Wandering Pink Salmon: 1999 and 2000 Thermal Mark Recoveries in Southeast Alaska

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Most salmon are believed to return to their natal stream to spawn (Hasler and Scholtz 1983). Although localized movement is known to occur (Habicht et al. 1998), long distance straying has rarely been documented (Quinn et al. 1987, Labelle 1992, Quinn 1993, Sharp et al. 1994). In 1999, pink salmon obtained from the Hawk Inlet fishery in southeast Alaska were examined for thermal-marked otoliths. We expected that most of these pink salmon would be from wild stocks. Based on current hypotheses regarding salmon homing, we expected that any thermal marked otoliths would contain a 5-ring pattern indicating they were released by the Macaulay Salmon Hatchery (formerly DIPAC), Juneau, AK.

From the initial sample, we found evidence that Prince William Sound (PWS) hatchery fish were present. Consequently, additional samples were collected in southeast Alaska, and a study was undertaken to determine if these marks were not PWS marks, but aberrant marks from DIPAC pink salmon or wild pink salmon with a natural pattern that mimicked a PWS mark.

Otoliths were collected in several locations in southeast Alaska in 1999 and in the Haines, Alaska area in 2000 (Fig. 1, Table 1). The first samples were collected during the 1999 test fishery in Hawk Inlet in northern Lynn Canal. Additional samples were collected by Alaska Department of Fish and Game (ADFG) personnel monitoring index streams for escapement counts and ADFG and National Marine Fisheries Service personnel collecting samples from DIPAC hatchery and from Auke Creek weir. Sampling was largely ad-hoc.

ADFG's Mark, Tag and Age Laboratory in Juneau processed the otoliths and examined them for thermal marks (Hagen et al. 1995). Readers made independent determinations on the presence and identification of thermal marks. At least two readings were made of each otolith.

Otoliths were photographed with a video camera attached to a microscope, and the images were measured with imaging software on a personal computer. Because salmon otoliths contain multiple primordia within the core, the location of the thermal mark was defined as the distance from the posterior primordia to the thermal mark along the posterior dorsal quadrant.

Measurements of the thermal marks were compared with measurements from vouchers or known marked samples of DIPAC fry obtained prior to release (n = 8). Measurements from known thermal-marked DIPAC otoliths were obtained from returning adult pink salmon found in the DIPAC

Fig. 1. Map of the study area.

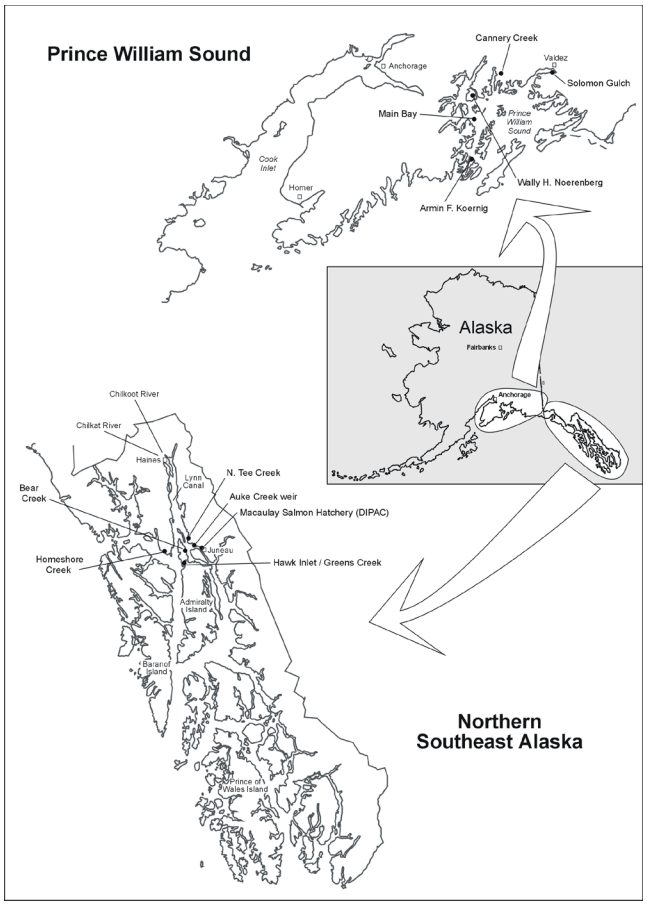

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Table 1. Summary of pink salmon samples collected and examined for otolith thermal marks in southeast Alaska in 1999 and 2000.

Sample	Harvest	Fishery		Marked?			Pattern				
Date	Type	Location	*N*	No	Yes	%	CCH97	DIPAC97	SGH97	WNH97	SGH98
18 Jul 99	Comm	Hawk Inlet	94	91	3	3.2			3		
21 Jul 99	Comm	Hawk Inlet	100	96	4	4.0		3	1		
20 Aug 99	Rack	DIPAC Hatchery	25	0	25	100.0		25			
25 Aug 99	Escape	Auke Creek	190	188	2	1.1	2				
16 Sep 99	Escape	Bear Creek	50	50	0	0.0					
16 Sep 99	Escape	Greens Creek	52	52	0	0.0					
16 Sep 99	Escape	Homeshore Creek	50	49	1	2.0	1				
20 Sep 99	Escape	Chilkat River	45	40	5	11.1	4			1	
20 Sep 99	Escape	Chilkoot River	50	50	0	0.0					
26 Sep 99	Escape	N. Tee Creek	39	39	0	0.0					
24 Jul 00	Escape	Chilkat River	49	49	0	0.0					
24 Jul 00	Escape	Chilkoot River	55	26	29	52.7					29
28 Jul 00	Escape	Hawk Inlet	107	107	0	0.0					

raceway (n = 8). The measurements were not statistically different between the two groups, so the data were pooled. Samples of known Solomon Gulf Hatchery (SGH) salmon were obtained from commercial catches in PWS (n = 12) as well as voucher samples (n = 11). These two collections were not statistically different, so the data were pooled.

The Advanced Instrumentation Laboratory, Department of Geology and Geophysics, University of Alaska Fairbanks, used an electron microprobe to examine the elemental composition of otoliths of known origin and compare them with unknown otoliths. Samples included four otoliths from Chilkat River escapement samples that contained a PWS mark (Cannery Creek Hatchery, CCH97), 25 otoliths from the same sample but identified as wild, and 25 otoliths (CCH97) from PWS commercial fisheries in 1999.

Five points on each otolith, approximately 130–250 microns from the primordia, were randomly selected for analysis. The elements examined included: calcium, potassium, chlorine, phosphorus, sulfur, sodium, magnesium, strontium, and associated oxides. Principal components and discriminant analysis (S-Plus) were used to determine if the elemental concentrations in the otoliths of the unknown pink salmon were similar to that of Chilkat River or PWS salmon.

Of 670 fish sampled in 1999, 15 (2.2%) contained thermal-marked otoliths (Table 1). Three (3; 20%) of the thermal marked otoliths contained the five-ring pattern (DIPAC97) used by Gastineau Hatchery in southeast Alaska. Twelve fish (80%) were marked by a PWS hatchery (SGH, CCH, or Wally H. Noerenberg (WHN)). In 2000, 29 (13.7%) of the sampled otoliths were thermal marked. All of these were marked by SGH (Figs. 2 and 3). These results were quite unexpected. In 1999, 80% of the marked fish were from PWS, and in 2000, 100% of the marked fish were from PWS. These fish were ~950 km from where they should have been.

Fig. 2. One of the pink salmon otoliths found in Chilkoot Lake, Haines, AK, 24 July 2000. Appears to have a 6-ring pattern similar to SGH98.

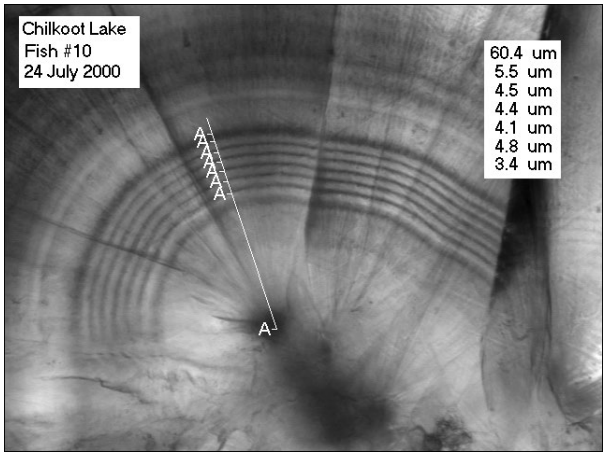
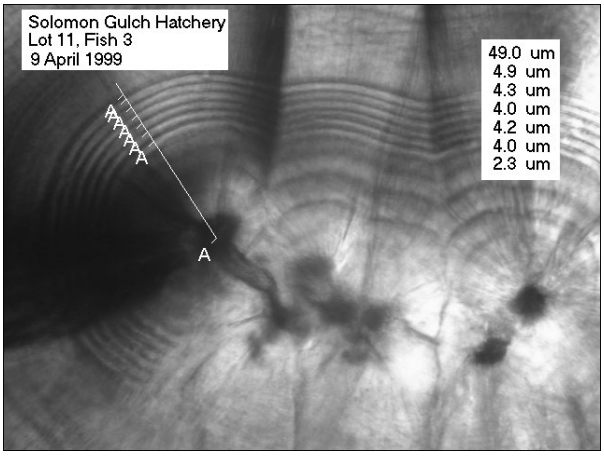


Fig. 3. Voucher specimen of the thermal mark applied by from Solomon Gulf Hatchery (SGH98), Prince William Sound in 1998. Also carries a six-ring pattern.



There was no significant difference in inter-ring spacing between the DIPAC97 (n = 16) otoliths and the SGH97 (n = 23) otoliths, but there was a significant difference in thermal mark location ($p < 0.0001$). Measurements from the unknown fish had the same ring spacing as DIPAC97 and SGH97, but the thermal mark location (ANOVA Post hoc test) was similar to that from SGH97. Thus, these results supported the hypothesis that these were PWS fish not DIPAC fish with an aberrant thermal mark.

Analysis of the microprobe data indicated that CCH97 otoliths found in the Chilkat River had trace elements that more closely matched known CCH fish than unmarked pink salmon from the Chilkat River. The elemental concentrations in the otoliths of the unknown fish were most similar to that of the Chilkat River or CCH pink salmon.

Principal components analysis showed that the first two principal components explained all of the variation among the groups. Component one was comprised of Na, Cl, S, Ca, Sr, and K, while component two was comprised of K, Ca, Sr, S, Cl, and P. Based on these components, the data were split into two distinct groups. Two of the unknowns fell well into the CCH97 category, while a third unknown fell marginally into the Chilkat category. Discriminant analysis indicated that replicate readings of elemental compositions of three unknown pinks were classified as CCH97 10 of 15 (66.7%) times, and 24 CCH97 pinks were classified as unknown fish 43 of 120 (35.8%) times. Thus, these results supported the hypothesis that these were PWS fish not wild fish with a natural pattern that mimicked PWS fish

There is a widely held notion that pink salmon are more prone to stray than other Pacific salmon species (Quinn 1984). A survey of the literature indicated that our observations are the furthest pink salmon have ever been recorded straying (~950 km). Although the extent of this straying is currently unknown, observations from the samples collected in 2000 indicate that straying may be significant at times.

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