Dungeness River Chinook Salmon Rebuilding Project

Progress Report 1993-1999

by

Bill Freymond, Chris Marlowe, Robert W. Rogers and Greg Volkhardt
Washington Department of Fish and Wildlife
Fish Program

Edited by
Chris Marlowe
Washington Department of Fish and Wildlife

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Abstract

Fish production from the Dungeness River chinook captive brood stock project and associated evaluation and monitoring efforts are reported for the time period spring 1993 through the releases of the 1999 brood year fry and smolts in summer 2000.

The annual average Dungeness system adult chinook spawner escapement estimates from 1986 through 1999 is 147, ranging from 45 to 335. Timing and location of redds by river sections are summarized for 1992 through 1999.

The origins of the fresh water and sea pen chinook brood stocks; the maturation and spawning of the mature captive brood stock; the incubation, marking and releases of the brood stock progeny, and fish health monitoring and treatment efforts are reported. Through the 1999 brood year, 2,290 crosses were made which yielded 7,478,000 ponded fry over the five reporting years. Estimates of anticipated production levels are projected for the remainder of the project. Adult returns from the project in return year 1999 are reported.

Fish health observations and treatments for the freshwater captive brood stock are outlined. Treatments administered to pre-spawning brood stock and results of pathogen screens done on all spawned fish are reported.

Estimates are presented of the numbers of downstream migrant chinook progeny from the captive brood program made at a calibrated migrant fish trap which operated in 1996 and 1997. Detailed methods for enumeration of wild and project origin smolt from the trap data are described. Survival estimates from release site to the trap site for release groups in 1997 consistently ranged from 21 to 23%. Survivals in 1996 were much more variable, ranging from 2% to 32%. These results and possible explanations are provided.

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Introduction

This is the second progress report on the captive brood stock effort aimed at restoration of the Dungeness River's chinook salmon. The first report, Smith and Wampler, 1995, summarized the stock status, described the rationale for the program and its strategies, described methods used and summarized the first year's (1992-93) results in establishing the captive brood stock program. This report summarizes the captive brood stock project's production and in-river evaluation efforts from the spring of 1993 through August 2000.

Program Formation

The Dungeness River Chinook Salmon Rebuilding Project (DRCSRP) was officially founded in December of 1991 with the signing of a Memorandum of Understanding among Long Live The Kings (private, non-profit conservation group), National Marine Fisheries Service (NMFS), Point No Point Treaty Council, U.S. Fish and Wildlife Service (USFWS), and Washington Department of Fish and Wildlife (WDFW). The rebuilding program has been developed and implemented by the Dungeness River Wild Chinook Restoration Steering Committee, which originally had representation from the above federal and state agencies, tribal government, and Long Live The Kings. Since 1996 the steering committee participation has been limited to WDFW and the Jamestown S'Klallam Tribe. Several regional enhancement groups and sportsmen's associations have also participated in the rebuilding program with countless volunteer hours.

Background

In the early to mid 1980s, elected officials of Clallam County grew concerned about the decline in abundance of chinook salmon (*Oncorhynchus tshawytscha*) in the Dungeness River and appointed a Dungeness River Management Team to address this decline as well as other river-related problems. An outgrowth of this effort resulted in extensive in-river spawner escapement surveys consisting of snorkel surveys by the USFWS and redd monitoring by WDFW. The snorkel surveys were conducted in 1981, 1982, 1986, and 1987, while the redd monitoring started in 1986 and continues to date. Information from these surveys led the state and the tribe to list the stock as "critical" based upon chronically depressed levels of spawners (WDF et al. 1993). This classification is reserved for stocks in jeopardy of a significant loss of within-stock diversity or at risk of extinction. Concern for the long-term future of this stock was heightened by the unstable ecological conditions in the Dungeness River. The depressed and vulnerable condition of this stock led to the establishment of the Dungeness River Chinook Salmon Rebuilding Project. In March 1999 the National Marine Fisheries Service listed Puget Sound chinook as threatened under the Endangered Species Act. The Puget Sound ecologically significant unit includes the Dungeness River stock.

Goal

The overall goal of the project is to provide a self-sustaining, natural population that maintains the genetic characteristics of the existing chinook salmon stock and meets the agreed-to escapement goal in three out of every four years by the year 2008. The current agreed-to escapement goal is 925 fish per year.

The goal of the rebuilding program is to provide a healthy, self-sustaining population that maintains the genetic characteristics of the existing chinook salmon stock. The intent is to achieve a population size compatible with the Dungeness River basin, that will maintain an adequate effective population size, and that can withstand moderately adverse ecological impacts. It is recognized that the long-term success of the rebuilding program is dependent upon significant restoration of chinook salmon habitat in the Dungeness River and correcting other factors that limit production. A key procedure selected for rebuilding the chinook salmon population in the Dungeness River is development of, and expansion from, a captive brood stock. This report summarizes seven years of the captive brood stock effort. Other efforts regarding habitat assessment and restoration are not reported . It is recognized that the use of a captive brood stock methodology for wild stock restoration is experimental and is being undertaken with acknowledged risks to genetic integrity and the long-term health of the stock(s).

Objectives

To achieve the goal, the following objectives were defined (Smith and Wampler, 1995).

Genetic Objectives:

1. Collect a representative sample of the total population to establish the brood stock program and lessen the risk of genetic bottlenecks. Sample 25 chinook salmon families throughout the Dungeness River watershed annually for eight consecutive years.
2. Develop and follow a captive brood stock spawning protocol, including:
   a. Identifying individual spawners by reading tags prior to spawning,
   b. Avoid full-sibling matings,
   c. Using 1:1 spawning techniques,
   d. Recording all spawning crosses.
3. Lessen the risk of domestication effects by conducting the captive brood stock program for no more than two consecutive generations (eight years). After that time, evaluate the program before deciding whether or not to continue.

Natural Production:

1. Allow natural production to continue concurrent with the captive brood stock program by limiting the removal of pre-emergent fry from each redd and monitoring the post-emergent fry collection adjacent to each redd.
2. Design and implement experiments to estimate the level of mortality on the natural population caused by the sampling technique used to collect chinook salmon fry for the production objectives (below).
3. Modify the sampling technique if collection-induced mortality exceeds 25%.

Production Objectives:

1. Obtain 5,000 pre-emergent and post-emergent chinook salmon fry each year; 2,500 for a freshwater captive Brood stock program and 2,500 for a saltwater captive brood stock program.
2. Collect 200 chinook salmon fry from each family from a minimum of 25 families per year. If additional families are available, samples should be collected from as many families as possible and the numbers collected per family reduced proportionally until a total of 5,000 fry has been collected. Excess fry should be returned to their respective
3. Maintain family integrity throughout the project by using separate rearing units or fish mark/tagging techniques. collection site in the river as fed fry once pre-emergent and post-emergent fry collection activities have ceased. Production shortfall due to low numbers of families sampled within any given year should be made up in succeeding years.
4. Rear fry to spawning adults with a total mortality of 50% or less in each family.
5. Release progeny back into the river in a manner that mimics the natural life history characteristics of the stock, has a high likelihood of success, and can be monitored and evaluated.
6. Compare the saltwater and freshwater captive Brood stock programs for operational and technical effectiveness. Report the findings in a technical or progress report.

Monitoring and Evaluation:

1. Coded-wire tag a statistically valid proportion of each release strategy.
2. Support a sampling rate of at least 20% in fisheries to which this stock contributes. Evaluate coded-wire tag recoveries to assess marine survival, stock distribution, and fishery contribution rates. Recommend harvest adjustments if the exploitation rate exceeds 60%.
3. Continue to conduct spawner surveys to:
   a. Estimate escapement and recover coded-wire tags,
   b. Sample at least 20% of the escapement for the presence of tags,
   c. Evaluate recoveries to assess spawner success from different release strategies.

Changes to Objectives Since 1995

Since the above listed objectives were defined, some have been modified, often based on realities and practical constraints, in the following ways:

Genetic Objectives:

1. The objective to sample 25 families was not achievable at times because of the low numbers of redds in the river and/ or high or turbid water conditions during collection periods.
2. The spawning protocol was modified as described in Chapter 5. Spawning was allowed prior to the reading of tags when very large numbers of spawners made pre-identification impractical.
3. The time period for brood stock collection was reduced to six years after recognition that the progeny of the project's jack returns should not be included in the brood stock in order to try and meet the goal of minimizing the risk of domestication selection.

Natural Production Objectives:

1. As described later, collection of brood stock was switched from pre-emergent fry to eyed egg collection.
2. No experiments on the effects of redd sampling on remaining fry in the redds was possible due to the large numbers of redds required for a valid experiment.

Production Objectives:

1. Fry collection goals were reduced when the estimated brood stock mortalities used in the initial planning phases proved to be too high. Lower mortalities during the rearing and tagging of the brood stock allowed fewer fish to be captured while achieving target green egg take levels of approximately 1.2 million.

Monitoring and Evaluation Objectives:

1. Coded-wire tagging of each release strategy was not achieved due to funding shortfalls for coded-wire tagging and difficulties rearing fry to tagging size at the appropriate time. Other marking strategies which had lower cost and were not dependent on size were employed to try and achieve monitoring and evaluation objectives.

Stock Status

(Bill Freymond)

The Dungeness wild chinook is considered a spring/summer stock of native origin. This section of the report will focus on stock assessment activities that have been conducted from the time of the first progress report in 1992-93 through spawner surveys of 1999. Stock assessment activities have focused on two main areas: 1) intensive spawning ground surveys conducted from August through October annually; and 2) out-migrant monitoring in 1996 and 1997.

Historical Abundance and Timing

An excellent historical perspective of Dungeness chinook abundance, sto include: 1) The ck identification, run timing, hatchery production and harvest impacts is presented in the original progress report of this program (Smith and Wampler, edit. 1995). Pertinent information provided by Carol Smith (WDFW) and Brad Sele (Jamestown S'Klallam Tribe) number of chinook counted at a single-barrier rack placed in the river near the Dungeness Hatchery ranged from 600-850 fish/year in the 1930s, dropped to about 300 fish/year in the mid–1940s through the 1950s, followed by a peak count of 1,305 in 1959 with a steady decrease annually (with the exceptions of two spikes of nearly 600 fish/year in 1962 and 1972) until the mid '70s and early '80s when counts were consistently below 100 fish/year. The rack was removed from the river in 1982; 2) analysis of geographical and temporal distributions of chinook redds resulted in the Restoration Committee agreement that only one stock of chinook exists in the river; 3) although precise run entry timing is unknown, the average start of spawning activity near the hatchery (August 18) is very similar to the average first arrival timing at the rack from 1938-81 (August 15); and 4) harvest impacts on this stock are basically unmeasured, however, a number of measures have been taken to minimize harvest impact. Those measures include: a) no chinook salmon fisheries allowed in the Dungeness River; b) no chinook harvest allowed in the Strait of Juan de Fuca recreational and commercial fisheries from April 15 through June 15; c) coho fishing delayed in the Dungeness River until October 15 (after chinook spawning has ceased); d) the recreational fishery in Dungeness Bay open to coho only in October, e) the steelhead fishery in river closed during August and thru October 15th and f) all Dungeness Bay commercial net fisheries must release all chinook unharmed.

Current Escapements/Monitoring Activities

The current agreed to escapement goal for chinook in the Dungeness River system is 925 spawners. This value was arrived at jointly by WDFW and the Jamestown S'Klallam tribe in 1994 and is based on an estimated 25.7 miles of available habitat and using a factor of 36 chinook spawners per river mile.

Estimated escapements from 1986 through 1991 ranged from 88 to 335 fish (Table 1). Since the beginning of the chinook restoration project in 1992, escapements have ranged from a low of 45 in 1993 (4.8% of escapement goal) to a high of 177 (19.1% of escapement goal) in 1996.

Table 1. Chinook salmon escapement estimates for the Dungeness River, 1986-99.

Return Year	Escapement
1986	238
1987	100
1988	335
1989	88
1990	310
1991	163
1992	150
1993	45
1994	58
1995	163
1996	177
1997	50
1998	110
1999	75
Average	147

Intensive spawner surveys have continued since the 92-93 progress report. The Dungeness River is divided into eight sections between the mouth up and river mile 18.7 at Gold Creek. The lower Gray Wolf River is also surveyed with results presented as footnotes at the bottom of Tables 2 and 3. Each section is usually surveyed weekly with some start dates later than others depending on location. During the years of brood stock collection, 1992-1997, in addition to redds being flagged, the specific locations were mapped for later fry/egg pumping efforts. During all spawner surveys, live and dead fish were counted and scale samples taken from all carcasses encountered.

Escapement estimates are calculated by multiplying the annual cumulative redd count by 2.5, which is the estimated average number of adults each redd represents. This expansion factor was developed from a study on the Skagit River (Orrell, 1976).

The number of chinook redds counted in the Dungeness and Graywolf Rivers ranged from 18 in 1993 to 71 in 1996 (Tables 2 and 3). Redd distribution in the mainstem Dungeness is summarized for three river segments, river miles 0-6.4; 6.4-10.8 and 10.8-18.7 and are presented in Table 3. Since 1992, 43% of redds have been observed in the lower 6.4 miles, 29% in the middle segment and 28% in the uppermost segment which ends at the documented limit of chinook spawning.

Table 2. Chinook redd counts by two-week periods in the Dungeness River, 1992-99.

Year[a]	Number of Chinook Redds by 2-week Period						
	Aug. 1-15	Aug. 16-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Totals
1992	0	20	20	15	5	0	60
1993[b]	0	9	5	4	0	0	18
1994	0	11	5	3	2	2	23
1995	0	5	28	25	6	1	65
1996	1	8	30	29	3	0	71
1997	3	5	10	2	0	0	20
1998	0	3	8	20	11	2	44
1999[c]	0	0	6	17	6	1	30
Totals	4	61	112	115	33	6	331
Avg. Prop.	0.01	0.18	0.34	0.35	0.10	0.02	

[a] 1992: 1 additional redd observed in the lower Graywolf.
1994: 3 additional redds observed in the lower Graywolf.
1996: 2 additional redds observed in the lower Graywolf.
[b] Seven of the redds originally counted were later determined to be pink salmon redds and are not included here.
[c] High water/poor survey conditions in August.

Table 3. Chinook redd counts by section of Dungeness River, 1992-99.

Year[a]	Number of Chinook Redds by Section			
	RM 0-6.4	RM 6.4-10.8	RM 10.8-18.7	Totals
1992	20	10	30	60
1993[b]	3	7	8	18
1994	6	2	15	23
1995	37	24	4	65
1996	36	24	11	71
1997	2	6	12	20
1998	22	15	7	44
1999	18	9	3	30

[a] 1992: 1 additional redd observed in the lower Graywolf.
1994: 3 additional redds observed in the lower Graywolf.
1996: 2 additional redds observed in the lower Graywolf.
[b] Seven of the redds originally counted were later determined to be pink salmon redds.

In most years, the earliest redd construction is in the upper river (RM 10.8-18.7) and begins in mid-August. Exceptions were observed in 1995 when very few redds were constructed in the upper river and in 1997, when mid-river reach redds were counted early in August. Redd construction in the middle section (RM 6.4-10.8) generally begins in late August and runs through most of September. The lower river (RM 0-6.4) redd construction begins in September and extends well into October. Table 2 summarizes in two week intervals the time of redd formation in the mainstem Dungeness from 1992 thru brood year 1999. The occasional chinook redds observed in the lower Gray Wolf River are footnoted.

Captive Brood Stock Program

(Chris Marlowe)

Collection Methods

Groups of pre-emergent fry, or eyed eggs ("families") were extracted from identified chinook redds using a hydraulic redd sampler starting in spring 1993 (1992 brood year) (Smith and Wampler, 1995) and continuing through brood year 1997. While electro-fishing was also used for the 1992 through 1995 brood year collections, after 1993, it accounted for progressively fewer and fewer of the brood stock collected. Electro-fishing was eventually phased out due to high pre- and post-tagging mortality as well as concerns for long–term mortality of both the brood stock animals and any un-captured fish in the river which had been exposed to the electrical field.

By 1995 only 71 of 2,391 fish were captured using electro-fishing. Electro-fishing captured fry were consolidated into groupings ("electro shock families") according to the river reaches in which they were collected. Consolidation was needed for good fish husbandry and to provide sufficient numbers to elicit good feeding behavior. Consolidation was also used to help manage the 1995 spawning such that fish from these "ES" groups could only be crossed with fry from pumped redds in the lower river. The assumption was that t he emerged fish did not move upstream and therefore the chances of full sibling (sib) crosses would be reduced.

Table 4 shows the numbers of rearing groups and their method of capture by brood year.

Table 4. Number of rearing groups and capture method by brood year.

Brood Year	Number of electrofishing groups	Number of redd-pumped "Families
1992	5	14
1993	8	4
1994	2	13
1995	1	39
1996	0	46
1997	0	9

The redd pumped collections in 1992 and 1993 were timed to collect fry which were just ready to emerge ("pre-emergent") from the gravel in the early spring. However, low success rates (i.e.,low number of redds from which fry were collected compared to the total number of redds attempted) led to a change in strategy for brood year 1994 collections. The collection effort was switched to a late fall period when redd contours were still visible and the eggs were calculated to be at the eyed egg stage and when redd contours were still visible in the river bed. This switch in collection strategy led to much higher success rates. The switch to eyed egg pumping was also prompted out of a desire to obtain fish from as many redds as possible before winter high water events caused streambed scouring, making successful pumping difficult in the early spring. The increased success rate and availability of more redds to sampling in the late fall contributed to the project's increased numbers of families taken for the brood stock program.

Early Rearing Protocol

All captured eggs/fry were brought back to the WDFW Hurd Creek Hatchery located on the lower Dungeness River near Sequim, WA . Fry were enumerated and kept segregated in small rearing troughs inside the hatchery. These troughs were supplied with pathogen free ground water, and for eggs/ fish collected early in the season chilled water was used to minimize the difference in developmental stages of early and late collected eggs/fish. Eyed eggs were incubated in vertical rearing trays.

After swim-up, the family groups were placed directly into separate 4 foot diameter circular tanks with 24 cubic feet of rearing space. The Hurd Creek facility has 30 such tanks to accommodate the program goal of 25 families per year. During early rearing and initial feeding, flow to the tanks was maintained at 1 to 2 gallons per minute (gpm.) which kept the circular current, or spin, to a minimum. This allowed the fry time to acclimate and start feeding. After approximately 3 to 4 weeks, flow was increased to 5gpm. A medium to strong spin was maintained in the rearing tanks for the remainder of the juvenile rearing cycle. This flow facilitated tank cleaning and is believed to have contributed to good fish health. Half of each tank had a opaque cover to prevent visual disturbances to the fish during feeding. Rearing densities never exceeded 0.55 lb/cu. ft. in the 4 foot. tanks and averaged under 0.5 lb/cu. ft. Family groups were reared in the 4 foot tanks until time of tagging after which they were moved to 20 foot diameter grow out tanks. Density routinely approached one lb/cu. ft. in the 20 foot. grow out tanks as the date for the transfer of maturing fish approached.

The program size goals for coded wire tagging was 20 fish per pound (fpp) which was usually attained by early September when the fish were approximately 1 year old. Fish determined to be in excess of program requirements were released back to the river near their original capture point prior to tagging. "Excess" fish occurred because the redd pumping process occasionally hit dense "pockets" of eggs and large numbers of eggs were collected in a few seconds which led to more eggs than the per family collection goal. Additionally, the collection goal per redd changed during the course of a collection season, as more or less redds were successfully sampled.

Standard WDFW rearing protocols which call for two prophylactic Erythromycin treatments for Bacterial Kidney Disease (BKD) when rearing yearling chinook were used. No other therapeutic treatments were administered to any group reared in the 4 foot circular tanks.

Tagging

Tagging of family groups for future identification was done after the fish reached at least 20 fpp (21 grams). Two different tags in three body locations were used to maintain family identification integrity. A visual implant (V.I.) tag was placed in the left adipose eye tissue, a standard coded–wire tag (CWT) was injected in the snout and an additional CWT was placed in the adipose fin. The redundant tagging protocol helped ensure identification in the event of a lost tag. After tagging fish were transferred to their grow out facility, either to the freshwater 20 foot tanks at Hurd Creek or to the South Sound Net Pen (SSNP) facility.

Half of the 1993-96 brood years' collections were so divided and reared separately. Dividing of each family/ collection group into fresh water reared and sea water reared halves was done to protect against catastrophic loss of a complete brood year, or in worst case, the entire program. Additionally, it allowed the project to compare saltwater and freshwater reared chinook brood stock performance.

Table 5 shows the numbers of tagged fish retained in each of the brood stock components.

Table 5. Tagged fish retained in each of the brood stock components.

Brood Year	Number of freshwater brood	Number in sea pens brood	Total Number
1992	3,694	0	3,694
1993	787	728	1,515
1994	1,205	1,185	2,390
1995	1,189	1,197	2,386
1996[a]	1,193	323	1,516
1997	1,189	0	1,189

[a] In April 1998, 240 brood stock fish of the 1996 brood year were moved to the NMFS captive brood stock facility at Manchester, WA for rearing in pathogen free seawater tanks as an alternative to SSNP where disease and toxic algal blooms were significant sources of mortality. It was hoped that these fish might be a source of males if males became limiting in future spawning.

Table 1A and 1B of Appendix A summarizes the number of fry from each of the family/groups which were the basis of the brood stock programs at Hurd Creek Hatchery (freshwater) and at SSNP (saltwater) from brood year 1995 through 1997. As indicated, these are the numbers tagged and do not reflect any fry mortality prior to tagging or numbers of fish which were returned prior to tagging to the river as surplus to project needs.

Throughout this report families are designated by a number representing the last digit or last two digits of the brood year followed by their family code. Thus 4A3 or 94-A3 is family A3 from brood year 1994. In the 1992 brood year collections, all group/family names which start with the letters ES are electro-fishing collected groups and are a consolidation of some smaller collections which were combined to form the ES groups. These "ES" designations are then referred to throughout the rest of this report (e.g.,92-ES3). In the 1993-95 collections electro-fishing collected groups are designated by having the letters EL at the end of their names (e.g., 93-D7EL). In the 1995 brood year collections, the high number of collection groups required the consolidation of two families into each of the 4–foot diameter rearing tanks prior to tagging. To keep these families identifiable for later tagging, one of the families destined for each of the tanks was left vent clipped while the other remained un-clipped. These families are designated by names which end in the letters LV (e.g., C5LV) and which follow the other conventions described for 1993 and 1994. For the brood years 1996 and 1997 the naming convention was shortened to the last digit of the brood year and the 2 character family name with no hyphenation (e.g. 6C2).

One other caveat regarding family coding and identification can be seen in Table D1, Appendix D. In that table, a list of all the CWT codes and associated families in the brood stock there are four CWTs presented in bold font. These four codes, two pairs of two, are sets of codes which were accidently used to code two families with the same code. In the case of code 63 49 58 used for families 94 B6EL and 96 6Z1, it was often possible at spawning to separate the two families because the two–year difference in age made fish size a distinguishing feature. Throughout this report the family identification for fish with this code are reported unambiguously for these two families when there was size information available. In cases where no size information was available, a joint identification is given(i.e., 4B6EL/6Z1). For the code, 63 56 17, both families were from the same brood year and were indistinguishable by size at spawning and are reported as 5A1/5C2.

Rearing to Maturation

Freshwater Component

After tagging, 1,200 fish per brood year, representing all of that year's families as equally as possible, were combined and transferred to the 20 foot circular tanks for rearing. Each tank contained 1,250 cubic feet of rearing space, with 100 gpm of water flow. Fish were held in the 20 foot tanks without handling or sampling until late July of the following year when any maturing fish were sorted out of the population. After the maturing 2–year old males ("jacks") were removed, the remaining fish were then divided into three ponds (approximately 350 fish per pond) for continued rearing. At the end of the third year of rearing, maturing males and females (small percentage) were removed from the population for spawning. The remaining fish were further divided into five ponds for continued rearing. At the end of the fourth year of rearing, maturing males (most of those remaining) and females were removed from the population for spawning. The remaining fish were divided into ponds at about 125 fish per pond. As the numbers of remaining fish in multiple brood years diminished, two brood years were consolidated into a single tank. This minimal handling policy of the fish except for the removal of maturing fish is believed to have contributed significantly to the high rates of survival from collected egg/ fry to maturation experienced by this program.

Feeding was done once a day, every day, for most of the year. Feeding was to approximately 75% of satiation each day, so the percent of body weight fed varied from day–to–day. The first three brood years (1992-94) were fed Bio Products diet grower for two years and BioDiet brood for the remainder of their rearing. The most recent broods (1995-97) were fed Moore Clark's Fry for the first two years and Moore Clark's Pedigree Trout Brood diet for the remainder of rearing.

Feeding was reduced as the fish approached maturation. Nine weeks prior to sorting (late May) feeding was reduced to five days per week. At five weeks prior to sorting, feeding was reduced to three days per week. Three weeks prior to sorting, feeding was stopped. This was done for two reasons: the first was to try and duplicate the normal condition of naturally returning adults; and the second was that it helps with the sorting out of maturing adults. The non–maturing fish lose some weight which makes them easier to tell from the maturing fish which continue to develop more rounded, full abdomens, due to gamete development.

Sea Pen (saltwater) Component

Starting in December 1994, a sea water phase of the Dungeness Spring Chinook captive brood stock program was started as insurance against a catastrophic failure in the fresh water brood stock program. A seawater based brood stock component was deemed desirable at the outset of the overall project because the practice of rearing chinook to maturity totally in fresh water was unproven, posing risk to a stock deemed to be at critically low abundance (see Chapter 5 in Smith and Wampler, 1995).

WDFW's SSNP had an ongoing sea–water brood stock of White River Spring Chinook (WRSC) operating from the spring 1989 until the fall 1997. Over the course of seven years the WRSC program produced an average of 850,000 green eggs per year with an average 68% successful egg to hatch rate. On average, 3,500 smolt at SSNP produced 766 adult spawners per year with a 22% survival of smolt to spawner product (3–year mature spawners and older) (Andy Appleby, WDFW, personal communication). At the time the Dungeness program was being started the White River Spring Chinook program was phasing out.

Four groups of brood year smolt (1993-96) from the Hurd Creek facility were transferred to SSNP. These sea–water transfers occurred from early to late winter with small pilot groups of 100 fish brought to SSNP a week in advance of the main groups to ensure transfer survival. Transfer groups consisted of smolts from all of the families being reared at Hurd Creek for the particular brood year's collections. Fish were transferred at 5-8/fpp with numbers ranging from 323 up to 1197 (see Table 5 above). Smolt acclimation survival was considered high with little or no visible loss observed during and after transfer. Because of the relatively few smolt numbers compared to the rearing capacity of the net pens, entire brood years were able to be reared from smolt to the older ages in one 40' x 40' x 18' net pen. Mesh size for the pens ranged from 5/8" to 3/4" (stretch) during the first year up to 2½" (stretch) mesh by the time the fish reached 2-3 lbs each. All pens were installed with bird predation control netting tightly secured over the top of the pens. Encircling predator nets, to prevent seal and dogfish shark predation, were also installed around the smaller mesh pens. The larger mesh pens with heavier gauge construction material were left without predator nets. From June through August frequent net changes (2-3 week intervals) were needed because of heavy levels of marine fouling organisms growing on the mesh.

BioDiet Brood (4.0 mm - 12.0 mm pellets) was hand fed 2-3 times daily on a 5–day schedule. Lower feed rates were maintained at times of low (less than 44°F) and high (exceeding 60°F) water temperatures. Optimum growing periods (temperature regimes 48°F - 56°F) occur approximately six months of the year with low winter and high summer ambient temperature capping potential growth capabilities. Feed rations for 3–year or older stocks were much reduced by mid–July with once a week feedings for the first two weeks of August. After this the fish were not fed until the maturing fish had been sorted out.

Annual physical inventories were accomplished when splitting or moving fish from one pen to another. This usually occurred once a year, coinciding with the separation of mature and non-maturing fish of the same year class. Accounting for mortality in the net pen rearing environment proved difficult. Dead fish were collected when they floated to the surface or during monthly diving surveys. Approximately 50% or more of the mortalities were not recovered. Possible explanations for the unaccounted losses include consumption of the fish by crabs from outside the pen, rapid disintegration of the carcass in warmer sea water, or cannibalism.

Besides inventory discrepancies, losses of fish occurred from diseases, algae toxins and pre– and post–spawning mortality. The causative agents for Bacterial kidney disease (BKD), vibrio and furunculosis were diagnosed periodically during the salt water rearing phase. The summer high water temperatures often contributed to these disease outbreaks. Losses due to vibrio and furunculosis were generally low and easily controlled using antibiotics. BKD was also diagnosed during colder water winter periods as well. Losses due to BKD occurred in the winters of 1996 and 1997 for brood year 1993 fish resulting in loss of more than 10% of the population. Brood year 1994 also experienced significant winter BKD losses in 1997. Brood year 1995 had only slight winter problems while brood year 1996 fish did not record a verified BKD loss. Therapeutic treatments of TM and erythromycin had been administered to help prevent losses due to BKD.

Pre–spawning mortality of maturing fish was observed prior to the freshwater transfer. BKD and high water temperatures are considered the likely cause. Sorting and handling losses of 1 to 9% occurred among the non–maturing fish within a few days after the mature fish had been transferred (late August and early September).

Two toxic algal mortality events occurred, with higher mortality experienced by the older fish. The first occurred on October 17-23, 1997. The non–mature fish had just recently finished a 10–day TM treatment for post handling infection and were feeding normally. Feeding stopped abruptly in mid–day on October 16, 1997. On the morning of October 17, numerous older (age 3+) fish were lethargic and near the surface with many fish convulsing, regurgitating feed and then dying. This kind of behavior lasted for approximately five days with peak loss counted on the 18th. By October 23, the loss had subsided. Severity of loss ranged from 80% in the oldest age Dungeness fish (1993 brood year) to 14% for the 2 year old animals. Toxicologic samples from swollen and discolored liver tissue showed traces of marine algal toxins. A second similar algal event occurred on June 24, 1998, mostly affecting the 1994 (4+) brood with a 44% loss.

Tables 6 shows the numbers and gender of the fish of SSNP origin by brood year which were transferred to Dungeness Hatchery for each year's spawning.

Table 6. Mature fish transferred from SSNP to Dungeness Hatchery for spawning			
Year of Maturity	Number of Females	Number of Males	Total matures transferred for spawning
1997	90	0	90
1998	75	308	383
1999	180	151	331
Total	345	459	804

In addition to the fish accounted for as spawned at the Dungeness Hatchery, 91 non–maturing fish were transferred to the Hurd Creek Hatchery in August 1999 when the SSNP project was terminated. These 77, 1996 brood year and 14, 1995 brood year fish all died shortly thereafter. Considering all factors, SSNP survival to maturity was 23% (804) of the 3433 (see Table 5) fish tagged and transferred to the net pens. It is not possible to compute brood year by brood year mortality rates due to lack to detailed records.

Weight Characteristics of Spawners

Tables 7 and 8 summarizes the average weights of freshwater and sea pen reared chinook captive brood stock at maturity.

Table 7. Average weight of freshwater reared chinook captive brood stock at maturity

Brood Year	Jacks	Females	Males	Females	Males	Females	Males	Females	Males	Largest Fish		Brood Year
	2YR	3YR		4YR		5YR		6YR		female	male	
	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	
1992	1.4	5.6	4.8	9.3	7.5	10.3	9.3	15.2	13.6	27		1993
1993	1.3	5.8	5.0	12.1	9.3	14.3	12.5	13.1	16.3		22	1992
1994	1.2	5.5	4.4	12.1	9.7	14.6	13.1					
1995	1.7	5.9	5.4	11.6	11.3							
1996	1.6	6.1	5.2									
1997	1.5											
Avg.	1.45	5.78	4.96	11.275	9.45	13.06	11.6	14.15	14.95			

Table 8. Average weight of net pen reared chinook captive brood stock at maturity.

Brood Year	Jacks	Females	Males	Females	Males	Females	Males	Females	Males	Largest Fish		Brood Year
	2YR	3YR		4YR		5YR		6YR		female	male	
	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	
1992	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
1993	nd	nd	nd	12.1	10.5	11.0	nd					
1994	1.2	nd	4.1	7.6	4.6	9.0	11.2					
1995	3.2	2.6	2.7	9.9	8.7							
1996	1.0	5.5	4.9									
1997												
Avg.	1.9	8.1	3.9	9.9	7.9	10.0	11.2					

Notes: There were no 1992 brood year fish reared in the net pens. nd= no data

General Handling Protocols of Spawners and Eggs

Handling of Mature Fish and Gametes

Protocols for the handling and spawning of maturing fish and the incubation of the resulting eggs were as follows. Exceptions to the general protocols and notes are provided after each spawning year's data.

Captive brood chinook were transferred from Hurd Creek and South Sound Net Pens to the Dungeness Hatchery in late July or early August. Fish were hauled in tank trucks at the standard rate of one pound of fish per gallon of water. Salt was added at the rate of 0.05 pounds per gallon of water. The fish were held at Dungeness in standard 10' x 100' raceways covered with black plastic. Loadings were maintained within the recommended guidelines of 0.5 cubic feet/pound of fish and 1gpm for each 15 pounds of fish. The fish received daily drip treatments of formalin at the standard dose of 167 ppm for fungus control.

Spawning began in late August or early September and continued once per week until all females had matured. During weeks when large numbers of fish matured, spawning took two consecutive days. The normal procedure consisted of killing approximately 25 females and 25 males (after checking for readiness to spawn). Immediately after killing males and females were numbered independently and consecutively. Fish were then brought into the hatchery building. Females were spawned by abdominal excision into separate 2–gallon, numbered buckets which were placed into a tote containing ice and wet burlap to maintain correct temperature. Males were spawned by abdominal "milking" into plastic (ziplock) bags, oxygenated and put on ice as well. The matings were completed after consulting with the genetic guidelines developed by the Technical Advisory Committee (TAC). In 1995 and 1996, identification of each fish was done prior to combining gametes so as to avoid full sibling crosses. As the number of families/groups increased (with the inclusion of the jacks from the 39 families of brood year 1995), the probability of full sib crosses decreased greatly. The need to have identification prior to spawning was dropped to speed up the spawning process. Family identification of each fish used in spawning continued, but not prior to the mixing of gametes.

Incubation and Hatching

Eggs were placed into vertical incubators (FAL), three females' eggs per tray, and disinfected and water hardened in an iodophore bath @ 100 ppm for one hour (standard practice). After disinfection water flow was set at 4gpm. Formalin treatments were administered every other day at the standard dose of 1,667 ppm for 15 minutes for the control of fungus. After the eggs acquired approximately 550-600 temperature units (TU) they were shocked and, within a few days, the dead eggs were removed. The remaining live eggs were sampled for size, enumerated and returned to the incubator trays containing an artificial substrate for hatching. The eggs hatched after acquiring the approximately 900 temperature units needed. The viable fry were placed in rearing containers. They were fed BioDiet starter and grower feed.

Table 9 summarizes the 5 years of egg production and survivals from green eggs through ponding for both the freshwater and sea pen components.

Table 9. Five year summary of egg production and survivals from green eggs to ponding

Year	1995-1999 Dungeness Chinook Egg Data					
	Eggs Taken	Egg Loss	% Egg Loss	Fry Loss	% Fry Loss	Fry Ponded
1995	42,803	9,914	23.16	11,797	35.9	21,092
1996	1,889,630	92,130	4.88	83,000	4.6	1,714,500
1997 FW	2,371,800	170,400	7.18	53,100	2.4	2,148,300
1997 SW	193,200	84,500	43.74	12,100	11.1	96,600
1998 FW	1,970,600	109,200	5.54	41,061	2.2	1,820,339
1998 SW	60,000	19,000	31.67	2,100	5.1	38,900
1999 FW	1,549,200	130,700	8.44	70,400	5.0	1,348,100
1999 SW	599,600	251,900	42.01	60,400	17.4	287,300

For each year when both freshwater(fw) and saltwater(sw) reared brood stock contributed, percent egg loss and percent fry losses were much higher in the saltwater reared component. Poor gamete quality in the saltwater reared females is the probable cause. It is hypothesized that either the warm water conditions at the SSNP in summer when ova were maturing or the timing of moving the maturing fish to the Dungeness Hatchery just prior to spawning could have caused the poor quality eggs.

Crosses Made 1995-99

There have been five years (1995-99) of spawning mature freshwater captive brood chinook and four of spawning sea pen reared brood stock (1996-99). Table 10 summarizes the crosses that have been made through the spawning of the 1999 brood year.

Table 10. Summary of the crosses made through the 1999 brood year's spawning

Spawning Year	Number of Freshwater Crosses	Number of Saltwater Crosses	Total Crosses
1995	9	0	9
1996	441	75	516
1997	664	59	723
1998	450	39	489
1999	425	128	553
Total	1,989 (87%)	301 (13%)	2,290

Cumulative Numbers and Replications of Family by Family Crosses, 1995-1999

Of the 2,290 artificial spawning crosses made from 1995 through 1999, there were 1,403 unique combinations of one year/family by another year/family. For example there were four times that fish from the year/ family 1992 D8 (designated 2D8) were spawned with fish from family 1994 A3

(4A3). The designation of this cross is 2D84A3. In tabulating these crosses it makes no difference whether the cross was made with eggs from a female of family 2D8 and milt from male of family 4A3 or milt from a male from 2D8 and eggs from a female of 4A3, only that the two year/ families' gametes were combined in a cross. The reported frequencies then are a tabulation of the numbers of times that a specific cross (e.g. 2D84A3) occurred during the five years of captive brood stock spawning. The ages of the fish when they were mature and spawned is not reflected in these numbers. Thus the males from the example family 4A3 could have been 2, 3, 4 or 5 years old when they matured and were used in a cross with any female from family 2D8. These frequencies are presented to provide a sense of the wide heterogeneity of the crosses that has been achieved in the production of the progeny of the captive brood stock using the project spawning protocols.

Table 11 summarizes the frequencies of the occurrence of all the unique crosses made through 1999. There were 973 (42.5%) crosses that occurred only once, 233 (10%) crosses that occurred twice and so on. Thus 52.5% of the crosses through 1999 were either unique or those two families had only been crossed one other time.

Electro- fishing caught brood stock contributed heavily to the spawning. Of the 57.5% of crosses where a particular cross occurred more than once, 498 (21.7% of the total crosses) involved at least one fish of the pair being from one of the electro-fishing collected groups. These collections of "electro-shocked" animals are presumably more diverse in their parental origins than the "families" which were pumped from individual redds, and therefore add higher genetic diversity to the brood stock progeny. The 6 most replicated crosses to date (73 total, 3.2% of the total) included at least one of these electro-fishing captured animal. The electro-fishing captured animals have accounted for 913 of the 4,580 fish used in crosses through 1999.

Table 11. Number of replicates of unique crosses made through the 1999 spawning.

Freq.	1	2	3	4	5	6	7	8	9	10	11	13	17
#	973	233	81	55	27	13	8	5	2	2	1	1	1

Twenty eight crosses were made where both male and female were from the same brood year/family group (i.e., full sib crosses). These full sib crosses occurred either accidentally in the first two years of spawning when all fish were identified before the gametes were mixed or are the result of the relaxation of the spawning protocol requirements in 1997, 98 and 99 when random crosses without prior identification was allowed for the sake of speeding up the spawning process. Appendix Table B1 lists all the crosses made between 1995 and 1999 and how many of each particular cross have been made.

Cumulative Brood Year Contributions to the Crosses

Table 12 summarizes the brood year by brood year contributions and the number of animals that were of unknown brood year origin in the brood stock crosses through 1999.

Table 12. Brood year contributions through 1999 spawnings							
Brood year	1992	1993	1994	1995	1996	1997	unknown
# Spawners	1594	570	1095	811	470	22	32
% Total Spawners	34.9	12.4	23.9	17.7	10.3	.5	.7

Cumulative Family Contributions to Progeny

A total of 152 families were involved in at least one cross through 1999. Table B2 in Appendix B summarizes the numbers and the percent of total numbers of spawners which the fish from each of the families/ groups have contributed through the 1999 spawning year. Table B2 follows the year/family naming convention described above.

Year by Year Results and Notes

Changes from the basic protocol, events of note or observations regarding each spawning year are presented below. Details of each days egg take, including origin of the brood stock used (i.e., freshwater or saltwater reared) , the numbers of eggs taken, the numbers successfully surviving to the eyed stage and then to the yolk sac adsorption stage ("ponding") are presented in the tables of Appendix C.

1995 Spawning and Early Rearing

There were nine, 3–year old (1992 brood) captive brood chinook females which were spawned at Hurd Creek in 1995. The eggs were taken to Dungeness Hatchery for incubation and rearing. Upon arrival at Dungeness Hatchery, eggs were placed into vertical incubators, one females' eggs per tray. Hatching success varied between individual female's eggs. Table C1, Appendix C shows the fertilization, hatching and ponding inventories of each of these crosses. The egg loss was due to either infertility (known as blanks) or death after partial development. The fry loss appeared to be related to a hard shell condition of the eggs (cause was not determined). Many of the fry died only partially hatched. Of the 42,803 green eggs taken, 21,092 survived to ponding, a 49.3 percent survival rate. The remaining fry were placed in rearing containers after acquiring approximately 1,600 temperature units. They were fed BioDiet starter and grower feed. Cataracts were noted in a portion of the remaining fry (cause was never determined). All fry were marked with an adipose clip and given a coded–wire-tag and released into the upper Dungeness River watershed. See this report's section on tagging/marking for more detail regarding tagging and release groups.

1996 Spawning and Early Rearing

Dungeness captive brood chinook were transferred to Dungeness Hatchery from Hurd Creek and South Sound Net Pens between July 29 and August 30, 1996.

The year classes and numbers transferred are listed below (Table 13).

Table 13. Year classes and numbers transferred for spawning in 1996.						
Brood Year	Male Spawners/ Surplus	Female Spawners/ Surplus	Male Mortalities	Female Mortalities	Total Males	Total Females
Hurd Creek- 1996						
1992	292	515	12	6	304	521
1993	25	6	0	0	25	6
1994	137	0	4	0	141	0
SSNP—There were 91 jacks from the 1994 brood year.						

Four hundred forty one crosses were made from freshwater origin adults and 75 from sea pen origin adults.

A total of 2,030,000 green eggs were taken in 6 spawning days. These eggs yielded 1,859,239 ponded fry, a 92% green egg to ponding survival rate. Details of each days egg take including origin of the brood stock used, numbers of eggs taken, numbers successfully surviving to the eyed stage and to "ponding" are included in Table C2, Appendix C.

During incubation, a portion of the eggs and or fry were otolith marked to distinguish them from other release groups (see marking, tagging section). This was accomplished by moving trays of eggs and alevins to an incubator supplied with heated water. This occurred at preset intervals so that a unique mark pattern was placed on the otolith. Time and space allowed the otolith thermal marking of 800,000 eggs/fry.

Fry were placed into rearing ponds between February 23, 1997, and April 30, 1997. The fry varied in size from 1,200 fpp to 1,548 fpp. All fish were fed BioDiet starter and BioDiet grower following feed manufacturers recommendations. Problems during the rearing cycle included cataracts of unknown origin, Bacterial Gill Disease and external parasites.

1997 Spawning and Early Rearing

Several changes occurred in the fish handling and spawning protocol for the 1997 egg collection compared with 1996. Due to water constraints at Hurd Creek, 380 adults were transferred to Dungeness Hatchery on April 10, 1997. Normally transfer of maturing fish from Hurd Creek is done in early August. Because the fish had not yet begun to show signs of sexual maturity, some 5–year old, non–maturing "brights" were inadvertently transferred as well. These fish either died during handling or were killed and donated to the local food bank.

In addition to the 380 adults mentioned above an additional 80 females and 20 males from the 1992 brood were donated directly from the Hurd Creek Hatchery to the Sequim, Washington Food Bank to further manage water constraints at Hurd Creek.

Prior to spawning, the chinook were identified by family, either by reading the Visual Implant tag behind the eye or the CWT from the adipose fin. A corresponding spaghetti tag was inserted under the dorsal fin. This identification was initiated in 1997 to speed the spawning operation by allowing quick identification instead of having to read each CWT while the stripped gametes waited on ice. The spaghetti tag pre- identification took three days, with a crew of five working each day. This procedure was abandoned after 1997 due to: 1) the need to cut the VI tags out of the fish before reading could be done because tissue had over grown the tag making them unreadable without excision, and 2) the high loss rate of the spaghetti tags between the time of tagging and spawning. The high spaghetti tag loss is thought to be caused by pre–spawning nipping and biting behavior in the raceways by the maturing fish.

The following sources, brood years and numbers of fish were transferred to the Dungeness Hatchery for the 1997 spawning effort (Table 14).

Table 14. Brood year and number of fish transferred for 1997 spawning.

Brood Year	Male Spawners/ Surplus	Female Spawners/ Surplus	Male Mortalities	Female Mortalities	Total Males	Total Females
Hurd Creek- 1997						
1992	264	515	23	47	287	562
1993	98	183	3	4	101	187
1994	228	6	7	1	235	7
1995	105	1	1	0	106	1
SSNP-1997						
1993	21	69	4	21	25	90
1994	40	0	30	0	70	0
1995	9	0	17	0	26	0

There were 664 crosses made from freshwater origin adults and 59 from sea pen origin adults which yielded 2,565,000 green eggs in 6 spawning weeks. These eggs yielded 2,244,900 ponded fry. The freshwater component had a 90% survival to ponding rate while the saltwater component's survival to ponding rate was 50%. Details of each days egg take for 1997, including origin of the brood stock used, numbers of eggs taken, numbers successfully surviving to the eyed stage and "ponding" are given in Table C3, Appendix C.

1998 Spawning and Early Rearing

The following sources, brood years and numbers of fish were transferred to the Dungeness Hatchery for spawning in 1998 (Table 15).

Table 15. Brood year and number of fish transferred for spawning in 1998.

Brood Year	Male Spawners/ Surplus	Female Spawners/ Surplus	Male Mortalities	Female Mortalities	Total Males	Total Females
Hurd Creek- 1998						
1992	33	26	1	3	34	29
1993	48	85	5	20	53	105
1994	111	355	2	13	113	368
1995	83	7	5	1	88	8
1996	171	0	18	0	189	0
SSNP-1998						
1993	0	1	0	0	0	1
1994	9	28	3	1	12	29
1995	88	16	170	29	258	45
1996	35	0	3	0	38	0

There were 450 crosses made from freshwater origin adults and 39 from sea pen origin adults which yielded 2,030,600 green eggs taken over 7 spawning weeks, four of which included 2 spawn days. These eggs yielded 1,859,239 ponded fry. The freshwater component had a 92% survival to ponding rate while the saltwater component's survival to ponding rate was 65%. Details of each days egg take in 1998, including origin of the brood stock used, numbers of eggs taken, numbers successfully surviving to the eyed stage and then to"ponding" are given in Table C4, Appendix C.

1999 Spawning and Early Rearing

The SSNP portion of the project was terminated at the time of mature adult transfers in 1999. The remainder of the SSNP fish were transported to the two hatcheries in the Dungeness River Basin. All of the matures were taken to Dungeness Hatchery to be used in the 1999 spawning and are accounted for in the table below. Ninety-one non maturing fish were taken to Hurd Creek for lack of another site where they died.

The following sources, brood years and numbers of fish were transferred for spawning (Table 16):

Table 16. Brood year and number of fish transferred for 1999 spawning.

Brood Year	Male Spawners/ Surplus	Female Spawners/ Surplus	Male Mortalities	Female Mortalities	Total Males	Total Females
Hurd Creek- 1999						
1992	5	2	0	2	5	4
1993	19	27	0	3	19	30
1994	48	102	4	11	52	113
1995	184	259	8	12	192	271
1996	169	38	11	2	180	40
1997	88	0	10	0	98	0
SSNP- 1999						
1994	1	3	0	1	1	4
1995	47	128	0	3	47	131
1996	98	44	5	1	103	45

There were 425 crosses made from freshwater origin adults and 128 from sea pen origin adults which yielded 2,147,800 green eggs taken over 7 spawning weeks, five of which included two days of spawning. These eggs yielded 1,630,100 ponded fry. The freshwater component had a 87% survival to ponding rate while the saltwater component's survival to ponding rate was 48%. Details of each days egg take including origin of the brood stock used, numbers of eggs taken, numbers successfully surviving to the eyed stage and to "ponding" are included in Table C5, Appendix C.

Marking and Tagging

Marking and tagging were done with four objectives: the need to evaluate the project's success in returning adults to the spawning grounds, the desire to compare freshwater and sea pen rearing of brood stock, the hope of re–populating the upper portions of the watershed with adult chinook, and the need to evaluate fishery contributions.

Goals

The following were defined as the chinook captive brood stock project's prioritized marking/tagging goals:

A. Estimate the harvest rates and compile information on the distribution of the stock from tag recoveries in marine fisheries.
B. Estimate overall marine survival of project progeny.
C. Evaluate the rebuilding program's contributions to the subsequent spawning populations.
D. Allow for the estimation of wild smolt production through identification of project smolts if a lower river smolt trap was in operation.

E. Allow non–lethal identification of all returning project produced adults resulting from releases of fingerling/smolts from the Dungeness Hatchery ("on–station releases") to allow "management options" in the use of these adults, primarily distribution of pre–spawning adults into the upper watersheds if spawner survey results showed little spawning activity in those areas.
F. Evaluate project acclimation and release strategies on the production of smolts and returning adults.

The following table summarizes, by brood year, the achieved and estimated future production of fry/ 0+ smolts which the project was and will be tasked with marking/ tagging (Table 17).

Table 17. Actual and Anticipated Captive Brood Stock Progeny Release Totals, 1995-2002.

Brood Year	Release level or projected release level
1995	13,000
1996	1.8 million
1997	2.1 million
1998	1.8 million
1999	1.6 million
2000	2.5 million
2001	2.5 million
2002	756,000 *

* projected egg production based on survivals and fecundity to date.

Options Considered

In order to achieve the goals, the following marking options were considered singly or in combination:

1. Coded–wire tagging and associated techniques
   The costs of coded–wire tagging (CWT) plus adipose fin clipping at $111/1000 fish was too high to consider annually marking the approximately 1.8 million+ fingerling/ smolt. Even with blank wire tagging costs at $58/1000, and adipose clip only at $25/1000 the magnitude of the releases made wire (coded or blank) injection and/or fin clipping costs prohibitive. As described below, use of wire tagging and adipose fin removal combinations were chosen to meet a select number of the project evaluation goals.

2. Thermal marking of otoliths
   Thermal marking of otoliths (Volk et al. 1999) offered the project a potentially cost effective method of marking all project produced fish. Unfortunately the needed capital improvements to the electrical capacity of the Dungeness Hatchery in order to mark all or a large proportion of the project production were deemed prohibitive. Without additional power, there was only enough capacity to heat water for one and one half stacks of Heath trays. This allowed the marking of 200,000 eggs at a time. The availability of heated water and the compressed duration of the egg take, four or five weeks, limited the total number of alevins which could be marked to between 700,000 and 1 million per brood year. The cost of reading thermally

marked otolith specimens is estimated to be $25-30/fish. Thermal otolith marks work best in constant temperature rearing environments. Unfortunately the Dungeness Hatchery's water supply is river water which has its own thermally changing regime which will make detection and interpretation of the applied marks more difficult.

3. Otolith chemistry of freshwater reared captive brood stock
   Volk et al. (in press), showed that otolith core strontium concentrations reflect maternal associations with freshwater and seawater and that these concentrations are an effective natural marker for captive brood stock programs where fish are raised to maturity in freshwater. Because the majority of the project's spawners have been freshwater reared, otolith chemistry offered a very cost effective mark (i.e., no cost for applying the mark) to identify project from wild produced adults on the spawning grounds. The cost of $25-30 per recovered sample is similar to the cost of analyzing otolith thermal marks. Through brood year 1999 approximately 94% of the project's production has come from fresh water reared females. Since 1999 was the last brood year to use sea pen reared adults for production, 100 percent of the remaining years of production will be able to use otolith chemistry as the primary marking method to determining the project's contribution to the spawner population (Objective C).

For all of the otolith based mark strategies described above it will be necessary to get scale samples from the carcases so that age can be determined and the fish assigned to the correct brood year.

Chosen Strategies

In order to get estimates for the evaluation goals, the following strategies were chosen:

1. Harvest rates and stock distribution
   To meet harvest rate and stock distribution goals from fisheries, CWT plus adipose clip marking of at least 400,000 fingerling/smolt was planned for each production year. This mark strategy was reserved for the smolt releases from the acclimation pond (200,000) and, if funding was available, the first 200,000 fingerling "scatter plants" in the upper watershed. This strategy was carried out for brood years 1996 and 1997. For brood year 1998 and beyond the numbers of CWT+ adipose clip were reduced, with 100,000 CWT+ adipose clip being released from the acclimation pond and another 100,000 released into the upper watershed. The other 200,000 which would have been CWT+adipose clip were coded wire tagged only, with no adipose clip, and acclimated and/ or released in the same manner and locations as the previously described 200,000. This was done to control the impact that the newly created selective fisheries for hatchery fish could potentially have on any CWT+adipose clipped fish.

2. Estimate marine survival of project progeny
   A summary of all harvest CWT tag recoveries in sampled fisheries plus CWT recoveries on the spawning grounds of project fish will allow estimates of ocean distribution and overall marine survival of the project progeny.

3. Evaluation of adult returns from the rebuilding program
   To determine the project's contribution to any given return of adult spawners, recovery of otoliths and scales (minimum of 20%) is planned. All freshwater reared brood stock progeny will be identifiable by analysis of otolith core chemistry for strontium. For the project progeny whose brood stock was sea pen reared, otolith thermal marks will provide identification. Scale interpretation should allow assignment of each fish to the correct brood year.

4. Evaluate out-migration success of project smolts.
   A down-river smolt trap was used in 1996 and 1997 (See chapter in this report) and is planned in future years. Visual or wire detection identification of project fish at the smolt trap is necessary since project and naturally produced smolts will be present.

5. Non-lethal identification of all returning project produced adults which came from fingerling/smolts "on-station" hatchery releases.
   Tagging of all "on–station releases" with blank wire, with or without adipose fin clip, was and will be done to allow identification and potential movement of adult fish returning to the vicinity of the hatchery. In a year(s) when few adult spawners return to the upper watershed, these tagged adults can be identified, captured and transported to the "under seeded" upper watershed areas.

6. Evaluate release strategies in terms of adult spawners.
   The highest priority of this element is the evaluation of the Gray Wolf River acclimation pond. This facility was developed to return adults into the Gray Wolf River, where good spawning habitat is available but is by spawning chinook. Table 18 lists the releases and their marks from the acclimation pond through the 1999 brood releases. As mentioned in number one above, the marking strategy for acclimation pond releases has changed in response to the potential for selective chinook fisheries.

The evaluation of the success of scatter planted fingerlings in the upper watershed is to be done with otolith thermal marks and/ or ad-CWT marks. Additional fingerlings which are "on–station" releases from the Dungeness Hatchery itself are adipose fin clipped and blank wire tagged. As noted after the tables, some years there is a small number of fingerlings which would have been blank wire tagged but were too small at the time of tagging to accept a CWT.. These fish have been adipose clipped only before being released on station.

Funding for the sample collection and laboratory analyses of the above evaluations is still being sought.

Release Strategies

The priority and sequence for the release strategies and their mark groups was:

1. Acclimation pond— smolts, volitional release, 200K CWT plus ad-clip,

2. Acclimation pond— fingerling and forced release— 400K thermal otolith marked plus ad clipped
3. Fingerling scatter plants in the upper watershed—First 200K were CWT and ad clipped and any additional were ad clipped with a thermal otolith mark. For 1999-on this was changed to 100K CWT+ad clipped and 100K ad-clipped only.
4. All additional production to be fingerling and smolt releases from the Dungeness Hatchery.

These prioritized categories were filled chronologically by spawning date, with fry from the earlier spawning days used for the acclimation pond smolt releases, the next fry to the acclimation pond fingerling group, and so on. It had been hoped that any given release strategy could be filled with fry proportionally throughout the spawning season, but the logistics of otolith thermal marking prevented that strategy.

Table 18 summarize the releases, dates, marks, locations, sizes at release and life stage through the 1999 brood year. Following the table are year by year explanatory notes describing unusual

Table 18. Dungeness chinook captive brood program releases, 1995 through 1999.

Date of Release	Release Location	Life Stage At Release	Number Released	Size at Release	Type of Mark
Dungeness Chinook Captive Brood Program					
Marks and Releases for the 1995 Brood Year					
06/24/96	Dungeness Forks	Fingerling	900	159/lb	Ad+CWT
06/24/96	East Crossing	Fingerling	300	159/lb	Ad+CWT
06/24/96	Gold Creek	Fingerling	300	159/lb	Ad+CWT
06/24/96	Gray Wolf River	Fingerling	1,150	159/lb	Ad+CWT
08/30/96	Gray Wolf River	Smolt	1,115	35/lb	Ad+CWT
08/30/96	Gray Wolf River	Smolt	9,248	93/lb	Ad+CWT
	Total Number Released		**13,013**		
Marks and Releases for the 1996 Brood Year					
06/24/97	Gold Creek	Fingerling	94,100	294/lb	Ad+Otolith 2
06/24/97	Klink Bridge	Fingerling	98,200	294/lb	Ad+Otolith 3
06/30/97	Gray Wolf Acclimation Pond	Fingerling	387,750	163/lb	Ad+Otolith 1
07/09/97	East Crossing	Fingerling	219,152	218/lb	Ad+CWT
07/14-28/97	Gray Wolf Acclimation Pond	Smolt	196,300	115/lb	Ad+CWT
07/21-08/08/97	Dungeness Hatchery	Fingerling	482,071	161/lb	Blank Wire
08/01-08/97	Dungeness Hatchery	Fingerling	286,963	198/lb	Blank Wire
08/08/97	Dungeness Hatchery	Fingerling	10,000	300/lb	AD Only
	Total Number Released		**1,774,536**		
Marks and Releases for the 1997 Brood Year					

05/05/98	Gold Creek	Fingerling	51,900	478/lb	Otolith 2+Strontium
05/12/98	Gold Creek	Fingerling	109,000	426/lb	Otolith 2
05/12/98	East Crossing	Fingerling	170,400	426/lb	Otolith 2
05/18/98	Gold Creek	Fingerling	45,700	412/lb	Otolith 2+Strontium
06/12/98	Dungeness Hatchery	Fingerling	200,500	440/lb	None
06/18/98	Gray Wolf Acclimation Pond	Fingerling	362,500	201/lb	Otolith 1
07/06/98	East Crossing	Fingerling	97,554	178/lb	Ad+CWT
07/06/98	Gold Creek	Fingerling	121,274	178/lb	Ad+CWT

Table 18 (continued). Dungeness chinook captive brood program releases.

Date of Release	Release Location	Life State At Release	Number Released	Size at Release	Type of Mark
Marks and Releases for the 1997 Brood Year (continued)					
07/20/98	Gray Wolf Acclimation Pond	Smolt	217,100	89/lb	Ad+CWT
07/25/98	Dungeness Hatchery	Smolt	236,100	140/lb	Blank Wire
08/01/98	Dungeness Hatchery	Smolt	183,477	90/lb	Blank Wire
08/08/98	Dungeness Hatchery	Smolt	254,390	111/lb	Blank Wire
05/17-05/27/99	Hurd Creek Hatchery	Yearling	56,075	6/lb	Ad+CWT
	Total Number Released	Smolt	**2,106,060**		
Marks and Releases for the 1998 Brood Year					
06/01/99	Gray Wolf River Bridge	Fingerling	24,000	269/lb	Otolith 2+ Strontium
06/21/99	Gray Wolf River Bridge	Fingerling	393,600	370/lb	Otolith 1
06/29-07/10/99	Gray Wolf Acclimation Pond	Fingerling	360,000	297/lb	Otolith 2
08/03/99	Gray Wolf River Bridge	Smolt	106,032	122/lb	CWT only
08/06/99	Gray Wolf River Bridge	Smolt	106,241	122/lb	Ad CWT
08/03-10/99	Gray Wolf Acclimation Pond	Smolt	103,006	97/lb	Ad CWT
08/03-10/99	Gray Wolf Acclimation Pond	Smolt	105,823	97/lb	CWT only
08/11-15/99	Dungeness Hatchery	Smolt	272,000	115/lb	Blank Wire
08/20-25/99	Dungeness Hatchery	Smolt	144,700	115/lb	Blank Wire
08/20-295/99	Dungeness Hatchery	Smolt	159,800	99/lb	Blank Wire
	Total Number Released		**1,775,202**		
Marks and Releases for the 1999 Brood Year					
May 30, 2000	Gray Wolf River Bridge	Fingerling	55,600	384/lb	Otolith 2 + Strontium
June 9, 2000	Dungeness Forks	Fingerling	45,780	307/lb	Otolith 2
June 11, 2000	Gray Wolf Bridge	Fingerling	30,880	307/lb	Otolith 2
June 26, 2000	Gray Wolf Acclimation Pond	Fingerling	381,700	192/lb	Otolith 1
June 27, 2000	Dungeness Forks	Fingerling	115,397	167/lb	Otolith 2 + Strontium
July 18, 2000	Gray Wolf Bridge	Fingerling	53,941	167/lb	Otolith 2 + Strontium
July 18, 2000	Dungeness Forks	Smolt	99,955	131/lb	CWT only
July 21, 2000	Dungeness Forks	Smolt	99,945	131/lb	Ad CWT
July 21, 2000	Gray Wolf Acclimation Pond	Smolt	99,215	91/lb	CWT only
August 11,	Gray Wolf Acclimation Pond	Smolt	101,521	91/lb	Ad CWT
2000	Dungeness Hatchery	Smolt	220,802	109/lb	Blank Wire
August 18,	Dungeness Hatchery	Smolt	182,236	86/lb	Blank Wire
2000	Dungeness Hatchery	Fingerling	14,044	282/lb	Blank Wire
August 18,	**Total Number Released**		**1,501,116**		
2000					

Explanatory notes:

Smolt definition: Salmonid that is changing to adapt to the marine environment.

Fingerling definition: Between 15-269 days old.

BY1995
- ! In the spring of 1996, the Gray Wolf River acclimation pond had not yet been constructed.

BY1996
- ! Three distinct otolith marks were applied in order to evaluate the difference between fed fry releases at Gold Creek and Klink bridge.
- ! The 10,000 fed fry on Aug.8th with an AD only mark happened because they were a group of small fish from the different lots which did not get big enough to tag, but it was decided that they should be released without blank wire because of the lateness in the year.

BY1997
- ! The group of 200,000 project fish which were released with no marks will still be distinguishable from wild production as spawners by using the otolith chemistry analysis as they were from freshwater reared females.
- ! The two Gold Creek releases with Otolith2 + Strontium mark means that the Otolith 2 thermal mark was applied and that they are progeny of sea pen reared females, therefore should have a detectable strontium signature in the otolith chemistry lab analysis.
- ! A group of 56,728 fry had been programmed for release as yearling smolts into Morse Creek, an neighboring draining in a proposed reintroduction effort. Due to various problems the Morse Creek project was abandoned. 56,075 yearling smolts were allowed to volitionally released from the Hurd Creek Hatchery between 5/17/99 and 5/27/99. An estimated 55,571 were Ad+CWT marked with tag code 630508. The remaining 504 fish are estimated fish with tag loss and therefore are Ad clipped only.
- ! An additional 390 fish deemed excess to the brood stock program were released at 3fpp and were CWT only marked and are not included in Table 18.

BY1998
- ! Due to the destruction of many upper river roads by winter storms the brood year 1998 releases in spring 1999 were confined to three locations: the Greywolf River acclimation pond, the Greywolf River Bridge which is just a few hundred feet up river from the acclimation pond and at the Dungeness Hatchery.
- ! The standard 200,000 0+ smolt production from the Gray Wolf acclimation pond was divided in half, one–half with CWT plus AD clip as in previous years and the other 100,000 was coded–wire tagged only in order to minimize expected harvesting of these fish in the predicted era of selective fisheries when adipose clipped fish are expected to be subjected to higher harvest rates.
- ! The 200,000 0+ smolt production from the Grey Wolf River bridge was divided in half with 100,000 coded–wire tagged only and 100,000 with CWT plus AD clip. This was done in order to minimize expected heavy harvesting of these fish in the predicted era of selective fisheries.
- ! The winter ‘98 and spring ‘99 was characterized by very cold water temperatures and subsequent slow growth by project fry. This led to fish reaching tagging size, 25/pound, much later than normal and all of the plants being a month or more later than in previous years.

BY1999
- ! 10-20,000 small fish were blank wire tagged and on station released in August.

Projected Production Levels

1997 - The Last Collection Year for the Brood Stock

The possibility of a large number of project produced 2–year old males returning in 1998 and the opinion that the collection of eggs sired by these males would pose genetic risks of inbreeding led to the decision to discontinue eyed egg collections after 1997. This decision ended brood stock collection two years earlier than had originally been planned.

Anticipated Brood Year Contributions

Based on the remaining brood stock and average survival and maturity schedules, Table 19 shows the anticipated brood year contributions and the projected project egg production from 2000 through 2002.

Table 19. Predicted maturing adults and egg production for years 2000 through 2002.

Year	Brood Year		Males	Females	Males (+/-)	Eggs
Year 2000	1993 + 1994	6	4	8		
	1995	5	131	214		
	1996	4	178	354		
	1997	3	69	0		
	Total		382	576	-194	2,073,600
Year 2001	1995	6	40	70		
	1996	5	2	130		
	1997	4	252	324		
	Total		294	524	-230	1,886,400
Year 2002	1996	6	0	10		
	1997	5	126	209		
	Total		126	219	-93	788,400

The minus's associated with the numbers in the Males(+/-) indicate anticipated male shortages if the one to one spawning protocol is used.

Project Adult Returns through October 1999

The first full production release of captive brood stock progeny occurred from the 1996 brood in the summer of 1997. The first substantial project adult returns (as three year olds) could have occurred in 1999.

In 1999 otolith samples from 16 adult chinook carcases were recovered from the spawning grounds. Of the 16, three were identified as project fish. A three year old male had an otolith with banding indicating it was a thermally marked project fish. It was recovered on Oct. 4th between river mile 3.3 and 6.4.
The second was a coded wire tagged, 3 year old male recovered in the upper watershed (RM 10.8-13.8) on Sept. 21. The third, a four year old female, was identified as a progeny of a freshwater captive brood stock female based on otolith core levels of strontium. All three were identified as sub-yearling out-migrants using scale analysis.

None of the other recoveries had project otolith marks, tags or had low enough strontium levels in their otolith core to be classified as being the progeny of an freshwater reared female. which would indicate they were project produced fish. All of the project's 1995 and 1996 releases, which would have been 3 and 4 year olds when recovered, were adipose clipped or adipose clipped with CWT or blank wire marked (See Table 18).

Captive Brood Stock Fish Health Summary

(Robert W Rogers)

The following summarizes the fish health observations and treatments for the freshwater component of the captive brood stock project. Except for the results reported in the Maturation and Spawning at Dungeness Hatchery section, no information is given on fish health at SSNP.

Incubation and Early Rearing at Hurd Creek

- Fish health issues of post redd-pumped eggs were minimal. Eyed eggs were surface disinfected for 10 minutes in 100 ppm active ingredient iodine upon arrival at Hurd Creek. Prophylactic treatments of eggs with formalin for control of fungus (*Saprolegnia* spp.) was not necessary.
- Low-level losses of sub-yearlings occurred initially in the 4' circular tanks. Lateral physical abrasions, frayed fins and tail-rot, and secondary mixed bacterial infections were observed but subsided after reducing flow velocity in the tanks.
- Very low prevalence of air bladder fungus, *Phoma spp*. in subyearling chinook was noted. No substantial losses observed. Body form, fin condition, gill condition, and internal fat levels were determined normal.
- Two prophylactic erythromycin medicated feed treatments, for control of bacterial kidney disease, were given to fish at 200 fpp and 20 fpp. Medicated feed acceptance has been good. Erythromycin toxicity has not been noted.

Post Tagging Rearing to Start of Sexual Maturation at Hurd Creek

External fungus (*Saprolegnia* spp.) was the primary concern post-transfer to the 20' circular tanks. Regardless of fish size, formalin was applied at 167 PPM immediately upon observation of external fungus to control infection. This was accomplished by adding 1.8 gallons of formalin in the first five minutes and then dripping 63 ml/minute for one hour. Treatment duration was dependant upon initial level of infection and on assessment of fungal control as treatment progressed. Treatment regimes ranged from 167 PPM 1-hour drip every 3rd day, to 167 PPM 1-hour daily drip for up to 30 days, as needed. Most commonly treatments were every other day. Formalin was ineffective in controlling fungal infections on fish with advanced infections.

- Prophylactic formalin treatments were generally initiated post-splitting or handling at 167 PPM for 1-hour daily drip for 7 days to prevent external fungus.
- Sorting and/or handling activities occasionally resulted in short term low level mortalities of yearling fish. Only *Pseudomonas spp* were isolated and identified from cultures on bacteriological media. Antibiotic therapy has not been necessary.
- External parasites were rarely cause for concern. Occasional treatments of subyearlings with 167 PPM formalin for 1-hour for control of Costiasis was required.
- Hexamitiasis was regularly noted in intestine smears from all brood years but was not a cause of mortality.
- Routine examination of mortalities noted occasional Nephrocalcinosis. This condition was not a cause of loss.

Bacterial Kidney Disease (BKD), Exam of Mortalities at Hurd Creek

- Early in the project, kidney tissues from mortalities were regularly examined by the direct fluorescent antibody technique (DFAT) for the presence of the bacteria *Renibacterium salmoninarum (Rs)*, the causative agent of Bacterial Kidney Disease (BKD). No *Rs* bacteria were seen by DFAT in forty (40) kidney tissue preparations collected in 1995 from 1992 brood year mortalities.
- Twenty-three kidney tissue preparations, collected in 1996 from twenty-three (23) 1994 brood year mortalities, were examined by the Enzyme Linked Immunosorbent Assay (ELISA) technique for BKD. Results were: 19 samples were Below Low; 2 were Low, and 2 were Moderate. One 1993 brood year mortality was Low by ELISA.
- Twenty-three kidney tissue preparations, collected in 1997 from twenty-three (23) 1992-94 brood year mortalities, were examined for BKD by ELISA. Results were: 12 were Low, 9 were Below Low and 2 were Moderate. The highest ELISA-BKD female mortalities examined in 1997 were also checked for the presence of whole bacteria by DFAT. No *Rs* bacteria were not seen in any prepared samples.
- To date, no gross pathology indicative of Bacterial Kidney Disease has been observed in mortalities or sacrificed fish examined at Hurd Creek.

Maturing Adults and Transfer to Dungeness Hatchery

- Prophylactic formalin treatments of maturing adults were initiated when changes in body form and color were observed. Treatment was started at 167 PPM, 1-hour drip, every 3rd day and increased to every other day as needed.
- Alternative fungal control efforts were initiated but determined ineffective. Salt, added at up to 500 pounds per 20' circular for 4 consecutive days did not control fungus. Hydrogen peroxide, at 75 ppm for 4 consecutive days, 1-hour bath each day, resulted in mortality of apparently healthy fish in 1 of 3 tanks. Chemical toxicity was determined as the probable cause of loss.
- Salt treatments during sorting and transfer of maturing adults from Hurd Creek to Dungeness were initiated primarily to reduce fish stress during the process. Salt in cloth bags was placed in the circular ponds at 0.22% by weight during the sorting process. Salt was added to 1000 gallon transfer tanks at 0.67% by weight during hauling.
- Losses occurred infrequently during sorting/transfer of maturing adults to Dungeness. Physical abrasions/scrapes of the caudal peduncle and both lobes of the caudal fin, evidenced by weeping sera/blood, was most probably a result of the handling. Temporary increases in loss (up to 1/day), seen post-sorting, were determined to be stress related. No pathogens were identified.
- As an *Rs* control measure, all maturing fish, three years and older, received a first injection of Erythro-200 in the dorsal sinus at 20mg/Kg of body weight just prior to transfer to Dungeness Hatchery. Non-maturing fish that remained at Hurd Creek were not injected. Subsequent injections with this antibiotic occurred every 3 to 4 weeks until spawning. Oxytetracycline (LA-200) was injected one time, also in the dorsal sinus, at 20mg/Kg of body weight for control of gram-negative bacteria.

Maturation and Spawning at Dungeness Hatchery

- Fish were successfully transferred to Dungeness as early as mid-April with minimal losses. Daily 167 PPM formalin treatments were necessary to control external fungus on maturing fish after transfer to Dungeness. No losses were attributed directly to external fungus when daily formalin treatments were applied.
- The bacteria causing Bacterial Cold-Water Disease (BCWD), *Flavobacterium psychrophilum*, was cultured and identified numerous times. *F. psychrophilum* caused severe external infections on maturing fish of all age classes, particularly in fish transferred to Dungeness from the salt-water site (SSNP). All cultured isolates recovered from adult mortalities in 1997 showed little or no sensitivity to Oxytetracycline. Examination of mortalities in 1998-99 again indicated BCWD as the primary cause of loss. Chloramine-T was used beginning 1999 to control pre-spawning losses of mature fish from BCWD at Dungeness. Application of 15mg/L Chloramine-T, two times per week, dripped into the inflow for one hour was successful.
- Regulated viral pathogens (Infectious Hematopoietic Necrosis Virus (IHNV), Infectious Pancreatic Necrosis Virus (IPNV), and Viral Hemorrhagic Septicemia Virus (VHSV)) have not been detected to date.

BKD Examination of Spawned Adult Females

- All spawned females were examined by ELISA for evidence of Bacterial Kidney Disease. Historical records indicate the most recent losses of Dungeness stock spring chinook from BKD occurred in the 1960 brood year juveniles in March-December 1961. No evidence of clinical BKD has been seen in juveniles since that date.
- Adult ELISA-BKD results for years 1996-99 are shown in Table 20. ELISA-BKD levels and corresponding optical density (OD) values are also included. Despite recording ELISA-BKD values in Moderate and High level categories, no observable gross pathology indicative of BKD was seen in any adult females spawned from the freshwater lot. In all year classes of freshwater adults from each year of spawn examined to date, ELISA-BKD values did not exceed on OD of >1.338. A few adult females spawned from the South Sound Net Pen site did exhibited gross pathology indicative of BKD. Optical density levels of all year classes of saltwater adults for each year of spawn examined to date did not exceed an OD of >0.370.

Table 20. ELISA-BKD Distribution of Fresh and Saltwater Families by Year Spawned (1996-1999) for Year Classes 1992-1996.

Elisa Level	Elisa Value
Below Low	0.099 or <
Low	0.1-0.199
Mod	0.2-0.449
High	0.45 or >

DUNGENESS SPRING CHINOOK FRESHWATER FEMALES----1996-1999

Year Spawned	Year Class Spawned	Nmbr Families Observed	Number of Females Spawned	ELISA-BKD Distribution Summary							
				%BL	n	%Low	n	%Mod	n	%High	n
1996	1992	18	513	56.1	288	40.4	207	3.5	18	0.0	0
	1993	2	3	100.0	3	0.0	0	0.0	0	0.0	0
	All	20	516	61.2	291	40.1	207	3.5	18	0.0	0
1997	1992	19	460	7.2	33	50.2	231	31.3	144	11.3	52
	1993	12	179	5.0	9	34.1	61	40.2	72	20.7	37
	1994	4	7	0.0	0	57.1	4	28.6	2	14.3	1
	1995	1	1	0.0	0	100.0	1	0.0	0	0.0	0
	All	36	647	5.6	42	42.6	297	38.4	218	13.4	90
1998	1992	7	25	4.0	1	28.0	7	40.0	10	28.0	7
	1993	11	81	0.0	0	46.9	38	37.0	30	16.1	13
	1994	15	340	21.8	74	69.1	235	8.8	30	0.3	1
	1995	4	6	50.0	3	50.0	3	0.0	0	0.0	0
	All	37	452	12.2	78	50.3	283	28.4	70	9.1	21
1999	1992	1	2	0.0	0	50.0	1	50.0	1	0.0	0
	1993	10	28	7.1	2	39.3	11	42.9	12	10.7	3
	1994	14	99	14.1	14	78.8	78	7.1	7	0.0	0
	1995	40	224	55.4	124	44.6	100	0.0	0	0.0	0
	1996	17	29	37.9	11	55.2	16	6.9	2	0.0	0
	All	82	382	42.2	151	48.1	206	9.0	22	0.7	3
All	All	All	1997	28.2	562	49.7	993	16.4	328	5.7	114

DUNGENESS SPRING CHINOOK SALTWATER FEMALES----1997-1999

Year Spawned	Year Class Spawned	Nmbr Families Observed	Number of Females Spawned	ELISA-BKD Distribution Summary							
				%BL	n	%Low	n	%Mod	n	%High	n
1997	1993	9	51	25.5	13	54.9	28	17.7	9	1.9	1
	1994	1	1	0.0	0	100.0	1	0.0	0		0
	All	10	52	25.0	13	55.8	29	17.3	9	1.9	1
1998	1993	1	1	0.0	0	100.0	1	0.0	0	0.0	0
	1994	8	21	47.6	10	47.6	10	4.8	1	0.0	0
	1995	10	15	53.3	8	46.7	7	0.0	0	0.0	0
	All	19	37	48.7	18	48.7	18	2.6	1	0.0	0
1999	1994	3	3	66.7	2	33.3	1	0.0	0	0.0	0
	1995	37	125	33.6	42	56.0	70	10.4	13	0.0	0
	1996	24	44	56.8	25	43.2	19	0.0	0	0.0	0
	All	64	172	40.1	69	52.3	90	7.6	13	0.0	0
All	All	All	261	38.3	100	52.5	137	8.8	23	0.4	1

Incubation and Rearing of Captive Brood Progeny at Dungeness Hatchery

- External fungus (*Saprolegnia* spp) on eggs was controlled with daily drip treatments of 1667 PPM formalin.
- Eggs spawned from saltwater reared females consistently exhibited higher egg mortality that did the freshwater lots. Exams of pre-eyed egg mortality indicated the majority of the eggs were not fertilized.
- Sperm motility and viability was examined from both mature freshwater and saltwater males and was determined to be acceptable. Sperm motility in excess of 85% was observed in all samples using a simple saline solution activation technique. A Pinacyanol Chloride stain showed normal sperm morphology in all samples examined.
- Fish losses from ponding to release were a combination of several factors. Cold incubation water, resulting in extended incubation time and prolonged starter feed presentation, coupled with reduced water clarity, induced a gut fungus condition in the first year. Subsequent changes to initial feed timing eliminated most of the gut fungus concern. Ponding from the incubators is postponed until all yolk material is completely utilized as determined by dissection and visual confirmation.
- Cataracts were first observed in fry from the 3 and 4 year old 1992 brood year females. Only occasional cataracts were seen in subsequent years. The cataracts were determined not to be feed associated or a result of lack of parental saltwater exposure.
- Bacterial Gill Disease (BGD), most commonly caused by *Flavobacterium branchiophilum,* occurred regularly during early rearing despite feed rates and rearing parameters well within recommended guidelines. Typical BGD (associated with clubbed gills) and a less typical "spicule" shaped gill bacteria (present on gills with normal morphology) was regularly observed. Regular prophylactic drip treatments with 2PPM potassium permanganate 2-3 times per week have effectively prevented BGD.
- Ichthyobodiasis, caused by *Ichthyobodo necator*, has been the primary ectoparasitic disease of concern. Losses, however, have been minimal and involved only small, malnourished fish. Recent observations have resulted in more frequent formalin treatments for control of this parasite.
- To date, no gross pathology indicative of Bacterial Kidney Disease has been observed in juveniles at Dungeness.

Freshwater Survival of Progeny,1996-97

(Greg Volkhardt)

Methods

We estimated the numbers of juvenile downstream migrant chinook progeny from a captive-brood chinook rearing program leaving the Dungeness River by operating a migrant fish trap throughout the release-migration period and calibrating the capture efficiency of this gear. Captive brood progeny were distinguished from wild chinook production by a combination of adipose marks, ventral fin marks, and coded-wire tags which enabled estimation of both wild production and the production and resulting survival of progeny from the captive brood chinook project.

Trapping Gear and Operation

A 5-ft diameter screw trap (Busack et al., 1991) built by E.G. Solutions was installed in the lower Dungeness River (R.M. 1.8) in 1996 and 1997 and was used to capture a portion of the juvenile chinook migrating from the river (Figure 1). Prior to installation of the screw trap, an inclined plane screen trap (scoop trap) was installed in the Dungeness River and operated for the first ten days of trapping in 1996. This trap was replaced by the screw trap when heavy debris loads made continuous operation of the incline trap nearly impossible. The screw trap employed a rotating cleaning drum in the live well which helped remove debris to enable nearly continuous fishing.

1996 Operation. Trapping began using the scoop trap on June 18. It was replaced by the screw trap on June 28 and continued until October 7. Both traps fished in the same location. During the period in which the scoop trap was used, the trap operated primarily at night. Trapping was suspended during the day, when few juveniles were caught, to allow the crew a chance to sleep or rest. Once the screw trap was installed, operation of the trap continued 24-hours per day except for two occasions. The first was a 27-hr period on July 8-9 when debris loads were very high. The second occasion occurred on August 16 when trapping was suspended five hours for trap repair.

1997 Operation. Trapping began using a screw trap on June 11 and continued until September 9. The trap was in operation almost continuously during this period, except for a few intervals during the beginning of the trapping season when catches were very low and for brief periods during the middle of the season when debris or maintenance requirements prevented trap operation.

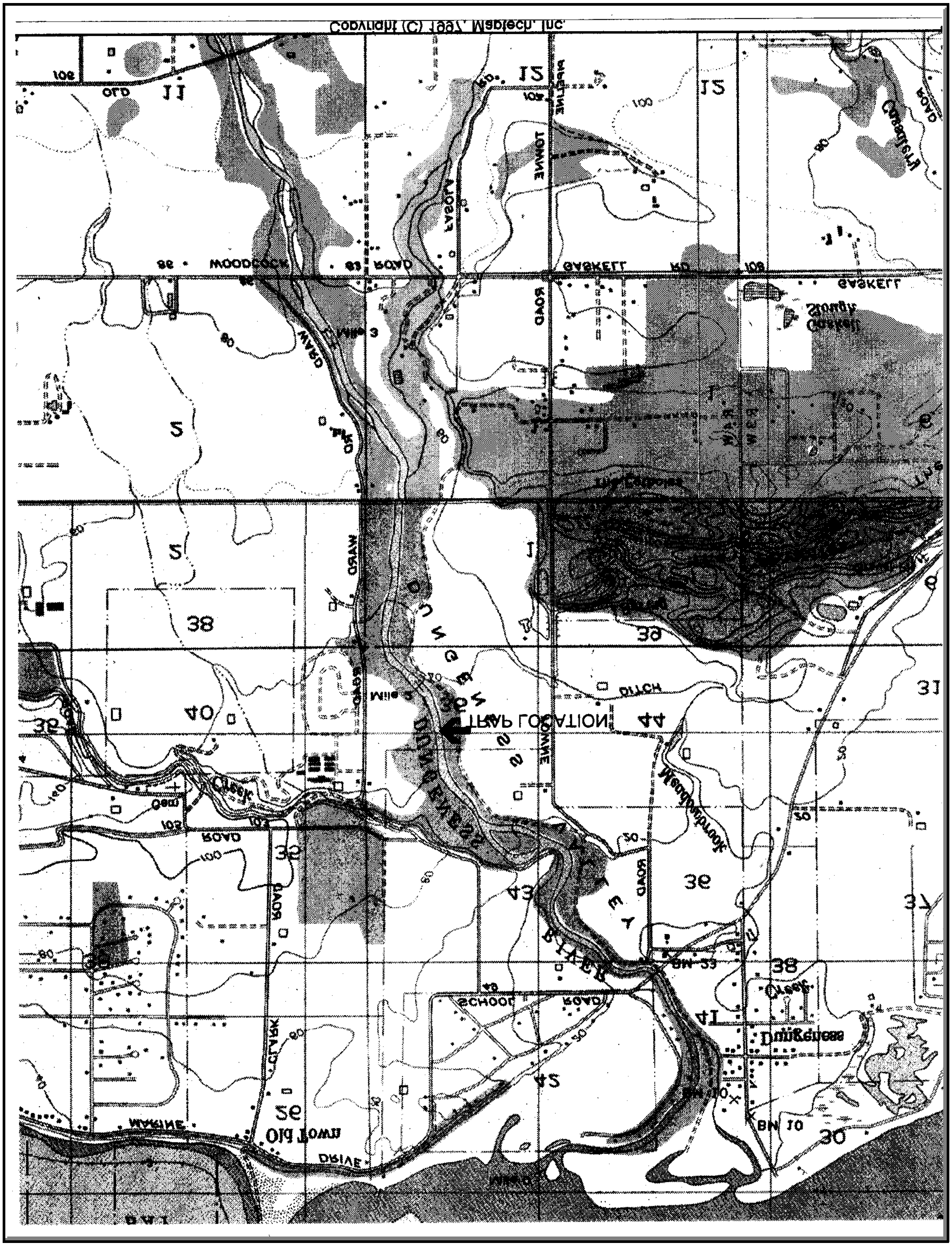

Figure 1. Site map showing the location of the smolt trap in the lower Dungeness River, 1996 and 1997

Trap Calibration

Trap calibration involves determining the capture susceptibility of a known number of marked juveniles passing the trap over a discreet period of time. Two assumptions must be met for the calibration to be accurate. The first assumption is that all of the marked juveniles released pass the gear within a certain recovery period. This requirement argues for releasing fish immediately upstream of the trap to minimize their exposure to predation. Marked juveniles, however, must also be captured at the same rate as unmarked fish (second assumption). Satisfying this assumption primarily involves achieving the same lateral distribution of marked and unmarked juveniles in the stream channel. The further upstream fish are released, the more likely they become distributed as are unmarked juveniles because they are subjected to the same currents.

During both years, marked juvenile chinook were released at a gravel pit located approximately 0.35-miles upstream of the trap. Juvenile chinook captured the previous night were alternately marked with either upper or lower lobe caudal clips. The release site was selected as a compromise between the opposing needs of releasing fish close enough to avoid predation loss and distant enough to ensure natural distribution.

1996 Trap Calibration. Eighteen calibration tests were made over the course of the trapping period. Two tests were made while the scoop trap was in operation and sixteen were made while the screw trap operated. All of the tests were made at night. Recovery rates were correlated with flow and trapping day to determine if stream discharge or temporal effects (e.g., increasing fish size) influenced capture rates. In addition, analysis of variance (ANOVA) was used to test whether there were differences in capture rates between scoop trap and screw trap operation.

1997 Trap Calibration. A total of 65 calibration tests were made in 1997. Forty three night tests were made while the trap fished in position 1 and 13 night tests were made while the trap fished in position 2. In addition, 9 day tests were made for position 1.

Recovery rates were correlated with mean daily discharge and calibration test date to assess the effect of flow and temporal effects, respectively, on instantaneous capture efficiency. ANOVA was used to test for differences in capture efficiency between the three calibration test strata (i.e., Position 1-night, Position 2-night, and Position 1-day).

Releases of Captive Brood Progeny

The focus of this study was the evaluation of production and survival of the released progeny of native Dungeness River chinook captive brood spawners. The first releases were made in 1996 (1995 brood) which were followed by much larger releases in 1997 (1996 brood).

1996 Releases

Progeny from captive brood adult chinook were released on June 24 and August 30. The two releases totaled of 13,013 juvenile chinook (Table 21). The June release totaled 2,650 chinook averaging 2.9 grams each. These fish were marked with the removal of the adipose fin and planted in five locations within the Dungeness and Grey Wolf Rivers.

The August 30 releases totaled 10,363 adipose and ventral fin marked chinook. All fish were released at the same location on the Grey Wolf River (Table 21). The fish were released in three lots with three different marks. These included 1,115 ad/RV-marked and 7,880 ad/LV-marked chinook. The third lot consisted of 1,368 ad-marked chinook. The ad/RV-marked fish averaged 13-grams each, whereas the others averaged 4.9 grams.

Table 21. Dungeness River captive-brood chinook releases and marks, 1996.

Plant No.	Release Date	River	Loc. (RM)	Number Released	Fish/ lb.	FkL	Marks
1	06/24	Dungeness	15.3	900	159	61.8	Admk
2	06/24	Dungeness	17.2	300	159	61.8	Admk
3	06/24	Dungeness	18.7	300	159	61.8	Admk
4	06/24	Gray Wolf	0.2	200	159	61.8	Admk
5	06/24	Gray Wolf	1.0	950	159	61.8	Admk
6	08/30	Gray Wolf	1.0	1,115	35	98.2	Ad/RV
7	08/30	Gray Wolf	1.0	7,880	92	72.7	Ad/LV
8	08/30	Gray Wolf	1.0	1,368	92	72.7	Admk
Total	Season			13,013			
	Admk			4,018			
	Ad/RV			1,115			
	Ad/LV			7,880			

1997 Releases

Over the season, 1.8 million juvenile chinook, all progeny from captive brood parents, were released in eight groups (Table 22). Of these, five groups were forced releases from the hatchery or outplants and three were volitional releases from the hatchery or acclimation pond. The average size of fish in the release groups ranged from 1.5 to 4 grams. Fish in each release group were marked with an adipose clip, a coded-wire tag, or both.

Table 22. Dungeness River captive-brood chinook releases and marks, 1997.

Plant No.	Release Date	River	Number Released	Fish/ lb.	Marks
1	06/24	Gold Creek	94,100	294	Admk
2	06/24	Klink Bridge	98,200	163	Admk
3	06/30	Acclimation Pond	387,750	163	Admk
4	07/09	East Crossing	219,152	218	AdCWT
5	07/14-28	Acclimation Pond	196,300	115	AdCWT
6	7/21-8/8	Hatchery	482,071	161	Blank Wire
7	8/1-8	Hatchery	286,963	198	Blank Wire
8	08/8	Hatchery*	10,000	300	Admk
Total	Season		1,774,536		
	Admk		590,050		
	AdCWT		415,452		
	Blank Wire		769,034		

* This group of fish were too small to tag

Freshwater Production and Survival Estimation

Estimation of total juvenile chinook migration and of the hatchery and wild components occurs in several steps. The data collected every trapping period, i, consisted of:

1. Count of unmarked, ad-marked, and other marked migrants taken in the trap, generically symbolized as - c_i
2. Proportion of marked migrants, m_i, released above the trap and subsequently retaken, r_i, or trap efficiency - e_i
3. Flow - f_i

Regression analysis was used to test the relationship between trap efficiency and flow. Where the relationship was significant, it provided an estimate of trap efficiency, e_i, and its variance, and any flow, f_i;

$$\hat{e}_i = \alpha + \beta f_i \qquad \textbf{(1)}$$

The variance of the predicted efficiency on any day d is;

$$Var(\hat{e}_d | f_d) = MSE\left(1 + \frac{1}{n} + \frac{(f_d - \bar{f})^2}{(n - 1)s_f^2}\right) \qquad \textbf{(2)}$$

where,

MSE = *the mean square error for the regression*,
n = *the number of observations in the regression*,
s_f^2 = *the sample variance of the observed flows, and*
$\bar{f}$ = *the mean of flows observed during efficiency tests*.

Regression analysis was also used to test the relationship between trap efficiency and the efficiency test date by substituting the Julian calendar test date, d, for flow in Equation 1. This analysis was used to detect any temporal effects that may alter trap efficiency, such as changing fish size.

Where neither flow nor the test date were found to be a significant predictor of trap efficiency, we assumed that differences were a result of random variation. However, year-specific circumstances required that we evaluate stratifying the trap efficiency data. In 1996, efficiency tests made during operation of the scoop trap and screw trap resulted in two gear-type strata. In 1997, efficiency tests made during the night while the trap fished in position 1 and position 2, and during the day while the trap fished in position 1, resulted in three strata. ANOVA was used to test whether efficiency estimates between strata were significantly different. Where between strata differences were found to be significant ($p<0.05$), trap efficiency was estimated separately for the strata. Strata were combined where they did not result in significantly different trap efficiency estimates.

Since the number of fish released in each test group varied, we decided to pool the test data within each final stratum, *s*, to avoid overly weighting the results of small test groups;

$$\hat{e}_s = \frac{\sum_{i=1}^{n} r_i}{\sum_{i=1}^{n} m_i} \tag{3}$$

The variance of the pooled trap efficiency estimate is;

$$V(\hat{e}_s) = \frac{\hat{e}_s(1 - \hat{e}_s)}{\sum_{i=1}^{n} m_i} \tag{4}$$

Pooling reduced the variance of the efficiency estimate relative to the variance of the mean of the samples. We believed this was acceptable since we were only interested in estimating the total migration for the stratum and not daily migration.

If trap efficiency is predicted using the regression equation (equation 1), the out-migration for trapping period i, N_i, is estimated using the estimated trap efficiencies;

$$\hat{N}_i = \frac{c_i}{\hat{e}_i} \tag{5}$$

and the variance is;

$$V(\hat{N}_i) = \hat{N}_i^2 \frac{V(\hat{e}_i)}{\hat{e}_i^2} \tag{6}$$

If trap efficiency is estimated using the pooled trap efficiency, then the migration estimate for the stratum, N_s, is estimated using;

$$\hat{N}_s = \frac{\sum_{i=1}^{s} c_i}{\hat{e}_s} \tag{7}$$

and the variance is;

$$V(\hat{N}_s) = \hat{N}_s^{\,2} \frac{V(\hat{e}_s)}{\hat{e}_s^{\,2}} \tag{8}$$

During periods when the trap was not operated, two techniques were used to estimate the catch that would have occurred if the trap were fishing. Estimation of catch for these un-fished periods was required to estimate migration using Equation 5 or 7. Trapping periods were designated as either daytime or nighttime periods for the purposes of this estimation due to diel differences in catch rates. The first technique was used to estimate catch for periods where only part of a day or night was not fished. In this case, catch was estimated by multiplying the amount of time that the trap was not fishing by the catch rate (i.e., migrants per hour) for the fished portion of that same daytime or nighttime trapping period, as appropriate. The second technique was used when the trap was not operated for one or more entire daytime or nighttime trapping periods. In this situation, the catch rate for the unfished period was estimated by interpolating between the catch rates for the previous and following daytime or nighttime fishing periods, and multiplied by the amount of time (daytime or nighttime hours) not fished to estimate the catch that would have occurred had the trap been operated.

The total out-migration, N_T, total wild migration, W_T, and total migration of uniquely marked hatchery groups, H_T, during the trapping period are the sums of all the daily respective or stratum-based out-migration estimates for these variables and the variances of the totals are the sums of the daily or stratum-based variances.

The total out-migration of mark group h is estimated by summing all of the daily or stratum-based estimates of outmigrating fry belonging to that group;

$$\hat{H}_{hT} = \sum_{d=1}^{D} \hat{H}_{hd} \tag{9}$$

and its variance is the sum of the daily variance estimates.

The total survival of each mark group h past the trap location is then estimated by;

$$\hat{s}_h = \frac{\hat{H}_{hT}}{R_h} \tag{10}$$

and the variance is;

$$V(\hat{s}_h) = \frac{V(\hat{H}_{hT})}{R_h^2} \tag{11}$$

This variance under-estimates the true variance of the survival ratio because we treated the number of fry released in the mark group, R_h, as a known value instead of as an estimate.

Other Biological Information

Fork lengths were taken from a subsample of the catch to evaluate the size of hatchery and wild juvenile chinook migrating from the Dungeness River. In addition, scale sample were taken in 1996 to determine the age structure of wild chinook migrants.

Species other than chinook that were captured in the traps were identified and counted. Fork lengths were taken on a subsample of the salmonids.

Results

1996

Catch

The wild juvenile chinook migration was underway when trapping began in June. A total of 35 wild chinook migrants were captured on the first night of trapping. Catches of about this magnitude continued until the third week of July. They peaked July 19, with a catch of 99 chinook before declining to very low levels by early to mid August. Captive brood progeny from the first release on June 24, which totaled 2,600 chinook, began showing up in the catch early the following morning. Daily catches remained at low levels, peaking on July 31-August 1 with a catch of 30 ad-marked migrants, before declining to very low levels by mid-August. Captive brood progeny from the second release on August 30 began to show up in the catch on September 1. Although this release was much larger than the first (10,400 chinook released), catches ranged from 0 to 21 per day with less than ten being caught on most days. The last of this release was captured on October 5, two days before the trap was removed from the river. Over the season, our catch of wild, ad-marked, ad/RV-marked, and ad/LV-marked migrants totaled 1,377; 400; 40; and 64 chinook, respectively (Appendix E).

Almost all of the chinook migrants were captured at night. Ninty one percent of wild chinook migrants and 93% of hatchery migrants were captured during nighttime trapping periods.

Expansion of the actual catch to estimate the catch that would have accrued had the trap been operated continuously over the 111-day trapping season resulted in the addition of 116 wild chinook. Expansion did not affect the number of marked fish caught since most of the periods when the trap was not operated occurred during the beginning of the trapping season before these fish were released. The expansion of the wild chinook catch represented an 8.4% increase over actual catch.

Efficiency Estimates

Tests to ascertain the capture efficiency of the migrant traps were made on eighteen nights between June 20 and August 12. Upper or lower lobe caudal marked chinook fry were alternately released during each test from a gravel mining site, located approximately 0.35-miles upstream from the trap. Two tests were conducted while the scoop trap was fishing and sixteen tests occurred during screw trap operation. ANOVA failed to detect differences in recapture rates between the two gear types ($p>0.05$).

Recapture rates from the 18 calibration tests ranged from 21.1% to 45.7% (Table 23). Linear regression analysis failed to show a relationship between capture efficiency and flow or the test date. Scatter plots of measured trap efficiency values arranged with these variables showed no discernable pattern, therefore other types of regression analysis were not attempted. Mean daily flow ranged from 200 cfs to 521 cfs during the tests with little difference in capture efficiency noted between tests conducted at these extremes. The lack of significance found in these tests suggested that variation in the test outcomes was primarily a result of random variation. Since the number of fish released in each test group ranged from as few as 3 to as many as 65, we pooled the tests to avoid weighting the results of tests using small release groups too highly. Pooling resulted in an overall capture efficiency of 31.5% for chinook.

Table 23. Capture efficiency test results from the Dungeness scoop and screw traps, 1996.

Gear	Date	MARK RECAP Chinook Rel	Rcp	Percent Rcp	V(ê)	Flow (cfs)
Scoop Trap	06/20	24	6	25.0%	0.008152	390
	06/25	17	6	35.3%	0.014217	521
	Pooled	41	12	31.9%	0.005049	
Screw Trap	06/28	23	9	39.1%	0.010827	484
	07/01	28	11	39.3%	0.008834	494
	07/06	47	16	34.0%	0.004881	406
	07/10	54	13	24.1%	0.003449	448
	07/12	65	19	29.2%	0.003232	429
	07/14	40	8	20.0%	0.004103	465
	07/16	32	14	43.8%	0.007939	452
	07/19	46	21	45.7%	0.005514	322
	07/22	35	9	25.7%	0.005618	309
	07/24	19	5	26.3%	0.010773	335
	07/28	14	3	21.4%	0.012951	310
	07/31	33	12	36.4%	0.007231	279
	08/03	30	11	36.7%	0.008008	241
	08/05	19	4	21.1%	0.009234	226
	08/07	23	6	26.1%	0.008764	205
	08/12	3	1	33.3%	0.111111	200
	Pooled	511	162	31.7%	0.000424	
	POOLED	**552**	**174**	**31.52%**	**0.000391**	

Fry Production

We estimated 1,267 ad-marked and 330 ad/vent-marked chinook migrated past the trap in the lower Dungeness River in 1996 (Figure 2). Of the ad/vent-marked fish, 127 had a left-vent mark and 203 had a right-vent mark. A total of 4,738 wild chinook migrants are estimated to have passed the smolt traps between June 18 and October 7. The wild chinook migration was in progress when the smolt trap was installed on June 18. Because we don't fully understand the pattern of the early emigration of wild Dungeness chinook, we did not attempt to estimate total chinook production.

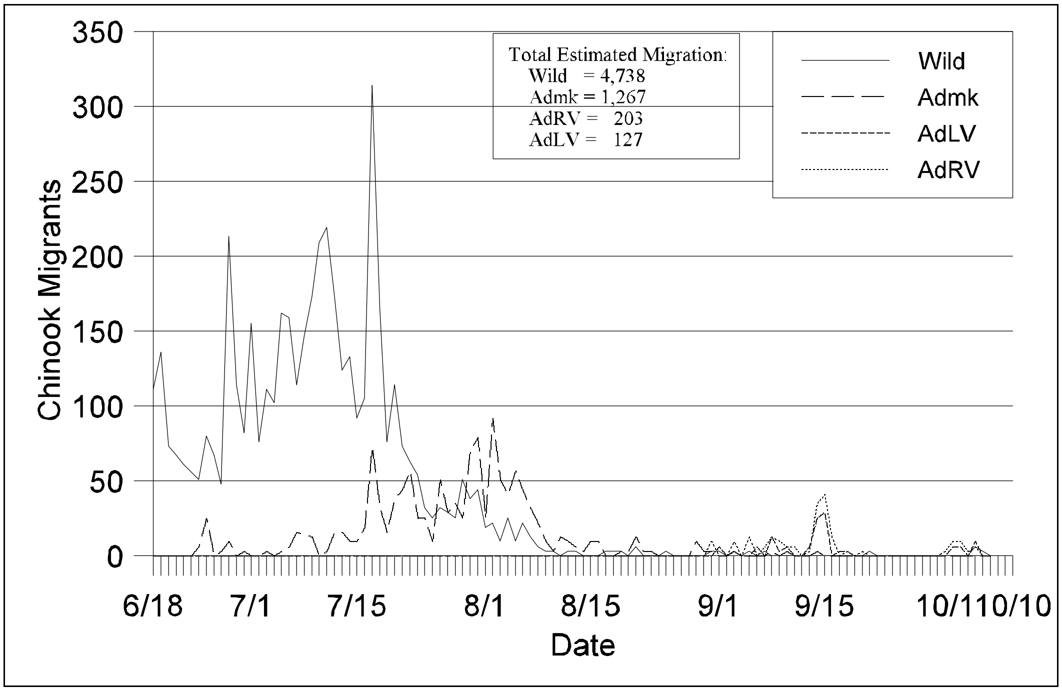

Figure 2. Migration timing for age 0+ wild and captive brood progeny chinook in the Dungeness River, 1996.

Table 24. Estimated migration and 95% CI in 1996.

Chinook Group	Estimated Migration	CV	95% CI	
			Low	High
Ad-Marked	1,267	6.27%	1,111	1,423
Ad/LV-Marked	127	6.27%	111	143
Ad/RV-Marked	203	6.27%	178	228
Hatchery Total	**1,597**	**5.07%**	**1,438**	**1,756**
Wild (unmarked) Chinook	4,738	6.27%	4,155	5,321
Chinook Total	**6,335**	**4.86%**	**5,731**	**6,939**

Survival of Captive Brood Progeny

Migrant chinook survival from the release sites to the trap were assessed for each of the three mark groups. The releases were made on two dates. Portions of the ad-marked group were released on both June 24 and August 30. The ad/vent-marked groups were released only on August 30. Marked fish began showing up in the trap the day after each release; however, all three mark groups exhibited a protracted migration timing. It wasn’t until July 30 that 50% of the ad-marked group had passed the trap and until September 15 that the migration was completed, 83-days following the release (Figure 3). The migration timing wasn’t quite as long for the two ad-vent marked groups. Both ad/vent-marked groups reached 50% migration by September 15 and finished their migrations by October 6, 35-days after release (Figures 4 and 5).

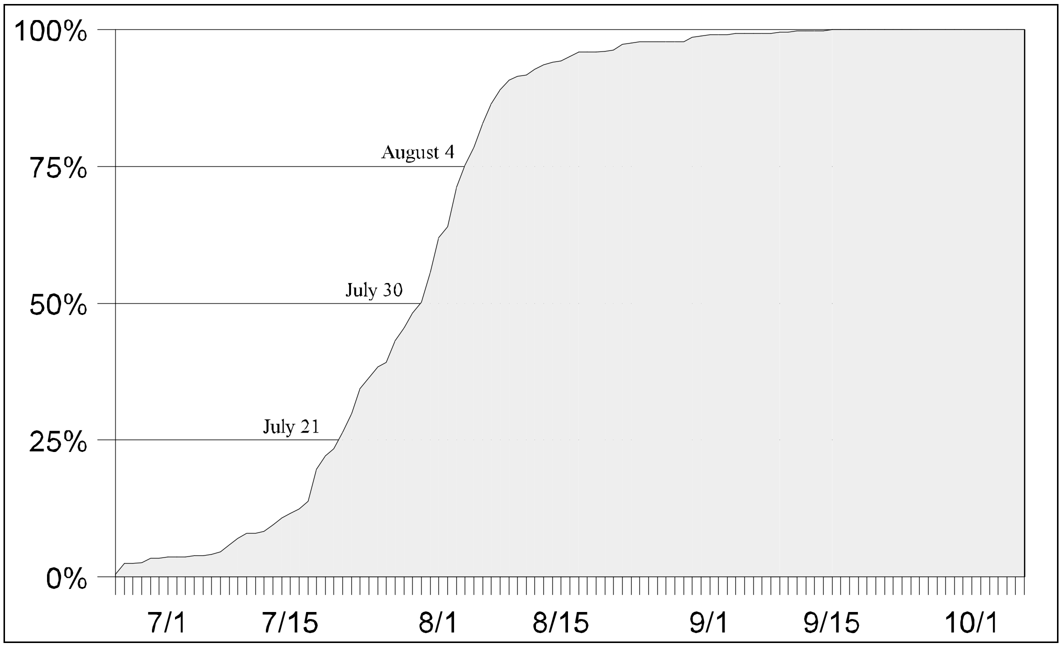

Figure 3. Cumulative percent migration for adipose-marked captive brood progeny released into the Dungeness River system, 1996.

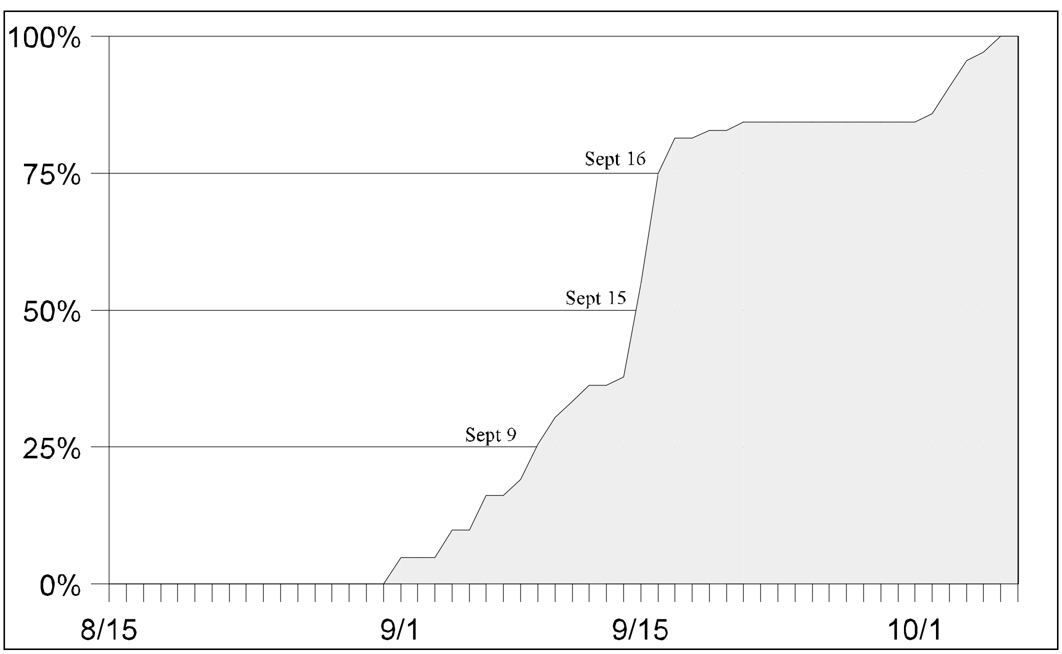

Figure 4. Cumulative percent migration for Ad/RV-marked captive brood progeny released into the Dungeness River system, 1996.

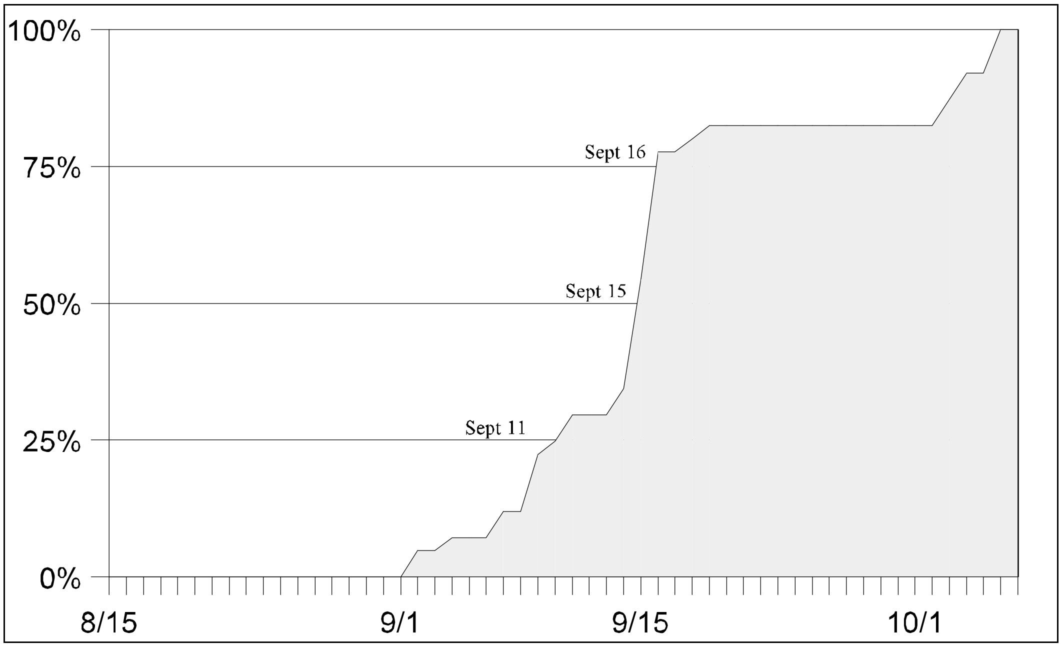

Figure 5. Cumulative percent migration for Ad/LV-marked captive brood progeny released into the Dungeness River system, 1996.

Estimates of survival from the release site to the trap was 32% for the ad-marked group. Of the vent marked groups, the ad/RV-marked group with larger sized fish had an 18% survival compared to only 1.6% survival for the smaller sized ad/LV-marked group (Table 25). Combined, only 3.7% of the ad/vent-marked groups released on August 30 survived to the trap.

Table 25. Estimated survival from the release site to the trap for chinook captive brood progeny, Dungeness River, 1996.

Hatchery Group	# Released	Estimated Migration	Estimated Survival	CV	95% $CI_{(survival)}$ Low	95% $CI_{(survival)}$ High
Admk	4,018	1,267	31.54%	6.27%	37.66%	35.42%
AdRV	1,115	203	18.21%	6.27%	15.97%	20.45%
AdLV	7,880	127	1.61%	6.27%	1.41%	1.61%
Hatchery Total	**13,013**	**1,597**	**12.27%**	**5.07%**	**11.05%**	**13.49%**

Size and Age Data

Fork lengths averaged 86-mm for wild migrants, 81-mm for migrants from the ad-marked group, 92-mm for the ad/LV-marked group, and 111-mm for the ad/RV-marked group (Tables 26a-d). Lengths were sampled at a high rate from the migrants captured. Sampling rates ranged from 56% for wild, unmarked chinook to 100% for ad/RV-marked fish.

Table 26a. Mean fork length, range, standard deviation, and sample sizes of wild chinook smolt, by statistical week, Dungeness River, 1996.

Stat	DATES		Mean	RANGE				Total	Sample
Wk	Start	End	(mm)	Min	Max	s.d	n	Catch	Rate
25	06/17	06/23	81.1	68	97	5.91	97	101	96.0%
26	06/24	06/30	82.2	68	105	7.05	90	165	54.5%
27	07/01	07/07	84.2	70	111	6.58	157	303	51.8%
28	07/08	07/14	86.0	65	116	6.65	191	325	58.8%
29	07/15	07/21	89.8	71	111	7.43	105	296	35.5%
30	07/22	07/28	90.8	74	117	8.51	56	82	68.3%
31	07/29	08/04	91.4	71	123	7.80	46	70	65.7%
32	08/05	08/11	92.6	79	106	7.71	17	18	94.4%
33	08/12	08/18	107.3	104	111	2.87	4	4	100.0%
34	08/19	08/25	111.3	106	120	6.40	4	4	100.0%
35	08/26	09/01	90.0	88	92	2.83	2	2	100.0%
36	09/02	09/08	102.7	97	108	5.51	3	3	100.0%
37	09/09	09/15						0	0.0%
38	09/16	09/22	107.0	107	107		1	1	100.0%
39	09/23	09/29						0	0.0%
40	09/30	10/06	102.7	93	108	8.39	3	3	100.0%
		Pooled	86.3	65	123	8.21	776	1,377	56.4%

Table 26b. Mean fork length, range, standard deviation, and sample sizes of ad-marked captive brood progeny, by statistical week, Dungeness River, 1996.

Stat	DATES		Mean	RANGE				Total	Sample
Wk	Start	End	(mm)	Min	Max	s.d	n	Catch	Rate
25	06/17	06/23						0	0.00%
26	06/24	06/30	64.1	60	67	2.15	9	14	64.29%
27	07/01	07/07	66.8	63	72	3.20	8	10	80.00%
28	07/08	07/14	70.6	65	76	2.66	18	18	100.00%
29	07/15	07/21	74.9	64	85	4.30	44	73	60.27%
30	07/22	07/28	79.2	70	86	3.66	64	73	87.67%
31	07/29	08/04	83.7	72	99	4.41	66	126	52.38%
32	08/05	08/11	88.1	78	101	4.72	56	57	98.25%
33	08/12	08/18	92.8	82	97	4.37	10	12	83.33%
34	08/19	08/25	93.4	91	95	1.52	5	8	62.50%
35	08/26	09/01	96.6	88	104	5.73	5	5	100.00%
36	09/02	09/08	99.5	97	102	3.54	2	2	100.00%
37	09/09	09/15	95.0	90	100	7.07	2	2	100.00%
38	09/16	09/22						0	0.00%
39	09/23	09/29						0	0.00%
40	09/30	10/06						0	0.00%
		Pooled	81.3	60	104	8.43	289	400	72.25%

Table 26c. Mean fork length, range, standard deviation, and sample sizes of ad/LV-marked captive brood progeny, by statistical week, Dungeness River, 1996.

Stat	DATES		Mean	RANGE				Total	Sample
Wk	Start	End	(mm)	Min	Max	s.d	n	Catch	Rate
25-32	06/17	08/11						0	0.00%
33	08/12	08/18						0	0.00%
34	08/19	08/25						0	0.00%
35	08/26	09/01	80.0	76	85	4.58	3	3	100.00%
36	09/02	09/08	90.5	83	99	4.61	13	13	100.00%
37	09/09	09/15	92.2	81	105	5.89	31	32	96.88%
38	09/16	09/22	93.4	88	102	5.41	5	6	83.33%
39	09/23	09/29						0	0.00%
40	09/30	10/06	96.4	89	102	3.81	9	10	90.00%
		Pooled	92.0	76	105	6.08	61	64	95.31%

Table 26d. Mean fork length, range, standard deviation, and sample sizes of ad/RV-marked captive brood progeny, by statistical week, Dungeness River, 1996.

Stat	DATES		Mean	RANGE				Total	Sample
Wk	Start	End	(mm)	Min	Max	s.d	n	Catch	Rate
25-32	06/17	08/11						0	0.00%
33	08/12	08/18						0	0.00%
34	08/19	08/25						0	0.00%
35	08/26	09/01	109.0	108	110	1.41	2	2	100.00%
36	09/02	09/08	110.3	101	122	7.65	7	7	100.00%
37	09/09	09/15	111.3	100	120	4.96	22	22	100.00%
38	09/16	09/22	109.0	108	110	1.41	2	2	100.00%
39	09/23	09/29						0	0.00%
40	09/30	10/06	113.9	106	120	5.70	7	7	100.00%
		Pooled	111.3	100	122	5.41	40	40	100.00%

Scales were read from 37 unmarked chinook migrants sampled between July 4 and July 21. Of the 29 samples containing readable scales, 28 or 97% were age 0+ migrants. These fish ranged in size from 56 to 116-mm fork length. One chinook migrant, 155-mm fork length, was aged at 1+. It was unclear from the scale data, however, whether this fish was wild or an unmarked hatchery smolt.

Other Species

A number of other species were captured during the trapping operation. Other salmonids captured are shown in Table 27.

Table 27. Numbers of salmonids captured in the main stem Dungeness River smolt trap, 1996-97.

Species	Catch 1996	Catch 1997
Chinook 0+	1,881	62,867
Coho 0+	110	67
Coho 1+	111	3,705
Chum	93	2
Pink	0	1
Sockeye	2	0
Unidentified Trout	191	306
Steelhead	19	19
Cutthroat	284	27
Bull Trout/Dolly Varden	0	3

1997

Catch

As in 1996, the wild juvenile chinook migration was underway on June 11 when trapping began. A total of 9 wild chinook migrants were captured on the first night of trapping. Daily catches ranged widely from less than ten to the upper thirties prior to the week of August 5. During this week, daily catches averaged 88 chinook. Catches peaked on August 8 when 143 unmarked chinook entered the trap. After August 11 catches declined, reaching very low levels by the end of August.

Adipose marked captive brood progeny were released in four groups between June 24 and August 8 (Table 22). Ninety eight percent of the 590,050 chinook with this mark were released on or before June 30. Chinook from the first release on June 24 began showing up in the catch that same evening. Catches peaked July 1 when 3,949 chinook migrants were captured. They remained at higher than 100 per day until August 15 , then declined to low levels by early September.

Adipose-marked and coded wire tagged (AdCWT) captive brood progeny were released from two locations between July 9 to 28. They began showing up in the trap on the evening of their release. Catches of AdCWT chinook quickly built to several hundred per day before peaking on July 24 with a catch of 1,272. Catches of over 100 per day continued until August 13. Catches then declined to low levels by early September.

The blank wire tagged chinook were released from the hatchery between July 21 and August 8. These fish began showing up in large numbers on the first night of their release. However prior to release, four CWT migrants were captured between July 13-18, suggesting a few (probably less than 50) had either escaped or were mixed in with one or more of the other release groups. Blank wire tagged migrants were captured at more than one thousand per day between August 2 - 11, and peaked on August 8 with the capture of 3,626 juvenile chinook. Catches declined to less than 30 per day by the end of the trapping season.

Over the season, our catch of juvenile chinook migrants totaled 1,450 unmarked; 21,117 ad-marked; 13,598 AdCWT; and 26,702 blank wire tagged chinook (Appendix F). As in 1996, almost all of the chinook migrants were captured at night. Ninety-one percent of wild chinook migrants and 94% of hatchery migrants were captured during nighttime trapping periods.

Expansion of the actual catch to estimate the catch that would have accrued had the trap been operated continuously over the 90-day trapping season resulted in the addition of 4 unmarked, 27 ad-marked, 15 AdCWT, and 128 blank wire tagged chinook to the catch. These increases represent less than a 0.6% increase over actual the actual catch for each mark group.

Efficiency Estimates

Sixty-five capture efficiency tests were conducted between June 26 and September 7. Upper or lower lobe caudal marked chinook fry were alternately released during each test from a gravel mining site, located approximately 0.35-miles upstream from the trap. The tests were grouped into four strata reflecting different trapping conditions. During nighttime fishing periods, forty one tests were conducted while the trap fished in position 1 (Stratum 1) and thirteen tests were conducted while the trap fished in position 2 (Stratum 2). Nine tests were conducted during daytime fishing period while the trap fished in position 1 (Stratum 3). Finally, two additional night tests conducted while the trap fished in position 1 were treated separately from the other forty one tests. The trap lost a foam seal between the screw and live well during the period when these two tests were conducted. The loss of the seal resulted in a noticeable decline in capture efficiency; therefore, the results from these two tests were separated from the other Stratum 1 results and used for that period when the seal was lost (Table 28). No further analysis was done to evaluate the results of these two tests (Stratum 4) relative to the others.

Table 28. Capture efficiency test results from the Dungeness screw trap, 1997.

		MARK RECAPTURE				
Test #	**Date**	**Chinook**		**Percent**		**Flow**
		Released	**Recaptured**	**Recaptured**	**V(ê)**	**(cfs)**
Stratum 1 - Nighttime, Trap Position 1						
1	06/26	45	9	20.0%	.0035560	523
2	06/27	44	11	25.0%	0.004261	488
3	06/28	46	7	15.2%	0.002805	474
4	06/30	30	7	23.3%	0.005963	607
5	07/01	50	7	14.0%	0.002408	653
6	07/02	148	23	15.5%	0.000887	636
10	07/07	100	25	25.0%	0.001875	704
13	07/11	44	8	18.2%	0.003381	594
14	07/12	88	18	20.5%	0.001849	553
15	07/13	109	18	16.5%	0.001265	568
16	07/15	99	23	23.2%	0.001802	584
17	07/16	103	24	23.3%	0.001735	580

Table 28. Capture efficiency test results from the Dungeness screw trap, 1997 (continued).

Test #	Date	MARK RECAPTURE Chinook Released	Recaptured	Percent Recaptured	V(ê)	Flow (cfs)
18	07/18	50	10	20.0%	0.003200	485
20	07/21	100	27	27.0%	0.001971	548
21	07/22	100	16	16.0%	0.001344	463
23	07/23	98	8	8.3%	0.000779	408
25	07/24	100	17	17.0%	0.001411	401
27	07/26	100	20	20.0%	0.001600	384
28	07/28	100	13	13.0%	0.001131	382
29	07/29	100	14	14.0%	0.001204	402
30	07/30	95	9	9.5%	0.000903	379
33	08/02	100	19	19.0%	0.001539	344
34	08/03	99	15	15.2%	0.001299	343
35	08/04	100	16	16.0%	0.001344	356
36	08/05	100	15	10.0%	0.000900	360
37	08/06	100	19	19.0%	0.001539	357
38	08/07	100	21	21.0%	0.001659	346
39	08/08	100	12	12.0%	0.001056	317
40	08/09	100	14	14.0%	0.001204	291
41	08/10	99	7	7.1%	0.000664	281
42	08/11	100	13	13.0%	0.001131	275
43	08/12	100	15	15.0%	0.001275	273
44	08/13	100	12	12.0%	0.001056	280
45	08/14	103	10	9.7%	0.000851	283
46	08/15	107	13	12.1%	0.000998	285
47	08/16	100	16	16.0%	0.001344	275
48	08/17	101	19	18.8%	0.001512	257
49	08/18	100	25	25.0%	0.001875	246
50	08/19	100	23	23.0%	0.001771	230
51	08/20	100	21	21.0%	0.001659	227
52	08/21	100	19	19.0%	0.001539	245
Total	41	3,758	638	17.0%	0.000038	
Stratum 2 - Nighttime, Trap Position 2						
53	08/22	100	18	18.0%	0.001476	226
54	08/23	77	13	16.9%	0.001822	221
55	08/24	90	16	17.8%	0.001624	215
56	08/25	50	6	12.0%	0.002112	219
57	08/26	50	15	30.0%	0.004200	253
58	08/27	100	16	16.0%	0.001344	306
59	08/28	100	20	20.0%	0.001600	270
60	08/29	49	11	22.4%	0.003553	232
61	08/31	72	14	19.4%	0.002175	214
62	09/01	49	17	34.7%	0.004624	200
63	09/02	46	11	23.9%	0.003955	193

Test #	Date		MARK RECAPTURE Chinook Released	Recaptured	Percent Recaptured	V(ê)	Flow (cfs)
64	09/05		72	14	19.4%	0.002175	167
65	09/07		62	6	9.7%	0.001410	157
Total		13	917	177	19.3%	0.000170	
Stratum 1 & 2 Pooled			4,675	815	17.43%	0.000031	
Stratum 3 - Daytime, Trap Location 1							
7	07/03		73	11	15.1%	0.001753	617
8	07/04		50	8	16.0%	0.002688	643
9	07/06		100	2	2.0%	0.000196	791
11	07/09		102	8	13.1%	0.001117	996
12	07/10		61	5	8.2%	0.001234	717
19	07/20		48	3	6.3%	0.001221	500
22	07/23		56	4	7.1%	0.001184	408
24	07/24		96	13	13.0%	0.001178	401
26	07/26		100	6	6.0%	0.000564	384
Total		9	686	60	8.7%	0.000116	
Stratum 4 - Nighttime, Trap Position 1, Broken Seal							
31	07/31		100	6	6.0	0.000564	355
32	08/01		100	5	5.0	0.000475	341
Total		2	200	11	5.5	0.000260	

Table 28. Capture efficiency test results from the Dungeness screw trap, 1997 (continued).

Capture rates for individual tests ranged from 7% to 27% for Stratum 1 tests, 10% to 35% for Stratum 2 tests, and 2% to 16% for Stratum 3 tests. Stratum 4 test results ranged from 5% to 6%. Regression analysis conducted on Strata 1 - 3 failed to show a significant relationship between capture efficiency and either flow or the test date. This analysis was conducted on each stratum and on the pooled data from all strata.

ANOVA done to evaluate capture efficiency estimates between Strata 1 - 3 found significant differences ($p<0.05$). Further ANOVA conducted on pairs of strata determined that Strata 1 and 2 capture rates were significantly different from Stratum 3 rates ($p<0.05$), but were not significantly different from each other. Based on these results, it was decided to pool the nighttime tests results into one stratum for use in expanding nighttime catches and the daytime results into another for use in expanding daytime catches (Table 28). Stratum 4 results from the two tests were pooled and used for the two days when the foam seal was lost.

Fry Production

We estimated 136,347 ad-marked, 87,768 AdCWT, and 160,260 CWT migrant chinook passed the trap in 1997 (Figure 6). A total of 9,212 wild chinook migrants are estimated to have passed the smolt traps between June 11 and September 8. As in 1996, the wild chinook migration was in progress when the trap was installed and we did not attempt to extrapolate the production estimate to the period before trapping began.

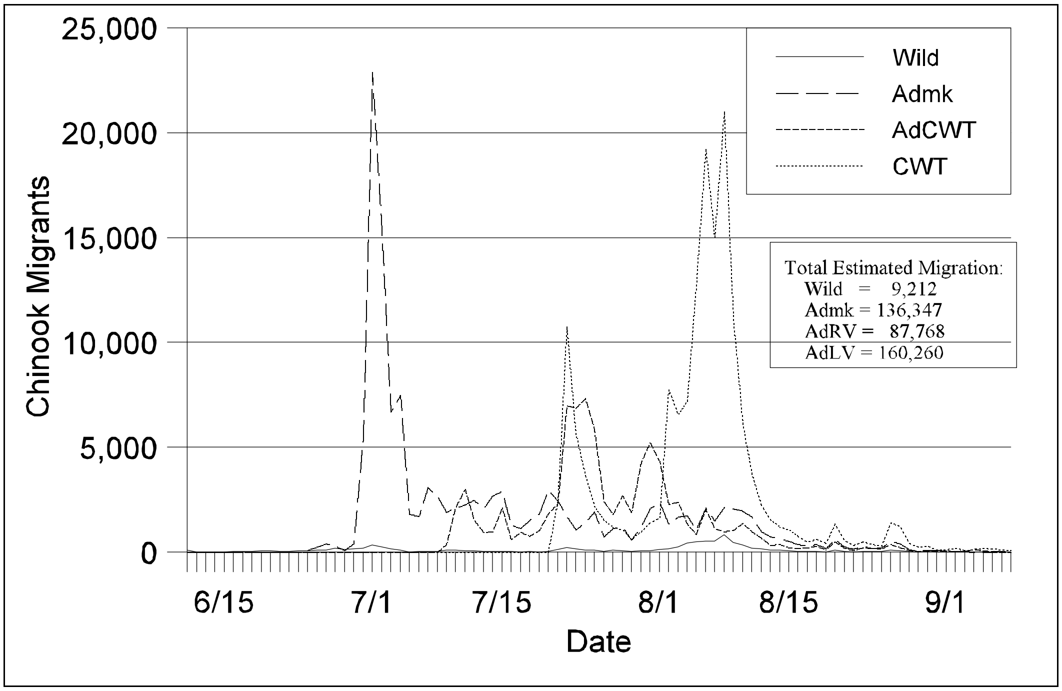

Figure 6. Migration timing for age 0+ wild and captive brood progeny chinook in the Dungeness River, 1997.

Table 29. Estimated migration and 95% CI in 1997.

Chinook Group	Estimated Migration	CV	95% CI	
			Low	High
Ad-Marked	136,347	3.46%	127,090	145,604
AdCWT	87,768	4.21%	80,521	95,015
Blank Wire	160,260	3.08%	150,597	169,923
Hatchery Total	**384,375**	**2.02%**	**369,157**	**399,593**
Wild (unmarked) Chinook	9,212	3.33%	8,783	9,641
Chinook Total	**393,587**	**1.97%**	**378,357**	**408,817**

Survival of Captive Brood Progeny

Migrant chinook survival from the release sites to the trap was assessed for each of the three mark groups. The survival estimates for each group represent average survival across the entire mark group, which is appropriate where the entire mark group is representative of one another. However, this was not the case with Dungeness chinook releases in 1997. For example, the ad-marked group was dispersed in four separate releases between late June and early August from four different sites. Fish size at release varied from 1.5 to 2.75 grams each. Each of these four releases probably experienced a different survival rate to the trap; however, we were only able to estimate survival for the entire mark group.

As in 1996, all three mark groups exhibited a protracted migration timing (Figures 7 -9). Ad-marked chinook were captured every day except two between June 24 and September 8. Fifty percent of the ad-marked group passed the trap by July 8. Similarly, AdCWT and blank wire marked fish were captured every day following their respective release dates through the end of the trapping period. Fifty percent of the AdCWT and blank wire groups had passed the trap by July 25 and August 6, respectively.

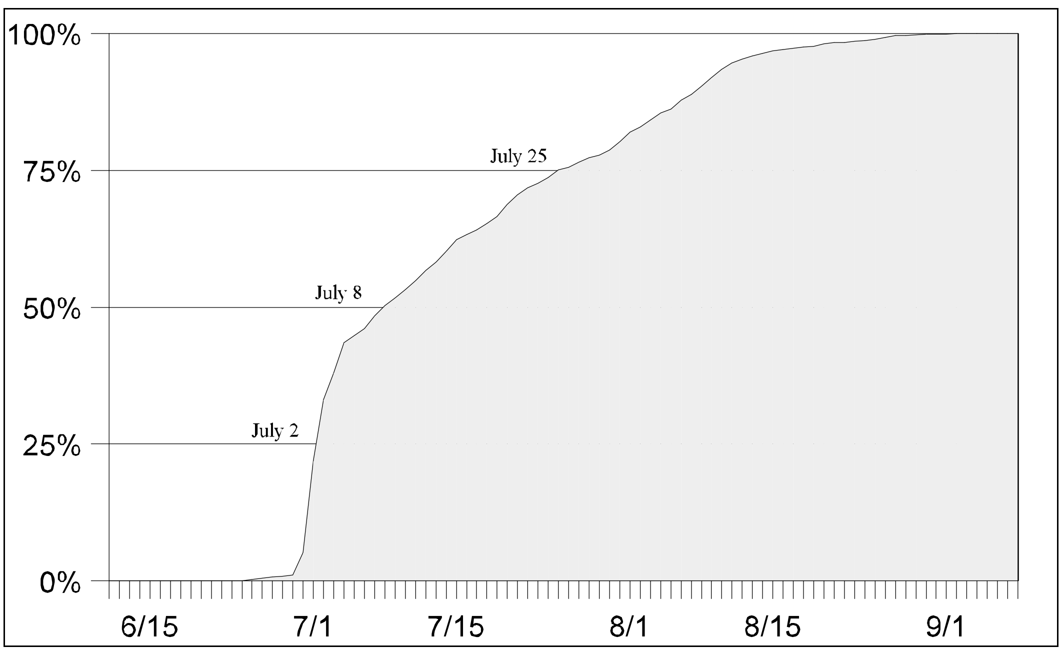

Figure 7. Cumulative percent migration for adipose-marked captive brood progeny released into the Dungeness River system, 1997.

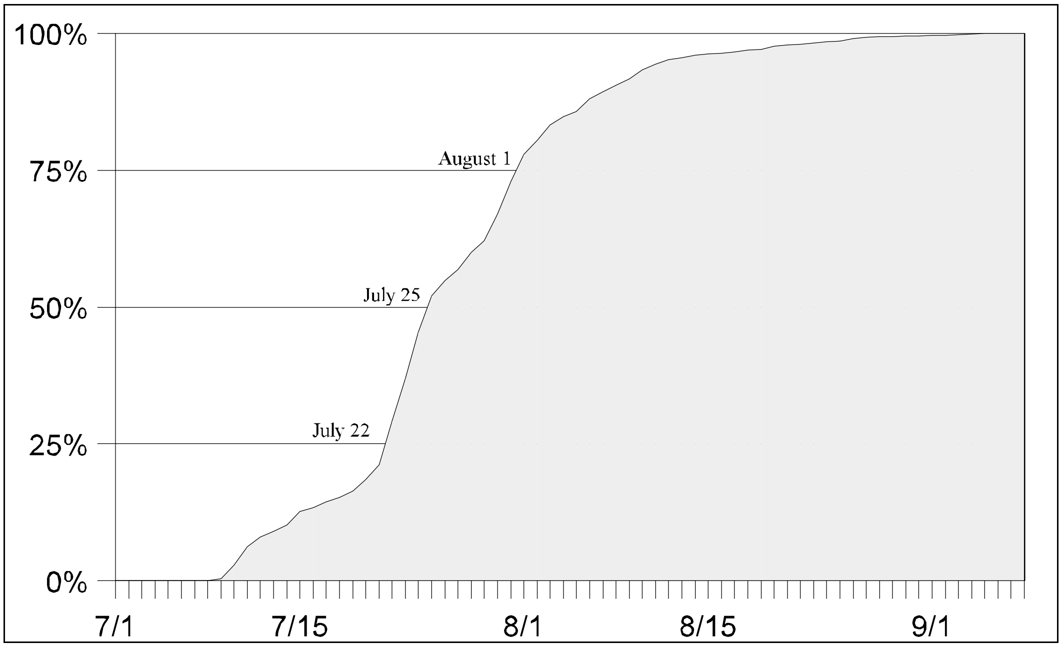

Figure 8. Cumulative percent migration for AdCWT-marked captive brood progeny released into the Dungeness River system, 1997.

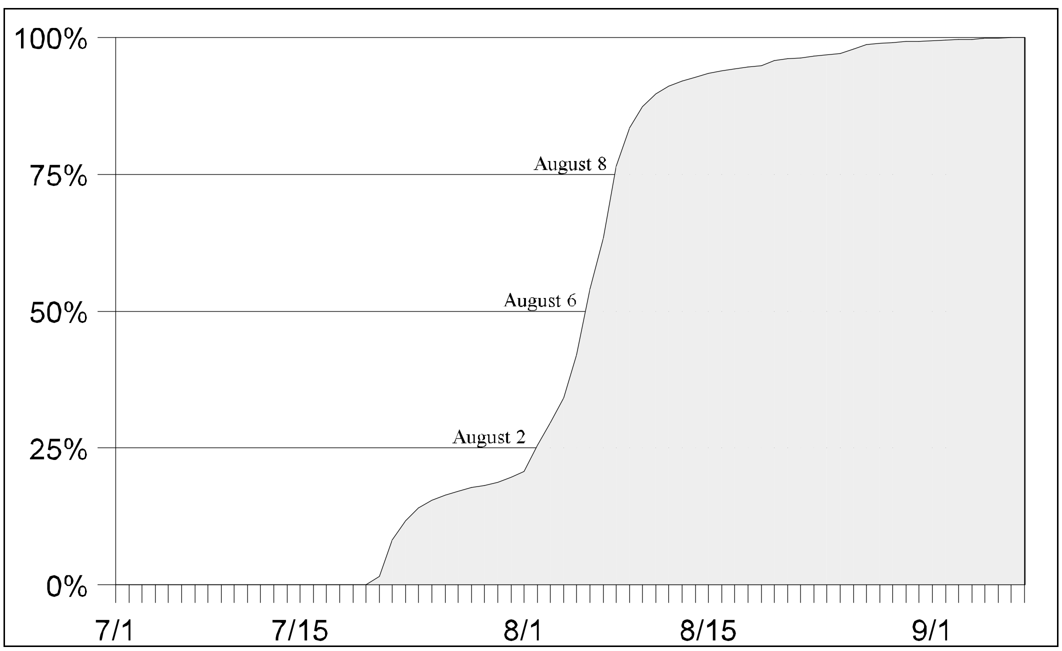

Figure 9. Cumulative percent migration for blank-wire tagged (no marks) captive brood progeny released into Dungeness River system, 1997.

Estimates of survival from the release site to the trap were fairly consistent between groups. They ranged from 21% to 23% for the three groups (Table 30).

Table 30. Estimated survival from the release site to the trap for chinook captive brood progeny, Dungeness River, 1997.						
Hatchery Group	**# Released**	**Estimated Migration**	**Estimated Survival**	**CV**	**95% $CI_{(survival)}$ Low**	**High**
Admk	590,050	136,347	23.11%	3.46%	21.54%	24.68%
AdCWT	415,452	87,768	21.13%	4.21%	19.39%	22.87%
Blank wire	769,034	160,260	20.84%	3.08%	19.58%	22.10%
Hatchery Total	**1,774,536**	**384,375**	**21.66%**	**2.02%**	**20.80%**	**22.52%**

Size Data

All of the hatchery reared migrants reaching the trap were similarly sized to each other and the captured wild chinook migrants. Fork lengths averaged 73-mm for wild migrants, 71-mm for ad-marked chinook, 78-mm for the AdCWT group and 71-mm for the blank wire group (Tables 31a-d). Lengths were sampled at a high rate (80%) for unmarked, wild migrants, but at a much lower rate (<5%) for marked fish. However, even at these low rates between 650 to 1,200 chinook were length sampled from each mark group.

Table 31a. Summary of fork length data, by stat week, unmarked chinook smolt, Dungeness River, 1997.

Stat Wk	**DATES Start**	**End**	**Mean (mm)**	**RANGE Min**	**Max**	**s.d.**	**n**	**Total Catch**	**Sample Rate**
24	06/11	06/15	77.9	69	88	8.67	7	11	63.6%
25	06/16	06/22	76.5	66	94	7.13	32	37	86.5%
26	06/23	06/29	81.3	64	106	9.49	67	115	58.3%
27	06/30	07/06	75.9	55	109	9.87	98	161	60.9%
28	07/07	07/13	73.7	51	111	10.90	58	60	96.7%
29	07/14	07/20	81.6	62	95	8.87	21	29	72.4%
30	07/21	07/27	72.0	57	89	5.04	120	136	88.2%
31	07/28	08/03	70.2	49	94	7.56	96	96	100.0%
32	08/04	08/10	72.6	52	109	8.12	482	617	78.1%
33	08/11	08/17	72.3	42	90	8.53	96	102	94.1%
34	08/18	08/24	74.5	56	88	7.75	34	35	97.1%
35	08/25	08/31	69.2	49	91	8.94	44	44	100.0%
36	09/01	09/07	63.9	47	76	12.08	7	7	100.0%
37	09/08	09/14							
	Pooled		73.3	42	111	8.75	1,162	1,450	80.1%

Table 31b. Summary of fork length data, by stat week, ad-only chinook smolt, Dungeness River, 1997.

Stat Week	DATES Start	End	Mean (mm)	RANGE Min	Max	s.d.	n	Total Catch	Sample Rate
24	06/11	06/15						0	
25	06/16	06/22						0	
26	06/23	06/29	60.7	49	78	6.70	93	210	44.3%
27	06/30	07/06	66.5	52	78	5.48	125	10,002	1.2%
28	07/07	07/13	65.9	53	75	4.91	79	2,277	3.5%
29	07/14	07/20	70.2	56	81	4.73	95	2,267	4.2%
30	07/21	07/27	71.3	62	82	4.29	46	1,701	2.7%
31	07/28	08/03	74.4	63	88	5.56	73	1,183	6.2%
32	08/04	08/10	74.8	44	95	11.06	32	2,054	1.6%
33	08/11	08/17	76.3	50	108	7.52	89	832	10.7%
34	08/18	08/24	78.3	56	100	8.03	81	310	26.1%
35	08/25	08/31	75.5	48	90	10.14	50	245	20.4%
36	09/01	09/07	78.2	55	105	13.50	25	34	73.5%
37	09/08	09/14						2	0.0%
		Pooled	70.8	44	108	8.96	788	21,117	3.7%

Table 31c. Summary of fork length data, by stat week, ad-marked/CWT chinook smolts, Dungeness River, 1997.

Stat Week	DATES Start	End	Mean (mm)	RANGE Min	Max	s.d.	n	Total Catch	Sample Rate
24	06/11	06/15						0	
25	06/16	06/22						0	
26	06/23	06/29						0	
27	06/30	07/06						0	
28	07/07	07/13	62.6	60	67	2.88	5	1,347	0.4%
29	07/14	07/20	72.7	58	85	6.52	79	1,372	5.8%
30	07/21	07/27	75.4	62	89	6.20	81	5,761	1.4%
31	07/28	08/03	79.6	62	93	5.60	221	2,741	8.1%
32	08/04	08/10	77.2	51	90	8.19	47	1,439	3.3%
33	08/11	08/17	78.0	56	93	7.85	53	467	11.3%
34	08/18	08/24	82.1	68	98	6.68	73	239	30.5%
35	08/25	08/31	79.1	54	110	12.51	42	164	25.6%
36	09/01	09/07	80.8	57	104	12.44	50	65	76.9%
37	09/08	09/14						3	0.0%
		Pooled	78.2	51	110	8.14	651	13,598	4.8%

Table 31d. Summary of fork length data, by stat week, blank wire-only chinook smolt, Dungeness River, 1997.										
Stat	**DATES**		**Mean**	**RANGE**					**Total**	**Sample**
Week	**Start**	**End**	**(mm)**	**Min**	**Max**	**s.d.**	**n**		**Catch**	**Rate**
24	06/11	06/15							0	
25	06/16	06/22							0	
26	06/23	06/29							0	
27	06/30	07/06							0	
28	07/07	07/13							1	0.0%
29	07/14	07/20							3	0.0%
30	07/21	07/27	67.6	54	78	4.63	85		4,732	1.8%
31	07/28	08/03	68.9	50	85	6.05	162		3,042	5.3%
32	08/04	08/10	71.7	53	89	7.27	276		15,684	1.8%
33	08/11	08/17	73.0	58	92	6.27	213		1,770	12.0%
34	08/18	08/24	75.0	57	92	5.91	174		629	27.7%
35	08/25	08/31	70.6	51	95	8.60	172		664	25.9%
36	09/01	09/07	69.1	52	89	9.74	116		163	71.2%
37	09/08	09/14							14	0.0%
		Pooled	71.3	50	95	7.42	1,198		26,702	4.5%

Other Species

A number of other species were captured during the trapping operation. Other salmonids captured are shown in Table 27.

Discussion

We believe our 1996 and 1997 migration and survival estimates for chinook captive brood progeny from brood years 1995 and 1996 to be reasonably accurate for the period trapped. The coefficient of variation for these estimates is quite low, partially a result of pooling the trap efficiency data but also due to the relatively high capture efficiency rates found during the tests. Confidence in these estimates is tied to how well we believe our assumptions have been met. A couple of these assumptions merit further discussion.

Application of Trap Efficiency Estimates to Untested Periods

In 1996, trap efficiency estimates were discontinued after August 12. After this date, too few chinook were captured each night to enable continuation of testing. Therefore, we had to use the results from these earlier tests to estimate migration for the mid-August to early October period, including the entire August 30 release.

Prior to August 12, all of the fish used for efficiency testing were either wild or ad-marked migrants from the June 24 release. While these fish were similar in size to the ad-marked and ad/LV-marked groups released on August 30, only the very largest individuals were similar in size to the ad/RV-marked fish, also released on that date. One could easily question whether capture efficiency would be the same for the later migrating, larger fish released on August 30.

Factors that may effect capture efficiency include channel morphology, flow or discharge, turbidity, water velocity, fish size/swimming ability, light conditions, and noise levels. These factors are not independent, but instead work in concert to influence capture efficiency. As fish grow in size, their swimming capabilities increase reducing our ability to trap them. However, increased swimming ability may be overridden by decreasing flow, high velocity, and a channel morphology that funnels the migrants into the trap with little room to escape. In 1996, increasing fish size had little effect on capture efficiency (Figure 10). Regression analysis which evaluated the effect of test date (an indicator of temporal effects such as increasing fish size) and flow on

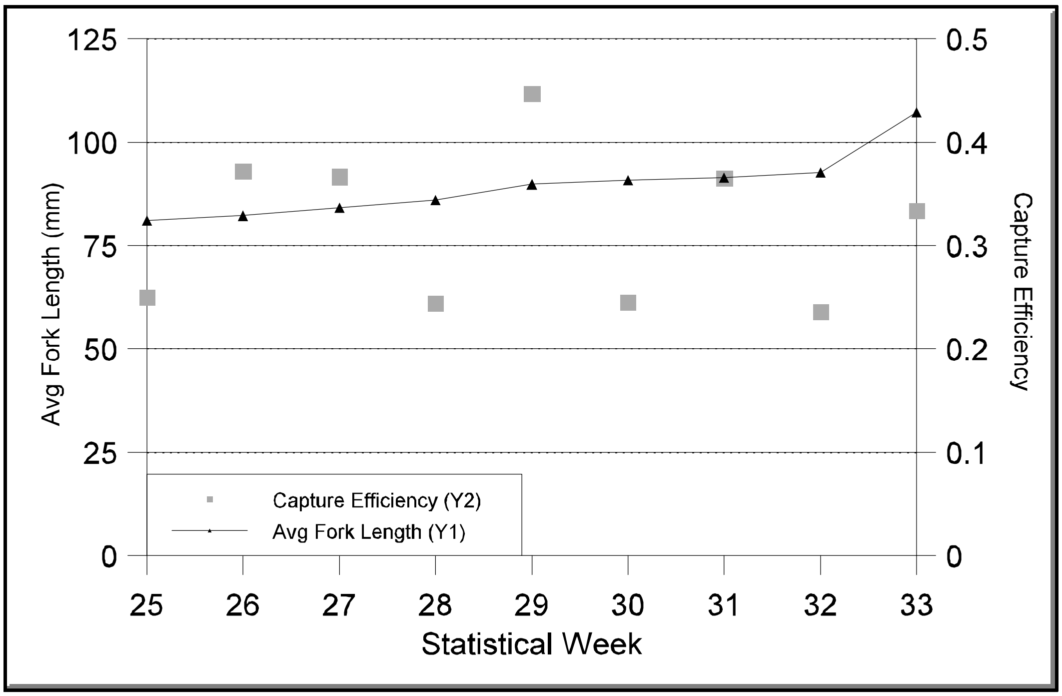

Figure 10. Relationship between average weekly fork length for wild chinook smolt and capture efficiency at the Dungeness River smolt trap, 1996.

capture efficiency failed to find significant relationships. These results lead us to accept the assumption that the earlier capture efficiency tests are representative of those occurring in the later part of the trapping period.

Potential Over-Wintering of Hatchery Released Chinook

Wild juvenile chinook smolt migration on most western Washington rivers is largely completed by the end of June (personal observation). However, on the Dungeness wild chinook migration was in progress when trapping was started and continued through the July-August period. This protracted migration is presumably due to colder water temperatures. Cold water temperatures certainly effected the growth rate of the captive brood progeny resulting in releases as late as August 30 in 1996.

Survival estimates of captive brood progeny would be underestimated if a portion of these fish overwintered and migrated as age 1+ fish. From the scale samples taken in 1996, apparently the vast majority of wild smolt leave the Dungeness as 0+ migrants. One smolt captured in 1996 was aged as a 1+ fish. It was unmarked, but there was uncertainty from the scale data as to whether it was of hatchery or wild origin. The fork length of this fish was 155-mm.

Any captive brood progeny from the 1995 brood which did not migrate the first year and survived to spring would not have been captured in 1997 if they migrated in the spring since the trap was not installed until June 11. Therefore, the number of captive brood progeny from the 1995 brood that over-wintered in the Dungeness and migrated in 1997 is unknown.

Survival of Captive Brood Progeny

Survival estimates for releases of captive brood progeny from the release site to the trap were very consistent in 1997, ranging from 21% to 23% for ad, AdCWT, and blank wire marked chinook. Survival was much more variable in 1996. The ad-marked group experienced a 32% survival rate to the trap, while the ad/RV and ad/LV-marked groups experienced only an 18% and 2% survival rate, respectively. Since the ad/RV and ad/LV-marked groups were released the same day, it is presumed that the ad/RV group survived better due to their larger size at release (13-g vs. 5-g).

The relatively poor survival of the August 30 release in 1996 may be related to flow. Flow has been correlated with survival of release groups at other sites (Seiler and Kishimoto 1997). During high flows, migrants are likely carried downstream more quickly than under low-flow conditions. There is also more habitat, cover, and other refugia available to avoid predation at higher discharge levels. Flows encounter during releases in 1996 and 1997 ranged from 165 to 996-cfs. The lowest flows (165-cfs) were recorded for the August 30, 1996 releases. These fish were released into the Gray Wolf system, approximately 12-miles upstream of the trap site. All other releases occurred when flows averaged over 300-cfs.

Progress Towards Stated Longer Term Goals

Smith and Wampler (1995) listed studies and data needs for making progress towards identification of the limiting factor(s) to restoring chinook salmon abundance in the Dungeness River. This section discusses accomplishments in addressing the captive brood stock, genetics and brood stock collection items.

1. Genetically characterize the Dungeness chinook salmon stock and compare it to other Puget Sound chinook salmon baselines.

   Tissue samples have been collected from at least one fish from 122 of the 125 redd pumped families in the captive brood stock program. These samples have been screened for the standard suite of loci used in genetic stock identification of chinook salmon from other Puget Sound stocks. Initially, these samples will not be used to characterize the stock but rather for an analysis to determine if samples collected from purported families can be used for a characterization of the stock which would allow comparisons with other chinook stocks whose baseline samples were collected from the spawning grounds.

2. Readdress the one or two stocks question for Dungeness River chinook.

   Review of existing data by the DRCSRP led that group's steering committee to conclude that there did not exist sufficient data to change the original conclusion of one stock.

3. Develop and implement a genetically sound, captive brood-stock spawning protocol.

   Brood stock spawning matrices of allowable crosses were developed and used for the 1995, 96 and 97 spawning years. After that random mating with documentation of crosses made was allowed. To date, of the 2,290 crosses made only 34 of them were between full siblings.

4. Planting of captive brood stock progeny issues.

   As described previously in this report, a multi-faceted planting program was developed and implemented as best as possible given year by year river access and fish culture constraints.

5. Compare the freshwater and saltwater captive brood stock programs.
   While no comprehensive analysis has been possible, a study comparing the fresh water and sea pen reared adult and some early life survival characteristics of those adults' progeny was performed and is reported in Marlowe, 1999. Data and descriptions in this report also allow comparison of the two fish culture environments regarding success in producing spawning adults and the viability of their gametes and progeny.

6. Monitor and evaluate genetic changes resulting from the captive brood stock.

   No funding has been provided for this evaluation to date.

7. Develop hatchery practices to reduce genetic change between captive brood stock and wild fish.

   Cessation of brood stock capture by redd pumping after the 1997 collections to avoid the risk of using fish whose parents could have come from the captive brood stock helps to accomplish this goal.

8. Conduct of a formal genetic risk assessment.

   This effort was not carried out.

In addition to the above needs, Smith and Wampler called for improvements in brood stock collection techniques. In particular:

1. Crew training in electro-shocking techniques.

   U.S. Fish and Wildlife personnel provided training in electo-shocking to WDFW crew members prior to the 1993 brood year collection efforts in the spring of 1994.

2. Experimental assessment of the effects of hydraulic sampling on fry remaining in the gravel.

   Experimental design efforts led researchers to conclude that 1) variance in fry emergence from naturally occurring chinook redds make sample size requirements prohibitive for use of natural redds and 2) the limited applicability of information gathered from artificially constructed redds made this type of study unsuitable.

3. Automated data management tools for family by family analysis.

   No specific data management tools were developed due to funding constraints but diligent and careful record keeping by hatchery personnel have kept good records of family mortalities and maturities. Some notable exceptions include fish maturing as jacks but not used in spawning and the problems described earlier in accounting for fish loss at SSNP.

Smith and Wampler (1995) also called for some efforts specifically aimed at long-term monitoring and evaluation.

1. Monitor and evaluate the rebuilding program.

   As described in this report, monitoring is an integral part of the project design. All phases of the captive brood stock program have been monitored including: egg and fry collections, juvenile and adult rearing, fish health, spawning protocols, out migrant success, adult escapements and tag recoveries. These same activities are planned for in future years.

2. Successes, failures, and impacts of the hatchery program on the indigenous stock.

   The long term monitoring of stock abundance after the return of all project progeny will be the basis for these types of evaluations.

3. Fishery impacts of the Dungeness chinook stock.

   Release groups of CWT marked captive brood stock progeny should in time provide this data.

4. Effectiveness, longevity and productivity of habitat restoration projects.

   This report does not include these aspects. It is the feeling of the technical team that successful recovery of the Dungeness chinook stock is largely dependent on improvements to habitat with the basin.

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Appendix A

Appendix Table A1. Dungeness chinook tagged by family and brood year (freshwater and saltwater), 1992,3,4.

1992			1993			1994		
Family	**Fresh**	**Salt**	**Family**	**Fresh**	**Salt**	**Family**	**Fresh**	**Salt**
92-A1(ES3)	55	0	93-C2EL	19	16	94-A1	95	95
92-A2(ES1)	41	0	93-C3EL	57	48	94-A2	88	88
92-A3(ES1)	30	0	93-C4EL	36	27	94-A3	100	101
92-A4(ES4)	54	0	93-C5EL	32	28	94-A4	99	99
92-A5(ES2)	33	0	93-D1	127	127	94-A5	95	94
92-A6(ES2)	26	0	93-D2	74	74	94-A6	100	99
92-A7(ES5)	25	0	93-D3	130	130	94-A7	9	9
92-B1	49	0	93-D4	99	98	94-B1	99	98
92-B2(ES3)	107	0	93-D5EL	78	66	94-B2	100	94
92-B3(ES1)	72	0	93-D6EL	100	92	94-B3	100	101
92-B4(ES3)	84	0	93-D7EL	9	5	94-B4	101	101
92-B5(ES4)	54	0	93-D8EL	26	22	94B5EL	29	34
92-B6(ES5)	83	0		787	733	94-B6EL	96	97
92-B7(ES2)	57	0				94-B7	94	94
92-C1	211	0				94-C1	0	10
92-C2	194	0					1205	1214
92-C3(ES2)	169	0						
92-C4	171	0						
92-C5	124	0						
92-C6(ES3)	160	0						
92-C7(ES4)	141	0						
92-C8	117	0						
92-D1	220	0						
92-D2	214	0						
92-D3	151	0						
92-D4	188	0						
92-D5	235	0						
92-D6	203	0						
92-D7	212	0						
92-D8	214	0						
	3694	0						

Note: For some of the 1992 brood year families which were electro-fishing capture the final family designations are given in parenthesis (e.g. ES1 through ES5) because capture groups were combined for fish culture reasons. The ES designations are used throughout this report.

Appendix Table A2. Dungeness chinook tagged by family and brood year (freshwater and saltwater), 1995,6,7.

1995			1996			1997		
Family	**Fresh**	**Salt**	**Family**	**Fresh**	**Salt**	**Family**	**Fresh**	**Salt**
95-A1	32	32	6A1	26	13	7C1	150	47
95-A2EL	32	32	6A2	26	15	7D1	98	0
95-A3	30	31	6A3	26	12	7D2	150	37
95-A4	31	32	6A4	26	14	7D3	150	116
95-A5	32	32	6A5	26	14	7D4	66	0
95-A6	32	32	6A6	26	14	7D5	150	31
95-A7	32	32	6A7	26	13	7D6	150	71
95-A7LV	10	11	6B1	26	13	7D7	125	0
95-B1	28	28	6B2	26	14	7D8	150	88
95-B2	32	32	6B3	26	13		1189	390
95-B2LV	32	32	6B4	26	13			
95-B3	31	32	6B5	26	13			
95-B4	32	32	6B6	26	15			
95-B4LV	32	32	6B7	26	15			
95-B5	32	32	6C1	26	19			
95-B6	32	32	6C2	26	15			
95-B6LV	32	32	6C3	26	14			
95-B7	30	31	6C4	26	14			
95-C1	32	32	6C5	26	14			
95-C1LV	32	32	6C6	26	14			
95-C2	32	32	6C7	26	14			
95-C2LV	32	32	6C8	26	14			
95-C3	30	31	6D1	26	15			
95-C4	31	32	6D2	26	15			
95-C5	32	32	6D3	26	6			
95-C5LV	32	32	6D4	26	14			
95-C6	32	32	6D5	26	17			
95-C6LV	32	32	6D6	26	13			
95-C7	31	32	6D7	23	0			
95-C8	31	32	6D8	26	20			
95-D1	32	32	6Y1	26	9			
95-D2	30	31	6Y2	26	13			
95-D3	32	32	6Y3	26	13			
95-D3LV	32	32	6Y4	26	15			
95-D4	23	24	6Y5	26	13			
95-D5	17	18	6Y6	26	14			
95-D6	27	27	6Y7	26	14			
95-D7	32	32	6Y8	26	13			
95-D7LV	32	32	6Z1	26	14			
95-D8	9	10	6Z2	26	13			
	1189	1202	6Z3	26	14			
			6Z4	26	14			
			6Z5	26	9			
			6Z6	26	14			
			6Z7	26	14			
			6Z8	26	7			
				1193	612			

Appendix B

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
2B12C2	1	2C22C2	1	2C44A2	4	2C82D6	6
2B12C4	1	2C22C4	3	2C44A3	4	2C82ES3	1
2B12D1	2	2C22D3	4	2C44A4	4	2C82ES4	3
2B12D4	2	2C22D6	6	2C44A5	2	2C82ES5	2
2B12D8	3	2C22ES1	10	2C44B7	1	2C83D3	1
2B12ES4	1	2C22ES2	4	2C45A3	2	2C83D6EL	1
2B12ES5	1	2C22ES3	7	2C45A7	1	2C84A4	1
2B14A1	1	2C22ES4	5	2C45B2LV	2	2C84A6	1
2B14A3	1	2C23C4EL	3	2C45B7	1	2C84B1	1
2B14A4	1	2C23D2	1	2C45C1LV	1	2C84B3	2
2B14A5	1	2C24A1	1	2C45D3	1	2C84B4	1
2B14B1	1	2C24A2	1	2C45D7LV	1	2C84B7	1
2B14B2	1	2C24A3	2	2C46A2	1	2C85B1	1
2B15D3	1	2C24A4	2	2C5? 1		2C85B3	1
2C12C2	2	2C24A5	3	2C52C5	1	2C85B7	1
2C12C8	1	2C24A6	1	2C52D1	2	2C85C1LV	1
2C12D1	5	2C24B2	1	2C52D2	2	2C85C5LV	1
2C12D2	2	2C24B3	1	2C52D3	2	2C85D6	1
2C12D3	1	2C25A1/C2	2	2C52D5	5	2D12C2	4
2C12D5	2	2C25A3	1	2C52D6	1	2D12C4	4
2C12D6	1	2C25B2LV	1	2C52D8	3	2D12D2	1
2C12D8	3	2C25B4	1	2C52ES3	6	2D12D6	3
2C12ES1	1	2C25C5	1	2C53D1	1	2D12D8	5
2C12ES2	4	2C25C8	1	2C53D3	1	2D12ES1	2
2C12ES3	8	2C25D2	2	2C53D8EL	2	2D12ES2	4
2C12ES5	1	2C26A3	1	2C54A2	1	2D12ES3	4
2C13C4EL	1	2C26D6	1	2C54A3	1	2D12ES4	2
2C13D3	1	2C26Y1	1	2C54A5	4	2D12ES5	2
2C14A1	3	2C42C4	6	2C54B2	1	2D13C2EL	1
2C14A2	4	2C42C5	1	2C54B3	1	2D13D1	1
2C14A3	1	2C42C8	1	2C54B7	2	2D13D3	3
2C14A4	4	2C42D3	4	2C55A3	1	2D13D6EL	1
2C14A5	5	2C42ES1	4	2C55B3	1	2D14A1	2
2C14B1	4	2C42ES3	7	2C55C1LV	1	2D14A2	1
2C14B2	8	2C42ES4	4	2C55C5	1	2D14A4	2
2C14B3	3	2C42ES5	1	2C55D3	1	2D14A5	5
2C14B4	2	2C43D1	4	2C55D7	1	2D14A6	1
2C14B6EL	4	2C43D4	3	2C55D7LV	1	2D14B1	1
2C14B7	1	2C43D5EL	4	2C82C2	2	2D14B2	2
2C15C1	1	2C44A1	1	2C82D2	3	2D14B4	1

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
2D14B6EL	2	2D26D3	1	2D43D2	1	2D54B6EL	2
2D14B7	2	2D3?	2	2D43D5EL	2	2D54B7	2
2D15A7	1	2D32D1	2	2D43D6EL	1	2D55C1LV	1
2D15B2LV	1	2D32D3	2	2D44A1	2	2D62B1	2
2D15C1	1	2D32D5	3	2D44A3	2	2D62C4	1
2D15C4	1	2D32D6	2	2D44A4	2	2D62D2	1
2D15C5	1	2D32ES2	4	2D44A6	1	2D62D5	2
2D15C5LV	1	2D32ES3	8	2D44B1	3	2D62D7	2
2D15C7	1	2D32ES5	1	2D44B2	2	2D62D8	4
2D15D3	1	2D33C3EL	2	2D44B3	1	2D62ES1	2
2D15D7LV	1	2D34A1	1	2D44B4	1	2D62ES2	2
2D22B1	1	2D34A2	2	2D44B6EL	1	2D62ES3	11
2D22C4	1	2D34A4	1	2D45C1	1	2D62ES5	1
2D22D2	2	2D34A5	1	2D45D3	1	2D63D4	1
2D22D3	2	2D34A6	2	2D52B1	1	2D64A3	3
2D22D5	3	2D34A7	2	2D52C2	1	2D64A4	2
2D22D8	4	2D34B1	3	2D52C4	3	2D64A5	2
2D22ES1	4	2D34B2	1	2D52C8	2	2D64B1	5
2D22ES2	6	2D34B4	1	2D52D1	5	2D64B3	4
2D22ES3	7	2D34B5EL	1	2D52D7	4	2D64B4	2
2D22ES4	2	2D34B6EL	1	2D52D8	5	2D64B6EL	3
2D22ES5	2	2D34B7	1	2D52ES1	2	2D64B7	1
2D23C3EL	1	2D35B2LV	1	2D52ES2	6	2D65C1	1
2D23C4EL	2	2D35B4LV	1	2D52ES3	1	2D65C2LV	1
2D23D6EL	3	2D35C2LV	1	2D52ES4	9	2D65D3	1
2D24A1	3	2D35D2	1	2D52ES5	2	2D72B1	2
2D24A2	1	2D4?	2	2D53C3EL	1	2D72C1	1
2D24A3	1	2D42C1	1	2D53C5EL	1	2D72C2	2
2D24A5	3	2D42C2	3	2D53D1	1	2D72C4	2
2D24A6	1	2D42C4	3	2D53D3	1	2D72C8	3
2D24B1	1	2D42C8	1	2D53D5EL	1	2D72D1	4
2D24B2	3	2D42D1	3	2D53D6EL	1	2D72D2	2
2D24B5EL	1	2D42D2	2	2D54A1	3	2D72D3	3
2D24B6EL	2	2D42D3	1	2D54A2	1	2D72D7	1
2D24B7	2	2D42D5	3	2D54A3	4	2D72D8	4
2D25A7	1	2D42D8	1	2D54A5	2	2D72ES1	2
2D25B1	1	2D42ES1	2	2D54B1	7	2D72ES2	4
2D25C5LV	1	2D42ES2	6	2D54B3	3	2D72ES3	10
2D26C1	1	2D42ES3	6	2D54B4	2	2D73C5EL	1
2D26C5	1	2D42ES4	2	2D54B5EL	1	2D73D2	1

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
2D74A2	2	2ES14B3	1	2ES33C4EL	2	2ES52ES1	1
2D74A3	2	2ES14B6EL	2	2ES33C5EL	1	2ES52ES4	4
2D74A4	5	2ES14B7	2	2ES33D2	1	2ES53D4	2
2D74A5	5	2ES15A7	1	2ES33D3	4	2ES54A1	1
2D74B1	5	2ES15B3	1	2ES33D4	2	2ES54A4	1
2D74B2	3	2ES15B4LV	1	2ES33D5EL	2	2ES54B1	2
2D74B3	3	2ES15C3	1	2ES33D6EL	1	2ES54B2	1
2D74B4	1	2ES15D2	1	2ES34A1	1	2ES54B3	1
2D74B5EL	1	2ES22B1	1	2ES34A2	3	2ES54B6EL	1
2D74B6EL	2	2ES22C4	4	2ES34A3	5	2ES55C2LV	1
2D75A1/C2	1	2ES22C5	1	2ES34A4	2	3C2EL3D7EL	1
2D75C5LV	1	2ES22C8	3	2ES34A5	2	3C2EL4A5	1
2D82C2	4	2ES22ES1	1	2ES34A6	1	3C2EL4A6	1
2D82C4	1	2ES22ES2	3	2ES34B1	4	3C2EL4B6EL	2
2D82C8	5	2ES22ES3	17	2ES34B2	4	3C2EL5A7	1
2D82D3	3	2ES22ES4	7	2ES34B3	1	3C2EL5B4	1
2D82ES3	6	2ES23C3EL	1	2ES34B4	5	3C2EL5C6	1
2D82ES4	7	2ES23C5EL	2	2ES34B6EL	1	3C2EL5D2	1
2D82ES5	3	2ES23D5EL	2	2ES34B7	5	3C2EL6D2	1
2D83C5EL	1	2ES23D6EL	4	2ES35A7	1	3C3EL2ES1	1
2D83D1	1	2ES24A1	1	2ES35C1LV	2	3C3EL2ES4	1
2D83D3	2	2ES24A3	2	2ES35C5	2	3C3EL3C5EL	3
2D83D4	1	2ES24A4	1	2ES35C5LV	1	3C3EL3D3	5
2D84A1	1	2ES24A5	4	2ES35D7	1	3C3EL3D5EL	1
2D84A3	4	2ES24A7	1	2ES35D7LV	1	3C3EL4A2	3
2D84A4	1	2ES24B1	4	2ES4?	1	3C3EL4A4	2
2D84A5	3	2ES24B2	1	2ES42D3	1	3C3EL4A5	1
2D84B1	6	2ES24B6EL	1	2ES43D3	1	3C3EL4A6	2
2D84B2	3	2ES24B7	2	2ES44A1	4	3C3EL4B6EL	2
2D84B3	1	2ES25B2	1	2ES44A2	3	3C3EL5B4LV	1
2D84B4	1	2ES25B2LV	1	2ES44A3	3	3C3EL5C2LV	1
2D84B6EL	2	2ES25B7	2	2ES44A4	4	3C3EL5D7	1
2D84C1	1	2ES25C1	1	2ES44A5	1	3C3EL6Y6	1
2D85C1LV	1	2ES25C5	1	2ES44B1	1	3C4EL3C4EL	1
2ES12D3	1	2ES25D3	1	2ES44B2	5	3C4EL3D1	1
2ES12ES1	1	2ES26C6	1	2ES44B3	4	3C4EL3D2	1
2ES12ES3	5	2ES3?	1	2ES44B4	2	3C4EL3D5EL	2
2ES12ES4	3	2ES32ES3	6	2ES44B5EL	1	3C4EL3D6EL	5
2ES13D5EL	2	2ES32ES4	13	2ES45A1/C2	1	3C4EL4A5	1
2ES14A5	3	2ES32ES5	6	2ES45C7	1	3C4EL4A6	1

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
3C4EL5A6	1	3D16Z5	1	3D42C8	1	3D5EL5B1	1
3C4EL5B3	2	3D22D3	1	3D42ES4	1	3D5EL5B4LV	1
3C4EL5C1	1	3D22ES4	1	3D43C4EL	1	3D5EL5D3	1
3C4EL6D1	1	3D23C5EL	1	3D43C5EL	1	3D5EL5D3LV	1
3C4EL6Y2	1	3D23D3	5	3D43D1	4	3D5EL5D7LV	1
3C5EL2C2	2	3D23D5EL	3	3D43D3	3	3D5EL6A5	1
3C5EL3D3	4	3D24A1	1	3D43D5EL	2	3D5EL6B5	1
3C5EL3D5EL	2	3D24A3	1	3D43D6EL	1	3D5EL6C8	1
3C5EL3D6EL	1	3D24A4	1	3D43D7EL	1	3D5EL6Z6	1
3C5EL4B1	1	3D24A5	1	3D43D8EL	2	3D6EL2B1	1
3C5EL4B6EL	1	3D24A6	2	3D44A1	9	3D6EL2C5	1
3C5EL5D7	1	3D24B4	2	3D44A2	5	3D6EL2D3	1
3C5EL6B2	1	3D24B7	2	3D44A3	5	3D6EL2ES4	1
3D12C2	1	3D25B4	2	3D44A4	2	3D6EL3C2EL	1
3D12D3	1	3D25C4	1	3D44A5	1	3D6EL3C3EL	2
3D12ES3	1	3D25D3	1	3D44A6	1	3D6EL3D2	1
3D13C2EL	1	3D26A4	2	3D44B1	1	3D6EL3D6EL	1
3D13C3EL	3	3D26C6	1	3D44B2	7	3D6EL3D8EL	1
3D13D1	1	3D26Y4	1	3D44B3	3	3D6EL4A1	2
3D13D2	4	3D32C2	1	3D44B4	8	3D6EL4A3	5
3D13D3	6	3D32C4	1	3D44B6EL	1	3D6EL4A5	3
3D13D5EL	2	3D32D2	1	3D44B7	4	3D6EL4A6	3
3D13D6EL	3	3D32D3	1	3D45A6	1	3D6EL4B1	2
3D13D8EL	1	3D32ES1	2	3D45B2	1	3D6EL4B4	4
3D14A2	4	3D33C2EL	1	3D45B4LV	3	3D6EL4B6EL	2
3D14A3	3	3D33D5EL	7	3D45C1LV	1	3D6EL4B7	2
3D14A4	1	3D34A2	1	3D45D3	1	3D6EL5A6	1
3D14A5	3	3D34A3	3	3D46A2	1	3D6EL5B2LV	2
3D14A6	2	3D34A5	1	3D5EL2C8	1	3D6EL5B5	1
3D14B2	1	3D34B1	1	3D5EL3D5EL	1	3D6EL5B6	1
3D14B3	1	3D34B2	1	3D5EL3D6EL	3	3D6EL5C4	1
3D14B4	4	3D34B3	2	3D5EL3D8EL	3	3D6EL6C5	1
3D14B6EL	5	3D34B4	2	3D5EL4A1	2	3D6EL6D1	1
3D15A3	1	3D34B6EL	8	3D5EL4A2	4	3D6EL6D3	1
3D15A4	2	3D34B7	3	3D5EL4A3	2	3D6EL6Y3	1
3D15A7LV	1	3D35B1	1	3D5EL4A5	1	3D6EL6Z1	1
3D16D2	1	3D35C5LV	1	3D5EL4B4	1	3D6EL6Z3	1
3D16D4	1	3D35D7LV	1	3D5EL4B6EL	3	3D6EL6Z8	1
3D16D6	1	3D4?	1	3D5EL4B7	2	3D6EL7D4	1
3D16D7	1	3D42C2	2	3D5EL5A5	1	3D7EL4B7	2

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
3D8EL2C4	1	4A23D6EL	3	4A43C5EL	1	4A55C7	1
3D8EL2ES3	1	4A24A5	1	4A43D5EL	1	4A55C8	1
3D8EL2ES4	1	4A24A6	3	4A43D6EL	2	4A55D2	1
3D8EL4A3	1	4A24B1	1	4A44A2	1	4A55D3	2
3D8EL4B4	2	4A24B6EL	2	4A44A4	2	4A56A4	1
3D8EL4B7	2	4A25A6	2	4A44A5	2	4A56A5	1
3D8EL5B4LV	1	4A25B1	1	4A44A6	4	4A56A6	1
3D8EL5C7	1	4A25B3	1	4A44B1	1	4A56B4	1
3D8EL6C5	1	4A25B4LV	2	4A44B5EL	1	4A56C1	1
4A14A3	1	4A25C7	1	4A45A1/C2	1	4A56C5	1
4A14A6	2	4A25C8	1	4A45A6	1	4A56C6	1
4A14B2	1	4A25D3	1	4A45A7LV	2	4A56Y1	1
4A14B3	1	4A25D6	1	4A45B4	1	4A56Y5	1
4A14B4	3	4A26A2	1	4A45B4LV	1	4A6?	1
4A15A1/C2	1	4A26B2	1	4A45C1	1	4A63D7EL	1
4A15A3	1	4A26C1	1	4A45C7	1	4A64A6	5
4A15A7	1	4A26C3	1	4A45D1	1	4A64B6EL	3
4A15B2LV	1	4A26C5	1	4A45D3LV	1	4A65A4	1
4A15C4	1	4A26D6	1	4A45D7LV	3	4A65A7LV	1
4A15C5	2	4A26Y3	1	4A46A5	1	4A65B2	2
4A15C5LV	1	4A33D5EL	2	4A46B1	1	4A65C3	1
4A15C7	1	4A34A2	1	4A46B2	1	4A65C4	1
4A15C8	1	4A34A4	1	4A46C5	1	4A65C6	1
4A15D1	1	4A34A6	4	4A46C6	1	4A65D2	1
4A15D7LV	3	4A34B7	2	4A46C8	1	4A65D3LV	2
4A16B2	1	4A35B2	2	4A46Y7	1	4A65D6	1
4A16B3	1	4A35B2LV	2	4A46Z3	1	4A65D7LV	1
4A16C1	1	4A35B4	2	4A46Z4	1	4A66C7	1
4A16C3	1	4A35C5	1	4A46Z6	1	4A66C8	1
4A16C7	2	4A36A2	1	4A52D5EL	1	4A66D6	1
4A16C8	1	4A36A5	1	4A53C5EL	1	4A66Y7	1
4A16D1	1	4A36A6	1	4A53D7EL	1	4A66Y8	1
4A16D6	1	4A36C3	1	4A54A1	1	4A66Z1	1
4A16D7	1	4A36C5	1	4A54A2	1	4A66Z7	1
4A16Y3	2	4A36D7	1	4A54A3	1	4A66Z8	1
4A16Y7	1	4A36Y5	1	4A54A6	3	4A73D6EL	1
4A16Z1	1	4A36Y7	1	4A54B6EL	2	4A74A4	1
4A16Z4	1	4A36Z6	1	4A54B7	2	4A74A6	1
4A16Z8	2	4A36Z8	2	4A55C2LV	1	4B13C3EL	2
4A22C2	2	4A43C4EL	2	4A55C5LV	1	4B13D1	1

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
4B13D7EL	1	4B26A6	2	4B44B7	3	4B6EL5C4	3
4B13D8EL	2	4B26B3	1	4B45A3	1	4B6EL5C6	1
4B14A3	1	4B26C1	1	4B45B2	1	4B6EL5C8	2
4B14A5	1	4B26C5	3	4B45B3	1	4B6EL5D2	1
4B14A6	2	4B26C6	1	4B45B4	1	4B6EL5D3	2
4B14B2	1	4B26C8	1	4B45C1	2	4B6EL5D6	2
4B14B5EL	2	4B26D3	1	4B45C4	2	4B6EL5D7	1
4B14B6EL	1	4B26D6	2	4B45C5	1	4B6EL6A4	1
4B14B7	4	4B26Y3	1	4B45C6	1	4B6EL6A7	1
4B15A2EL	1	4B26Z6	1	4B45C6LV	1	4B6EL6B5	1
4B15A5	1	4B34A6	1	4B45D3	2	4B6EL6C6	1
4B15B4LV	2	4B34B3	1	4B46A2	1	4B6EL6C7	3
4B15C1	1	4B34B4	3	4B46A3	1	4B6EL6D1	1
4B15C6	1	4B34B6/6Z1	1	4B46B2	1	4B6EL6D6	2
4B15C8	1	4B34B6EL	1	4B46B5	2	4B6EL6Y4	1
4B15D3LV	1	4B34B7	1	4B46C5	2	4B6EL6Y6	1
4B15D7LV	1	4B35A3	1	4B46D3	1	4B6EL6Z3	1
4B15D8	1	4B35B2	1	4B46D6	1	4B6EL6Z4	1
4B16C2	1	4B35C5LV	2	4B46Y1	1	4B6EL6Z8	1
4B16C5	2	4B35D6	1	4B46Z4	2	4B73C3EL	1
4B16C8	1	4B36A2	1	4B5EL4A6	1	4B74A1	1
4B16D6	3	4B36B5	2	4B5EL4B5EL	1	4B74A2	1
4B16Z4	1	4B36B7	1	4B5EL4B7	1	4B74A6	1
4B23D5EL	1	4B36C5	1	4B5EL5C1	1	4B74B2	1
4B24A3	1	4B36D1	1	4B5EL5C7	1	4B74B6EL	2
4B24A6	1	4B36Y5	1	4B5EL5D3	1	4B74B7	2
4B24B6EL	2	4B36Y6	1	4B5EL5D3LV	2	4B75A1/C2	1
4B25A1/C2	1	4B36Z5	2	4B5EL6B2	2	4B75A3	1
4B25B1	1	4B42C2	1	4B5EL6Y4	1	4B75A4	1
4B25B4	1	4B42C4	1	4B6/6Z16Z2	1	4B75A6	2
4B25B4LV	1	4B42ES1	1	4B6/6Z17D7	1	4B75B2LV	1
4B25C1	1	4B42ES2	1	4B6/6Z16A5	1	4B75B4	2
4B25C4	1	4B43C3EL	1	4B6EL?	1	4B75B6	1
4B25C5	1	4B44A3	2	4B6EL4B5EL	1	4B75B6LV	1
4B25C5LV	2	4B44A4	1	4B6EL4B6EL	1	4B75C2LV	2
4B25C6	2	4B44A6	1	4B6EL5A1/C2	1	4B75C4	1
4B25C6LV	1	4B44B2	1	4B6EL5A3	1	4B75C7	1
4B25D3	1	4B44B4	2	4B6EL5A5	1	4B75D1	1
4B25D3LV	1	4B44B5EL	1	4B6EL5B4LV	2	4B75D2	1
4B25D5	1	4B44B6EL	3	4B6EL5B7	1	4B76A2	2

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
4B76B5	2	5A46A2	1	5B16B5	1	5B45D6	1
4B76C1	1	5A46B6	2	5B16C2	1	5B45D7LV	1
4B76C5	1	5A46D4	1	5B16Y7	1	5B46A3	1
4B76D3	1	5A46Y4	1	5B22C4	1	5B46A4	1
4B76D8	1	5A54B7	1	5B24A2	1	5B46C3	1
4B76Z4	1	5A55B1	1	5B25B6LV	1	5B46C7	2
5A1/C26Y8	1	5A55B6LV	1	5B25B7	1	5B46Y2	1
5A1/C27D7	1	5A56A7	1	5B25C5	2	5B46Z2	1
5A1/C26Y4	1	5A56C7	1	5B26B4	1	5B46Z3	1
5A1/C25D2	1	5A56D5	1	5B2LV4B4	1	5B46Z8	1
5A1/C27D4	1	5A56Y2	1	5B2LV5B2	1	5B4LV5A3	1
5A1/C26D8	1	5A56Y7	1	5B2LV5C2LV	1	5B4LV5B3	1
5A1/C26D4	2	5A56Z1	1	5B2LV5C6	1	5B4LV5C5	1
5A1/C26B7	1	5A56Z3	1	5B2LV5D3LV	1	5B4LV5D4	1
5A1/C26B4	1	5A6?	1	5B2LV6A5	1	5B4LV6A6	2
5A1/C25D7	1	5A64A1	1	5B2LV6B3	1	5B4LV6A7	1
5A1/C25D4	2	5A64B4	1	5B2LV6B5	1	5B4LV6Y7	1
5A1/C25C5LV	1	5A65A3	1	5B2LV6D1	1	5B4LV6Z8	1
5A1/C25A5	1	5A65B2	2	5B2LV6D3	1	5B54B6/6Z1	1
5A2EL5A3	1	5A65B2LV	1	5B2LV6Y2	1	5B55B3	1
5A2EL5B2	1	5A65C4	1	5B2LV6Y5	1	5B55C5LV	1
5A2EL5B6	1	5A65C7	2	5B2LV6Z3	1	5B65D6	1
5A2EL5C3	1	5A65D7	1	5B3?	2	5B66D4	1
5A2EL6B1	1	5A66C7	1	5B34A5	1	5B66D8	1
5A2EL6B3	1	5A66D6	1	5B35C1	1	5B67D8	2
5A2EL6Z3	1	5A74B7	1	5B35D3	1	5B6LV6C7	1
5A36C6	1	5A76C2	1	5B35D7LV	1	5B75B5	1
5A36D4	1	5A76D1	1	5B36B7	2	5B75C8	1
5A36Y8	1	5A76Y8	1	5B36C3	1	5B76A2	1
5A36Z5	2	5A76Z8	1	5B36D1	1	5B76A3	1
5A44B2	1	5A7LV5D2	1	5B36D4	1	5B76A6	1
5A44B6/6Z1	1	5A7LV6B5	1	5B36D8	1	5B76C1	1
5A45A1/C2	1	5A7LV6C3	1	5B36Z5	1	5B76Y3	1
5A45A4	2	5A7LV6D8	1	5B36Z6	1	5B76Y6	1
5A45B2LV	2	5B15A1/C2	1	5B37D7	1	5B76Z3	1
5A45B5	1	5B15B6	1	5B45B7	2	5B77D2	1
5A45B7	1	5B15C3	1	5B45C4	1	5C14B6/6Z1	1
5A45C6	1	5B15D2	1	5B45C5	1	5C15A4	1
5A45C7	2	5B16A2	1	5B45C5LV	2	5C15A7	1
5A45D6	1	5B16B2	1	5B45D5	1	5C15B2LV	2

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
5C15B6LV	1	5C5LV6Z4	1	5C84B6/6Z1	1	5D3LV5B5	1
5C15D3LV	2	5C5LV6Z5	1	5C85A1/C2	1	5D3LV5C2LV	1
5C16Y3	1	5C5LV6Z8	2	5C85B2	1	5D3LV6A5	1
5C16Y4	1	5C5LV7D4	1	5C85B3	1	5D3LV6D1	1
5C16Y5	1	5C65A1/C2	1	5C85C6LV	1	5D3LV6Y3	1
5C16Z7	1	5C65A7	1	5C86A5	1	5D46A5	1
5C17D8	1	5C65B6LV	1	5C86Y2	1	5D46C4	1
5C2LV6A3	1	5C65B7	1	5D15B1	1	5D46Z2	1
5C2LV6B7	1	5C65C3	1	5D15C2LV	1	5D47D7	1
5C2LV6D8	1	5C65D2	2	5D15D3LV	1	5D56B3	1
5C2LV6Y2	1	5C66B5	1	5D15D4	1	5D56D3	1
5C2LV6Y5	1	5C66D2	1	5D16A2	1	5D56D4	1
5C35B2LV	1	5C66D4	1	5D16A5	1	5D65A2EL	1
5C35B4LV	1	5C66D5	1	5D16A7	1	5D65B1	1
5C37D4	1	5C66Y2	1	5D16Z7	2	5D65B2	1
5C44A4	1	5C66Y7	2	5D17D4	1	5D65C5	1
5C45A5	1	5C6LV4B3	1	5D25A5	1	5D65C6	1
5C45B2	1	5C6LV5A6	1	5D25D6	1	5D65D7LV	1
5C45B7	1	5C6LV5B6	2	5D26B2	1	5D66A5	1
5C45C6LV	1	5C6LV5D6	1	5D26D4	1	5D66D2	1
5C45C7	1	5C6LV6D5	1	5D26Y3	1	5D66D8	2
5C46A2	1	5C6LV6Y6	1	5D26Z4	2	5D66Y5	1
5C46A5	1	5C6LV7D4	1	5D27D4	1	5D66Y8	1
5C46B3	1	5C6LV7D7	1	5D27D8	1	5D76A1	1
5C46B7	1	5C75A7	1	5D34A6	2	5D76Y1	1
5C55D2	1	5C75B1	1	5D35A1/C2	1	5D76Y3	1
5C56A7	1	5C75C5	1	5D35A4	1	5D76Y8	1
5C56B1	1	5C75C5LV	1	5D35B1	2	5D7LV3D1	2
5C56B3	1	5C75C6LV	3	5D35B2	1	5D7LV4A2	1
5C56C2	1	5C75D5	1	5D35B4LV	2	5D7LV5A1/C2	2
5C57D7	1	5C76A1	1	5D35C4	1	5D7LV5A3	1
5C5LV4A4	1	5C76A6	2	5D35C7	1	5D7LV5B1	1
5C5LV5B1	1	5C76B4	1	5D35D8	1	5D7LV5B5	1
5C5LV5C1	1	5C76C6	1	5D36A2	1	5D7LV5B6	1
5C5LV5C3	1	5C76D3	1	5D36A5	1	5D7LV5C2LV	1
5C5LV5C4	1	5C76D8	1	5D36Y1	1	5D7LV5C6	2
5C5LV6C4	1	5C76Y2	1	5D36Y2	1	5D7LV5C6LV	1
5C5LV6C7	1	5C76Z6	1	5D36Y5	2	5D7LV5C7	1
5C5LV6D2	1	5C77D2	1	5D36Y7	1	5D7LV6A1	1
5C5LV6Y8	1	5C84A4	1	5D3LV4A2	1	5D7LV6A7	1

Appendix Table B1. Frequencies of crosses made from 1995 through 1999.

CROSS	FREQ	CROSS	FREQ	CROSS	FREQ	CROSS	FREQ
5D7LV6C8	1	6C86A5	1	?5D3	1		
5D7LV6Y1	1	6D15A3	1				
5D85A4	1	6D15B4LV	1				
5D85B1	1	6D15C1	1				
5D85B4LV	1	6D16D3	1				
5D85D2	1	6D16Z5	1				
5D85D7	1	6D25A7LV	1				
5D86Y2	1	6D25B2LV	1				
5D86Z6	1	6D25B4	1				
6A25B6	1	6D26A3	1				
6A26D3	1	6D26Z7	1				
6A26D5	2	6D35B5	1				
6A37D7	1	6D36A7	1				
6A4? 1		6D65A7	1				
6A44B6/6Z1	1	6D65D4	1				
6A46B6	1	6D66A4	1				
6A55B2	1	6D66D4	1				
6A55D7	1	6D66D5	1				
6A56C1	1	6D66Y3	1				
6B25C1	1	6D66Z5	1				
6B55C3	1	6D76C3	1				
6B56Y3	1	6D86Y2	1				
6B65B2	1	6Y36D4	1				
6B66B3	1	6Y45A7	1				
6B66D4	1	6Y66A6	1				
6B66Y5	1	6Y66C4	1				
6C16C8	1	6Y76Z4	1				
6C35D7	1	6Z16Z1	1				
6C55D7	1	6Z54A1	1				
6C56A2	1	6Z55A2EL	1				
6C56A6	1	6Z56A7	1				
6C56Y3	1	6Z56C3	1				
6C56Y4	1	6Z56Z2	1				
6C56Y5	1	6Z66D4	1				
6C56Z4	1	6Z85B5	1				
6C66Z6	1	?2D1	1				
6C76D4	1	?2ES1	1				
6C76Y3	1	?2ES2	1				
6C76Y4	1	?4A2	1				
6C86A1	1	?4A3	1				

Appendix Table B2. Frequency and percent of total crosses from 1995 through 1999 including fish from each of the families

Yr-Family	Number of crosses	Percent of crosses	Yr-Family	Number of crosses	Percent of crosses
2A3	1	0.022	4A5	97	2.118
2B1	26	0.568	4A6	80	1.747
2C1	75	1.638	4A7	7	0.153
2C2	106	2.314	4B1	95	2.074
2C4	102	2.227	4B2	89	1.943
2C5	50	1.092	4B3	58	1.266
2C8	54	1.179	4B4	101	2.205
2D1	89	1.943	4B5	8	0.175
2D2	85	1.856	4B5EL	15	0.328
2D3	75	1.638	4B6	15	0.328
2D4	61	1.332	4B6EL	87	1.9
2D5	93	2.031	4B7	91	1.987
2D6	78	1.703	4C1	2	0.044
2D7	80	1.747	4D6EL	1	0.022
2D8	93	2.031	5A1	3	0.066
2ES1	64	1.397	5A1/C2	21	0.459
2ES2	118	2.576	5A2EL	10	0.218
2ES3	194	4.236	5A3	20	0.437
2ES4	100	2.183	5A4	29	0.633
2ES5	36	0.786	5A5	17	0.371
3C2EL	14	0.306	5A6	22	0.48
3C3	1	0.022	5A7	17	0.371
3C3EL	38	0.83	5A7LV	9	0.197
3C4EL	30	0.655	5B1	24	0.524
3C5EL	26	0.568	5B2	25	0.546
3D1	74	1.616	5B2LV	33	0.721
3D2	40	0.873	5B3	25	0.546
3D3	78	1.703	5B4	31	0.677
3D4	86	1.878	5B4LV	31	0.677
3D5	2	0.044	5B5	10	0.218
3D5EL	70	1.528	5B6	14	0.306
3D6EL	79	1.725	5B6LV	6	0.131
3D7EL	7	0.153	5B7	21	0.459
3D8	1	0.022	5C1	30	0.655
3D8EL	23	0.502	5C1LV	8	0.175
3ES5	1	0.022	5C2	4	0.087
4A1	92	2.009	5C2/A1	1	0.022
4A2	77	1.681	5C2LV	16	0.349
4A3	93	2.031	5C3	11	0.24
4A4	87	1.9	5C4	26	0.568

Appendix Table B2. Frequency and percent of total crosses from 1995 through 1999 including fish from each of the families (continued).

Yr-Family	Number of crosses	Percent of crosses	Yr-Family	Number of crosses	Percent of crosses
5C7	34	0.742	6Y4	10	0.218
5C8	16	0.349	6Y5	12	0.262
5D1	13	0.284	6Y6	7	0.153
5D2	26	0.568	6Y7	11	0.24
5D3	40	0.873	6Y8	7	0.153
5D3LV	18	0.393	6Z1	7	0.153
5D4	9	0.197	6Z2	5	0.109
5D5	6	0.131	6Z3	9	0.197
5D6	27	0.59	6Z4	12	0.262
5D7	15	0.328	6Z5	16	0.349
5D7LV	35	0.764	6Z6	9	0.197
5D8	9	0.197	6Z7	5	0.109
6A1	5	0.109	6Z8	13	0.284
6A2	19	0.415	7C1	1	0.022
6A3	7	0.153	7D2	2	0.044
6A4	10	0.218	7D4	8	0.175
6A5	18	0.393	7D7	7	0.153
6A6	11	0.24	7D8	4	0.087
6A7	8	0.175	?5A1/C2	4	0.087
6B1	3	0.066	?6Z1/4B6	8	0.175
6B2	10	0.218	??	20	0.437
6B3	8	0.175			
6B4	4	0.087			
6B5	14	0.306			
6B6	7	0.153			
6B7	6	0.131			
6C1	10	0.218			
6C2	5	0.109			
6C3	9	0.197			
6C4	4	0.087			
6C5	23	0.502			
6C6	9	0.197			
6C7	15	0.328			
6C8	10	0.218			
6D1	14	0.306			
6D2	13	0.284			
6D3	12	0.262			
6D4	15	0.328			
6D5	7	0.153			
6D6	24	0.524			
6D7	5	0.109			

Appendix C

Appendix Table C1. 1995 egg take and survival by individual cross.

Egg Take No.	Egg Take Date	# of Fem.	Eggs Per Fem.	Eyed Egg Sample	Eggs to Hatch	Egg Loss	% Egg Loss	Fry Loss	% Fry Loss	Fry Ponded	Egg Tot.
1	09/11	1	5,185	3,472	5,125	60	1.16%	31	0.60%	5,094	5,185
2	09/18	1	5,517	4,347	1,138	4,379	79.37%	714	62.74%	424	5,517
3	09/18	1	4,715	4,838	4,625	90	1.91%	1,425	30.81%	3,200	4,715
4	09/18	1	4,827	5,172	2,117	2,710	56.14%	1,727	81.58%	390	4,827
5	09/25	1	5,503	5,128	5,323	180	3.27%	3,383	63.55%	1,940	5,503
6	09/25	1	4,493	4,167	2,884	1,609	35.81%	1,714	59.43%	1,170	4,493
7	09/25	1	5,012	3,977	4,900	112	2.23%	1,980	40.41%	2,920	5,012
8	10/02	1	3,834	3,488	3,530	304	7.93%	259	7.34%	3,271	3,834
9	10/02	1	3,717	2,973	3,247	470	12.64%	564	17.37%	2,683	3,717
Total/Avg		9	4,756		32,889	9,914	23.16%	11,797	35.87%	21,092	42,803

Appendix Table C2. 1996 egg take and survival to ponding by spawning day.

1996 Egg and Fry Report											
Egg Take No.	Egg Take Date	# of Fem	Eggs Per Fem.	Eyed Egg Sam.	Eggs to Hatch	Egg Loss	% Egg Loss	Fry Loss	% Fry Loss	Fry Ponded	New Egg Totals
1	8/27/98	9	3,378	1,900	28,300	2,100	6.91	3,000	10.60	25,300	30,400
2	9/03/98	14	3,170	1,900	41,100	3,280	7.39	2,200	5.35	38,900	44,380
3	9/10/98	117	3,621	2,100	403,200	20,500	4.84	24,900	6.18	378,300	423,700
4	9/17/98	103	3,664	2,125	361,200	16,200	4.29	11,100	3.07	350,100	377,400
5	9/24/98	142	3,965	2,100	545,000	1,800	3.20	16,200	2.97	528,800	563,000
6	10/01/98	119	3,524	2,068	396,500	22,900	5.46	23,500	5.93	373,000	419,400
7	10/08/98	10	3,135	2,315	22,200	9,150	29.19	2,100	9.46	20,100	31,350
Total		514	3,676		1,797,500	92,130	4.88	83,000	4.62	1,714,500	1,889,630

Appendix Table C3. 1997 egg take and survival to ponding by spawning day.

1997 Egg/Fry Survivals											
Egg Take No.	**Egg Take Date**	**# Of Female**	**Eggs Per Female**	**Eyed Egg Sample**	**Eggs To Hatch**	**Egg Loss**	**% Egg Loss**	**Fry Loss**	**% Fry Loss**	**Fry Ponded**	**Egg Totals**
1	9/3	48	3,250	1,700	140,000	16,000	10.3	8,000	5.71	132,000	156,000
2	9/9	55	3,655	1,680	177,800	23,200	11.5	5,800	3.26	172,000	201,000
3	9/16	179	4,007	1,820	677,600	39,600	5.5	13,000	1.92	664,600	717,200
4	9/17	132	3,292	1,700	401,900	32,600	7.5	13,300	3.31	388,600	434,500
4 salt	9/17	29	2,845	1,364	50,000	32,500	39.4	2,500	5.00	47,500	82,500
5	9/23	176	3,625	1,825	597,000	41,000	6.4	8,000	1.34	589,000	638,000
5 salt	9/23	18	3,056	1,705	23,000	32,000	58.2	3,600	16.65	19,400	55,000
6	9/30	70	3,216	1,935	207,100	18,000	8.0	5,000	2.41	202,100	225,100
6 salt	9/30	22	2,532	1,750	35,700	20,000	35.9	6,000	16.81	29,700	55,700
Total/Average		729	3,519		2,310,100	254,900	9.94	65,200	2.82	2,244,900	2,565,000

Appendix Table C4. 1998 egg take and survival to ponding by spawning day.

Stock and Species: 98 Dungeness Chinook

1998 Egg and Fry Survival													
Egg Take No.	**Egg Take Date**	**# of Fem.**	**Eggs Per Fem.**	**Green Eggs Taken**	**Eyed Egg Sam.**	**Eggs To Hatch**	**Egg Loss**	**% Egg Loss**	**Fry Loss**	**% Fry Loss**	**Fry Ponded**	**Over + - Short**	**New Egg Totals**
1	9/1	24	4,475	84,000	1,780	90,400	17,000	15.83	1,800	2.0	88,600	23,400	107,400
2	9/8	113	4,192	395,000	1,667	442,500	31,200	6.59	12,600	2.8	429,900	78,700	473,700
3	9/15	118	4,331	417,000	1,724	480,000	31,100	6.08	11,500	2.4	468,500	94,100	511,100
3 salt	9/15	4	2,250	10,000	1,560	5,400	3,600	40.00	300	5.6	5,100	(1,000)	9,000
4	9/23	108	4,316	391,000	1,892	450,000	16,100	3.45	9,000	2.0	441,000	75,100	466,100
4 salt	9/23	13	1,723	32,000	1,700	15,000	7,400	33.04	600	4.0	14,400	(9,600)	22,400
5	9/29	61	4,692	213,000	1,873	277,500	8,700	3.04	4,500	1.6	273,000	73,200	286,200
5 salt	9/29	15	1,413	37,000	1,960	17,600	3,600	16.98	1,000	5.7	16,600	(15,800)	21,200
6	10/6	20	1,325	70,000	1,900	82,500	4,000	4.62	1,161	1.4	81,339	16,500	86,500
6 salt	10/6	5	1,480	10,000	2,630	3,000	4,400	59.46	200	6.7	2,800	(2,600)	7,400
7	10/13	8	4,950	26,000	2,174	38,500	1,100	2.78	500	1.3	38,000	13,600	39,600
Total		489	4,153	1,685,000		1,902,400	128,200	6.31	43,161	2.3	1,859,239	354,600	2,030,600

Appendix Table C5. 1999 egg take and survival to ponding by spawning day.

STOCK AND SPECIES: 99 Dungeness Chinook

1999 Egg and and Fry Survival

Egg Take No.	Egg Take Date	# Of Fem.	Eggs Per Fem.	Green Eggs Taken	Eyed Egg Sam.	Eggs To Hatch	Egg Loss	% Egg Loss	Fry Loss	% Fry Loss	Fry Ponded	Over + - Short	New Egg Totals
1	8/31	11	4,509	44,000	1,590	4,500	4,600	9.27	3,000	6.7	42,000	5,600	49,600
2	9/7	41	4,195	164,000	1,678	157,500	14,500	8.43	2,500	1.6	155,000	8,000	172,000
3	9/14	71	4,425	284,000	1,938	281,000	33,200	10.57	14,700	5.2	266,300	30,200	314,200
3 salt	9/14	3	2,667	12,000	1,800	2,800	5,200	65.00	500	17.9	2,300	(4,000)	8,000
4	9/21	113	4,009	452,000	2,000	427,000	26,000	5.74	24,600	5.8	402,400	1,000	453,000
4 salt	9/21	41	3,178	123,000	1,923	67,500	62,800	48.20	10,200	15.1	57,300	7,300	130,300
5	9/28	72	4,171	288,000	2,180	277,500	22,800	7.59	12,500	4.5	265,000	12,300	300,300
5 salt	9/28	59	3,712	207,000	1,953	140,000	79,000	36.07	15,000	10.7	125,000	12,000	219,000
6	10/5	53	3,509	212,000	2,325	163,000	23,000	12.37	9,800	6.0	153,200	(26,000)	186,000
6 salt	10/5	23	3,557	58,000	1,880	51,700	30,100	36.80	12,400	24.0	39,300	23,800	81,800
7	10/12	20	3,705	80,000	2,158	67,500	6,600	8.91	3,300	4.9	64,200	(5,900)	74,100
7 salt	10/12	46	3,467	138,000	1,800	80,700	78,800	49.40	22,600	28.0	58,100	21,500	159,500
Total		553	3,884	2,062,000		1,761,200	386,600	18.00	1,311,000	7.4	1,630,100	85,800	2,147,800

Appendix D

Appendix Table D1. Family/Collection Groups and Tag Codes Used by Brood Year, 1992-1997.

1992 brood

Family	Code		
92 ES5	63	47	3
92 ES2	63	47	5
92 ES3	63	47	12
92 ES2	63	47	15
92 ES4	63	47	20
92 B1	63	47	23
92 ES3	63	47	27
92 ES1	63	47	33
92 ES5	63	47	45
92 ES4	63	47	48
92 ES3	63	47	54
92 ES2	63	47	58
92 ES1	63	47	60
92 ES1	63	47	63
92 D6	63	49	9
92 ES4	63	49	17
92 C5	63	49	18
92 C8	63	49	20
92 D1	63	49	23
92 D4	63	49	27
92 D2	63	49	29
92 C1	63	49	30
92 ES3	63	49	33
92 D5	63	49	34
92 ES2	63	49	36
92 D3	63	49	39
92 D7	63	49	46
92 D8	63	49	48
92 C2	63	49	54
92 C4	63	49	57

14redds
electro 5 electro
groups

1993 brood

Family	Code		
93 C5 elec	63	45	14
93 C4 elec	63	45	28
93 C3 elec	63	46	25
93 D7 elec	63	46	55
93 C2 elec	63	46	58
93 D8 elec	63	46	60
93 D6 elec	63	46	61
93 D5 elec	63	47	24
93 D1	63	50	43
93 D3	63	50	57
93 D2	63	52	29
93 D4	63	53	3

4 redds + 8 electro
8 electros
groups

1994 brood

Family	Code		
94-B4	63	42	27
94-A5	63	46	12
94-B5 elec	63	46	15
94-B1	63	46	18
94-B6 elec	**63**	**49**	**58**
94-B2	63	50	24
94-B3	63	52	34
94-A1	63	52	51
94-A6	63	53	33
94-A7	63	54	51
94-A4	63	55	5
94-C1	63	56	36
94-A3	63	56	58
94-B7	63	57	2
94-A2	63	59	55

C1 = 10 yoke sack fry

13 redds + 2 electro
2 electro grps
gruops

1995 brood

Family	Code		
95-B6	63	41	27
95-A2 elec	63	47	36
95-B1	63	47	39
95-B4	63	48	6
95-D2	63	48	15
95-A5	63	48	16
95-C1	63	48	25
95-B4LV	63	49	24
95-B3	63	50	3
95-C1LV	63	50	6
95-A7LV	63	50	10
95-D5	63	50	12
95-A6	63	50	17
95-C5	63	50	48
95-C5LV	63	51	61
95-B6LV	63	52	39
95-C3	63	53	10
95-B2	63	53	11
95-D4	63	53	29
95-D7	63	53	34
95-A7	63	53	36
95-B2LV	63	53	44
95-B7	63	53	47
95-A3	63	53	50
95-D3LV	63	54	7
95-C2LV	63	54	42
95-A4	63	54	43
95-C8	63	55	40
95-A1	**63**	**56**	**17**
95-C2	**63**	**56**	**17**
95-D8	63	56	40
95-C7	63	56	53
95-C4	63	57	8
95-B5	63	57	14
95-D3	63	57	16
95-D6	63	57	28
95-D7LV	63	57	32
95-C6	63	58	25
95-D1	63	58	56
95-C6LV	63	58	57

39 redds + 1 electro
1 electro
group

1996 brood

Family	Code		
6Y1	63	1	27
6B6	63	1	33
6B5	63	1	40
6B7	63	1	48
6B3	63	1	58
6Y3	63	3	34
6D8	63	3	39
6Z3	63	3	43
6Y8	63	42	12
6Z6	63	48	14
6Z1	**63**	**49**	**58**
6D7	63	50	25
6D4	63	51	3
6D2	63	51	15
6C8	63	51	16
6B1	63	52	9
6C2	63	53	35
6A2	63	53	43
6C5	63	53	62
6D6	63	54	2
6Z5	63	54	11
6D5	63	54	12
6Y7	63	54	30
6C7	63	54	47
6A5	63	55	29
6Y6	63	55	30
6C1	63	56	9
6C3	63	57	9
6C6	63	57	17
6D1	63	57	25
6Z4	63	57	43
6Y4	63	58	29
6D3	63	59	29
6A6	63	59	62
6A7	63	60	4
6C4	63	60	10
6Y2	63	60	61
6A1	63	61	1
6Z2	63	61	13
6Z8	63	61	50
6Z7	63	61	55
6B2	63	63	25
6B4	63	63	41
6A4	63	63	48
6A3	63	63	49
6Y5	63	63	52

46 redds

1997 Brood

Family	Code		
97 C1	63	7	1
97 D1	63	7	2
97 D2	63	7	3
97 D3	63	7	4
97 D4	63	7	5
97 D5	63	7	6
97 D6	63	7	7
97 D7	63	7	8
97 D8	63	7	9

9 redds

Numbers shown **BOLD** are duplicates

Appendix E

Appendix Table E. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1996.

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	LV	RV	Wild	Admk	LV	RV
06/18	35	0	0	0	35	0	0	0
06/19	43	0	0	0	43	0	0	0
06/20	23	0	0	0	23	0	0	0
06/21	TRAP OUT				21	0	0	0
06/22	TRAP OUT				19	0	0	0
06/23	TRAP OUT				18	0	0	0
06/24	16	2	0	0	16	2	0	0
06/25	22	8	0	0	25	8	0	0
06/26	21	0	0	0	21	0	0	0
06/27	15	1	0	0	15	1	0	0
06/28	55	3	0	0	67	3	0	0
06/29	36	0	0	0	36	0	0	0
06/30	26	1	0	0	26	1	0	0
07/01	49	0	0	0	49	0	0	0
07/02	24	0	0	0	24	0	0	0
07/03	35	1	0	0	35	1	0	0
07/04	32	0	0	0	32	0	0	0
07/05	51	1	0	0	51	1	0	0
07/06	50	2	0	0	50	2	0	0
07/07	36	5	0	0	36	5	0	0
07/08	4	0	0	0	46	5	0	0
07/09	50	4	0	0	55	4	0	0
07/10	66	0	0	0	66	0	0	0
07/11	69	1	0	0	69	1	0	0
07/12	55	5	0	0	55	5	0	0
07/13	39	5	0	0	39	5	0	0
07/14	42	3	0	0	42	3	0	0
07/15	29	3	0	0	29	3	0	0
07/16	33	6	0	0	33	6	0	0
07/17	99	23	0	0	99	23	0	0
07/18	52	10	0	0	52	10	0	0
07/19	24	5	0	0	24	5	0	0
07/20	36	12	0	0	36	12	0	0
07/21	23	14	0	0	23	14	0	0
07/22	20	18	0	0	20	18	0	0
07/23	17	8	0	0	17	8	0	0
07/24	10	8	0	0	10	8	0	0
07/25	8	3	0	0	8	3	0	0
07/26	10	16	0	0	10	16	0	0

Appendix Table E. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1996 (continued).

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	LV	RV	Wild	Admk	LV	RV
07/27	9	9	0	0	9	9	0	0
07/28	8	11	0	0	8	11	0	0
07/29	16	8	0	0	16	8	0	0
07/30	12	22	0	0	12	22	0	0
07/31	14	25	0	0	14	25	0	0
08/01	6	8	0	0	6	8	0	0
08/02	7	29	0	0	7	29	0	0
08/03	3	16	0	0	3	16	0	0
08/04	8	13	0	0	8	13	0	0
08/05	3	18	0	0	3	18	0	0
08/06	7	14	0	0	7	14	0	0
08/07	4	10	0	0	4	10	0	0
08/08	2	7	0	0	2	7	0	0
08/09	1	3	0	0	1	3	0	0
08/10	1	1	0	0	1	1	0	0
08/11	0	4	0	0	0	4	0	0
08/12	1	3	0	0	1	3	0	0
08/13	1	2	0	0	1	2	0	0
08/14	0	1	0	0	0	1	0	0
08/15	0	3	0	0	0	3	0	0
08/16	0	3	0	0	0	3	0	0
08/17	1	0	0	0	1	0	0	0
08/18	1	0	0	0	1	0	0	0
08/19	1	1	0	0	1	1	0	0
08/20	0	1	0	0	0	1	0	0
08/21	2	4	0	0	2	4	0	0
08/22	0	1	0	0	0	1	0	0
08/23	0	1	0	0	0	1	0	0
08/24	0	0	0	0	0	0	0	0
08/25	1	0	0	0	1	0	0	0
08/26	0	0	0	0	0	0	0	0
08/27	0	0	0	0	0	0	0	0
08/28	0	0	0	0	0	0	0	0
08/29	0	3	0	0	0	3	0	0
08/30	0	1	0	0	0	1	0	0
08/31	1	1	0	3	1	1	0	3
09/01	1	0	2	0	1	0	2	0
09/02	0	0	0	0	0	0	0	0
09/03	1	1	1	3	1	1	1	3

Appendix Table E. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1996 (continued).

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	LV	RV	Wild	Admk	LV	RV
09/04	0	0	0	0	0	0	0	0
09/05	1	0	0	4	1	0	0	4
09/06	0	0	2	0	0	0	2	0
09/07	1	0	0	2	1	0	0	2
09/08	0	1	4	4	0	1	4	4
09/09	0	0	1	3	0	0	1	3
09/10	0	1	2	2	0	1	2	2
09/11	0	0	0	2	0	0	0	2
09/12	0	0	0	0	0	0	0	0
09/13	0	0	2	1	0	0	2	1
09/14	0	1	8	11	0	1	8	11
09/15	0	0	9	13	0	0	9	13
09/16	0	0	0	4	0	0	0	4
09/17	0	0	1	0	0	0	1	0
09/18	0	0	1	1	0	0	1	1
09/19	0	0	0	0	0	0	0	0
09/20	0	0	0	1	0	0	0	1
09/21	1	0	0	0	1	0	0	0
09/22	0	0	0	0	0	0	0	0
09/23	0	0	0	0	0	0	0	0
09/24	0	0	0	0	0	0	0	0
09/25	0	0	0	0	0	0	0	0
09/26	0	0	0	0	0	0	0	0
09/27	0	0	0	0	0	0	0	0
09/28	0	0	0	0	0	0	0	0
09/29	0	0	0	0	0	0	0	0
09/30	0	0	0	0	0	0	0	0
10/01	0	0	0	1	0	0	0	1
10/02	0	0	2	3	0	0	2	3
10/03	0	0	2	3	0	0	2	3
10/04	0	0	0	1	0	0	0	1
10/05	2	0	3	2	2	0	3	2
10/06	1	0	0	0	1	0	0	0
10/07	0	0	0	0	0	0	0	0
10/08					TRAP OUT			
10/09					TRAP OUT			
10/10					TRAP REMOVED			
Total Catch	1,373	395	40	64	1,493	400	40	64
Capture Efficiency					31.52%	31.52%	31.52%	31.52%

Estimated Migration		4,738	1,267	127	203

Appendix F

Appendix Table F. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1997.

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	AdCWT	CWT	Wild	Admk	AdCWT	CWT
Nighttime								
06/11	7	0	0	0	2	0	0	0
06/12	0	0	0	0	0	0	0	0
06/13	0	0	0	0	0	0	0	0
06/14	0	0	0	0	0	0	0	0
06/15	0	0	0	0	2	0	0	0
06/16	1	0	0	0	2	0	0	0
06/17	1	0	0	0	2	0	0	0
06/18	0	0	0	0	8	0	0	0
06/19	3	0	0	0	3	0	0	0
06/20	1	0	0	0	8	0	0	0
06/21	1	0	0	0	2	0	0	0
06/22	1	0	0	0	4	0	0	0
06/23	1	0	0	0	9	0	0	0
06/24	2	0	0	0	9	17	0	0
06/25	2	5	0	0	14	31	0	0
06/26	3	15	0	0	12	42	0	0
06/27	7	4	0	0	21	38	0	0
06/28	7	3	0	0	7	12	0	0
06/29	6	28	0	0	15	15	0	0
06/30	8	105	0	0	18	744	0	0
07/01	5	43	0	0	48	3,906	0	0
07/02	5	93	0	0	34	2,485	0	0
07/03	4	42	0	0	21	1,080	0	0
07/04	5	311	0	0	9	685	0	0
07/05	0	57	0	0	1	204	0	0
07/06	1	54	0	0	2	193	0	0
07/07	1	194	0	0	6	150	0	0
07/08	0	140	0	0	5	182	0	0
07/09	5	102	15	0	5	125	32	0
07/10	4	67	9	0	7	235	354	0
07/11	0	36	3	0	11	321	515	0
07/12	2	28	6	0	9	377	253	0
07/13	0	42	8	1	5	278	152	0
07/14	1	106	22	0	2	258	129	0
07/15	0	22	7	0	7	461	356	2
07/16	0	7	4	0	4	208	101	0
07/17	0	6	3	0	2	185	158	1
07/18	0	13	11	0	5	238	111	0

Appendix Table F. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1997 (continued).

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	AdCWT	CWT	Wild	Admk	AdCWT	CWT
07/19	0	9	2	0	3	303	176	0
07/20	0	68	30	0	5	383	262	0
07/21	4	30	16	13	14	366	374	407
07/22	2	42	41	25	35	216	1,137	1,822
07/23	1	2	0	2	24	181	1,200	980
07/24	0	6	7	9	17	235	1,265	623
07/25	0	28	19	2	16	279	987	377
07/26	0	0	0	0	7	129	422	267
07/27	0	13	20	2	16	174	273	203
07/28	3	39	64	26	3	130	344	137
07/29	0	4	5	3	5	96	321	100
07/30	1	3	4	0	7	209	738	172
08/02	0	27	24	7	27	180	355	1,337
08/03	4	46	58	53	35	202	303	1,040
08/04	0	18	7	31	76	240	207	1,141
08/05	3	28	16	46	82	130	116	2,111
08/06	3	26	26	88	87	316	305	3,184
08/07	3	11	14	50	83	238	170	2,517
08/08	1	16	9	38	142	340	155	3,588
08/09	0	0	0	0	82	362	182	1,947
08/10	0	1	2	4	59	339	238	1,059
08/11	5	48	26	82	20	196	120	488
08/12	0	12	7	21	26	149	104	349
08/13	3	10	4	16	10	109	53	241
08/14	1	3	1	10	14	109	60	190
08/15	0	2	3	9	9	87	31	163
08/16	0	3	1	4	8	58	28	124
08/17	2	9	8	11	4	37	21	62
08/18	1	10	5	11	6	42	37	86
08/19	0	0	0	0	2	33	22	77
08/20	3	16	18	43	8	76	52	151
08/21	2	7	6	14	2	30	19	66
08/22	0	3	2	8	2	19	14	43
08/23	0	3	0	9	5	42	36	70
08/24	1	4	3	11	3	25	25	40
08/25	0	0	0	0	6	38	26	54
08/26	2	6	3	17	12	79	61	214
08/27	0	6	2	10	11	57	34	193
08/28	0	5	2	8	8	12	13	60

Appendix Table F. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1997 (continued).

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	AdCWT	CWT	Wild	Admk	AdCWT	CWT
08/29	0	0	1	5	1	10	3	33
08/30	0	0	0	1	4	18	8	45
08/31	0	0	0	0	0	14	11	24
09/01	0	0	0	0	3	10	10	24
09/02	0	0	0	2	2	8	8	27
09/03	0	0	1	3	0	8	3	13
09/04	0	0	0	1	0	1	26	21
09/05	0	0	1	2	0	0	7	28
09/06	0	0	0	3	0	0	7	20
09/07	0	1	0	1	2	6	2	18
09/08	0	0	0	0	0	2	3	14
Total Nighttime Catch	129	2,088	546	702	1,314	18,793	12,535	25,953
Capture Efficiency					17.43%	17.43%	17.43%	17.43%
Estimated Migration					7,537	107,802	71,904	148,871
Daytime								
06/11	7	0	0	0	7	0	0	0
06/12	0	0	0	0	0	0	0	0
06/13	0	0	0	0	0	0	0	0
06/14	0	0	0	0	0	0	0	0
06/15	0	0	0	0	0	0	0	0
06/16	1	0	0	0	1	0	0	0
06/17	1	0	0	0	1	0	0	0
06/18	0	0	0	0	0	0	0	0
06/19	3	0	0	0	3	0	0	0
06/20	1	0	0	0	1	0	0	0
06/21	1	0	0	0	1	0	0	0
06/22	1	0	0	0	1	0	0	0
06/23	1	0	0	0	1	0	0	0
06/24	2	0	0	0	2	0	0	0
06/25	2	5	0	0	2	5	0	0
06/26	3	15	0	0	3	15	0	0
06/27	7	4	0	0	7	4	0	0
06/28	7	3	0	0	7	3	0	0
06/29	6	28	0	0	6	28	0	0
06/30	8	105	0	0	8	105	0	0
07/01	5	43	0	0	5	43	0	0

Appendix Table F. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1997 (continued).

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	AdCWT	CWT	Wild	Admk	AdCWT	CWT
07/02	5	93	0	0	5	93	0	0
07/03	4	42	0	0	4	42	0	0
07/04	5	311	0	0	5	311	0	0
07/05	0	57	0	0	0	57	0	0
07/06	1	54	0	0	1	54	0	0
07/07	1	194	0	0	1	194	0	0
07/08	0	140	0	0	0	140	0	0
07/09	5	102	15	0	5	102	15	0
07/10	4	67	9	0	4	67	9	0
07/11	0	36	3	0	0	36	3	0
07/12	2	28	6	0	2	28	6	0
07/13	0	42	8	1	0	42	8	1
07/14	1	106	22	0	1	106	22	0
07/15	0	22	7	0	0	22	7	0
07/16	0	7	4	0	0	7	4	0
07/17	0	6	3	0	0	6	3	0
07/18	0	13	11	0	0	13	11	0
07/19	0	9	2	0	0	9	2	0
07/20	0	68	30	0	0	68	30	0
07/21	4	30	16	13	4	30	16	13
07/22	2	42	41	25	2	42	41	25
07/23	1	2	0	2	1	2	0	2
07/24	0	6	7	9	0	6	7	9
07/25	0	28	19	2	0	28	19	2
07/26	0	0	0	0	0	0	0	0
07/27	0	13	20	2	0	13	20	2
07/28	3	39	64	26	3	39	64	26
07/29	0	4	5	3	0	4	5	3
07/30	1	3	4	0	1	3	4	0
08/02	0	27	24	7	0	27	24	7
08/03	4	46	58	53	4	46	58	53
08/04	0	18	7	31	0	33	13	57
08/05	3	28	16	46	3	28	16	46
08/06	3	26	26	88	3	26	26	88
08/07	3	11	14	50	3	11	14	50
08/08	1	16	9	38	1	16	9	38
08/09	0	0	0	0	0	0	0	0
08/10	0	1	2	4	0	1	2	4
08/11	5	48	26	82	5	48	26	82

Appendix Table F. Actual catch, expanded catch, and estimated migration of chinook captive brood progeny, Dungeness River, 1997 (continued).

Date	ACTUAL CATCH Chinook				EXPANDED CATCH Chinook			
	Wild	Admk	AdCWT	CWT	Wild	Admk	AdCWT	CWT
08/12	0	12	7	21	0	12	7	21
08/13	3	10	4	16	3	10	4	16
08/14	1	3	1	10	1	3	1	10
08/15	0	2	3	9	0	2	4	11
08/16	0	3	1	4	0	3	1	4
08/17	2	9	8	11	2	9	8	11
08/18	1	10	5	11	1	10	5	11
08/19	0	0	0	0	0	0	0	0
08/20	3	16	18	43	3	16	18	43
08/21	2	7	6	14	2	7	6	14
08/22	0	3	2	8	0	3	2	8
08/23	0	3	0	9	0	3	0	9
08/24	1	4	3	11	1	4	3	11
08/25	0	0	0	0	0	0	0	0
08/26	2	6	3	17	2	6	3	17
08/27	0	6	2	10	0	6	2	10
08/28	0	5	2	8	0	5	2	8
08/29	0	0	1	5	0	0	1	5
08/30	0	0	0	1	0	0	0	1
08/31	0	0	0	0	0	0	0	0
09/01	0	0	0	0	0	0	0	0
09/02	0	0	0	2	0	0	0	2
09/03	0	0	1	3	0	0	1	3
09/04	0	0	0	1	0	0	0	1
09/05	0	0	1	2	0	0	1	2
09/06	0	0	0	3	0	0	0	3
09/07	0	1	0	1	0	1	0	1
09/08	0	0	0	0	0	0	0	0
Total Daytime Catch	129	2,088	546	702	129	2,104	553	731
Capture Efficiency					8.75%	8.75%	8.75%	8.75%
Estimated Migration					1,475	24,054	6,319	8,353
Broken Seal								
07/31	4	115	287	78	4	115	287	78
08/01	7	132	238	89	7	132	238	89
Total Broken Seal Catch	11	247	525	167	11	247	525	167
Capture Efficiency					5.50%	5.50%	5.50%	5.50%
Estimated Migration					200	4,491	9,545	3,036
Stratum Totals								
Total Catch	269	4423	1617	1571	1,454	21,144	13,613	26,850

Total Migration		9,212	136,347	87,768	160,260