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**CHARACTERIZING THE DISTRIBUTION OF ESA-LISTED SALMONIDS
IN THE NORTHWEST TRAINING AND TESTING AREA WITH
ACOUSTIC AND POP-UP SATELLITE TAGS
11 March 2022**



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14. ABSTRACT The Northwest Fisheries Science Center is currently conducting a study to characterize the occurrence of Chinook salmon within the Northwest Training and Testing area (NWTT). To date, we have surgically implanted acoustic transmitters into Chinook salmon along the coast of Washington (n = 142) from May to August 2019, near Kodiak, Alaska (AK) (n = 80) in October 2020, near Yakutat, AK (n = 32) in March 2021, and near Chignik, AK (n = 36) in August 2021. To detect acoustically tagged fish we deployed and serviced acoustic receivers along the coast of Washington (n = 107) in a 4.5 km grid from 3 nm to 10 nm offshore within the Olympic Coast National Marine Sanctuary (OCNMS) in 2019 to 2020. Receiver orientation was changed to maximize the detection of Chinook salmon tagged in Alaska in July 2020 to two dense receiver lines (North Jetty line, n = 42, Long Beach line, n = 34, 1.25 km spacing) and one sparse receiver line (Willapa line, n = 8, 4 km spacing) perpendicular to the coast. Additionally, four receivers were deployed across the mouth of the Columbia River in July 2020. In September 2021 a line of receivers was deployed north of Grays Harbor extending diagonally southward to Grays Canyon (Grays Canyon line, n = 10, 5 km spacing). Stock origins analysis using genetics indicated that 11 evolutionary significant units (ESUs) of Chinook salmon were captured along the coast of Washington. This included three ESUs that are listed as Endangered Species Act (ESA) threatened: Lower Columbia River (55.8%), Willamette Spring (2.2%), and Snake River spring (0.6%). The origin of Chinook salmon captured in Kodiak, AK consisted of six ESUs. This included two ESUs that are listed as ESA threatened: Willamette Spring (6.3%) and Lower Columbia River (3.6%). The origin of fish captured in Yakutat, AK consisted of five ESUs. This		

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included two ESUs that are listed as ESA threatened: Willamette Spring (16.7%) and Lower Columbia River (3.7%). To date, we have detected 13.8% of Kodiak and 15.6% of Yakutat acoustically-tagged Chinook salmon. Salmon tagged in Chignik are expected to be return to rivers starting in 2022. Once the detection histories are final, we will examine the migration route, estimated amount of time, and detection month for each ESU of detected Chinook salmon that occurred within the NWTT study area.

15. SUBJECT TERMS

Monitoring, tagging, Chinook salmon, endangered species, habitat use, Northwest Training Range Complex, Northwest Training and Testing, Alaska, Washington Coast

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Abstract

The Northwest Fisheries Science Center is currently conducting a study to characterize the occurrence of Chinook salmon within the Northwest Training and Testing area (NWTT). To date, we have surgically implanted acoustic transmitters into Chinook salmon along the coast of Washington (n = 142) from May to August 2019, near Kodiak, Alaska (AK) (n = 80) in October 2020, near Yakutat, AK (n = 32) in March 2021, and near Chignik, AK (n = 36) in August 2021. To detect acoustically tagged fish we deployed and serviced acoustic receivers along the coast of Washington (n = 107) in a 4.5 km grid from 3 nm to 10 nm offshore within the Olympic Coast National Marine Sanctuary (OCNMS) in 2019 to 2020. Receiver orientation was changed to maximize the detection of Chinook salmon tagged in Alaska in July 2020 to two dense receiver lines (North Jetty line, n = 42, Long Beach line, n = 34, 1.25 km spacing) and one sparse receiver line (Willapa line, n = 8, 4 km spacing) perpendicular to the coast. Additionally, four receivers were deployed across the mouth of the Columbia River in July 2020. In September 2021 a line of receivers was deployed north of Grays Harbor extending diagonally southward to Grays Canyon (Grays Canyon line, n = 10, 5 km spacing). Stock origins analysis using genetics indicated that 11 evolutionary significant units (ESUs) of Chinook salmon were captured along the coast of Washington. This included three ESUs that are listed as Endangered Species Act (ESA) threatened: Lower Columbia River (55.8%), Willamette Spring (2.2%), and Snake River spring (0.6%). The origin of Chinook salmon captured in Kodiak, AK consisted of six ESUs. This included two ESUs that are listed as ESA threatened: Willamette Spring (6.3%) and Lower Columbia River (3.6%). The origin of fish captured in Yakutat, AK consisted of five ESUs. This included two ESUs that are listed as ESA threatened: Willamette Spring (16.7%) and Lower Columbia River (3.7%). To date, we have detected 13.8% of Kodiak and 15.6% of Yakutat acoustically-tagged Chinook salmon. Salmon tagged in Chignik are expected to be return to rivers starting in 2022. Once the detection histories are final, we will examine the migration route, estimated amount of time, and detection month for each ESU of detected Chinook salmon that occurred within the NWTT study area.

Background:

The United States (U.S.) Navy conducts military training and testing in Pacific Northwest range areas to prepare combat-ready military forces, whereas the National Oceanic and Atmospheric Administration (NOAA) Fisheries is responsible for managing threatened and endangered species in marine waters and providing permits to the U.S. Navy for incidental take and letters of authorization for training and testing activities. NOAA Fisheries and the U.S. Navy share the common goals of minimizing the impact of military training and testing activities on endangered species and reducing adverse environmental effects without compromising training and testing realism. This work provides vital geographic and distributional data within the Navy's range areas, allowing the Navy the flexibility to proceed with training and testing activities while providing protective measures for both salmonids and killer whales.

The U.S. Navy, Commander Pacific Fleet has been annually funding NOAA Northwest Fisheries Science Center since 2014 to conduct research on Southern Resident killer whale (SRKW)

occurrence offshore of Washington State to determine the extent of overlap with the NWTT study area. Since 2018, the U.S. Navy, Commander Pacific Fleet has been funding the NOAA Northwest Fisheries Science Center to fill an important knowledge gap regarding the relationship between salmonids and critically endangered SRKW along the Washington Coast. This multi-year project characterized the ocean distribution of salmon using acoustic and satellite tags to understand how salmon affect the distribution and effort expended by foraging SRKW, thus affecting their survival. This internationally coordinated effort with scientists from the Canadian Department of Fisheries and Oceans, University of Alaska Fairbanks, University of Washington, Oregon State University, and others largely began in 2018; acoustic receivers have been deployed along hundreds of miles of the Washington Coast and to date 222 Chinook salmon, 35 coho salmon, 17 bull trout, and 55 steelhead kelts have been captured, tagged, and tracked. Additional Chinook salmon are scheduled to be tagged near Sitka, AK (n = 74) and Craig, AK (n = 74) in June 2022.

Summary of Tasks:

Task 1 – Service acoustic receiver array

Receivers were deployed in February 2021 (Figure 1). Receivers were downloaded in late spring and redeployed. Most receivers were retrieved and downloaded in September 2021. A receiver array was deployed north of Grays Harbor and near the mouth of the Columbia River in September 2021 and are currently still deployed. We plan to redeploy most receivers in February 2022.

Tagging summary

Washington Coast 2019: We tagged 143 Chinook salmon with Innovasea V9 transmitters. Scales and fin clips were collected to determine natal river origin, age, and life history (ocean migration as a sub-yearling vs. yearling) of each individual. The genetic stock identification (GSI) of fish captured varied by month of capture (Figure 2) and the detections by GSI also varied through time (Figure 3). Tags with depth sensors showed that Chinook salmon were shallowest during the summer and deepest in the winter, and not much variation between day and night (Figure 4).

Chinook - Kodiak, AK: We implanted Innovasea V16 acoustic tags in 80 Chinook salmon (48.5 – 80 cm fork length) in the coastal waters of Kodiak, Alaska between 16 October 2020 and 28 October 2020. Scales and fin clips were collected to determine natal river origin, age, and life history (ocean migration as a sub-yearling vs. yearling) of each individual. The GSI of fish tagged in Kodiak indicated that 18.6% of fish were from the Columbia River, 4.5% were from the Oregon coast, 38.3% were from Canadian rivers, 37.4% were from Alaska rivers, and 3.6% were from either Alaska or Canada (Figure 5).

Chinook - Yakutat, AK: We surgically implanted Innovasea V16 acoustic tags in 32 Chinook salmon (50 - 84 cm fork length) in the coastal waters of Yakutat Alaska between 8 March 2021 and 29 March 2021. We collected scales and fin clips to determine natal river origin, age, and life history (ocean migration as a sub-yearling vs. yearling) of each individual. The GSI of fish

tagged in Yakutat indicated that 25.0% of fish were from the Columbia River, 40.4% were from Canadian rivers, 25.0% were from Alaska rivers, and 9.6% were from either Alaska or Canada (Figure 6).

Chinook - Chignik, AK: We surgically implanted Innovasea V16 acoustic tags in 36 Chinook salmon (50 - 84 cm fork length) in the coastal waters of Chignik Alaska between 13 August 2021 and 17 August 2021. We collected scales and fin clips to determine natal river origin, age, and life history (ocean migration as a sub-yearling vs. yearling) of each individual. The genetics are currently being analyzed for these fish.

Steelhead – Willapa, WA: In addition to tagging Chinook salmon in Alaska, we deployed 86 Vemco V9 acoustic tags (52-82 cm fork length) and 14 pop-up satellite tags (PSAT) on female hatchery steelhead kelts (66 – 84 cm fork length) on 03 February 2021. Fish were collected at the Forks Creek Hatchery in Raymond, WA. Steelhead tagged with PSAT tags were transported to the mouth of Willapa Bay, outfitted with a Wildlife Computers miniPAT tag using methods developed by Michael Courtney and Andy Seitz (University of Alaska Fairbanks), and released. We detected 8 steelhead at ocean receivers (Figure 7).

Alaska Chinook Detections: Thus far, we have detected 11 Chinook salmon out of 80 that were tagged in Kodiak, AK and 5 Chinook salmon out of 32 that were tagged in Yakutat, AK (Table 1). The Chinook salmon tagged in Chignik, AK are expected to return to rivers in 2022.

Future Analyses: There are likely a number of active tags from Chinook that were captured in Kodiak, Yakutat, and Chignik. We will analyze data from receivers that will be downloaded in 2022, update our current figures and continue analysis and modeling efforts to describe the movement histories of distinct Chinook stocks that have sufficient tag data. We will model spatial and temporal distributions relative to oceanographic model output (LiveOcean; UW) and satellite data using a model framework that explicitly accounts for autocorrelation among sample points. We will analyze and describe the movements of ten satellite-archival tagged steelhead that popped off and reported in 2020.

Collaborations: This project collaborates with other Navy-funded projects including Andy Seitz (UAF, Chinook salmon), Michael Courtney (UAF, Chinook salmon), Laura Heironimus (WDFW, green sturgeon), and Mary Moser (NWFSC, green sturgeon). All projects share data to improve the overall impact of each independent study.

2021 Acoustic Receiver Locations

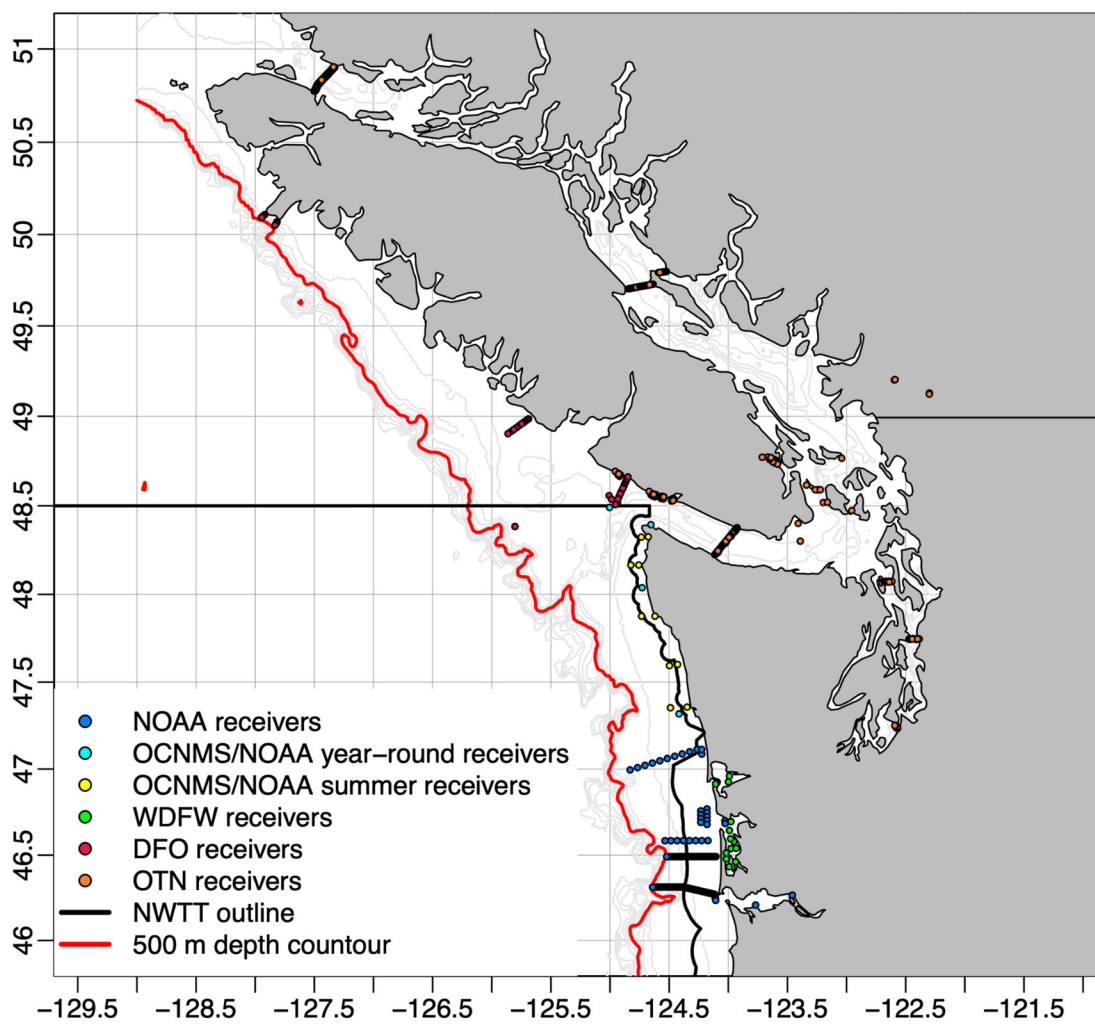


Figure 1. Acoustic receiver locations from this project as well as other collaborators that share data.

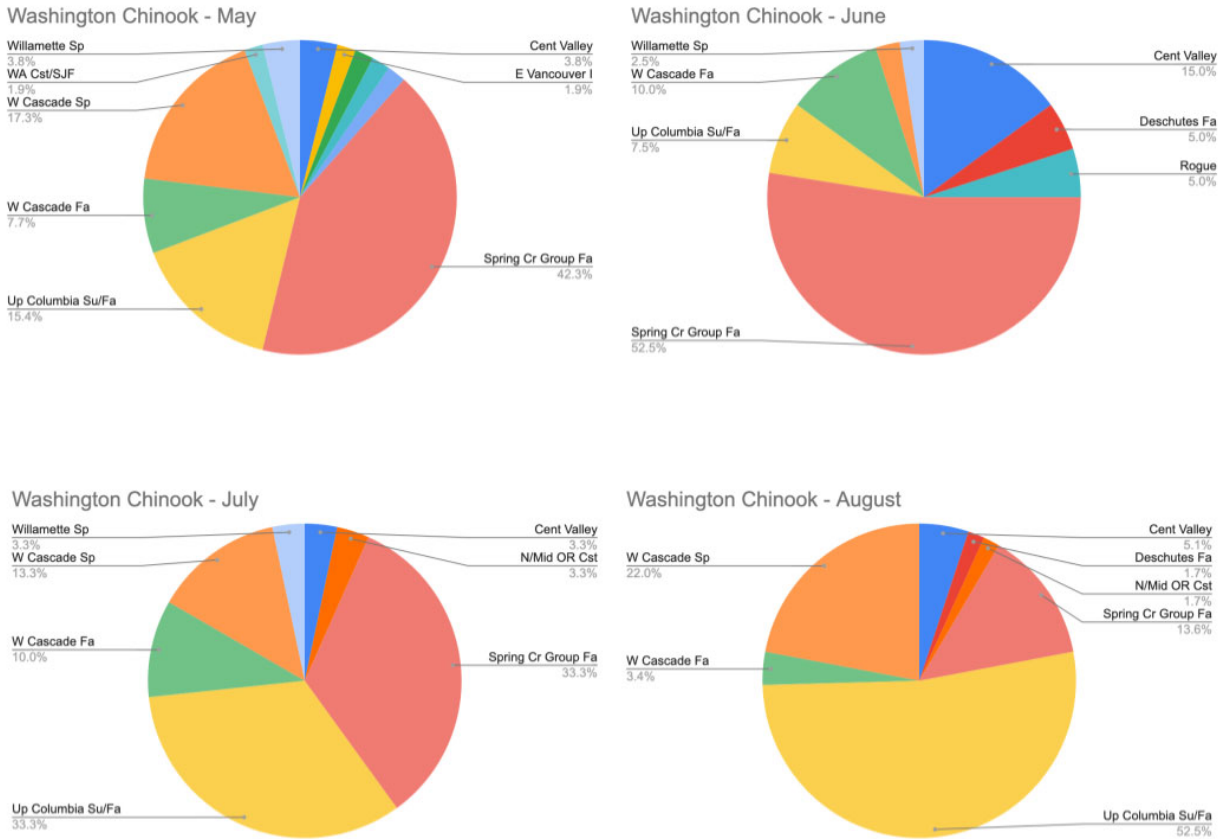


Figure 2. Proportion of genetic stock identification of Chinook salmon by month captured in 2019 along the coast of Washington State.

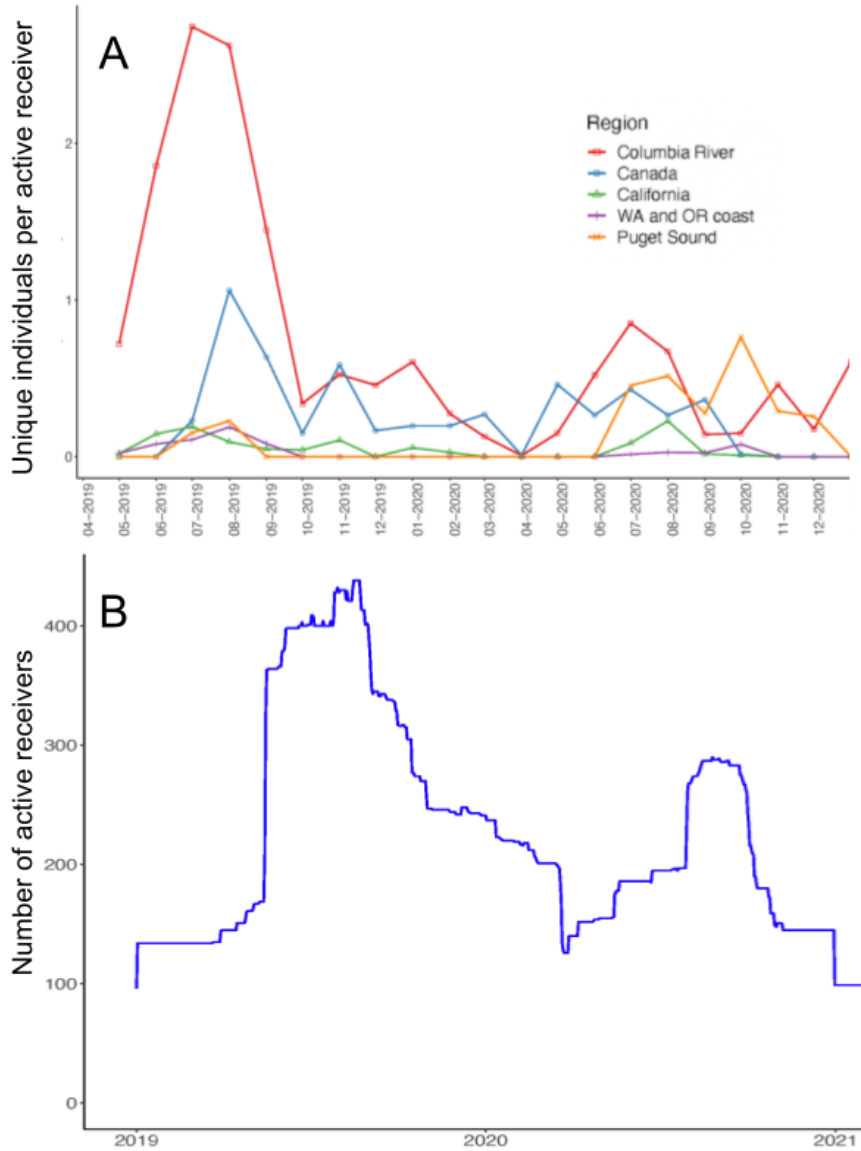


Figure 3. Number of unique individuals detected per active receiver by genetic stock identification (line colors) through time of Chinook salmon tagged along the coast of Washington State (A), and the number of active receivers through time (B).

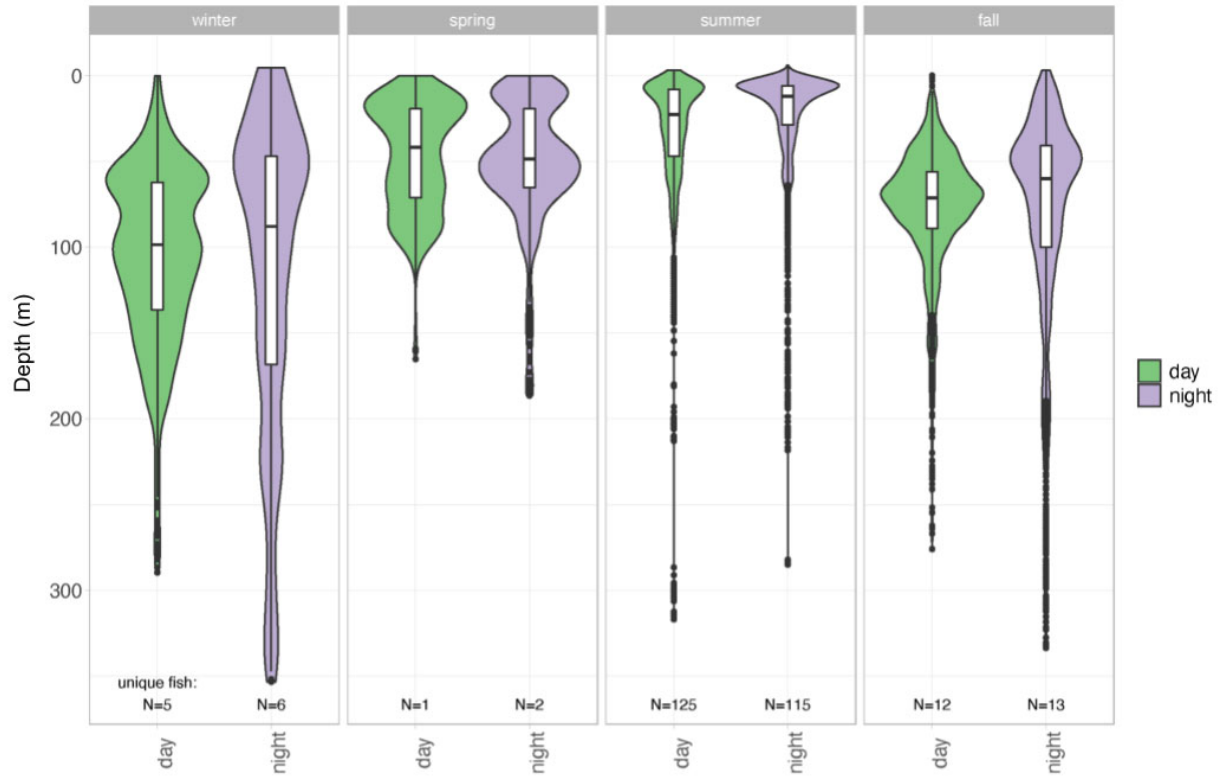


Figure 4. Depth of Chinook salmon tagged in coastal waters of Washington State by season during the day and night.

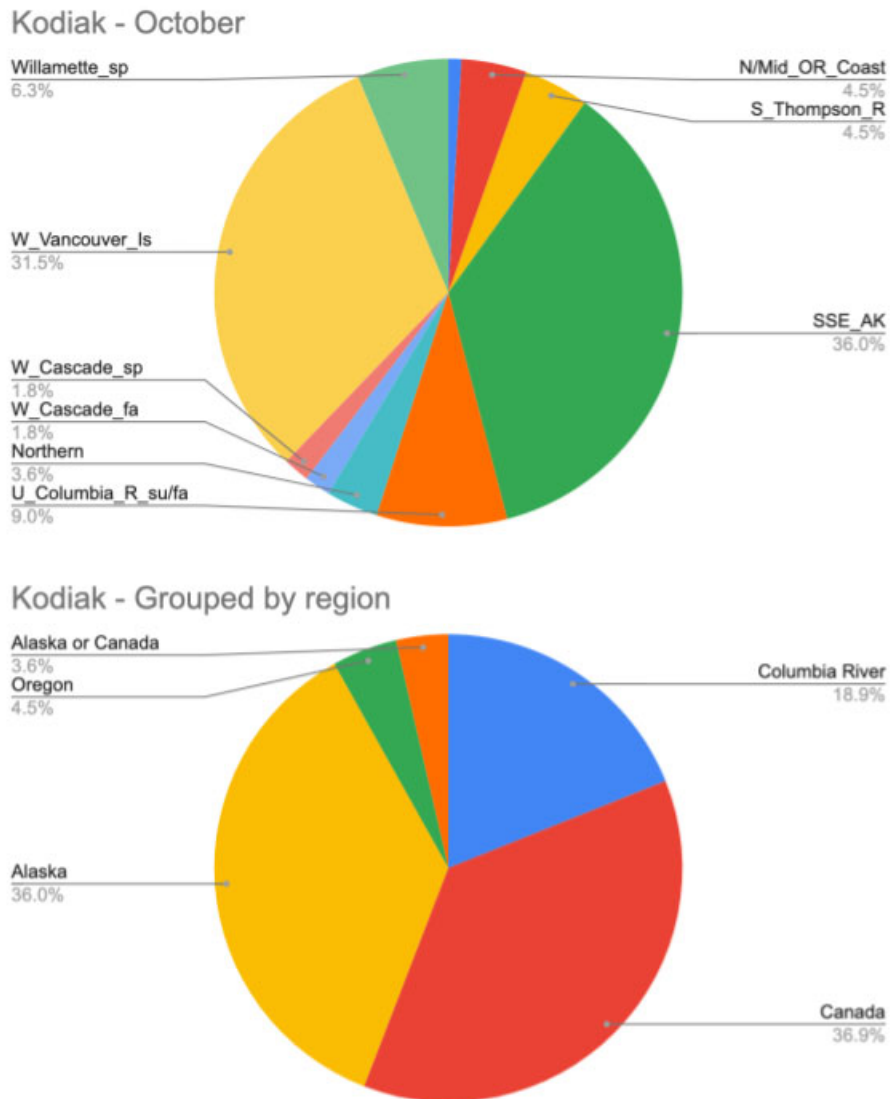


Figure 5. Proportion of genetic stock identification of Chinook salmon captured near Kodiak, Alaska in October 2020.

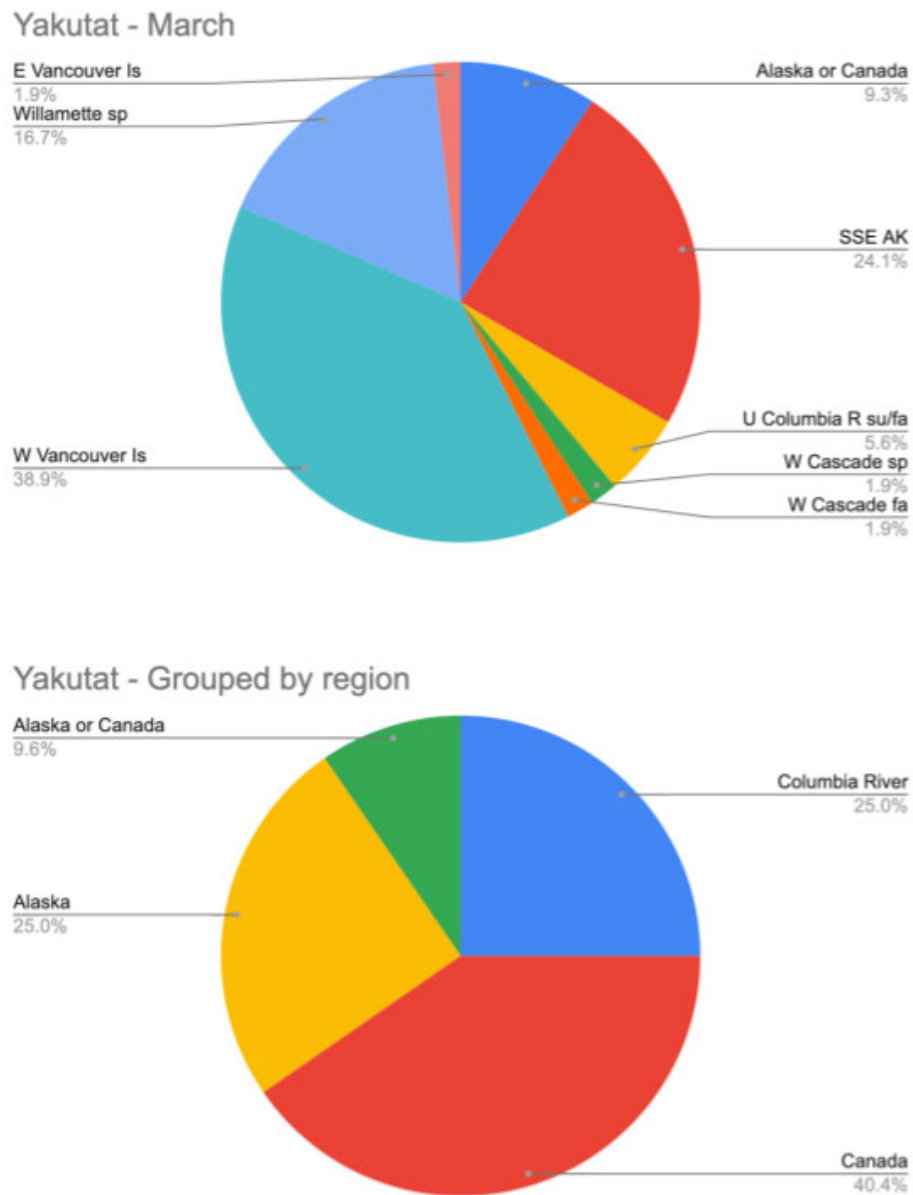


Figure 6. Proportion of genetic stock identification of Chinook salmon captured near Yakutat, Alaska in March 2021.

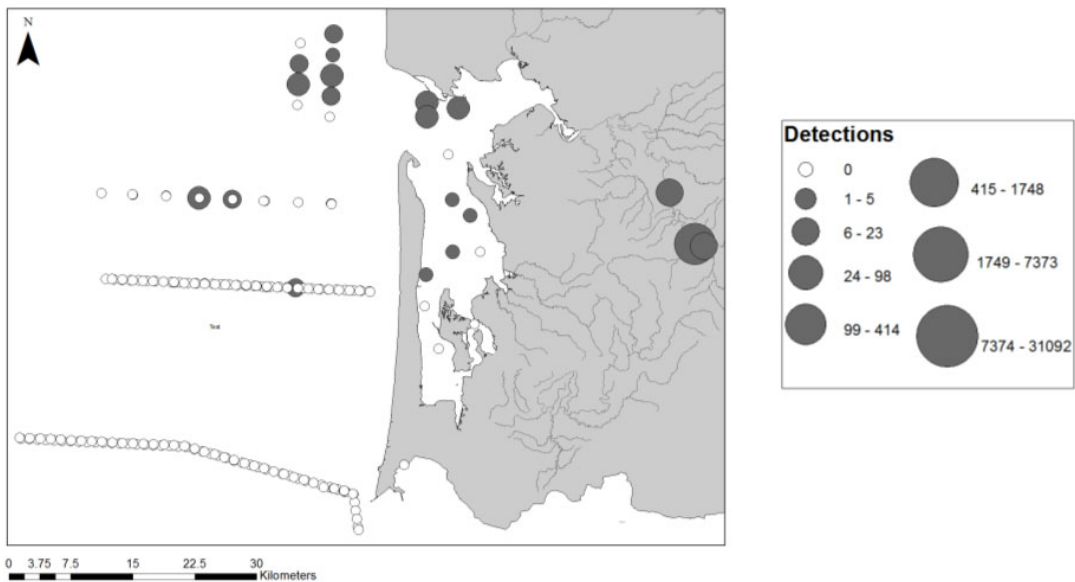


Figure 7. Detections of female steelhead kelts in Willapa Bay and in the ocean.

Table 1. The detection history of 16 Chinook salmon by month with fork length (FL) and genetic stock identification (GSI). GSI labels include: WVI = West Vancouver Island, SEA = Southeast Alaska, Up Col. S/F = Upper Columbia River Summer/Fall, STR = South Thompson River, WS = Willamette Spring. The general location by month. Location labels include: PWS = Prince William Sound, KR = Kitsumkalum River, BC, NS = Nootka Sound, BC, WC = Washington Coast, SVI = South Vancouver Island, CR = Columbia River. Gray shade indicates the time between release and last detection.

Fish ID	FL (cm)	GSI	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021
Kodiak_Chinook_10	59	WVI	Kodiak							PWS				
Kodiak_Chinook_17	75	SEA	Kodiak											KR
Kodiak_Chinook_29	69	WVI	Kodiak	PWS										
Kodiak_Chinook_47	65	Up Col. S/F	Kodiak											WC, CR
Kodiak_Chinook_48	74	Up Col. S/F	Kodiak					WC						
Kodiak_Chinook_61	65	Unknown	Kodiak										NS	
Kodiak_Chinook_64	72	STR	Kodiak					PWS						
Kodiak_Chinook_65	64	WVI	Kodiak		PWS									
Kodiak_Chinook_68	66	WVI	Kodiak		PWS		PWS	PWS	PWS					
Kodiak_Chinook_75	63	SEA	Kodiak					PWS						
Kodiak_Chinook_77	73	WS	Kodiak								SVI	CR		
Yakutat_Chinook_02	70	WVI						Yakutat				SVI	SVI	
Yakutat_Chinook_06	70	Up Col. S/F						Yakutat					WC, CR	
Yakutat_Chinook_08	67	WS						Yakutat	WC	CR				
Yakutat_Chinook_14	84	WS						Yakutat				WC, CR		
Yakutat_Chinook_26	79	Alaska/Canada						Yakutat			SVI			