

**Stock Composition of Chum Salmon
Intercepted in Canadian Area 3
Commercial Fisheries
Results of Analysis of Otoliths in 2018**

Katie Beach, Stock Assessment Biologist

Fisheries & Oceans Canada
Science Branch, Pacific Region

417-2nd Avenue West
Prince Rupert, British Columbia
V8J-1G8

April 2019

This project has been funded by the Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund from X-2017.

CONTENTS

List of Tables iii
List of Figures iii
Abstract iv
Introduction..... 1
Methods..... 1
Results..... 2
Discussion 4
Acknowledgements..... 4
References 6
Tables 7
Figure 1. Location of Area 3 in northern British Columbia. 12

LIST OF TABLES

Table 1: Chum otolith sampling results by fishing week and gear in 2018..... 7
Table 2: Percentage of marked chum by fishing week 2012-2018 (all areas, both gear types). 7
Table 3: Percentage of marked chum by sub-Area 2012-2018..... 7
Table 4: Percentage of marked chum by sub-Area and fishing week 2012-2018. 7
Table 5: Percentage of marked chum catch per gear type 2012-2018..... 10
Table 6: Origin of chum by fishing week in 2018 10

LIST OF FIGURES

Figure 1. Location of Area 3 in northern British Columbia. 12

ABSTRACT

Beach, K. 2019. Stock Composition of Chum Salmon Intercepted in Canadian Area 3 Commercial Fisheries: Results of Analysis of Otoliths in 2018. Unpublished report for the Pacific Salmon Commission Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund 2016. File NF-2016-I-8A.

Otoliths were collected from Chum salmon (*Oncorhynchus keta*) caught in Canadian Area 3 commercial fisheries in 2018 to identify the component of hatchery stocks with thermal marks. A total of 916 chum otoliths were sampled in Area 3 between the dates of June 26th and July 31st, 2017 and 891 were readable. Two of 4 open sub areas of Area 3 (3B, 3C) were sampled during 4 gillnet and 5 seine commercial fishing openings.

Of the specimens sampled, 66.1% were marked, 34% were not marked, and 3% could not be read. Of those marked, 99.7% were released in southern southeast Alaska, with 85.6% released specifically in Nakat Inlet, Alaska.

INTRODUCTION

Funding for this project was provided by the Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund (Northern Fund) to estimate hatchery contributions to Chum salmon (*Oncorhynchus keta*) fisheries in Area 3. The project sampled otoliths from chum salmon caught in Canadian commercial seine and gillnet fisheries in Area 3, seeking to determine the proportions of Alaskan hatchery chum caught weekly in commercial fisheries in up to four subareas of Area 3 by examining otoliths for the presence or absence of hatchery thermal markings. The goal of this project was to use hatchery proportion data to identify chum retention opportunities for the Area 3 commercial fishing fleet while minimizing impacts on weak wild chum stocks. 2018 marked the 7th year of analysis of otolith marks.

Current sockeye and pink salmon directed commercial fisheries in Area 3 are limited by concerns for bycatch of chum stocks originating from Area 3 and 4. Time and area closures and non-retention of chum salmon are used to limit commercial fishing impacts on chum stocks of concern, but greater information about stock composition of chum by-catch can reduce those limitations. The program was initially requested by DFO fish management in response to direct requests for this information from commercial fishermen. Advice and consultation occurred between Canadian and US technical representatives including a visit to the US otolith lab in 2012 to observe the methods, and to meet and discuss the project with local staff. The project and the potential uses of the data will be of great interest to the commercial and Environmental Non-Government Organizations (ENGO's) with a vested interest in rebuilding Area 3 and 4 chum stocks while supporting harvest opportunities.

Because of limited fishing in recent years, DFO sought to provide up to 2100 samples to the Alaska Department of Fish and Game (ADF&G) Mark, Tag and Age (MTA) Laboratory in Juneau, Alaska. This was to include up to 100 chum salmon samples from up to four fishing locations per gear type per week during Area 3 commercial fisheries. However, limited fish abundance, less fishing opportunities, fewer participating vessels and weather patterns were factors which determined the number of samples actually collected.

The project continued to use ADF&G otolith labs to determine the presence or absence of thermal marks and the location of origin. This was to ensure accurate results, and to be cost efficient. Data were analyzed and reported by DFO North Coast Stock Assessment.

METHODS

The sample collection approach was to coordinate the chum sampling effort with the existing sockeye stock id sampling program. This program involved on-water sampling crews approaching seine and gillnet fishers in two 5.4 meter rigid-hauled inflatable boats (RHIBs) and requesting to board. During fisheries where chum salmon retention was allowed, chum were tagged using separate colored zap straps depending on the sub Area as they were landed on the fishing vessels and picked up the heads from processing plants. During fisheries where chum salmon retention was prohibited, samplers would be present while incidental chum were brought

on board and the fish was recovered before they were released. Because of difficulties removing otoliths on the water, fish were sampled in Prince Rupert. Otolith removal was done by cutting the head with a knife from the back of the head to just behind the eye (Shaw, 1998, p. 79). Otoliths were then removed with forceps, cleaned and placed in numbered trays for shipment to Alaska. In Alaska the otoliths were checked for thermal marks and the results documented. Data collected was entered into an excel spreadsheet (Table 1 and Table 2)

Thermal marking of salmonid otoliths is an effective tool for identifying hatchery salmon (Munk and Smoker 1991; Volk et al. 1990), because thermal mark identification is quick and fairly accurate (Hagen et al. 1995). Salmonid otoliths are thermal marked by exposing them to repeated temperature cycles that create patterns of optically-dense bands (Volk et al. 1990).

The chum salmon otoliths were prepared for thermal mark examination in the ADF&G Thermal Mark Lab. The otoliths were cleaned with a chlorine solution (5%), rinsed with a de-chlorine solution (0.7% thiosulfate), and then mounted on 1- by 2-inch glass slides with thermoplastic cement. Otoliths were examined for thermal mark presence by grinding the otolith on a grinder using 800 grit grinding paper until the primordia were visible under 200x magnification on a compound microscope. Fine polishing was performed by hand using 9 µm grinding paper. Readers identified specimens as marked, unmarked, or unreadable. If a specimen was marked, readers described the mark with special codes known as hatch codes. For quality control, each specimen was independently read a second time, and any conflicts between the two reads were resolved

RESULTS

Standards that are fundamental to the success of this program were indicated in the proposal as;

- 1) To meet the sampling objectives of the project design (2100 max).
 - 916 chum otoliths were sampled in Area 3 between the dates of June 26th and July 20th, 2018. Two of four sub areas of Area 3 (3B, 3C) were sampled during 4 gillnet and 5 seine commercial fishing openings. Sampling was constrained by a number of factors, including:
 - Less openings during times when chum were present (earliest gillnet openings targeting sockeye do not encounter enough chum to warrant sampling).
 - Less fishing effort due to low sockeye returns.
 - Less chum encountered while fishing.
- 2) To provide all chum biological sampling information collected.
 - Findings from 7 years of chum otolith analysis is available in Table 1-6
 - Table 1: Chum otolith analysis results by fishing week and gear in 2018.
 - There was a sharp drop in marked chum caught in Area 3 commercial fisheries in the third week of July (Alaskan week 29, Canadian week 93).
 - Table 2: Percentage of marked chum catch by fishing week 2012-2018 (all areas, both gear types).

- By the third week of July, there is a drop in the percentage of marked chum caught in Area 3 commercial fisheries and a very noticeable drop in the percentage of marked chum caught in August. More consistent sampling across all years would be helpful to see patterns but fisheries management has curbed fisheries during August to protect weak Area 3 and Area 4 stocks.
 - Note that percentages of marked chum catch may differ slightly from percentages of marked chum sampled as it is based on catch and retention patterns in fisheries.
 - Table 3: Percentage of marked chum by sub-Area 2012-2018.
 - Outside fisheries (3B) encounter a lower percentage of unmarked chum, meaning that they have less chance of impacting weak Area 3 and Area 4 chum stocks.
 - Table 4: Percentage of marked chum by sub-Area and fishing week 2012-2018.
 - The breakdown by sub-Area and fishing week helps to see that the fisheries that occur in August and moving up towards the Nass River have the most encounters with unmarked chum salmon.
 - Table 5: Percentage of marked chum catch per gear type 2012-2018.
 - Gear does not appear to influence the impact on unmarked chum as much as time and area.
 - Table 6: Origin of chum by fishing week in 2018.
 - Most of the marked chum originate from hatcheries in Southern Southeast Alaska.
- 3) To prepare otoliths for lab analysis.
 - 916 chum were sampled with 25 otoliths not being readable by the ADF&G otolith lab.
 - 4) To obtain sample specific hatchery thermal marking information.
 - Throughout the sampling in 2018, 66% of otoliths showed thermal marking while 32% did not and 3% were unreadable.
 - 5) To analyze and report spatial-temporal Area 3 chum mark rates and biological characteristics.
 - The specific area and stat week collection of samples was carried out as available. Data was recorded in Table 1 in this report and Table 2 as an electronic attachment.

DISCUSSION

This project aligns with the mandate of the Northern fund, “to assist stocks and fisheries covered under the Pacific salmon Treaty” and contribute to all of the Northern fund committee objectives outlined in Chapter 2 part 5 of the Pacific salmon Treaty:

- A) Evaluate the effectiveness of management actions;
- B) Identify and review the status of pink, chum, sockeye and coho stocks;
- C) Present the most current information on harvest rates and patterns on these stocks and develop a joint data base for assessments;
- D) Collate available information on the productivity of stocks in order to identify escapements which produce maximum sustainable harvests and allowable harvest rates;
- E) Present historical catch data, associated fishing regimes and information on stock composition in fisheries harvesting this stock;
- F) Devise analytical methods for the development of alternative regulatory and production strategies;
- G) Identify information and research needs, including future monitoring programs for stock assessments; and
- H) For each season make stock and fishery assessments and recommend to the Northern Panel conservation measures consistent with the principals of the Treaty

The intent of the program is to better understand the temporal and geographical patterns of wild chum abundance in Area 3 commercial fisheries in order to ensure that management actions in place to protect weak Area 3 and Area 4 fisheries are successful.

With the information obtained through this projects, managers have been advised that earlier fisheries, further away from the Nass River, encounter less unmarked chum (see Table 2-5). This is intuitive information due to migration patterns of Area 3 and 4 chum salmon, but the percentages of marked chum salmon encountered in these fisheries were surprising. Further analysis into the origin of the unmarked fish requires DNA SNP analysis to identify the origin populations, which will be the focus of continuing this research with Northern Funding in 2019. The Northern Boundary Run Reconstruction Model feeds an Area 3-5 Chum Model that assumes that very few of the chum encountered in the Area 3 fisheries are destined for Area 3 or Area 4. These assumptions are based on tagging studies in the 1980s (before expansions of Alaskan hatchery programs) and assumptions of similar migration patterns to sockeye and pink salmon. If these assumptions are true, the impact of Area 3 fisheries on chum destined for Area 3 or 4 is very minimal under the current management regime. However, if that assumption is not correct and more of the unmarked fish in Area 3 fisheries are destined to spawn in Area 3 or 4, more management actions may be required in years of lower abundance of returning chum salmon. Further research is required to more fully understand the impacts of Area 3 fisheries on Canadian chum stocks of concern.

ACKNOWLEDGEMENTS

This project was possible thanks to the in-kind work of the DFO Stock Assessment Division sampling crew and the ADF&G thermal mark lab for the timely shipping of sampling equipment

and for otolith reading and interpretation. We also want to thank Canada's gillnet and seine fishing fleets in Area 3 for their cooperation and understanding during sampling.

REFERENCES

- Hagen, P., K. Munk, B. W. Van Alen, and B. White. 1995. Thermal mark technology for inseason fisheries management: a case study. *Alaska Fishery Research Bulletin* 2(2):143-155.
- Munk, K., and W. W. Smoker 1991. Temperature-induced mass-marking of pink salmon otoliths. Production trial at Gastineau Channel. University of Alaska Fairbanks, Juneau, Alaska
- Pacific Salmon Commission. 2000. Pacific Salmon Treaty, 1999 Revised Annexes, Memorandum of Understanding (1985), Exchanges of Notes.
- W. Shaw. 1994. Biological Sampling Manual for Salmonids- A Standardized Approach for the Pacific Region 1998. Can. Tech Rep of Fish and Aquatic Science No. 1998. 167 p
- Volk, E. C., S. L. Schroder, and K. L. Fresh. 1990. Inducement of unique otolith banding patterns as a practical means to mass-mark juvenile Pacific salmon. *American Fisheries Society Symposium* 7:203-215.

TABLES

Table 1: Chum otolith sampling results by fishing week and gear in 2018.

Stat Week (CDN/AK)	Gear	Area	# of samples	Unread	Marked	Unmarked	% Marked	% Unmarked
64/26	GN	3B	26	0	23	3	88%	12%
71/27	SN/GN	3B	131	2	102	27	78%	21%
72/28	SN	3B/C	406	6	299	101	74%	25%
73/29	SN	3B/C	405	18	211	176	52%	43%
All	GN/SN	All	970	28	805	137	73%	25%

Table 2: Percentage of marked chum by fishing week 2012-2018 (all areas, both gear types).

Year	Fishing week (CDN/AK)							
	64/26	71/27	72/28	73/29	74/30	75/31	81/32	82/33
2012	87%	89%	85%	94%	77%	46%	56%	-
2013	-	79%	79%	63%	67%	92%	-	-
2014	71%	83%	84%	81%	72%	81%	28%	-
2015	-	-	87%	83%	-	75%	46%	39%
2016	77%	81%	78%	69%	62%	69%	-	-
2017	100%	82%	87%	78%	80%	79%	-	-
2018	88%	78%	74%	52%				
Average	85%	82%	82%	74%	72%	74%	43%	39%

Table 3: Percentage of marked chum by sub-Area 2012-2018.

Year	Sub-Area		
	3B	3C	3D
2012	80%	71%	
2013	83%	64%	
2014	72%	70%	
2015	82%	68%	
2016	76%	68%	
2017	84%		67%
2018	mixed	mixed	
Average	80%	68%	67%

Table 4: Percentage of marked chum by sub-Area and fishing week 2012-2018.

Year	SubArea	Fishing Week	% Marked	Average per Stat Area
2012	3B	71/27	91%	80
		72/28	88%	
		73/29	94%	
		75/31	43%	

	3C	81/32	84%	71
		64/26	87%	
		71/27	82%	
		72/28	84%	
		73/29	84%	
		74/30	77%	
		75/31	47%	
		81/32	28%	
2013	3B	71/27	89%	83%
		72/28	82%	
		73/29	82%	
		74/30	67%	
		75/31	92%	
	3C	71/27	69%	64%
		72/28	75%	
		73/29	63%	
2014	3B	71/27	83%	72%
		72/28	83%	
		73/29	77%	
		74/30	80%	
		75/31	83%	
		82/33	26%	
	3C	64/26	71%	70%
		71/27	83%	
		72/28	85%	
		73/29	84%	
		74/30	63%	
		75/31	79%	
		82/33	29%	
2015	3B	71/27	87%	82%
		72/28	86%	
		73/29	81%	
		75/31	76%	
	3C	71/27	90%	68%
		72/28	87%	
		73/29	84%	
		75/31	60%	
2016	3B	81/32	46%	76%
		82/33	39%	
		64/26	77%	
		71/27	88%	
		72/28	81%	
		73/29	74%	
74/30	64%			

		75/31	72%	
	3C	64/26	76%	68%
		71/27	73%	
		72/28	71%	
		73/29	63%	
		74/30	59%	
		75/31	66%	
2017	3B	71/27	97%	84%
		72/28	87%	
		73/29	78%	
		74/30	80%	
		75/31	79%	
	3D	71/27	67%	67%
2018	3B	64/26	88%	
	3B	71/27	78%	
	3B/3C*	72/28	71%	
	3B/3C*	73/29	52%	

Table 5: Percentage of marked chum catch per gear type 2012-2018.

Year	Seine	Gillnet	Average
2012	92%	87%	90%
2013	79%	75%	77%
2014	80%	83%	82%
2015	83%	86%	85%
2016	68%	77%	73%
2017	92%	100%	96%
2018	mixed	mixed	mixed
Average	82%	85%	83.5%

Table 6: Origin of chum by fishing week in 2018

Row Labels	Count of MARK_ID
	333
ANITABAY13	1
28	1
ANITABAY14	14
27	3
28	8
29	3
ANITABAY15	3
29	3
ANITABAYLL15	1
29	1
BURNETTINLET15	2
28	1
29	1
DIPAC14	2
28	1
29	1
KENDRICK13	4
28	3
29	1
KENDRICK15	55
27	1
28	14
29	40
NAKATINLET12SUM	1
28	1
NAKATINLET13SUM	61
27	6
28	50

29	5
NAKATINLET14SUM	351
26	23
27	76
28	162
29	90
NAKATINLET15FALL	2
28	2
NAKATINLET15SUM	131
27	14
28	51
29	66
NEETSBAY14SUM	4
27	1
28	3
NEETSBAY15SUM	3
27	1
28	2
Grand Total	968

FIGURE 1. LOCATION OF AREA 3 IN NORTHERN BRITISH COLUMBIA.

