An Assessment of Mark Select Fisheries for Chinook Salmon in Southeast Alaska

PREPARED FOR:

Northern Southeast Regional Aquaculture Association

PREPARED By:

DG Fisheries Services

McDowell Group

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McDowell Group Anchorage Office
1400 W. Benson Blvd., Suite 510
Anchorage, Alaska 99503

McDowell Group Juneau Office
9360 Glacier Highway, Suite 201
Juneau, Alaska 99801

Website: www.mcdowellgroup.net

McDowell GROUP

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Introduction and Methodology

Mark Select Fisheries (MSFs) have been implemented in West Coast Pacific coho and Chinook salmon fisheries beginning in the 1990s. A MSF provides the ability to selectively retain marked hatchery fish while releasing unmarked fish. This allows a reduction in mortality of comingled natural-origin stocks (or of stocks being enhanced for rebuilding) relative to non-selective fisheries (SFEC 2016).

The most recent agreement of the Pacific Salmon Commission (Commission), provisionally applied January 1, 2019, recognizes that MSF may play a role in management of coho and Chinook salmon fisheries under its jurisdiction (see relevant text in Appendix 1). MSFs for Chinook salmon have regularly occurred in Commission areas in Oregon and Washington while MSFs for coho salmon have occurred in Washington and British Columbia.

The Alaska Department of Fish and Game (ADF&G) has experimented with MSF as a management tool in the commercial summer troll fishery. MSFs for Chinook salmon were implemented during the summer Chinook Non-Retention (CNR) periods in 2016 and 2017. Chinook salmon retained during these fisheries counted towards the treaty quota. For the 2019 season, ADF&G submitted three MSF proposals to the Commission but did not necessarily intend to implement them (and did not). No MSF proposals were submitted for the 2020 season.

The Northern Southeast Regional Aquaculture (NSRAA) Board of Directors requested an evaluation of the benefits of MSF for Chinook salmon in the Southeast Alaska fisheries, as well as the costs associated with MSF and mass marking (MM) of Chinook salmon from Southeast Alaska hatcheries. See Appendix 2 for a discussion of MM costs at Southeast Alaska hatcheries.

This paper provides a retrospective analysis of harvest and incidental mortalities if a commercial MSF troll fishery had been in place during the period 1985-2017. The paper also discusses what may be expected if MSF is implemented in the sport fishery.

Methodology

The ADF&G Coded Wire Tag Laboratory (Tag Lab) hosts data on the adipose fin clip rate during sampling and for the estimate of hatchery Chinook salmon. Two Tag Lab reports were used to generate data: the Contribution Summary Report and the Commercial Expansion by Harvest Code Report. The Commercial Expansion by Harvest Code Report provided the adipose clip rate and harvest by troll period. The Contribution Summary Report provided the total estimate of hatchery Chinook salmon harvested by troll period. Expansion estimates were based on period and quadrant.[1]

Additional data came from the annual management report for the Southeast troll fishery.

[1] There are four quadrants in Southeast Alaska. The periods change from year to year and generally number between four and six.

The numbers of Chinook salmon encounters in commercial troll fisheries were provided by ADF&G (John Carlile, personal communication). These data are based on observer programs that were conducted in the late 1990s and early 2000s. A description of methods can be found in TCCHINOOK (11)-1.

Additional methodology details are provided throughout the report.

Historical Harvest

The analysis focuses on the period beginning with the signing of the Pacific Salmon Treaty (PST) and establishment of the Commission in 1985 and continues through the last year for which complete data is available, 2017. This time period also encompasses the development of the Alaska hatchery Chinook salmon program, which, in part, was tied to the implementation of the PST.

The commercial troll fishery harvests the greatest number of Chinook salmon in Southeast Alaska (Table 1). Total Chinook harvests are fixed by the Commission, with the Alaska Board of Fisheries (BOF) responsible for allocating those harvests among Alaska user groups. The total harvest by troll gear ranged from 130,000 in 2017 to 356,000 in 2014.

Table 1. Chinook salmon harvest by gear type (thousands), 1985-2017

Year	Troll	Net	Sport	Total	Alaska Hatchery	Year	Troll	Net	Sport	Total	Alaska Hatchery
1985	216	34	25	**275**	13	2002	325	32	70	**427**	78
1986	238	22	23	**282**	17	2003	331	39	69	**439**	68
1987	243	16	24	**282**	24	2004	355	64	81	**499**	91
1988	231	22	26	**279**	29	2005	338	68	87	**493**	74
1989	236	24	31	**291**	29	2006	282	67	86	**436**	57
1990	288	28	51	**367**	54	2007	268	54	83	**405**	77
1991	264	35	60	**359**	70	2008	152	43	49	**244**	75
1992	184	32	43	**259**	44	2009	176	48	70	**294**	71
1993	227	28	49	**304**	40	2010	196	31	59	**285**	62
1994	186	36	42	**264**	36	2011	242	48	67	**357**	74
1995	138	48	50	**256**	69	2012	209	39	46	**295**	61
1996	141	37	58	**237**	89	2013	150	51	56	**257**	73
1997	246	25	72	**340**	63	2014	356	50	80	**485**	59
1998	192	24	55	**271**	34	2015	270	54	80	**403**	75
1999	146	33	72	**251**	59	2016	276	42	71	**389**	42
2000	159	41	63	**252**	85	2017	130	25	54	**209**	30
2001	153	40	72	**266**	87						

Source: Hagerman et al., 2018.
Note: Data under the column "Alaska Hatchery" are a subset of the Total column.

The net fishery was the second largest harvester in 1985 but since 1986 has been less than the sport fishery. The total net harvest was limited primarily by the BOF allocation policies but was increased in 2004 after an agreement on Chinook salmon sharing in the Transboundary rivers was reached in the PST.

Since 1986, the sport fishery has been the second largest harvester of Chinook salmon. The harvest was limited by the Commission's Chinook salmon model abundance index and the BOF allocations.

Alaska hatchery Chinook salmon production was boosted by the implementation of the PST. The total harvest of Alaska hatchery Chinook salmon by common property fisheries has ranged from 13,000 in 1985 to 91,000 in

2004 (Table 1). In recent years, survival rates and harvests of Alaska hatchery Chinook salmon have decreased – similar to survival rates and harvests of wild Southeast Alaska Chinook salmon stocks.

Coded-Wire-Tag Program

Although a MSF offer a means of differentially harvesting hatchery produced salmon over wild salmon, it is not without controversy and cost to the Pacific salmon management system. The introduction of the Coded-Wire-Tag (CWT) brought about a major improvement in how Pacific salmon are managed. Inserting the CWT into the snouts of a proportion of hatchery produced Pacific salmon – along with a statistically sound recovery program in the fisheries and escapement – allowed the estimation of total returns by stock, brood year, and age-specific exploitation rates. To practically facilitate the program, an external means to identify salmon that carried a CWT was needed. The adipose fin clip was sequestered through coastwide agreement in 1977 to serve as an indicator to samplers that a salmon may have a CWT.

Accurate and unbiased CWT data is so important to coastwide management that when the PST was signed in 1985, the parties also agreed to a Memorandum of Understanding (MOU) committing both countries to maintain a viable CWT program:

> *"The Parties agree to maintain a coded-wire tagging and recapture program designed to provide statistically reliable data for stock assessments and fishery evaluations."*

In the early 1990s, as the concept of Mass Marking (MM) and subsequent MSF was being developed, the Commission established an Ad-hoc Selective Fishery Evaluation Committee (ASFEC) to assess any implications of implementation on the viability of the CWT program as outlined in the MOU. Viability of the CWT program was defined with three criteria by the ASFEC as:

1. It must provide the ability to use CWT data for assessment and management of wild stocks of coho and Chinook salmon;
2. It must be maintained such that the uncertainty in stock and fishery assessment and their applications does not unacceptably increase management risk; and,
3. It must provide the ability to estimate stock- specific exploitation rates by fishery and age.

In 2016, the now permanent Selective Fishery Evaluation Committee (SFEC) concluded that the MM and MSF programs currently implemented do not meet criteria 1 and 3, while interpretation of whether criteria 2 has been met "depends on policy determination of whether the current level of management risk is acceptable or not." The Commission has not reached a conclusion on criteria 2 (PSC SFEC, 2016).

Incidental and Total Mortalities

The incidental mortality (IM) rate is defined as the proportion of fish captured, but not reported as landed catch, that subsequently die as a result of the capture and release process (PSC CTC, 1997). The total quantity of incidental mortality depends on the incidental mortality rate and the number of fish encountered. Incidental mortalities occur on both legal and sublegal Chinook salmon and the rates vary by gear group, geographic area, and fish size.

The sum of landed catch and incidental mortalities is total mortality. Throughout the 1990s, there was an interest in moving towards total mortality management regimes. The Chinook Technical Committee (CTC) was instructed to provide estimates of incidental mortality so that total mortality could be identified. There was particular concern about the legal incidental mortalities that occurred in the Alaska troll CNR fishery. The 1999 PST Agreement provided some guidelines and instructed the CTC to construct tables similar to those for landed catch at different Abundance Index levels, but for total mortality instead of landed catch. The CTC struggled with the task and did not undertake the technical analysis until after the 2008 PST Agreement. The CTC analysis and description of a total mortality fishing regime was completed in 2011 (CTC 2011). The Commission did not adopt the regime as outlined in the document.

In the most recent agreement, at Chapter 3, 4(f) is the current attempt to limit IM in the AABM fisheries;

> *"that, if it is determined by the Commission through the monitoring and evaluation described in sub-paragraph (e), that an AABM fishery has a level of incidental mortality that exceeds 59,400 for the SEAK AABM fishery or 38,600 for the combined aggregate for the NBC and WCVI AABM fisheries, the Commission shall review the information, determine if fishery adjustments are needed during the Chapter Period, and recommend any appropriate remedial action to ensure that the Parties do not exceed incidental mortality limits;"*

Incidental mortality in the Southeast Alaska AABM fishery has been calculated from 1985 through 2017 for sublegal and legal sized Chinook salmon caught by three gear types: commercial troll, sport, and commercial net, including both seine and gillnet (Table 2). The largest percentage of incidental mortality during this period comes from sublegal fish encountered in the commercial troll fishery (41%). The second largest is 21% for legal fish in the troll fishery. The lowest is 4% for legal fish in the net fishery.

Table 2. Incidental mortalities for legal and sublegal Chinook salmon in Alaska, by fishery, 1985-2017

Year	Troll		Sport		Net		Total Treaty IM	Abundance Index
	LIM	SIM	LIM	SIM	LIM	SIM		
1985	15,319	79,828	2,397	3,413	6,545	41,606	149,107	1.30
1986	21,169	63,137	1,982	2,823	6,880	25,268	121,259	1.46
1987	35,097	66,688	2,112	3,007	1,142	10,730	118,776	1.75
1988	11,997	34,995	2,315	3,297	6,563	15,046	74,213	2.11
1989	24,573	47,841	2,788	3,970	7,305	32,912	119,390	1.74
1990	20,490	49,423	4,494	15,554	3,401	16,562	109,925	1.77
1991	22,633	41,165	2,831	5,292	3,605	18,803	94,330	1.70
1992	24,737	43,468	4,832	7,129	24,728	103,344	208,238	1.61
1993	20,148	44,953	4,277	5,979	2,580	12,194	90,131	1.59
1994	24,611	45,623	2,747	6,051	8,937	39,091	127,060	1.47
1995	13,745	29,666	3,020	5,291	3,440	12,441	67,602	1.04
1996	14,576	27,280	3,404	4,242	221	427	50,149	0.97
1997	11,452	25,423	6,768	6,219	729	3,049	53,640	1.24
1998	5,791	11,728	4,479	5,246	1,173	6,860	35,278	1.15
1999	16,517	15,618	5,924	8,835	514	2,357	49,764	1.06
2000	9,746	19,040	4,525	5,593	222	536	39,661	0.96
2001	11,020	24,406	5,633	5,993	426	1,621	49,100	1.14
2002	8,440	33,248	5,690	6,089	249	1,429	55,145	1.74
2003	10,678	20,196	5,147	6,804	415	9,232	52,471	2.16
2004	14,061	15,482	7,060	7,233	4,901	4,177	52,913	1.92
2005	11,915	13,961	5,793	9,321	143	4,781	45,913	1.72
2006	10,256	17,291	6,106	8,706	223	5,393	47,975	1.48
2007	10,628	21,673	5,245	8,834	4,126	21,010	71,517	1.12
2008	11,711	16,582	4,608	4,686	246	290	38,123	0.89
2009	11,620	18,361	4,817	6,434	136	3,595	44,963	1.04
2010	12,763	16,942	3,754	4,558	142	261	38,420	1.15
2011	10,400	14,809	6,144	7,231	379	2,651	41,613	1.42
2012	7,315	22,797	3,703	4,948	1,414	5,712	45,890	1.13
2013	14,569	14,930	6,662	8,381	2,987	11,853	59,382	1.57
2014	14,441	16,445	6,376	7,950	105	5,630	50,945	2.19
2015	10,761	11,747	7,538	8,192	1,859	9,051	49,148	1.82
2016	9,830	20,908	4,653	7,118	99	8,404	51,012	1.65
2017	14,561	14,732	3,712	5,678	753	2,912	42,349	1.27
Average	**14,775**	**29,103**	**4,592**	**6,367**	**2,927**	**13,310**	**71,073**	
Percent of Total	**21%**	**41%**	**6%**	**9%**	**4%**	**19%**		

Source: TCCHINOOK (18)-2. Abundance Index estimates from Hagerman et al., 2018.
Notes: LIM = Legal Incident Mortality, SIM = Sublegal Incident Mortality.

The Troll LIMs in this table are higher than those considered in our Summer CNR analysis due to inclusion of drop off mortality in the retention periods. Drop off mortality is mortality associated with unsuccessfully landing legal Chinook salmon.

The 59,400 incidental trigger point identified in the recent Agreement was exceeded beginning each year with 1985 and continuing through 1995 (Table 3). Between 1996 and 2017, it was exceeded in 2007 and nearly hit in 2013. Implementation of a delayed summer start date, closure of areas of high Chinook salmon abundance during CNR periods, adaptation of a new management plan in 1994, and a reduction in the number of boat days of effort contributed to the reduction in IM since 1995.

Table 3. Effort in Summer Commercial Troll Fishery Retention and Non-Retention Periods (boat-days), 1985-2017

Year	Retention Period	Non-Retention Period	Total	Year	Retention Period	Non-Retention Period	Total
1985	31,197	30,567	61,764	2002	11,104	8,072	19,176
1986	35,646	29,901	65,547	2003	10,811	8,422	19,233
1987	21,819	34,604	56,423	2004	7,353	14,665	22,018
1988	11,357	22,820	34,177	2005	10,083	12,688	22,771
1989	10,507	33,278	43,785	2006	9,821	13,486	23,307
1990	17,988	27,742	45,730	2007	10,628	12,819	23,447
1991	6,898	30,720	37,618	2008	5,745	15,855	21,600
1992	3,878	34,367	38,245	2009	7,589	15,307	22,896
1993	12,094	27,009	39,103	2010	5,549	16,641	22,190
1994	7,489	34,216	41,705	2011	5,479	12,611	18,090
1995	9,013	19,963	28,976	2012	13,024	8,495	21,519
1996	5,446	20,489	25,935	2013	2,671	19,785	22,456
1997	9,161	14,054	23,215	2014	5,405	16,973	22,378
1998	12,068	11,091	23,159	2015	3,174	12,758	15,932
1999	4,328	22,037	26,365	2016	10,183	11,077	21,260
2000	6,237	13,399	19,636	2017	2,177	19,751	21,928
2001	7,458	13,438	20,896				

Source: Hagerman et al., 2018.

It is interesting to note that the majority of incidental mortality is from sublegal fish. An increase in survival – such as would occur under improved ocean conditions and survival rates – would be a positive sign for the fishery but initially penalize trollers by increasing incidental mortality but not harvests.

Fisheries Considered for MSF

If MSF were to be implemented in Alaska, it would most likely be in the troll and sport fisheries as these both actively pursue Chinook salmon. Although MSF apparently has been implemented in Chinook salmon net fisheries outside of Alaska, implementation in Alaskan net fisheries seems impractical, particularly for gill nets, and was not considered in this report. Also excluded from this analysis is the winter troll fishery, which is not under consideration for a possible MSF (John Carlile, personal communication).

The commercial spring troll fishery is targeted at Alaska hatchery origin Chinook salmon. Alaska hatcheries increased production of Chinook salmon as a means to mitigate for treaty-related reductions in Chinook salmon quotas. The ADF&G genetic policy (ADF&G 1985) allows only local stocks to be used for hatchery production. All Chinook salmon in Alaska are spring type (also known as stream type) as opposed to the fall Chinook salmon more common down south. Spring type Chinook salmon spend one year as juveniles rearing in freshwater before migrating to the ocean the following spring. Fall Chinook salmon typically migrate to the ocean as juveniles in their first year after emerging from the spawning gravel. The one year in freshwater makes it expensive to raise spring type Chinook salmon in a hatchery. Another significant difference between spring and fall Chinook salmon is the timing of migration and spawning. Spring type Chinook salmon return to the natal river or hatchery primarily in May and June while fall Chinook salmon do not return until September/October.

Prior to the late 1970s, the commercial troll fishery operated all year long but with a distinction in area between the winter and summer fisheries. During the summer fishery, trollers were allowed to fish on the open ocean, while during the winter fishery (October 1 through April 14) they were restricted to waters inside the surfline. However, as a result of the PST, the start of the summer fishery was gradually delayed until it became July 1 in 1988. Most of the Alaska Chinook salmon, both wild and hatchery, rear in distant waters and are only available for harvest when they return in May and June. The spring fisheries are intended to provide time and area for harvest of Alaska hatchery origin Chinook salmon.

Management of the commercial spring troll fishery is described in annual management plans (Hagerman and Ehresmann, 2019). The spring troll fishery has been identified for consideration for MSF.

To estimate what the harvest may look like under MSF, historical fishery data were recast assuming MSF regulations were in place (Table 4). Data from the ADF&G Tag Lab was used to calculate the adipose clip rate for each year beginning in 1986 and continuing through 2017 (Commercial Expansion by Harvest Code). The CWTs were tallied as from Alaska hatcheries or other. Additional data (harvest and the number of fish designated as being from Alaska hatcheries) for the analysis came from Table 15 in Hagerman et al., 2018.

Results and Discussion

If a MSF had been in place in the spring fishery from 1986 through 2017 (i.e. only Chinook salmon with an adipose clip had been harvested), there would have been a dramatic reduction in the catch and value. During this period, the percentage of Chinook salmon with an adipose clip ranged from 6.0% to 20.2%. The harvest (excluding terminal areas) during this period ranged from 776 to 55,186 Chinook salmon with an average of 27,345. At a 6.0% adipose clip rate, the average harvest would have been 1,641, while at 20.2% it would have been 5,524 Chinook salmon.

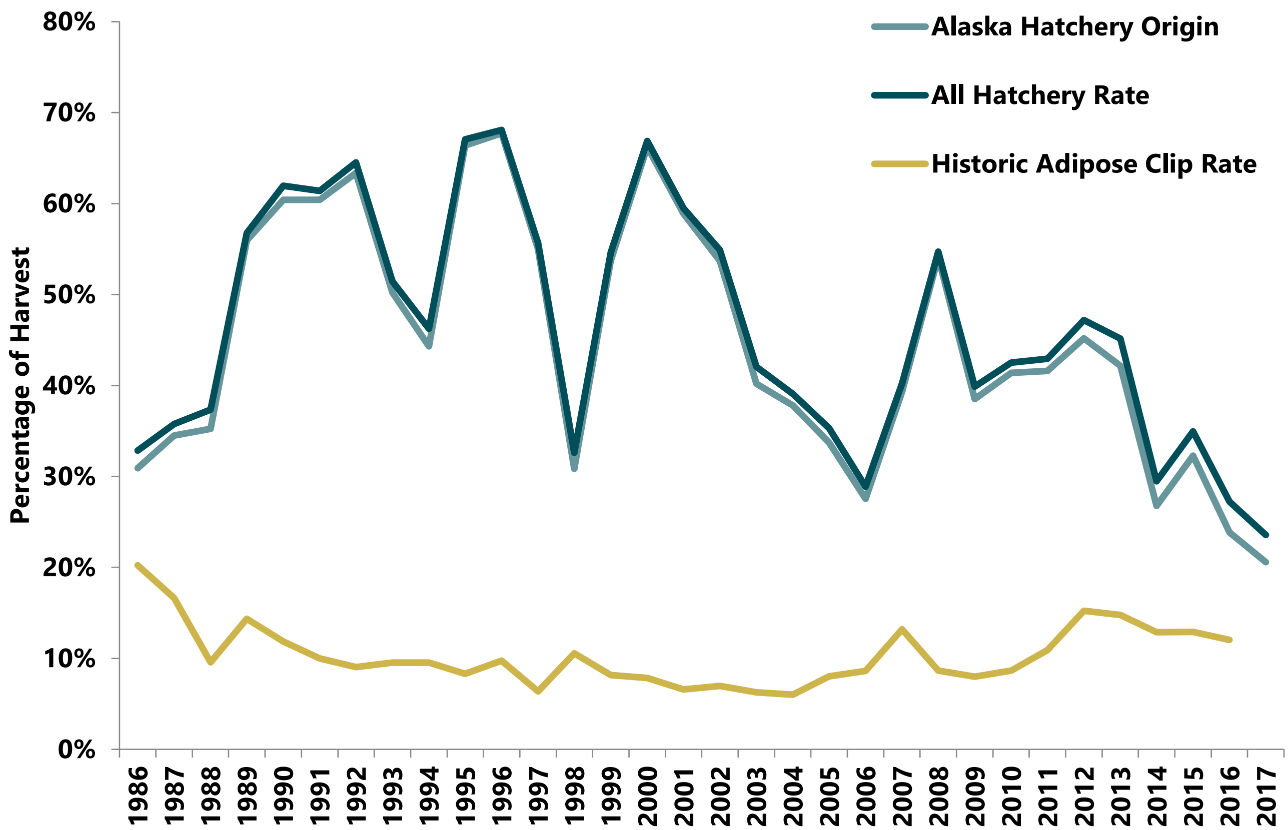
Even if all Alaska hatchery Chinook salmon were adipose clipped and other adipose clipped fish were retained, the historical harvest would range from 20.9% of the actual harvest to 65.1%. The average catches would have ranged from 5,715 to 17,802. In addition, it is important to note that the percentage of the spring harvest from Alaska hatcheries has been declining. See Table 4 and Figure 1 below.

Table 4. Spring Troll Fishery Historic Harvests and Harvests under Adipose Clip Rate and All Hatchery MSF Scenarios, 1986-2017

Year	Spring Harvests (not including terminal areas)	% of Harvest Adipose Clipped	MSF Harvest based on Ad Clip Rate	% of Harvest from Alaska Hatcheries	% Adipose Clipped & Not from Alaska Hatcheries	MSF Harvest based on All Hatchery Rate
1986	776	20.1%	156	31%	1.9%	255
1987	4,488	20.2%	908	34%	1.3%	1,604
1988	8,505	16.6%	1,415	34%	2.1%	3,113
1989	2,366	9.6%	226	39%	1.1%	948
1990	7,052	14.4%	1,012	60%	1.5%	4,363
1991	13,984	11.9%	1,659	44%	1.4%	6,326
1992	11,229	10.0%	1,123	50%	1.6%	5,786
1993	15,826	9.1%	1,433	41%	1.5%	6,755
1994	11,269	9.5%	1,073	44%	1.9%	5,157
1995	21,750	9.5%	2,076	64%	0.7%	14,149
1996	30,963	8.3%	2,575	51%	0.6%	15,845
1997	32,791	9.8%	3,198	41%	0.9%	13,847
1998	19,195	6.4%	1,222	26%	1.9%	5,374
1999	18,351	10.6%	1,938	48%	1.0%	8,951
2000	20,990	8.2%	1,712	53%	0.9%	11,401
2001	28,250	7.8%	2,215	49%	0.8%	13,946
2002	37,610	6.6%	2,478	46%	1.4%	17,918
2003	35,452	7.0%	2,473	34%	2.1%	12,680
2004	55,186	6.3%	3,454	36%	1.3%	20,575
2005	58,421	6.0%	3,513	31%	1.6%	19,147
2006	36,918	8.0%	2,958	26%	1.4%	9,936
2007	48,476	8.6%	4,175	38%	0.9%	18,711
2008	36,638	13.2%	4,839	48%	0.6%	18,007
2009	32,581	8.6%	2,816	38%	1.4%	12,822
2010	28,617	8.0%	2,282	39%	1.2%	11,498
2011	38,936	8.6%	3,367	38%	1.4%	15,493
2012	24,771	10.9%	2,704	43%	2.1%	11,272
2013	37,308	15.2%	5,682	41%	3.0%	16,306
2014	42,548	14.8%	6,280	25%	2.8%	11,650
2015	53,692	12.9%	6,922	31%	2.7%	18,254
2016	42,502	12.9%	5,483	23%	3.4%	11,352
2017	17,606	12.1%	2,095	18%	3.1%	3,682

Note: Terminal area harvests not included. Adipose clip rate calculated as adipose clips/catch sampled with data from Troll Expansion by Harvest Code (ADF&G Tag Lab). All Hatchery Rate includes 100% clipping of Alaska hatchery production and historic harvests of adipose clipped fish not from Alaska hatcheries.

Figure 1. Adipose Fin Clip Rate and Hatchery Percentage in the Spring Troll Fishery, 1985-2017



Source: Author calculations based on ADF&G Tag Lab data.
Note: Yellow line represents actual historic encounter rates for clipped fish. Adipose clipped rate assumes 100% Alaska hatchery Chinook salmon are clipped. Additional harvests come from clipped Chinook salmon from outside Alaska.

In both scenarios, due to the number of Chinook salmon released (all unclipped Chinook salmon), there would also have been an increase in incidental mortality (Table 4). However, there would have been a decrease in total mortality as not all of the Chinook salmon released would die. No attempt was made to estimate the harvest if all other (non-Alaskan) hatchery origin Chinook salmon were marked.

It seems likely that the implementation of a MSF in the spring fishery would only occur during periods of poor production of Alaska wild Chinook salmon stocks such as is occurring in recent years. Unfortunately, the Alaska hatchery stocks appear to have poor production at the same time.

Implementation of a MSF in the spring fishery will drastically reduce harvest numbers and ex-vessel value going to commercial trollers. Adding reductions to an already low volume fishery could lead to diminishing returns on investment and threaten the viability of the fishery.

Summer CNR Commercial Troll MSF

In the Alaska commercial salmon troll fishery there are periods during which salmon species are targeted but Chinook salmon retention is not allowed. In most other Chinook salmon MSF fisheries, marked fish are directly targeted by the fishery and total harvest is likely less than would be under a directed landed quota fishery where all legal sized Chinook salmon, marked or unmarked, may be retained. Chinook and coho salmon fisheries outside of Alaska are generally managed similar to the Alaska winter troll fishery, where once the quota is achieved, the fishery is closed.

This analysis considers a MSF for Alaska hatchery Chinook salmon during the CNR periods of the summer fishery. A possible use of such a fishery could be to harvest small amounts of quota remaining after the second directed Chinook salmon opening in August. At the request of a NSRAA board member, a scenario is also analyzed using a CNR MSF to achieve a harvest of an additional 7.5% over the quota (to make up for treaty-related reductions).

Both of these scenarios involve applying MSF management to historic data. Similar to the approach used for the Spring MSF analysis, harvest simulations were conducted based on both (1) actual historic adipose clip rates; and (2) a rate based on an assumption that all hatchery fish were adipose clipped.[2]

For harvests based on historic clip rates, the adipose clip rate from the initial summer Chinook salmon opening was applied to the CNR encounters estimated for that year. For harvests based on an all hatchery clipped rate, the CNR encounters were multiplied by the estimated hatchery proportion from the ADF&G Contribution Summary Report with data for the commercial troll fishery selected. Unfortunately, the all hatchery rate estimates proved to be unreliable and resulted in misleading findings, as discussed in more detail below.

The harvest of marked Chinook salmon under the MSF scenarios correspondingly reduces the number of legal Chinook salmon that are released. The associated incidental mortality of legal fish was recalculated to reflect this reduction.

Results

Summer CNR Troll MSF

For the Summer CNR fishery, simulated harvests under MSF management were estimated by multiplying the number of encounters by the adipose clip rate. See Table 5 for these harvest estimates, as well as the associated incidental mortality under MSF.

It is important to note that the analysis assumes no change in troller behavior during the CNR periods. Under this assumption, trollers seek to maximize coho harvest with no effort focused on catching Chinook salmon.

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[2] Note that in the Spring analysis, the all-hatchery clipped rate assumed 100% clipping of Alaska hatchery Chinook production, whereas the Summer analysis considers 100% clipping of all hatchery Chinook in Alaska and Outside. The latter approach was not used in the Spring analysis due to limitations in readily available data and the diminished importance of Outside Chinook in that fishery.

The adipose clip rate for the summer fishery was lowest in 1991 and between 1985 and 2009 never exceeded 7.2%. Between 1999 and 2017, the adipose clip rate was between 9.91% and peaked at 21.75% in 2015. Based on these historic clip rates, MSF harvests would have ranged from 680 in 1998 to 11,862 in 2013 (Table 5).

Decreases in IM under both rates were relatively small, averaging -8% based on historic clip rates.

Table 5. Estimated Harvest and Legal Incidental Mortality under Summer CNR MSF, 1985-2017

Year	CNR Chinook Encounters	LIM	Adipose Clip Scenario		
			Adipose Clip %	MSF Harvests	Revised LIM
1985	63,275	13,857	4.64%	2,938	13,214
1986	90,356	19,788	5.40%	4,879	18,719
1987	158,102	34,624	5.19%	8,204	32,828
1988	48,635	10,651	5.08%	2,469	10,110
1989	106,578	23,341	4.33%	4,612	22,331
1990	88,846	19,457	7.18%	6,377	18,061
1991	98,384	21,546	2.02%	1,990	21,110
1992	110,065	24,104	4.38%	4,817	23,049
1993	86,498	18,943	3.60%	3,118	18,260
1994	109,581	23,998	4.54%	4,975	22,909
1995	63,933	14,001	5.80%	3,710	13,189
1996	65,619	14,370	3.63%	2,382	13,849
1997	45,010	9,857	3.31%	1,488	9,531
1998	20,103	4,403	3.38%	680	4,254
1999	72,747	15,932	4.24%	3,088	15,255
2000	42,070	9,213	5.15%	2,167	8,739
2001	47,677	10,441	5.46%	2,605	9,871
2002	28,242	6,185	5.52%	1,558	5,844
2003	38,538	8,440	5.65%	2,176	7,963
2004	54,359	11,905	5.67%	3,081	11,230
2005	45,045	9,865	5.21%	2,345	9,351
2006	38,177	8,361	4.59%	1,753	7,977
2007	41,053	8,991	4.59%	1,886	8,578
2008	50,779	11,121	6.31%	3,206	10,418
2009	49,022	10,736	9.91%	4,858	9,672
2010	53,295	11,672	10.31%	5,497	10,468
2011	40,389	8,845	15.68%	6,333	7,458
2012	27,208	5,958	17.32%	4,713	4,926
2013	63,363	13,876	18.72%	11,862	11,279
2014	54,358	11,904	21.47%	11,670	9,349
2015	40,859	8,948	21.75%	8,887	7,002
2016	35,459	7,766	19.80%	7,019	6,228
2017	63,170	13,834	16.64%	10,513	11,532

Source: Author calculations. Encounters provided by John Carlile, ADF&G.

All Hatchery Rate

Between 1985 and 2008, the percentage of the summer CNR Chinook harvest attributable to hatchery production (all hatchery rate) averaged 25%, while the adipose clip rate averaged 4.8%. The ratio of hatchery versus clipped fish, therefore, averaged around 5.2 – generally in line with known clip rates at hatcheries during this time.

A clear shift began in 2008, when the all hatchery rate began to decline while the adipose clip rate increased dramatically to 15-21% of the harvest. From 2011 onward, the all hatchery rate has been lower than the adipose clip rate – an illogical result given negligible clip rates of wild fish. Experts interviewed attributed these results to releases of adipose clipped hatchery fish with no representative CWT group. Such releases are thought to be increasing due to establishment of mark select fisheries down south (primarily in Washington State). Unsuccessful efforts were made to explore this data contradiction in more detail; the topic has apparently not been studied in any significant detail by ADF&G personnel or other researchers.

The goal of a MSF simulation based on the all hatchery rate was to determine if an MSF CNR fishery made sense under the aggressive assumption that all hatcheries coastwide transitioned to 100% clipping of Chinook. This is not plausible but provides a useful best-case situation for making a CNR MSF viable. Based on the all hatchery rate obtained for the ADF&G Tag Lab, CNR MSF harvests would have ranged from 3,546 in 2012 to 51,153 in 1992. These results are not presented in detail due to questions about the accuracy of the all hatchery rate estimates.

Recovering 7.5% Harvest Cut Through a CNR MSF

There has been discussion of using a CNR MSF fishery to compensate for treaty-related reductions in Chinook harvests. A simulation was developed to evaluate this scenario. Preseason quotas were compiled from Hagerman et al. (2018) and multiplied by 7.5% to calculate the quota reduction that would have to be compensated for through a CNR MSF.

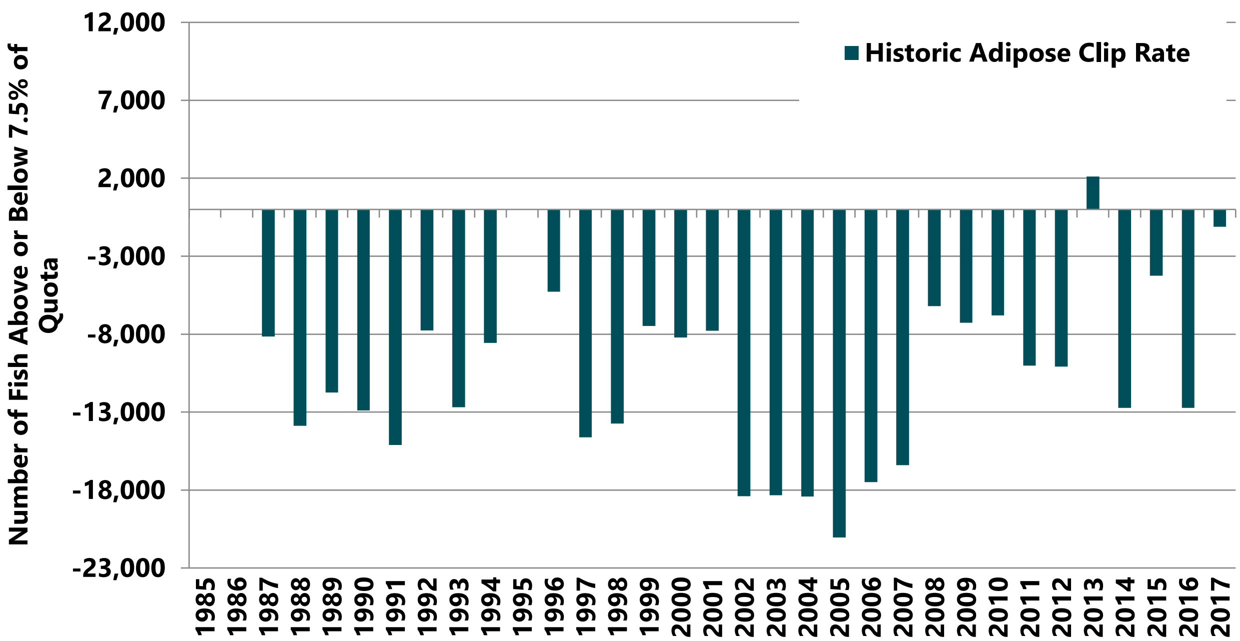
Table 6. Troll Chinook Pre-Season Quota and 7.5% of Quota, 1985-2017

Year	Pre-Season Quota	7.5% of Quota	Year	Pre-Season Quota	7.5% of Quota
1985	-	-	2002	266,056	19,954
1986	-	-	2003	273,406	20,505
1987	218,000	16,350	2004	286,728	21,505
1988	218,000	16,350	2005	311,916	23,394
1989	218,000	16,350	2006	256,664	19,250
1990	257,000	19,275	2007	243,747	18,281
1991	228,000	17,100	2008	125,408	9,406
1992	167,790	12,584	2009	161,637	12,123
1993	210,690	15,802	2010	163,864	12,290
1994	180,400	13,530	2011	218,060	16,355
1995	-	-	2012	197,272	14,795
1996	102,000	7,650	2013	129,862	9,740
1997	214,761	16,107	2014	325,411	24,406
1998	192,176	14,413	2015	175,145	13,136
1999	140,728	10,555	2016	263,197	19,740
2000	138,507	10,388	2017	154,880	11,616
2001	138,507	10,388			

Source: Hagerman et al. (2018) (Table 1) and author calculations.
Note: For various reasons, no pre-season quota was established or available for 1985, 1986, and 1995.

A logical question is whether there are enough Chinook encounters during the CNR to harvest 7.5% of the quota through a CNR MSF. Using the number of encounters and actual adipose clip rates, enough Chinook salmon could be harvested to make the 7.5% in only one year, 2013 (Figure 2).

Figure 2. Results of Whether a Summer CNR MSF Could Recover a 7.5% Quota Cut, 1985-2017
(assuming no change in troller behavior)

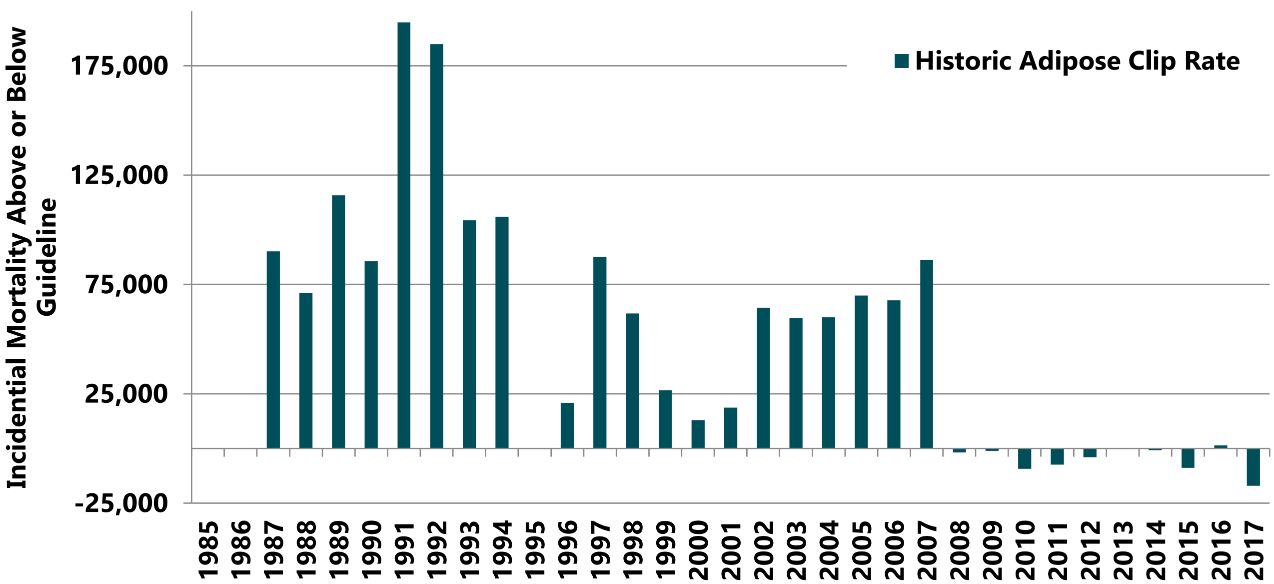


Source: Author calculations.

To increase the encounter rate and achieve the additional harvests contemplated, trollers could change their behavior and target Chinook salmon under a CNR MSF. While no data are available to evaluate whether this would have been possible, a scenario was developed where it is assumed the 7.5% increase was achieved via a CNR MSF. This additional effort would lead to higher IM due to increased encounters with unclipped Chinook salmon. The purpose of this analysis is to determine if the additional effort would result in IM numbers that exceeded the IM guideline of 59,400 set under the most recent treaty agreement. The results of this analysis are presented in Figure 3.

Under actual historic clip rates, the revised estimated incidental mortality was above the guideline for all years between 1985 and 1995. From 1996 through 2017, incidental mortality estimated using the adipose clip rate exceeded the guideline in 13 of 22 years.

Figure 3. Number of Chinook Salmon IMs Above or Below the 59,400 PST Guideline
(assuming change in troller behavior to target Chinook and harvest 7.5% of quota through a CNR MSF)



Source: Author calculations.

Discussion

In a summer MSF CNR fishery, simulated harvests over the 1986-2017 period ranged from 680 to 11,862 using the actual adipose clip rate.

When MSF is conducted in the manner as assumed in this analysis (no change in troller behavior), it decreases the total incidental mortality. However, if during a MSF, Chinook salmon are actively sought, the number of encounters increases which could ultimately increase total incidental mortality.

The analysis of recovering a 7.5% quota cut through a summer MSF provided a means of examining what may happen to IM under MSF. The result in this case was that the number of incidental mortalities increased such that the 59,400 guideline was frequently exceeded (based on historic adipose clip rates).

Encounter Rate Issue

In the commercial troll Summer CNR fishery, ADF&G estimates the number of encounters based on observer programs from the late 1990s and early 2000s. If the behavior of the fleet changes from that time, the estimated number of encounters will be incorrect. The SFEC noted that angler behavior changes during MSF. Although the SFEC most likely based this comment on sport anglers it is likely that at least some commercial trollers would change their behavior under a CNR MSF.

Options available to trollers to increase Chinook salmon encounters include using Chinook salmon gear on the bottom spreads, selecting an area to fish in that may be more likely to encounter Chinook salmon, and/or circling back through areas once a legal Chinook salmon is brought aboard. If these changes were adopted, ADF&G may be required to conduct new observer studies in order to estimate a more accurate encounter rate.

If the number of encounters increases, the incidental mortality will also increase. The 2019 PSC Agreement notes that once total incidental mortality reaches 59,400 in the Alaska fisheries that the fishing regime is subject to review.

The sport fishery has typically not had a CNR period. However, in 2018 and 2019, poor returns of Alaska Chinook salmon stocks resulted in spring closures in inside waters. Additionally, sport fisheries were closed to Chinook salmon from mid-August to October 2016. Due to the relative lack of non-retention periods, there are very little data to examine that may provide an insight into the future. This analysis highlights how adipose clip rates by geographic area and discusses what may happen if MSF were implemented during spring closures (such as those seen in 2018 and 2019).

The Chinook salmon harvest by area as estimated by the Statewide Harvest Survey was downloaded from the ADF&G website. While the Statewide Harvest Survey is considered the most accurate source of harvest numbers, it does not provide information on the adipose clip rate and hatchery contribution. This data is available based on creel surveys (dockside data collection by ADF&G staff) and was downloaded from the ADF&G Tag Lab. Two Tag Lab reports were used to generate data: the Sport Contribution Summary Report and the Sport Expansion Report.

Analysis

The sport fishery is the second largest harvester of Chinook salmon in Southeast Alaska. Based on data in Table 1, the average combined troll and sport Chinook salmon harvest for the last 10 years was 278,900 fish of which 77.3% and 22.7% were harvested by the troll and sport fisheries respectively.

It seems unlikely that an areawide sport fishery MSF would be implemented. Therefore, estimates for individual areas were gathered. The Statewide Harvest Survey provides individual estimates for nine geographical areas in Southeast Alaska. Average annual harvests were calculated for each of these areas over the follow three periods: 1996-1997, 1998-2007, and 2008-2017 (Table 7).

Table 7. Average number of Chinook salmon harvested annually over time period, by area

Year	Ketchikan	POW Island	Kake, PSG, Wrangell	Sitka	Juneau	Skagway	Haines	Glacier Bay/Cross Sound	Yakutat	Total
1996-1997	5,347	7,332	4,774	22,024	14,642	779	409	4,489	524	60,320
1998-2007	10,711	10,071	6,644	25,163	11,827	841	546	3,424	575	69,802
2008-2017	10,767	9,767	4,341	25,644	7,065	301	201	3,152	705	61,948

Source: Statewide Harvest Survey, ADF&G.

The largest harvests during the most recent period (2008-2017) are in Sitka, followed by Ketchikan, Prince of Wales Island, and Juneau. The smallest harvests during the 2008-2017 period are in Haines, Skagway, and Yakutat. The magnitude of the harvests appears to be related to proximity to the open ocean and effort (human population centers). Overall, Southeast Alaska annual harvests averaged 61,943 for the 2008-2017, roughly ten percent lower than average harvests in the 1998-2007 period.

In addition to the harvest survey data, ADF&G has conducted sport fish sampling in 11 geographical areas for different time periods since 1985 (Appendix 3). Only Haines, Juneau, Ketchikan, Petersburg and Sitka have been continuously sampled since 1985. The sampling includes determination of the adipose clip rate and recovery of heads for CWTs. In addition, the number of biweeks (two-week periods) sampled in each area and each year has not been consistent – further complicating use of these data.

Although expansions of hatchery harvest can be made, they often are not reasonable due to the small sample sizes and harvests in the individual areas. However, the adipose clip sampling rate and relative difference in the number of Alaska hatchery and other hatchery CWTs are useful information (recognizing that different hatcheries CWT and mark at different rates).

In general, the adipose clip rates rise over time in the outer coast fisheries such as Sitka and Craig, with large catches and highly mixed stock. The Elfin Cove and Yakutat fisheries are likely too small to provide useful data. The larger inside fisheries, Ketchikan, Petersburg, and Juneau show adipose clip rates that remain fairly steady over time.

Sampling data was summarized to identify the most important attributes of each sport fishery (Table 8). The adipose clip rate during the last sampling period (2013-2017) ranged from 4.0% in Wrangell to 19.4% in Elfin Cove. In two of the area's fisheries, Haines and Skagway, the CWTs have been exclusively of Alaska origin. In four of the area's fisheries, Juneau, Ketchikan, Petersburg and Wrangell, the CWTs are primarily of Alaska origin. In four of the area's fisheries, Craig, Elfin Cove, Sitka and Yakutat, the CWTs are primarily of other origin while one fishery, Gustavus, can best be described as mixed.

Table 8. Attributes of Sport Fish Sampling Programs by Area.

Area	Last period Sampled	Adipose Clip Rate	Relative Stock Comp
Craig	2013-2017	12.6%	Primarily Other
Elfin Cove	2013-2017	19.4%	Primarily Other
Gustavus	2013-2017	14.7%	Mixed
Haines	2013-2017	Up to 10%	Exclusively Alaska
Juneau	2013-2017	8.9%	Primarily Alaska
Ketchikan	2013-2017	9.5%	Primarily Alaska
Petersburg	2013-2017	8.2%	Primarily Alaska
Sitka	2013-2017	16.6%	Primarily Other
Wrangell	2013-2017	4.0%	Primarily Alaska
Skagway	2013-2017	16.7%	Exclusively Alaska
Yakutat	2013-2017	11.1%	Primarily Other

Source: Author calculations based on ADF&G Tag Lab data.
Note: An all hatchery scenario (where all hatchery Chinook salmon are clipped) is not considered due to low sample sizes and the inability to expand the data.

The adipose clip rates are lower than that of the troll fishery, particularly those in the inner waters. Due to low clip rates encountered, a Sport MSF fishery would result in relatively high number of incidental mortalities due to the large number of fish that would be released.

Discussion

Sport fisheries in Southeast Alaska operate very differently than the commercial fisheries. Commercial fisheries need to harvest fish in order to create profit while simply providing opportunity can generate income for charter operations. In addition, while participation in the troll fishery is limited, participation in the sport fishery is not. Indeed, both the number of anglers and number of sportfish angler days has, on average, increased over the long term (See Appendix 3).

As with the troll spring fisheries, the sport fisheries in some areas can affect some wild stocks – particularly in Haines, Juneau, Petersburg, Wrangell and Ketchikan. During the recent low returns of wild stocks, fishing in many of these areas was restricted. Restrictions in the other fisheries were primarily limited to bag limits and seasonal limits for non-residents.

Any management by MSF would increase incidental mortality. However, if all Alaska hatchery Chinook salmon were to be marked, MSF could provide opportunities for the sport fisheries that have been limited during periods of low wild Chinook salmon abundance. Although there would still be some incidental mortality of wild stocks, it would be lower than the 100% mortality of landed catch of wild fish during a non-MSF.

Conclusions

Spring MSF

- Implementation of MSF in the spring fishery would result in large reductions of harvest, particularly at current adipose clip rates. The reductions would still be large even if all Alaska hatchery Chinook salmon production was adipose clipped.
- If a MSF was implemented in the Spring along with an extended season, the lower catch rate may not justify the expense and effort of fishing.
- Implementation of MSF in the spring fishery would result in an increase of incidental mortality through release of unclipped Chinook salmon.
- It appears that the survival of Alaska hatchery and Southeast Alaska wild Chinook salmon vary together. In years of low abundance, the harvest of adipose clipped fish alone may be too low to support a viable spring troll fishery.
- In years with extremely low Chinook salmon abundance, a spring MSF could provide some harvest with greatly reduced impact on wild stocks – an argument outlined in January 2, 2019 ADF&G memo to the Alaska Trollers Association. Even if use of MSF was limited to this situation, the frequency of years with a conservation concern may not justify the cost of mass marking over the long run.

Summer CNR MSF

- A MSF in the summer CNR fishery based on current troller behavior (clipped Chinook encountered are kept rather than released) would result in relatively small harvests. It would also reduce the overall incidental mortality.
- A MSF fishery harvesting 7.5% of the troll quota (to make up for cuts) would require many more encounters than were estimated during 1985 through 2017. To achieve the increase, trollers would have to modify their behavior and target Chinook salmon.
- Recovering a 7.5% quota cut via a summer CNR MSF fishery would result in the guideline incidental mortality rate of 59,400 being met in some years.
- Implementation of a MSF that results in a change in behavior and an increase in the number of encounters may require a new study to update the encounter rate.

Sport MSF

- The adipose clip encounter rates in the sport fishery are lower than those in the troll fishery.

- Introduction of a sport MSF could lead to substantially increased effort as there is currently no limit on this sector. Increased effort would result in a corresponding large increase in incidental mortality.

Overall

- The current PST agreement does not allow for harvest from a MSF to be in addition to the quota. If there is no increase in the quota, MM will increase the costs for hatchery operators without providing any increase for the commercial fisheries.
- Increasing the number of CWT would reduce the risk factor and could increase the Alaska hatchery add-on – though the total potential gain is minimal for the effort and cost (see Appendix 4 for more information).
- It is unclear that implementing a MM/MSF fishery would benefit conservation of Alaska stocks.
- The guideline incidental mortality rate includes sublegal fish. Consideration should be given to a guideline that used only legal sized fish.
- If MM and MSF are implemented, ADF&G may be required to implement Double Indexing to account for variable mortality rates on clipped and unclipped fish.
- The impact of MM/MSF on the viability of the CWT database should be considered, as their compatibility has been called into question by PSC-SFEC.

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Appendix 1. Pacific Salmon Treaty Agreement Text

The most recent agreement of the Pacific Salmon Commission (Commission), provisionally applied January 1, 2019, states in Chapter 3 (Chinook Salmon) 1(d)(iv):

the continued modification of fisheries to maintain or increase the overall harvest rates exerted on hatchery-origin Chinook, where desirable, while simultaneously decreasing or maintaining limit on the overall mortality rates on natural-origin Chinook;

With this provision, any party to the Pacific Salmon Treaty implement Mark Select Fisheries (MSF) subject to 4(g):

(i) MSFs for Chinook shall be conducted in a manner that selectively reduces fishery impacts on natural spawning salmon relative to hatchery-origin salmon,

(ii) annual post-season reports generated by each Party shall contain a summary of the MSFs implemented in that season,

(iii) MSFs implemented by either Party that affect stocks subject to this Treaty shall be sampled, monitored, and reported in accordance with the applicable protocols reviewed by the SFEC and adopted by the Commission; including estimates of catches and releases of mass-marked and unmarked Chinook for sublegal and legal-size categories,

(iv) SFEC shall report on MSF, assist with developing analytical procedures, and recommend to the Commission approaches that could improve the estimation of impacts on natural Chinook stocks, and

(v) subject to the availability of funds, the U.S. shall establish a Mark Selective Fishery Fund (Fund). The Fund shall be administered by the Commission to assist fishery management agencies with equipment and operations, as needed, to mass-mark hatchery produced Chinook salmon, to estimate incidental mortality, and to maintain and improve the ability to estimate exploitation rates on Chinook salmon indicator stocks that are encountered in MSF, including improvements and development of bilateral analytical tools. The Commission shall adopt procedures to solicit proposals from U.S. and Canadian management entities for the use of the Fund, be advised on the merits of proposals by specialists as it determines appropriate, and make funding decisions.

Appendix 2. Mass Marking Costs

A variety of costs would be incurred under a MM/MSF Chinook salmon fishery, most notably increased marking costs borne by the region's hatcheries. Hatchery managers interviewed for this analysis provided a variety of information related to hatchery operations and operating and capital costs associated with 100% adipose clipping of hatchery Chinook salmon.

NSRAA

NSRAA currently rears Chinook salmon at the Medvejie and Hidden Falls hatcheries, with releases of roughly 3.5 million and 600,000 in 2017, respectively. A key logistical hurdle presented by mass marking is freshwater holding space limitations. Current capacities are designed for a marking process that takes a shorter period of time compared to 100% marking, even with the use of a mass marking trailer.

Medvejie is clearly the most important hatchery for NSRAA with regard to Chinook salmon production. If marking increased to 100% at Medvejie and the status quo was maintained at Hidden Falls, the organization would achieve a mark rate of close to 90 percent.

Both NSRAA hatcheries are tight on space and the addition of a mass marking trailer would complicate other site logistics as well, including storage, parking, and snow removal. These complications can be overcome given adequate funding, according to the organization.

As shown in the table below, NSRAA estimates capital costs associated with marking 100% of Chinook salmon production to be roughly $3.6 million. This equates to roughly $150,000 in annual amortization costs over the estimated 20-year life of the equipment, according to NSRAA calculations. It is possible that an Auto Fish trailer would be used only at Medvieje hatchery; in this scenario capital costs would decrease to roughly $1.8 million (or $75,000 in annual amortization costs).

Annual operational cost increases will be modest as the existing tagging crews would shift their focus and only one additional staff member would be required.

Table 9. Estimated Mass Marking Costs, NSRAA

Costs:	Unit	Number of Units	Total
Capital Costs			
Auto Fish trailer	$1,345,000	2	$2,690,000
Auto Fish upgrades	$200,000	2	$400,000
Tunnel Detector	$90,000	2	$180,000
T-Wands	$3,900	3	$10,000
3-year warranty	$100,000	2	$200,000
Transportation	$7,500	2	$15,000
Infrastructure	$15,000	2	$30,000
Fish pump	$30,000	4	$120,000
Total Capital Costs			$3,645,000
Operating costs (annual)			
Annual Personnel	$100,000	1	$100,000
DIT & Evaluation	$35,000	1	$35,000
Annual Maintenance	$10,000	2	$20,000
Total Operating Costs			$155,000

Source: NSRAA.

Due to low ocean survival rates, recent year classes of NSRAA Chinook salmon (at both Hidden Falls and Medvieje) have cost the association more to produce than the value recovered through harvests (including both common property and cost recovery harvests). Adding Chinook salmon production costs, without additional funding support, will require further subsidies derived primarily from chum production.

SSRAA

SSRAA current produces around 3 million Chinook salmon annually at four hatcheries (Neets Bay, Chrystal Lake, Deer Mountain, and Whitman Lake), which are then transported to eight release sites. In 2017, 10% of Chinook salmon released were marked (along with around 428,000 coho) by a 5-person crew over a 74-day period with a total cost of $67,606. Increasing Chinook salmon marking rates to 100% is estimated to increase annual costs by $342,000 to $410,000. These costs – which consider a mark and tag rate both at 100% – are itemized in the table below. It should be noted that SSRAA experimented with increasing mark rates to 20% in 2018 but ran into logistical issues and staffing conflicts (especially for supervisory staff) resulting from a lengthened marking season. In 2019, the organization returned to a 10% tagging rate.

Table 10. Estimated Mass Marking Operating Costs, SSRAA

	Cost
Operating costs (annual)	
Aqui-S	$750
Price of Tags (1M discount)	$316,480
Transportation (Autofish Trailer)	$2,300
Transportation (People and Vehicles)	$5,250
Wages	$60,745
Living Costs	$5,750
Lodging	$5,600
Autofish and related maintenance	$10,000
Total Operating Costs	$410,000

Source: SSRAA.
Notes: Includes costs for marking both Chinook and coho.

Capital cost estimates at SSRAA are similar on a per trailer basis to those estimated by NSRAA. SSRAA estimates roughly $1.4 million in initial expenses for the purchase of one autofish trailer. Annual amortization costs of around $73,000 are estimated based of a 20-year life of the equipment and including other anticipated future expenses. The trailer would be used at hatcheries on the road system (Chrystal Lake, Deer Mountain, and Whitman Lake), while the remote Neets Bay hatchery would likely continue to mark via manual methods.

DIPAC

DIPAC released nearly one million Chinook salmon in 2019 at five release sites near the Juneau road system. All of these Chinook salmon were produced at the Macaulay Salmon Hatchery in Juneau, with a mark rate of 20% (adipose fine clipping and CWT). DIPAC's Chinook salmon clip/tag rate was increased from 10% in 2017 to 20% starting in 2018. Seasonal staff were kept on for an additional 7-10 days to achieve this higher mark rate.

According to DIPAC staff interviewed, a further increase to 100% adipose fin clipping (holding CWT rate steady at 20%) – if required – would be require use of a mass marking trailer. DIPAC staff interviewed expressed a preference to borrow a trailer from NSRAA or SSRAA for the 11-20 days required to mark all Chinook salmon (with 2 staff required during this time).

Appendix 3. Additional Sportfish Data

Table 11. CWT sampling location, years sampled, catch, number of fish sampled, adipose clip rate and the number of Alaska and other CWTs.

Area	Period	# of Biweeks Sampled	Catch	Sampled	Ad Clip Rate	Alaska CWTs	Other CWTs
Craig	1992	5	1,155	288	2.1%	1	5
	1993-1997	9.6	1,294	1,130	3.7%	5	32
	1998-2002	9.8	3,945	1,390	4.0%	11	42
	2003-2007	10	5,603	1,785	3.1%	7	40
	2008-2012	9.2	1,522	1,514	9.5%	10	59
	2013-2017	8.8	3,441	3,419	12.6%	16	138
Elfin Cove	1998-2002	3.5	54	48	6.1%	2	2
	2003-2007	9	1752	675	5.8%	7	26
	2008-2012	8.4	339	325	14.7%	6	15
	2013-2017	8.6	1084	506	19.4%	3	28
Gustavus	1998-2002	8	499	172	5.8%	6	2
	2003-2007	10	353	249	6.1%	7	4
	2008-2012	9.4	254	240	12.3%	2	6
	2013-2017	8.6	512	367	14.7%	2	15
Haines	1985-1987	6	1,144	125	0.5%		
	1988-1992	4	217	48	2.6%		
	1993-1997	4	261	94	10.7%	11	
	1998-2002	4	194	97	4.0%	2	
	2003-2007	5.2	292	139	8.4%	5	
	2008-2012	4.4	136	72	10.1%	1	
	2013-2017	2.5					
Juneau	1985-1987	12.3	6,034	764	6.5%	99	9
	1988-1992	11.4	6,793	1,045	8.8%	113	12
	1993-1997	11.2	6,825	926	8.1%	108	4
	1998-2002	12.6	4,611	1,072	9.4%	112	3
	2003-2007	11.4	4,595	849	8.8%	97	3
	2008-2012	10.2	2,140	522	6.8%	27	3
	2013-2017	10.0	1,824	490	8.9%	29	3
Ketchikan	1985-1987	9.7	3,598	690	22.4%	125	16
	1988-1992	11.0	6,237	645	9.0%	86	19
	1993-1997	11.0	2,885	362	8.6%	45	8
	1998-2002	10.8	3,816	799	9.7%	88	14
	2003-2007	11.2	6,163	1,310	6.7%	110	24
	2008-2012	10.2	2,823	714	7.6%	37	8
	2013-2017	10.0	2,349	1,011	9.5%	28	28
Petersburg	1985-1987	7.7	1,079	188	11.7%	21	6
	1988-1992	6.3	1,277	192	6.9%	30	3
	1993-1997	5.4	556	116	6.3%	23	3
	1998-2002	6.4	239	112	6.3%	20	2
	2003-2007	10.0	345	78	5.4%	21	4
	2008-2012	9.2	97	86	5.8%	9	1
	2013-2017	9.0	157	76	8.2%	3	2
Sitka	1985-1987	8.0	1,227	65	3.9%	4	10
	1988-1992	7.7	4,349	570	4.5%	22	38
	1993-1997	11.0	13,087	1,356	5.2%	55	66
	1998-2002	11.0	17,433	4,996	4.5%	71	183
	2003-2007	11.2	22,681	7,091	4.2%	79	210
	2008-2012	10.2	12,984	4,336	10.8%	33	165
	2013-2017	10.0	19,319	5,042	16.6%	30	233
Wrangell	1985-1987	7.3	1,479	180	1.5%	8	2
	1988-1992	4.8	1,582	329	1.5%	4	2
	1993-1997	5.2	953	348	2.5%	6	1
	1998-2002	6.0	798	225	1.6%	3	2

	2003-2007	10.0	1,311	416	2.3%	8	2
	2008-2012	9.2	192	189	2.2%	2	2
	2013-2017	9.0	467	186	4.0%	6	2
Skagway	1997	3	19	19	89.5%	14	
	1998-2002	5.0	44	44	21.3%	6	
	2003-2007	7.8	86	86	25.7%	21	
	2008-2012	4.3	10	10	5.9%	3	
	2013-2017	6.0	9	9	16.7%	3	
Yakutat	1998-2002	12.0	214	214	05.1%	3	11
	2003-2007	6.3	115	108	4.3%	2	4
	2008-2012	9.2	231	198	10.9%	1	9
	2013-2017	8.6	257	181	11.1%	3	6

Source: ADF&G Tag Lab.

Table 12. Estimated number of anglers by area, Southeast Alaska, 1996-2017

Year	Ketchikan	POW Island	Kake, PSG, Wrangell	Sitka	Juneau	Skagway	Haines	Glacier Bay/Cross Sound	Yakutat	Total
1996	24,000	14,292	9,371	21,360	28,160	2,362	5,472	8,065	5,403	105,847
1997	23,914	12,871	9,575	23,080	29,708	2,791	5,278	10,412	6,613	110,395
1998	22,441	12,667	8,632	27,130	26,487	3,073	3,903	8,287	6,118	106,625
1999	26,647	15,397	9,536	24,870	28,405	2,725	4,561	9,023	6,901	115,763
2000	26,808	15,251	8,867	22,591	27,252	3,320	4,961	8,391	5,591	111,255
2001	26,155	14,201	8,328	25,057	27,971	3,886	5,801	8,630	4,630	113,922
2002	29,924	15,782	7,813	22,288	24,252	2,895	6,545	7,738	3,798	108,743
2003	27,218	15,361	7,794	24,002	26,375	3,200	6,079	8,203	6,790	114,337
2004	34,193	15,710	10,258	25,734	29,452	2,467	7,362	10,008	6,614	129,796
2005	34,511	17,804	8,843	25,931	29,380	2,095	6,490	11,128	7,374	132,390
2006	31,141	16,257	9,423	27,582	26,393	2,160	5,848	11,366	7,303	128,460
2007	32,086	17,679	9,173	28,611	25,956	2,588	5,067	14,107	7,979	133,563
2008	30,304	17,694	9,761	28,483	24,497	2,027	4,942	13,060	7,171	129,308
2009	30,692	14,071	9,597	21,216	25,967	2,492	5,145	11,432	5,527	115,914
2010	24,627	14,825	9,055	22,013	21,583	1,832	4,595	9,392	7,120	107,053
2011	23,328	14,852	7,165	20,583	24,804	1,980	5,437	8,121	7,182	106,057
2012	25,112	15,725	10,065	21,350	22,927	2,029	5,809	8,978	6,155	109,571
2013	28,051	15,610	11,577	22,244	23,918	2,134	5,557	11,513	6,021	115,578
2014	29,554	16,874	9,610	24,122	25,197	2,089	4,400	11,094	7,378	121,438
2015	31,380	19,174	13,659	23,765	28,773	1,731	5,077	13,362	6,517	132,866
2016	29,357	17,827	12,471	25,647	22,706	1,694	4,439	10,280	6,870	122,098
2017	27,327	17,260	11,655	26,917	25,291	1,753	5,972	12,144	7,174	126,288

Source: Statewide Harvest Survey, ADF&G.

Table 13. Estimated number of days of sportfish angler days by area, Southeast Alaska, 1996-2017

Year	Ketchikan	POW Island	Kake, PSG, Wrangell	Sitka	Juneau	Skagway	Haines	Glacier Bay/Cross Sound	Yakutat	Total
1996	71,526	44,795	32,831	56,933	96,907	5,804	19,336	22,371	19,903	370,406
1997	68,287	52,564	38,040	73,186	109,790	9,641	20,019	38,671	29,943	440,141
1998	55,903	48,599	32,637	68,644	97,151	6,754	12,643	22,962	25,114	370,407
1999	88,496	75,857	51,185	90,362	130,375	6,745	20,508	37,702	33,387	534,617
2000	95,943	68,728	53,300	90,891	128,481	10,528	21,910	41,375	30,209	541,365

2001	80,918	65,559	41,699	92,390	124,846	7,644	28,556	42,466	23,163	507,241
2002	91,018	68,264	45,236	67,750	108,680	5,765	31,885	31,679	19,019	469,296
2003	76,050	75,820	36,442	69,843	116,070	6,051	27,598	34,224	35,094	477,192
2004	103,533	73,060	47,719	81,631	125,803	7,049	35,469	39,750	33,235	547,249
2005	97,521	82,095	39,847	88,490	135,712	7,074	29,309	49,813	37,923	567,784
2006	79,440	74,270	49,520	89,297	104,906	4,615	28,720	42,434	43,634	516,836
2007	85,045	80,196	46,766	92,370	113,237	4,460	20,228	52,605	45,366	540,273
2008	88,425	83,134	49,272	86,340	104,459	3,370	20,106	40,151	34,348	509,605
2009	113,959	63,035	54,271	60,458	117,684	5,938	16,739	41,157	26,832	500,073
2010	73,372	66,440	47,022	66,152	100,133	4,955	19,187	32,015	34,565	443,841
2011	70,926	80,694	37,699	63,191	92,562	5,732	25,720	32,573	38,510	447,607
2012	68,696	86,255	49,851	75,131	98,217	5,605	24,753	39,094	31,405	479,007
2013	107,493	81,418	59,976	82,756	110,444	5,963	22,005	45,796	30,199	546,050
2014	103,591	89,175	54,430	90,545	114,255	3,800	24,343	42,388	41,783	564,310
2015	95,979	101,951	71,658	77,725	133,071	3,260	25,996	47,582	37,268	594,490
2016	83,969	88,159	60,235	86,307	93,087	7,237	16,372	36,851	46,489	518,706
2017	86,810	92,390	59,359	93,426	112,221	5,729	21,423	47,082	39,655	558,095

Source: Statewide Harvest Survey, ADF&G.

Appendix 4. Risk Adjustment Factor

The following table (provided by ADF&G) predicts the size of the risk adjustment factor – Alaska hatchery fish that must be included as part of the SEAK treaty catch – at different levels of tagging and sampling. Troll fisheries are generally sampled at around 40%, while sport and net fisheries are generally sampled at around 20%.

If Alaska hatcheries moved to 100% marking of Chinook releases – from the currently predominant 10% rate – the risk adjustment factor would decrease by roughly 800 to 1,200 Chinook.

Risk Adjustment Factor for the SEAK All-Gear Pre-terminal Harvest as the Percent of Catch Sampled and Percent Tagged Change.

Catch Known & Fraction Tagged Known.

% Catch Sampled	As % Tagged Increases											
	1%	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
1%	23525	10519	7436	5255	4289	3712	3319	3028	2802	2620	2469	2341
5%	10519	4699	3319	2341	1906	1647	1469	1338	1235	1153	1084	1025
10%	7436	3319	2341	1647	1338	1153	1025	931	858	798	748	706
15%	6070	2706	1906	1338	1084	931	826	748	687	637	596	560
20%	5255	2341	1647	1153	931	798	706	637	583	539	502	471
25%	4699	2091	1469	1025	826	706	622	560	511	471	437	407
30%	4289	1906	1338	931	748	637	560	502	456	419	387	359
35%	3970	1763	1235	858	687	583	511	456	413	377	347	321
40%	3712	1647	1153	798	637	539	471	419	377	343	314	288
45%	3499	1551	1084	748	596	502	437	387	347	314	285	260
50%	3319	1469	1025	706	560	471	407	359	321	288	260	235
55%	3164	1399	975	669	529	443	382	335	297	265	238	213
60%	3028	1338	931	637	502	419	359	314	276	245	217	192
65%	2909	1284	892	609	478	397	339	294	257	226	198	173
70%	2802	1235	858	583	456	377	321	276	240	209	180	154
75%	2706	1192	826	560	437	359	304	260	224	192	163	136
80%	2620	1153	798	539	419	343	288	245	209	176	147	118
85%	2541	1117	772	520	402	328	274	231	194	161	130	99
90%	2469	1084	748	502	387	314	260	217	180	147	114	78
100%	2341	1025	706	471	359	288	235	192	154	118	78	0

Source: John Carlile, ADF&G.