**Regional Information Report No. 5J10-07**

# Observations of the Distribution of Hatchery Chum Salmon in Southeast Alaska, 1980–2006

**by**

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**Alaska Department of Fish and Game** **Division of Commercial Fisheries**

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**Weights and measures (metric)**

| | |
|---|---|
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| milliliter | mL |
| millimeter | mm |

**Weights and measures (English)**

| | |
|---|---|
| cubic feet per second | $ft^3/s$ |
| foot | ft |
| gallon | gal |
| inch | in |
| mile | mi |
| nautical mile | nmi |
| ounce | oz |
| pound | lb |
| quart | qt |
| yard | yd |

**Time and temperature**

| | |
|---|---|
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| degrees kelvin | K |
| hour | h |
| minute | min |
| second | s |

**Physics and chemistry**

| | |
|---|---|
| all atomic symbols | |
| alternating current | AC |
| ampere | A |
| calorie | cal |
| direct current | DC |
| hertz | Hz |
| horsepower | hp |
| hydrogen ion activity (negative log of) | pH |
| parts per million | ppm |
| parts per thousand | ppt, ‰ |
| volts | V |
| watts | W |

**General**

| | |
|---|---|
| Alaska Administrative Code | AAC |
| all commonly accepted abbreviations | e.g., Mr., Mrs., AM, PM, etc. |
| all commonly accepted professional titles | e.g., Dr., Ph.D., R.N., etc. |
| at | @ |
| compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| copyright | © |
| corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| District of Columbia | D.C. |
| et alii (and others) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g. |
| Federal Information Code | FIC |
| id est (that is) | i.e. |
| latitude or longitude | lat. or long. |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S.C. | United States Code |
| U.S. state | use two-letter abbreviations (e.g., AK, WA) |

**Measures (fisheries)**

| | |
|---|---|
| fork length | FL |
| mideye-to-fork | MEF |
| mideye-to-tail-fork | METF |
| standard length | SL |
| total length | TL |

**Mathematics, statistics**

| | |
|---|---|
| *all standard mathematical signs, symbols and abbreviations* | |
| alternate hypothesis | $H_A$ |
| base of natural logarithm | *e* |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | (F, t, $\chi^2$, etc.) |
| confidence interval | CI |
| correlation coefficient (multiple) | R |
| correlation coefficient (simple) | r |
| covariance | cov |
| degree (angular ) | ° |
| degrees of freedom | df |
| expected value | *E* |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $\log_2$, etc. |
| minute (angular) | ' |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | α |
| probability of a type II error (acceptance of the null hypothesis when false) | β |
| second (angular) | " |
| standard deviation | SD |
| standard error | SE |
| variance | |
| population | Var |
| sample | var |

*REGIONAL INFORMATION REPORT NO. 5J10-07*

# OBSERVATIONS OF THE DISTRIBUTION OF HATCHERY CHUM SALMON IN SOUTHEAST ALASKA, 1980–2006

by

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Division of Commercial Fisheries, Publications Section

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# ABSTRACT

From 1976 to 2000, the number of documented wild and hatchery strays identified by coded wire tags and thermal marks was summarized for Southeast Alaska. Recoveries were either random recoveries (the number of fish examined for marks was recorded), or select recoveries (there is no record of the number of fish examined). For coded wire tags, a total of 89 random recoveries came from the examination of 19,160 fish in 20 natural systems; an additional 1,033 select tags were recovered from natural systems. Only six of these tags were from releases over five miles from the recovery site. There have been 2.4 million chum salmon examined for coded wire tags in hatchery broodstocks and 8,048 tags recovered; in addition, 4,994 tags were recovered from an unknown number of fish examined in hatchery broodstocks. Of these 13,042 tags, there were only 68 from release sites over five miles from the recovery hatchery; 52 were at Whitman Lake from fry incubated at that site, but released at more distant sites. The most distant hatchery strays were a Medvejie-released tag recovered at Neets Bay (160 miles), a Hidden Falls-released tag recovered at Ward Creek (170 miles), and a Marx Creek-released tag recovered at Auke Creek (240 miles). In spite of an occasional long-distance recovery, the data for coded wire tags suggests that straying over five miles from the release site is a rare event. Thermal mark recoveries suggest that straying may be more prevalent than indicated by coded wire tags; 28% of recovered thermal marks were from fish that were released from a site over five miles distance. The data were insufficient to estimate straying rates or to evaluate factors affecting straying.



Key words: chum salmon, Southeast Alaska, straying, hatchery, escapement, coded wire tag


# INTRODUCTION

The production of Southeast Alaska hatchery chum salmon *Onchorhychus keta* has grown tremendously in the last three decades. The total run of hatchery chum salmon in Southeast Alaska has grown from 800 in 1977 to over 13 million in 2006 (White, 2007). The total run of wild stocks is not available; however, between 1995 and 2004 Clark et al. (2006) reports the average annual hatchery chum salmon contribution was 71% in the Southeast commercial common property harvests. When hatcheries were first sited, and as additional release sites were incorporated into programs, it was Alaska Department of Fish and Game (ADF&G) policy to avoid releasing salmon in close proximity to significant wild stocks (McGee 2004; Heard 2003). The current *Southeast Comprehensive Salmon Plan* lists several best practices that minimize straying and its effects by directing hatchery planners to "Choose a release site that is not proximal to the natal streams of any highly significant wild stocks of the same species or other species with similar run timing and habitat utilization characteristics." and to "Choose a release site with a strong and consistent supply of fresh water." (Joint Southeast RPT 2004).

While it is common to see large numbers of hatchery chum salmon spawning in freshwater streams adjacent to their release site, the assumption has been that straying beyond five miles is insignificant. Heinl (2005) found a 2.3% per year increase for escapement counts in an 82-stream index in Southeast Alaska over a 21-year period ending in 2004, but he did not suggest any relationship to hatchery fish. However, a similar observation of increased chum salmon escapement in Prince William Sound streams prompted ADF&G to undertake a study to determine the incidence of hatchery chums in streams in that area (Merizon and Moffitt, *In prep*). Hatchery fish were found in most surveyed streams. Southeast Alaska hatcheries used local stocks for their brood stocks in compliance with the department's genetic policy which dictates that the donor stock must be shown to be appropriate for the proposed [hatchery] plan (Davis et al. 1985). This was in recognition of the effect that hatchery fish in a wild stock system, or the presence of wild stocks in a hatchery broodstock, may result in loss of fitness if strays are poorly adapted to the new environment (Davis and Burkett 1989).

The department recognized that chum salmon straying existed in Southeast Alaska, but based on observations of hatchery programs and coded wire tag recoveries, did not believe that straying

was significant beyond five miles from release sites (Jim Seeb, former Chief of Research for Anadromous Fishes, ADF&G, Anchorage, personal communication). While in 2006 there had not been any directed studies of chum salmon straying in Southeast Alaska, there was considerable data to provide some perspective on the distribution of hatchery chum salmon. To demonstrate what was known of the extent of straying of hatchery chum salmon in Southeast Alaska in 2006, I looked at recoveries of coded wire tags in both freshwater systems and hatcheries. I also examined thermal mark recoveries up to that point in time.

# METHODS

The department maintains a comprehensive database of releases of anadromous salmon in Alaska. Information concerning coded wire tagging and thermal marking of otoliths is collected and stored for ready retrieval by anyone with access to the internet. Recovery information of coded wire tagged fish in Alaska, as well as numbers of fish examined and dates of sampling, along with other associated information, is maintained and accessible on two databases; sampling information and results from collections by the department and hatchery operators is on the ADF&G database, while information on samples collected by National Marine Fishery Service (NMFS) is on a separate database. Records of fish collected by NMFS at the Auke Creek and Little Port Walter Hatcheries are stored at the Regional Mark Processing Center[1]. These data are available through various public reports from the web sites or via specialized queries of the ADF&G database by the Mark Tag Age (MTA) Lab staff. Coded wire tag data and thermal marked otolith data from both of these databases were used to assess distribution of hatchery chum salmon.

While the use of coded wire tags to identify releases of salmon from hatcheries has been common since the 1970s, typically only a portion of the numbers released are tagged. Thermal marking of salmon otoliths by manipulating water temperatures has proved to be an efficient means for 100% marking of salmon (Volk et al. 1990). When salmon embryos or alevins are exposed to a rapid drop in temperature, otolith growth is temporarily disrupted and this results in a discontinuity in the otolith's microstructure. When viewed under transmitted light microscopy, this discontinuity appears as a dark ring. By controlling the number of temperature drops and the timing between drops, a coded pattern of dark rings can be recorded on the otolith and this pattern can be recovered from otoliths of older fish by removing the overlaying material and exposing the otolith core. Entire release groups from different hatcheries and release sites are given unique marks for each brood year (Josephson and Oxman 2010). For hatcheries that release a large number of fish, this method of marking has been shown to be particularly cost effective (Munk et al. 1993).

Records of the release of coded wire tags and thermal marks were compiled with a standard report from the MTA Lab web site. Recoveries of coded wire tags take two forms. The first is those from surveys where sampling crews observed chum salmon in freshwater systems and systematically examined fish for the presence or absence of the adipose fin. These samples are considered *random* and the number of fish sampled, clips observed, and tags recovered are all available. The other method is more opportunistic; fishery workers in the field will often note a fish with a missing adipose fin and collect the head. However, if they are not also keeping track

[1] Coded-wire-tag data from ADF&G as well as other agencies involved with salmon tagging and sampling is stored on the Regional Mark Processing Center database. It can be accessed at www.rmpc.org.

of all fish observed, those samples are considered *select* because associated information regarding numbers sampled is not available.

Both recoveries provide information on distribution, although only the random recoveries provide opportunity for an estimate of the number of hatchery fish in the sample. To demonstrate what is known of the extent of straying of hatchery chum salmon in Southeast Alaska based on coded wire tags, I looked at in the MTA Lab database accessible at tagotoweb.adfg.state.ak.us and the Regional Mark Processing Center database accessible at www.rmpc.org. Some specialized queries were used on the MTA Lab database.

The sampling for thermal marks in natural systems has been somewhat intermittent. When the first thermal marked chum returned to Macaulay Hatchery in 1995 and 1996, there was some sampling in local Juneau area streams. In 2000, there was some expanded sampling in the Lynn Canal area, as well as broader looks at three systems in Northern Southeast. Single samples were collected by area biologists at Ralphs Creek in 2002, and at Traitors Cove Creek in 2006. When chum salmon are processed for determination of thermal marks by the department, the results are stored on the MTA lab database. Data of thermal–mark recoveries and related information were collected through ad hoc queries of the MTA Lab database.

Distances between release and recovery sites were estimated in miles with Google Earth[2] as a straight line distances from the release site to the mouth of the freshwater system where the marked salmon were recovered.

## RESULTS

Hatcheries in Southeast Alaska started coded-wire-tagging chum salmon with the 1975 brood fish at Beaver Fall Hatchery when 55,575 tagged chum salmon representing 1,427,503 fish were released in 1976. Tagging chum salmon still continues, although the last significant numbers tagged were the brood year 2002 fish from Southern Southeast Regional Aquaculture Association hatcheries near Ketchikan. The general approach with coded wire tagging is to represent a release of hatchery salmon by tagging a subset with coded wire tags (Clark 2004). The cost and labor involved with coded wire tagging generally allows tagging of only a small component of hatchery releases group. The last year when greater than 1% of hatchery chum releases in Southeast Alaska were tagged was 1981 (Table 1). The first recorded recoveries of coded wire tags in chum salmon occurred in 1980.

Chum salmon have been tagged at most hatcheries in Southeast Alaska during some period of their operations (Table 2). Hatcheries that have released, but never coded-wire-tagged chum salmon, are 17 Mile Stream Incubation, 31 Mile Stream Incubation, Burro Creek, Herman Creek Spawning Channel, Kowee Creek, Port Armstrong, Port Camden, Sandy Bay, Sheldon Jackson, and Starrigavan. Collectively, annual chum salmon releases from these hatcheries have averaged 2.6% of the Southeast region total. In addition to the hatchery tagging of chum salmon, wild stocks were tagged at Fish Creek 101-15 and the Harding River.

Random sampling records for coded wire tags are available for escapements to 20 wild stock systems in Southeast. The number of fish examined by system ranged from 2 to 6,833 fish, while the number of tags recovered ranged from 0 to 55. To better characterize the number of hatchery fish represented by the recovered tags, an expansion estimate is presented in Table 3. (The

[2] Product names used in the publication are included for completeness but do not constitute product endorsement.

expansion is determined by multiplying the number of recovered tags by the tag ratio for the respective tag groups, which is the total number of fish released, divided by the number of tagged fish; MTA Lab Web Site Glossary.) There were 89 tags recovered from 19,160 fish examined in these 20 systems. In only two cases had the tags been released more than five miles from the recovery site. A Burnett Inlet tag was recovered at Traitors Creek, 50 miles from the release site, and a Hidden Falls tag was recovered at Ward Creek (near Ketchikan), 170 miles from the release site. These release and recovery sites, as well as other locations discussed in this report, are presented in Figure 1. The anadromous waters catalog stream numbers (Johnson and Blanche, 2010) for all sampled natural systems are listed in Appendix A.

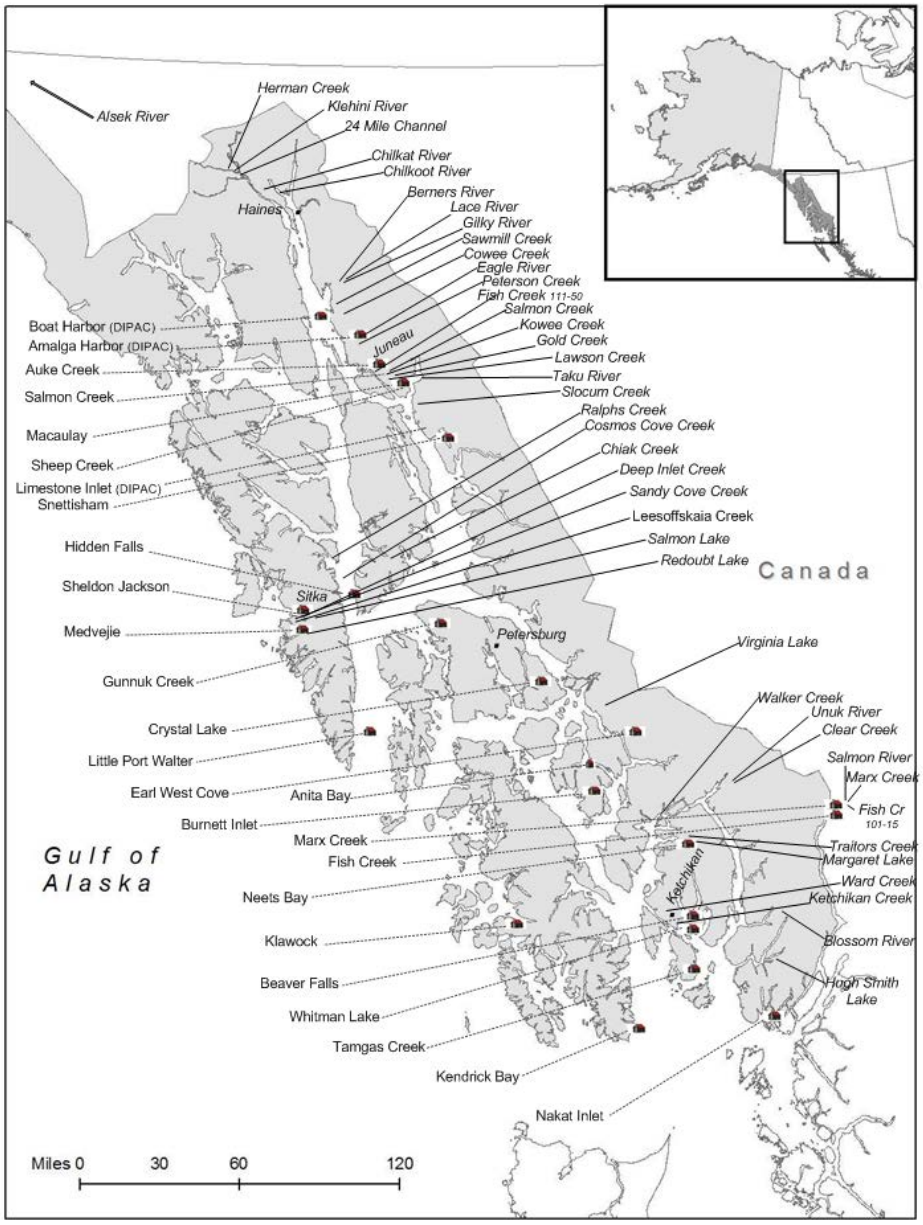


**Figure 1.–**Release and recovery sites for Southeast Alaska chum salmon. Release sites are on the left and recovery sites on the right.

In addition to the random recoveries of chum salmon, there were select recoveries from natural spawning escapements in wild stock systems and in the Marx Creek spawning channel. These adipose-clipped salmon were recovered in the course of field work, the heads were collected, and the tags were recovered at the MTA lab. There are 1,033 of these tags in the database (Table 4). The majority of these select recoveries (996) were tags released at Marx Creek or Fish Creek 101-15 and subsequently recovered at the other stream. The Marx Creek Spawning Channel is on the Salmon River near Hyder, Alaska, and is less than two miles from Fish Creek 101-15, the donor system; a full report of the project is presented by Heinl et al. (2000). The other 37 recoveries are from eight Southeast systems. Similar to the recoveries from random sampling, there were only four recoveries further than five miles from the release site. These four fish were recovered at Hugh Smith Lake, and included three tags from Nakat Inlet (18 miles distant) and one tag from Whitman Lake (35 miles distant). Hugh Smith Lake does not support a natural run of chum salmon but does support a run of sockeye salmon and the department operates a weir at the mouth of that system.

Sampling results at the hatcheries provide a much larger number of observations. There have been over 2.4 million chum salmon examined for adipose clips at hatcheries during the collection of broodstock. Tags recovered in this type of sampling are considered random recoveries. There were 8,048 tags recovered in this sampling, with the majority recovered at the original hatchery release site. However, 10 tags were recovered from release sites over five miles distant from the release site (Table 5). Eight of the recovered tags were within the Ketchikan sphere of hatcheries and release sites, while the most distant recoveries included a Medvejie Hatchery fish released near Sitka and recovered at Neets Bay, a distance of 160 miles, and a Marx Creek tag recovered at Auke Creek, a distance of 240 miles. The tag ratio expansion is provided in the table to provide some indication of how many fish could have been represented by the tags observed.

Select recoveries of tags also occurred at the hatcheries. The number of chum salmon examined is not available in these situations. There are 4,994 select recoveries listed in MTA Lab database (Table 6). A total of 58 tags were recovered from release sites over five miles from the recovery site. As with the random recoveries, most were in the Ketchikan area; 52 recoveries at Whitman Lake were from fry that were incubated at that site and transported to either Nakat Inlet or Neets Bay. The other six tags recovered over five miles from the release site were distributed as follows: one tag at Beaver Falls from a Nakat Inlet release, one tag at Burnett Inlet from a Neets Bay release, two tags at Neets Bay from Nakat Inlet and Beaver Falls releases, and two tags at Hidden Falls from Little Port Walter releases.

Thermal marking of production releases of hatchery chum salmon was first done with the 1991 brood year at two hatcheries operated by nonprofit aquaculture associations in Southeast: the Douglas Island Pink and Chum Macaulay Hatchery and the Northern Southeast Regional Aquaculture Association (NSRAA) Hidden Falls Hatchery. For the 1991 brood year, the Macaulay Hatchery released 63 million thermal marked chum salmon and NSRAA released 20 million. Since 1991, thermal marking has increased dramatically and for the 2005 brood year, over 335 million (88%) chum salmon released from hatcheries in Southeast Alaska were reported to have been thermally marked (Table 7).

Some sampling for thermal marked chum has been conducted in natural systems. The MTA Lab has results from 1,467 fish examined for the presence of a thermal mark in 22 different systems for the period from 1995 through 2006 (Table 8). This sampling has been relatively unsystematic; however, in 1995 and 1996, sampling in the Juneau area was conducted with the

goal of understanding something about the distribution of hatchery chum in local streams. Similarly, in 2000, samples were collected in October from the Alsek, Chilkat, and Taku Rivers with the intent of looking for hatchery chum in wild stock escapements. The rationale for choice of systems or timing of collection is not known for these or other samples. A total of 505 thermal marks was recovered from natural systems, 100 of which were from a release location more than five miles distant from the release site. In some cases a hatchery released fish with the same mark was found at multiple release sites. In the case of the Macauley Hatchery, these included sites from Limestone Inlet to Boat Harbor, a lineal distance of 60 miles. The closest of the possible release sites was used to estimate the stray distance for Macauley Hatchery thermal mark recoveries. Using this criterion, most recoveries were somewhat proximate to the release location and all but two were recovered within 65 miles of the release site. The exceptions were a recovery at Traitors Cove Creek from a release in Gastineau Channel (a distance of 203 miles) and a recovery at Fish Creek 111-50 near Juneau from a release at Hidden Falls (a distance of 78 miles).

# DISCUSSION

The intent of this report is to document what is known about distribution of hatchery chum salmon in hatchery returns and natural streams in Southeast Alaska based on coded wire tags. The coded wire tag data supports the department's observation that chum salmon straying did not appear to be significant in Southeast Alaska during most of the growth of the hatchery program. The coded wire tag data is accurate because of the lack of ambiguity in reading tag codes, but provides poor resolution because of low marking rates. In one study, code wire tag placement was found to affect homing (Habicht et al. 1998); this possibility was not considered in looking at Southeast Alaska data, but if homing was affected, it would be expected to exacerbate straying. Thermal marking has now replaced coded wire tags for marking chum salmon in Alaska. One of the advantages of thermal marking is that an entire hatchery's production can be marked for substantially less cost than tagging (Hagen et al. 1995). For example, 100% of the chum salmon production (63 million to 105 million fry annually) from the Macaulay Hatchery in Juneau have been marked since 1991. Thermal marks can provide a cost-effective means for determining the presence of hatchery fish in a commercial fishery or wild stock escapement (Hagen et al. 1995; Joyce and Evans 1998). Use of thermal marks does require special interpretive skills in pattern recognition—some thermal marks can be challenging to identify, and wild salmon may contain otolith patterns which can mimic the features imposed through thermal marking. Consequently, it may be difficult to identify the otolith as a hatchery fish (Blick and Hagen 1998). However, ADF&G has identified hundreds of thousands of marks from all species of salmon and in only one case was a mark–recovery listed as an unknown mark. This fish was recovered at Ralph's Creek near Hidden Falls Hatchery in 2002; while the thermal mark technicians are certain it is a mark, the pattern does not match any known release. Single occurrences of tags or thermal marks should, of course, be viewed critically. Nonetheless, thermal mark data has tremendous power for studying the distribution and contribution rate of hatchery fish in both catches and escapements. The release records through brood year 2005 show that over 300 million hatchery thermally marked chum salmon were released annually in Southeast Alaska since brood year 2003. This compares with a peak of 577,000 coded wire tagged chum salmon released in 1990, and less than 10,000 a year since 2004. It is unlikely that coded wire tagging will be used to represent releases of hatchery chum salmon in the future. The 2006 results based on thermal mark sampling at Traitors Cove Creek further demonstrate the

power of thermal marking for studying straying; 87% of the sample was thermal marked (Table 8). While this creek is very close to a primary release site, the marks included recoveries from some more distant release sites, including a single fish from Macaulay Hatchery.

There are several studies currently being planned or implemented in Alaska that will use thermal mark recoveries to better understand the extent of chum salmon straying. I look forward to seeing the results of those studies.

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# TABLES

**Table 1.–**Numbers of chum salmon released with coded wire tags and the total released in Southeast Alaska for brood years 1974–2005.

| Brood year | Adipose clipped and coded wire tagged | Total released | Percent tagged |
|---|---|---|---|
| 1974 | 0 | 966,764 | 0.00% |
| 1975 | 55,575 | 2,370,444 | 2.34% |
| 1976 | 45,845 | 2,662,588 | 1.72% |
| 1977 | 105,035 | 3,067,809 | 3.42% |
| 1978 | 17,630 | 5,285,850 | 0.33% |
| 1979 | 106,870 | 8,933,756 | 1.20% |
| 1980 | 594,596 | 47,444,177 | 1.25% |
| 1981 | 577,872 | 42,891,976 | 1.35% |
| 1982 | 458,868 | 77,592,743 | 0.59% |
| 1983 | 307,459 | 81,325,990 | 0.38% |
| 1984 | 450,067 | 134,410,461 | 0.33% |
| 1985 | 432,443 | 154,949,853 | 0.28% |
| 1986 | 412,597 | 185,534,343 | 0.22% |
| 1987 | 408,658 | 210,652,759 | 0.19% |
| 1988 | 554,047 | 233,521,707 | 0.24% |
| 1989 | 514,986 | 172,770,562 | 0.30% |
| 1990 | 577,062 | 281,867,283 | 0.20% |
| 1991 | 488,881 | 286,462,380 | 0.17% |
| 1992 | 533,567 | 321,293,168 | 0.17% |
| 1993 | 390,883 | 288,628,079 | 0.14% |
| 1994 | 417,582 | 356,688,209 | 0.12% |
| 1995 | 425,396 | 405,523,495 | 0.10% |
| 1996 | 259,071 | 358,546,902 | 0.07% |
| 1997 | 273,622 | 356,754,980 | 0.08% |
| 1998 | 266,615 | 354,729,405 | 0.08% |
| 1999 | 293,067 | 386,228,786 | 0.08% |
| 2000 | 228,901 | 371,277,904 | 0.06% |
| 2001 | 276,288 | 330,139,315 | 0.08% |
| 2002 | 282,950 | 348,638,045 | 0.08% |
| 2003 | 1,113 | 427,007,434 | 0.00% |
| 2004 | 993 | 433,834,358 | 0.00% |
| 2005 | 8,226 | 381,322,791 | 0.00% |

**Table 2.–**Numbers of chum salmon released with coded wire tags by hatchery location in Southeast Alaska for brood years 1974–2005.

| Brood year | Anita Bay | Auke Creek | Beaver Falls | Burnett Inlet | Crystal Lake | Earl West Cove | Gunnuk Creek | Hidden Falls | Kendrick Bay | Klawok | Little Port Walter | Macauley | Marx Creek | Medvejie | Nakat Inlet | Neets Bay | Salmon Creek | Sheep Creek | Snettisham | Tamcag Creek | Whitman Lake | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | | | 55,575 | | | | | | | | | | | | | | | | | | | 55,575 |
| 1976 | | | 32,809 | | | | | | | | 13,036 | | | | | | | | | | | 45,845 |
| 1977 | | | 88,208 | | | | | | | | 16,827 | | | | | | | | | | | 105,035 |
| 1978 | | | | | | | | | | | 17,630 | | | | | | | | | | | 17,630 |
| 1979 | | | | | | | | 24,681 | | 23,222 | | | | | 49,117 | | | | | 9,850 | | 106,870 |
| 1980 | | 36,100 | | | 11,572 | | | 60,103 | | 50,283 | 57,186 | | | | 134,284 | 71,714 | 84,272 | | 45,602 | 43,480 | | 594,596 |
| 1981 | | 48,722 | 71,801 | | 15,993 | | | 59,425 | | 35,672 | | | | 39,241 | 40,949 | 34,467 | 93,573 | | 99,644 | 38,385 | | 577,872 |
| 1982 | | 41,742 | 30,077 | | 27,805 | | | 60,706 | | 24,501 | | | | 60,540 | 28,134 | 83,426 | 74,481 | | 27,456 | | | 458,868 |
| 1983 | | | | | 33,834 | | | 55,992 | | 31,647 | | | | 70,031 | | 72,456 | | | 43,499 | | | 307,459 |
| 1984 | | | | | | | | 67,697 | | 87,118 | | | | 57,170 | 64,579 | 81,298 | | | 92,205 | | | 450,067 |
| 1985 | | 20,311 | | | | 44,837 | | 67,706 | | | | | 26,969 | 53,364 | 76,147 | 83,250 | | | 59,859 | | | 432,443 |
| 1986 | | | | 25,749 | | 46,295 | | | | | | | 30,554 | | 88,666 | 98,315 | | 56,501 | 66,517 | | | 412,597 |
| 1987 | | | | 25,688 | | 38,642 | | | | | | | 102,326 | | 76,678 | 97,200 | | | 68,124 | | | 408,658 |
| 1988 | | | | 27,641 | | 34,387 | 47,493 | | | | | 59,860 | 97,688 | | 79,908 | 76,212 | | | 44,198 | 86,660 | | 554,047 |
| 1989 | | | | 32,528 | | | 50,551 | | | | | 87,303 | | 28,798 | 95,439 | 108,904 | | | 67,363 | 44,100 | | 514,986 |
| 1990 | | | | 30,872 | | 45,245 | 26,801 | | 45,022 | | | 145,871 | | | 93,768 | 132,961 | | 56,522 | | | | 577,062 |
| 1991 | | | | 33,279 | | 44,584 | 51,585 | | 46,623 | | | 51,304 | | | 69,157 | 140,599 | | 51,750 | | | | 488,881 |
| 1992 | | | | 69,785 | | 48,089 | 38,953 | | 45,545 | | | 60,763 | | | 64,010 | 145,007 | | 61,415 | | | | 533,567 |
| 1993 | | | | 59,193 | | 42,392 | 34,337 | | 31,128 | | | | | | 62,710 | 132,948 | | | | 28,175 | | 390,883 |
| 1994 | | | | 59,762 | | 40,659 | 46,046 | | 39,804 | | | | | | 61,673 | 130,744 | | | | 38,894 | | 417,582 |
| 1995 | | | | 74,352 | | 35,868 | 47,367 | | 32,597 | | | | | | 68,811 | 134,036 | | | | 32,365 | | 425,396 |
| 1996 | | | | | | 35,293 | | | 34,760 | | | | | | 69,746 | 119,272 | | | | | | 259,071 |
| 1997 | | | | | | 33,236 | | | 34,205 | | | | | | 65,017 | 141,164 | | | | | | 273,622 |
| 1998 | | | | | | 32,920 | | | 32,615 | | | | | | 63,262 | 137,818 | | | | | | 266,615 |
| 1999 | | | | | | 35,601 | | | 34,578 | | | | | | 69,363 | 153,525 | | | | | | 293,067 |
| 2000 | 30,919 | | | | | | | | 29,424 | | | | | | 61,750 | 106,808 | | | | | 30,919 | 228,901 |
| 2001 | 54,387 | | | | | | | | 32,566 | | | | | | 65,896 | 123,439 | | | | | 54,387 | 276,288 |
| 2002 | 55,817 | | | | | | | | 31,799 | | | | | | 64,204 | 127,282 | | | | 3,848 | 55,817 | 282,950 |
| 2003 | | | | | | | | | | | | | | | | | | | | 1,113 | | 1,113 |
| 2004 | | | | | | | | | | | | | | | | | | | | 993 | | 993 |
| 2005 | | | | | | | | | | | | | | | | | | | | 8,226 | | 8,226 |

**Table 3.–**Numbers of chum salmon examined, tags recovered, and estimated hatchery fish based on tagged ratios for random escapement sampling in Southeast Alaska, by stream location.

| Stream | Number sampled | Number of tags Expansion | Release location for recovered coded wire tags: (W) Fish Cr. 101 | Burnett Inlet | Hidden Falls | Marx Creek | Medvejie | Neets Bay | Salmon Creek | Whitman Lake |
|---|---|---|---|---|---|---|---|---|---|---|
| Blossom R 101-55 | 2 | 0 | | | | | | | | |
| Chiak Cr 112-80 | 2,243 | 0 | | | | | | | | |
| Clear Cr 101-75 (Not Named) | 2 | 0 | | | | | | | | |
| Deep Inlet Cr 113-41 (Not Named) | 31 | 1 | | | | | 1 | | | |
| | | 72 | | | | | 72 | | | |
| Fish Cr 101-15 | 903 | 0 | | | | | | | | |
| Fish Cr 111-50 | 1,137 | 1 | | | | | | | 1 | |
| | | | | | | | | | 1 | |
| Hugh Smith Lk 101-30 | 1 | 0 | | | | | | | | |
| Ketchikan Cr 101-47 | 2 | 0 | | | | | | | | |
| Leesoffskaia Cr 113-41 (Not Named) | 140 | 1 | | | | | 1 | | | |
| | | 1 | | | | | 1 | | | |
| Margaret Lk 101-90 | 184 | 0 | | | | | | | | |
| Marx Cr 101-15 | 6,340 | 27 | 13 | | | 14 | | | | |
| | | 218 | 14 | | | 204 | | | | |
| Redoubt Lk 113-41 | 22 | 0 | | | | | | | | |
| Salmon Cr 111-40 | 6,833 | 55 | | | | | | | 55 | |
| | | 1,621 | | | | | | | 1,621 | |
| Sandy Cove Cr 113-41 (Not Named) | 250 | 0 | | | | | | | | |
| Taku R 111-32 | 39 | 0 | | | | | | | | |
| Traitors Cr 101-90 | 181 | 2 | | 1 [a] | | | | 1 | | |
| | | 1,353 | | 677 | | | | 676 | | |
| Unuk R 101-75 | 580 | 0 | | | | | | | | |
| Virginia Lk 107-40 | 4 | 0 | | | | | | | | |
| Walker Cr 101-80 (Hatchery Cr) | 2 | 0 | | | | | | | | |
| Ward Cr 101-47 | 264 | 2 | | | 1 [a] | | | | | 1 |
| | | 313 | | | 21 | | | | | 293 |
| Total | 19,160 | 89 | 13 | 1 | 1 | 14 | 2 | 1 | 56 | 1 |
| | | 3,579 | 14 | 677 | 21 | 204 | 23 | 676 | 1,622 | 293 |

[a] Recovery over 5 miles from release site or stream greater than 5 miles from nearest release site.

**Table 4.–**Numbers of select recoveries of coded-wire-tagged chum salmon in Southeast Alaska (not part of a scheduled sampling event.)

| | Release location for recovered coded wire tags | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Stream | (W) Fish Cr 101-15 | Hidden Falls | Marx Creek | Medvejie | Nakat Inlet | Salmon Creek | Whitman Lake | Grand Total |
| Cosmos Cove Cr 112-11 (Not Named) | | 1 | | | | | | 1 |
| Deep Inlet Cr 113-41 (Not Named) | | | | 7 | | | | 7 |
| Fish Cr 101-15 | 829 | | 17 | | | | | 846 |
| Fish Cr 111-50 | | | | | | 1 | | 1 |
| Hugh Smith Lk 101-30 | | | | | 3 [a] | | 1 [a] | 4 |
| Leesoffskaia Cr 113-41 (Not Named) | | | | 1 | | | | 1 |
| Marx Cr 101-15 | 130 | | 20 | | | | | 150 |
| Salmon Lk 113-41 | | | | 3 | | | | 3 |
| Salmon R 101-15 | 19 | | | | | | | 19 |
| Sandy Cove Cr 113-41 (Not Named) | | | | 1 | | | | 1 |
| Grand Total | 978 | 1 | 37 | 12 | 3 | 1 | 1 | 1,033 |

[a] Recovery over 5 miles from release site.

**Table 5.–**Numbers of chum salmon examined, tags recovered, and estimated hatchery fish expanded from tag ratios for random hatchery sampling in Southeast Alaska, by hatchery.

| Hatchery sampling site | Number sampled | No. of tags / Tag ratio expansion | Release location for recovered coded wire tags: Auke Creek | Beaver Falls | Burnett Inlet | Earl West Cove | Gunnuk Creek | Hidden Falls | Kendrick Bay | Klawock | Little Port Walter | Macaulay | Marx Creek | Medvejie | Neets Bay | Salmon Creek | Sheep Creek | Snettisham | Tamgas Creek |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Auke Creek | 1,535 | 283 | 280 | | | | | | | | | 2 | 1 [a] | | | | | | |
| | | 1,515 | 294 | | | | | | | | | 1,206 | 15 | | | | | | |
| Beaver Falls | 20,672 | 122 | | 119 | | | | | | | | | | | 2 [a] | | | | 1 [a] |
| | | 9,668 | | 9,426 | | | | | | | | | | | 228 | | | | 14 |
| Burnett Inlet | 54,604 | 65 | | | 65 | | | | | | | | | | | | | | |
| | | 23,627 | | | 23,627 | | | | | | | | | | | | | | |
| Gunnuk Creek | 769 | 4 | | | | | 4 | | | | | | | | | | | | |
| | | 75 | | | | | 75 | | | | | | | | | | | | |
| Hidden Falls | 125,304 | 322 | | | | | | 322 | | | | | | | | | | | |
| | | 72,296 | | | | | | 72,296 | | | | | | | | | | | |
| Klawock | 23,907 | 327 | | | | | | | | 327 | | | | | | | | | |
| | | 16,518 | | | | | | | | 16,518 | | | | | | | | | |
| Little Port Walter | 2,606 | 2,126 | | | | | | | | | 2,126 | | | | | | | | |
| | | 2,455 | | | | | | | | | 2,455 | | | | | | | | |
| Macaulay | 53,957 | 72 | | | | | | | | | | 65 | | | | | 7 | | |
| | | 15,246 | | | | | | | | | | 12,174 | | | | | 3,072 | | |
| Medvejie | 81,473 | 1,438 | | | | | | | | | | | | 1,438 | | | | | |
| | | 47,065 | | | | | | | | | | | | 47,065 | | | | | |
| Neets Bay | 1,428,355 | 2,368 | | | 2 [a] | 2 [a] | | | 1 [a] | | | | | 1 [a] | 2,362 | | | | |
| | | 950,481 | | | 773 | 262 | | | 138 | | | | | 123 | 949,185 | | | | |
| Salmon Creek | 5,117 | 257 | | | | | | | | | | | | | | 257 | | | |
| | | 803 | | | | | | | | | | | | | | 803 | | | |
| Sheep Creek | 593,599 | 290 | | | | | | | | | | 10 | | | | | 280 | | |
| | | 148,039 | | | | | | | | | | 4,001 | | | | | 144,038 | | |
| Snettisham | 59,303 | 374 | | | | | | | | | | | | | | | | 374 | |
| | | 53,405 | | | | | | | | | | | | | | | | 53,405 | |
| | | 8,048 | 280 | 119 | 67 | 2 | 4 | 322 | 1 | 327 | 2,126 | 77 | 1 | 1,439 | 2,364 | 257 | 287 | 374 | 1 |
| Total | 2,451,201 | 1,341,193 | 294 | 9,426 | 24,400 | 262 | 75 | 72,296 | 138 | 16,518 | 2,455 | 17,381 | 15 | 47,188 | 949,413 | 803 | 147,110 | 53,405 | 14 |

[a] Recovery over 5 miles from release site or stream greater than 5 miles from nearest release site.

**Table 6.–**Summary of coded wire tagged chum salmon recovered at Southeast Alaska hatchery sites when total number of fish examined is not available.

| | Release location for recovered coded wire tags | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hatchery sampling site | Auke Creek | Beaver Falls | Burnett Inlet | Crystal Lake | Hidden Falls | Klawock | Little Port Walter | Macaulay | Medvejie | Nakat Inlet | Neets Bay | Salmon Creek | Sheep Creek | Snettisham | Total |
| Auke Creek | 1,985 | | | | | | | 1 | | | | | | | 1,986 |
| Beaver Falls | | 15 | | | | | | | | 1 [a] (47) | | | | | 16 |
| Burnett Inlet | | | 351 | | | | | | | | 1 [a] (35) | | | | 352 |
| Crystal Lake | | | | 209 | | | | | | | | | | | 209 |
| Hidden Falls | | | | | 647 | | 2 [a] (55) | | | | | | | | 649 |
| Klawock | | | | | | 59 | | | | | | | | | 59 |
| Macaulay | | | | | | | | 108 | | | | | 41 | | 149 |
| Medvejie | | | | | | | | | 148 | | | | | | 148 |
| Nakat Inlet | | | | | | | | | | 147 | | | | | 147 |
| Neets Bay | | 1 [a] (30) | | | | | | | | 1 [a] (74) | 424 | | | | 426 |
| Salmon Creek | 1 | | | | | | | | | | | 174 | | | 175 |
| Sheldon Jackson | | | | | | | | | 8 | | | | | | 8 |
| Snettisham | | | | | | | | | | | | | | 618 | 618 |
| Whitman Lake | | | | | | | | | | 50 [a] (46) | 2 [a] (31) | | | | 52 |
| Total | 1,986 | 16 | 351 | 209 | 647 | 59 | 2 | 109 | 156 | 199 | 427 | 174 | 41 | 618 | 4,994 |

[a] Recovery over 5 miles from release site; distance is shown in parenthesis.

**Table 7.–**Numbers of chum salmon released with and without thermal marks in Southeast Alaska by brood year, 1974–2005.

| Brood year | Not thermal marked | Thermal marked | Percent thermal marked |
|---|---|---|---|
| 1974 | 966,764 | | 0% |
| 1975 | 2,370,444 | | 0% |
| 1976 | 2,662,588 | | 0% |
| 1977 | 3,067,809 | | 0% |
| 1978 | 5,285,850 | | 0% |
| 1979 | 8,933,756 | | 0% |
| 1980 | 47,444,177 | | 0% |
| 1981 | 42,891,976 | | 0% |
| 1982 | 77,592,743 | | 0% |
| 1983 | 81,325,990 | | 0% |
| 1984 | 134,410,461 | | 0% |
| 1985 | 154,949,853 | | 0% |
| 1986 | 185,534,343 | | 0% |
| 1987 | 210,652,759 | | 0% |
| 1988 | 233,521,707 | | 0% |
| 1989 | 172,770,562 | | 0% |
| 1990 | 281,867,283 | | 0% |
| 1991 | 203,675,491 | 82,786,889 | 29% |
| 1992 | 217,161,321 | 104,131,847 | 32% |
| 1993 | 187,852,401 | 100,775,678 | 35% |
| 1994 | 237,309,429 | 119,378,780 | 33% |
| 1995 | 264,881,787 | 140,641,708 | 35% |
| 1996 | 239,275,689 | 119,271,213 | 33% |
| 1997 | 224,338,276 | 132,416,704 | 37% |
| 1998 | 209,312,856 | 145,416,549 | 41% |
| 1999 | 229,274,189 | 156,954,597 | 41% |
| 2000 | 173,344,265 | 197,933,639 | 53% |
| 2001 | 163,451,765 | 166,687,550 | 50% |
| 2002 | 122,809,817 | 225,828,228 | 65% |
| 2003 | 93,900,699 | 333,106,735 | 78% |
| 2004 | 94,852,708 | 338,981,650 | 78% |
| 2005 | 45,811,086 | 335,511,705 | 88% |

**Table 8.–**Results of sampling for chum salmon thermal marks in natural systems in Southeast Alaska, 1996–2006. The numbers in parenthesis are estimated straight line distances between the nearest potential release site and recovery site in miles.

| | | | Recovered thermal marks | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream name | Sample date | Year | Dipac91 | Hidden Falls91 | Dipac92 | Dipac96 | Dipac97 | Amalga98 | Anitabay02 | Gastineau02 | Kendrick02 | Nakatinlet02 | Neetsbay02 | Neetsbay03 | Unknown Mark | Not marked | Number sampled |
| 24 Mile Channel | September–October | 2000 | | | | 1 [a](60) | | | | | | | | | | 126 | 127 |
| Alsek River | October 13 | 2000 | | | | | | | | | | | | | | 50 | 50 |
| Berners River | August | 1996 | | | 11 [a](17) | | | | | | | | | | | 1 | 12 |
| Berners River | August 6 | 2000 | | | | 9 [a](17) | | | | | | | | | | 21 | 30 |
| Berners River | August 15 | 2001 | | | | | 1 [a](17) | 1 [a](25) | | | | | | | | 17 | 19 |
| Chilkat River | July 24 | 2000 | | | | 1 [a](58) | | | | | | | | | | 20 | 21 |
| Chilkoot River | July 24 | 2000 | | | | 16 [a](51) | | | | | | | | | | 6 | 22 |
| Cowee Creek | August 17 | 1996 | | | 20 [a](9) | | | | | | | | | | | 4 | 24 |
| Eagle River | August 14 | 1995 | 4 | | 2 | | | | | | | | | | | 12 | 18 |
| Fish Creek 111-50 | July–August | 1995 | 5 | 1 [a](78) | 11 | | | | | | | | | | | 28 | 45 |
| Fish Creek 111-50 | August 1 | 1996 | | | 51 | | | | | | | | | | | 15 | 66 |
| Gilkey River | August 9 | 1996 | | | 2 [a](17) | | | | | | | | | | | 27 | 29 |
| Gold Creek | August 6 | 1996 | | | 3 | | | | | | | | | | | 67 | 70 |
| Herman Creek | August–October | 2000 | | | | | | | | | | | | | | 112 | 112 |
| Klehini River | September 28 | 2000 | | | | | | | | | | | | | | 43 | 43 |
| Kowee Creek | August 17 | 1996 | | | 13 | | | | | | | | | | | 35 | 48 |
| Lace River | August 8 | 1996 | | | 9 [a](18) | | | | | | | | | | | 33 | 42 |
| Lawson Creek | August 17 | 1995 | | | | | | | | | | | | | | 5 | 5 |
| Lawson Creek | August 8 | 1996 | | | 8 | | | | | | | | | | | 51 | 59 |
| Peterson Creek | August | 1995 | 2 | | 8 | | | | | | | | | | | 12 | 22 |
| Peterson Creek | August 6 | 1996 | | | 50 | | | | | | | | | | | 0 | 50 |
| Ralphs Creek | July 31 | 2002 | | | | | | | | | | | | | 1 | 59 | 60 |
| Salmon Creek | August | 1995 | 3 | | 5 | | | | | | | | | | | 63 | 71 |
| Salmon Creek | August | 1996 | | | 38 | | | | | | | | | | | 35 | 73 |
| Sawmill Creek | August 18 | 1995 | 2 [a](10) | | | | | | | | | | | | | 21 | 23 |
| Sawmill Creek | August 17 | 1996 | | | 18 [a](10) | | | | | | | | | | | 5 | 23 |
| Slocum Creek | August14 | 1996 | | | 40 [a](7) | | | | | | | | | | | 10 | 50 |
| Taku River | July 6 | 1996 | | | 2 [a](32) | | | | | | | | | | | 4 | 6 |
| Taku River | July–August | 1998 | | | | | | | | | | | | | | 12 | 12 |
| Taku River | October 4 | 2000 | | | | | | | | | | | | | | 43 | 43 |
| Traitors Cove Creek | August | 2006 | | | | | | | 1 | 1 [a](203) | 1 [a](61) | 4 [a](65) | 135 | 25 | | 25 | 192 |
| Total | | | 16 | 1 | 291 | 27 | 1 | 1 | 1 | 1 | 1 | 4 | 135 | 25 | 1 | 962 | 1,467 |

[a] Recovery over 5 miles from release site.

# APPENDIX

**Appendix A.–** Anadromous waters catalog stream numbers for sampled systems.

| ASTREAM NAME | ASTREAM_CODE |
|---|---|
| ALSEK R 182-30 | 182-30-10100 |
| 24 MI CHANNEL 115-32 (NOT NAMED) | 115-32-10250-2977 |
| BERNERS R 115-20 | 115-20-10100 |
| BLOSSOM R 101-55 | 101-55-10400 |
| CHIAK CR 112-80 | 112-80-10280 |
| CHILKAT R 115-32 | 115-32-10250 |
| CHILKOOT R 115-33 | 115-33-10200 |
| CLEAR CR 101-75 (NOT NAMED) | 101-75-10300-2014-3004 |
| COSMOS COVE CR 112-11 (NOT NAMED) | 112-11-10120 |
| COWEE CR 115-20 | 115-20-10620 |
| DEEP INLET CR 113-41 (NOT NAMED) | 113-41-10380 |
| EAGLE R 111-50 | 111-50-10070 |
| FISH CR 101-15 | 101-15-10500-2028 |
| FISH CR 111-50 | 111-50-10690 |
| GILKEY R 115-20 | 115-20-10300-2004 |
| GOLD CR 111-40 | 111-40-10200 |
| HERMAN CR 115-32 | 115-32-10250-2077-3061 |
| HUGH SMITH LK 101-30 | 101-30-10750-0010 |
| KETCHIKAN CR 101-47 | 101-47-10250 |
| KLEHINI R 115-32 | 115-32-10250-2077 |
| KOWEE CR 111-40 | 111-40-10900 |
| LACE R 115-20 | 115-20-10200 |
| LAWSON CR 111-40 | 111-40-10890 |
| LEESOFFSKAIA CR 113-41 (NOT NAMED) | 113-41-10350 |
| MARGARET LK 101-90 | 101-90-10390-0010 |
| MARX CR 101-15 | 101-15-10500-2036 |
| PETERSON CR 111-50 | 111-50-10100 |
| RALPHS CR 112-21 | 112-21-10060 |
| REDOUBT LK 113-41 | 113-41-10440-0010 |
| SALMON CR 111-40 | 111-40-10150 |
| SALMON LK 113-41 | 113-41-10320-0010 |
| SALMON R 101-15 | 101-15-10500 |
| SANDY COVE CR 113-41 (NOT NAMED) | 113-41-10400 |
| SAWMILL CR 115-20 | 115-20-10520 |
| SLOCUM CR 111-32 | 111-32-10990 |
| TAKU R 111-32 | 111-32-10320 |
| TRAITORS CR 101-90 | 101-90-10290 |
| UNUK R 101-75 | 101-75-10300 |
| VIRGINIA LK 107-40 | 107-40-10070-0010 |
| WALKER CR 101-80 (HATCHERY CR) | 101-80-10680-2030 |
| WARD CR 101-47 | 101-47-10150 |