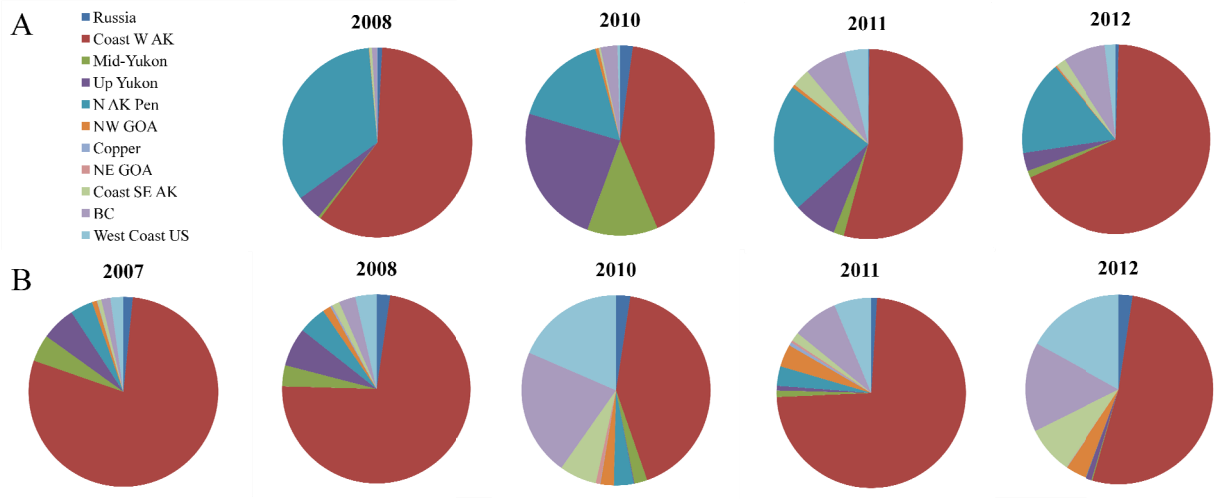

Figure 10. -- Comparison of "A" season genetic stock composition estimates for 2008, 2010-12 based on available genetic samples from the BSAI Chinook salmon bycatch. Comparison of "B" season genetic stock composition estimates for 2007, 2008, 2010-12 stock composition estimates based on available genetic samples from the BSAI "B" season Chinook salmon bycatch. The same genetic baseline and regional groupings were used in all analyses.

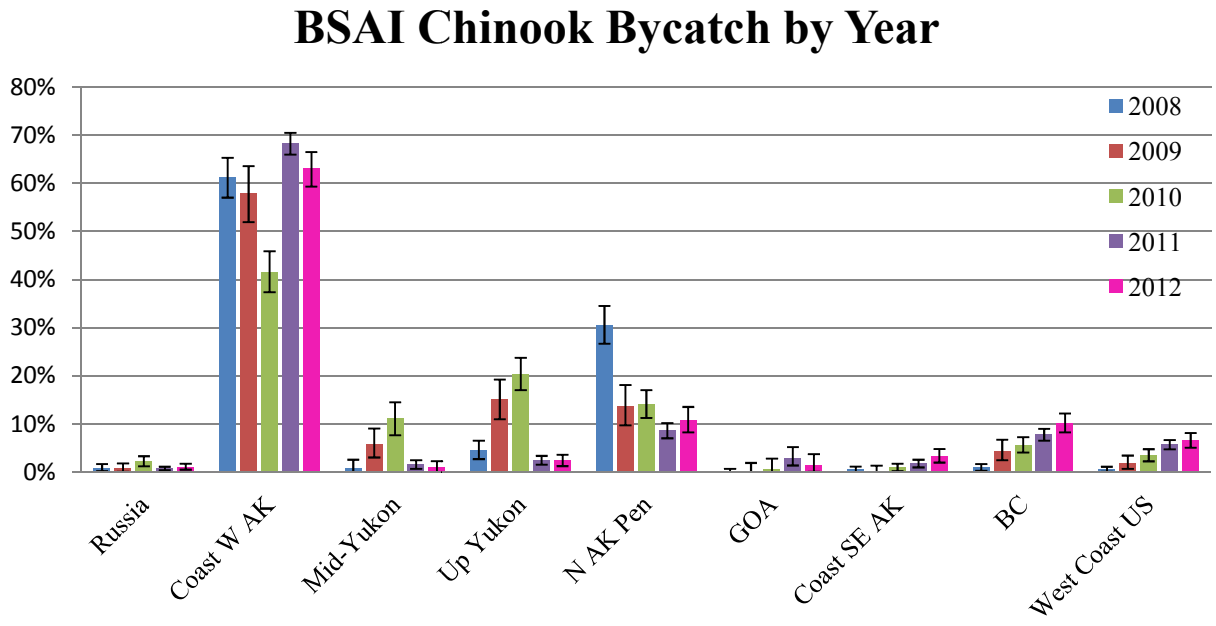

Figure 11. -- Comparison of yearly stock composition estimates (2008-2012) based on genetic samples from the BSAI Chinook salmon bycatch. The same genetic baseline and general regional groupings were used in all analyses. GOA group consists of combined values for NWGOA, Copper, and NE GOA. BAYES 95% credible intervals are plotted for yearly estimates.

The 2007, 2008, and 2011 "B" season stock composition estimates were similar with large amounts from Coastal Western Alaska (Fig. 10). In contrast with the other "B" season estimates, the 2010 and 2012 "B" season estimates identified larger contributions from British Columbia, West Coast U.S. and Coastal Southeast Alaska stocks. In contrast to 2011 and similar to most other previous years studied, most of the Chinook salmon bycatch occurred in 2012 during the "A" season. As in 2011, systematic random sampling was employed in 2012, where genetic samples were collected from one of every 10 Chinook salmon encountered.

While changes in sampling protocols between years necessitate caution in comparing analyses across years, when the stock compositions were analyzed for the entire year, Coastal Western Alaska stock compositions trended downward between 2008 and 2010 but increased in 2011, and remained at a similar level in 2012 (Fig. 11). North Alaska Peninsula stock compositions have remained consistent since 2009 reporting 11% of the bycatch in 2012 (Fig. 11). The upper and middle Yukon River contribution continued to be low in 2012, while Coastal Southeast Alaska, British Columbia and West Coast U.S. stock compositions continued their 5-year upward trend (Fig. 11).

For the GOA, the opportunistic sampling protocols employed between 2010 and 2012 limit the results to indentifying only presence of individual stocks; however, the greater number of available samples (948) allowed temporal and geographical analyses for the first time in 2012. Recognizing these limitations, Figure 12 shows the stock composition in the GOA of samples collected in 2010, 2011, and 2012. All years show an abundance of southern stock groups (British Columbia, West Coast U.S., and Coastal Southeast Alaska). The NW GOA dropped in abundance in 2012, similar to levels in 2010 and there was a corresponding increase in British Columbia and West Coast U.S. groups. There appear to be more Coastal Southeast Alaska fish

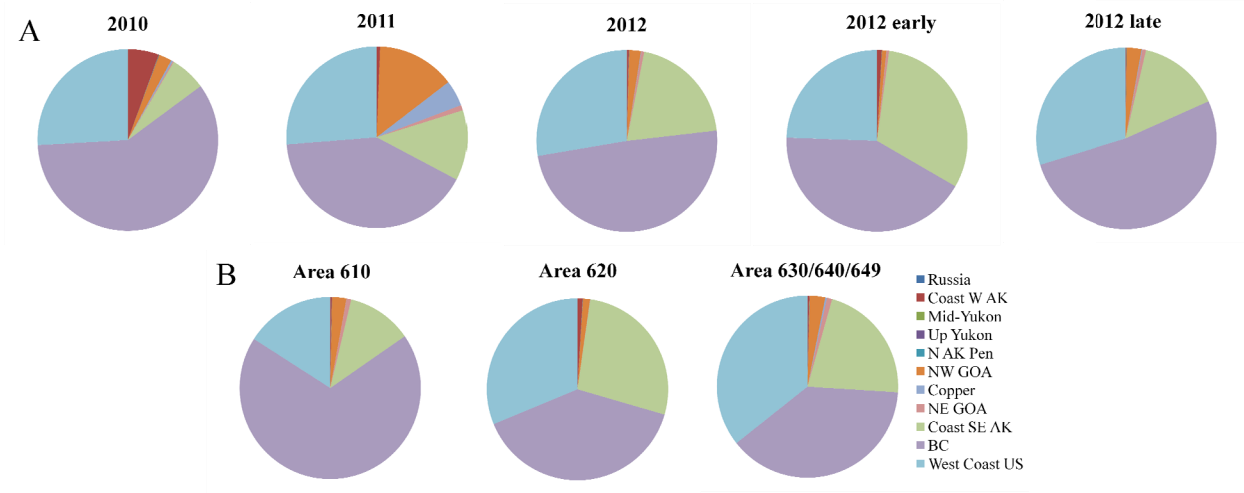

Figure 12. -- Comparison of genetic stock composition estimates for 2010-12 based on available genetic samples from the GOA Chinook salmon bycatch. Panel A shows comparisons across time. Panel B shows comparisons between NMFS Statistical Areas in 2012. The same genetic baseline and regional groupings were used in all analyses.

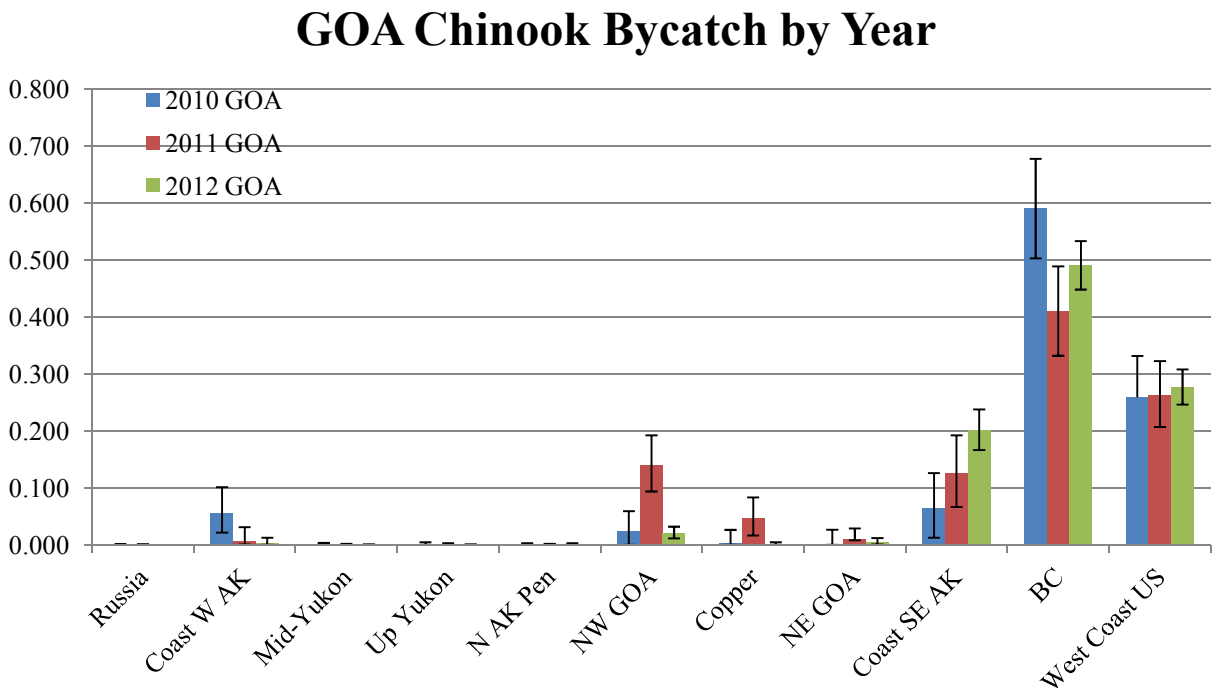

Figure 13. -- Comparison of yearly stock composition estimates (2010-2012) based on available genetic samples from the GOA Chinook salmon bycatch. The same genetic baseline and general regional groupings were used in all analyses. BAYES 95% credible intervals are plotted for yearly estimates.

early in 2012, than in late 2012 (Fig. 12A). There also appears to be more British Columbia fish in the west, in area 610, while the composition of West Coast U.S., and Coastal Southeast Alaska fish increased in the more eastern areas (620/630/640/649) (Fig.12B). Throughout all years, British Columbia remained the most abundant group, followed by the West Coast U.S., and the upward trending Coastal Southeast Alaska (Fig. 13)

SUMMARY

Communities in western Alaska and elsewhere are dependent on Chinook salmon for subsistence and commercial purposes. Decreasing Chinook salmon returns to western Alaska rivers have caused hardships in these communities and led to fisheries disaster declarations for Yukon River Chinook salmon in 2010 and 2012 by the U.S. Secretary of Commerce (Locke 2010, Blank 2012), and in the Kuskokwim Rivers, and Cook Inlet in 2012 (Blank 2012). Salmon-dependent communities have expressed concern regarding the numbers of salmon caught as bycatch in the Bering Sea trawl fishery (Gisclair, 2009). The incidental harvest of Chinook salmon in the Bering Sea pollock fishery averaged 38,624 salmon per year during 1991-2012, but increased to a peak of 121,638 in 2007. The Bering Sea Chinook salmon bycatch has abated in more recent years dropping to a total of 11,343 Chinook salmon in 2012, a number which is 27,281 fish below the 22-year average.

In addition to the Bering Sea, there is also a federally managed pollock trawl fishery in the Gulf of Alaska. The incidental harvest of Chinook salmon in the GOA averaged 14,647 salmon per year during 1991-2012, with a peak of 44,779 in 2010. The GOA Chinook salmon bycatch was above the 22-year average in 2012 at 18,850 Chinook salmon.

Stock composition estimates of the Chinook salmon bycatch are needed for pollock and salmon fishery managers to understand the biological effects of the incidental take of salmon in the trawl fishery. This report provides stock composition analysis of genetic sample sets from the 2012 Bering Sea and GOA Chinook salmon bycatch. The results and limitations of this analysis are summarized below.

Sampling Issues

Bering Sea-Aleutian Islands

With the implementation of systematic random sampling in the 2011 prohibited species catch, 2012 is the second year from which representative samples have been collected from the Chinook salmon bycatch. This represents a lot of effort over many years to develop standardized protocols for collecting sets of samples from numerous observers both at sea and in shore-based processing plants, the efforts of which are clearly apparent in the representative nature of the sample sets (Figs. 4 and 5). The observed genetic sampling rate in 2012 was 9.8%, the highest ever observed and in close agreement with the goal. The resulting Chinook salmon Bering Sea bycatch sample set was 1,111.

Gulf of Alaska

Although opportunistic sampling was employed for the collection of the GOA Chinook salmon bycatch genetic samples between 2010 and 2012, the sampling effort improved from a 0.4% sampling rate in 2010 to 1.7% in 2011 to 5.0% in the 2012. The overall sample set was larger than the two previous years combined at 948, although the lack of representative samples hinders calculating statistically reliable stock composition estimates of the 2012 GOA Chinook

salmon bycatch as a whole. Nonetheless the stock composition of the available samples provides at least an indication of stock presence, although repeated estimates across years will eventually provide generalized composition estimates.

Stock Composition Estimates

Bering Sea-Aleutian Islands

Genetic stock composition analysis showed the majority of bycatch samples collected in the Bering Sea were from Alaskan stocks predominantly originating from river systems directly flowing into the Bering Sea. The stock composition of the Chinook salmon bycatch during the 2012 "A" season differed from the 2012 "B" season, demonstrating temporal differences in the stocks intercepted. This was especially apparent in the Coastal Western Alaska (68% vs. 52%) and the North Alaska Peninsula (16% vs. 0.1%) stock groups.

Salmon Excluder Test Samples

Genetic analysis showed that the samples collected from the spring 2012 salmon excluder device test were predominantly from Coastal Western Alaska with an overall stock composition very similar to the 2012 Bering Sea "A" season estimate. In addition, the sample set provided a unique opportunity to compare the stock composition of Chinook salmon taken at sea in two different hauls. Although the variance will increase with smaller sample sets, stock compositions for the Coastal Western Alaska and the North Alaska Peninsula stock groupings between hauls were outside the standard deviation intervals suggesting the potential for some degree of stock aggregation even over small spatial and temporal groupings.

Gulf of Alaska

As in previous years, the opportunistic nature in which genetic samples were collected from the GOA Chinook salmon bycatch limited the 2012 stock composition results to indicators of presence/absence, although the sample sizes were much improved allowing for temporal and geographic analyses. As in 2010 and 2011, the 2012 GOA Chinook salmon bycatch samples were predominantly from the west coast of the United States, British Columbia, and Coastal Southeast Alaska (Fig. 12).

Application of These Estimates

The extent to which any salmon stock is impacted by the bycatch of the Bering Sea trawl fishery is dependent on many factors including 1) the overall size of the bycatch, 2) the age of the salmon caught in the bycatch, 3) the age of the returning salmon, and 4) the total escapement of the affected stocks taking into account lag time for maturity and returning to the river. As such, a higher contribution of a particular stock one year does not necessarily imply greater impact than a smaller estimate the next. Stock composition estimates for the Bering Sea Chinook salmon bycatch were performed using representative samples and the estimates are considered to be representative of the overall bycatch. Opportunistic sampling used for the GOA estimates limit the application of those estimates to presence of a stock group.

ACKNOWLEDGMENTS

Genotyping for this analysis was funded by the Alaska Fisheries Science Center, National Marine Fisheries Service, the North Pacific Fisheries Research Foundation, and the Alaska Sustainable Salmon Fund. We are grateful to Katharine Howard, Chris Habicht, Nicholas

DeCovich and Bill Templin of ADF&G for providing suggestions and advice regarding the analysis, and reviewing this report. We are also grateful for the help from the AFSC's FMA Program including Martin Loefflad, Liz Chilton, and the many participating observers who provided genetic samples. We would also like to thank Joseph Colling, Katy McGauley, and John Gauvin regarding the collection of genetic samples from the 2012 salmon excluder device test. MALDI-TOF genotyping and assay design performed in collaboration with Colleen Ramsower and Dr. Ryan Sprissler from the genotyping core facility at the University of Arizona. Phil Mundy helped review the report. Special thanks to AFSC editorial staffers, James Lee and Gary Duker, for their rapid and thorough editorial review of this document.

CITATIONS

ADF&G (Alaska Department of Fish and Game). 2003. SPAM Version 3.7b: Statistics Program for Analyzing Mixtures. Alaska Department of Fish and Game, Commercial Fisheries Division, Gene Conservation Laboratory, Anchorage, Alaska.

Blank, R. 2012. Acting Commerce Secretary Rebecca Blank announces "Fishery Failure" determination for Alaska Chinook salmon. In Commerce News release, September 12, 2012, U.S. Department of Commerce, Washington, DC.

Gabriel, S., L. Ziaugra, and D. Tabbaa. 2009. SNP genotyping using the Sequenom MassARRAY iPLEX platform. Current Protocols in Human Genetics Chapter 2, Unit 2 12.

Gisclair, B.R. 2009. Salmon Bycatch Management in the Bering Sea Walleye Pollock Fishery: Threats and Opportunities for Western Alaska. Am. Fish. Soc. Symp. 70:799–816

Guthrie, C. M. III, H. Nguyen, and J. R. Guyon. 2012. Genetic stock composition analysis of Chinook salmon bycatch samples from the 2010 Bering Sea trawl fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-232, 22 p.

Guthrie, C. M. III, H. Nguyen, and J. R. Guyon. 2013. Genetic stock composition analysis of Chinook salmon bycatch samples from the 2011 Bering Sea and Gulf of Alaska trawl fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-244, 28 p.

Guyon, J. R., C. M. Guthrie, and H. Nguyen. 2010a. Genetic stock composition analysis of Chinook salmon bycatch samples from the 2008 Bering Sea pollock fishery, 32 p. Report to the North Pacific Fishery Management Council, 605 W. 4th Avenue, Anchorage AK 99510.

Guyon, J. R., C. M. Guthrie, and H. Nguyen. 2010b. Genetic stock composition analysis of Chinook salmon bycatch samples from the 2007 “B” season and 2009 Bering Sea trawl fisheries, p. 32. Report to the North Pacific Fishery Management Council, 605 W. 4th Avenue, Anchorage AK 99510.

Larson, W. A., F. M. Utter, K. W. Myers, W. D. Templin, J. E. Seeb, C. M. Guthrie III, A. V. Bugaev, and L. W. Seeb. 2013. Single-nucleotide polymorphisms reveal distribution and migration of Chinook salmon (*Oncorhynchus tshawytscha*) in the Bering Sea and North Pacific Ocean. Can. J. Fish. Aquat. Sci. 70(1):128-141.

Locke, G. 2010. Commerce Secretary Gary Locke announces "Fishery Failure" determination for Alaska Chinook salmon. In Commerce News release, January 15, 2010, U.S. Department of Commerce, Washington, DC.

NMFS (National Marine Fisheries Service). 2009. Bering Sea Chinook salmon bycatch management - Volume 1, Final Environmental Impact Statement, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Regional Office, Juneau, AK.

NMFS (National Marine Fisheries Service). 2012. BSAI Chinook salmon mortality estimates, 1991-present, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Regional Office, Juneau, AK. http://www.fakr.noaa.gov/sustainablefisheries/inseason/chinook_salmon_mortality.pdf

Peakall, R., and P. E. Smouse. 2006. GenAlEx 6: genetic analysis in Excel. Population genetic software for teaching and research. Mol. Ecol. Notes 6:288-295.

Pella, J., and H. J. Geiger. 2009. Sampling considerations for estimating geographic origins of Chinook salmon bycatch in the Bering Sea pollock fishery. Alaska Dep. Fish Game Spec. Pub. No. SP 09-08. 58 p.

Pella, J., and M. Masuda. 2001. Bayesian methods for analysis of stock mixtures from genetic characters. Fish. Bull., U. S. 99:151-167.

Templin, W. D., J. E. Seeb, J. R. Jasper, A. W. Barclay, and L. W. Seeb. 2011. Genetic differentiation of Alaska Chinook salmon: the missing link for migratory studies. Mol. Ecol. Res. 11 (Suppl. 1):226–246.

APPENDIX

Chinook salmon populations in the ADF&G's single nucleotide polymorphisms (SNP) baseline with the regional designations used in the analyses of this report. S.=South, R.=River, H.=Hatchery, and L.=Lake.

Population name	Reg Num	Region Name	Population name	Reg Num	Region Name
Bistraya River	1	Russia	Henshaw Creek	3	Mid Yukon
Bolshaya River	1	Russia	Kantishna River	3	Mid Yukon
Kamchatka River late	1	Russia	Salcha River	3	Mid Yukon
Pakhatcha River	1	Russia	Sheenjek River	3	Mid Yukon
Andreafsky River	2	Coast W AK	S. Fork Koyukuk River	3	Mid Yukon
Aniak River	2	Coast W AK	Big Salmon River	4	Up Yukon
Anvik River	2	Coast W AK	Blind River	4	Up Yukon
Arolik River	2	Coast W AK	Chandindu River	4	Up Yukon
Big Creek	2	Coast W AK	Klondike River	4	Up Yukon
Cheeneetnuk River	2	Coast W AK	Little Salmon River	4	Up Yukon
Eek River	2	Coast W AK	Mayo River	4	Up Yukon
Gagaryah River	2	Coast W AK	Nisutlin River	4	Up Yukon
George River	2	Coast W AK	Nordenskiold River	4	Up Yukon
Gisasa River	2	Coast W AK	Pelly River	4	Up Yukon
Golsovia River	2	Coast W AK	Stewart River	4	Up Yukon
Goodnews River	2	Coast W AK	Takhini River	4	Up Yukon
Kanektok River	2	Coast W AK	Tatchun Creek	4	Up Yukon
Kisaralik River	2	Coast W AK	Whitehorse Hatchery	4	Up Yukon
Kogrukluk River	2	Coast W AK	Black Hills Creek	5	N AK Pen
Kwethluk River	2	Coast W AK	King Salmon River	5	N AK Pen
Mulchatna River	2	Coast W AK	Meshik River	5	N AK Pen
Naknek River	2	Coast W AK	Milky River	5	N AK Pen
Nushagak River	2	Coast W AK	Nelson River	5	N AK Pen
Pilgrim River	2	Coast W AK	Steelhead Creek	5	N AK Pen
Salmon R. -Pitka Fork	2	Coast W AK	Anchor River	6	NW GOA
Stony River	2	Coast W AK	Ayakulik River	6	NW GOA
Stuyahok River	2	Coast W AK	Benjamin Creek	6	NW GOA
Takotna River	2	Coast W AK	Chignik River	6	NW GOA
Tatlawiksuk River	2	Coast W AK	Crescent Creek	6	NW GOA
Togiak River	2	Coast W AK	Crooked Creek	6	NW GOA
Tozitna River	2	Coast W AK	Deception Creek	6	NW GOA
Tuluksak River	2	Coast W AK	Deshka River	6	NW GOA
Unalakleet River	2	Coast W AK	Funny River	6	NW GOA
Beaver Creek	3	Mid Yukon	Juneau Creek	6	NW GOA
Chandalar River	3	Mid Yukon	Karluk River	6	NW GOA
Chena River	3	Mid Yukon	Kasilof River mainstem	6	NW GOA

Population name	Reg Num	Region Name	Population name	Reg Num	Region Name
Kenai River mainstem	6	NW GOA	Kowatua River	9	Coast SE AK
Killey Creek	6	NW GOA	Little Tatsemenie River	9	Coast SE AK
Ninilchik River	6	NW GOA	Macaulay Hatchery	9	Coast SE AK
Prairie Creek	6	NW GOA	Medvejie Hatchery	9	Coast SE AK
Slikok Creek	6	NW GOA	Nakina River	9	Coast SE AK
Talachulitna River	6	NW GOA	Tahltan River	9	Coast SE AK
Willow Creek	6	NW GOA	Unuk R.-Deer Mountain H.	9	Coast SE AK
Bone Creek	7	Copper	Unuk River - LPW	9	Coast SE AK
E. Fork Chistochina River	7	Copper	Upper Nahlin River	9	Coast SE AK
Gulkana River	7	Copper	Big Qualicum River	10	BC
Indian River	7	Copper	Birkenhead River spring	10	BC
Kiana Creek	7	Copper	Bulkley River	10	BC
Manker Creek	7	Copper	Chilko River summer	10	BC
Mendeltna Creek	7	Copper	Clearwater River summer	10	BC
Otter Creek	7	Copper	Conuma River	10	BC
Sinona Creek	7	Copper	Damdochax Creek	10	BC
Tebay River	7	Copper	Ecstall River	10	BC
Tonsina River	7	Copper	Harrison River	10	BC
Big Boulder Creek	8	NE GOA	Kateen River	10	BC
Kelsall River	8	NE GOA	Kincolith Creek	10	BC
King Salmon River	8	NE GOA	Kitimat River	10	BC
Klukshu River	8	NE GOA	Klinaklini River	10	BC
Situk River	8	NE GOA	Kwinageese Creek	10	BC
Tahini River	8	NE GOA	Louis River spring	10	BC
Tahini River - Pullen Creek H.	8	NE GOA	Lower Adams River fall	10	BC
Andrews Creek	9	Coast SE AK	Lower Atnarko River	10	BC
Blossom River	9	Coast SE AK	Lower Kalum River	10	BC
Butler Creek	9	Coast SE AK	Lower Thompson River fall	10	BC
Chickamin River	9	Coast SE AK	Marble Creek	10	BC
Chickamin River-LPW	9	Coast SE AK	Middle Shuswap R. summer	10	BC
Chickamin R.Whitman L. H.	9	Coast SE AK	Morkill River summer	10	BC
Clear Creek	9	Coast SE AK	Nanaimo River	10	BC
Cripple Creek	9	Coast SE AK	Nechako River summer	10	BC
Crystal Lake Hatchery	9	Coast SE AK	Nitinat River	10	BC
Dudidontu River	9	Coast SE AK	Oweegee Creek	10	BC
Genes Creek	9	Coast SE AK	Porteau Cove	10	BC
Hidden Falls Hatchery	9	Coast SE AK	Quesnel River summer	10	BC
Humpy Creek	9	Coast SE AK	Quinsam River	10	BC
Kerr Creek	9	Coast SE AK	Robertson Creek	10	BC
Keta River	9	Coast SE AK	Salmon River summer	10	BC
King Creek	9	Coast SE AK	Sarita River	10	BC

Population name	Reg Num	Region Name	Population name	Reg Num	Region Name
Stuart River summer	10	BC	Lower Deschutes R. fall	11	West Coast US
Sustut River	10	BC	Lyons Ferry H. summer/fall	11	West Coast US
Torpy River summer	10	BC	Makah National Fish H. fall	11	West Coast US
Wannock River	10	BC	McKenzie River spring	11	West Coast US
Alsea River fall	11	West Coast US	Sacramento River winter	11	West Coast US
Carson Hatchery spring	11	West Coast US	Siuslaw River fall	11	West Coast US
Eel River fall	11	West Coast US	Soos Creek Hatchery fall	11	West Coast US
Forks Creek fall	11	West Coast US	Upper Skagit River summer	11	West Coast US
Hanford Reach	11	West Coast US			
Klamath River	11	West Coast US			

RECENT TECHNICAL MEMORANDUMS

Copies of this and other NOAA Technical Memorandums are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22167 (web site: *www.ntis.gov)*. Paper and electronic (.pdf) copies vary in price.

AFSC-

269 MATEO, I., and D. H. HANSELMAN. 2014. A comparison of statistical methods to standardize catch-per-unit-effort of the Alaska longline sablefish, 71 p. NTIS number pending.

268 FOWLER, C. W., R. D. REDEKOPP, V. VISSAR, and J. OPPENHEIMER. 2014. Pattern-based control rules for fisheries management, 116 p. NTIS No. PB2014-104035.

267 FOWLER, C. W., and S. M. LUIS. 2014. We are not asking management questions, 48 p. NTIS No. PB2014-104034.

266 LAUTH, R. R., and J. CONNER. 2014. Results of the 2011 Eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate fauna, 176 p. NTIS No. PB2014-104036.

265 TRIBUZIO, C. A., J. R. GASPER, and S. K. GAICHAS. 2014. Estimation of bycatch in the unobserved Pacific halibut fishery off Alaska, 506 p. NTIS No. PB2014-101866.

264 STONE, R. P., K. W. CONWAY, D. J. CSEPP, and J. V. BARRIE. 2014. The boundary reefs: glass sponge (Porifera: Hexactinellida) reefs on the international border between Canada and the United States, 31 p. NTIS No. PB2014-101865.

263 SHELDEN K. E. W., D. J. RUGH, K. T. GOETZ, C. L. SIMS, L. VATE BRATTSTRÖM, J. A. MOCKLIN, B. A. MAHONEY, B. K. SMITH, and R. C. HOBBS. 2013. Aerial surveys of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, June 2005 to 2012, 122 p. NTIS No. PB2014-104033.

262 WHITEHOUSE, G. A. 2013. A preliminary mass-balance food web model of the eastern Chukchi Sea, 164 p. NTIS No. PB2014-104032.

261 FERGUSON, M. C., and J. T. CLARKE. 2013. Estimates of detection probability for BWASP bowhead whale, gray whale, and beluga sightings collected from Twin Otter and Aero Commander aircraft,1989 to 2007 and 2008 to 2011, 52 p. NTIS No. PB2014-104031.

260 BREIWICK, J. M. 2013. North Pacific marine mammal bycatch estimation methodology and results, 2007-2011, 40 p. NTIS No. PB2014-104030

259 HIMES-CORNELL, A., K. HOELTING, C. MAGUIRE, L. MUNGER-LITTLE, J. LEE, J. FISK, R. FELTHOVEN, C. GELLER, and P. LITTLE. 2013. Community profiles for North Pacific fisheries - Alaska. (Volumes 1-12). NTIS No. PB2014-104038.

258 HOFF, G. R. 2013. Results of the 2012 eastern Bering Sea upper continental slope survey of groundfish and invertebrate resources, 268 p. NTIS No. PB2014-100750.

257 TESTA, J. W. (editor). 2013. Fur seal investigations, 2012, 90 p. NTIS No. PB2014-100751.

256 LAUTH, R. R., and D. G. NICHOL. 2013. Results of the 2012 eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate resources, 162 p. NTIS No. PB2014100850.

255 BOVENG, P. L., J. L. BENGTSON, M. F. CAMERON, S. P. DAHLE, E. A. LOGERWELL, J. M. LONDON, J. E. OVERLAND, J. T. STERLING, D. E. STEVENSON, B. L. TAYLOR, and H. L. ZIEL.2013. Status review of the ribbon seal (*Histriophoca fasciata*), 174 p. NTIS No. PB2009104582.

254 ECHAVE, K. B., D. H. HANSELMAN, and N. E. MALONEY. 2013. Report to industry on the Alaska sablefish tag program, 1972 - 2012, 47 p. NTIS No. PB2013111080.