UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

November 21, 2017

Dan Hull, Chairman
North Pacific Fishery Management Council
605 West 4th Avenue, Suite 306
Anchorage, Alaska 99501

Re: Review of an Exempted Fishing Permit application to test upgraded salmon excluder device designs on trawl vessels targeting pollock in the Bering Sea from 2018 through 2020.

Dear Chairman Hull:

On August 15, 2017, NMFS received an application from John Gauvin on behalf of the Gauvin and Associates, LLC, for an exempted fishing permit (EFP). We are providing the application to the U.S. Coast Guard, State of Alaska, and the North Pacific Fishery Management Council (Council), as required by 50 CFR 600.745(b)(3)(i) and 50 CFR 679.6(c)(2). This EFP would allow the operators of three vessels named on the EFP to test improvements to current salmon excluder device designs in the winter Bering Sea pollock trawl fishery from 2018 through 2020. The purpose of the experiment is to continue the development and testing of salmon excluder devices on vessels from three different horsepower and size classes in the fishery to identify upgraded excluder design(s) and specific rigging configurations most likely to produce the greatest relative reduction in Chinook salmon bycatch rates, while maintaining the potential for the full harvest of the pollock total allowable catch (TAC) within specified prohibited species catch (PSC) limits. Issuance of EFPs is authorized by the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area and its implementing regulations at 50 CFR 679.6, Exempted Fisheries.

On November 6, 2017, the Alaska Fisheries Science Center found the EFP application constitutes a valid fishing experiment appropriate for further consideration. The study conducted under this EFP would focus on Chinook salmon escapement and would occur in areas of overlap between pollock and high salmon concentration during the Bering Sea pollock trawl fishery's "A" season (January 20 through June 10) each year from 2018 through 2020. The EFP would allow crew members to insert upgraded salmon excluder devices into a pollock trawl net with improved camera and lighting systems to monitor the flow of salmon and pollock within the net and the level of escapement through the excluder portal during normal fishing operations. The effectiveness of the excluder devices would be monitored under a set of systematic vessel operations for each vessel class.

The EFP would exempt the participating vessels from certain regulations for observer requirements (§§ 679.50), Steller sea lion conservation area restrictions (§§ 679.22(a)(7)(ii) and (vii)), groundfish TACs (§ 679.20(a)(5)(i)), and PSC limits (§ 679.21). Catcher/processors would not be exempt from observer requirements for non-EFP fishing during trips in which both EFP and non-EFP fishing occurs.

After reviewing the proposed EFP in relation to NOAA Administrative Order (NAO) 216-6A, NMFS has determined that the proposed EFP research would not have a significant effect on the human environment. Specifically, the proposed action falls into the category of actions subject to categorical exclusion identified in Appendix E of NOAA's Companion Manual for NAO 216-6A, B12, for the issuance of EFPs.

We are initiating consultation with the Council by forwarding the application, as required by 50 CFR 679.6(c)(2). We understand that you have scheduled Council review of the proposed project at the Council's December 2017 meeting. Please notify John Gauvin, of Gauvin and Associates, LLC, of your receipt of the application and invite him to appear before the Council during the December meeting in support of the application. We will publish a notice of receipt of the application in the *Federal Register* with a brief description of the proposal.

Sincerely,

James W. Balsiger, Ph.D.
Administrator, Alaska Region

Enclosures:
EFP Application
AFSC memorandum of approval of the experimental design
Categorical Exclusion supporting this proposal

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Seattle, Washington 98115-6349

November 6, 2017

MEMORANDUM FOR: James W. Balsiger
Administrator, Alaska Region

FROM: Douglas P. DeMaster
Science and Research Director, Alaska Region

SUBJECT: Exempted Fishing Permit application from Gauvin and Associates for Continuation of the Salmon Excluder Device Testing

The Alaska Fisheries Science Center (AFSC) has reviewed the attached Exempted Fishing Permit (EFP) from Gauvin and Associates (Gauvin). The AFSC finds the experimental design to be valid for the stated objective of continuing the testing of a salmon excluder device.

The overall goal is for the trials to culminate in an excluder design that effectively and reliably allows for salmon escapement for all vessel types, and under certain conditions. For the success of this project, Gauvin requests the EFP vessel be exempted from regular observer coverage requirements for vessels when participating in our salmon excluder EFP field tests.

The AFSC requests clarification on the following items. When a participating vessel is conducting a mixed EFP-AFA trip, will the number of observers and sea samplers be two each? The AFSC requests that, if there are only two observers covering both EFP duties and required observations, Gauvin work with the AFSC to devise a plan for the observers to separate required observations and EFP duties. Finally, the AFSC seeks clarification as to if flow scale and video monitoring regulations would continue to apply. If so, the AFSC requests confirmation that testing of the flow scale will be done every 24 hours and that participating vessels will ensure all cameras are in working condition.

With the above issues addressed, the AFSC recommends approval of this EFP application and looks forward to working with Gauvin on this project.

CC: F/AKC6 – C. Rilling, L. Thompson
F/AKC – J. Napp, N. Yochum
F/AKR – B. Mansfield

November 3, 2017

MEMORANDUM FOR: The Record

FROM: James W. Balsiger, Ph.D.
Regional Administrator, Alaska Region

SUBJECT: NEPA Categorical Exclusion for an Exempted Fishing Permit to Test Salmon Excluder Devices that Reduce Chinook Salmon Bycatch on Bering Sea/Aleutian Islands Pollock Trawl Vessels; RIN 0648-XF760

The National Oceanic and Atmospheric Administration's (NOAA) Environmental Review Procedures for Implementing the National Environmental Policy Act, NOAA Administrative Order (NAO) 216-6A, dated April 22, 2016, NOAA's Companion Manual for NAO 216-6A dated January 13, 2017, and Council on Environmental Quality regulations require all proposed projects to be reviewed with respect to environmental consequences on the human environment.

Description of the Action

NMFS received an application for an exempted fishing permit (EFP) from John Gauvin of Gauvin and Associates, LLC on August 15, 2017. The objective of the requested EFP is to test refinements to existing salmon excluder devices on vessels in different horsepower and size classes within the fishery to identify the excluder design(s) and rigging that are most likely to produce the greatest relative reductions in Chinook salmon bycatch rates. The current, most effective salmon excluder designs and rigging configurations are proposed to be refined and tested systematically under conditions that approximate as closely as possible actual commercial fishing practices in the Bering Sea pollock trawl fishery. Testing would be conducted each year from 2018 through 2020 during the fishery's winter "A" season from January 20 through June 10.

The experiment would be conducted on vessels authorized to fish in the Bering Sea pollock trawl fishery. Tests would be performed in each of the following three vessel classes: 1) catcher vessels equal to or less than 1,800 horsepower, 2) catcher vessels greater than 1,800 horsepower, and 3) catcher processors. Experimental methods specify that each device and specific adjustments to be tested be inserted into a pollock trawl net with improved camera and lighting systems to monitor 1) the flow of salmon and pollock within the net and 2) the level of escapement through the excluder portal during normal fishing operations. The effectiveness of the excluder devices will be monitored under a set of systematic vessel operation types for each vessel class. Improvements in Chinook salmon escapement and pollock retention rates for these excluder devices would provide an enhanced opportunity to minimize Chinook salmon bycatch in the Bering Sea pollock fishery to the extent practicable, while maintaining the potential for the full harvest of the pollock total allowable catch within specified prohibited species catch limits.

During an EFP fishing trip, a permitted vessel and its operator would be exempt from the applicability of the following regulations:

> **§ 679.7(a)(2):** which prohibits the conduct of fishing contrary to notification of inseason action, closure, or adjustment issued under § 679.20, § 679.21, § 679.22, and § 679.25, as applied to the specific regulations detailed below. This exemption is necessary to allow the permit holder to fish in a manner that would encounter higher concentrations of Chinook salmon for testing the excluder device.
>
> **§ 679.7(a)(3)(i)**: which prohibits fishing for groundfish except in compliance with the terms of the Groundfish and Halibut Observer Program.
>
> **§ 679.7(a)(16):** which prohibits retention of groundfish bycatch that exceeds the maximum retainable amount. This exemption is necessary to allow EFP-permitted vessels to account for and weigh all groundfish catch under the EFP.
>
> **§ 679.20(d):** an exemption related to the previous exemption at § 679.7(a)(16). During an EFP fishing trip, the permit holder and participating vessels are exempt from § 679.20(d)(1)(iii)(B) for pollock and other groundfish caught as an incidental species. Section 679.20(d)(1)(iii)(B) states "Except as described in § 679.20(e)(3)(iii), if directed fishing for a target species or species group is prohibited, a vessel may not retain that incidental species in an amount that exceeds the maximum retainable amount, as calculated under paragraphs (e) and (f) of this section, at any time during a fishing trip." This exemption will allow an EFP-permitted vessel to exceed the maximum retainable amount for species listed in Table 11 to Part 679 during EFP fishing.
>
> **§ 679.21(b)(2)(i):** requirement to minimize catch of prohibited species, because this project will, by implication, require vessel operators to conduct EFP testing in areas and modes of fishing that otherwise increase the chances of Chinook salmon encountering the trawl net and salmon excluder device. The implication to capture Chinook salmon is inconsistent with this regulation. This exemption will only apply during EFP fishing.
>
> **§ 679.21(f):** The exempted fishing under the terms of this permit is exempted from the Bering Sea salmon bycatch management program. The program includes a Chinook salmon prohibited species catch limit of 60,000 Chinook salmon and a performance standard of 47,591 Chinook salmon. NMFS annually allocates the prohibited species catch limit to sectors, cooperatives, and Community Development Quota groups that participate in an industry-developed incentive plan agreement, which provides incentives for each vessel to avoid Chinook salmon and chum salmon bycatch. During the period that the vessels authorized under this permit are engaged in exempted fishing, these provisions of the program at paragraphs (f)(1) through (f)(15) do not apply. This exemption is necessary to allow for a sufficient number of Chinook salmon to enter the

trawl net and encounter the salmon excluder during the testing of the salmon excluder device to meet the sampling design requirements of the EFP.

§ 679.22(a): Experimental fishing under the terms of this permit is authorized in the Bering Sea subarea, including the areas otherwise closed to fishing with trawl gear under 50 CFR part 679: § 679.22(a)(7)(ii). Exempted fishing must be conducted outside Steller sea lion protection areas closed to pollock trawl fishing, as described at § 679.22(a)(7), except the sector closure of the Steller Sea Lion Conservation Area (SCA) under § 679.22(a)(7)(vii)(C)(*2*). The SCA exemption will only apply as long as the combined amount of pollock taken from the SCA does not exceed the 28 percent annual total allowable catch limit (TAC) before April 1, as specified in the Steller sea lion protection measures (§§ 679.20(a)(5)(i)(C) and 679.22(a)(7)(vii)).

§ 679.50: except as described in this permit, observer requirements at § 679.50 while conducting activities under this EFP..[1]

Effects of the Action

Salmon excluder device experiments were conducted by members of the pollock trawl sector under EFP 08-02, EFP 11-01, and EFP 15-01 in 2008, 2013 through 2014, and 2015 through 2016, respectively, in the Gulf of Alaska and the Bering Sea and Aleutian Islands management areas. Under EFP 11-01 Chinook salmon and pollock escapement rates of 33 to 54 percent and 1 to 9 percent, respectively, were achieved in tests in the Central Gulf of Alaska. Tests under EFP 15-01 in the Bering Sea resulted in salmon and pollock escapement rates of 3.4 to 18.1 percent and 0.6 to 2.2 percent, respectively. The experiment conducted under the proposed EFP in the Bering Sea would be expected to improve Chinook salmon escapement achieved under EFP 15-01 in the Bering Sea, with the goal of approaching or improving on rates achieved under 11-01 in the Gulf of Alaska.

The EFP would apply during the Bering Sea pollock trawl fishery's winter "A" season in 2018, 2019, and 2020 in areas open to directed fishing for pollock. Following the practice that the North Pacific Fishery Management Council and NMFS have approved for past EFP experiments dedicated to salmon bycatch reduction, groundfish and prohibited species taken during the experiment would not be counted against the annual TAC and prohibited species catch (PSC) limits (65 FR 55223, September 13, 2000). The final 2018 Bering Sea pollock harvest specifications were published on February 27, 2017 (82 FR 11830). The acceptable biological catch (ABC) level is 2,979,000 mt, and the TAC is 1,345,000 mt. Up to 2,500 mt of pollock per year would be allowed to be harvested under the proposed EFP without accruing against the Bering Sea pollock TAC. That amount equates to 0.08 percent of the 2018 Bering Sea pollock ABC, 1.8 percent of the TAC, and 1.5 percent of the difference between the ABC and the TAC. The ABC and TAC levels for 2019 and 2020 would be set under the normal harvest

[1] The vessel owners or operators are exempt from selected observer requirements at §§ 679.50, 679.51, and 679.55, while conducting activities under this EFP. Instead, the catch and discards will be monitored by "sea samplers" who are NMFS-qualified observers hired to provide the data collection and sampling support for the experiment. However, the sea samplers will be considered NMFS observers for purposes of §§ 679.53 and 679.7(g), and the permit holder is required to comply with these provisions for their sea samplers.

specifications setting process as stipulated at § 679.20. If Bering Sea pollock ABC and TAC levels for those years are similar to 2018, the amount of pollock taken under the EFP would represent similarly low fractions of the ABC and TAC.

The incidental take of salmon during the experiment is crucial for determining the effectiveness of the excluder device. The EFP would allow for the take each year of up to 600 Chinook and 600 non-Chinook (primarily chum) salmon, based on the estimated amount of salmon required to meet the needs of the experimental design. This is the same level of Chinook and non-Chinook salmon take authorized under EFP 15-01 for the Bering Sea pollock "A" season. That level of Chinook take would be equivalent to approximately 1.8 percent of the 2016 Chinook salmon bycatch in the BSAI groundfish fisheries for all gear and 2.7 percent of the Chinook salmon bycatch in the 2016 Bering Sea pollock fishery. The five-year average (2012 through 2016) of Chinook salmon bycatch in the Bering Sea pollock trawl fishery is 15,933, and 600 Chinook would be approximately 3.8 percent of this five-year average. The limit for Chinook salmon taken in the Bering Sea pollock fishery is 60,000 fish based on BSAI FMP Amendment 91 (75 FR 53026, August 30, 2010). If Chinook salmon bycatch amounts in 2018 through 2020 are similar to amounts caught under EFP 15-01, the amount of Chinook salmon taken under the EFP and in the Bering Sea pollock fishery is not likely to exceed Chinook salmon bycatch limits under Amendment 91. The number of non-chinook salmon requested reflects the level expected to be encountered during experimental tows during the Bering Sea pollock "A" season based on past EFPs. This level would be 2.12 percent of the most recent five year average (282,439) of non-chinook salmon bycatch for all BSAI groundfish fisheries and 2.15 percent of the most recent five year average (278,637) of non-chinook salmon bycatch for the Bering Sea pollock fishery.

NMFS has completed Environmental Assessments under the National Environmental Policy Act for previous salmon excluder EFPs.[2], each of which included a finding of no significant impact under the National Oceanic and Atmospheric Administration Administrative Order (NAO) 216-6 (May 20, 1999) criteria for determining the significance of the impacts of a proposed action and under the Council on Environmental Quality regulations at 40 CFR1508.27, which provide context and intensity criteria for significance determinations. The proposed EFP would be of limited scope and duration and would not appreciably alter trawling by the pollock catcher vessel or catcher/processing sectors, including fishing location, timing, effort, or authorized gear types. Harvest levels may be increased slightly, since catch under the EFP would not accrue against any groundfish TACs or PSC limits, but would be well below the Bering Sea pollock ABC levels. Consultations completed under section 7 of the Endangered Species Act for ESA-listed species that may be affected by the action have determined that the proposed EFP was not likely to adversely affect those species. For these reasons this EFP would not have any significant effects on the environment.

Extraordinary Circumstances

[2] The Environmental Assessments for EFPs 15-01, 13-01, and 11-01 may be found at https://alaskafisheries.noaa.gov/analyses/search

This action can be reviewed independently from other actions. Additionally, I considered the context in which the action could have extraordinary circumstances listed in NOAA's Companion Manual for NAO 216-6A Section 4 and expect no extraordinary circumstances.

Based on the description of the action and its anticipated effects set out above, I have determined that the proposed action has no potential for significant adverse effects on human health or safety; areas with unique environmental characteristics; species or habitats protected by the Endangered Species Act, the Marine Mammal Protection Act, the Magnuson-Stevens Act, or the Migratory Bird Treaty Act; or properties listed or eligible for listing on the National Register of Historic Places. Furthermore, this action has no potential to generate, use, store, transport, or dispose of hazardous or toxic substances. Nor is there the potential to cause disproportionately high and adverse effect on the health or the environment of minority or low-income communities, compared to the impacts on other communities. This action will not contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species. The action does not pose a potential violation of Federal, State, or local law or requirements imposed for protection of the environment; involve environmental effects that are highly controversial, uncertain, unique, or unknown; establish a precedent or decision in principle for future actions, or result in cumulative significant impacts.

Categorical Exclusion

As defined in Section 4 and Appendix E of NOAA's Companion Manual for NAO 216-6A, this action is categorically excluded from the need to prepare either an Environmental Assessment or an Environmental Impact Statement. Specifically, the proposed action falls into the category of actions subject to categorical exclusion identified in Appendix E of NOAA's Companion Manual for NAO 216-6A, B12, for the issuance of EFPs.

Bmansfield 10/24/17; rev 11/30/17
GHarrington 10/26/2017
GAberle 11/2/2017

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Request for an exempted fishing permit (EFP) to continue work with the Bering Sea pollock fishery to increase Chinook salmon escapement rates with improved salmon excluders

Date of Application: August 15, 2017

Name, mailing address, and phone number of applicant:

Signature of Applicant:

EFP Applicant and Principal Investigator:
John R. Gauvin
Gauvin and Associates LLC
2104 SW 170th Street
Burien, WA 98166
(206) 660-0359

Collaborators:

Mr. John Gruver, United Catcher Boats Association

Dr. Noelle Yochum, RACE Division, Alaska Fisheries Science Center

Ed Richardson, At-Sea Processors Association

Motivation: The case for additional work on a salmon excluder for the Bering Sea pollock fishery

Looking at Chinook (*Oncorhynchus tshawytscha*) bycatch data for the previous five Bering Sea winter/spring seasons (January through April, AKA the pollock "A" season) one can see that Chinook salmon bycatch rates have been increasing (see figure below).

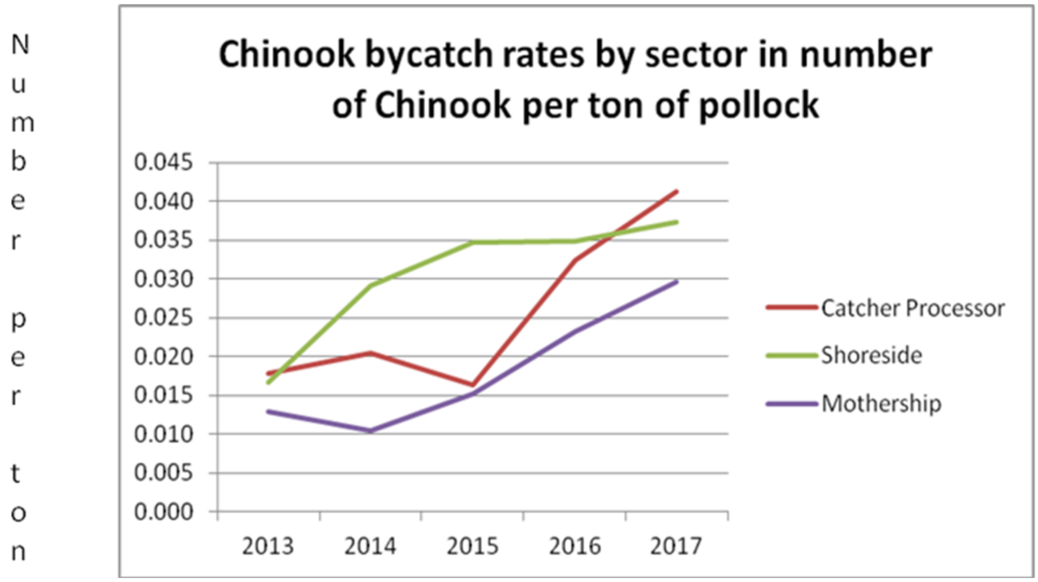


Fig 1. Bering Sea "A" season Chinook bycatch rates (number per metric ton of pollock) for catcher-processor, catcher vessels delivering to motherships, and catcher vessels delivering shoreside 2013-2017.

At a recent salmon excluder workshop in May 2017 in Seattle, WA organized by investigators on this proposal, many Bering Sea pollock captains indicated that they think the upward trend in Chinook bycatch rates is driven by a steady increase in Chinook salmon abundance. They attribute this to improved ocean conditions for stocks that inhabit the Bering Sea in their sub-adult phase. Increasing abundance has captains concerned that existing tools such as data sharing for hotspot avoidance, rolling closures, and salmon excluders may not be sufficient to allow the industry to harvest its pollock under bycatch control measures in place under Amendment 91. This concern is further fueled by the fact that a few pollock vessels in the fleet have reportedly already come close to their vessel-specific bycatch allowances during this past A season, completed in April. Others are concerned they will not be able to stay under their Chinook allowances for 2017 despite all their efforts to avoid catching Chinook salmon.

To fully understand the unease pollock captains have for the downstream effects of what appears to be increasing Chinook abundance, it is important to consider how salmon bycatch management measures affect the pollock fishery. Because the principle approach of controlling bycatch is to move away from bycatch hotspots, pollock fishermen believe they will be spending more and more time/resources moving away from salmon. This is problematic because areas of relatively high salmon abundance can be the same areas with otherwise good pollock fishing and/or high-valued roe bearing pollock. This tends to defeat the main intent of the American Fisheries Act, which is to create an increase in economic value by giving fishermen the ability to go fishing when/where it makes economic sense. This challenge is magnified by the relatively weak prices for pollock over the last few years. In this setting, fuel is one of the principle costs affecting vessel profit margins, especially for catcher vessels. To help preserve the bottom line, pollock captains are eager to avoid the costs of unnecessarily relocating the vessel to avoid salmon bycatch.

A more effective salmon excluder could therefore help mitigate the consequences of increasing salmon abundance for the pollock fishery by keeping rates low enough in some areas where salmon bycatch rates would otherwise be too high for a vessel to continue fishing. Based on results from the last two salmon excluder EFP tests conducted by North Pacific Fisheries Research Foundation (NPFRF), Bering Sea salmon excluders are not performing with the same consistency and efficacy as those in the Gulf of Alaska (GOA) pollock fishery. Specifically, in the 2013-2014 NPFRF testing the central Gulf of Alaska, escapement of up to 35%-55% for Chinook was achieved with the most promising result in the fall of 2014 with mean escapement at close to 55%. By contrast, the 2015-2016 NPFRF EFP in the Bering Sea showed much lower salmon escapement rates for the three size classes of vessels participating in the study (see Figure 2 below). Bering Sea A season results (where Chinook escapement is the main salmon species taken as bycatch) ranging from of 7-18%. Figure 2 shows that even the upper end of the range of escapement rates for Bering Sea boats are still well under mean escapement rates achieved in the GOA. As illustrated, not only are mean rates of escapement lower, but variability associated with Bering Sea trials is higher.

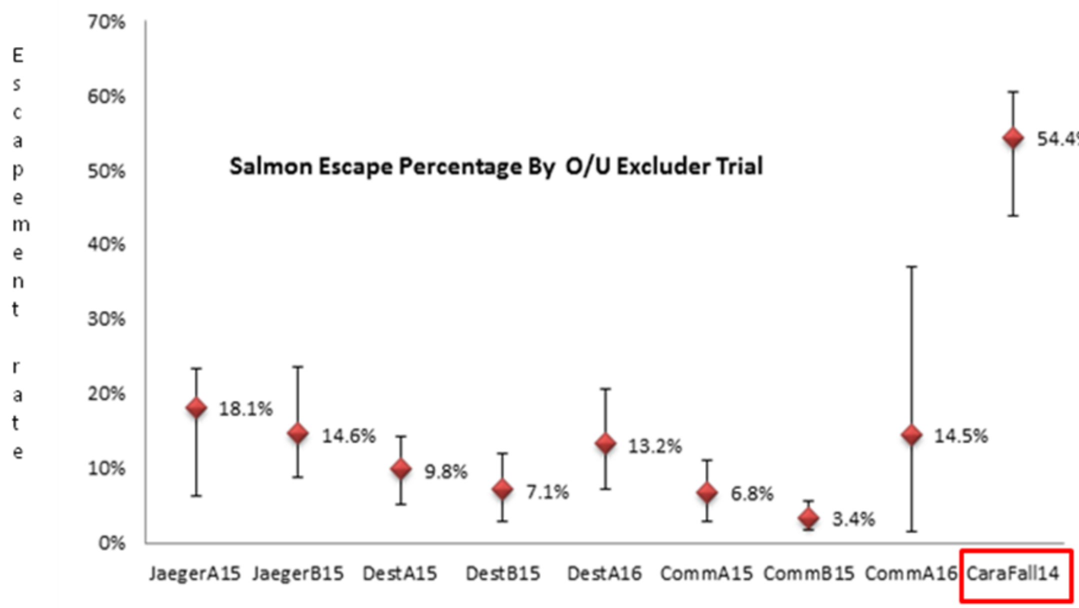


Figure 2 Percent of salmon that escaped during EFP trials, listed by vessel, year (2014, 2015, 2016), and season (A and B). Vessels conducting trials in the Bering Sea include the C/P *Northern Jaeger* ("Jaeger"), C/V *Destination*, and C/V *Commodore*. The result shown in the figure from the GOA (outlined in red) occurred in the fall of 2014 aboard the C/V *Caravelle.* Note that Chinook is the principle bycatch species year round in the Gulf of Alaska pollock fishery. Confidence intervals in the figure (α= 0.05) illustrate between-tow variability in escapement rates.

In considering escapement rate differences between the GOA and Bering Sea, it is worthwhile noting that the trials were conducted employing the same excluder design (the "over and under" excluder) and the same testing methods. While the same excluder was used in both the Gulf of Alaska and Bering Sea, the excluder was "scaled up" to be of appropriate size for the larger size/horsepower of Bering Sea pollock vessels. Previous trials have not always allowed for direct comparisons of the same excluder/testing methods. For this reason, results shown are a very useful for comparison. Also of note was that the GOA tests showed more consistent escapement rates on a tow by tow basis, hence relatively narrower confidence intervals. NPFRF feels that lower variability in escapement rates is an important indicator of effectiveness because it gives fishermen more confidence that the excluder will reliably exclude salmon, which affects the captain's decision making process for consideration of whether he needs to move the vessel to an alternative fishing location.

The topic of the status of excluders in the face of increasing Chinook abundance was discussed at the aforementioned salmon excluder workshop. The purpose of the workshop was to better understand what fishermen have been doing to adapt and improve excluders in the Bering Sea pollock fishery since the last Bering Sea EFP and to solicit ideas for further improvements. The workshop generated a high turnout among leaders in the fishing, scientific, and technology development communities, leading to a great deal of information exchange, feedback, and new ideas. A detailed summary of the May 2017 salmon excluder workshop is attached to this application.

One of the main 'take-home' messages from the excluder workshop was that fishermen and gear manufacturers have ideas for improvements to existing excluders, and are interested in doing more work to improve escapement (including additional efforts with lighting systems). It was clear from the workshop that there are new, innovative ideas for approaching salmon excluder development. Most importantly, attendees expressed a strong interest in new efforts to improve excluders, and believe that better salmon escapement rates are attainable through the use of excluders. Most workshop attendees agreed that systematic testing of excluders (both through individual sector efforts and NPFRF's efforts across all sectors) and technical support with video equipment/review of video footage have been critical to the progress made on excluder design and use. They also expressed the opinion that systematic testing often cannot be achieved well on vessels involved in the regular pollock fishery due to inability to slow down and do systematic testing.

This need for systematic gear trials is the primary motivation for using an EFP as the vehicle for further excluder development and field testing. An EFP field test is not as constrained by the economic operating margins of the regular fishery where slowing down costs the boat money. Participating vessels can focus more on testing according to the prescribed protocol. Although this slows them down, they get to, in exchange, catch additional groundfish to defray the costs of participation. Another advantage to testing with an EFP is that there is an upfront commitment to fishing systematically and to following the testing protocol with oversight to ensure it occurs. In the regular fishery, captains often change the rigging or other aspects of the excluder on a tow by tow basis based on what they see on that haul. Setting up the experiment under an EFP allows for more rigorous scientific design.

An additional benefit of the EFP for this research is that participants are provided exemptions to fish in areas of higher abundance of salmon than would otherwise be possible under Amendment 91 bycatch controls. Based on past experience, this appears to increase the chance that excluder performance can be determined in a statistically valid manner within a reasonably short duration of time devoted to field testing. The separate allowance for salmon under the EFP allows for increased power (i.e., higher and more consistent encounters with salmon per tow hence better sample sizes) to detect statistically significant differences.

For all of the reasons indicated above, Bering Sea pollock fishermen are interested in being directly involved with and carrying out further research to improve salmon excluders to reduce Chinook bycatch under an EFP. They recognize that this is a necessary step in generating the data necessary for furthering the development of salmon excluders. At the excluder workshop, many expressed the view that NPFRF's previous EFP work has been instrumental to the industry's ability to improve the performance of salmon excluders in the past, and that further EFP research is needed to continue along that path towards reliable and effective excluders.

<u>EFP objectives and plan for achieving them</u>:

Our previous EFP work has shown that excluder performance variability in the Bering Seas is strongly linked to the size/horsepower of the vessels. Recognizing this important covariate, <u>the goal of this EFP is to work with fishermen from the different horsepower/size classes of the Bering Sea pollock fishery to identify which excluder design(s) and what specific rigging applied to them are most likely to produce the greatest relative improvements in terms of reductions in Chinook bycatch rates</u>. Excluder designs and rigging configurations identified by fishermen as "promising" will be tested systematically in field tests under conditions that approximate as closely as possible actual commercial fishing practices in the Bering Sea pollock fishery. This will be done in 2018, 2019, and 2020, with results from each year guiding the design, for each vessel size class, to be tested the subsequent year. The field testing will provide data and information to evaluate the performance of each excluder/ rigging combination. These data will be disseminated to the fishery through follow up workshops after each field season of the EFP. Ideas for improvements from the subsequent workshops based on what was learned from the data and fish behavior video will be used through an interactive process of field trails and workshops to make consensus-based changes in the excluder design and rigging to be tested in the following field seasons. This process will be followed to hopefully achieve significant improvements to excluder performance for each specific size classes for the Bering Sea pollock fishery.

Specific steps to attain objectives are as follows:

1) Prior to first field testing in late winter of 2018, we will organize meetings with captains and other representatives of each vessel size class in the Bering Sea pollock fishery (small catcher vessels, CV, = <1,800 HP, large CV =>1,800 HP, and catcher processors, CP). These meetings will be used to generate a short list of the most promising ideas for improvements to existing excluders or new designs for each vessel size class grouping. Discussions with meeting attendees will result in the selection of the highest priority excluder design/rigging combination to be field tested in the EFP the first field season. A trip to the flume tank in St. Johns Newfoundland to look at models of designs of interest and a Cooperative Research Workshop in the fall of 2017 will also provide additional

venues for discussions of excluder designs to prioritize for the first season of field testing.

2) We will conduct three field seasons of testing for each excluder set up and vessel size class using methods described below. The first season will start with the most promising idea and the agreed upon excluder rigging set-up (e.g., how much weighting on the excluder panels and/or how much artificial light). The second and third field seasons will test adjustments to the initial device/set up based on what was learned in the initial field tests.

3) We will analyze data from each field test at the completion of each field testing season, and will present findings to the pollock fishing industry and interested public as soon as the results are available. Through improved data collection and analysis described below, we expect this study to be more definitive as to the factors affecting performance than in previous EFP research.

4) We will draft a final report to convey our methods and results which will include a description of our process to determine which excluder designs/rigging to test and each iterative change based on what was learned in the field testing stages of the EFP. The analysis will include an improved data analysis described below where we anticipate being able for the first time to evaluate escapement with respect to what was going on in the net and with the vessel speed etc. at the specific time of the escapement occurred. We expect this to result in a much-improved analysis of how covariates affect performance than was possible in the past with "averaged" vessel speed, groundfish catch rates, and other data for analysis of covariates in our past EFPs. The end result should be a more definitive assessment of factors affecting escapement which is turn should help to better inform which excluder designs and fishing practices are most important for improving excluder performance in the future.

Table 1 below illustrates the major steps and milestones that will be undertaken to accomplish the objectives of this EFP

Activity	Nov-Dec 2017	Jan-Mar2018	May-Sept 2018	Nov-Dec 2018	Jan-Mar2019	May-Sept 2019	Nov-Dec 2019	Jan-Mar2020	May-Dec 2020
Meetings to discuss most promising excluder options per vessel class	x								
Flume tank trip to develop excluder designs of interest from meetings	x								
AFSC Cooperative Research workshop	x								
Construction/rigging of excluders for testing		x							
NMFS panel selects the 3 vessels for the 3 seasons of field testing		x							
First season of field testing		x							
Video review and data analysis			x						
2nd meetings with CP, LCV, SCV to discuss results, prioritize changes				x					
Construction/adjustment of excluders for 2nd field season					x				
2nd field testing season					x				
Video review and data analysis						x			
3rd meetings with CP, LCV, SCV to discuss results, prioritize changes							x		
Construction/adjustment of excluders for 3rd field season							x		
3rd field testing season								x	
Video review and data analysis									x
Final meetings with CP, LCV, SCV to discuss results									x

Testing Methods

<u>Overview:</u>

When considering the methods described below, we think it's important to keep in mind that cooperative research with the pollock industry on a salmon excluder straddles the line between science and an iterative process that needs to engage and retain the commitment of fishermen whose knowledge is critical to the eventual success of the excluder designs. Fishermen depend on excluders to help them avoid the consequences of catching too many Chinook salmon under the cap and rolling closure program. So the incentives for fishermen to want to participate are clear. At the same time, from a scientific perspective we know that seasonal and year-to year variability, vessel size/horsepower, and other vessel and net-specific factors affect excluder performance. From a pure science perspective, therefore, we would want to hold an excluder design/rigging constant for testing across vessel size classes for several fishing seasons. This would hopefully control for sources of variability affecting excluder performance independent of the excluder design itself. The problem with that approach in our context, however, is that under some scenarios doing so would likely diminish the buy-in from fishermen to the point where there might be not be much willingness to devote the time and energy to develop ideas through the process outlined above to improve/perfect those designs.

In the extreme we know from our experience that fishermen will not be willing to collaborate in a process involving multiple tests of the same exact excluder that does not perform well in the initial trial. This stems from the practical perspective that an effective excluder would be highly likely to show some promising selectivity in the initial trial and if it does not show much promise right out of the blocks it probably never will be a workable design. In our experience, however, fishermen are reasonably willing to do repeated trials on an excluder works the first time. At that point it seems they will invest the time because they want to see if performance will hold up over different seasonal fishing conditions so they can rely on that in the fishing decisions they make.

This background is offered to assist with the collective understanding of the testing methods described herein noting that we have used the same approaches over multiple EFP projects and we have had considerable success determining excluder performance and retaining a good cooperative working relationship with fishermen over time. For this reason, this EFP also employs a "progression" approach wherein an agreed upon starting point for an excluder design/rigging is determined from feedback from the meetings with fishermen in each vessel size class. Adjustments to that initial starting point are made based on performance data. If the initial trials show little promise then the second round of testing will start with a new design. This iterative process has been used in all of our salmon excluder trials since 2006 and the progression process is more formalized in this EFP than before based on feedback from the recent salmon excluder workshop mentioned above.

After the initial trials, consensus modifications will be made based on the data and experience from the field trial. In this regard we expect the performance data this time to be more useful than our interim analyses in the past reflecting the improvements in our methods to assess performance through the use of "real time" information about what was occurring at the time of escapements, near escapements, or lack of escapement in the net and with the vessel towing the net. Additionally, we expect that the cameras collecting data on fish behavior will once again provide useful information to fishermen about how fish behave as the attempt to escape. This is obviously a supplement to the escapement performance data for fishermen to think about how to modify the excluder and its rigging to make it work better in this progression. Overall, this collaborative and iterative approach has worked in past to allow for an assessment of excluder performance with useful confidence intervals on salmon escapement rates. It has also achieved solid buy-in from industry and we expect that the improvements we are making to process in this EFP will increase that success.

In summary, we think it is important to make clear that we recognize the potential scientific value of holding factors constant in repeated scientific trials to account for the potential effects of seasonal variability in the conditions affecting salmon abundance and therefore salmon excluder performance. Our testing methods attempt to incorporate as much standardization and control to account for seasonal variability and other sources of inherent variance. To help control factors to the extent possible, we will keep the same test vessels, same trawl doors and nets (the net itself not the excluder), the same codends, towing speeds, and other factors in our control as constant as possible over each of the three testing seasons.

At the same time, to rigorously look at how seasonal variability affects excluder performance from a scientific perspective would potentially mean keeping the same exact excluder and rigging over several seasons even if that excluder did not work in the first season. This would be fine with fishermen under the scenario where performance in the initial trial achieve reasonable selectivity. In fact, encountering that very situation in its initial testing of an over and under design excluder in NPFRF’s excluder trials in the Gulf of Alaska EFP in 2013-2014, we had full support of our industry collaborators for holding that excluder constant over repeated trials because there was considerable interest in knowing whether the 35-50% rate the escapement was a fluke or not (it was not). But in the case where the starting point for the excluder proves not to be an improvement over current Bering Sea designs (or it underperforms the current designs), we will not make multiple trials of an excluder/rigging configuration.

For additional context, it is important to point out that fishermen in their *ad hoc* trials would and typically do make changes to the excluder they are working on (outside an EFP) after as little as one or two tows. This is done when they see things aren’t working from the number of salmon they are catching or some relatively small amount of video data they have collected. So in reality, getting fishermen to hold the excluder and rigging constant for one complete seasonal trial in the context of this EFP is already seen as an accommodation for the purposes of systematic testing by fishermen. We know from experience that fishermen are willing and committed to doing this and understand its importance.

With the background above, we also recognize that a great deal of specific detail on methods for determining escapement rates for pollock and salmon in our EFPs is already written up in the final report for EFP 15-01. That material covers in detail how different excluders were tested, how testing protocols were designed and followed, how vessels were selected to participate in the EFP, etc. Given this, we focus here on providing explanations where we are proposing to make small modifications to the methods from EFP 15-01 based on the recommendations from the final report for that EFP and other lessons learned/new ideas/improvements in equipment since that EFP.

Improvements for collecting data to determine salmon and pollock escapement rates: The general approach to tracking escapement relies on underwater recording video cameras deployed in nets by field project managers. NPFRF's work on field testing excluders started with recapture nets more than a decade ago, but concerns from pollock fishermen that recapture nets affect escapement rates led to the use of underwater camera systems to track escapement. This also became more possible with improved capabilities of video systems that can be deployed on fishing nets in recent years.

For the proposed EFP research, the camera installations will be where we can best collect definitive data on escapement. We are prioritizing this because at times in the past it has been difficult to know for sure whether salmon moving towards the escape hole have actually left the net, due mainly to limitations in the distance cameras can record with sufficiently clear visibility to determine whether fish are actually outside the net. To collect information on fish behavior and shape of the excluder and net near the escapement portal(s) we will rely on different cameras installed expressly for that purpose.

Information on success rate with the camera system used in the last Bering Sea EFP is reported on page 15 of the final report for that project (Table 2), which we have excerpted below. "Success" in this context is the proportion of tows where the video camera(s) collected data sufficiently to determine salmon escapements throughout the entire duration of the haul. The success rate ranged from 85% -100% of the EFP tows by testing season and participating EFP vessel. The overall success rate for all vessels and testing seasons was 95% based on the overall number of tows for EFP 10-01. This relatively high rate of success was due to NPFRF's use of two cameras at each escapement portal which was expensive in terms of equipment and video review costs but rather worthwhile as it turned out because the "redundant" camera covered for most of the times when the main camera failed. While a fairly high overall success rate, in the worst vessel-specific case at least we had a failure rate of 15% and this required us to drop several of the EFP tows from the analysis.

Percentage of EFP tows with complete video per vessel per testing season

	A 2015	B 2015	A 2016
CV Commodore	100%	95%	95%
CV Destination	90%	96%	85%
CP N. Jaeger	97%	96%	100%

Table 2. Camera performance assessment over the seasonal testing (A and B seasons) for vessels that participated in EFP 15-01.

With the goal of improving camera system performance for this proposed EFP research, NPFRF has been working since the last EFP with a deep-sea video/monitoring equipment company called Williamson and Associates located in Ballard, WA. This company has significant experience with collection of video at depths far greater than those fished in the pollock fishery. With Williamson and Associates we have recently completed this *Beta*-testing a new design of underwater camera system. Trials show that the new cameras will significantly reduce the issues experienced during research from the past two EFPs. The new systems are fully contained inside a 3 inch diameter tubular aluminum case (hence referred to as “tube cameras”).

These “tube- style” cameras have a viewing portal that allows the camera lens to collect video through the center of the tube. From our experience this is preferred for both tracking fish escapement and looking at fish behavior in pollock nets due to ease of installation in the net and efficiency of aiming at the desired area of the net. This style of camera also largely avoids the often-encountered problem of fish becoming pinned on a flat surface thereby blocking the view.

Tube cameras were used in the previous two EFPs. These first generation cameras have since been improved. The new camera systems (the *Beta* version of our new camera is seen in the figure below) have a sapphire crystal portal in the middle of the strong metal housings, a major upgrade in strength and resilience. Battery capacity to power the lights, camera, and recorder has been upgraded to approximately 12 hours of continuous operation on a reliable basis (compared to typically less than eight hours with the former systems). This aligns better with towing times under realistic fishing conditions, especially in summer when tow duration is longer (up to 8 hours per tow is not uncommon). In addition to the gains in durability and battery capacity, the most important upgrade with these systems is that data downloads and charging are done through an external USB port. In the past, downloads and charging required the camera tube be opened each time. While faster in terms of turn-around, the need to open the cameras for each recharge/data download led to failures of the seals to seat correctly at times thus leading to flooding and system failures.

Fig 3 *Beta* version of the tube camera developed by Williamson and Associates that will be used to quantify salmon and pollock escapement in the proposed EFP research.

Data collection methods for this EFP will reflect lessons learned during previous EFP studies. Specifically, all video data will have a synchronous time stamp so that escapement events can be tracked with other potentially useful data collected simultaneously. The additional data collected along with the video of escapements will include instantaneous vessel speed, relative volume of fish flowing through the net where the excluder is installed, shape of the net where the excluder is installed, and other information that we think could be important for understanding how, when, and hopefully "why" excluders work or fail to do so.

Following each EFP season, our field technicians will review the video and count salmon and pollock escapement. For pollock, the average length of the fish in the codend will be converted to estimate weight of pollock loss. We feel comfortable with this approach because, during our earlier testing that relied on recapture nets, size distribution of escaping pollock closely mirrored that of retained pollock. Salmon escapement will continue to be monitored and accounted for by number, but not species because species cannot always be determined from underwater video. As was done in the past, escapement rate analysis will assume that the predominant species of escapement will be Chinook during the A season fishing because winter/spring is when Chinook is the predominant species of salmon bycatch in the Bering Sea pollock fishery. Further, the fraction of retained Chinook versus non-Chinook salmon species in the codend will also be calculated per field test to help ensure this assumption about seasonality of salmon bycatch species remains accurate.

In reviewing the video footage, NPFRF's field project managers will write down the time corresponding to escapements from the time indicator that is stamped to the video. Times of near escapements and other "events of interest" such as salmon moving back through the net with no apparent notice of/effort to use the excluder will also be recorded during the video review process. Having these events in a time-referenced format will allow us to evaluate them in the context of what was going on relative to fishing conditions. The intent here is to use these "auxiliary" data to enhance our understanding of what results in escapements and what does not. These covariate data will include, relative volume of fish moving through the excluder section at a specific time, time-referenced speed over ground for the vessel, shape of the excluder over time during each tow, fishing depth over time, sea state, and time of day.

We anticipate that inclusion of covariate data into the analysis will not only greatly enrich our understanding of factors that affect escapement, but will also increase our power to detect significant relationships between the covariates and escapement. At this time we anticipate using binary logistic regression to evaluate covariates but we will be working with our collaborator from the Alaska Fishery Science Center's RACE Division (Dr. Noelle Yochum) to refine approaches to the covariate analysis once we have some data from the initial field season. The importance of the covariates was discussed in detail in the final report for the 2015-2016 EFP (see EFP 15-01) and these additions to data collection and the analysis are in response to what was learned from the findings of EFP 15-01. For example, these additional data will allow us to evaluate the way pollock catch rates affect salmon (and pollock) escapement rates. Without having data to track instantaneous catch rates, our analysis had to rely on average pollock catch rates (total catch divided by towing hours). This may well have affected our ability to evaluate the linkage between pollock catch rates and salmon escapement in previous EFP studies because inherently instantaneous amount of fish at the time a salmon passes through the section of the net with the excluder seems more likely to affect escapement than average rate.

<u>Test fishing sample size to afford a reasonably high chance of detecting significant differences and having sufficiently representative results:</u>

At the start of NPFRF's work on salmon excluders more than ten years ago, power analyses were developed to help evaluate target sample sizes for evaluating the effect of the excluder in the context of inherent seasonal and spatial variability in salmon catch rates. The motivation for the earlier analyses was the inherent variability in salmon catch rates, which affected the desired amount of statistical precision selected for the test. While the power analysis from ten years ago was interesting, it was admittedly highly influenced by the proxy selected to represent the among-tow variability. Because there were no data available for the actual area/time where the experiment was going to take place, the power analysis relied heavily on experience from the areas/times open to fishing. Data from the areas open to fishing at that time (and today) reflect highly variable Chinook salmon bycatch rates, which resulted in a power analysis indicating that sample sizes needed to be very large to have any real chance of detecting significant differences.

From this starting point, we learned from EFP fieldwork that encounter rates and consistency of salmon encounters in the closed areas (rolling hotspots) were actually relatively more stable and predictable compared to the high variability outside the closures. This meant that variance associated with encounter rates inside the closures was relatively lower, helping to make differences in escapement rates attributable to the excluder easier to detect. This meant that testing with relatively smaller sample sizes could achieve useful confidence intervals around mean escapement rates.

From this observation NPFRF evolved to rely on an amount of test fishing (groundfish catch associated with a desired number of tows) that has in the past allowed for the analysis to generate useful confidence intervals around mean escapement rates for salmon. This approach has been successful not only in terms of generating statistically meaningful estimates of excluder performance, but also in terms of industry buy-in that the results are valid and representative of what could be expected from use of the excluder at least under similar fishing conditions to those occurring during the test.

For the aforementioned reasons, we are opting to base our target sample sizes on those which previously have allowed us to conduct statistically relevant analyses. We know that reasonable confidence intervals around mean escapement rates for salmon have been obtained from 10-12 tows per EFP vessel per season. Based on these numbers, we are requesting the same groundfish and salmon bycatch allowances (based solely on winter/spring or "A" season testing amounts within EFP 15-01) for this EFP. Our allowances are designed around A season catch expectations because this EFP is solely focused on Chinook salmon escapement and winter/spring or the pollock A season is predominantly when Chinook salmon are encountered in the Bering Sea pollock fishery.

Table 3 below details the catch allowances we are requesting for this EFP.

Year	EFP Testing Seaso	Groundfish allowance (MT	Chinook catch allowance (#)	Non-Chinook catch allowance (#)
2018	A season (1/20 - 6/10)	2,500	600	600
2019	A season (1/20 - 6/10)	2,500	600	600
2020	A season (1/20 - 6/10)	2,500	600	600

Table 3 Specific catch allowances of groundfish (metric tons), and Chinook and non-Chinook salmon (individuals) requested for this EFP by year and fishing season.

Given we are modeling our sample size on the last Bering Sea salmon excluder EFP (EFP 15-01), the amounts of groundfish and Chinook salmon are essentially the same as what was requested (and granted) for A season testing seasons within EFP 15-01. Note that EFP 15-01 had two field seasons during the A season focused on Chinook escapement and one field season focused on "non-Chinook" (chum salmon) escapement. The requested numbers of Chinook and non-Chinoook salmon for this EFP were therefore adjusted to reflect our sole focus on Chinook bycatch performance. For this EFP the requested numbers of Chinook are based on the numbers requested for the A season tests that were part of EFP 15-01. A buffered allowance of non-Chinook salmon is requested here to avoid problems we encountered in the 2015 EFP A season testing. Specifically, the requested number of chum salmon is designed to cover the minimal catches one would expect in A season except that we have buffered those numbers up to reflect the expectation that encounters of non-Chinook appear to be getting more common in the A season in recent years than in the past.

This was not anticipated in the application for EFP 15-01 the permit was issued based on what was requested. This unfortunately led to our first A season field tests in EFP 15-01 being terminated before the amount of testing that was slated to occur was accomplished. Following that, we requested a modification to the permit and granted but this consumed considerable Agency time and resources and we want to avoid a repeat of that here. To do so, we have simply requested the same number of chums per season as Chinook for each testing season of this EFP. We are confident under this plan that chum salmon catches will not constrain our testing for this EFP.

To ground truth the requested numbers of Chinook in the context of bycatch rates from the most recent A season pollock fishing (January –April 2017), which is one season more recent than the data we had from our A season 2016 encounter rates, we requested Sea State Inc. provide us with 2017 A season Chinook bycatch rate data from the regular Bering Sea pollock fishery. This is useful for evaluating our requested numbers of Chinook against the latest A season Chinook bycatch rates. There are lots of ways to look at bycatch rates in any pollock A season. In this case we relied on Sea State's experience with monitoring salmon bycatch in the fishery and simply asked them to come up with their best proxy for bycatch rates that would be most representative of what would be encountered inside the closure areas where we plan to do our testing. Sea State evaluates Chinook bycatch data from the pollock fishery to trigger the temporary "hot spot" rolling closures and because some or all of our EFP testing will be inside those areas it makes sense to use data from the tows that effectively set up those closures.

To reply to our data request, Sea State relied on average bycatch rates (number of Chinook per metric ton of pollock) from the set of tows that accounted for 25% and 50% (respectively) of overall bycatch of Chinook in numbers for the 2017 pollock A season. Accordingly these were:

25% of bycatch in top 113 hauls, or 3.8% of tows, average rate = 0.239 Chinook per ton of Pollock
50% of bycatch in top 372 hauls, or 12.3% of hauls, average rate = 0.146 Chinook per ton of Pollock

Using these rates as the best available proxy for what would be expected to be encountered inside the closed areas we then “back calculated” what our numbers of bycatch Chinooks taken in the EFP would be if we do all of the EFP fishing for the requested allowance of groundfish inside the closed areas and the average rates above were applicable to our EFP testing. Accordingly, using the Sea State’s rate from the tows that accounted for 25% of the overall number of bycaught Chinook in the pollock fishery in A season 2017, the average bycatch rate was 0.24 Chinook per ton of Pollock and multiplying that rate times 2,500 mt of groundfish (per testing season) we therefore derive an estimate of 597 Chinook caught per testing season.

In this light, our requested number for this EFP based on mirroring what was requested in 2015-2016 EFP is 600 Chinook (to be shared among the three vessel classes). Based on this our requested number seems to measure up fairly well. We note here that the use of “average” rates for the small number of tows accounting for 25% of the A season bycatch in 2017 is somewhat of a dart throwing exercise. This is because the very small number of tows in the EFP could still have higher (or lower) than average rates relative to our expectation what will be present in the closed areas when we dod the testing in 2018-2020. At the same time, our expectation is that the excluder tested will be of a design that outperforms the ones used in the fishery on average. Salmon that escape during the EFP are not counted towards the limit applied to the EFP catch allowance. The fishery data from the high bycatch rate tows used by Sea State does reflect excluder use but the excluder in use for the EFP boats should be expected to outperform the fishery on average so this should create a little more of a buffer to help ensure that EFP catches stay below the 600 per season limit. In fact the allowance requested in the application for EFP 2015 used similar data to come up with a requested number of Chinook. The 600 Chinook limit each A season for the 2015-2016 was actually not taken. The total number of Chinook that did not escape (recovered in the codends from EFP tows) was 439 in 2015 and 352 in 2016).

<u>Testing protocol</u>: To make the EFP results meaningful, the rigorous methods used in previous EFP research will be followed. These include: ensuring that the excluder is not changed during the course of any of the seasonal tests; if the excluder becomes damaged then restoring it to the original shape and rigging, maintaining towing speed and other fishing variables as constant as possible while catching commercially representative amounts of fish per haul etc. The EFP testing protocol has been used over several EFPs

and it has proven to be practical for all the vessels selected by AFSC's selection panel over all our fieldwork.

To ensure the protocol is followed and that the test tows are standardized, prior to the test, participating vessels will make a series of pre-test tows to establish that the excluder and net are achieving the intended shape, and that lights etc. are functioning as designed. The codend will be closed for these hauls to ensure water flow reflects what will occur in the actual testing; however, the pre-test tows will be completed in areas without fish so that allotted groundfish and salmon are not expended at this point. If any problems are detected with the shape or rigging, these will be resolved and additional pre-test verification tows will be done to ensure everything is as intended prior to commencing the official test tows.

During the application process, applicants must agree to commit to follow the EFP testing protocol if selected to participate in the EFP. One of the biggest challenges in preparing their applications is that captains must explain how he will accommodate the placement of cameras into their fishing activities as part of the testing protocol. In our experience, the installation of cameras greatly affects how fast the net can be set, and, therefore, the degree to which the net actually be set in a manner that will allow it to encounter the school of pollock that that is targeted. The issue here is that the delay to install cameras, no matter how efficient the project manager and crew are at this task, reduces the chances that the captain can get the net set on the specific fish marked on his sonar instruments when he selected the specific location for a haul. To limit this interference in timing, camera installations are done in pre-designated and marked locations in the net. This can nevertheless add up to delays of 20 minutes per tow, especially when the weather complicates camera installation and deployment.

In their application participating vessels will also be required to describe how they plan to fish while still allowing us to collect all the EFP data during the test. This includes their strategy for how to maintain pollock catch rates that are representative of normal fishing conditions while taking steps to stay in areas with above average salmon bycatch rates, etc. This latter requirement will be the most demanding given that it often requires a lot planning to come up with a fishing location that meets this standard of having representative pollock catch rates and above-average salmon bycatch potential. In the past, EFP vessels have shared salmon bycatch and pollock catch rate information whenever concurrent testing occurs. Sharing information is important because when testing occurs in the closed areas there are no other sources of catch information available. Sharing information saves all parties fuel and time because they are the only vessels operating inside the closures whenever EFP testing occurs inside the rolling hotspots.

Once the vessel works out the specifics of how it will fish according to the standardized plan, during the test the project manager will monitor operations to confirm that the vessel continues to fish as closely as possible to what it outlined for the testing and will be tasked with ensuring that tows are completed as systematically as possible. This entails maintaining the same towing speed and other aspects of fishing, maintaining the way the excluder is rigged in the net and the lighting equipment, making sure the flotation, weighting and other aspects of the rigging of the excluder remains as constant as possible throughout the EFP testing for that season. If for some reason a large amount of catch occurs or fish become pinned in the net in a manner that affects the excluder, time must be taken to restore the excluder to the original state. Spare webbing and materials will be brought out for the EPF testing to ensure this can occur.

In order to ensure that the EFP testing is encountering sufficient levels of salmon to meet the objectives of the test, steps will be taken to get an index of how many salmon the testing is encountering in near real time during the test. This is done by examining the number of salmon in the codend as the codend is dumped for catcher vessels and looking at the salmon collected for donation in the factory as soon as the contents of a haul is run over the flow scale and sorted for CP vessels. Tracking salmon encounter rates in real time helps ensure that the test tows are actually encountering sufficient numbers of salmon to meet the objectives of the study. This is necessary because, even when testing occurs inside the closed areas, salmon encounters cannot be assumed to occur and rates can still be low inside the closed areas at times. If the number of encounters is low relative to expectations, the test vessel will be informed that it needs to shift EFP fishing to another part of the closed area or other area where the target conditions (at least average pollock fishing conditions and above-average numbers of salmon) can be found.

For catcher vessels, a single seasonal test typically spans two to three back to back fishing trips with three to five tows per trip on average. For catcher-processor vessels the EFP catch allowance is typically a portion of a single trip. In recent EFPs, NMFS has allowed CP vessels to catch EFP fish and non-EFP fish on the same trip. This allows CP vessels to incorporate the EFP fishing into one of its regular trips. This accommodation is important to CP participants because it avoids the need to offload all non-EFP products before commencing an EFP trip or vice versa. This saves fuel and time associated with a port call and offload when the boat is not at frozen product hold capacity. The allowance for mixing EFP and AFA fish on the same trip is limited to CP vessels because the official accounting of CP catches is done at-sea for catcher processor vessels via their certified and inspected flow scale and other catch accounting and reporting facilities on board. For purposes of proper accounting, normal AFA fishing and EFP fishing cannot occur on the same day.

From the perspective of the objectives, the allowance to do EFP and AFA fishing on the same trip is beneficial because, with the proper commitment from the vessel to follow the testing protocol for an entire trip, the EFP is able to increase sample size without increasing the amount of pollock and groundfish requested in the EFP application. As was mentioned above, there are advantages to expanding sample size even if the amount of fishing from the EFP allowances alone is expected to be sufficient for statistically valid results. The testing done on CP vessels while they are using their own allocation of fish is typically not as likely to be useful for deriving statistically robust results simply because during the portion of the trip where the vessel is using its own fish and salmon allowances they are not able to operative inside the bycatch hotspot closed areas and typically they operate in areas with far lower encounter rates for Chinook salmon. At times lower but non-zero catch rates of Chinooks have occurred while the vessel is using its own fish so there is value to this extra fishing. Additionally, the additional fishing in under regular fishing conditions does provide the captain with additional and valuable information about how the excluder works in terms of pollock escapement and other factors even if the encounter rate with Chinook salmon is likely to be far lower during that portion of the trip.

Process for selecting EFP vessels:
As part of its duties to conduct and manage the EFP, NPFRF sends out a request for proposals (RFP) to all Alaska pollock trade associations and cooperatives. The RFP informs vessel owners and captains of the opportunity to participate in the EFP research including a short description of the objectives and how the field testing fits into the overall development of excluders. The RFP also includes considerable detail on the testing protocol interested applicants must follow if selected to participate, the target catch allowances participating vessels can harvest assuming they successfully follow the protocols, a description of how participation in the testing has affected the catch rates of participating vessels in the past..The RFP also provides a template for applicants to follow for drafting their proposed fishing plan, essentially what they need to include to fully describe the facilities for testing on the proposed vessel and the experience of their crew with pollock fishing, salmon excluder usage and testing, and other experience with scientific charters and research. By and large the RFP is designed to be a template for how to apply to participate in the EFP. It also includes all logistical information, including deadlines and key metrics for how applications will be judged.

In addition to sending out the RFP, NPFRF will provide information about the EFP testing at the focal meetings with each vessel size class sector of the Bering Sea pollock fishery. At these meetings we will work with participants to select the salmon excluder/ rigging set ups that will be tested under the EFP. Information about the EFP will also be made available to attendees at a salmon excluder workshop at the flume tank at Memorial University (St. Johns, Newfoundland, Canada) in November 2017 (hosted by investigators of this proposal). Finally, Dr. Noelle Yochum our AFSC collaborator for this project is putting together a workshop on cooperative research slated to occur just after the flume tank trip in November. Many pollock fishermen are expected to attend the AFSC workshop and between that and the flume tank trip this EFP will have an above-average outreach where fishermen can learn about the EFP and the opportunity to participate.

Applications by vessel owners/captains will be reviewed first for completeness by NPFRF. The RFP specifically informs applicants that if submitted in advance of the deadline, they will be afforded an opportunity to address oversights/ missing information in their applications based NPFRF initial review of the application. Applicants will still have to meet the deadline if they elect to make amendments to their applications.

After the deadline, NPFRF will work with the director of the RACE Division of the Alaska Fishery Science Center, Jeff Napp, to review applications. Dr. Napp will assemble a review team comprised of RACE staff experienced in reviewing proposals and other submissions for engaging NMFS' charter vessels for the trawl survey and other NMFS charters. The review committee ranks the applications based on the criteria spelled out in the RFP. NMFS' assistance in the review and ranking of applications is instrumental in objectively selecting the best-qualified vessels for the field testing. This review process has worked well in the past due to the RACE Division's considerable experience with what makes vessels suited for doing scientific work. They also take into account what constitutes a safe platform for a unique approach to applied research spanning fishing and collection of scientific data.

<u>Exemptions needed to pollock fishing regulations during 2018-2020 Pollock A seasons:</u>

1. While conducting EFP testing under this permit, we request that the EFP vessel be exempted from the "Rolling Hot Spot" area closures (now promulgated under Amendment 91) so that the EFP field work can be conducted in the salmon bycatch hotspots areas as necessary.
2. While conducting EFP testing under this permit, we request that the EFP vessel be exempted from the regulations regarding fishing in the Sea Lion Conservation Area (SCA).
3. While conducting EFP testing under this permit, we request that the EFP vessel be exempted from regular observer coverage requirements for vessels when participating in our salmon excluder EFP field tests. We need to be able to place up to two sea samplers working directly for the principal investigator and field project manager on vessels participating in this EFP. Additionally, we need to redirect sampling to concentrate on effects of the excluder on salmon and pollock catches. This is the same exemption we have requested and been granted in the past salmon excluder EFP studies. Sea samplers will be provided all equipment needed to do their work and no NMFS-issued equipment will be used by sea samplers during data collection or other activities promulgated under this EFP.
4. While conducting EFP testing under this permit, we request that all groundfish and salmon catches not count against the regular groundfish TACs or any salmon bycatch caps affecting the regular pollock fishery or other in-season salmon bycatch control measures in place for the regular pollock fishery (e.g., bycatch avoidance agreements under Amendment 91).

<u>Areas where EFP testing is expected to occur during 2018-2020 Pollock A seasons:</u>

Predicting where adequate concentrations of salmon and pollock will occur from year to year is inherently difficult due to inter-annual variation in pollock distribution. For this reason, it is impossible to specify exactly where the EFP testing will occur over the three A seasons tests from 2018-2020. The figures below show areas where most pollock fishing typically occurs during A Season but these are fairly broad and, in reality, in any one year a great deal of the winter pollock harvest would be expected to occur in a small portion of one of more of these areas.

Figure 4: Common fishing areas around the Pribilof Islands

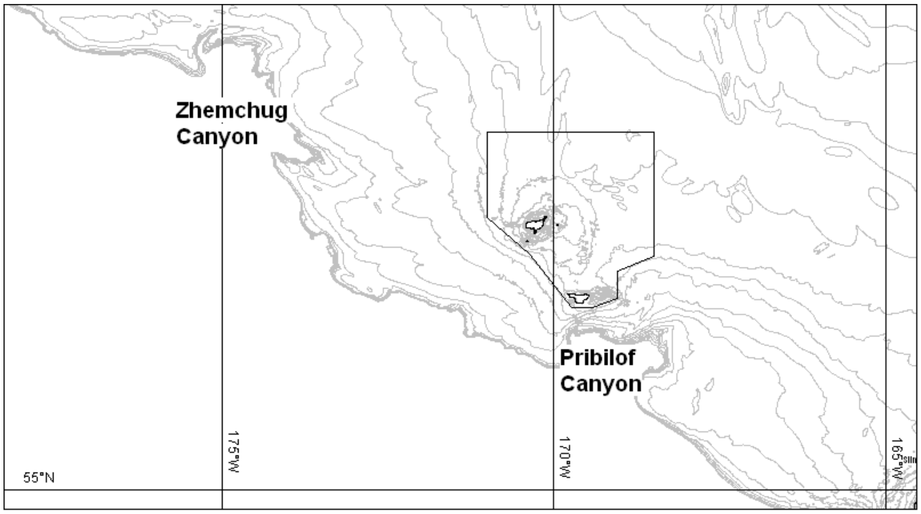
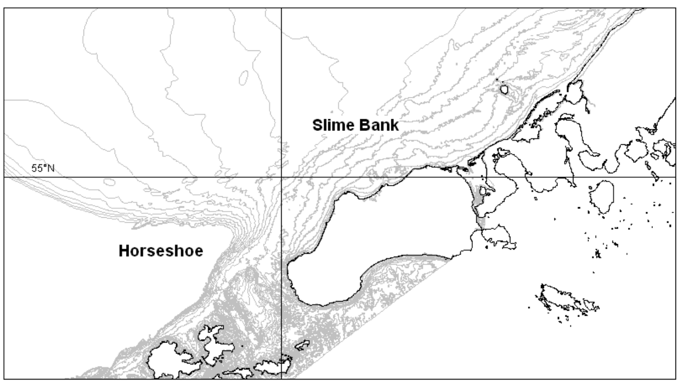


Figure 5: Common fishing areas around Unimak Pass and Bering Canyon (Horseshoe)



Administration of the EFP: Administration of the EFP will follow the same procedures used for the previous salmon excluder EFPs by the same EFP researchers. The exempted fishing permit holder (EFP applicant) will be responsible for the overall execution of the EFP research, including carrying out and overseeing all field research and associated responsibilities of the EFP. This includes hiring qualified personnel to manage the field experiments, and working with the NMFS-certified observer provider companies to ensure the experiments utilize qualified sea samplers. The permit holder will ensure that sea samplers are provided with instruction and briefing materials to understand their sampling duties for the EFP. Likewise, the EFP permit holder will prepare materials for and conduct the meetings with the different sectors of the pollock fishery to select the most promising ideas to test and subsequently to make adjustments based on information from each testing season. To engage vessels for the fieldwork, the permit holder will draft the RFP and the other explanatory materials needed to solicit applications for qualified EFP vessels. The RACE division will review the RFP and suggest changes as needed before it is advertised. The permit holder will also be responsible for informing the Alaska Region of National Marine Fisheries Service of field testing dates and required EFP vessel information prior to each field test.

At the completion of the EFP field testing activities, the permit holder will be responsible for data analysis and preliminary and final report drafting in consultation with Dr. Noelle Yochum of the Alaska Fishery Science Center and other RACE scientists assigned to this project. The permit holder will present results from the each field work season to the pollock industry, and the North Pacific Fishery Management Council (Council) and its advisory panels according to the direction of the Council.

Attachment 1. EFP 15-01 Final Report

Bering Sea Salmon Excluder EFP 15-01 Final Report

John Gauvin
North Pacific Fisheries Research Foundation
December 2016

Summary:

EFP 15-01 set out to test an "over and under" (O/U) style salmon excluder in the Bering Sea Pollock fishery. The impetus to focus on this particular excluder was that it achieved 33%-54% escapement for Chinook salmon with 1-9% Pollock escapement in the Central Gulf of Alaska (GOA) EFP during trials in 2013 and 2014. With escapement portals on the top and bottom of the net, this new excluder has been largely embraced as the excluder to use by GOA Pollock captains and many feel it provides advantages over other designs in terms of adaptability into GOA Pollock nets and lower need for tuning to achieve the desired shape at normal towing speeds.

The main question for EFP 15-01 was whether the differences in towing power/speed of Bering Sea Pollock vessels or other factors would affect the escapement performance. Given that performance of other excluder designs has tended to vary by vessel size, EFP 15-01's testing was purposely divided between three classes of Bering Sea pollock vessels, a smaller class catcher vessel at under 1,800 HP, a larger class catcher vessel in the 1,800 to 3,000 HP range, and a catcher processor vessel.

The testing spanned 2015 A season, 2015 B season and 2016 A season (February 2015 – March 2016). Vessels selected were F/V Commodore (133 feet, 1,700 hp), the F/V Destination (180 feet, 3,000 hp), and the F/T Northern Jaeger (336 feet, 7,200 hp). Escapement rates of salmon and pollock were generated from video observations of fish escapes. Whereas overall pollock escapement was negligible (0.5-2.2%), salmon escapement rates ranged from 3-18% across the three vessels. Overall, salmon escapement rates were considerably lower than hoped relative to GOA EFP results and even some previous Bering Sea salmon excluder EFP's using older excluder styles (flapper versions). Even more enigmatic was the finding that performance results did not follow expectations based on horsepower and towing differences between Bering Sea vessels in the EFP as well.

Reasons for the poor performance are not obvious but could be a combination of factors including tow speed, horse power, door size and spread, bridle rigging, mesh opening, fishing behavior, excluder shape (achievement of sufficiently large pathways for salmon to move out of the flow of Pollock and move forward to escapement portals). Differences in Pollock catch rates and flow of fish through the net that may create congestion and difficulty for salmon to find/utilize the escapement pathways may also be important for explaining the differences between GOA and Bering Sea results.

Future salmon excluder research should incorporate the use of sensors to accurately monitor and record previously unmonitored variables such as speed over ground in step with actual timing of escapements, size/shape of the escapement portals and access them (e.g. polllock catch rates that block access), and relative amount of "congestion" in the net over the course of a haul. Scaling the excluder that worked best in the GOA trials to the Bering Sea fishery appears to have not worked for this round of trials, but

existing BSAI salmon excluder designs, most notably the flapper excluder currently used by many Bering Sea Pollock vessels took considerable time and multiple trials to develop and refine. Achievement of high rates of Chinook escapement similar to those in the GOA may still be possible with the O/U excluder in the Bering Sea. Steps needed to definitively resolve the differences in performance are outlined in this report.

Evolution of salmon excluders leading up to EFP 15-01

EFP 15-01 is the latest in a suite of exempted fishing permits (EFP's) issued to North Pacific Fisheries Research Foundation (NPFRF) (John Gauvin as principle investigator) to explore ways to reduce salmon bycatch through gear modification. EFP 15-01 included three field testing seasons in the Bering Sea pollock fishery from January 2015 to March 2016, two occurring in winter/spring months when Chinook is normally the predominant salmon bycatch species and one in fall of 2015 when chum (non-Chinook) is the primary salmon bycatch species.

This section provides relevant information on NPFRF's work on salmon excluders to provide context for understanding the specific focus and outcomes for EFP 15-01. The information provided in this section was pulled from previous EFP final reports (these reports can be found at http://alaskafisheries.noaa.gov/ram/efp.htm and www.npfrf.org).

The development of salmon excluders started in 2003 via the NPFRF's partnership with Dr. Craig Rose of the Alaska Fisheries Science Center (AFSC), now retired, and Carwyn Hammond (AFSC, RACE Division). At each step in the development of salmon excluders, significant contributions of time and resources have been made by Dr. Rose and Carwyn Hammond, many pollock fishermen, pollock companies, and net manufacturers.

Early research with video cameras deployed in unmodified pollock nets showed significant differences in swimming ability and behavior between salmon and pollock, most notably the salmon's ability to swim forward inside the net at normal towing speeds. By comparison, pollock were most often seen dropping steadily backwards even if they can at times make short bursts forward against the flow. Taking this into consideration, the concept behind a salmon excluder was to create an area out of the main flow of pollock through the net with a little slower water speed (a lee) where salmon can rest and eventually move forward via an escapement pathway and escapement portal. This should occur with salmon escaping without any significant contact with the excluder.

Fishermen were at first concerned that modifications to pollock nets for salmon excluders, particularly large escapement portals, could not be installed without high losses of pollock and other problems with reducing water flow in the net. In fact, seeing the large size of escapement holes in the first excluder prototypes fueled considerable consternation. But the desire to look at excluders was still strong with fishermen recognizing the need for additional tools to control salmon bycatch.

The process to come up with designs for salmon excluders started with ideas from fishermen and net manufacturers discussed at workshops held by NPFRF. Vetted ideas were later transferred to formal drawings and scale models that fishermen and gear makers could examine. From this process input was solicited as to which ones were worth trying in field tests. Following that, a single season of fairly limited field trials under the first EFP was done in fall of 2003 and then a second set of workshops was held to discuss the preliminary results.

NPFRF's first field test in the fall of 2003 showed salmon escapement rates of just over 12% with pollock loss around 3%. This was an unexpected result and when these preliminary results were reported many fishermen suspected that the pollock escapement rate would have been much higher if a recapture net had not been used in the testing (a recapture net was used to collect fish that escaped from the net so escapement could be quantified). This stemmed from their thought that as the codend of the recapture net filled, lift from the kites used to separate the recap net from the trawl intermediate was lost. The eventual result was, they suspected, that the pathway for escapement was blocked and hence pollock escapement had been underestimated. NPFRF took this possibility seriously and undertook considerable work to examine it. In the end the concern was shown to be unwarranted but a related issue fishermen flagged in this process about a recapture net affecting fish behavior (e.g. are escapement rates accurately determined if escaping fish can see a recapture net in the process of attempting to escape?) was deemed to be more important and this was fundamental in NPFRF's ultimate decision to use video cameras to track escapement in lieu of recapture nets.

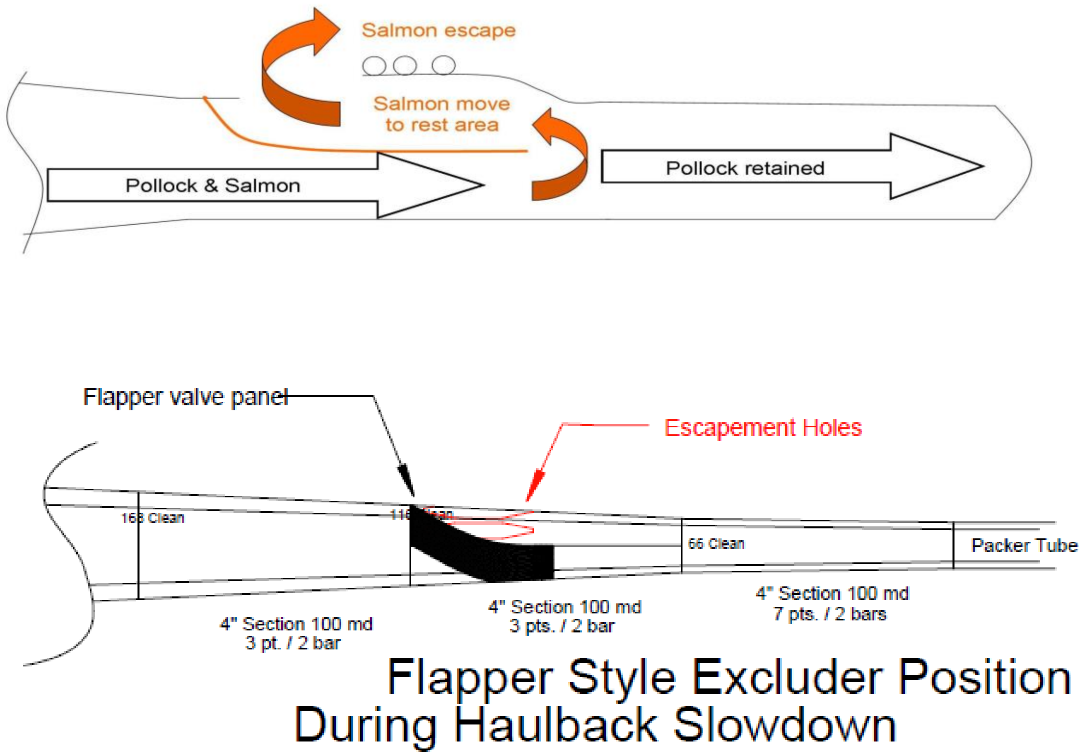
NPFRF's switch to tracking escapement with video alone, almost a decade later, was made possible by improvements in the capacity and reliability of the camera systems so that deployments could be done without putting limitations on fishing practices. The new systems were smaller, therefore creating lower drag and effects on the shape of the net where the camera(s) were installed. Also, advances in batteries and data storage capacity enabled the new systems to be operational for the duration of a normal commercial fishing haul. Improvements to salmon excluders in terms of reductions in pollock escapement with successive excluder designs were also instrumental to NPFRF's ability to switch to cameras for escapement accounting. Specifically, with relatively high pollock escapement early on, accounting with cameras would have been nearly impossible due to the sheer volume of pollock escapement and the challenges for counting individual fish escapes. Large volumes of pollock escapement also affect accounting for salmon escapes due to the increased potential that salmon escapes would be obscured by "clouds" of escaping pollock.

Status of salmon escapement rates leading into EFP 15-01

The two most relevant salmon excluder EFPs as context for EFP 15-01, were EFP 11-01 (2011/2012), the last Bering Sea EFP before 15-01, and the Gulf of Alaska EFP 13-01 (2013/2014). Progress on devices used and escapement rates in those EFP's are the most relevant baseline for understanding both the NPFRF's selection of excluder designs for this EFP and performance expectations so some details from those tests are provided here.

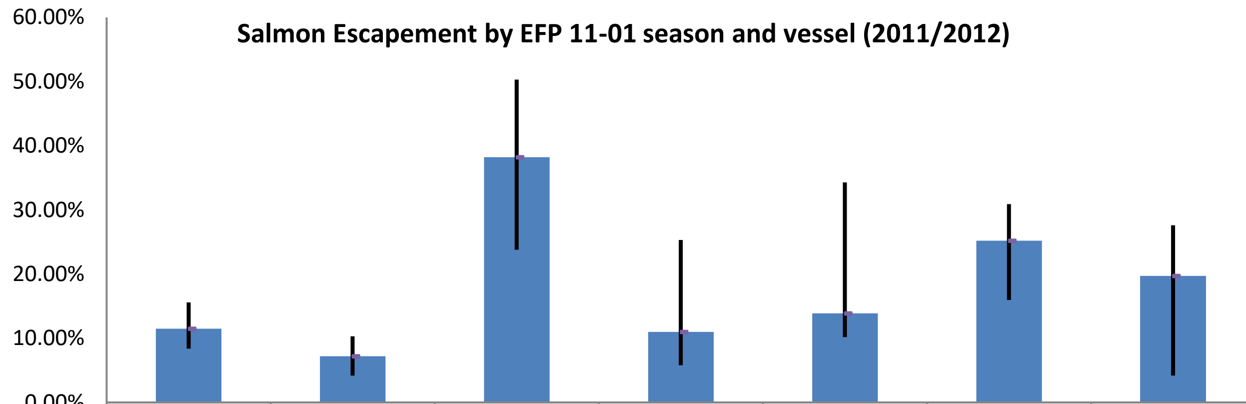
Bering Sea EFP 11-01 results showed mean escapement rates for Chinook salmon in the range of 12%-38%. This EFP tested the "flapper excluder" design, an excluder that uses a weighted panel to control access to a large escapement portal at the top of the net. For that design, lead line weighting on the "flapper" panel of webbing is added to the point where escapement pathway is open and sufficiently large for salmon to make use of it at the vessel's normal towing speed. When the vessel slows down to make a turn or hauls the net back, any salmon or pollock moving forward are directed up to the escapement portal because the weighted panel "ramps" fish moving forward up to the escapement area (Figure 1).

Figure 1. Bering Sea flapper style salmon excluder schematic.



While results with the flapper excluder were encouraging, a concern from tests done in EFP 11-01 was that Chinook escapement rates were quite variable on a tow-by-tow basis within individual seasonal tests. This is evident from the relatively wide confidence intervals around the mean escapement rates shown in Figure 2. This variability in performance raised questions about what factors/conditions might explain excluder performance differences between tows within a seasonal test and for trials on different vessels. An analysis of covariates was undertaken to explore this but it did not elucidate the issue to any great extent.

Figure 2. (Excerpted from EFP 11-01) Percent salmon escapement with 95% confidence by EFP field season and vessel with salmon species of interest (Chinook or chum)



	SB11BChum1	SB11BChum2	SB11BChn	SB12AChn	Dest12AChn	Dest12BSalm	Prince12BSalm
Mean	11.50%	7.20%	38.20%	11.00%	13.90%	25.20%	19.70%
Upper	15.30%	10.00%	50.00%	25.00%	34.00%	30.60%	27.30%
Lower	8.70%	4.50%	24.10%	6.10%	10.50%	16.30%	4.50%
Mean	11.50%	7.20%	38.20%	11.00%	13.90%	25.20%	19.70%

The improved escapement seen in EFP 11-01 for Chinook salmon on the Starbound (see result for SB 11B Chn) was viewed as a step forward in terms of having a workable excluder for Chinook salmon by many pollock fishermen in the Bering Sea despite the fairly large confidence interval around that result. At the same time, chum salmon escapement rates with the flapper excluder clearly trailed behind (results pertaining to chum salmon with the flapper excluder are SB 11B Chum1, SB 11 B Chum2). In that respect, the most pressing issue for the field testing seasons on the back end of EFP 11-01 was to attempt to come up something that would be more effective for chums.

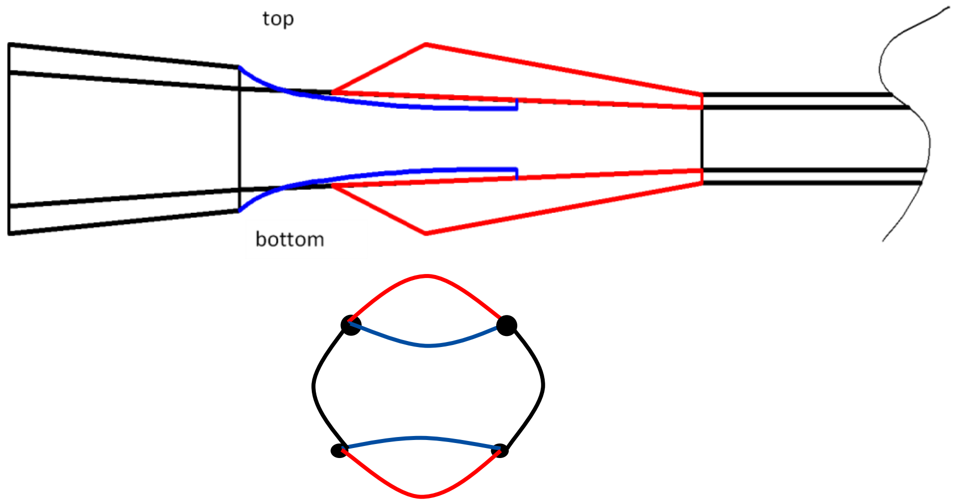
To focus on chum salmon escapement, the last phase of testing in EFP 11-01 in 2012 looked at two new approaches. The first was the use of artificial lights to increase salmon escapement. This idea came from video observations of chum salmon from earlier testing where they appeared to be attracted to camera lights and at times remained near them for extended periods of time.

Adding light to attract chums to swim out of the excluder, however, proved to be more challenging than expected. One issue was the inability to contain the light in the locations where lights were installed. In fact the illumination tended to bleed down into portions of the net intermediate ahead of the excluder where escapement was actually not possible. If chum salmon were attracted to locations where escapement is not actually possible, then adding light may actually be counter-productive. Experimentation with lighting was reassessed at this point in recognition of the complexity of evaluation its effects on escapement.

The second focus for increasing chum escapement was to design a completely new excluder style that would allow escapement out of both the top <u>and</u> bottom of the net. The idea came from talking to salmon seiners who believed that chum behavior in response to a net was to dive rather than swim up to escape. With this information, John Gruver, NPFRF's excluder designer, came up with a new design called the "over and under" or O/U. The O/U uses a weighted panel on the top and a floated panel on the bottom to "corral" fish into the center of the net as they move through the intermediate. This creates a lee behind each panel of the excluder and an area for salmon to get out of the flow of pollock. This set up is designed to give salmon an opportunity to use one of two escapement pathways built into the net; one on the bottom with a weighted scoop and one at th

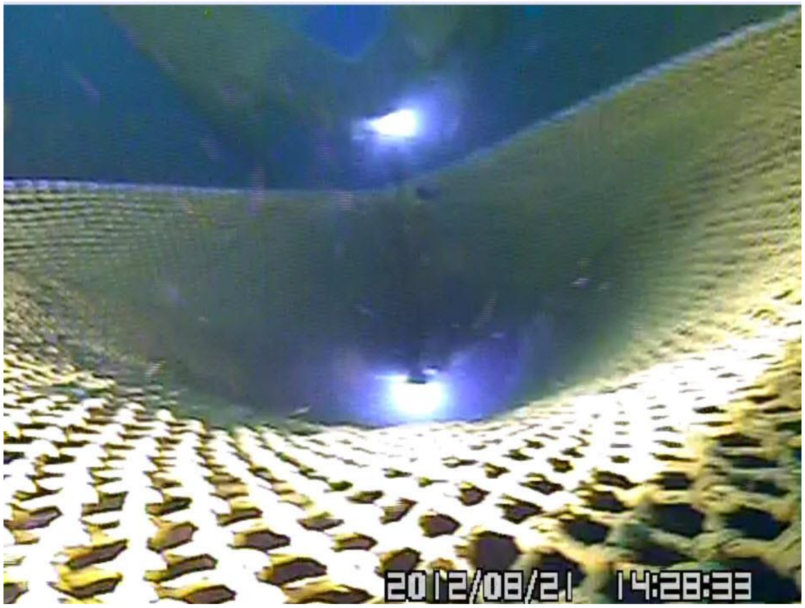
e top with a floated hood (Figure 3).

Figure 3. Conceptual schematic of the Over and Under (O/U) excluder (side view). Cross section below.



The final field season of EFP 11-01 in fall of 2012 focused on a Beta version of the O/U excluder installed on two of the Bering Sea test vessels. Fortuitously, pre-EFP tows showed the early version of the O/U closely achieved the desired shape with minimal adjustment needed. Under full towing speed with a closed codend during the EFP fishing, however, the degree to which the weight and floatation corralled fish into the center was less than desired amount of clearance, particularly at the bottom escapement portals (Figure 4). Despite this, the fall 2012 trials of the O/U did show that chum salmon escapement rates improved relative to previous trials. Those specific results are labeled in Figure 2 for chum as "Dest12B Salmon" and "Prince 12 B Salmon".

Figure 4. Beta version of the O/U excluder, Pacific Prince 2012 B season. View is from aft of the excluder looking forward.



Once again, however, relatively high variability in escapement rates from tow to tow meant that performance was not very consistent. Also, mean chum salmon escapement still lagged well behind what was achieved for Chinook salmon with the flapper excluder.

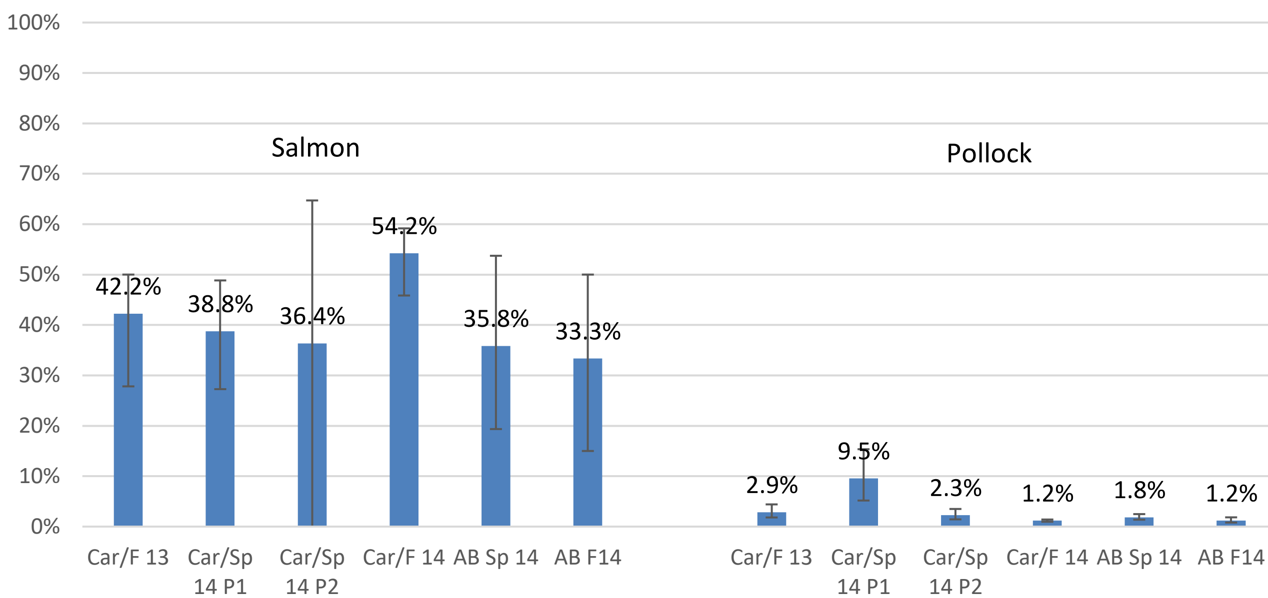
Following EFP 11-01, NPFRF's attention shifted to salmon bycatch in the Gulf of Alaska given the recently implemented Chinook salmon bycatch caps in that management area. Initial work in the GOA started with a trial of the flapper excluder adapted to the size/scale of central GOA pollock boats. But after the initial trials of a flapper in the GOA showed poor performance, work soon shifted to an O/U style excluder. The main challenge with flappers in the GOA was achieving the correct shape at towing speeds on lower horsepower vessels.

The Gulf EFP results for the O/U design showed high Chinook escapement (33-54%), the main salmon species of concern for bycatch in the GOA pollock fishery. Figure 5 shows the mean escapement rates and associated confidence intervals for Chinook salmon and pollock in GOA field trials using the O/U excluder in 2013 and 2014.

Each stage of testing looked at slightly different versions of the O/U style excluders on each GOA pollock vessels (one in the 800 HP, one at 1,300 HP categories). Each adjustment was tailored to bringing the shape of the excluder closer to where the floated and weighted panels come fairly close together in the center at normal towing speeds. This maximized the room salmon would have to move out of the flow of pollock so they could make use of the escapement pathways on the top and bottom of the O/U excluder.

As can be seen from Figure 5, average rates of escapement with the O/U were generally higher than rates seen in the Bering Sea (for Chinook and chum). For fall 2014 the trial on the F/V Caravelle in particular, the escapement rate was 54% and not only was Chinook escapement at an all-time high but performance was consistent over the course of the tests so confidence intervals were relatively tight. This success set a whole new expectation for what was achievable with salmon excluders. The Caravelle's fall 2014 results were also notable because a relatively high number of salmon were encountered in the test. This helped the GOA captains to believe in the result. Finally, the rather low loss rate for pollock, a little over one percent, was also very encouraging.

Figure 5. Salmon and pollock escape rates using the over/under style salmon excluder: by EFP leg/vessel with 95% CI boundaries. P1 = Phase I, P2 = Phase II. (Excerpted from EFP 13-01 final report)



The GOA results constituted a major performance milestone relative to what had been achieved in the past. Due to the time needed to establish results from video review and the lead time needed to get an EFP application through the NMFS approval process, results from the final season of the GOA EFP actually came to light after the application for a new Bering Sea (EFP 15-01) had been submitted to the NMFS Alaska Region. With the Caravelle's fall 2014 results, however, it became clear to NPFRF that a course correction was merited in the selection of an excluder for the next stage of testing in the Bering Sea. Further work with adding light to the excluder was not as important as seeing if the O/U could reduce Chinook bycatch by similar amounts in the BSAI. The new plan was to test an excluder that mirrored the one tested in the fall of 2014 on the Caravelle but scaled to the nets/vessels of the Bering Sea pollock fishery.

Objectives of EFP 15-01

When originally proposed, EFP 15-01 set out to refocus on the relatively lower escapement rates for chum salmon bycatch in the Bering Sea seen in the last Bering Sea EFP (11-01). This would be done through adding lighting and further design changes to the flapper or version one of the O/U excluder tested in the Bering Sea in 2012. To focus on chum salmon, the original application requested that two of the three field seasons (fall of 2014 and 2015) occur when chum bycatch would be expected to be the predominant bycatch species.

As it turned out, agency consultations concerning marine mammals in the EFP review process took longer than expected and the original application for 15-01 was still under review during the fall of 2014 when the results from the final GOA salmon excluder trials became available. This prompted NPFRF to request the opportunity to make changes to the application. The new plan was to have two field seasons focusing on Chinook salmon in winter/spring (2015 and 2016) and one fall season focusing on chum salmon escapement, also using an O/U.

In looking back at NPFRF's discussions prior to EFP 15-01 it is clear that NPFRF was realistic about the chances of duplicating the Caravelle's GOA performance from fall 2014 in the Bering Sea. This is because getting the floated and weighted panels of the excluder to come together as they did in the GOA was recognized as a challenge. Specifically, horsepower ratings for the GOA vessels were 800 and 1,300 HP and towing speeds in the range of 2.5 to 3.0 knots in the GOA pollock fishery. This is different from Bering Sea pollock vessels that tow at speeds ranging from 3.0 to 4.2 knots, with average speeds closer to four knots than three. Also, net spread is greater in the Bering Sea with more efficient trawl doors and larger horsepower boats. This affects the degree that trawl net meshes open, the size of the intermediate portion of the net, and the flow of water through the net. Overall, NPFRF was aware that adapting the O/U excluder to the Bering Sea vessels would be challenging but at the same time certainly worth all the effort if that excluder could achieve results similar to the GOA trials on Caravelle.

EFP 15-01 RFP and Methods

Recognizing that EFP tests have consistently shown significant differences in performance of excluders by vessel size classes, there was every reason to believe that this would be the case with the O/U excluder. For this reason, NPFRF's testing plan included a representation of the main vessel sizes/horsepower classes for Bering Sea pollock fishery including a catcher vessel with around 1,800 HP (the smaller vessel class for the Bering Sea), a larger catcher vessel with horsepower of between 1,800 and 3,000 HP, and a pollock catcher processor in the 3,000 HP to 7,000 HP range. To do this, NPFRF drafted a request for proposals (RFP) soliciting applications to participate in the EFP in each of the three vessel classes.

The EFP allowed for a total of 7,500 metric tons of groundfish harvest over the three testing seasons from January 2015 through April 2016. The seasonal guideline amount of 2,500 mt of groundfish was divided into 900, 900, and 700 mt for the CP, large CV and smaller CV vessel categories respectively. Average tow amounts for the three vessel categories was used to establish these divisions with an objective of getting at least 10 test tows per testing season per vessel class category.

EFP 15-01 requested salmon allowances for the EFP based on catch rates in the regular pollock fishery in areas with relatively high bycatch rates. The rates used for the EFP application pertained to 2012-2014, the most recent years at the time the EFP application was drafted. NPFRF recognized , however that annual variability in salmon bycatch rates occurs and therefore there was no way to guarantee that the requested EFP allowances for Chinook and chum would be adequate to allow the EFP testing to consistently occur in areas of relatively high abundance of salmon. The stated objective for selecting testing locations during the EFP was areas with representative (average) pollock catch rates and relatively high salmon bycatch rates to help ensure the results were meaningful.

The seasonal salmon limits were divided pro-rata among the EFP vessels based on the vessel's groundfish allowances for the EFP: 600, 250, and 600 Chinook salmon were allocated for 2015 A season, 2015 B Season , and 2016 A Season respectively so these limits were divided pro rata among the vessels. For chum salmon, the limits across the same seasons were 250, 2,500, and 250 respectively.

To engage interested pollock vessel owners to apply to participate in the EFP and inform them of EFP responsibilities and catch opportunities, NPFRF's RFP described amounts of groundfish available to EFP participant and seasonal limits on salmon bycatch. The RFP also included an explanation of the objectives of the EFP, and a description of the testing protocol that participants would need to follow, and other pertinent details. The RFP was sent out to different sectors of the pollock fishery in October of 2014.

A panel of experts from the Alaska Fishery Science Center's Resource Assessment and Conservation Engineering division reviewed the applications received in response to the RFP. The panel possessed decades of experience with selection of vessels for NMFS' charters and previous EFPs for the salmon excluder and other EFPs dealing with tests of gear modifications.

Nine applications were received, two in the CP category and five applications split between the catcher vessel categories with some applications on the cusp between vessel categories. RACE's application review panel conducted their review in December of 2014 and ranked the applications. The top-ranked application in the lower horsepower category for catcher vessels was the F/V Commodore, at 133 ft and 1,700 hp. For the larger catcher vessel, the 180 ft and 3,000 HP Destination was selected. For the catcher processor, the 336 ft and 7,200 HP F/T Northern Jaeger was the top ranked vessel. With the selections in hand, NPFRF started to work with the top-ranked applicants to arrange for how to get the excluder built and shipped up to Dutch Harbor as well timing for NPFRF's project manager and the sea samplers to board and disembark each vessel during the first testing season.

In the process of making these arrangements, the CP Northern Jaeger flagged an interest in conducting the excluder test over an entire trip (approximately 25 tows) instead of just the 10 or so that the EFP groundfish allotment would provide. Their rationale for this was that it would make the test more robust. From the Northern Jaeger's perspective there were benefits in terms of cost savings from avoiding the fuel costs and down time needed to bring the EFP personnel back to the Dutch Harbor in the middle of a fishing trip when the EFP fish had been caught. An allowance to incorporate the EFP into a regular American Fisheries Act (AFA) trip was made in the permit for catch-processor vessels because they have a certified flow scale, two full time fishery observers, and a catch accounting system that does final catch accounting at sea. According to the permit, this would have to be done without mixing EFP and AFA catches in the same calendar day to simplify catch accounting. Abiding by that rule was not a problem for the Northern Jaeger. This combined EFP/AFA testing regime took place in the B season 2015 and A season 2016 (no AFA fishing A season 2015).

For each of the three 15-01 EFP vessels, the plan was for NPFRF to provide an O/U excluder for the test based on the one tested in fall of 2014 on Caravelle in the GOA. Each excluder would be scaled and custom built to the EFP vessel's relative horsepower and net size. The photo below (Figure 6) taken during the fall of 2014 testing on Caravelle, shows the excluder shape during normal towing speed. Note how the floated and weighted panels in the excluder come close together in the center, maximizing the area used for escapement. A salmon in the process of moving forward to escape is shown in the photo.

Figure 6. O/U Salmon excluder at depth on the Caravelle, GOA EFP 13-01. The camera is looking forward towards the mouth of the net and a salmon is seen swimming forward to escape out of one of the escape portals.

At the start of each Bering Sea EFP 15-01 test, a set of pre-test tows in mid-water (not in fish sign) were made to examine how well the shape achieved the desired parameters. Adjustments (e.g. adding floatation or leadline) were made as needed to allow the upper and lower excluder panels to come together as closely as possible at the vessel's normal towing speeds. Once the shaping was confirmed, the vessel commenced with the EFP tows.

Prior to setting the net into fish sign at the start of EFP fishing, cameras were placed in selected locations close to the egress point in the excluders scoop or hood. This was the optimal location for recording escapements of salmon and pollock. With the O/U excluder, there are two escapement locations to monitor, one at the top and one at the bottom. Whenever possible, two cameras would be placed at each escapement portal. This would help avoid missed data if one camera failed to record or if one of the camera views became blocked by pollock or other matter (jellyfish, kelp). While two cameras per escapement location was the desired plan, based on experience in previous EFPs we knew that camera breakdowns might force us at times to rely on a single camera per location even if each NPFRF project manager had a back-up system. For each tow, NPFRF personnel installed fresh batteries before the net was reset. In between tows, NPFRF personnel would do a quick review of the video to ensure that the cameras were placed and recording properly.

The data collection plan to account for the salmon and pollock in the net (what did not escape) was fairly standard relative to accounting for salmon catches on a tow by tow basis is used in normal AFA sector. For the two EFP vessels with flow scales, catch from each haul was weighed on the vessel's scale as it entered the processing area. Sea samplers working for the EFP would conduct species composition sampling which would be used to estimate the fraction of pollock in the overall weight of allocated species per haul. All salmon that did not escape were accounted for by crew as per normal AFA accounting procedures.   Sea samplers measured all salmon and a sample of pollock to allow sufficient data to characterize pollock escapement on a per-haul or daily basis. Sea samplers also collected genetic samples from salmon under a data collection protocol designed specifically for the EFP by Dr. Jeff Guyon of the Auke Bay Laboratory of the AFSC. Genetic sampling of salmon was an add-on project for the EFP and all samples were forwarded to Dr. Guyon.

Because the catcher vessel Commodore, the vessel in the lower horsepower category, did not have a motion compensated flow scale, catch of groundfish per haul were estimated through a "dump box" bin accounting approach. Commonly used in the Gulf of Alaska, this process involves running the contents of each codend onto a conveyor belt that fills a bin of known weight to a designated fill line. The weight for the bin at the fill line was established at the processing plant prior to starting EFP fishing. The number of filled bins was tallied to estimate the weight of groundfish catch per haul.

Data collected by the sea samplers were monitored by the EFP project manager to ensure that the area selected for testing (normally a designated hot-spot under the rolling hotspot system used in the pollock fishery during the regular fishery) in fact possessed relatively high numbers of salmon per ton of groundfish. In addition to checking the number of salmon in the haul based on the codend count, a quick review of the video by the project manager was also done to provide an indication of whether there was sufficient salmon in the area. This was necessary because when an excluder is working well, the number of salmon in the codend may not be a good indicator of salmon encounter rates.

Upon completion of the testing, the video was reviewed by the NPFRF project managers. In cases where very large numbers of video hours were collected, and particularly for the case of an entire trip on the CP vessel, it was recognized that review of the data would likely take months. In this case, the project manager hired and trained auxiliary video reviewers to assist in the review to avoid long delays in getting the results.

One final detail of importance for understanding the testing plan was that it was recognized at the outset that small adjustments to the excluders would be necessary during the second and third seasons of the EFP. Readers interested in the specifics of these adjustments should refer to the NPFRF field project managers' reports for each season of the EFP (http://www.npfrf.org).

Recognizing that nets are not in a static state, the NPRFRF started each testing season with test tows to verify that the excluder was taking the desired shape. If not, then modifications were made to add or subtract weight and/or floatation to get the excluder panels back to the desired positions. In the context of controlled scientific testing, one might expect a protocol that no changes would be made to a device during testing or at least there would be a systematic and calibrated way to detect small changes to the device and corrections could be confirmed systematically. This kind of controlled testing and metrics to establish it is actually not currently possible with excluder testing even if systematic protocols are followed (discussed later). This is important because small changes in nets typically occur gradually just through normal fishing. Recognizing these subtle changes (drift) from the desired construction parameters and shape over time is subjective and difficult at present. This would only be possible from video observations and because the camera angles are affected by the dynamic environment of the net, changes to the shape affect the degree to which a camera view can actually be useful for detection of the changes.

Because fishermen would normally make adjustments to gear if it were not performing as desired, NPFRF's testing incorporated the approach of making adjustments to the excluder to re-establish the desired shape at the start of each testing season to the extent possible. Adjustments during a test would only be done if for some reason the excluder became damaged. These adjustments were for obvious things such as when floats on the lower panel were lost or damaged or lead lines became detached during the testing.

Results:

Testing on the Commodore took place February 17-28th in 2015 (13 tows); August 25-September 7th 2015 (12 tows); and March 2-15th 2016 (11 tows). For the Destination, the larger catcher vessel, testing occurred February 18-24th 2015 (12 tows), August 25 to September 2, 2015 (12 tows); and February 28th to March 9th, 2016 (14 tows). For the CP vessel Northern Jaeger testing dates were February 28 to March 3rd 2015 (9 tows); September 8 –September 23, 2015 (full trip 29 tows); and February 14 through February 26th (full trip 25 tows).

For the most part, the testing went as planned but a few problems did occur. Table 1 below details the EFP allowances and harvests (groundfish, Chinook salmon, non-Chinook salmon) by season and vessel (see appendix at the end of this report for detailed catch by species): 7,319 mt were harvested of the 7,500 mt EFP groundfish allowance; 813 Chinook were landed compared to the 1,450 Chinook salmon EFP limit; and 2,666 non-Chinook salmon were landed compared to the 3,000 non-Chinook salmon EFP limit. A total of 1.2 mt of halibut PSC mortality were taken (EFP limit = 36 mt). As can be seen in Table 1, one overage (for chum salmon) did occur in winter of 2015. After consultation with NMFS' Alaska Regional Office, this resulted in needing to stop testing on F/T Northern Jaeger during the winter/spring 2015 A season before all EFP tows were completed.

Table 1. EFP 15-01 groundfish and salmon limits and harvests by season and vessel.

Seasonal targets and overall limit for EFP metric tons (groundfish not allocated by season)								
	2015 A target	Catch	2015 B target	Catch	2016 A target	Catch	Total Catch	EFP limit
Northern Jaeger	900	744	900	1,075	900	845	2,664	
Destination	900	887	900	922	900	917	2,726	
Commodore	700	637	700	647	700	645	1,929	
Total	2,500	2,268	2,500	2,644	2,500	2,407	7,319	7,500
Target per vessel, catches, and seasonal and total limits for Chinook (numbers)								
	2015 A limit	Catch	2015 B limit	Catch	2016 A limit	Catch	Total Catch	EFP limit
Northern Jaeger	216	273	90	6	216	187	466	522
Destination	216	98	90	13	216	115	226	522
Commodore	168	78	70	3	168	50	131	406
Total	600	439	250	22	600	352	813	1450
Per vessel targets, catches, and seasonal and total limits for Non-Chinook (numbers)								
	2015 A limit*	Catch	2015 B limit	Catch	2016 A limit	Catch	Total Catch	EFP limit
Northern Jaeger	90	188	900	89	90	56	333	
Destination	90	113	900	721	90	3	837	
Commodore	70	32	700	1461	70	3	1496	
Total	250	333	2500	2271	250	62	2666	3000
*Note: Red indicates overage and requirement to cease EFP operations for that year; NMFS later agreed to modify permit manage non-Chinook catches to overall EFP limit								

Attainment of the seasonal limit for chum salmon during the 2015 A season was unexpected because pollock vessels seldom encounter chums at that time of year. In winter of 2015, however, the AFA pollock fishery encountered relatively high chum salmon catches and the rate of encounters increased throughout that season. Recognizing this, the plan was to keep a close eye on chum catch rates in the EFP and take steps to avoid areas with high chum encounters to the degree possible without compromising the objectives of the EFP. This proved to be problematic for Northern Jaeger because they started the EFP on February 28, 2015, about ten days after the other two test vessels started and by then the two EFP catcher vessels had accumulated considerable catches of chums. This left little potential for a rollover of unused chum salmon from the other two EFP vessels. Given this, NPFRF carefully monitored daily catches of chums against the 250 chum limit but unfortunately with two high-catch-rate tows by Northern Jaeger occurring before accounting caught up with the catches and the seasonal limit of 250 chums was exceeded. When NPFRF reported the overage, Northern Jaeger had only completed approximately 65% of the testing slated to occur on the vessel for A season 2015.

Upon learning of the overage, the Alaska Region of NMFS decided the EFP would have to be terminated for that season but suggested that they might grant a modification to the permit (later granted in July of 2015) to alleviate this unforeseen problem. The permit modification was to manage the EFP to the overall number of chums allowed for the permit instead of three separate seasonal limits. The process to request and approve this modification would require time, however, so the first testing season came up short in terms of testing objectives of the EFP for this reason.

The second problem related to the reliance on camera systems as the only means to track escapement for this EFP. In making the move to use cameras alone, NPFRF understood that it might have to accept gaps in escapement data from mechanical failures and deployment errors even if its project managers had considerable experience with underwater cameras systems. Based on past experience with cameras used opportunistically to understand fish behavior, the types of mechanical problems included DVRs that did not record, failures in the switches used to power the cameras, malfunctions in battery chargers, and other technical glitches. Another issue for this project was the potential for loss of effective monitoring of escapement at times when cameras become obscured temporarily. This occurs when pollock become pinned on or in front of the lens.

To help prevent loss of EFP data through technical failures, NPFRF supplied each field project manager with a sufficient number of camera systems to have two cameras deployed at both the lower and the upper escapement portals of the O/U excluder, plus a minimum of one back-up system (minimum of five systems per project manager per deployment). While two cameras in each escapement location would create redundant video when cameras worked perfectly, in the event that one camera failed or its view became temporarily blocked, this would help prevent loss of escapement data.

For the first testing season when NPFRF's camera systems were relatively new having two cameras per escapement location proved to be mostly redundant. But at times this did prevent small losses of data at times, mostly from views blocked temporarily by fish. In the latter two testing seasons when camera equipment failure rates increased, despite full maintenance of cameras between seasons, even with the second camera there were some losses of video data. Typically this was only for a relatively short portion of time on a few tows, and only at one of the escapement locations. But at times data loss was more than minimal. Towards the end of the second and throughout the third testing season, some cameras ceased to function completely or for part of a testing season even if repairs done between seasons were expected to correct for earlier issues. This meant that even with the back-up camera in use, some hauls were limited to only one camera placement in one or both of the escapement portals. If there were three working cameras, the bottom escapement portal was preferred for the single camera installation because the volume of escapement over time there is generally lower there. Reliance on a single camera in the upper escapement portal obviously increased the chances for data loss when a fish blocked the view or an insufficient battery charge led to incomplete coverage.

Table 2 below reports the percentage of time that camera deployments per vessel and season were successful (either with one or two cameras) for fully tracking escapement rates. For cases where performance was less than 100%, there was at least one escapement location that had a temporary camera problem resulting in some loss of video coverage of escapement. Equipment performance was particularly poor for F/V Destination in its final testing season with a 15% loss of video hours.

Table 2. Percent complete video hours per season and vessel.

Percentage of testing hours with complete video per vessel per testing season			
	A 2015	B 2015	A 2016
CV Commodore	100%	95%	95%
CV Destination	90%	96%	85%
CP N. Jaeger	97%	96%	100%

Given the incomplete video coverage, NPFRF decided to report the results in Table 3 below based on tows with 100% video coverage in both escapement locations. Complete video coverage means that at least one camera per escapement location worked without failure throughout the tow. This excludes very brief periods of time when a fish may have blocked the view but where project managers felt this did not meaningfully impact assessment of escapement.

Based on using on the data for complete video tows, salmon escapement ranged from 3.4% on the Commodore to 18.1% on the Northern Jaeger. Pollock escapement was low, ranging from 0.6%-2.2% across all EFP legs.

For the results table below, specific EFP seasons are indicated with an "A" (pollock A season) for winter/spring months when Chinook are the usually the principal species encountered in the testing. Seasons indicated with a "B" are for fall seasons when most of the salmon encountered are chum salmon.

Table 3. EFP salmon and pollock escapement rates by vessel and season, 2015-2016. Only tows with complete video are included. Also noted is the percent salmon escapement from the top portal

EFP 15-01 Escapement rate results for salmon and pollock									
vessel	year/season	salmon escapes	codend salmon	salmon escape rate	% escapes from top	pollock escape tons	codend	pollock escape rate	
Commodore	A 15	6	83	6.8%	50%	8.7	388.4	2.2%	
	B 15	51	1461	3.4%	84%	3.3	642.9	0.5%	
	A16	9	53	14.5%	67%	15.9	461.2	3.4%	
Destination	A 15	23	211	9.8%	47%	10.1	875.1	1.1%	
	B 15	56	734	7.1%	56%	5.7	914	0.6%	
	A16	18	118	13.2%	53%	18.6	909.1	2.0%	
N. Jaeger	A 15	102	461	18.1%	55%	12.3	730.3	1.7%	
	B 15	41	240	14.6%	70%	42.7	3818.2**	1.1%	
	A16	32	328	8.9%*	n/a	38.2	2651.4**	1.4%	
*excluder tested was boat's flapper excluder with lighting system they use									
**test done on full trip combining AFA and EFP fish									

By excluding tows with incomplete video, the potential exists that excluded hauls may have had better escapement. To look at this, NPFRF's project managers also calculated escapement rates for all EFP tows including ones with incomplete video coverage. The results in that case would reflect a lower bound escapement rate given that accounting for what did not escape (counts of salmon in the codend) was likely to be complete and partial accounting for salmon escapement with video on those tows can only be equal to or underestimate escapement. Calculations including the tows with incomplete video coverage, however, did not appreciably change the average escapement rates. It is still possible that relatively large escapements occurred when we were unable to detect them. For this reason we cannot dismiss the possibility that escapement was higher for salmon and pollock than what is reported in the tables for complete video coverage.

The anomalous encounter rates of chums in A season of 2015 (but not 2016) also need to be kept in mind for interpreting results for escapement for that particular season. We do know from the codend accounting on the vessels what the actual catch distribution was for Chinook versus chums for each season. But because escapement is accounted for by video alone and we cannot reliably identify salmon to species in the video, we have to assume escapement by species mirrors the proportion of salmon species in the codend. Making this assumption is probably sound when the EFP testing is encountering the normal pattern of salmon species by season (Chinook in winter, chums in summer and early fall). But for winter 2015, the unanticipated high rate of chum bycatch makes the assumption that escapement rates apply to Chinook questionable. For the 2016 A season it is probably safe to assume that escapement rates apply to Chinook given that rates of encounter for chum in winter/spring 2016 were back to their normal (close to zero) level.

What stands out most from the mean escapement rates for salmon in EFP 15-01 is that they are well below what occurred in the GOA tests for the O/U excluders and particularly far below the design used in the fall of 2014 on the Caravelle, the design that worked best in the GOA testing. Recall also that all the GOA tests with O/U excluders resulted in mean escapement rates in the range of 33-54% (see results for AB Spr 14, CaraSpr 14, CaraFall 14 below) while rates from the Bering Sea tests for this EFP are all below 20%, several under 10%.

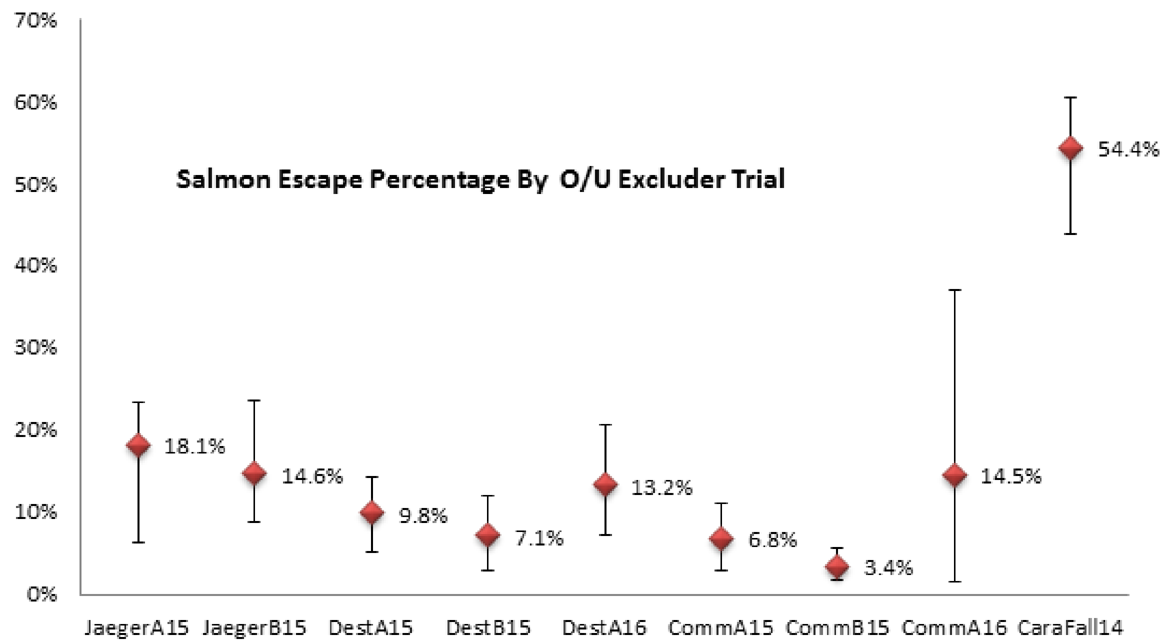
The bottom line is that it was hoped that by "scaling up" the Caravelle's excluder from the fall 2014 test to the Bering Sea vessels' horsepower and net size parameters, comparable results would be achieved but this was not the case. We can say this with considerable confidence because the testing covered three seasons and three different vessels.

At the same time, Bering Sea pollock escapement rates are also lower than what occurred in the GOA. This would have been a positive result if escapement of salmon had been of similar magnitude in the Bering Sea trials. One way to look at this might be that escapement rates in general were lower in the Bering Sea tests. This might indicate that with faster towing speeds (bigger nets, higher volume of flow of fish through the net) escapement for salmon or pollock is simply going to occur at lower rates. This makes some intuitive sense but as will be seen in the discussion below, it may not be that simple.

Thinking about the differences in rates between GOA and Bering Sea in the context of vessel size, towing speeds, and horsepower, an even more perplexing aspect of the Bering Sea results is that one would have expected to find salmon escapement results on the catcher vessels in the Bering Sea, particularly the lower horsepower vessel (Commodore) to be the closest in terms of salmon escapement to the results from the GOA vessels. But in fact the Commodore's salmon escapement (and that of the larger CV vessel Destination) is lower than what was seen on the 7,200 HP catcher-processor (see NJ 15-A and NJ 15B). Northern Jaeger actually had results in the range of 15-18% for tests with the O/U excluder and this is at least closest to the GOA results, arguably in the lower range of what occurred in the GOA.

To look at potential for variability around mean results to help explain outcomes, Figure 7 below includes 95% confidence intervals for GOA and Bering Sea excluder salmon escapement rates. Confidence intervals were calculated using a re-sampling routine implemented with Resampling Stats, an add-on for Excel (see: www.resample.com). This was used to fill the sample sizes from each group with salmon and pollock catches and escapes from that group's results, randomly selected, with replacement, for each haul (R routine). Selections were repeated 5000 times, with percent escapes for pollock and salmon computed for each selection. The results were sorted and the 5% lower (125th) and upper (4875th) values provided as the upper and lower confidence limits at an Alpha of 5%. Results from the GOA and Bering Sea trials are grouped together in Figure 7 below.

Figure 7. Mean salmon escapement rates in excluder trials in the Bering Sea (2015/2016) and Gulf of Alaska (Caravelle fall 2014) by vessel and season with 95% CI's.



The Bering Sea results are the first eight mean values with confidence intervals from left to right. The final seasonal test on Northern Jaeger in A season 2016 did not test an O/U excluder as will be explained below. Based on 95% confidence, the results span from 3%-35% salmon escapement considering the wide confidence intervals around the result for Commodore in A season 2016 but for the rest of the trials, the results are in the 3% to 24% range. By comparison, the result from the Gulf of Alaska trials that were used to select the O/U device (Caravelle fall 2014) ranges from 42% to 60%. Given the wide disparity, it is clear that the Bering Sea results are quite different and a hypothesis test is not needed to determine that the Bering Sea results are categorically different from our expectation in the EFP for performance for the GOA excluder that performed best.

The other result of interest from the 15-01 tests was focused on the vessel's flapper excluder in use on the vessel prior to their being selected for EFP 15-01. The impetus to test Northern Jaeger's flapper arose after seeing the two seasons of somewhat disappointing results on their vessel and other EFP15-01 vessels during the first two seasons. In gearing up for the final testing season, the captain of the Northern Jaeger pointed out that escapement with the O/U excluder tested on his vessel during the first two seasons had occurred predominantly out the top escapement portal. From this he wondered whether escapement out the bottom was actually important and whether the O/U excluder really outperforms a flapper excluder. He felt that the flapper excluder, particularly the one he was using prior to the EFP, was achieving better results than what he had seen so far in the first two seasons of 15-01. The captain had modified their flapper excluder to have two pathways for escapement out the top of the net. He also explained that he had added a strong light to illuminate the escapement area in the hopes that it would attract salmon. On their own, the crew of the Northern Jaeger had monitored escapement periodically with the vessel's recording video system. Based on this they expected their device would outperform NPFRF's O/U.

Given the somewhat disappointing results thus far, NPFRF agreed to test Northern Jaeger's flapper-style excluder for the final season of testing in winter/spring of 2016. Given the similarity in results from the first two trials on the vessel, NPFRF felt pretty comfortable that a third test would result in similar results. The opportunity to look at something the captain thought might work better was interesting, particularly given their use of a large green light at the forward escapement portal which was a quite different approach to lighting than anything that NPFRF had examined. The addition of a second portal to allow salmon to access the escapement pathway was innovative and the lighting utilized a powerful (1,200 lumen) "egg-shaped green light" that the crew charged periodically made it quite unique. The excluder as rigged for the A season 2016 testing on Northern Jaeger is shown below.

The Northern Jaeger's hope that salmon escapement would be better with their flapper device unfortunately did not pan out from the testing done in the EFP. The result for that test was a mean salmon escapement of 8.9% (95% confidence interval from 6-12%) with slightly higher nominal Pollock escapement rates than the boat had in the first two O/U tests. This flapper test encompassed an entire trip combining AFA and EFP fish and this same approach was done for the Jaeger's fall 2015 EFP test (B 15 results) in Figure 7. While probably not definitive, the results on the Northern Jaeger with O/U excluders suggest that the O/U excluder performed better than their flapper excluder.

<u>Salmon genetics/Sea Share</u>: All encountered Chinook salmon were measured and weighed and scanned for the presence of coded wire tags. Tissue samples were also collected from Chinook salmon when there were more than 50 Chinook salmon in the haul for stock of origin analysis. Tissue samples (PAP's) were collected for DNA/stock of origin analysis and sent to Auke Bay for processing. Per the requirements of the permit, all salmon meeting the quality requirements of the Sea Share program were donated to food banks through the Prohibited Species Donation program.

Discussion:

Several factors merit consideration in exploration of possible reasons for the difference between expectations from the GOA performance and what occurred in the Bering Sea. As was mentioned, towing speed was one that NPFRF expected to be an important factor from the outset. But as will be seen below, the answer may not be as straight-forward as differences in towing speed, particularly since the results for the slower-towing catcher vessels Bering Sea vessel in the EFP showed lower salmon escapement than was seen on the fastest towing catcher processor vessel. In this regard, a set of other possible explanations is offered in the discussion below.

<u>Towing Speed</u>: The towing speed (measured as speed over ground for all EFP vessels either GOA or BS) for the two GOA pollock vessels ranged from 2.5 to 3.0 knots during the 2013-2014 trials. For the Bering Sea vessels in EFP 15-01, speeds per vessel were as follows: Northern Jaeger's ranged from 3.5 to 4.2 knots, Destination towed from 3.8 to 4.0 knots, and Commodore ranged from 3.0-4.0 knots. In reality, this amounts to just a little more than a knot faster than the GOA vessels for the larger CV and CP vessel although these boats tow in the upper part of their ranges more often than in the lower part. For the smaller Bering Sea catcher vessel Commodore, on average their speed was just half a knot faster. Could towing approximately one knot faster or as little as half a knot for the smaller Bering Sea vessel on average account for the performance difference alone? It could but other factors might be equally or even more important.

Consistency in speed might also be a factor. Speed varies during a tow depending on whether the vessel is towing with or against the tide and/or the seas. The angle of the vessel's pathway relative to the tide and seas can vary within a single tow as well. This is especially true if the vessel's fishing practice includes one or more turns during a tow. Some fishermen do not fish in a way that normally involves turns favoring fishing along a depth contour or edge where Pollock sign was seen during searching or from prior tows in an area. Others actually try to fish a dense patch of fish in area where they feel the fish sign in suitable for concentrated fishing with several turns to stay in that area during the tow. The point here is that we know from the video that escapement does not always occur steadily and it probably occurs more when speed and water flow conditions are best for salmon. Perhaps escapement of salmon occurs most when the most advantageous speed to occur, at when these speeds overlap with when salmon happen to be passing through the section of the net where the excluder is installed. Differences in fishing practices may affect the chances that the right speed occurs when salmon are passing through that section of the net or when salmon swim forward to make a second attempt at escapement, such as during slowdowns and turns. From this we can hypothesize that the more variable speed is within a tow the greater the potential that salmon escapement will occur.

In this regard, all else being equal, we would expect that for larger vessels, speed would generally be steadier due to the vessel's inherent horsepower and towing force which can compensate for factors like towing into rough seas and other conditions that would likely slow smaller vessels down or make their progress over ground more variable. Fishing practices like frequency of turns would also have to be taken into account as well. Having more of this detailed information about towing speed within a tow and variability in speeds might be helpful for determining whether instantaneous towing speed explains much about when salmon escapement occurs. The range of towing speeds during the EFP were collected but our data do not provide an archive of speed during tows in time step with when salmon escapements occurred.

Door spread, mesh opening, and towing characteristics: Observations by NPFRF's project managers in reviewing video from this EFP and the one in the GOA was that salmon did not appear to have difficulty moving forward against the water flow in the Gulf of Alaska or Bering Sea Pollock nets. What project managers did mention, however, was that for the Bering Sea vessels, particularly the larger ones, the webbing in the trawl intermediate where the excluder was installed appeared to be "more stretched and tighter" than for the Gulf of Alaska vessels in the EFP there. This is a complex issue that might be important for understanding performance differences as well.

The way a trawl system takes shape and performs is dependent not just on towing speed but the size and design of the doors which spread the trawl. Doors, in combination with the net bridles and towing speed affect the degree to which meshes are spread and how thereby determine "tight" the netting will be. This in turn affects the relative size of the net at different parts of its taper from front to back. For example, two vessels can be using the same net model made by the same manufacturer and of approximately the same degree of use (e.g. brand new, one season, two seasons, repaired once or more). One of those "identical" nets might have large mesh spread and a much larger diameter of the tube of the net at the same location than another vessel. The difference is probably explained most by door size, bridles, and towing speed which all affect this outcome.

All these factors might be important to performance of an excluder in terms of salmon and pollock escapement with the O/U excluder. For example, rigidity of the netting in the trawl intermediate affects the degree to which the O/U's floated and weighted panels come together in the center. Recall that the GOA trials and the specifics of the Caravelle's O/U excluder design were based on the inner excluder panels coming relatively close together in the center of the intermediate. From this we surmise that panels coming together tends to corral fish into the center thus maximizing the amount of room available in the upper and lower escapement pathways (in addition to increasing the room available to salmon to get out of the flow of pollock passing backwards). The degree to which the panels in the Bering Sea trials came together was affected by the amount of weight and floatation on the panels and the rigidity (tension) in the netting. Adding weight and floatation to the panels is intended to compensate for rigidity to some extent in helping the desired shaping of the excluder to occur. But the degree to which the panels come together is limited by the rigidity of the webbing and at a certain point the addition of floats and leadline starts to increase the drag against the flow therefore reducing their marginal contribution to the objective of pulling the panels together in the center.

The photos below were selected as a good representation of how the excluder panels and escapement pathways looked "on average" during towing for each EFP boat. The view in each case is looking forward from aft of the floated and weighted panels. Some differences in size and shape of each specific intermediate section in relation to distance from the camera to the area behind the excluder panels affects our ability to systematically determine differences in the shaping. The photos essentially show how the excluder was set up for escapement of salmon as salmon moved back through the excluder section of the trawl (or when a salmon swam forward after passing this section). By "set up" is meant how much room was available for accessing the escapement pathway and how much room out of the flow of pollock was created. The photos start with the GOA vessel Caravelle's excluder, the shape of which was the objective for this EFP (Figure 8). The remaining pictures (Figure 9, Figure 10, Figure 11) show the O/U excluder on the Bering Sea test vessels for shape comparison purposes.

Figure 8. Caravelle O/U excluder, Fall 2014. View is from aft of the excluder looking forward towards the mouth of the net. The large over and under escape portals are clearly shown with a salmon swimming forward towards the bottom escape hole.

Figure 9. Commodore O/U excluder, 2016

Figure 10. Destination O/U salmon excluder, 2015.

Figure 11. Northern Jaeger O/U excluder, 2015

Looking at the photos, one can see the differences in size of the section in which the excluder is installed and the relative degree to which the upper and lower panels of the excluder come together. The photos also show differences in rigidity of the webbing at towing speed.

Although subjective, the Bering Sea vessel that comes closest to the shape seen on the Caravelle appears to be the smaller Bering Sea vessel (Commodore). But that vessel's salmon escapement rates were the lowest of the Bering Sea test vessels. In this regard, the shaping for Northern Jaeger appears to create the least room for escapement and the narrowest pathway forward to the escapement holes. But that vessel had the closest salmon escapement results to those of the Caravelle.

The bottom line here is that there are too many factors controlling shape alone when one considers speed, net and mesh spread, room available to get out of the flow and for movement forward. The results suggest that speed and shape alone are not necessarily going to guarantee better results.

One final aspect of a net that could affect escapement is how "fast" or "slow" it tapers (transitions to smaller, more retentive meshes) from front to back. This affects the length of the net from the opening to where the excluder is installed. A "slow" tapered net (more gradual) would be longer and this could possibly affect how fatigued a salmon would be when it arrives at the section where the excluder is installed. Nets used in the Goa trials tended to be shorter (faster, more abrupt taper) relative to the Bering Sea nets used in EFP 15-01. This could have influenced escapement assuming that the ability of a salmon to make use of the escapement opportunity is dependent on degree of fatigue. Water flow and other factors are affected by the degree of taper in the net and these would also need to be taken into account in assessing how tired a salmon might be when it encounters the excluder. Size of salmon might also need to be taken into consideration as well, as is discussed next.

<u>Size of salmon as a factor affecting escapement</u>

One idea we considered to potentially explain the differences between GOA and Bering Sea results was that for the same species (Chinook is really the only GOA species encountered), size distribution of the salmon encountered in the EFP might be related to escapement performance differences. The expectation might be that if GOA Chinooks are larger and better swimmers so they could escape at a higher rate. Data collected in the EFP allowed for examination of this but because data on escapement was collected via video alone, firm conclusions on this issue cannot be made. The use of video to track escapement leaves only length data pertaining to salmon that did not escape. Ignoring that issue for the moment, the size frequency graphs shown below (Figure 12, Figure 13, Figure 14, Figure 15) do not show any remarkable differences in size of salmon between GOA and BS by species. Most of the Bering Sea and GOA Chinook salmon are in the range of 45 to 75 cm. Somewhat anecdotally we can say that the salmon in the video seen escaping look similar in size to those that do not (those seen in the codend). Without a systematic way to measure salmon in video footage, however we can only report that salmon escapements appear to resemble salmon that did not escape as a qualified guess. Another piece of potentially relevant information here comes from our past use of recapture nets to track escapement. Back when salmon escapement was tracked that way, we did not see any significant differences in salmon size between the codend salmon and those in the recapture net.

Figure 12. Salmon size frequencies, Commodore (2015 A season).

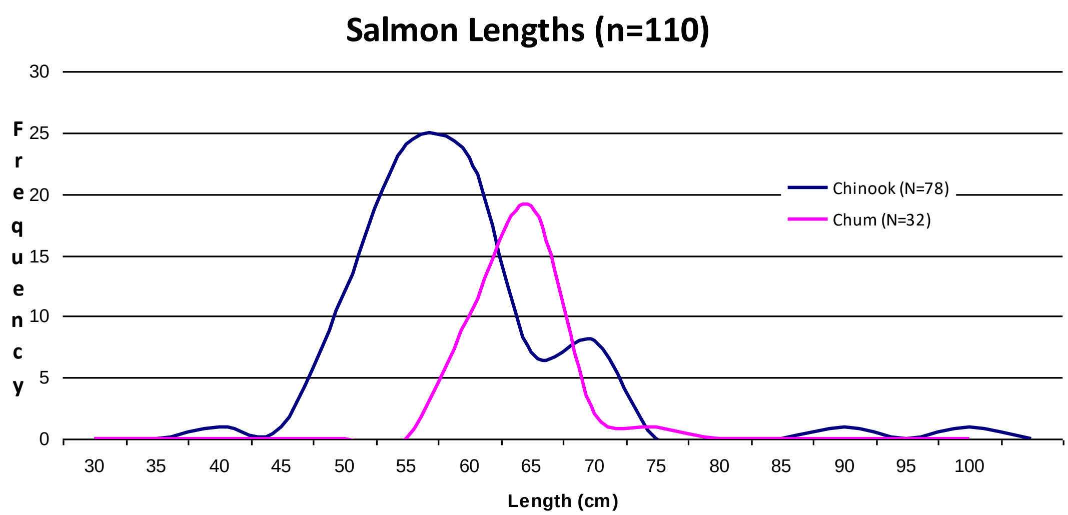


Figure 13. Salmon size frequencies, Destination, 2015 A season.

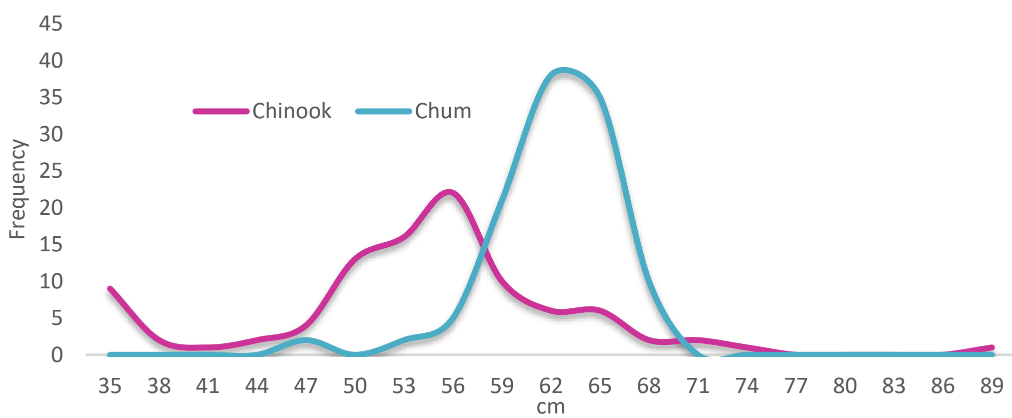


Figure 14. Salmon length frequencies, Northern Jaeger, 2015 A season.

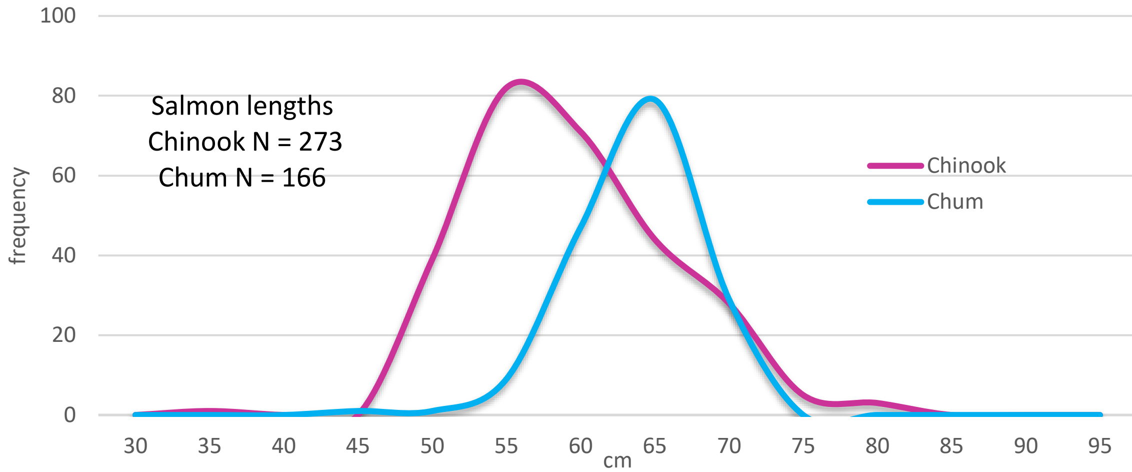
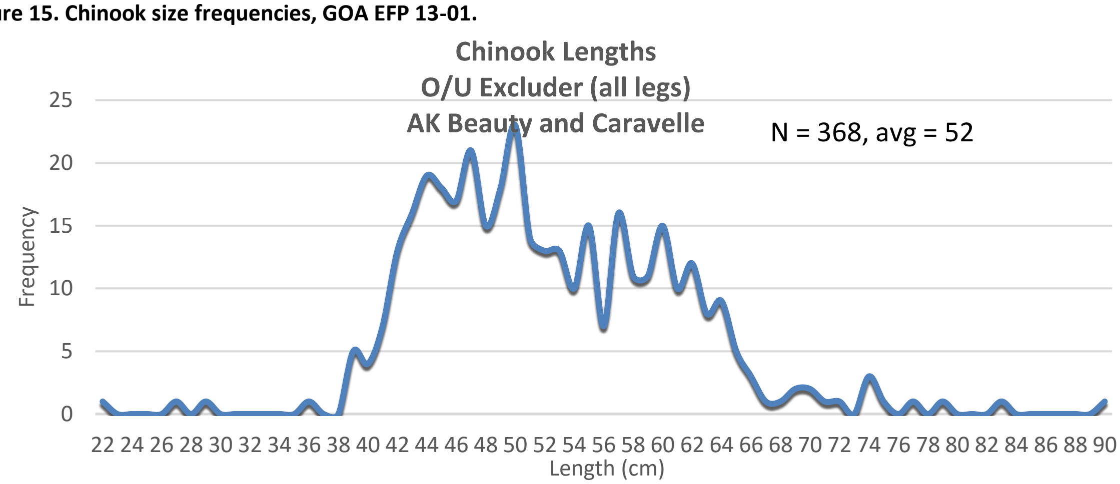


Figure 15. Chinook size frequencies, GOA EFP 13-01.



<u>Effect of pollock catch rates on salmon escapement.</u> One last possible explanation that was considered was the possibility that pollock catch rates could affect salmon escapement rates. Catch per hour of towing was examined to see if, for example, Bering Sea catch rates differed significantly from GOA rates. What was found when these data were analyzed both by simple regression analysis and visually through scatter plots is that there is a very large variability in catch per hour over the Bering Sea and Gulf of Alaska trials. Rates ranged from as low as a few tons an hour to highs of over 40 metric tons per hour in each area. The repressions and scatter plots of salmon escapement and groundfish catch per hour for Bering Sea and Gulf of Alaska showed nothing useful in terms of correlation here.

In discussing the lack of a finding of some (probably negative) correlation between Pollock catch rates and salmon escapement with fishermen, they were not at all surprised. Their reasoning was that catch per hour on average was probably not a very relevant way to think about how pollock catch rates might affect salmon escapement. Alternatively, they thought it is probably really about the relative amount of congestion that occurs when a salmon is trying to find its way out and this would occur intermittently over the course of a tow. In their experience, schools of pollock tend to be patchy and the fish do not always feed into the net steadily. All the fish caught in a three hour of towing might come from just a few minutes of fishing when a dense patch of pollock enters the net or this could occur over the entire duration of the tow. This suggests that data on catch per hour could really miss the key factors affecting congestion as fish move through the excluder section of the net.

To really understand how pollock moving back and flowing through a net might affect salmon escapement, fishermen suggested that a recording echo-sounder would need to be installed in the intermediate where the excluder is located. The density of fish moving through could then be tracked over time and examined to see if the timing of salmon escapements coincides with dense patches of fish moving through the excluder section or not. To do this correctly, the video would need time stamps that track with the eco-sounder data so an actual measure of congestion could be tracked in time step with salmon escapements. This is a very interesting area for exploration but unfortunately NPFRF did not collect this kind of data in our EFP.

Recommendations for future research

Based on NPFRF's research, the performance of the O/U in the Gulf of Alaska trials still represents the upside expectation for an effective excluder in the pollock fishery. The findings from EFP 15-01 suggest that scaling the excluder that worked best in the GOA trials to the Bering Sea fishery is not a straight-forward endeavor and getting the excluder to take the correct shape consistently is a first order step for future work on the O/U excluder in the Bering Sea. To attempt to do this systematically based on what was learned in this EFP, a set of measurement devices and parameters, some probably unique, would be very useful to gauge achievement of standardization and effects on performance of fishing variables. For example, measurement devices, many of which are available today could be used to track and record tension on net meshes. This could be tracked with speed over ground during a tow to gauge differences with towing speed, door spread, and other factors.

To evaluate shaping standardization, instead of relative visual distance between the excluder panels, the degree to which they come together could be measured with lasers designed to do standardized length/distance measurements. This could be used to give more systematic and precise estimates of escapement pathways and vertical room available for salmon to get out of the flow of Pollock and variability of these with tow speeds, door size and net spread.

Likewise, a recording echo-sounder device could to be developed that provides a calibrated estimate of the amount of pollock moving through the intermediate over time. With this the escapement events in the video data could be evaluated in time sequence to see if salmon escapements are affected negatively or positively by congestion from groundfish moving through the excluder.

Other types of meters and metrics along these lines could probably be fashioned with input from fishermen, gear manufacturers, fish behavior experts. These would be intended to elucidate potentially important variables systematically and in a manner that can be compared in real time to escapement throughout the duration of tows (dynamic rates).

Another approach for moving forward in the Bering Sea would be to set up a testing opportunity where fishermen would be selected for the EFP based on the degree to which they are able to make their O/U excluder take the desired shape based on the GOA device that worked best. This could be done by adjustments to the construction/rigging of their excluder, adjustments to trawl gear including doors, and/or changes in fishing practices such as towing speed. Fishermen could tap into the ideas of gear manufacturers, other experts, or rely on their own ideas on how to best get their excluder to take the desired shape based on what was the most efficient way to make that happen for their net/vessel horsepower, doors, fishing practices.

As a starting point for this approach, as set of systematic measurements as discussed above would need to be made for the GOA excluder during normal Pollock towing conditions. This baseline shape and mesh rigidity would serve as the objective to achieve in the Bering Sea and its achievement would be established through the same systematic measurement process that would be done for the GOA excluder.

One benefit to this approach would be that the test tows at the outset would simply be to confirm the shaping and this would obviate the need to use any of the EFP groundfish allowance to make adjustments to the excluder. Another benefit would be that fishermen could use whatever approaches are most efficient for them to use in order to achieve the desired shape. Given the heterogeneity of vessels and nets, this avoids the need to come up with a “one size fits all” approach to excluder construction/shaping/usage recommendations, something that is clearly not realistic.

In thinking about setting up such a challenge, it would be important to note that are surely limits on the degree to which Bering Sea pollock gear and the way it is fished can be modified and still catch pollock efficiently. For instance, trawl doors and other gear in the Bering Sea are tailored to the boats in the fishery. Simply slowing down the vessel by, for example, one knot might make the gear perform poorly for catching pollock. Reducing catch per unit effort might be more problematic than expected because even if it improved the effectiveness of the salmon excluder to some extent, the savings may be negative in terms of salmon bycatch reduction if the vessel has to tow longer to catch its allotment of pollock.

The attractiveness of setting up a testing opportunity based on meeting a set of systematic shape and size parameters for the excluder is that it avoids the “top down” engineering approach. In the end what might be discovered is that some small, relatively simple modifications to gear and fishing practices, something that was not expected to have too great an effect, might actually be all it takes to get the excluder to work in the Bering Sea. Trying to figure these out in an engineering setting might not be as effective as letting people who make a living with trawl gear figure out how to do it simply and cost effectively.

Whatever process is used to figure out how to get the excluder to have the desired shape/room for escapement attributes in the Bering Sea, an actual field test of the modified device and its fishing practices would need to be conducted to ensure it actually works. That test would once again only be truly relevant if it included a realistic range of vessel/horsepower differences in the Bering Sea Pollock fishery. Systematic proof that the O/U excluder performs like it did in the GOA (or better) is very important because simply assuming that getting the desired shape would generate the same escapement results ignores the possibility that the O/U may not work was well for the Bering Sea pollock fishery due to reasons other than shape and how the net is fished. If after that test it still turns out that the O/U excluder does not work as well in the Bering Sea, at least at that point the research can focus on differences that are independent of the excluder.

Acknowledgements:

NPFRF first and foremost wants to thank its field project managers Katy McGauley, Cory Lescher, and Ken Hansen. This EFP would not have been possible without their incredible work at sea with camera deployments and oversight of testing protocols on EFP boats. NPFRF also wants to thank the captains and crew of the Northern Jaeger, Destination, and Commodore for their cooperation and patience.. Their insights and ideas during the testing were also very much appreciated. NPFRF also thanks Swan Nets for their work to construct the O/U excluders used in these tests, often on short notice, and their willingness to help with deliveries to vessels and installations in Dutch Harbor. We also thank Jeff Hartman and Brandee Gerke in the NMFS Alaska Regional Office who did all the work to review our EFP application and provide all the work to support the application through the review stage as well as permit drafting. Finally, NPFRF thanks Chris Rilling and his staff at AFSC's FMA Division who worked with us to accommodate the EFP as a part of a regular AFA fishing trip on the Northern Jaeger as well as their willingness to allow observers to work as sea samplers and to use their NMFS-issued equipment for taking biological samples during the EFP.

Appendix

<u>Table of total groundfish and halibut catches from EFP 15-01 (based on ELandings/fish tickets, note: salmon catches reported in Table 1 above)</u>

Species FT lbs	Dest A 15	NJ A 15	Comm A 15	Dest B 15	NJ B 15	Comm B 1	Dest A 16	NJ A 16	Comm A 1	Total lbs	Total MT
Pollock	1,968,690	1,610,360	1,378,242	1,935,292	2,325,874	1,420,859	2,043,463	1,836,647	1,409,622	15,929,049	7,225.3
P. cod	9,123	13,732	21,891	11,946	12,101	4,366	19,695	5,207	10,877	108,938	49.4
Rex sole	0	532	130			22		4,988	5	5,677	2.6
Rock sole	3,818	1,809	193		62		484	69	10	6,445	2.9
Flathead	1,020	10,479	1,990	211	507		408	4,944	343	19,902	9.0
Arrowtooth	186	530	100	91	2,809	6	30	1,794	20	5,566	2.5
Kamchatka Fl		87			789			641		1,517	0.7
Turbot		261			60					321	0.1
Thornyheads		170								170	0.1
Dusky RF				7			6	4		17	0.0
POP		39	8			17		360		424	0.2
Shortraker RF								41		41	0.0
Atka Mack.				11	11		6			28	0.0
Sculpin		69	63		631					763	0.3
Skate	577	586	698		5,454		49	33	1	7,398	3.4
Squid	0	925	1	35		167		2,698	2	3,828	1.7
Octopus		103			9			1,472		1,584	0.7
Shark								12		12	0.0
non-Groundfish											
Eulachon	0	126						267		393	0.2
Jellyfish	906	5,396	87	116	227			285	193	7,210	3.3
Eels		47								47	0.0
Prowfish	1			13					4	18	0.0
Lamprey		17								17	0.0
Misc.					104			118		222	0.1
Poacher	1									1	0.0
Lumpsucker	247	418	150		11		477	171	2	1,476	0.7
Herring			1	457	97				2	557	0.3
Tanner Crab					7					7	0.0
Halibut	37	332	10	0	71	0	19	2,185		2,654	1.2
Total lbs GF	**1,983,414**	**1,639,682**	**1,403,316**	**1,947,593**	**2,348,306**	**1,425,437**	**2,064,141**	**1,858,898**	**1,420,880**	**16,091,667**	**7,299.1**
Total MT GF	**899.7**	**743.7**	**636.5**	**883.4**	**1,065.2**	**646.6**	**936.3**	**843.2**	**644.5**	**7,299.1**	

Attachment 2.
Summary of May 2017 Salmon Excluder Workshop

Detailed Summary of NPFRF's Salmon Excluder Workshop
May 9, 2017 at the Mountaineers Club Seattle

Attendance: The workshop started at 9:30 am with roughly 35 people in attendance at that point. By 10:30 am there were close to 50 in the room. Attendees were a good cross section of CP and CV sector captains and the full range of horsepower categories within the Bering Sea Pollock catcher vessel sector. Several NMFS and industry-sector researchers who have worked on field testing salmon excluders attended the workshop as well. Finally, two California commercial salmon fishermen and one Washington charter operator were there and participated in the discussion.

Workshop Findings:
During the 5 hour workshop, various perspectives were presented on what works for excluders, what does not, and how what works differs by vessel class. The most basic message was that salmon excluders are an important tool to address the salmon bycatch problem and while performance of different excluder designs differs by vessel class, everyone faces similar challenges. Examples of common issues are problems from fish becoming gilled in the excluder, problems getting lights to work as intended, problems with the current types of cameras available to evaluate excluder performance, the challenge of how to get excluders to work while maintaining target catch rates, a more-informed understanding of the parameters of nets and door/bridles that work for the economics of the Bering Sea Pollock fishery and how that affects excluder use and performance, and finally the challenge of excluder testing and improvement in the context of the regular Pollock fishery where doing things to test gear costs time and money. The workshop also illustrated that while there are some common challenges with salmon excluder for all sectors of the BS Pollock fishery, the emphasis is different for different sectors and the solutions to these problems may very well differ for different scales of vessel and door/rigging configurations.

Overall everyone who was invited to give a formal presentation and others who spoke up at the workshop thought that significant progress has been made with excluders and lights to make them more effective but additional work needs to be done to get to levels of performance in the Bering Sea such as 50% escapement. This 50% performance target likely comes from what was achieved in excluder tests in the GOA and individual tows with high escapement in APA's work in the Bering Sea. The consensus at the workshop was that better tools are needed to make the next round of improvements to excluders. Some of the tools needed for moving the ball forward that were discussed were:

- Small affordable recording cameras that work more reliably and are easier to use

- Getting real-time cameras to a place where they are more affordable and more practical, particularly for smaller boats that don't currently have the ability to affordably install a "4th wire" cable winch system.
- Availability of field testing helpers and technicians to deploy cameras on boats to help captains understand what their excluder is doing. Along with this, these technicians would provide trained eyes and the patience to summarize the video into what is important and short enough for a captain to watch.
- Improvements in sonar equipment to image the shape of the net in locations aft of the headrope and potentially all the way back to the codend.
- Lighting that is brighter with batteries that allow for long duration between charges. Also, research on colors and types of lighting to help fishermen understand potential for increasing escapement with different types and colors of light.
- Better ways to shape excluders with water flow and increased spreading of meshes (e.g. T90) with less reliance on weight and floatation
- Improvements in and more affordable types of float rope so it can be used in place of individual floats that break and lose buoyancy and tend to snag during the setting of the net.
- Arrangements to help fishermen test new ideas that allow the research to be done effectively and in a manner that does not penalize fishermen so heavily from lost time and development costs. An example here was APA's making Ed Richardson available to conduct field research and review video. Another was EFPs which provide added fishing opportunity and allowance for extra salmon outside of the regular fishery to fund the slowdowns associated with testing.

While the workshop did tend to focus on what is needed to move the ball forward on excluders, almost all speakers commented that a great deal of progress has been made since the last workshops involving all sectors of the fishery associated with the first set of NPFRF EFPs. The consistent message from this workshop was that people want to do more to get excluders to work and want to focus on what makes the most sense for their vessels and makes use of what has been done in the past. Many speakers started from the premise that a lot has been learned to guide people to selecting the best excluder for their boat and how to make it work but additional work needs to be done to make this information available to fishermen (not so much the ones that attended the workshop but the others who elected not to come or were unable to do so).

Another common thread was that while there is now considerable information available to those who want to select the best excluder design for their boat/net and add lighting to the exclude, it still remains very important to tune the excluder to the boat and net. One of the most repeated statements was that "There is no plug and play excluder" or even any formula that will reliably allow someone to just put on an excluder and get decent performance. Many speakers and attendees highlighted the need to tune the excluder to the specifics of each vessel and its trawl system. Video work is the only way to do that. Having the technical help from a video technician to get video to confirm the desired shape is being attained and verify escapement rates is an important step in making excluders work. Many stated that technicians and better equipment to make that process easier and more streamlined is a key need for achieving improvements.

The APA work on the flapper excluder has brought performance for the Pollock FTs further than where things were when NPFRF tested excluders via an EFP. Rates in the 25-35% range (for chums) are being achieved and the CP sector representatives at the workshop felt that the addition of artificial lights is mostly what has allowed for the gains in performance although other factors in excluder tuning are also important.

Regarding ideas for new directions for NPFRF to improve excluder performance, Kurt Cochran presented a rather wide set of new ideas based on things he has been able to look at in his self-guided trials. Kurt has spent an enormous amount of time and energy working on excluders and excluder concepts in the GOA Pollock and other trawl fisheries. He distilled this to six new ideas ranging from "haulway" excluders to high-spreading meshes, to scoops to improve water flow, and excluders that blend elements of flapper, over and under, and excluders used in the hake fishery. He felt all these ideas could be used in some way to improve performance in the Bering Sea.

In addition to providing perspectives on what he has learned about flapper excluder and light from his work with Ed Richardson and his camera deployments, Dave Irvine (captain of the Starbound), presented a new idea for where to focus. His thought is to use light in the front end of the net. This would be in the bigger mesh section of the net where salmon could potentially swim out without any modifications to the net. The discussion of this idea focused on how to install lights in the front part of the net without creating high risk of tangling up the front of the net and how to test the effectiveness of this given challenges for using video to see very far in the "big mesh" front portion of the net which is far bigger than any known camera can cover.

Mike Stone (catcher boat owner and former net designer) talked about his "bowtie" design can be used to get the shaping of the flapper or over and under without using the weight and floats. He came up with the design because he feels that weight and floatation can make the excluder cumbersome and susceptible to tangling during setting. Mike has put this idea into a flume tank but it has not been tried in a Pollock (went in the water for a tow or two but without a camera).

A West Coast salmon fisherman in attendance wondered if anyone had tried placing an electric current on the trawl warp, doors, or headrope/footrope based on the notion that some salmon boats with an odd electrical charge in their troll gear or the vessel itself seem to repel salmon.

Other more conventional ideas brought up at the workshop were for double or even triple O/U excluders or multiple flappers in the net, one behind the other with some spacing. These, it was stated, would best be looked at in the flume tank where RD is cheaper although there were varying opinions about the utility of the flume tank to look at ideas. This was based on concern that something that looks good in the tank might not take the exact same shape in the real world. Several who feel the tank work has been critical to excluder development pointed out that in their experience tank work has allowed them to attain the proper shape faster when the design in translated into full scale in a net. As for how fish react to excluders, advocates for the value of tank work were clear that they never expected to get information on fish behavior or reaction to the shaping of the excluder from tank work.

Overall the sharing of ideas between sectors at the workshop was significant and very productive. Feedback after the workshop was that a lot was learned about what other sectors were doing whether it was on the smallest or the largest vessels represented at the workshop. Also, the invited salmon fishermen appeared to come away a deeper appreciation and understanding of what the Pollock and hake industries are doing to reduce salmon bycatch.

Some detailed points of interest from the invited presentations at the workshop were as follows:

*John Gauvin presented the findings from the NPFRF' latest Bering Sea EFP covering 2015-2016. The goal of the EFP was to take what performed well in the GOA O/U excluder trials and test it on three vessel classes in the Bering Sea. Adjustments were made for each stage in the fieldwork to try to get closer to the shape of the excluder from the GOA trials on the F/V Caravelle. The overall results were that the Bering Sea trials never really tested what worked well in the GOA due to challenges in achieving the correct shape on larger Bering Sea vessels/nets, difference in towing speed, or other factors. The EFP resulted in a set of recommendations for tracking escapement during a tow and looking at catch rates, tow speed, and other factors when actual escapes occurred instead of looking at averages for these for the entire tow and assuming that difference during the tow did not matter. The EFP also used lights on the cameras to gauge salmon excluder performance but the effects of light on escapement rates in the context of escapement rates overall cannot be disentangled.

* Ed Richardson presented his findings from 16B and 17A 'ride along' trials using lights. He also talked about the 'Jaeger hole' in addition to the flapper. Ed's tests were done on a flapper design excluder in the straight section of the net just ahead of the codend. He talked about the pineal gland/ pineal window and how research into salmon physiology and biology with light makes him feel like light has a lot of potential. He talked about violet/ blue light being inhibitory and green/orange light being excitatory. He talked about how light color could affect salmon behavior in the nets. He said that for 17A he worked with the Northern Jaeger and Starbound and tests covered about 40 tows. He said that the limiting variable for the research is lights, and talked about the questions that still remain in using light- some of these questions may be answered by fieldwork by Noelle Yochum who has replaced Craig Rose in AFSC's RACE Division. Ed spoke a little about the scattering layer and how the biota there fouled the net, and how that affects the efficacy of the excluder, in addition to the concern with filling up the bag into the section where the excluder is located. He said that in 16B he worked with the Northern Jaeger and tried out the 'Jaeger hole' and looked at different light colors (white vs blue vs green/orange). He didn't see any differences with color. He did mention the issue of the flapper puckering. He theorized that chums were more excited by lights than Chinook, and that the 'Jaeger hole' increased escapement of small pollock. Note that he and Gauvin

put the 'stimulating' light in different places on the excluder. The NPFRF testing had the lights on the hood and scoop, whereas for Ed's work the lighting was at the top of the flapper ramp beaming back into the excluder.

* Kurt Cochran provided extensive background on the excluders he has used, including a Foulweather design with escape out the sides (Lomeli); the Swan flapper; the Green Line excluder; and the Over/Under. He also mentioned the puckering issues, and said that the Over/Under was most adaptable, worked the best for smaller boats. He talked about a new design- the Turbo tube- made by LFS- it is a cone shape design that works with the change in water flow. Time did not allow him to get into a lot of detail on many of the technical details. He mentioned that lights can attract SSLs. He uses the L-P lights, and said the more that are used, the better. He has not tried different light colors to see whether that affects escapement.

* Dan Martin talked about his experience with excluders in the BS EFP and on his own. He uses an Over/Under in the last tapered section of the net. He talked about using T90 and how it holds the bag open, but it increases the strain. In the hoods, the T90 made the hood stand up 8-9 feet and in the bottom the hood kept its shape without weights. He talked about going away from plastic floats in favor of float rope for more uniform lift and to avoid snags that occur when individual trawl floats get hung up in the meshes. He said there is a lot more to discover/ many issues to solve, but the issue is the cost of R&D.

* Jamie Buskirk talked about excluder designs he has used and all the EFP testing he has been involved in on the Pacific Prince and Destination. He is currently using the Over/ Under. He talked about how we need to figure out the right combo of net, door size, flapper design, and tow speed to get at the problem of salmon bycatch.

* Dave Irvine has been working with Ed Richardson to test the lights with the flapper excluder in the straight section, the last section before the codend. Length of the straight section is important for excluder performance and to avoid loss of Pollock. He remarked on the need to get people to watch some of the video collected and the need to have someone with technical ability watch it and reduce it to something a captain has time to watch. He talked about how escapement is reduced when the gear gets wobbly. 32% escape is the best he has seen. He is using the Swan flapper and likes the ease of it. He, like Ed, was using the Westmar light, but feels that it is not enough. The more light the better.

* Tim Thomas talked about how bad weather affects pollock loss when using the excluder. He acknowledged the fear of losing out on pollock when using excluders, and how each vessel is different in this regard but really Pollock loss has not been anything big enough to worry about for quite a while. He said that, overall, of importance is the opening in the escape area in terms of size and that the materials need to be pretty still to avoid spooking salmon and they move up to the opening. He remarked that in his experience, Chinook are not as aggressive as chum, and are less willing to go out. He is using the JT Electric LED light (green) like Ed has used. He remarked that light is important. He talked about how the marine layer really affects the dynamics of the

excluder (plugs it) when fishing deep. He also said that the excluder can affect the how the catch indicator devices work.

* Mike Stone talked about how the gear is shaped and how this can be controlled with changes in speed. He talked about a new “butterfly” excluder design that he plans to try. It has four openings (hoods) in the top and bottom- like the Over and Under x4, but it uses tapering and adding meshes to achieve the shape instead of floatation and lead-core line (weighting). The design ends up looking like it would look if you looked down the barrel of a double-barrel shotgun. A potential downside he can see is that fish can come out of the scoops on deck depending on the length of the extension.