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

March 2, 2021

MEMORANDUM FOR: Barry Thom
Administrator, West Coast Region

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

SUBJECT: Part II of 2019 Annual Report for the Alaska Groundfish Fisheries Chinook Salmon Coded Wire Tag and Recovery Data for Endangered Species Act Consultation

This report includes the stock origins of coded-wire tagged (CWT) Chinook salmon recovered in the 2019 Gulf of Alaska and Bering Sea-Aleutian Islands groundfish fisheries. It is meant to supplement Part II of the annual salmon bycatch report sent in September 2020 to the West Coast Region.

This report fulfills one of the terms and conditions of the incidental take statements in the December 2, 2009, and January, 11, 2007 (NMFS 2009a and NMFS 2007) supplements to the November 30, 2000, Biological Opinion (BiOp) regarding authorization of the BSAI and GOA groundfish fisheries (NMFS 2000), and the supplemental BiOp issued on January 9, 2012 (NMFS 2012).

The 2021 installation of Part II of the annual salmon bycatch report, including genetic reports, 2020 CWT data, and annual data from the Alaska Fisheries Science Center's North Pacific Observer Program bycatch sampling, will be forthcoming this fall.

cc: Christina Iverson, West Coast Region
Susan Bishop, West Coast Region

February 25, 2021

MEMORANDUM FOR: Megan Mackey
NOAA Fisheries Alaska Regional Office

FROM: Michele Masuda
NOAA Fisheries Alaska Fisheries Science Center

SUBJECT: 2019 Coded-Wire Tagged Chinook Salmon Recoveries in the Gulf of Alaska and Bering Sea-Aleutian Islands (Including 2019 Recoveries from U.S. Research)

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SUMMARY

We document in this report the stock origins of coded-wire tagged Chinook salmon recovered in the 2019 Gulf of Alaska (GOA) and Bering Sea-Aleutian Islands (BSAI) groundfish fisheries. Stock origins also include any listings under the U.S. Endangered Species Act (ESA). We also report coded-wire tagged Chinook salmon recovered in domestic research surveys and by private industry in GOA fisheries. Four coded-wire tagged Chinook salmon from ESA-listed evolutionarily significant units (ESUs) were recovered in the 2019 GOA groundfish fisheries: Upper Willamette River (N = 4). No coded-wire tagged Chinook salmon from ESA-listed ESUs were recovered in the 2019 BSAI groundfish fisheries. Three coded-wire tagged Chinook salmon from ESA-listed ESUs were recovered by private industry in the central GOA rockfish trawl fishery: Snake River fall run (N = 1), Upper Willamette River (N = 1), and Lower Columbia River (N = 1).

CODED-WIRE TAG SAMPLING

Gulf of Alaska fisheries and research

Groundfish fisheries (2019)
In the 2019 GOA groundfish fisheries, observers of the North Pacific Observer Program (Observer Program) sampled snouts for coded-wire tagged Chinook salmon. Sampling of snouts for coded-wire tags (CWTs) was based on visual detection only of a clipped adipose fin. Observers sampled 3,241[1] Chinook salmon and collected snouts from 236 fish with clipped adipose fins (Table 1). Of the snouts examined, 79 had readable CWTs (Table 1). In addition, one coded-wire tagged coho salmon was recovered.

Rockfish trawl fishery (2019)
Electronic detection of CWTs in the salmon bycatch of the central GOA rockfish trawl fishery was conducted by Alaska Groundfish Data Bank in 2019, and Chinook salmon bycatch were scanned with handheld CWT detection wands. Of the 695 Chinook salmon scanned with handheld wands, 98 (14.1%) had clipped adipose fins, and 35 (5.0%) had readable CWTs (Table 1). Of the 35 with readable CWTs, 28 (80.0%) had clipped adipose fins and 7 were unclipped (Table 1).

U.S. research (1996–2016)
The National Marine Fisheries Service (NMFS) has not conducted research surveys on juvenile salmon in non-state waters of the GOA since 2016.

Bering Sea-Aleutian Islands fisheries and research

Groundfish fisheries (2019)
In the 2019 BSAI groundfish fisheries, observers of the Observer Program sampled snouts for coded-wire tagged Chinook salmon. Sampling of snouts for CWTs was based on visual detection

[1]Number of Chinook salmon sampled for genetics in the pollock and non-pollock fisheries (Fisheries Monitoring and Analysis Division of the Alaska Fisheries Science Center).

of a clipped adipose fin. Some observers used electronic handheld wands to detect CWTs; however, detection was still mostly visually based. Observers sampled 2,592[2] Chinook salmon in the BSAI and collected 50 snouts from fish with clipped adipose fins (Table 1). Of the snouts examined, 16 had readable CWTs (Table 1).

U.S. research (2019)
In 2019 NMFS conducted research on juvenile and immature salmon in the northern Bering Sea. Researchers first visually checked fish caught in trawls for missing adipose fins and second used a handheld wand detector on those fish to sample for CWTs. Researchers caught 132 juvenile and 24 immature Chinook salmon, of which 2 had readable CWTs (Table 1).

ORIGINS OF CODED-WIRE TAGS

Results in this report are summarized for two time periods. For the GOA fisheries, results are summarized for periods 2001–2011 and 2012–2019 because of the implementation of a revised genetic sampling protocol by the Observer Program in 2012. For the BSAI fisheries, results are summarized for periods 2001–2010 and 2011–2019 because of a revised genetic sampling protocol implemented in 2011.

Gulf of Alaska fisheries

Groundfish fisheries (2019)
Coded-wire tagged Chinook salmon recovered as bycatch in the GOA are comprised of stocks originating from Alaska, British Columbia, Washington, Idaho, and Oregon and are summarized for 2001–2019 in Table 2. Chinook salmon tagged in Alaska and harvested in the GOA have historically originated from two regions, Cook Inlet and Southeast Alaska, with most of the coded-wire tagged Alaska Chinook salmon originating from Southeast Alaska (Table 3). Since the tagging of Cook Inlet Chinook salmon with CWTs by the Alaska Department of Fish and Game (ADF&G) has been intermittent since the 2008 brood year (2010 release), most coded-wire tagged Alaska Chinook salmon harvested in the GOA for 2012–2019 originated from Southeast Alaska (Table 3).

Most of the Chinook salmon represented by CWTs and harvested in the GOA originated from hatchery production (Table 4), a reflection that wild stocks of Chinook salmon are under-represented by CWTs, especially outside of Alaskan production. Chinook salmon recovered in the GOA are comprised of a variety of run types (Table 5) that are designated by the tagging agency. Chinook salmon recovered in the GOA are also comprised of a variety of age classes (Table 6). Total age of each fish was calculated by subtracting the brood year of the coded-wire tagged recovery from the recovery year and includes freshwater and saltwater residency.

Rockfish trawl fishery (2019)
Recoveries of coded-wire tagged Chinook salmon in the bycatch of the GOA rockfish trawl fishery are summarized by state or province of origin for 2013–2019 (Table 7).

[2]Number of Chinook salmon sampled for length in the pollock and non-pollock fisheries (Fisheries Monitoring and Analysis Division of the Alaska Fisheries Science Center).

Bering Sea-Aleutian Islands fisheries

Groundfish fisheries (2019)
Coded-wire tagged Chinook salmon recovered as bycatch in the BSAI are comprised of stocks originating from Alaska, the Yukon Territory, British Columbia, Washington, and Oregon and are summarized for 2001–2019 in Table 8. Starting in 2011, sampling expansion factors were calculated for coded-wire tagged recoveries in the bycatch of the BSAI groundfish fisheries, and total estimated numbers by state or province of origin are reported for 2011–2019 (Table 9). Chinook salmon tagged in Alaska and harvested in the BSAI have historically originated from two regions, Cook Inlet and Southeast Alaska (Table 10). Since the tagging of Cook Inlet Chinook salmon with CWTs by ADF&G has been intermittent since the 2008 brood year (2010 release), most coded-wire tagged Alaska Chinook salmon harvested in the BSAI in 2011–2019 originated from Southeast Alaska (Table 10).

Most of the Chinook salmon represented by CWTs and harvested in the BSAI groundfish fisheries originated from hatchery production (Table 11), a reflection that wild stocks of Chinook salmon are under-represented by CWTs, especially outside of Alaskan production. Chinook salmon recovered in the BSAI are comprised of a variety of run types (Table 12) that are designated by the tagging agency. Chinook salmon recovered in the BSAI are also comprised of a variety of age classes (Table 6). Total age of each fish was calculated by subtracting the brood year of the coded-wire tagged recovery from the recovery year and includes freshwater and saltwater residency.

ESA-LISTED RECOVERIES

The NMFS Alaska Regional Office contracted Cramer Fish Sciences to compile a database of coded-wire tagged release groups of West Coast salmon listed under the U.S. ESA; this database was last updated in July 2020 (Flaherty and Berge 2020). The database was compiled using the Pacific States Marine Fisheries Commission Regional Mark Information System CWT database and a list of artificial propagation programs determined by NMFS to be included in ESA-listed ESUs. We determined from this database the coded-wire tagged Chinook salmon recovered in the GOA and BSAI that originated from ESA-listed ESUs.

GOA and BSAI groundfish fisheries (2019)
Coded-wire tagged Chinook salmon from ESA-listed ESUs have been recovered in GOA and BSAI fisheries (Tables 13–14). Since 1981, coded-wire tagged Chinook salmon recovered in GOA groundfish fisheries have originated from the following ESA-listed ESUs: Lower Columbia River, Snake River fall run, Snake River spring/summer run, Upper Columbia River spring run, and the Upper Willamette River (Tables 13–14). Coded-wire tagged Chinook salmon recovered in BSAI groundfish fisheries have also originated from ESA-listed ESUs: Lower Columbia River, Snake River spring/summer run, and the Upper Willamette River (Tables 13–14).

GOA rockfish trawl fishery (2019)
Coded-wire tagged Chinook salmon recovered in the GOA rockfish trawl fishery have originated from the following ESA-listed ESUs: Lower Columbia River, Puget Sound, Snake River fall run, Snake River spring/summer run, Upper Columbia River spring run, and Upper Willamette River (Table 15).

U.S. research (1996–2016)
U.S. research surveys directed at juvenile salmon in the GOA have also documented the occurrence of Chinook salmon from ESA-listed ESUs. Since 1996, research surveys in the GOA have recovered coded-wire tagged Chinook salmon from the following ESA-listed ESUs: Lower Columbia River, Puget Sound, Snake River fall run, Snake River spring/summer run, Upper Columbia River spring run, and Upper Willamette River (Tables 16–17). NMFS has not conducted research surveys on juvenile salmon in non-state waters of the GOA since 2016. No ESA-listed, coded-wire tagged Chinook salmon have been recovered in U.S. research surveys in the BSAI.

Ocean Distribution of Chinook Salmon from ESA-listed ESUs, 1981–2019

Maps show the ocean distribution of coded-wire tagged Chinook salmon from ESA-listed ESUs from the Pacific Northwest (Figures 1–7). These maps were compiled from the historical database of CWT recoveries (1981–2019) from high seas commercial fisheries and research surveys: GOA and BSAI groundfish fisheries, GOA rockfish trawl fishery, at-sea Pacific hake trawl fishery off the U.S. West Coast, and the West Coast groundfish trawl fishery, as well as domestic and foreign research surveys in the North Pacific Ocean, GOA, and BSAI. Note that data from the 2019 West Coast groundfish trawl fishery were not available for the maps in this report (Figures 1–7).

ACKNOWLEDGMENTS

Fishermen, processors, observers, contractors, and scientists who participated in the high seas CWT recovery program are gratefully acknowledged, especially Katy McGauley of Alaska Groundfish Data Bank. Annie Masterman dissected salmon snouts, decoded CWTs, and entered CWT recovery data in an electronic database.

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Table 1. Number of Chinook salmon sampled, number with clipped adipose fins (ad-clipped), and number with readable coded-wire tags (CWTs) in the various sampling programs in the Gulf of Alaska (GOA) and Bering Sea-Aleutian Islands (BSAI) in 2019. The number of Chinook salmon with readable CWTs that were also ad-clipped is in parentheses.

Region	Year	Fishery	Sampling program	Detection method	Number sampled	Number ad-clipped	Number with readable CWTs
GOA	2019	Groundfish	Observer Program	Visual	3,241[1,2]	236	79 (79)
GOA	2019	Rockfish trawl	Alaska Groundfish Data Bank	Electronic	695	98	35 (28)
BSAI	2019	Groundfish	Observer Program	Visual	2,592[2,3]	50	16 (16)
BSAI	2019	Research trawl	National Marine Fisheries Service	Visual	156	156	2 (2)

[1]Number of Chinook salmon sampled for genetics in the pollock and non-pollock fisheries.
[2]Number from the Fisheries Monitoring and Analysis Division of the Alaska Fisheries Science Center.
[3]Number of Chinook salmon sampled for length in the pollock and non-pollock fisheries.

Table 2. Observed and mark-expanded numbers of coded-wire tagged Chinook salmon captured in the bycatch of the Gulf of Alaska groundfish fisheries (excluding augmented sampling in the rockfish trawl fishery, 2013–2019, and salmon excluder device testing, 2013–2014), by run year and state or province of origin: A) 2001–2011 and B) 2012–2019. Average numbers and percentages of the total averaged over years are reported.

A. 2001–2011

	Alaska		British Columbia		Idaho		Oregon		Washington		Total	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
2001	10	100.2	6	74.8	0	0	12	16.5	4	4.0	**32**	**195.6**
2002	10	47.2	5	113.0	0	0	4	4.3	3	3.7	**22**	**168.2**
2003	2	22.4	2	28.6	0	0	4	8.3	1	1.0	**9**	**60.3**
2004	3	30.5	4	22.0	0	0	5	16.9	1	1.1	**13**	**70.6**
2005	3	33.6	4	86.5	0	0	2	3.1	2	2.2	**11**	**125.4**
2006	10	58.3	7	158.3	0	0	2	2.1	5	14.5	**24**	**233.1**
2007	13	99.1	3	50.9	0	0	2	2.1	5	21.3	**23**	**173.3**
2008	6	52.3	1	1.0	0	0	3	9.3	12	12.9	**22**	**75.5**
2009	5	41.4	2	5.2	0	0	2	2.8	4	4.5	**13**	**53.9**
2010	10	81.3	4	4.0	0	0	10	25.9	12	23.7	**36**	**135.0**
2011	3	32.3	1	51.4	0	0	2	13.4	2	2.0	**8**	**99.2**
Mean	**6.8**	**54.4**	**3.5**	**54.2**	**0**	**0**	**4.4**	**9.5**	**4.6**	**8.3**	**19.4**	**126.4**
% of total averaged over years	**34%**	**46%**	**20%**	**38%**	**0%**	**0%**	**23%**	**9%**	**23%**	**7%**		

Table 2. Continued.

B. 2012–2019

	Alaska		British Columbia		Idaho		Oregon		Washington		Total	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
2012	6	43.6	0	0	0	0	2	2.0	2	10.8	**10**	**56.5**
2013	5	25.9	9	38.1	0	0	7	69.4	6	7.4	**27**	**140.7**
2014	5	62.6	10	48.8	1	1.0	13	77.9	5	6.7	**34**	**197.0**
2015	27	311.2	30	176.2	0	0	15	17.3	30	48.6	**102**	**553.4**
2016	59	364.0	69	318.6	0	0	60	284.5	86	125.6	**274**	**1,092.7**
2017	33	186.2	40	235.2	0	0	64	195.6	42	75.7	**179**	**692.7**
2018	11	54.8	19	91.3	2	2.2	11	30.0	25	53.2	**68**	**231.4**
2019	17	90.9	17	67.6	0	0	17	34.9	28	82.5	**79**	**275.9**
Mean	**20.4**	**142.4**	**24.3**	**122.0**	**0.4**	**0.4**	**23.6**	**89.0**	**28.0**	**51.3**	**96.6**	**405.0**
% of total averaged over years	**25%**	**38%**	**24%**	**26%**	**1%**	**0.0%**	**24%**	**22%**	**27%**	**14%**		

Table 3. Observed and mark-expanded numbers of coded-wire tagged, Alaska-origin Chinook salmon captured in the bycatch of the Gulf of Alaska groundfish fisheries (excluding augmented sampling in the rockfish trawl fishery, 2013–2019, and salmon excluder device testing, 2013–2014) by run year and release region: A) 2001–2011 and B) 2012–2019. Numbers averaged over time periods are reported. The Chinook salmon tagging program in the Cook Inlet, Alaska region has been intermittent since the 2008 brood year (2010 release).

A. 2001–2011

	Cook Inlet, Alaska		Southeast Alaska		Alaska Total	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
2001	2	2.0	8	98.2	**10**	**100.2**
2002	1	1.0	9	46.2	**10**	**47.2**
2003	0	0	2	22.4	**2**	**22.4**
2004	0	0	3	30.5	**3**	**30.5**
2005	0	0	3	33.6	**3**	**33.6**
2006	0	0	10	58.3	**10**	**58.3**
2007	0	0	13	99.1	**13**	**99.1**
2008	2	2.0	4	50.3	**6**	**52.3**
2009	1	1.0	4	40.4	**5**	**41.4**
2010	0	0	10	81.3	**10**	**81.3**
2011	0	0	3	32.3	**3**	**32.3**
Mean	**0.5**	**0.5**	**6.3**	**53.9**	**6.8**	**54.4**

B. 2012–2019

	Cook Inlet, Alaska		Southeast Alaska		Alaska Total	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
2012	0	0	6	43.6	**6**	**43.6**
2013	0	0	5	25.9	**5**	**25.9**
2014	0	0	5	62.6	**5**	**62.6**
2015	0	0	27	311.2	**27**	**311.2**
2016	1	1.0	58	363.0	**59**	**364.0**
2017	3	3.1	30	183.2	**33**	**186.2**
2018	2	2.0	9	52.7	**11**	**54.8**
2019	2	2.0	15	88.9	**17**	**90.9**
Mean	**1.0**	**1.0**	**19.4**	**141.4**	**20.4**	**142.4**

Table 4. Observed numbers of coded-wire tagged Chinook salmon captured in the bycatch of the Gulf of Alaska groundfish fisheries (excluding augmented sampling in the rockfish trawl fishery, 2013–2019, and salmon excluder device testing, 2013–2014) by rearing type and state or province of origin: A) 2001–2011 and B) 2012–2019. Percentages of the total are reported.

A. 2001–2011

	Rearing type		
Origin	**Hatchery**	**Mixed**	**Wild**
Alaska	59	0	6
British Columbia	33	0	0
Idaho	0	0	0
Oregon	36	0	0
Washington	35	10	2
% of total	**90%**	**6%**	**4%**

B. 2012–2019

	Rearing type		
Origin	**Hatchery**	**Mixed**	**Wild**
Alaska	150	0	13
British Columbia	194	0	0
Idaho	3	0	0
Oregon	183	0	6
Washington	220	0	4
% of total	**97%**	**0%**	**3%**

Table 5. Observed numbers of coded-wire tagged Chinook salmon captured in the bycatch of the Gulf of Alaska groundfish fisheries (excluding augmented sampling in the rockfish trawl fishery, 2013–2019, and salmon excluder device testing, 2013–2014) by run type and state or province of origin: A) 2001–2011 and B) 2012–2019. Percentages of the total are reported.

A. 2001–2011

	Run type			
Origin	**Spring**	**Summer**	**Fall**	**Late fall upriver bright**
Alaska	67	0	0	0
British Columbia	7	12	20	0
Idaho	0	0	0	0
Oregon	20	0	25	3
Washington	1	18	29	3
% of total	**46%**	**15%**	**36%**	**3%**

B. 2012–2019

	Run type			
Origin	**Spring**	**Summer**	**Fall**	**Late fall upriver bright**
Alaska	161	2	0	0
British Columbia	12	115	67	0
Idaho	0	0	0	3
Oregon	122	0	64	3
Washington	15	92	99	18
% of total	**40%**	**27%**	**30%**	**3%**

Table 6. Observed numbers of coded-wire tagged Chinook salmon captured in bycatch of the Gulf of Alaska (GOA) groundfish fisheries (excluding augmented sampling in the rockfish trawl fishery, 2013–2019, and salmon excluder device testing, 2013–2014) and the Bering Sea-Aleutian Islands (BSAI) groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by age during time periods. Age was calculated by subtracting the brood year of the coded-wire tagged recovery from the recovery year and includes freshwater and saltwater residency. Percentages are in parentheses.

		Age				
Fishery	**Time period**	**2**	**3**	**4**	**5**	**6**
GOA	2001–2011	14 (7%)	89 (42%)	92 (43%)	16 (8%)	2 (1%)
	2012–2019	146 (19%)	411 (53%)	185 (24%)	29 (4%)	1 (0%)
BSAI	2001–2010	34 (12%)	141 (49%)	92 (32%)	20 (7%)	2 (1%)
	2011–2019	2 (2%)	59 (45%)	54 (41%)	16 (12%)	1 (1%)

Table 7. Observed number and mark- and sample-expanded numbers of coded-wire tagged Chinook salmon captured in the bycatch of the Gulf of Alaska rockfish trawl fishery, 2013–2019, by run year and state or province of origin. Average numbers and percentages of the total averaged over years are reported.

	Alaska		British Columbia		Idaho		Oregon		Washington		Total	
Run year	Observed number	CWT mark- and sample-expanded number	Observed number	CWT mark- and sample-expanded number	Observed number	CWT mark- and sample-expanded number	Observed number	CWT mark- and sample-expanded number	Observed number	CWT mark- and sample-expanded number	Observed number	CWT mark- and sample-expanded number
2013	4	27.1	9	62.3	5	7.4	28	137.8	67	111.9	**113**	**346.5**
2014	3	41.0	1	4.6	0	0	10	39.1	3	4.7	**17**	**89.4**
2015	3	80.8	2	17.0	1	2.0	13	39.9	8	9.9	**27**	**149.5**
2016	1	1.0	4	31.1	0	0	7	12.5	11	14.0	**23**	**58.6**
2017	2	32.3	2	2.2	0	0	3	3.1	7	8.0	**14**	**45.6**
2018	5	54.6	1	1.0	0	0	7	7.4	14	26.5	**27**	**89.5**
2019	0	0	2	2.0	0	0	10	23.0	23	59.4	**35**	**84.5**
Mean	**2.6**	**33.8**	**3.0**	**17.2**	**0.9**	**1.3**	**11.1**	**37.5**	**19.0**	**33.5**	**36.6**	**123.4**
% of total averaged over years	**10%**	**34%**	**9%**	**14%**	**1%**	**0%**	**34%**	**25%**	**46%**	**27%**		

Table 8. Observed and mark-expanded numbers of coded-wire tagged Chinook salmon captured in the bycatch of the Bering Sea-Aleutian Islands groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by run year and state or province of origin: A) 2001–2010 and B) 2011–2019. Average numbers and percentages of the total averaged over years are reported.

A. 2001–2010

	Alaska		British Columbia		Oregon		Washington		Yukon Territory		Total	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
2001	14	16.9	6	31.0	2	2.0	1	1.7	1	1.0	**24**	**52.6**
2002	27	32.7	18	284.8	21	42.8	12	31.2	1	1.0	**79**	**392.5**
2003	6	24.6	13	82.3	4	4.1	3	18.3	2	2.0	**28**	**131.3**
2004	16	37.2	21	122.3	11	115.8	6	7.7	2	2.0	**56**	**285.1**
2005	12	15.9	17	114.6	8	22.8	7	7.9	1	1.0	**45**	**162.2**
2006	16	38.8	8	93.7	6	12.9	5	5.2	1	1.0	**36**	**151.5**
2007	5	19.4	1	12.2	2	2.0	1	1.5	0	0	**9**	**35.2**
2008	0	0	0	0	0	0	0	0	0	0	**0**	**0**
2009	0	0	3	4.8	1	10.2	0	0	0	0	**4**	**15.0**
2010	0	0	2	2.9	4	37.9	7	9.8	0	0	**13**	**50.6**
Mean	**9.6**	**18.6**	**8.9**	**74.9**	**5.9**	**25.1**	**4.2**	**8.3**	**0.8**	**0.8**	**29.4**	**127.6**
% of total averaged over years	**30%**	**18%**	**33%**	**49%**	**20%**	**26%**	**15%**	**7%**	**2%**	**1%**		

Table 8. Continued.

B. 2011–2019

	Alaska		British Columbia		Oregon		Washington		Yukon Territory		Total	
Run year	**Observed Number**	**CWT mark expanded number**	**Observed number**	**CWT mark expanded number**	**Observed number**	**CWT mark expanded number**	**Observed number**	**CWT mark expanded number**	**Observed number**	**CWT mark expanded number**	**Observed number**	**CWT mark expanded number**
2011	0	0	0	0	0	0	2	2.0	0	0	**2**	**2.0**
2012	1	1.7	1	9.4	1	1.0	2	2.0	0	0	**5**	**14.2**
2013	0	0	1	2.6	1	1.0	2	3.4	0	0	**4**	**7.0**
2014	0	0	1	2.8	3	3.9	1	1.0	0	0	**5**	**7.7**
2015	1	16.7	3	7.1	2	7.8	3	14.9	2	2.1	**11**	**48.5**
2016	4	15.3	14	79.2	5	9.6	4	4.3	1	1.0	**28**	**109.5**
2017	9	99.3	18	93.5	8	25.7	9	15.0	0	0	**44**	**233.5**
2018	3	18.6	8	42.6	2	4.5	4	7.6	0	0	**17**	**73.3**
2019	0	0	10	34.1	4	7.6	2	3.6	0	0	**16**	**45.3**
Mean	**2.0**	**16.8**	**6.2**	**30.2**	**2.9**	**6.8**	**3.2**	**6.0**	**0.3**	**0.3**	**14.7**	**60.1**
% of total averaged over years	**9%**	**14%**	**33%**	**45%**	**22%**	**15%**	**34%**	**26%**	**2%**	**1%**		

Table 9. CWT mark- and sample-expanded numbers of Chinook salmon captured in bycatch of the Bering Sea-Aleutian Islands groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by run year and state or province of origin: 2011–2019. Observed numbers are in parentheses.

	Estimated numbers				
Run year	Alaska	British Columbia	Oregon	Washington	Yukon Territory
2011	0 (0)	0 (0)	0 (0)	21.4 (2)	0 (0)
2012	18.9 (1)	105.4 (1)	11.5 (1)	22.7 (2)	0 (0)
2013	0 (0)	31.9 (1)	12.2 (1)	40.7 (2)	0 (0)
2014	0 (0)	32.6 (1)	45.7 (3)	11.7 (1)	0 (0)
2015	214.6 (1)	91.1 (3)	99.9 (2)	192.1 (3)	26.6 (2)
2016	206.9 (4)	1,071.1 (14)	130.1 (5)	58.7 (4)	13.7 (1)
2017	1,163.3 (9)	1,095.9 (18)	300.9 (8)	176.2 (9)	0 (0)
2018	224.5 (3)	513.9 (8)	54.7 (2)	91.8 (4)	0 (0)
2019	0 (0)	413.9 (10)	92.0 (4)	43.5 (2)	0 (0)

Table 10. Observed and mark-expanded numbers of coded-wire tagged, Alaska-origin Chinook salmon captured in bycatch of the Bering Sea-Aleutian Islands groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by run year and release region: A) 2001–2010 and B) 2011–2019. Numbers averaged over time periods are reported. The Chinook salmon tagging program in the Cook Inlet, Alaska region has been intermittent since the 2008 brood year (2010 release).

A. 2001–2010

	Cook Inlet, Alaska		Southeast Alaska		Alaska Total	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
2001	14	16.9	0	0	**14**	**16.9**
2002	25	28.9	2	3.8	**27**	**32.7**
2003	4	4.1	2	20.6	**6**	**24.6**
2004	11	11.1	5	26.1	**16**	**37.2**
2005	8	8.2	4	7.7	**12**	**15.9**
2006	11	11.4	5	27.4	**16**	**38.8**
2007	2	2.0	3	17.4	**5**	**19.4**
2008	0	0	0	0	**0**	**0**
2009	0	0	0	0	**0**	**0**
2010	0	0	0	0	**0**	**0**
Mean	**7.5**	**8.3**	**2.1**	**10.3**	**9.6**	**18.6**

B. 2011–2019

	Cook Inlet, Alaska		Southeast Alaska		Alaska Total	
Run year	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion
2011	0	0	0	0	**0**	**0**
2012	0	0	1	1.7	**1**	**1.7**
2013	0	0	0	0	**0**	**0**
2014	0	0	0	0	**0**	**0**
2015	0	0	1	16.7	**1**	**16.7**
2016	1	1.0	3	14.3	**4**	**15.3**
2017	2	2.1	7	97.2	**9**	**99.3**
2018	1	1.0	2	17.6	**3**	**18.6**
2019	0	0	0	0	**0**	**0**
Mean	**0.4**	**0.5**	**1.6**	**16.4**	**2.0**	**16.8**

Table 11. Observed numbers of coded-wire tagged Chinook salmon captured in bycatch of the Bering Sea-Aleutian Islands groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by rearing type and state or province of origin: A) 2001–2010 and B) 2011–2019. Percentages of the total are reported.

A. 2001–2010

	Rearing type		
Origin	**Hatchery**	**Mixed**	**Wild**
Alaska	90	0	6
British Columbia	89	0	0
California	2	0	0
Oregon	59	0	0
Washington	40	1	1
Yukon Territory	8	0	0
% of total	**99.3%**	**0.3%**	**0.3%**

B. 2011–2019

	Rearing type		
Origin	**Hatchery**	**Mixed**	**Wild**
Alaska	15	0	3
British Columbia	56	0	0
California	0	0	0
Oregon	26	0	0
Washington	28	0	1
Yukon Territory	3	0	0
% of total	**97.0%**	**0%**	**3.0%**

Table 12. Observed numbers of coded-wire tagged Chinook salmon captured in bycatch of the Bering Sea-Aleutian Islands groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by run type and state or province of origin: A) 2001–2010 and B) 2011–2019. Percentages of the total are reported.

A. 2001–2010

	Run type			
Origin	**Spring**	**Summer**	**Fall**	**Late fall upriver bright**
Alaska	93	0	0	0
British Columbia	12	34	39	0
Oregon	17	0	40	0
Washington	8	2	30	2
Yukon Territory	6	0	2	0
% total	**48%**	**13%**	**39%**	**1%**

B. 2011–2019

	Run type			
Origin	**Spring**	**Summer**	**Fall**	**Late fall upriver bright**
Alaska	18	0	0	0
British Columbia	1	34	21	0
Oregon	13	0	12	1
Washington	1	7	19	2
Yukon Territory	3	0	0	0
% total	**27%**	**31%**	**39%**	**2%**

Table 13. Observed and mark-expanded numbers of coded-wire tagged Chinook salmon listed under the Endangered Species Act and captured in bycatch of the Gulf of Alaska (GOA) groundfish fisheries (excluding augmented sampling in the rockfish trawl fishery, 2013–2019, and salmon excluder device testing, 2013–2014) and Bering Sea-Aleutian Islands (BSAI) groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by evolutionarily significant unit (ESU) for 1981–2019.

	GOA		BSAI	
Chinook salmon ESU	Observed number	CWT Mark Expanded Number	Observed number	CWT mark expanded number
Lower Columbia River	38	136.4	10	10.1
Snake River fall run	7	10.4	0	0
Snake River spring/summer run	1	1.9	1	1.9
Upper Columbia River spring run	1	1.0	0	0
Upper Willamette River	204	718.9	21	91.1

Table 14. Observed and mark-expanded numbers of coded-wire tagged Chinook salmon listed under the Endangered Species Act and captured in bycatch of the Gulf of Alaska (GOA) groundfish fisheries (excluding augmented sampling in the rockfish trawl fishery, 2013–2019, and salmon excluder device testing, 2013–2014) and Bering Sea Aleutian Islands (BSAI) groundfish fisheries (excluding salmon excluder device testing, 2015–2016) by evolutionarily significant unit (ESU) and year, 1981–2019.

A. Lower Columbia River Chinook salmon ESU

	GOA		BSAI	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	5	14.1	0	0
1985	1	1.0	0	0
1986	0	0	0	0
1987	1	1.3	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	1	1.0	0	0
1991	0	0	0	0
1992	1	1.6	0	0
1993	1	60.3	0	0
1994	2	2.8	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	2	18.8	0	0
1999	4	5.9	0	0
2000	2	2.0	0	0
2001	2	2.0	1	1.0
2002	0	0	1	1.0
2003	0	0	0	0
2004	1	1.1	3	3.0
2005	0	0	3	3.1
2006	0	0	1	1.0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	1	1.0
2013	1	5.7	0	0
2014	1	1.0	0	0

Table 14. Continued.

A. Lower Columbia River Chinook salmon ESU

	GOA		BSAI	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
2015	4	5.0	0	0
2016	6	6.0	0	0
2017	1	1.0	0	0
2018	2	5.7	0	0
2019	0	0	0	0

Table 14. Continued.

B. Snake River fall-run Chinook salmon ESU

	GOA		BSAI	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	2	3.0	0	0
2013	0	0	0	0
2014	1	1.0	0	0
2015	0	0	0	0
2016	1	2.1	0	0
2017	0	0	0	0
2018	3	4.2	0	0
2019	0	0	0	0

Table 14. Continued.

C. Snake River spring/summer-run Chinook salmon ESU

	GOA		BSAI	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
1981	0	0	0	0
1982	0	0	0	0
1983	1	1.9	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	1	1.9
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0

Table 14. Continued.

D. Upper Columbia River spring-run Chinook salmon ESU

	GOA		BSAI	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	1	1.0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0

Table 14. Continued.

E. Upper Willamette River Chinook salmon ESU

	GOA		BSAI	
Run year	Observed number	CWT mark expanded number	Observed number	CWT mark expanded number
1981	0	0	0	0
1982	1	12.0	0	0
1983	2	2.0	0	0
1984	11	16.8	1	1.0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	4	4.0	0	0
1991	1	13.3	0	0
1992	4	28.5	0	0
1993	14	52.1	0	0
1994	3	8.8	0	0
1995	2	4.9	0	0
1996	1	1.3	1	1.0
1997	1	7.5	0	0
1998	4	30.7	0	0
1999	20	49.3	1	1.0
2000	16	16.6	1	1.0
2001	7	7.1	1	1.0
2002	1	1.0	2	12.4
2003	1	5.3	0	0
2004	1	5.8	1	7.9
2005	0	0	2	10.9
2006	1	1.0	0	0
2007	0	0	0	0
2008	1	6.5	0	0
2009	1	1.8	1	10.2
2010	3	12.8	1	15.5
2011	2	13.4	0	0
2012	11	44.5	0	0
2013	2	2.0	0	0
2014	5	18.8	1	1.0
2015	2	4.1	2	2.0
2016	31	191.5	0	0
2017	41	123.1	5	22.7
2018	6	17.9	1	3.5
2019	4	14.4	0	0

Table 15. Observed and mark-expanded numbers of coded-wire tagged Chinook salmon listed under the Endangered Species Act and captured in bycatch of the Gulf of Alaska rockfish trawl fishery by evolutionarily significant unit (ESU) and year, 2013–2019.

	Lower Columbia River		Puget Sound		Snake River fall run	
Run year	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion
2013	0	0	1	1.0	4	6.3
2014	0	0	0	0	0	0
2015	1	1.0	0	0	1	2.0
2016	0	0	0	0	1	1.0
2017	0	0	0	0	0	0
2018	1	1.0	0	0	0	0
2019	1	1.4	0	0	1	28.5

	Snake River spring/summer run		Upper Columbia River spring run		Upper Willamette River	
Run year	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion
2013	1	1.0	1	1.0	5	7.6
2014	0	0	0	0	2	13.4
2015	0	0	0	0	0	0
2016	0	0	0	0	1	3.8
2017	0	0	0	0	0	0
2018	1	1.2	0	0	0	0
2019	0	0	0	0	1	2.0

Table 16. Observed and mark-expanded numbers of coded-wire tagged Chinook salmon listed under the Endangered Species Act (ESA) and captured in U.S. research surveys, 1996–2016. NMFS has not conducted research surveys on juvenile salmon in non-state waters of the GOA since 2016. No coded-wire tagged Chinook salmon from ESA-listed evolutionarily significant units (ESUs) were recovered in Gulf of Alaska (GOA) research surveys before 1996, and no coded-wire tagged, ESA-listed Chinook salmon have been recovered in Bering Sea-Aleutian Islands research surveys.

	GOA	
ESU	Observed number	CWT mark expanded number
Lower Columbia River	11	26.6
Puget Sound	1	1.0
Snake River fall run	6	7.1
Snake River spring/summer run	41	137.5
Upper Columbia River spring run	27	54.9
Upper Willamette River	28	92.2

Table 17. Observed and mark-expanded numbers of coded-wire tagged Chinook salmon listed under the Endangered Species Act (ESA) and captured in U.S. research surveys in the Gulf of Alaska (GOA) by evolutionarily significant unit (ESU) and year, 1996–2016. NMFS has not conducted research surveys on juvenile salmon in non-state waters of the GOA since 2016. No coded-wire tagged Chinook salmon from ESA-listed ESUs were recovered in GOA research surveys before 1996.

	Lower Columbia River		Puget Sound		Snake River fall run	
Run year	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	1	1.0	0	0	0	0
2000	0	0	0	0	0	0
2001	1	1.0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	1	1.0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	1	5.7	0	0	2	3.1
2013	4	9.6	0	0	2	2.0
2014	3	8.3	0	0	1	1.0
2015	1	1.0	0	0	0	0
2016	0	0	0	0	1	1.0

Table 17. Continued.

	Snake River spring/summer run		Upper Columbia River spring run		Upper Willamette River	
Run year	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion	Observed Number	CWT Mark Expansion
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	2	5.8	0	0	2	2.3
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	3	11.1
2002	0	0	0	0	3	26.6
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0
2011	0	0	0	0	1	1.0
2012	12	27.0	13	26.4	9	14.0
2013	13	52.0	6	10.0	5	15.9
2014	8	29.5	6	16.4	1	3.5
2015	4	13.0	0	0	3	15.7
2016	2	10.2	2	2.0	1	2.1

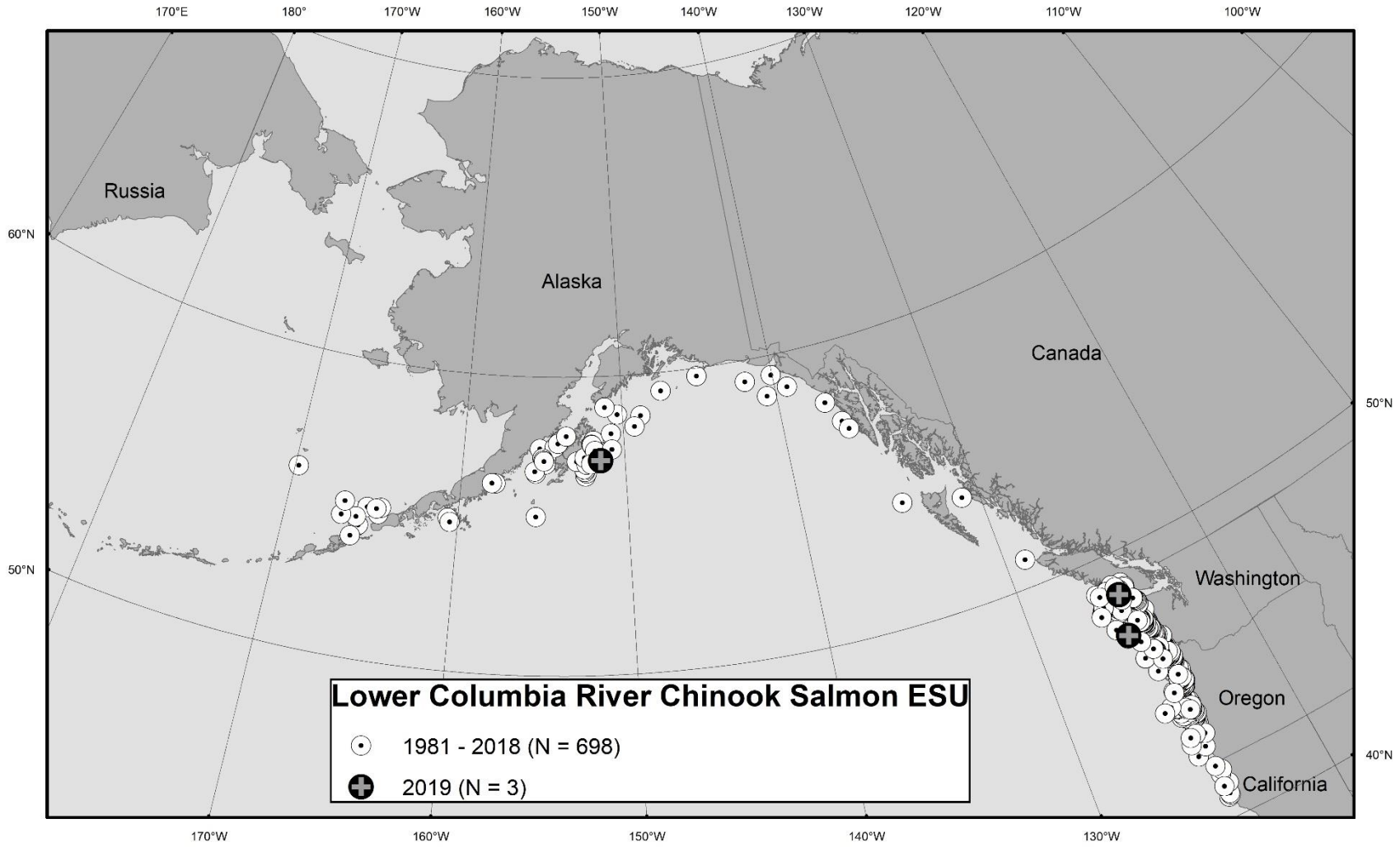

Figure 1. Ocean distribution of coded-wire tagged Chinook salmon recoveries from the Lower Columbia River ESU, 1981–2019. Coded-wire tags were recovered in fisheries and research surveys.

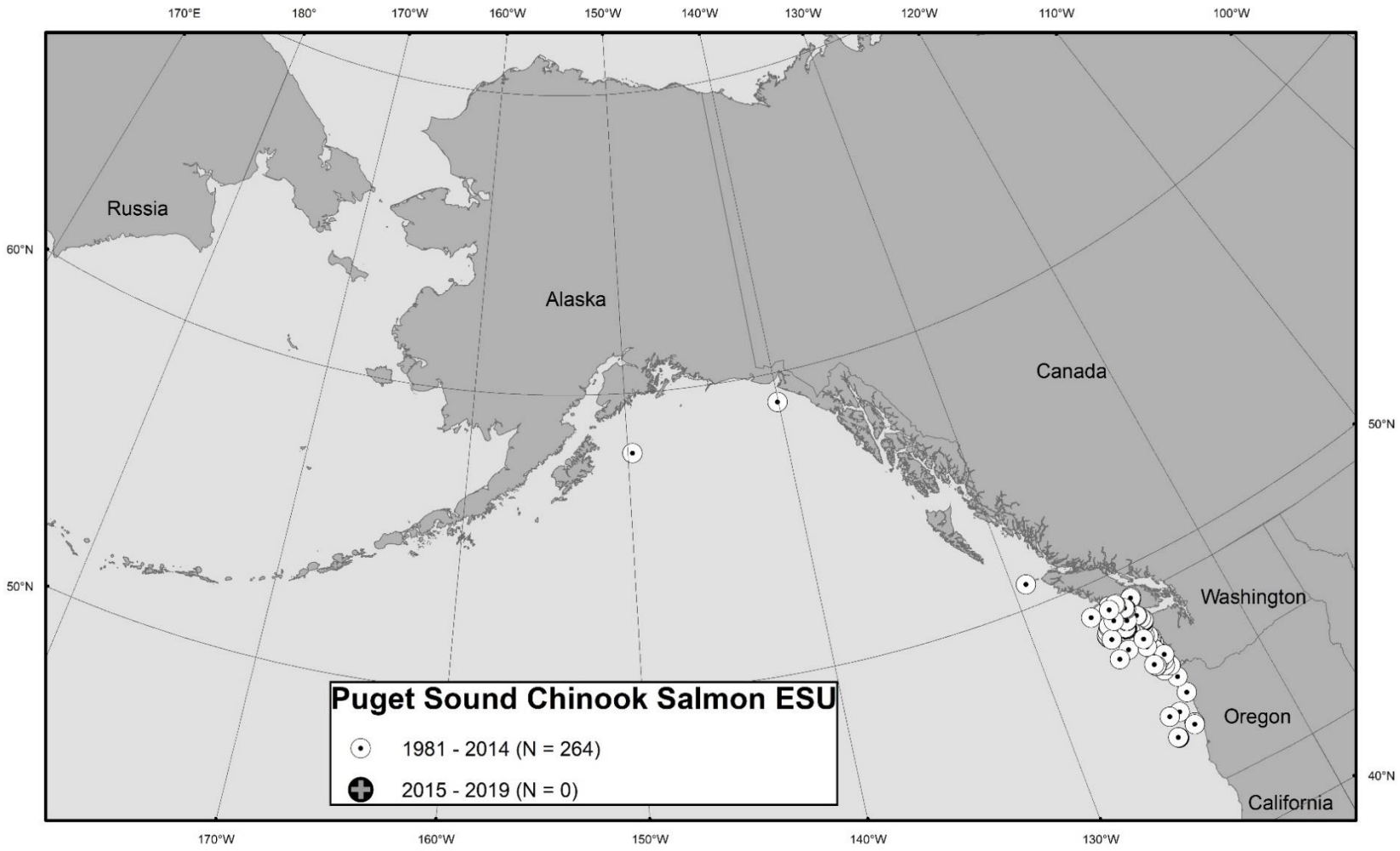

Figure 2. Ocean distribution of coded-wire tagged Chinook salmon recoveries from the Puget Sound ESU, 1981–2019. Coded-wire tags were recovered in fisheries and research surveys.

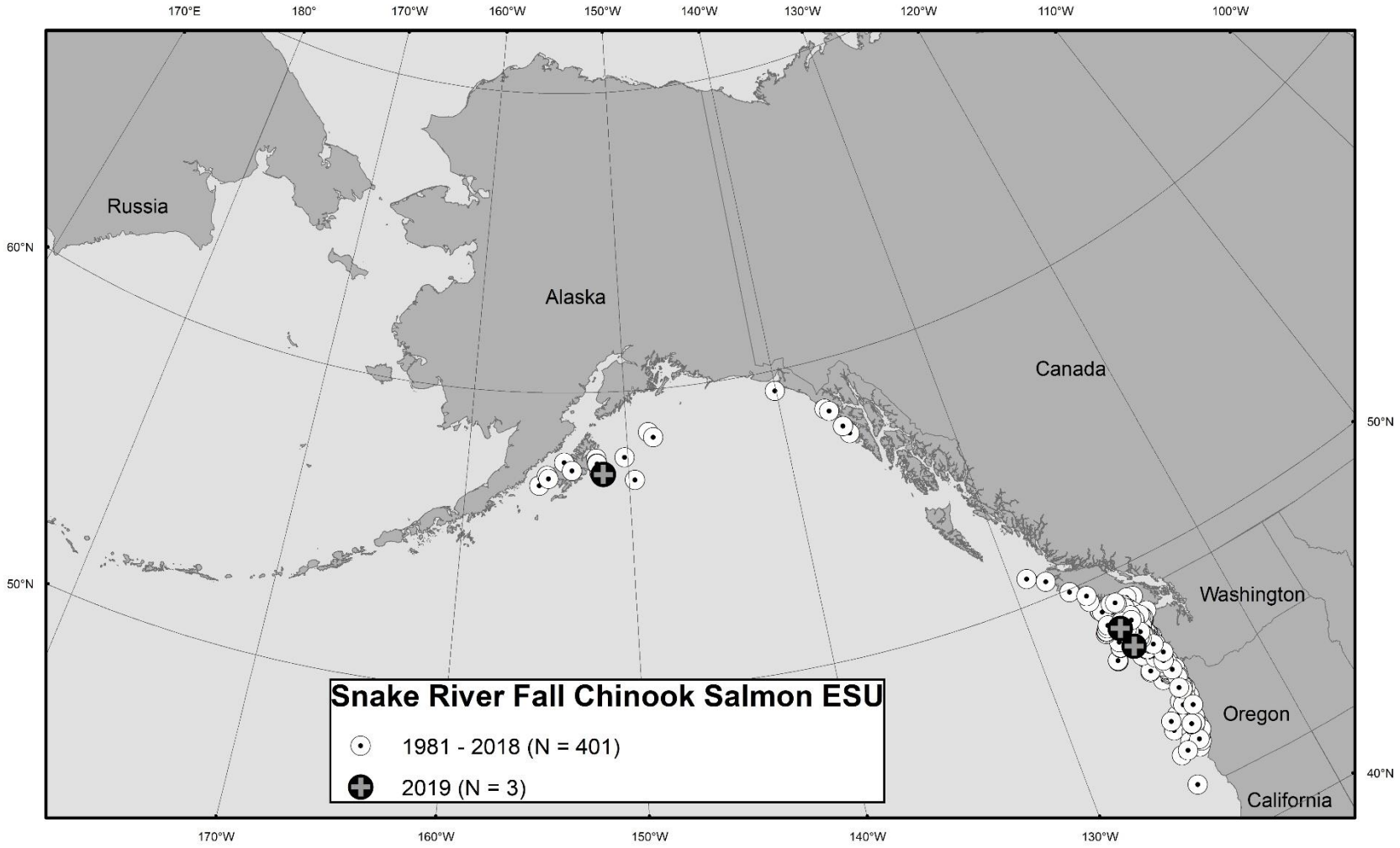

Figure 3. Ocean distribution of coded-wire tagged Chinook salmon recoveries from the Snake River fall-run ESU, 1981–2019. Coded-wire tags were recovered in fisheries and research surveys.

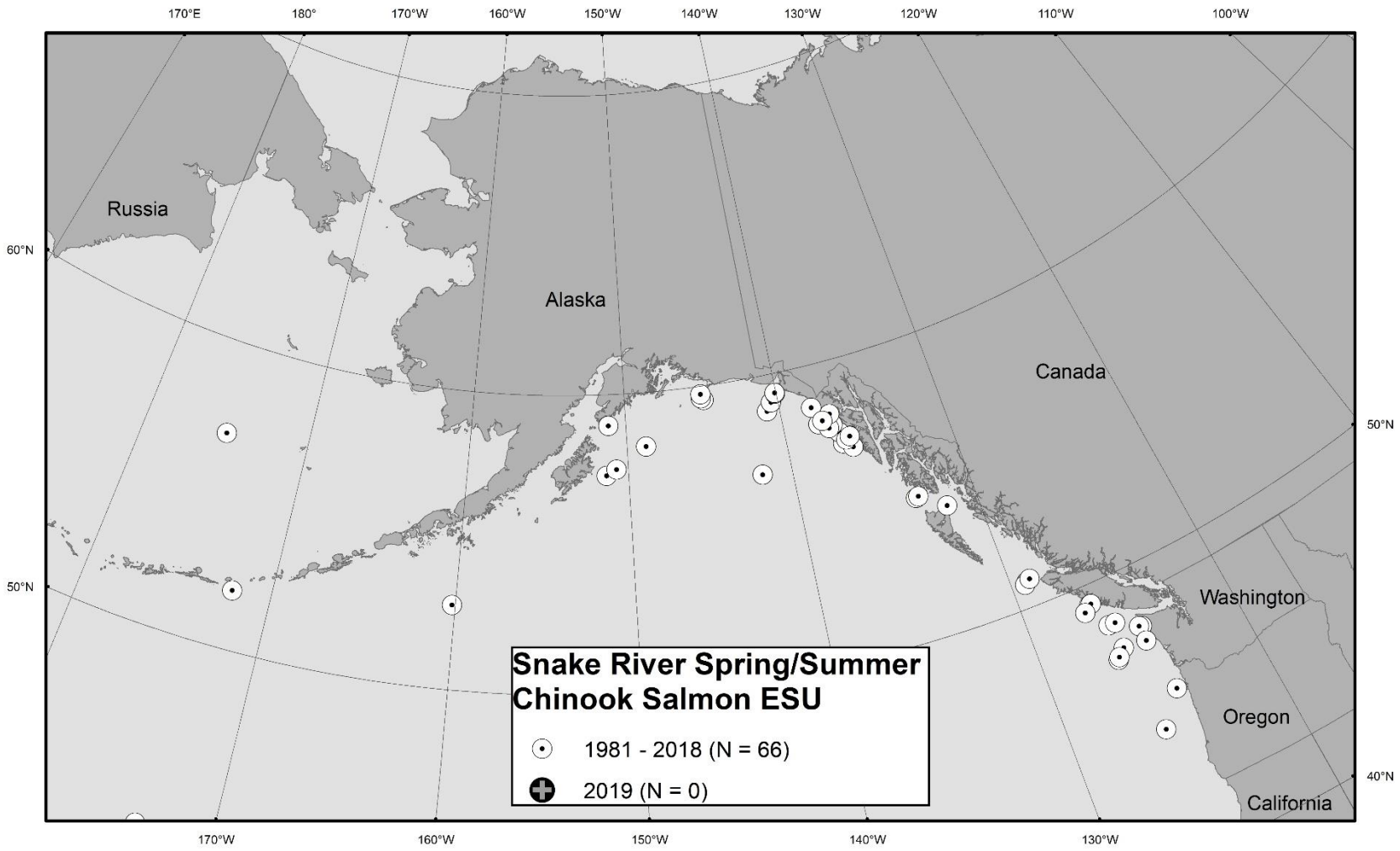

Figure 4. Ocean distribution of coded-wire tagged Chinook salmon recoveries from the Snake River spring/summer-run ESU, 1981–2019. Coded-wire tags were recovered in fisheries and research surveys.

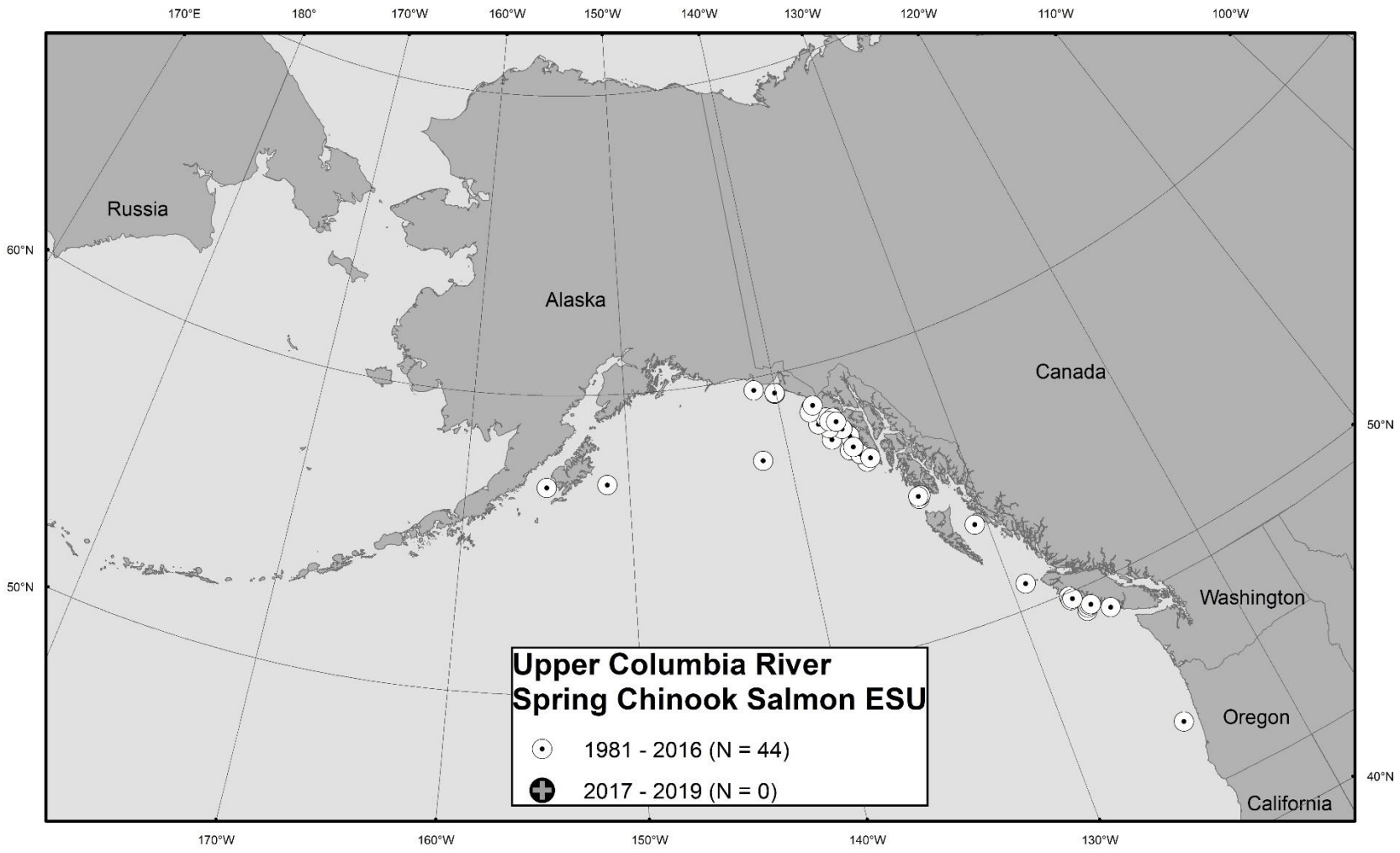

Figure 5. Ocean distribution of code-wire tagged Chinook salmon recoveries from the Upper Columbia spring-run ESU, 1981–2019. Coded-wire tags were recovered in fisheries and research surveys.

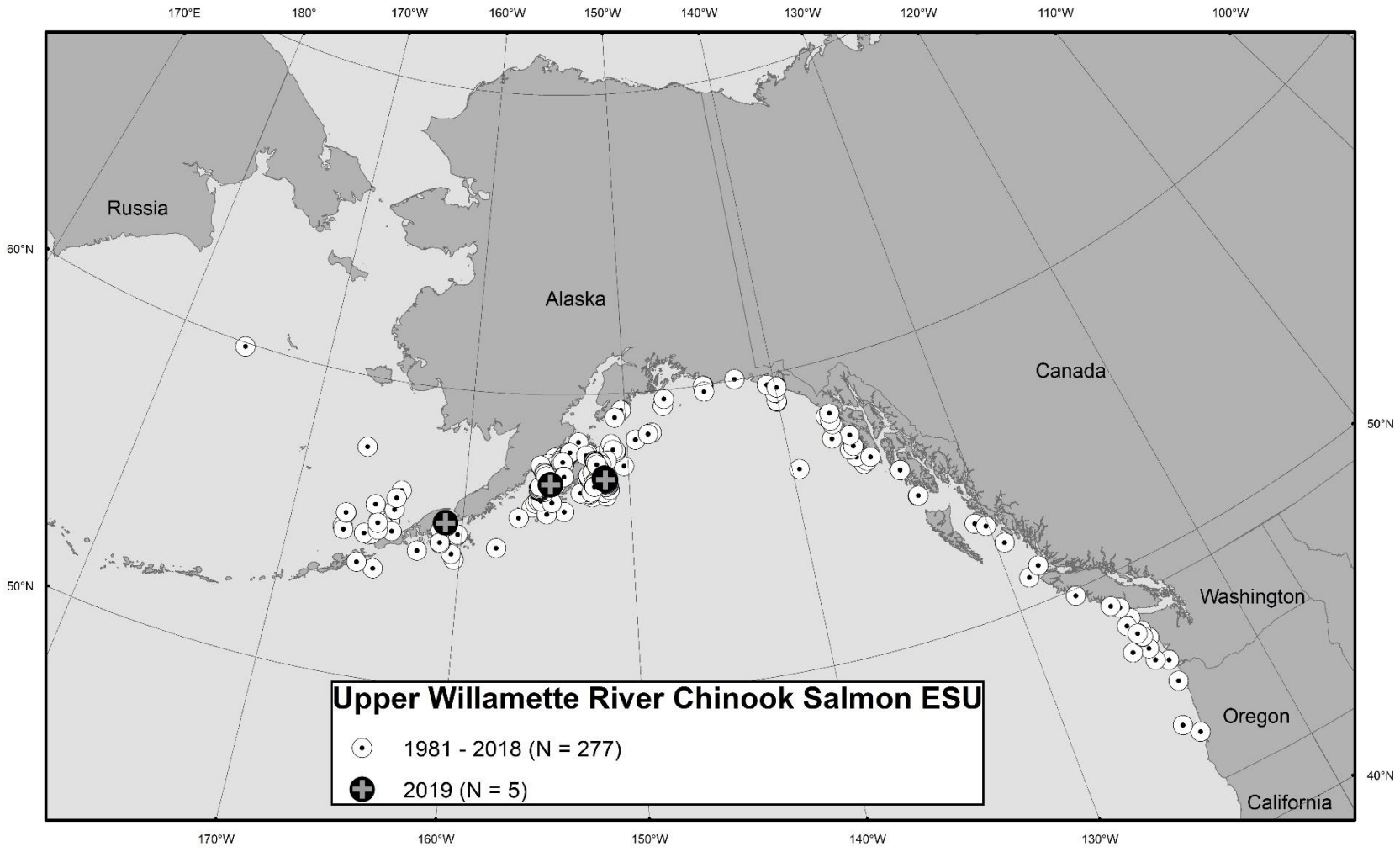

Figure 6. Ocean distribution of coded-wire tagged Chinook salmon recoveries from the Upper Willamette River ESU, 1981–2019. Coded-wire tags were recovered in fisheries and research surveys.

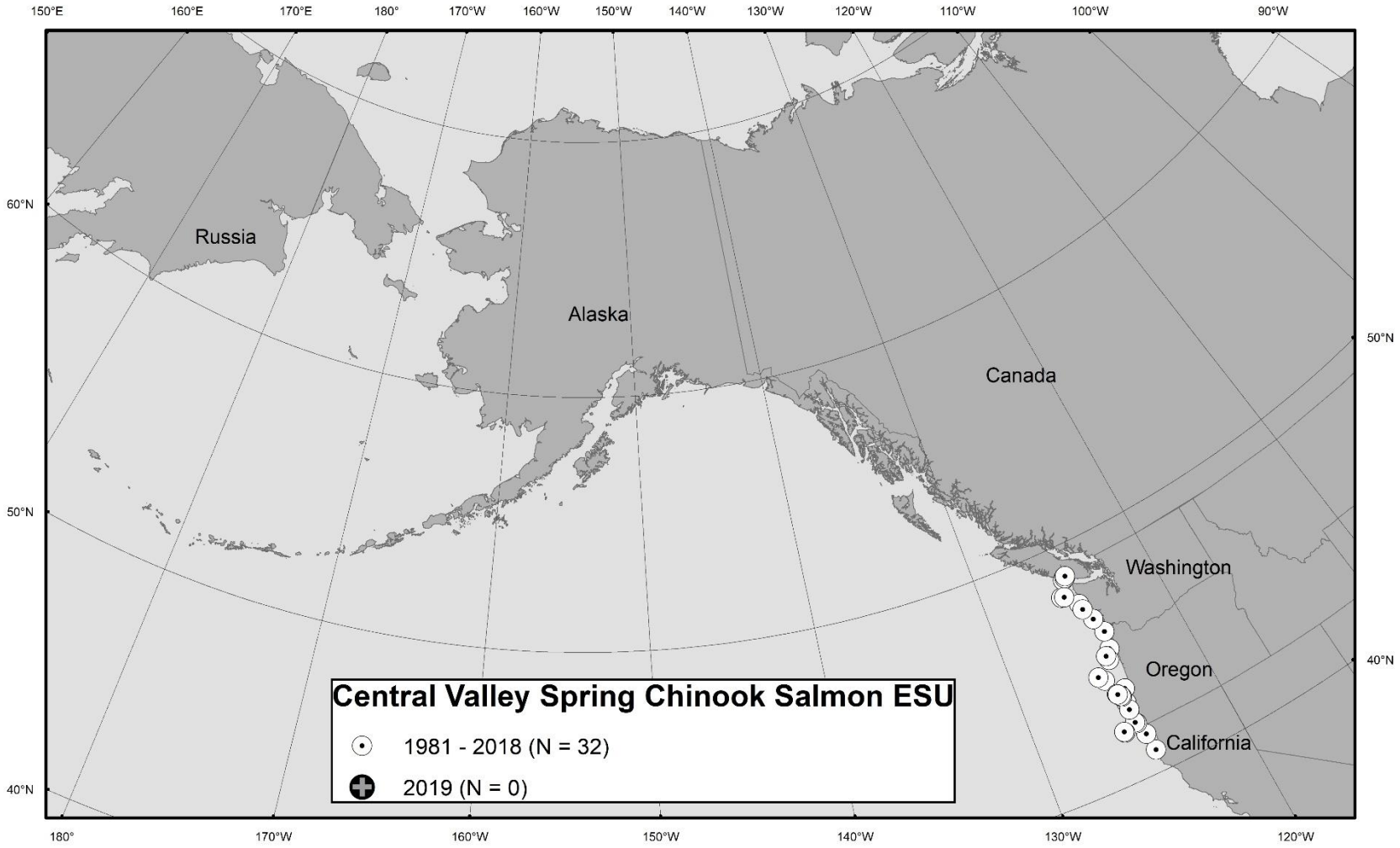

Figure 7. Ocean distribution of coded-wire tagged Chinook salmon recoveries from the Central Valley spring-run ESU, 1981–2019. Coded-wire tags were recovered in fisheries and research surveys.

APPENDIX 1

Recovery Estimation Technique by Adrian Celewycz

The total number of fish from a particular release group that are caught in a particular area during a particular time period can be estimated in a two-step process (Nandor et al. 2010). The first step is to calculate a sampling expansion factor (a) for the fishery in each year (Johnson 2004):

> a = (total catch of each species by fishery by year)/ (sampled catch of each species by fishery by year).

A sampling expansion factor can only be calculated from CWTs recovered from *inside* a sample where the number of sampled fish is known. CWT recoveries from *outside* the sample ("select" recoveries where the total number of fish examined is unknown) cannot be used to calculate a sampling expansion factor.

For the sampled catch, the estimated total recoveries of tags for each release group of interest by fishery and year are calculated:

$$R_{Ti} = aR_{Oi};$$

R_{Ti} = estimated total recoveries of tags for the i^{th} release group;
R_{Oi} = observed number of tags for the i^{th} release group release group;
a = sampling expansion factor for each fishery in each year.

The second step is to account for the fraction of each release group of interest that was tagged (Johnson 2004):

$$C_T = \sum_{i=1}^{n} b_i R_{Ti};$$

C_T = the total estimated contribution for a release group of interest;
b_i = a CWT marking expansion factor for the i^{th} release group = (total fish released)/ (total fish marked) for the i^{th} release group;
R_{Ti} = estimated total recoveries of tags for the i^{th} release group.

The contribution estimates are then summed over all relevant area and time strata. These are the simplest forms of recovery expansion equations (Nandor 2010).

For ESA-listed ESUs, the CWT mark expansion factor can be additionally expanded to take into account the untagged, wild component of each ESU that is not represented by CWTs. A total mark expansion factor (c_j) for each ESU can be calculated:

> c_j = 1 / (proportion hatchery component for the j^{th} ESU).

The proportion hatchery component is calculated separately for each ESU based on the mean hatchery/wild ratio of a number of years of adult returns for each ESU (Appendix Table 1). The total estimated mark expansion of recoveries (R_{TMEj}) can be calculated:

$$R_{TMEij} = c_j \, b_{ij} \, ;$$

R_{TMEij} = the total estimated mark expansion for the i^{th} release group in the j^{th} ESU;
c_j = 1 / (proportion hatchery component for the j^{th} ESU);
b_{ij} = the CWT marking expansion for the i^{th} release group in the j^{th} ESU.

Once again, the contribution estimates are then summed over all relevant area and time strata. For these calculations, each tag code is considered to be a separate release group.

Appendix Table 1. Percentages of hatchery and wild components and Total Mark Expansion Factors for Chinook salmon ESUs.

Chinook salmon ESU name	% Hatchery	% Wild	Total Mark Expansion Factor	Source of hatchery/wild ratios
Lower Columbia River	88.9	11.1	1.12	2008–2010 adult return estimates[1]
Puget Sound	95.0	5.0	1.05	Recent adult return estimates[2]
Snake River fall run	75.2	24.8	1.33	2007–2011 spawning escapement estimates[3]
Snake River spring/summer run	73.2	26.8	1.37	1995–2012 adult return estimates[4]
Upper Columbia River spring run	89.1	10.9	1.12	1995–2012 adult return estimates[4]
Upper Willamette River	81.7	18.3	1.22	2005–2010 adult return estimates[1]

[1] Vaughan 2011.
[2] LaVoy 2013a.
[3] LaVoy 2013b.
[4] Joint Columbia River Management Staff 2013.

APPENDIX 2

Excerpts from "Analysis of Recoveries of Coded-Wire Tags (CWTs) from Chinook Salmon in the Gulf of Alaska (GOA) and Bering Sea-Aleutian Islands (BSAI), 2012 and 2013" by Adrian Celewycz

Processing Snouts for Coded-Wire Tags (CWTs) at Auke Bay Laboratories CWT Lab at TSMRI

At the Auke Bay Laboratories (ABL) Coded-Wire Tag (CWT) Lab at TSMRI, snouts are processed to recover CWTs from tagged salmon collected in the bycatch in Federally-managed groundfish fisheries as well as from domestic and foreign research surveys in the Gulf of Alaska (GOA) and Bering Sea-Aleutian Islands (BSAI). The CWTs are extracted from each snout, read and verified under a microscope, and then recovery data associated with each snout are entered into a NMFS database. Once the recovery data and tag data have been verified and finalized, they are incorporated into the master historical database of all CWTs processed by ABL's CWT Lab and reported to the coastwide Regional Mark Information System (RMIS) of the Pacific Stated [sic] Marine Fisheries Commission (PSMFC). At that point the data are available for further analysis. ABL's historical CWT database contains records of CWT recoveries from the salmon bycatch of the GOA and BSAI groundfish fisheries dating back to 1981.

The CWT Program in the Greater Pacific Region of North America

Since the late 1960s, CWTs have been used in the greater Pacific region (Alaska, British Columbia, Washington, Idaho, Oregon, and California) to mark anadromous salmonids, particularly hatchery fish (Nandor et al. 2010). Coastwide, more than 53 million juvenile Chinook salmon have been tagged with CWTs in the last several years (2009 and 2010 brood years) by 36 State, Federal, Tribal, and private entities in the U.S. and Canada, at more than 160 hatcheries and rearing facilities on the West Coast, in addition to natural origin fish trapped and tagged at many sites. The total number of Chinook salmon represented by these 53 tagged million Chinook salmon is over 162 million fish annually (2009 and 2010 brood years). Over a billion Chinook salmon from the greater Pacific region have been tagged with CWTs since 1968. CWT data are used for many purposes, including stock contribution studies where fishery managers seek information on the contribution rates of key stocks in a given fishery (by time and area strata) in order to better manage harvest rates for conservation of the resource (Nandor et al. 2010). CWT data play a key role in the U.S-Canada Salmon Treaty allocations and management of transboundary stocks (Nandor et al. 2010). After 40 years, the CWT program in the greater Pacific region of North America continues to be the most important tool for salmonid research and management (Nandor et al. 2010).

However, CWTs do not provide information on all Chinook salmon stocks harvested in the GOA and BSAI. In particular, no wild or hatchery origin Alaska Chinook salmon stocks are currently being tagged with CWTs in other regions outside of Southeast Alaska. A tagging program on Chinook salmon in the Cook Inlet, Alaska region ended with the 2008 brood year, and no Western Alaska Chinook salmon stocks are currently being tagged. The only tagging of Chinook salmon in the whole Yukon River drainage has been conducted by the Whitehorse Hatchery, Yukon Territory, Canada.

Although some tagging of wild stocks occurs (mainly in Alaska), CWTs are used mostly for tagging of hatchery fish. Wild stocks of Chinook salmon are generally under-represented by CWTs, especially outside of Alaska. In the greater Pacific region, Alaska has had the strongest tagging program on wild stocks of Chinook salmon. Of the 26 million CWT Chinook salmon that have been tagged and released in Alaska from the 1992 brood onward, 88% were of hatchery origin and 12% were from wild stocks. Of the 787 million CWT Chinook salmon that have been tagged and released in all locations other than Alaska from the 1992 brood onward, 98% was of hatchery origin, 1% was from wild stocks, and 1% was from mixed-origin stocks.

Because of recent persistent statewide declines in Chinook salmon productivity in Alaska, the Alaska Department of Fish and Game (ADF&G) Chinook Salmon Research Team is recommending establishing a suite of twelve Chinook salmon indicator stocks of wild origin that will provide an ongoing statewide index of Chinook salmon productivity and abundance trends (ADF&G Chinook Salmon Research Team 2013). The twelve Chinook salmon indicator stocks originate in the Unuk, Stikine, Taku, Chilkat Rivers in the Southeastern Alaska region, the Copper, Susitna, and Kenai Rivers in the Central Alaska region, the Karluk, Chignik, Nushagak, Kuskokwim Rivers in Western Alaska, and the U.S. side of the transboundary Yukon River (ADF&G Chinook Salmon Research Team 2013). A key component of the recommended stock assessment program will involve tagging a representative number of wild juvenile Chinook salmon from each indicator stock with CWTs (ADF&G Chinook Salmon Research Team 2013).

Sampling for CWTs

Historically, the only sampling for CWTs in salmon harvested as bycatch in the Gulf of Alaska (GOA) and Bering Sea-Aleutian Islands (BSAI) groundfish fisheries has been conducted by vessel and plant observers based on visual detection of a missing adipose fin in select samples. A missing adipose fin can be a visual indicator of the presence of a CWT. In 2012 and 2013, however, in addition to visual sampling for missing adipose fins by observers, electronic detection of CWTs was initiated in several new sampling programs in the GOA to supplement the number of CWTs collected in GOA groundfish fisheries. Electronic detection allows CWTs to be recovered from salmon irrespective of whether the fish had an adipose fin clip. In addition, a small percentage of salmon are released from hatcheries with a CWT but no adipose fin clip; electronic detection is the only way to recover these CWTs without the visual indicator of a fin clip.

CWT Expansions

Ideally, it would be preferable to calculate a total estimated contribution of Chinook salmon from stocks of interest harvested in GOA and BSAI groundfish fisheries in order to determine the total impact of the fisheries on these stocks. Total estimated contributions for CWT recoveries can be calculated in a two-step process involving a sampling expansion factor and a CWT marking expansion factor (see Appendix 1, Recovery Estimation Technique for a more detailed explanation).

Starting in 2011 in the BSAI pollock fishery, sampling expansion factors can be calculated for CWT recoveries from the bycatch, thus allowing calculation of total estimated contributions for stocks of interest. In 2011 in the BSAI, a systematic random [sic] sampling design recommended by Pella and Geiger (2009) was implemented by the Observer Program to collect genetic samples and check for adipose fin-clipped salmon from approximately 1 out of 10 Chinook salmon (10% sampling rate) encountered as bycatch in the BSAI pollock fishery. This 10% sampling rate was established to meet genetic sampling goals, and snouts from adipose fin-clipped salmon have been collected at this same rate.

A sampling rate adequate for genetic sampling, however, may not necessarily be adequate for CWT sampling. According to the Regional Mark Processing Center of the Pacific States Marine Fisheries Commission, all recovery agencies should strive to randomly sample at least 20% of the commercial landings to have a statistically acceptable estimate of total tag recoveries for a given area-time stratum (Nandor et al. 2010). The ADF&G Chinook Salmon Research Team also recommends that sampling for CWTs be increased to the coastwide standard of 20% of the catch in both the Eastern Bering Sea and Gulf of Alaska trawl fisheries (ADF&G Chinook Salmon Research Team 2013). It should also be pointed out that CWTs do provide certain data that genetic sampling cannot replicate, such as positive identification that a fish originated from an ESA-listed ESU.

Sampling expansion factors cannot be calculated for the CWT recoveries in the GOA pollock fishery at all or in the Bering Sea pollock fishery before 2011 because of limitations with how the data were collected. In these fisheries, salmon heads from adipose fin-clipped salmon were collected not only from the observers' samples, but also opportunistically when encountered by observers outside of the sample. For CWT recoveries from these fisheries, it is unknown whether the CWTs were collected from *inside* or *outside* either the genetics or the observer species composition sample sets. A sampling expansion factor can only be calculated from CWTs recovered from *inside* a sample where the total number of sampled fish is known. Of the 71 documented CWT recoveries of Chinook salmon from ESA-listed ESUs (post-listing) by observers in the GOA trawl fishery before 2012, three CWTs are known to have been recovered from *inside* the sample, three CWTs were recovered *outside* the sample, and for the remaining 65, the sample status is unknown. Starting in 2012 in the GOA, under revised sampling protocols implemented by the Observer Program intended to be as consistent as possible with the sampling changes implemented by the Observer Program in the Bering Sea pollock fishery in 2011, adipose fin-clipped salmon were collected randomly and systematically only from inside a genetic sample at the offload or from inside the vessel observer's species composition sample. Nonetheless, even with voluntary 100% retention of all salmon and random, systematic sampling

for fish with missing adipose fins, sampling expansion factors can still not be calculated for the GOA pollock fishery because not all vessels were sampled.

However, CWT marking expansions can be calculated for each CWT recovery from the mark expansion factors for each tag code. Because not all fish in a tag release group are actually tagged with CWTs, marking expansion factors account for the fraction of each release group that is not tagged (see Appendix 1, Recovery Estimation Technique). Additionally for ESA-listed ESUs, the CWT mark expansion of each CWT recovery can be adjusted to take into account the untagged, wild component of each ESU that is not represented by CWTs to derive a total mark expansion for each ESU (Appendix 1). Without being able to calculate total estimated contributions because of unknown sampling expansion factors, total mark expansions offer the closest approximation to the contribution of Chinook salmon from ESA-listed ESUs. Total mark expansions should be considered minimal estimates for the actual total contribution of Chinook salmon from ESA-listed ESUs in the GOA at the present time and in the BSAI before 2011.