Information about these fisheries and their management through forecasts, plans, inseason actions through Emergency Orders, and history can be found in fishery management plans referenced below; via the ADF&G Emergency orders and news releases; and board meeting materials.

Kuskokwim Stock Status

A sharp decline of Kuskokwim River Chinook salmon abundance occurred in 2010 (Larson 2023). The 2012–2014 Kuskokwim River Chinook runs were the lowest estimated total runs on record. Chinook salmon runs from 2015–2018 showed improvement and have remained consistent, but they were still below the historical average. The 2019 Chinook salmon total run was near average and was the largest run observed since 2009. Chinook total runs between 2020 and 2022 declined compared to the 2019 run and were like run sizes observed during 2015–2018 (Smith et al. 2022; Larson 2023). These relatively poor runs have resulted in restrictions to subsistence fisheries and delay of chum and sockeye salmon directed subsistence and commercial fisheries to avoid incidental catch of Chinook (Smith and Gray 2022). Kuskokwim River Chinook salmon subsistence harvest has been below the established amounts necessary for subsistence (ANS) since 2011 (McDevitt and Koster 2022). Fishing restrictions have resulted in escapements that generally fall within all established drainagewide and tributary escapement goals, which have the highest potential to meet future escapement and harvest needs (Dickerson et al. 2019; Larson 2023).

The size and age at maturity of Kuskokwim River Chinook salmon has declined over time due to natural drivers that appear unrelated to fisheries selectivity (e.g., Lewis et al. 2015). Studies suggest that changes in demographic characteristics of adult spawners have resulted in reductions in stock productivity (Ohlberger et al. 2018; Staton et al. 2021).

Kuskokwim River Chinook salmon were designated a stock of yield concern in 2001, by the board, and reaffirmed in 2004. The stock of concern designation was removed by the board in 2007 following several years of historically large runs. ADF&G and the board reviewed stock status during the January 2023 meeting and determined that a stock of concern designation was not warranted because escapement goals have largely been met in recent years and stock productivity continues to support annual yield for subsistence fisheries.

Kuskokwim Regulatory Changes

1985 – Commercial fishing restricted to mesh sizes of less than or equal to six inches.

1987 – Discontinued the directed commercial Chinook salmon fishery in the Kuskokwim River.

1987 and 1993 – Positive finding for customary and traditional use for all salmon in the entire Kuskokwim Area. Confirmed in 1993 and established ANS range of 192,000 – 242,000 salmon.

2001 – Revised customary and traditional use findings to apply to individual salmon species and established ANS range of 64,000 – 83,000 Kuskokwim River Chinook salmon.

2001 – Designated Kuskokwim River Chinook salmon a stock of yield concern and prompted development of a rebuilding plan.

2001 – Adopted the Kuskokwim River Salmon Management Rebuilding Plan (5AAC 07.365)

2004 – Continued stock of yield concern designation for Kuskokwim River Chinook salmon.

2007 – Discontinued stock of yield concern designation for Kuskokwim River Chinook salmon.

2007 – Authorized up to 8-in mesh gillnets in District 1 by Emergency Order and discontinued the commercial Chinook salmon fishery closure. The intent was to provide options to effectively manage multi-species commercial salmon fisheries based on run strength and harvestable surplus.

2013 – Adopted a new Kuskokwim River Salmon Management Plan (5AAC 07.365) and established within the plan a drainagewide SEG of 65,000 – 120,000 Chinook salmon.

2013 – ANS ranges revised for Kuskokwim Chinook salmon to 67,200 – 109,800.

2013 – Rescinded regulation to allow up to 8-inch mesh gillnets in the Kuskokwim River commercial fishery. This regulatory option had not been implemented by Emergency Order.

2014 – Added dip nets as legal gear for taking salmon other than Chinook salmon during times of Chinook salmon conservation.

2014 – Authorized restricting subsistence gillnet length from 50-fathoms to 25-fathoms during times of Chinook salmon conservation.

2015 –Authorized the use of 4-inch mesh gillnets, not to exceed 60 feet in length, and to be operated as bank-oriented shore set nets during times of Chinook salmon conservation.

2015 – Authority to specify the length of gillnets used during subsistence salmon fishing periods.

2015 – Authorized the use of fish wheel chutes to allow Chinook salmon to be immediately returned to the water during times of Chinook salmon conservation.

2016 – Established regulation to annually suspend directed subsistence fishing for Chinook salmon in the Kuskokwim River until after June 11 to distribute king salmon throughout the drainage for equitable harvest opportunity and to conserve fish for escapement purposes.

2016 – During times of Chinook salmon conservation, the Kuskokwim River may be divided into five subsistence fishing sections by Emergency Order to implement geographically appropriate harvest opportunities more precisely.

2017 – Direction to provide at least one non-salmon subsistence fishing opportunity per week with 4-in or less mesh set gillnets during the regulatory front-end closure, regardless of Chinook salmon run abundance.

2017 – Established a limited household subsistence harvest permit system in the Kuskokwim River waters from the Yukon Delta National Wildlife Refuge boundary at Aniak upstream to the headwaters of the Kuskokwim River. The permit limited harvest to a maximum of 10 Chinook salmon during years when ADF&G determine adequate surplus exists.

2020 – Direction to provide at least one subsistence fishing opportunity per week with 6-in or less mesh set gillnets during the regulatory front-end closure, when the projected escapement of king salmon is above the upper bound of the drainagewide escapement goal.

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2023 Arctic-Yukon-Kuskokwim Board of Fisheries Meeting Materials

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Yukon River

The Yukon River, in Western Alaska, is the largest river in the state and the fifth-largest drainage in North America. The river originates in British Columbia, Canada, within 30 miles of the Gulf of Alaska, and flows over 3,190 km (1,980 mi) through Yukon Territory and Alaska before emptying into the Bering Sea at the Yukon–Kuskokwim Delta. It drains an area of approximately 832,700 km^2 (321,500 mi^2), of which 195,200 mi^2 lies within Alaska. Within the Canadian portion of the watershed, the Yukon River and its tributaries flow through both remote and urban environments characterized by extensive areas of pristine habit intermixed with a patchwork of historic mining and hydroelectric activity. There has been a history of industrial mining activity in tributaries of the Yukon River, in Alaska. Except for the Fairbanks North Star Borough, and surrounding areas, the Yukon River watershed in Alaska is remote and generally pristine, with few roads and little industrial development.

All five species of Pacific salmon are present in the Yukon River and support subsistence, personal use, commercial, and sport fisheries. The genetically distinct summer and fall chum salmon stocks are the most abundant salmon species returning annually to the Yukon River. The Yukon River supports a modest run of coho salmon and relatively small runs of sockeye and pink salmon. Historically, the annual Chinook salmon run was the largest in Alaska and supported one of the largest Chinook salmon subsistence salmon fisheries in the world and a prolific commercial fishery.

Management of the Yukon River salmon fishery is complex because of many factors, including difficulties in determining stock-specific abundance and timing, overlapping multi-species salmon runs, increasing efficiency of the fishing fleet, the gauntlet nature of the fisheries, allocation issues between lower and upper river Alaska fisheries, allocation and conservation issues between Alaska and Canada, and the immense size of the drainage. Management of Canadian-origin Chinook salmon is governed by the Pacific Salmon Treaty, Yukon River Salmon Agreement (YRSA) between the U.S. and Canada.

Yukon Stock Assessment Overview

Yukon River Chinook salmon return to spawn in over 200 tributaries (Brown et al. 2017) which aggregate into genetically distinct management stocks (Lee et al. 2021). At its most base level, the genetic baseline for Yukon River Chinook is used to differentiate U.S. from Canadian-origin fish, which is critical for carrying out the terms of YRSA. Within Alaska, the genetic baseline can differentiate lower and middle stock groups. Depending on the application, more fine-scale stock reporting is possible. In-river harvest management decisions are based on stock-specific run and escapement information, requiring a robust annual assessment program.

ADF&G and numerous partner organizations have assessed Yukon River Chinook salmon since statehood using a variety of methods. For simplicity, the assessment program can be summarized by projects designed to provide preseason, inseason, and post season information. Furthermore, assessment methods can be broken into harvest and escapement monitoring.

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Preseason run predictions for the total Yukon River and the Canadian-origin Chinook salmon stock are produced annually to inform early season harvest management decisions. Preseason forecasts for the Canadian-origin stock are produced by the bilateral (U.S./Canada) Yukon River Panel, Joint Technical Committee (JTC 2023). The JTC uses three separate models to forecast adult returns of the Canadian-origin stock: a spawner-recruit production model; a sibling age-class model; and a marine juvenile abundance model (Howard et al. 2020). The three models are integrated into a single forecast using Bayesian statistical techniques. The total run forecast of all Yukon River Chinook salmon stocks is prepared jointly by ADF&G and the National Oceanic and Atmospheric Administration using a marine juvenile abundance model (Howard et al. 2020). The marine juvenile models predict adult returns up to three years in advance, providing opportunities for proactive fishery management and research coordination. Additionally, adult Chinook salmon run timing across the Yukon River Delta (Mundy and Evenson 2011) is predicted preseason by the Alaska Ocean Observing System.

In 2022, the JTC Chinook Salmon Escapement Goal Subcommittee produced a comprehensive summary of all available U.S. and Canadian abundance data, age, and stock composition information useful for reconstructing historical stock-specific run, harvest, and escapement information (Pestal et al. 2022). That document presents details about historical and current project methods and abundance trends. The following is a summary of inseason and postseason assessment activities in Alaska.

Inseason projects include a mainstem test fishery, two mainstem sonars, genetic stock apportionment, and harvest reports. The Lower Yukon Test Fishery (LYTF) began in 1963 and methods were modified over time to provide daily and cumulative gillnet catch-per-unit-effort indices of run timing and relative abundance at several Yukon River mouth distributaries. The Pilot Station Sonar is located at river kilometer (rkm) 197 and has used sonar, drift gillnets, and stock apportionment techniques to produce stock-specific estimates of daily and cumulative Chinook salmon passage since 1986 (Morrill et al. 2021). The Eagle sonar is in Alaska, downriver from the international border, and has used sonar and gillnet catches to estimate daily and cumulative abundance of the Canadian stock entering Canada since 2005 (McDougal and Brodersen 2020). Inseason harvest of Chinook is monitored using commercial fish tickets and a weekly public teleconference including subsistence harvesters and stakeholders from all Alaskan and Canadian communities.

Post season projects include aerial surveys, weirs/sonars, and subsistence harvest surveys. Aerial surveys provide a standardized index (i.e., raw unexpanded counts) of Chinook salmon spawning abundance. There are three priority Yukon River tributaries, with long-term datasets, for which one-time peak abundance surveys are flown annually. Ground based assessment using weirs/sonars is conducted annually within tributaries of the Andreafsky, Koyokuk, and Tanana River drainages. These ground-based assessment efforts provide standardized estimates of total escapement and age-sex-length composition (Hamazaki 2018; Larson 2020) for representative tributary spawning populations. Postseason subsistence harvest is estimated annually through a statistically robust stratified subsistence harvest survey (Padilla et al. 2021; Brown et al. 2022).

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The age and genetic composition of the inriver run (Lee and Clark 2023) and subsistence harvest has been estimated (Larson et at. 2020). Composition and harvest data are combined annually to estimate the stock origin of the commercial and subsistence fisheries (Larson et al. 2020).

Additional assessment projects include drainagewide mark-recapture studies, fish health assessments, smolt outmigration studies, marine surveys. From 2002–2004, Yukon River Chinook salmon were tagged with radio transmitters in the lower portion of the Yukon River and data were used to evaluate spawning distribution, migration patterns, and estimate abundance upstream of the tag site (Spencer et al. 2009). ADF&G is currently undertaking a 2023-2025 telemetry effort to monitor upriver migration survival. Extensive fish health studies were conducted addressing high priority topics including *Ichthyophonus* disease (JTC 2011), heat stress (von Biela et al. 2022), and thiamine deficiency (Larson and Howard 2019). ADF&G and U.S. Fish and Wildlife Service are currently undertaking a 2022-2024 study to develop an annual Chinook salmon *Ichthyophonus* monitoring program. Smolt outmigration timing and condition have been monitored since 2014 (Howard et al. 2017; Weiss and Miller 2023). Standardized marine trawl surveys in the Northeastern Bering Sea have been conducted since 2002 and have provided information on juvenile Yukon River Chinook salmon abundance, distribution, diet, and condition (Howard et al. 2020, Garcia and Sewall 2021). Information from marine and freshwater research programs are actively reviewed to determine Yukon Chinook salmon critical life history stages and potential drivers of production (e.g., Howard and von Biela 2023).

ADF&G and the JTC have developed a multi-stock Yukon River Chinook salmon run reconstruction model published in 2021 (Hamazaki 2021) and expanded in 2022 (Connors et al. 2023). Simultaneous estimates of stock-specific total abundance and escapement are available for the lower, middle, and Canadian stock components using a Bayesian model developed for use in data-limited situations. The model provides an approach to combine and weight available harvest, escapement, mainstem sonar, mark-recapture, and genetic information about Yukon River Chinook salmon abundance to arrive at a scientifically defensible estimate of total run size and escapement. Estimates produced by the model represent the most likely run size given the observed data back to 1981. For the Canadian-stock component, run reconstruction results were integrated with a state-space spawner recruit analysis to describe the stock production dynamics and estimate biological reference point useful for establishing spawning escapement goals (Connors et al. 2023). The model results were found to be scientifically sound and appropriate for informing management by a bilateral U.S./Canada peer review process facilitated by the Canadian Science Advisory Secretariat (see supplemental documents associated with Connors et al. 2023).

Escapement goals have been established for Yukon River Chinook salmon (Liller and Savereide 2022). Sustainable escapement goals (SEG) are established for four lower river tributaries and are representative of the lower U.S. stock group. Biological escapement goals (BEG) are established for two Tanana River tributaries and are representative of the middle U.S. stock group. Escapement objectives for the Canadian-origin stock are established by the bilateral Yukon River Panel (Panel) based on recommendations from the JTC. From 2010-2022, the Panel established an interim management escapement objective (IMEG) of 42,000-55,000 Canadian-origin Chinook salmon (JTC 2023). The JTC has determined that this goal range is higher than what would theoretically be associated with maximum sustainable yield and serves as a sustainable escapement goal. The Panel did not establish a new escapement objective for the 2023 season and the Canadian-origin stock continues to be managed for the 42,500-55,000 IMEG.

Yukon Fisheries Management

Yukon River Chinook salmon have the longest spawning migration of any salmon. Chinook salmon begin entry into the mouth of the Yukon River in late May, peak in late June, and decline in mid-July. Chinook salmon migrate at a rate of approximately 40 miles (64 km) per day. As such Chinook salmon arrival to upriver locations is dependent on distance traveled. For example, it takes Canadian-origin Chinook salmon about 30 days to swim from the lower Yukon River to the international border. In the lower river, the timing of the Chinook salmon upriver spawning migration overlaps broadly with summer chum, sockeye, and pink salmon and is separated temporally from the later migrating fall chum and coho salmon. Summer chum, pink, and sockeye salmon are largely absent upriver from the Tanana River confluence, due to their natural distribution patterns. In all areas of the river, there are numerous non-salmon species (e.g., whitefish) that are harvested for subsistence or personal use at the same time Chinook salmon migration occurs (Gryska and Baker 2022; Ransbury et al. 2022; and Stuby 2022).

The Yukon management area is divided into seven districts, 10 subdistricts, and 31 statistical areas for management, regulatory, and reporting purposes. Districts include the Coastal District; Districts 1-5 numbered sequentially from the mouth of the river to the Canadian border; and District 6 in the Tanana River. The level of granularity allows for fine-scale management actions to affect harvest and/or conservation as required to achieve escapement goal and YRSA objectives.

In addition to the U.S. fisheries, Aboriginal, commercial, sport, and domestic salmon fisheries occur in the Canada portion of the Yukon River drainage. The Department of Fisheries and Oceans, Canada conducts the corresponding fishery management activities. Details about fisheries management in the Canada portion of the Yukon River drainage can be found in the annual Yukon River Panel Joint Technical Committee (JTC) reports (e.g., JTC 2023).

Conservative management of the Yukon River is required to achieve spawning escapement goals, ensure sustainable yield, and maintain a subsistence harvest priority. ADF&G uses an adaptive management strategy that evaluates run strength inseason to determine a harvestable surplus above escapement requirements. The primary tools used by ADF&G to manage Chinook salmon fisheries are management plans and commercial guideline harvest ranges established by the Board of Fisheries (board), Emergency Order authority to implement time and area openings/closures and gear restrictions. The Chinook salmon run is managed according to the guidelines described in the *Yukon River King Salmon Management Plan* (5 AAC 05.360), the *Tanana River Salmon Management Plan* (5 AAC 05.367), the *Chena and Salcha River King Salmon Sport Harvest Management Plan* (5 AAC 74.060), and YRSA under the Pacific Salmon Treaty. Alaskan management plans include reducing fishing mortality to meet spawning escapement goals, providing opportunity for subsistence users to harvest levels within the ANS range, and reestablishing the historical range of harvest levels by other users to the extent possible. Objectives set out in YRSA are fundamentally associated with sharing the burden of conservation and sharing harvestable surpluses above escapement needs. For the U.S., one of the more prominent annual YRSA objectives is to deliver enough Canadian-origin Chinook salmon to the Canadian border to achieve the escapement objective and Canadian harvest share.

Directed commercial harvest of Yukon River Chinook salmon, has not occurred since 2007. Beginning in 2008 all commercial harvest of Yukon River Chinook salmon was incidental in small-mesh gillnet fisheries directed at summer chum salmon. Beginning in 2011, sale of incidental Chinook salmon harvest was prohibited, except for a few exceptions in large run years or in the fall season. Beginning in 2013, ADF&G began providing summer chum salmon commercial opportunities with beach seines, dipnets, and fish wheels and requiring the live release of all Chinook salmon. The use of live release gear provided economic benefits while also protecting Chinook salmon. No commercial salmon fisheries for any species occurred from 2020-2023 due to concurrent low runs of Chinook and summer chum salmon.

Chinook salmon is the most targeted subsistence species by number of participants. Subsistence stakeholders target Chinook salmon throughout the Yukon River drainage and coastal waters (Brown et al. 2022). Prior to 1998 and in years with adequate Chinook salmon run sizes, intensive management of subsistence fisheries was not necessary. In 1998, Chinook salmon productivity began declining, and run sizes were considerably weaker than historical runs; the most dramatic drop in run sizes began in 2007. Since 2008, Chinook fishing restrictions, in addition to those imposed by the regulatory subsistence fishing schedule, have been necessary for most years to meet escapement goals. Beginning in 2012, intensive subsistence fishery management was required, including full fishing closures around pulses of fish, fishing time reductions, gear restrictions, and full fishing closures for Chinook salmon most of the summer season. Chinook run sizes began to rebound in 2016, and restrictions were relaxed. By 2019, subsistence harvests reached the highest harvest since 2007. Chinook run abundance took a dramatic downturn in 2020 and severe harvest restrictions were required from 2020-2023. No directed salmon fishing opportunities were provided in 2021 or 2022, and the ongoing 2023 season started closed.

Management of Yukon River Chinook fisheries occurs through a cooperative process. Most notably the Panel process brings together multiple agencies, advocacy groups, and stakeholders from the U.S. and Canada to implement the terms of YRSA. Within Alaska, the Yukon River drainage includes a patchwork of Federal lands, requiring close coordination with the U.S. Fish and Wildlife Service. Preseason and weekly inseason teleconferences are facilitated by the Yukon River Drainage Fisheries Association as a platform for sharing management, scientific, and local/traditional knowledge. ADF&G engages regularly with State Advisory Committees and the public, through the board process.

Information about these fisheries and their management through forecasts, plans, inseason actions through Emergency Orders, and history can be found in the Yukon River References section below.

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Yukon Stock Status

Historically, the Yukon River Chinook salmon run was one of the largest in Alaska, but all stock components have experienced a prolonged period of low production and decreasing run sizes since the early 2000s (Jallen et al. 2022; Connor et al. 2023). On average, the Canadian stock produces the largest annual run sizes of three primary stock components, followed by the lower river stock, and then the middle river stock. Annual run sizes are moderately correlated among stocks, such that periods of high and low abundance are geographically similar over time. Large run sizes were observed from 1981-1997. During this period, total run (all stocks combined) averaged about 390,000 fish of which 30% was lower river stock, 25% was middle stock, and 45% was Canadian. From 1998-2000, all stocks experienced a steep decline, with the 2000 run size (129,000 fish) being the smallest on record at that time. Run sizes quickly rebounded to historic levels by 2003, after which, abundance steadily declined over the next 10 years. The 2013 run (100,000 fish) was the smallest on record at that time. From 2014-2019, run sizes rebounded to about half of their historic levels. Beginning in 2020, all stocks declined, culminating in a record low run size of only 37,000 fish in 2022 (i.e., 15,200 lower stock; 8,500 middle stock; and 13,300 Canadian). The run sizes referenced here are from the JTC multi-stock run reconstruction model and differ slightly from other estimates. The overall temporal trends and relative magnitude of changes in abundance are consistent across data sets.

In contrast to run size, total and stock-specific escapements have been relatively stable over time (Connors et al. 2023), due to harvest reductions and conservative escapement-based management (Jallen et al. 2022; Ransbury et al. 2022). Fishing restrictions have resulted in escapements that generally fall within established tributary escapement goals and meet YRSA objectives, which have the highest potential to meet future escapement and harvest needs. From 2014-2018, conservative harvest management resulted in escapements near the upper end of most Alaska tributary goal and exceeded YRSA border passage and escapement objectives (Jallen et al. 2022; JTC 2023). On the contrary, record low runs in 2020-2022 were not large enough to achieve goals despite severe restrictions and complete closures to salmon fisheries in Alaska and Canada.

The size and age at maturity of Yukon River Chinook salmon has declined over time due to natural drivers that appear unrelated to fisheries selectivity (e.g., Lewis et al. 2015). Studies suggest that changes in demographic characteristics of adult spawners have resulted in reductions in stock productivity (Ohlberger et al. 2020; Conners et al. 2023).

The board classified Yukon River Chinook as a stock of yield concern in September 2000. This determination as a stock of yield concern was initially based on low harvest levels from 1998–2000 and anticipated low harvest in 2001. The board continued the classification as a stock of yield concern in 2004, 2007, 2010, 2013, 2016, and 2019. Most recently, ADF&G and the Board reviewed the stock of concern designation in 2023. Based solely on escapement and harvest over the prior 5-year period, an argument could have been made to remove the stock of yield concern designation. However, the marine juvenile forecast indicated that Chinook salmon returns were likely to remain at a low level of productivity for the next three years. Therefore, the yield concern classification for the Yukon River Chinook stock was continued.

Yukon Regulatory Changes

There have been numerous regulatory changes to improve sustainable management of Yukon River Chinook salmon. A detailed summary of these changes is available in the Yukon stock status and annual management reports prepared by ADF&G (Jallen et al. 2022). Here, we provide a summary of the most notable changes that occurred since the board designated Yukon River Chinook salmon a stock of yield concern in 2000 and an initial action plan was adopted in 2001.

2001 – In response to the stock of yield concern designation, the Yukon River King Salmon Management Plan was modified to clarify management objectives and allocate guideline commercial harvest amongst districts and subdistricts.

2001 – Numerous changes to subsistence fishing gear to be implemented during times of salmon and Chinook salmon conservation.

2001 – Adopted regulations that defined subsistence harvest of Chinook salmon as primarily human food.

2010 – Effective in 2011, a maximum gillnet mesh size of 7.5-inches was established for subsistence, commercial, and personal use fisheries. Previously mesh size was unrestricted.

2010 – Emergency Order authority to prohibit sale of incidentally harvested Chinook salmon.

2010 – Emergency Order authority to close all salmon fishing in a district or portion of a district if run assessment information indicates an insufficient abundance of Chinook salmon.

2012 – Established options to require Chinook salmon release from commercial fish wheel harvests directed at summer chum salmon.

2013 – Require first pulse protection in the Chinook salmon management plan regardless of preseason run forecasts.

2013 – Prohibit the sale of Chinook salmon from the Yukon River drainage if Chinook salmon escapement goals are not going to be met or subsistence salmon fishing is restricted in more than one district or portion of a district.

2013 – Several commercial fishing gear changes to provide options for targeting summer chum salmon in Districts 1-3 and District 6 during times of Chinook conservation, including: small mesh gillnets, beach seines, dip nets, and “fish friendly” fish wheel specifications.

2016 – Require the live release of Chinook salmon from beach seines during times of Chinook salmon conservation for subsistence and commercial fisheries.

2018 – Removed the mandatory closure on the first pulse of Chinook salmon in Districts 1 and 2, directed the Chinook salmon run be managed conservatively, and required first pulse closure in Districts 1 and 2 if annual forecasts indicate a poor run of Chinook salmon.

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2018 – Specified Chinook salmon caught incidentally in commercial fisheries may be sold if Chinook salmon escapement goals are projected to be met, subsistence fishing is not restricted, and subsistence fishing opportunity for Chinook salmon has been provided within the season.

2019 – During times of Chinook salmon conservation, fish wheels must be closely attended, and all Chinook salmon must be immediately released to the water alive by means of a chute, net, or tote, and may not enter any live box.

2019 – Added dip nets to the list of legal gear types subsistence fishers may use for salmon. Additionally, during times of Chinook salmon conservation, the retention of Chinook salmon from dip nets, beach seines, or fish wheels may be allowed by Emergency Order.

2023 – During times of conservation gillnets may be required to be operated as a set net and be limited in distance from the shore.

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Alaska Ocean Observing System – Yukon River Chinook Run Timing

APPENDIX C

Norton Sound– Unalakleet River

The Unalakleet River is a remote salmon spawning system in western Alaska that drains into the southeastern portion of Norton Sound. The Unalakleet River and its six major tributaries have a drainage area of 2,815 km^2. The river runs for approximately 130 river miles (210 rkm) before emptying into the Bering Sea near the village of Unalakleet. Habitat throughout the drainage is considered pristine, and the upper 81 miles (130 rkm) have been designated a National Wild River. There are no roads or industrial development within the drainage, except in the village of Unalakleet.

All five species of Pacific salmon are present in the Unalakleet River and have historically supported subsistence, commercial, and sport fisheries. Chum and pink salmon are the most abundant salmon species returning annually to the Unalakleet River. The drainage supports a modest run of coho salmon and a small run of sockeye salmon. Chinook salmon abundance in the Unalakleet river is relatively small compared to other species. However, Unalakleet River Chinook salmon are one of the most northerly coastal populations in the world and is the largest, and most important, Chinook salmon run in Norton Sound.

Management of Unalakleet River Chinook salmon is complex due to the remoteness of the drainage; multiple species with overlapping run timing, separation between where harvest and assessment occurs; inability to genetically differentiate between Unalakleet Chinook salmon and other Chinook salmon populations in Norton Sound.

Unalakleet Stock Assessment Overview

Chinook salmon return to spawn in small numbers throughout Norton Sound, with the largest populations occurring in southeastern Norton Sound, Unalakleet and Shaktoolik rivers. Current genetic baselines are unable to differentiate Unalakleet Chinook salmon from other Norton Sound Chinook salmon populations in mixed fisheries occurring in nearshore marine waters (Templin et al. 2011). In most applications, Norton Sound Chinook are grouped genetically with other Costal Western Alaska stocks, except the Yukon River. Tagging studies conducted in the late 1970s suggested nearshore marine waters of the Unalakleet Subdistrict are a mixing area for multiple populations and stocks (Gaudet and Schaefer 1982). Fish captured in the Unalakleet Subdistrict marine waters are believed to be primarily fish bound for the Unalakleet River; however, a percentage are thought to return to the nearby Shaktoolik River to the north and the Yukon River to the southwest.

ADF&G and numerous partner organizations have assessed Unalakleet River Chinook salmon, since statehood, using a variety of methods. Formal preseason forecasts of Unalakleet River Chinook salmon are not produced, but general outlooks are prepared based on prior year abundance and escapement trends. From 1981-2013, a small-mesh set gillnet test fishery was conducted near the mouth of the river to provide an index of salmon timing and abundance. Sonar was attempted, unsuccessfully, in three years. Historically, escapement was monitored using aerial surveys. However, water clarity and channel morphology make aerial surveys challenging, except in clearwater tributaries like the North and Old Woman rivers. As such, aerial survey data are inadequate for analyses. Currently, inseason escapement information is collected from two ground-based escapement monitoring projects, which are incomplete until the entire run is evaluated post-season. A counting tower was installed on the North River and operated intermittently from 1972-1986 and operated continuously since 1996 (Bell and Leon 2018). The North River tower operates from late June to early September and provides a standardized estimate of total Chinook salmon escapement to that system. In 2010, the Unalakleet River weir was installed 13 miles (22 km) upriver from the mouth and nine miles upriver from the confluence with the North River. The weir operates from late June through mid-August to encompass the entirety of the Chinook salmon run (Bell and Leon 2018; Bavilla and Leon 2019). Telemetry studies conducted in 1997, 1998, 2009, and 2010 indicated that the North River escapement made up 34%-54% of the total escapement to the Unalakleet River (Joy and Reed 2014). However, recent comparisons between tower and weir counts indicate a high level of variability in the percentage of the escapement past each project. The sum of Chinook salmon escapements from the North River tower and Unalakleet weir represents the total escapement to the Unalakleet River drainage. Age-sex-length data are collected from all ground-based escapement locations.

Commercial and subsistence harvest of Unalakleet River Chinook salmon occurs annually. Commercial harvest is documented on fish tickets when fisheries occur, and commercial catch and effort statistics are used to inform inseason run strength. Subsistence salmon harvest surveys have been conducted sporadically since statehood. In 2004, annual post season subsistence salmon household surveys began in Unalakleet. In addition to annual household surveys, from 1985-2012, daily surveys of Unalakleet River and ocean subsistence fishery participants were conducted after fishing periods, during the Chinook salmon run. Effort and catch information from these daily surveys were used inseason to judge the timing and magnitude of the Chinook salmon run. These surveys were discontinued because major reductions to subsistence fishing time and gear restrictions limited the utility of the data.

Efforts to reconstruct Unalakleet River Chinook salmon total abundance and escapement have occurred. Prior to 2010, when only the North River tower operated, total escapement was derived by expanding North River tower counts to the total Unalakleet River drainage based on aerial survey or telemetry results. Since 2010, the North River tower and Unalakleet River weir escapements were summed to represent total escapement. The total annual run is then the sum of total escapement and Unalakleet Subdistrict commercial and subsistence harvests. A variety of assumptions about marine harvest proportions have been explored to reconstruct total run, develop brood tables, and evaluate spawner-recruitment dynamics (e.g., Estensen and Evenson 2006; Schindler et al. 2013). The length of the total run datasets varies depending on assumptions but go back at least as far as 1996.

Additional studies focused on Unalakleet River Chinook salmon include investigations of female fecundity (Bell and Kent 2012) and egg thiamine levels. (Larson and Howard 2019).

A sustainable escapement goal (SEG) exists for North River Chinook salmon, based on historical percentiles of tower counts. The percentile method used to establish the goal may not be optimal given the low contrast observed throughout the time series and high harvest rates in some years. However, the SEG is the only formal basis that currently exists for evaluating adequacy of escapement to sustain harvest. ADF&G plans to review the North River SEG, establish an escapement goal for the Unalakleet River upriver from the weir, and consider options for a Unalakleet River drainagewide goal (Liller and Savereide 2022).

Unalakleet Fisheries Management

Information contained in this summary is documented in Clark 2022, Menard et al. 2022, and Scanlon 2022.

The Unalakleet River Chinook salmon stock has been subjected to substantial commercial, subsistence, and sport fisheries in the past. Nearly all commercial and subsistence users are residents of the village of Unalakleet. The commercial harvest occurs by set gillnet in the coastal marine waters around the mouth of the Unalakleet River. Subsistence users fish in the coastal marine waters near the mouth of the river and in the lower parts of the Unalakleet River (Magdanz et al. 2005). Users of the sport fishery include residents of Unalakleet, and fishermen who fly in to take advantage of several guide services. The sport fishery occurs in the main river from the mouth up to the Chiroskey River and several kilometers up the North River.

Unalakleet River Chinook salmon is managed following the guidelines outlined in the *Subdistricts 5 and 6 King Salmon Management Plan* (5 AAC 04.395), that was first implemented during the 2007 season. The plan is conservative and intended to result in increased Chinook salmon escapements. Under the plan, commercial and subsistence fishery management guidelines encompass both subdistricts 5 (Shaktoolik) and 6 (Unalakleet) because it is thought the salmon bound for Unalakleet and Shaktoolik rivers intermingle in the marine waters of these districts (Gaudet and Schaefer 1982; Estensen and Evenson 2006).

Subdistricts 5 and 6 consistently attract commercial markets due to larger fish volumes and better transportation services. Inseason management of the commercial fishery switches species focus throughout the season, with an early emphasis on Chinook salmon, switching to chum salmon around July 1, then gradually shifting to coho salmon during the fourth week in July. Pink salmon are abundant during even-numbered years, but often, no buyer is available for this species except as incidental harvest in other salmon directed fisheries. Under the management plan, directed commercial Chinook salmon fishing can only occur if the midpoint of the North River tower SEG range is projected to be reached. If the escapement goal range is not expected to be met, commercial fishing periods for any species are not allowed until after June 30. Commercial fishing in the Norton Sound area, by regulation, is conducted with set gillnets. Management actions include emergency orders to open or close fishing seasons and periods and to establish gillnet mesh size specifications. In Subdistricts 5 and 6, 8.25-inch stretched mesh gillnets are commonly used when Chinook salmon fishing occurs in June through early July. During years when large pink salmon runs occur and there is buyer interest, ADF&G restricts gillnets used to 4.5-inch mesh or less.

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The subsistence fishery in Subdistrict 6 uses gillnets in the coastal marine waters near the mouth of the Unalakleet, and to a lesser extent, in the main river. The management plan directs ADF&G to provide escapement windows by restricting subsistence gillnet fishing for salmon from mid-June to mid-July to two 48-hour fishing periods a week in marine waters and two 36-hour fishing periods a week in Unalakleet River. Subsistence fishing time can only be liberalized if ADF&G projects that the lower end of the SEG range for North River Chinook salmon passage will be achieved. If ADF&G projects that the lower end of the SEG range for North River Chinook salmon passage will not be achieved, ADF&G is directed to close the Chinook salmon subsistence fishery.

Declines in total run size of Unalakleet River Chinook salmon have resulted in commercial fishery closures for Chinook salmon and a reduction in salmon harvest in Subdistricts 5 and 6. Commercial harvest of Chinook salmon in Subdistricts 5 and 6 has been incidental to directed chum, pink, and coho salmon fisheries since 2001, except for a small directed commercial harvest of Chinook salmon in 2005. In response to conservative management, commercial harvests of Chinook salmon during the 2018–2022 period declined 92% compared to the 1994–1999 historical commercial harvest average.

Although subsistence Chinook salmon harvests have decreased in Subdistricts 5 and 6, the decrease was not as dramatic as the commercial harvest. Subsistence fishing closures in Subdistricts 5 and 6 were implemented in 2003, 2004, and annually since the 2006 season, except for 2019–2021, because of difficulty achieving the North River tower SEG and low Unalakleet River weir escapement counts of Chinook salmon. Chinook salmon subsistence harvests over the 2018–2022 period declined 66% from the 1994–1999 historical subsistence harvest average.

Unalakleet Stock Status

Subdistricts 5 and 6 Chinook salmon were designated as stocks of yield concern in 2004, and the Alaska Board of Fish continued this designation in 2007, 2010, 2013, 2016, 2019, and 2023. Chinook salmon escapements to the Unalakleet River have been highly variable and achievement of the North River SEG has been inconsistent. The North River SEG has only been met in two of last five years (2018–2022) and 10 of the 23 years (1999–2022) since the goal was first established. However, escapements in 2018 and 2019 were two of the three largest since 1996. Chinook salmon escapement upriver of the Unalakleet River weir have ranged between 1,290 in 2022 and 9,956 in 2019.

Although historical total run data are limited, there is evidence of a 64% decline in total run from 1997 and 1998 compared to present (Clark 2022). Productivity of Unalakleet River Chinook salmon has declined and is not currently sufficient to support a commercial fishery, nor customary subsistence levels (Schindler et al. 2013). While productivity does not currently support use, sufficient numbers are present to provide for the long term sustainability of this stock.

Unalakleet Regulatory Changes

2004 – Adopted regulations restricting subsistence gillnet mesh size to 6-inches or less by Emergency Order during times of Chinook salmon conservation.

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2004 – The sport fish daily bag and possession limit was reduced from 11 to 2 Chinook salmon, only one of which may exceed 20-inches in length.

2004 – The sport fish annual limit was reduced to 4 Chinook salmon greater than 20-inches, of which only two can be taken from the North River.

2007 – A more conservative regulatory management plan was implemented which included:

- Implementation of a subsistence fishing schedule of two 48-hour periods per week in marine waters and two 36-hour periods per week in the Unalakleet River drainage.
- The sport fish annual limit for Chinook salmon greater than 20-inches was reduced to two.
- If the North River Chinook salmon escapement goal was not projected to be achieved, all Chinook fisheries will be closed.
- A commercial king salmon fishery of no more than two 24-hour periods per week may be opened only if the midpoint of the escapement goal is projected to be achieved.
- Subsistence gillnet mesh size may be restricted to 4.5-inches or less to allow for pink salmon fishing while conserving Chinook salmon.

2007 - Regulations allowed for cash sales of up to $200 of subsistence-taken finfish per household, per year, in the Norton Sound–Port Clarence Area, which was increased in 2013 to $500.

2013 – A directed pink or chum salmon commercial fishery may open prior to July 1 if there were no mesh size or fishing period reductions in the Chinook salmon marine subsistence fishery.

2013 – Sale of Chinook salmon caught incidental in chum and pink commercial fisheries was prohibited unless the mid-point of the Chinook escapement goal is projected to be achieved.

2016 – Adopted regulations allowing beach seine gear in Subdistricts 5 and 6 commercial chum and pink salmon fisheries requiring all Chinook salmon to returned to the water alive.

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Emergency orders and news releases

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2019 Arctic-Yukon-Kuskokwim Board of Fisheries Meeting Materials

2023 Arctic-Yukon-Kuskokwim Board of Fisheries Meeting Materials