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Outplanting Normal and Sterilized Hatchery Coho Fall Fingerlings into Two Small British Columbia Lakes: An Evaluation

Robert A. Bams

Department of Fisheries and Oceans
Biological Sciences Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

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Robert A. Bams

Department of Fisheries and Oceans
Biological Sciences Branch
Pacific Biological Station
Nanaimo, British Columbia
Canada V9R 5K6

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ABSTRACT

Bams, R. A. 1990. Outplanting normal and sterilized hatchery coho fall fingerlings into two small British Columbia lakes: An evaluation. Can. Tech. Rep. Fish. Aquat. Sci. 1765: 28 p.

This report describes the results of an experiment that compared hormonally sterilized coho fingerlings with normal fish of the same stock following introduction in late summer into two small anadromously inaccessible lakes. There were no differences in survival and in time of initiation, rate, and duration of the smolt runs, nor were there differences in seawater readiness, as measured by blood sodium levels, and general health. Food was limiting in both lakes and body condition (K-factor) declined to extreme levels (0.7) without, however, affecting seemingly normal smoltification. There was a large difference in growth rates between the two lakes and a small, statistically significant one between treatments within lakes. The results suggest that sterile stock may be an alternative for outplanting coho into areas where subsequent adult returns are undesirable, e.g. by posing a genetic risk.

RÉSUMÉ

Bams, R. A. 1990. Outplanting normal and sterilized hatchery coho fall fingerlings into two small British Columbia lakes: An evaluation. Can. Tech. Rep. Fish. Aquat. Sci. 1765: 28 p.

Dans ce rapport, on donne les résultats d'une expérience dans laquelle on a comparé des alevins de saumon coho stérilisés à des poissons normaux issus du même stock, après les avoir lâchés à la fin de l'été dans deux petits lacs inaccessibles pour les poissons anadromes. On n'a noté aucune différence entre les deux groupes aux points de vue suivants: survie, début de la migration du smolt, vitesse et durée de la migration, degré de préparation aux conditions marines d'après le taux de sodium sanguin et état de santé général. La nourriture était un facteur limitant dans les deux lacs et l'état général (facteur K) a baissé jusqu'à des valeurs extrêmes (0,7) sans toutefois influer sur la smoltification, apparemment normale. On a observé une grande différence de taux de croissance entre les deux groupes ainsi qu'un petit écart statistiquement significatif entre les traitements dans les lacs. Ces résultats indiquent que les poissons stériles pourraient servir à éliminer le saumon coho des secteurs où le retour d'adultes n'est pas souhaitable, c'est-à-dire qu'il y a risque génétique.

INTRODUCTION

One salmon enhancement technique currently gaining popularity in the Pacific Northwest is the colonization of habitats suitable for rearing juvenile salmon but lacking the species for a variety of reasons, e.g. inaccessibility to anadromous adults due to an impassable barrier. Stock commonly used for such 'out-plants' may comprise 'hatchery surplus' or 'salvaged' wild fish of diverse origins, e.g. from summer-drying streams. It is increasingly recognized that when local stocks can be used for enhancement projects, there is reduced opportunity to influence negatively the genetic integrity of the resulting mixed spawning stock. The use of such stock is, indeed, general policy of the Department of Fisheries in B.C. Limited trials of this type of colonization are on-going in B.C. (Hurst and Blackman 1988; Burns et al. 1987; Blackmun et al. 1985).

Despite all this, several practical considerations give rise to deployment of other options in procuring 'seeding' stock for outplanting. One reality is that hatcheries tend to produce more fry than their rearing facilities can hold, and more or less appropriate release locations are going to be found for such surplusses. Another is that there is likely to be a chronic shortage of wild broodstock in the typical, smaller, coho-producing systems and that location and capture of such stock would be considered too costly and labour intensive to be practical. Such factors promote the use of non-native stocks in or in close proximity to systems having productive endemic stocks.

In general it is undesirable to have maturing adults resulting from genetically compromised outplanting efforts return and interbreed with local wild stock. The recent advent of techniques capable of easy sterilization of large numbers of salmonid fry in a production hatchery offers a possibility to produce non-returning but harvestable coho in economically meaningful quantities. This option may prove timely and important because the extent of potentially available coho habitat above migration barriers may be extensive (e.g. Burns and Tutty 1986) and there are strong demands for increased coho production.

Methodology developed recently to sterilize larval salmonids with applications of synthetic sex hormones for use under special circumstances in aquaculture is described in Donaldson and Hunter 1982 and Donaldson 1986. Releases at the smolt stage of such sterile fish into the wild have been undertaken with coho salmon (<u>Oncorhynchus</u> <u>kisutch</u>), chum salmon (<u>O</u>. <u>keta</u>), and kokanee (<u>O</u>. <u>nerka</u>). Data on growth and survival to the adult stage were reported for two releases of treated and control groups of coho from the Capilano Salmon Hatchery, North Vancouver, B.C. (Solar et al. 1986, and Baker et al. 1989). Fully sterilized fish did not return to the hatchery but remained available to various fisheries for several years following the time they would normally have matured and returned to their stream of origin.

This paper gives the results of an experiment that compared sterile coho fingerlings with unsterilized fish of the same stock following their introduction in late summer into two small anadromously inaccessible lakes. We compared their growth and survival from late summer to spring, smolting and migration from the lake, and for a large group of fish that were forced to remain in the lake for an additional summer, subsequent growth and relative survival. To my knowledge only the work reported by Parkinson and Tsumura (1988) with sterilized coho and kokanee covers some of this area of interest.

METHODS

1. The fish

The 1984-broodyear coho stock used was from the Quinsam River, located on the east coast of Vancouver Island at Campbell River, British Columbia. This stock has been partially hatchery propagated yearly since 1974. The run numbers from 20,000 to 40,000 adults yearly of which from 5 to 10% are taken randomly for hatchery rearing; the rest propagates naturally. Experimental stock was obtained from routine spawn-taking sessions and arbitrarily divided into two groups of about 25,000 eggs each, one of which remained untreated, the other was treated as described below. The two groups were kept in separate incubators (Heath-Techna) and rearing troughs ('Cap' troughs) throughout and treated identically in all other respects. The control fish were fed standard Oregon Moist Pellet (OMP), prepared by Moore-Clarke Company, La Conner, Washington, and the treated fish hormone-enhanced OMP diets, all at standard rates. No major mortalities or outbreaks of disease occurred. Several weeks prior to release all experimental fish were marked by surgical removal of either ventral fin and the proximal half of either maxillary to identify rearing area (lake) and treatment, respectively.

The sterilization treatment started with four successive immersion exposures in a static bath containing 17α-methyltestosterone at a concentration of 200 μg per liter. The fish were fully hatched on April 2, 1985 and the treatments were carried out on April 4, 11, 18, and 25, each lasting 2 hrs. Incubation temperatures ranged from about 5 to 10 and rearing temperatures from 9 to 11° C. The fish were ponded on May 1 to the outside rearing troughs with each treatment divided to form two subgroups, one of each treatment for each of two lakes, for a total of four experimental groups. The sterile groups received specially treated OMP containing the 17α-methyltestosterone at a concentration of 10 mg per Kg of food for 115 days following first feeding, i.e. until August 24, 1985, and received standard OMP until the day prior to release.

On August 26 the four experimental groups were sampled (n = 25 each). Individual lengths and weights were taken and histological examination demonstrated that the untreated fish showed immature male or female gonads in equal proportion, typical of that age, and that the treated fish were successfully sterilized: no gonadal development was present. Based on previous experience with histological examinations and treatment results it was expected that more than 90% of all hormonally treated fish would remain sterile for life (I.Baker, pers. com.).

2. The Lakes

The experimental lakes are part of a tributary to a small coastal system, Menzies Creek, situated 18 km north of Campbell River and entering Discovery Passage at Menzies Bay. The lakes perch at less than 300 m above sea level, are ice-covered in winter, and have warm (>20 C) surface layers and shallows in the summer with well-established thermoclines and temperatures below 10° C at 10 to 15 m. Conductivity was 30 to 35 micro-mho throughout the water column in mid-summer. There was very little submerged vegetation. The general area is in stable secondary-growth forest, with the creek segments between and immediately below the lakes very steep and impassable upstream to salmonids at any level of flow. The main stream has wild coho.

The upper lake is Jasper Lake, about 11 ha in size with a limited littoral zone. The water is clear and contains cutthroat trout (*O. clarkii*) and three-spine stickleback (*Gasterosteus aculeatus*). The lake drains into Burnt-out Lake, 1.4 km away, but there is no outflow from either lake from early summer to late fall. Burnt-out Lake is similar to Jasper Lake in area but has a more extensive littoral zone and adjacent bogs. Most of the lake is over 10-m deep and is brown in color. Many sunken logs litter the extensive outlet shallows and there is no clear passage to the poorly defined outlet, which spills over and seeps through a silted log/beaver dam.

The fish were introduced into the lakes on September 20 and 21, 1985, by helicopter drop when the surface temperatures had declined to below 15° C, while the hatchery temperature was 10° C.

The estimated numbers of fish released were:

in Burnt-out Lake: LV LM 8,000 and LV RM 8,000 fish,
and in Jasper Lake: RV LM 12,100 and RV RM 12,000 fish.

The usual hatchery count accuracy was reported to be within about 5%.

3. The Sampling

From November 13 to 15, 1985, we sampled the Burnt-out Lake fish population with baited Gee-traps to determine growth and relative survival over the first two months.

Simple V-wing traps tapering to lengths of 15-cm dia. flexible black plastic ('Big-O') pipe leading to lockable, 'Marquisette'-lined holding facilities were installed on both outlet streams adjacent to Burnt-out Lake. Both traps were serviced continually from mid-December 1985 to end-of-June 1986. Frost and floods disabled the weirs only briefly on several occasions when no, or very few, fish are believed to have been migrating. All fish caught were examined for marks, counted, and released below the weir. Periodically groups of fish were measured for fork length and, less frequently, wet weight. Fish usually were processed within one or two days following capture. Condition factors were calculated as $K = 10^6 \cdot W(g) \cdot L(mm)^{-3}$. Data analyses were done with Minitab Release 7 (DOS) statistical software. Sample length and weight ranges were sufficiently small that data conversions proved unneccessary. Samples of live smolts were taken to the laboratory in Nanaimo for testing of seawater adaptability, as described by Blackburn and Clarke 1987, and for a basic health check by members of the Station's Fish Disease Control Program.

A populations estimate was carried out in Burnt-out Lake in October 1986 on fish remaining in the lake following the incomplete smolt migration of that year. Baited Gee-traps (n = 88) were set out in three shallow areas of the lake and fished overnight. All fish caught were marked by partial removal of the upper lobe of the caudal fin and released. The traps were reset later in the day and fished overnight and the resulting catch examined for marks old and new. Samples of up to 50 fish in each experimental group were measured for length and weight. Bait used in the traps was not available to the fish.

RESULTS

On August 28 1985, two days after completion of the sterilization treatment, and on September 20, the day the outplanting of the fingerlings began, the four experimental groups were measured, as follows.

Date	Group	N	L(mm)	SE	W(g)	SE	K	SE
Aug. 28	LV RM	25	73.2	1.01	4.53	.192	1.141	.016
	RV RM	25	69.0	1.13	3.48	.164	1.048	.017
	LV LM	25	77.0	1.31	5.33	.269	1.145	.023
	RV LM	25	66.2	1.21	3.28	.195	1.104	.015
Sept.20	LV RM	60	78.5	0.89	5.37	.202	1.083	.008
	RV RM	90	77.1	0.49	5.09	.108	1.096	.006
	LV LM	60	80.2	0.62	5.76	.142	1.104	.009
	RV LM	90	76.6	0.63	5.06	.126	1.107	.007

LV=Burnt-out Lake LM=sterile
RV=Jasper Lake RM=control

The August samples were taken from single rearing troughs and were smaller than those obtained in September, when 30 fish were taken from all available troughs, i.e. two for each LV-group and three for each RV-group. This may account for the seemingly excessive variability among growth rates of the different groups. Differences among troughs within treatments exceeded those between treatments. The differences in lengths and weights between treatments at time of planting were not significant (2-way ANOVA, $p > .3$) within lakes, but fish of both treatments were significantly ($p = .001$) larger in the Burnt-out Lake group than in the Jasper Lake group (Table 1). There was a significant difference ($p < .05$) in condition between treatments, but not between lakes ($p = .3$).

JASPER LAKE RESULTS

The Jasper Lake outlet smolt trap was in operation all winter and no coho were caught prior to May 7 1986. The run built gradually, with the middle 80% occurring between May 23 and June 14 for the control and May 23 and June 18 for the sterilized fish (table 2). The last fish out was on July 18. As the percent columns show, fish of both groups migrated very much in unison and the sterilization treatment appeared not to have affected smolt migration initiation, rate, or duration.

Survival from September to outmigration was 40.2% for the sterile fish and 35.1% for the control and it is concluded that sterilization had not affected subsequent survival in the lake negatively. Baited Gee-traps (n = 66) and a gillnet set overnight on October 27 1986 produced four cutthroat trout (length range 154 - 190 mm and K range 1.025 - 1.119), but no coho. It is concluded that few coho had failed to migrate from the lake in the spring and, therefore, no residualism was associated with either treatment.

Smolt lengths were monitored throughout the run and weights and condition factors were obtained at intervals (table 3). Differences between treatments and in time were analyzed by summing all samples having both lengths and weights (table 4), and by 2-way ANOVA, by date and by treatment (table 5). Treatment effects were highly significant ($p = .000$) for differences in length (at 3.2%) and weight (at 9.4%), with the control fish being larger, but not significant ($p > .5$) for condition over the entire run. The not to be ignored interaction term for length at $p = .07$ is indicative of length increasing faster in the control fish during the smolt run than in the sterile fish. Smolt condition changed significantly ($p = .000$) over time, with a rapid decline during the first four sampling dates, believed to be caused by starvation, and a partial recovery for the last three dates, evident in both treatments.

A random sample of Jasper Lake smolts (n = 20 for each treatment) were challenged for seawater readiness on May 21 1986 with statistically identical results for both treatments: mean plasma sodium levels and standard errors were 163.8 and 1.2 and 167.3 and 1.7 for sterile and control fish, respectively. These sodium levels are interpreted as being indicative of complete smolting (Blackburn and Clarke 1987). There were also no differences in the visual characteristics, e.g. black pigmentation on the otherwise colorless fins and silvering of the sides, usually associated with smolting. Thus, there was no evidence suggesting that sterilization had affected the physiology of this biologically important process.

BURNT-OUT LAKE RESULTS

1. Early growth.

Gee-trapping was carried out during November 13-15, 1985, in Burnt-out Lake when the lake was homeo-thermic to a depth of 15 m at 6° C. On the first night 48 traps caught about 500 coho, on the second night 12 traps got about 250 coho. From each catch a random sample of 100 fish were measured for length and weight.

Mark	N	L(mm)	SE	W(g)	SE	K	SE
LV LM	98	82.6	0.64	5.20	.123	0.907	.005
LV RM	80	81.2	0.57	5.01	.106	0.927	.005
NM	18	101.1	3.12	10.96	1.20	0.997	.013

LV=Burnt-out Lake LM=sterile
NM=unmarked fish RM=control

The differences between the two treatments were small and statistically not significant (Student's t-test, $p > .05$) for lengths and weights, but not for condition (K), $t = 2.81$, $df = 176$, $p < .01$. Evidently the control fish were in somewhat better condition than the sterile fish at this time. Somewhat unexpected was the number of unmarked coho of various sizes, residualized left-overs from plantings by the Quinsam hatchery done prior to our experiment. Based on a simple ratio of numbers of marked and unmarked fish caught in this sample and a presence of 15,000 marked fish in the lake, there would have been some 1500 residuals present. The scale patterns disclosed 2 and 3 annuli, and one mature female (fork length 34 cm) was found with 756 eggs, with an average diameter of only 5.8 mm, loose in the body cavity. We observed no fry-of-the-year in 1985 nor in 1986.

Growth from September 20 (day of release) to November 15 was positive only for length (just over 3%), weight was lower by about 8%, and condition was, accordingly, much reduced from its level of about 1.1 at planting. The fish, clearly, were slimming and, presumably, starving.

2. The smolt run.

The smolt trap was operated from mid-December 1985 with occasional minor breaks in continuity due to freezing or flooding. Low water levels and/or high surface temperatures affected outmigration greatly during periods of low run-off, which occurred during the last halves of February and March, the middle of April, and the first three weeks in June, followed by a virtual cessation of overflow after July 4. Table 6 records daily and cumulative catches from January 24 to July 18. Prior to this period fish migrated irregularly from the lake starting December 23 1985 with from 2 to 12 fish per week. All these early migrants were parr like and appeared completely unsmolted. A sample was tested for seawater-readiness in February.

The run (table 6) clearly was intermittent and irregular, reflecting difficulties in egress caused by low water levels, the shallow and extensive outlet area that was plugged with many large, submerged logs, and beaver activity, which repeatedly resulted in a dysfunctional outlet pipe. The mid-80% of the run was from March 24 to June 20, which was earlier and more protracted than the run from Jasper Lake, and had an approximate mid-point some 6 weeks earlier. The sterile fish may have migrated at a slightly faster rate than the controls. The unmarked hatchery fish (2^+ and older) migrated over the same time period, but at a consistently slower rate until the fourth week in June when the remaining 50% of the run emerged quickly.

The Jasper Lake smolts, which had been entering Burnt-out Lake in significant numbers since the last week in May (table 2) started showing up at the lower fence on June 1 and continued until the first week in July. A total of 1707 fish left the lake before the outlet dried up, which was only 18.8% of what had come in.

Survivals of Burnt-out reared fish based on fingerlings in and smolts out are not meaningful because it is known that fish of all sources residualized extensively. Of the sterilized treatment 6.8% and of the controls 4.6% of the numbers released moved out as smolts. This compares with 8.3 and 5.9% for the Jasper Lake smolts and would, therefore, suggest mortality rates in Burnt-out Lake of about 75 and 80%, respectively. These higher rates of mortality could be associated with the much reduced growth performance of our experimental fish in this lake and the presence of a significant residualised older coho population.

Smolt sizes changed during the protracted run in both treatments (Table 7). Fish gained notably in length but far less in weight, which resulted in a further drop in condition from an already low 0.8 in March to an extreme approaching 0.6 in late June, indicating continuing starvation. Table 8 gives basic statistics on lengths, weights, and condition factors for smolts of all sources on the combined samples available for the entire run, including the earlier hatchery outplants and the Jasper Lake smolts. Means and variances for length, weight, and condition factor were very similar between the two experimental treatments. A 2-way analysis of variance (table 9) shows highly significant differences for all three parameters with time ($p < .005$), and between treatments non-significant differences in length and condition ($p > .05$), but a statistically significant ($.05 > p > .01$) difference in weight. This weight difference, however, is small relative to the means (about 5%) as well as to the observed ranges (table 8), and should probably be ignored as being biologically meaningless.

The Jasper-Lake reared smolts emerged from Burnt-out Lake over only 5 weeks and showed no change in length over this time ($p > .1$), but significant ($p = .001$) reductions in weight and condition, again indicating continuing starvation to really extreme K-levels as low as .4 and .5 (tables 8 and 10). Differences between treatments were significant for mean lengths

($p = .000$) and weights ($.05 > p > .01$), but not for condition ($p > .3$); these results are virtually identical to those obtained on the larger Jasper Lake samples as the fish emerged from that lake (table 4).

The 2^+ progeny of earlier hatchery outplants were larger and much more variable than the two experimental Burnt-out Lake groups (table 8). This population's size distribution was strongly skewed to the right due to the presence of some large, older, fish. Even though the average length was comparable to the 1-year old fish from Jasper Lake, the trimmed means and the medians show that most of the population was considerably smaller, although larger than the Burnt-out experimental populations.

3. Post-smolt lake sampling in October 1986.

A total of 88 baited Gee-traps were set in three locations on Burnt-out Lake on the eve of October 27. Overnight, the traps caught 225 coho fingerlings, which were tail-clipped and released. The distribution of marks in this sample was not determined. The traps were reset in the afternoon and fished overnight, and delivered the following catch the next morning.

Group	Clipped	Un-clipped	Total	Ratio
No Mark	4	122	126	30.5
LV RM	10	51	61	5.1
LV LM	4	33	37	8.3
RV RM	4	34	38	8.5
RV LM	5	44	49	8.8
TOTAL	27	284	311	-

The ratio between un-clipped and clipped fish within the groups of the sample shows an unexpected and undesirable heterogeneity, preventing a straight-forward expansion to population numbers. It appears that a presumably hatchery-reared and recently outplanted young-of-the-year group was present that was considerably more mobile than the 1^+ fish, and its dilution rate of 30.5 may reflect better the total lake population numbers than does the average 8.3 ratio of the 'established' groups. The former ratio would suggest experimental group sizes of approximately 1400 fish, which is more reasonable than the latter ratio which predicts an unrealistic 385 fish only for each group. The ratios as found may indicate a reduced migratory daily behavior in the established coho populations.

Up to 50 fish of each group as available were processed for length and weight and condition factors were calculated (table 11). The recently introduced fish had sizes similar to the experimental fish the year previous (table 7). The remaining experimental fish showed highly significant ($p = .000$) differences in all three characteristics between lakes of origin, smaller, but still significant, differences between treatments in length ($.02 > p > .01$) and weight ($.005 > p > .001$), and a not significant ($p = .1$)

difference in condition (table 12).

4. Seawater challenge and general health tests.

Four random samples of Burnt-out Lake smolts were tested for seawater readiness at the laboratory in Nanaimo from the smolt runs in 1985 and 1986. Fish of the second year were a mixture of the two treatments. The results were as follows for freshwater control (FW) and challenged (SW) subsamples (plasma sodium levels are in mmol/l).

DATE	GROUP	N	SODIUM	SE
May 02 '85	FW.	6	138.6	3.0
	SW.	16	161.7	2.7
May 19 '85	FW.	8	122.9	6.4
	SW.	12	168.3	4.0
Feb.02 '86	FW.	8	147.4	1.8
	SW.	18	185.1	2.1
Apr.25 '86	FW.	9	140.5	2.0
	SW.	20	164.6	1.9

The results obtained for all the controls indicate that the fish were in fairly poor condition (as was suggested earlier by their condition factors), that the fish were not smolted in February, but that they were fully smolted later in both years and quite comparable to the sample obtained from the Jasper Lake run on May 21, 1986.

A general health test was run by the Fish Disease Control people of the Biological Station on a random sample of 60 fish of the combined treatment groups obtained on April 23, 1986. No pathogenic bacteria were isolated from kidney tissue plated on Tryptic Soy Agar, and no bacteria or protozoan parasites were found in Gram stains of kidney material. One fish had a pale liver. A nematode, <u>Eustrongylides</u> <u>sp</u>., and a cestode, <u>Diphyllobothrium</u> <u>sp</u>., were found in fish with externally visible swellings. Of special interest was clinical evidence of poor general condition: hematocrit readings ranged from 21 to 46% with an average value of 33.1%, which compares with normal salmonid averages of from 35 to 45% (Dorothee Kieser, pers. com.). Fish were judged "very thin", and some were noted to have "unusually large eyes".

DISCUSSION

1. Treatment effects.

SURVIVAL in the lakes to the smolt stage and the process and timing of smolting were not negatively affected by the sterilization treatment in our experiment. However, Parkinson and Tsumura (1988) concluded that first-year survival of hormone sterilized coho and kokonee salmon released into a landlocked lake in British Columbia was only about 10% of that of control populations. They sampled with gill nets 4 and 15 months after what would have been the normal time of out-migration of the coho (April) following their release the previous June. Total recoveries from the two 13.5 K coho releases were small, 39 and 17 fish, and included only 5 and 2 sterilized fish, respectively.

Survival in the wild from smolt to adult was also affected negatively in two reported releases of sterilized smolts from the federal hatchery at the Capilano River, B.C. (Solar et al. 1986, and Baker et al. 1989). Adult recovery rates from the coastal fisheries were only about half those of hatchery production groups used as controls and that included the non-trivial recoveries of 4- and 5-year old sterile fish. Although interpretation of these results is confounded by the absence or presence of sexual maturation in the different groups, the observed reduced survival following smolting in some of the sterile groups is of concern and requires further elucidation before field application of the technique can be considered as a cost-effective alternative.

GROWTH of fish of both treatments can be compared at several dates. Average sizes were abstracted from the Results section and GAIN (in %) was calculated for length, weight, and condition by date, lake, and treatment, based on the September 1985 (= time of release) data, on table 13. In Jasper Lake the control group showed a consistent small advantage in both lengths and weights at all three sampling times. The differences were statistically significant ($p = .000$) in the large, summed, June sample (table 5). In the October sample of residualized fish from Burnt-out Lake a 1-way ANOVA on the Jasper fish only was significant for length and weight at only $p = .10$ and $.04$ respectively, but a 2-way ANOVA on the combined sample (fish from Jasper and Burnt-out lakes) showed $p = .016$ and $.003$ respectively (table 11). The calculated gains appear realistic and were much larger in the controls at both sample dates, indicating consistently superior growth in this group (table 13). Condition factors dropped dramatically following introduction and, although similar and statistically not significantly different between the two treatments, the loss was consistently greater in the sterilized fish.

Due to some bias during rearing both treatment groups started out significantly ($p = .001$) larger in Burnt-out Lake than in Jasper Lake, with the sterile fish being the largest. The within-lake difference was statistically not significant, but in both the November '85 and the May '86 samples the sterile fish had maintained some advantage in both length and weight, with the differences in the large May sample being significant at $p = .12$ and $.02$, respectively. The consistently higher growth rates in the control fish steadily decreased the original difference and by October '86 the control fish had become significantly larger. A 1-way ANOVA of the Burnt-out fish on this final date showed significance for differences in length and weight of $p = .075$ and .023, respectively. I conclude that in this lake also superior growth was demonstrated in the control fish in comparison to the sterilized group. A small but consistent difference in condition factors favoring the control fish was noted in each pair of lake samples obtained.

The general conclusion emerges that in both lakes the sterilized fish demonstrated a small but consistent reduction in growth rate compared to the controls. These results are consistent with those reported by Solar et al. 1986, who observed reduced growth (of from 10 to 28% in body length) in sterile coho reared in net pens at the Pacific Biological Station during their third year when compared with a control group consisting of hormonally induced all female fish. Fish of this same experiment that had been released into the wild and were caught upon their return to coastal waters were 8% shorter than fish of the same all female control group, and 7% shorter than a production group of coho simultaneously reared at and released from the same hatchery. Comparisons in weight at this time are inappropriate because of differences in sexual maturation.

CONDITION FACTORS further illustrate the difference in growth patterns observed in our lakes. At time of fry introduction the sterile fish, on average, were of similar length and weight ($p > .3$) but significantly heavier for their size ('fatter') than the controls ($p = .04$) (text p. 5 and table 1). In Jasper Lake the two subsequent samples showed K-factors decreasing in both treatments but the rate of decrease in the control fish was so much less than in the sterile fish that the original difference was nullified at time of smolting and had become significantly higher in the opposite direction by fall 1986. At Burnt-out a similar change occurred over the three samples taken. Already at the first sample, in November 1985, the difference between the treatments had reversed, with the control group in significantly ($p < .01$) better condition. Condition at time of smolting was severely reduced in both groups but the control fish were still in relatively better shape. In October 1986 condition of the fish remaining in the lake had improved in both groups but, again, the control group was in better condition.

It is possible that there was a small but consistent difference between fish of the two treatments in food and/or fat conversion efficiency or metabolic rate. Fagerlund et al. 1979 mention a reduction in visceral fat content with methyltestosteron application. The long period of hormone treatment also may have induced some toxic effects (Dr C. Clark, pers. com.). However, the difference is not necessarily a physiological one: it may simply reflect a difference in general activity. This notion is supported by the sterile fish being fatter than the control fish at the end of their hatchery rearing stage where they had been fed at high but identical rations in a much simplified environment. The hormone is also known to act as a growth promoter (Fagerlund et al. 1979) but this was not evident in lengths or weights at that time (p. 5).

Based on their general performance in this and earlier controlled release tests, results to date suggest that, although there is somewhat diminished growth, sterilized coho are unlikely to have adversely affected performance or a reduced success rate when used as an alternative outplanting stock, at least up to time of ocean entry. A test in which food is less limiting than it was in this experiment and carried out over a longer growth period (e.g. using a 'spring-' rather than a 'fall-plant') should demonstrate the general usefulness of this strategy as an adjunct to current enhancement practices. Marine survival and growth should be further assessed.

2. LAKE EFFECTS.

At time of release the Jasper Lake fish were significantly ($p = .001$) shorter and lighter than the Burnt-out Lake fish, but their condition (K) was the same ($p = .3$) within treatments. The November 1985 Burnt-out Lake sample showed that the fish had experienced significant weight loss immediately, although some 3% growth in length had occurred. By spring fish lengths had increased in both lakes, by 44% in Jasper but only by 6% in Burnt-out Lake. Weight had doubled in Jasper but was reduced by 19% in Burnt-out Lake. Clearly, food had been severely limiting in Burnt-out, probably during the entire period of residency in the lake, but in Jasper a period of substantial growth had taken place. Because the final K-factors were indicative of an extended period of insufficient rations it appears likely that the growth here had taken place in the fall. No such growth spurt occurred in Burnt-out where the fish were both thin and small.

The October 1986 sample from Burnt-out Lake contained the residualized 2^+ fish from both lakes. Fish of the two lake origins behaved very differently over the summer: the Jasper Lake fish of both treatments reduced their average length, weight, and condition. The Burnt-out Lake groups both displayed net growth in length and weight and a substantial improvement in condition. The reduction in mean size of the Jasper Lake fish was not due to a selective migration from Burnt-out Lake, because the average sizes of these two groups (table 8) were less than those of the fish that migrated from Jasper Lake in June (table 4). Size dependent mortality, selective for the larger fish, seems more likely to have caused the discrepancy, a notion possibly supported by the much lower condition factor of the surviving Jasper fish, which, on average, were much larger than the Burnt-out Lake fish (c.f. means and ranges on table 8). Limited food availability and, perhaps, available prey sizes appear to have favored the smaller fish.

Existing differences between treatments, within lakes of origin, were maintained or attenuated during this period (table 13). In the Jasper fish the control group maintained the advantage in length and weight shown during the smolt run (albeit at smaller average sizes), while the Burnt-out fish put on significant growth in both length and weight, with the control fish getting ahead of the sterile fish. Since we are dealing with populations now that have undergone various kinds of possibly selective mortality, it is perhaps no longer valid to ascribe such differences to the original treatment but, at least, these results do not contradict the earlier conclusions regarding differential growth in fish of the two treatments.

The fish in Burnt-out Lake grew minimally, were consistently low in body condition, and were noted by the fish-health people to be "thin" and "have unusually large eyes" (p.12). We had observed this phenomenon, especially in the larger (L >10 cm) residualized fish, which took on the appearance of certain deep ocean fishes with eye diameters very large relative to head size. The combination of this feature with the narrow body depth resulted in almost snake-like and most unusual looking coho. The fish of Jasper Lake put on significant growth, presumably in the fall, but also displayed poor condition at time of smolt migration. However, it is important to note that what appeared to be rather severe starvation did not lead to excessive mortality or a suppression of the smolting process and production of this type of fish may prove typical of hatchery outplants into marginal, food-limiting habitats such as these small lakes. It would even be possible to make this a deliberate outplanting strategy that could produce smolts to the ocean as long as the fish can properly migrate from the lake in the spring following their release.

Such a strategy would de-emphasize the importance of the carrying capacity of the outplanting habitat and, instead, emphasize the creation of fish large and fat enough, as late in the year as possible as permitted by space requirements in the production hatcheries, to have them survive to the spring largely on their built-in reserves, when put into any physiologically suitable kind of natural overwintering "container". By being exposed to natural conditions they would smolt normally and migrate to sea at an appropriate time. Poor condition at time of salt water entry may, of course, adversely affect subsequent marine survival, a factor requiring evaluation before an outplanting strategy to food-arm "container lakes" could be considered on any kind of working level. The Quinsam outplants described by Blackmun et al. (1985) concerned large fish (over 10 g from 1980 to 1982) that were planted in mid-September. Such plants could, presumably, survive to successful smolt without much additional growth. The Quinsam smolts have proved equal to the hatchery produced coho in survival and contribution to the fisheries (Hurst and Blackman 1988, Appendix I).

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Table 1. Two-way Analyses of Variance (GLM) on Lengths, Weights, and Condition (K) on four groups of Coho fingerlings just prior to planting in Jasper and Burnt-out lakes. Factors are V = Lakes (2) and M = Treatments (2).

Analysis of Variance for Length

Source	DF	Seq SS	Adj SS	Adj MS	F	P
V	1	448.00	448.00	448.00	14.26	0.000
M	1	9.72	9.72	9.72	0.31	0.578
Error	297	9329.82	9329.82	31.41		
Total	299	9787.55				

Analysis of Variance for Weight

Source	DF	Seq SS	Adj SS	Adj MS	F	P
V	1	17.072	17.072	17.072	11.54	0.001
M	1	1.360	1.360	1.360	0.92	0.338
Error	297	439.352	439.352	1.479		
Total	299	457.785				

Analysis of Variance for K

Source	DF	Seq SS	Adj SS	Adj MS	F	P
V	1	0.004275	0.004275	0.004275	1.07	0.302
M	1	0.016950	0.016950	0.016950	4.24	0.040
Error	297	1.185980	1.185980	0.003993		
Total	299	1.207205				

Table 2. Daily (ND)[1], cumulative (NC), and cumulative percent (CUM%) smolt counts of control, sterile, unmarked (NM)[2], and total coho produced from Jasper Lake in 1986.

	CONTROL [RV RM]			STERILE [RV LM]			NM	TOTALS		
DATE	ND	NC	CUM%	ND	NC	CUM%	ND	ND	NC	CUM%
May 07	3	3	0.1	2	2	0.0	1	6	6	0.1
10	12	15	0.4	7	9	0.2	1	20	26	0.3
13	16	31	0.7	17	26	0.5	1	34	60	0.6
16	43	74	1.8	31	57	1.2	3	77	137	1.4
19	111	185	4.4	111	168	3.5	36	258	395	4.2
23	292	477	11.3	324	492	10.1	20	636	1031	10.9
26	257	734	17.5	269	761	15.6	128	654	1685	17.8
27	157	891	21.2	170	931	19.1	35	362	2047	21.6
28	128	1019	24.2	125	1056	21.7	42	295	2342	24.7
29	117	1136	27.0	131	1187	24.4	30	278	2620	27.6
30	471	1607	38.2	463	1650	33.9	21	955	3575	37.7
31	226	1833	43.6	271	1921	39.5	10	507	4082	43.0
June 01	150	1983	47.1	248	2169	44.6	5	403	4485	47.3
02	193	2176	51.7	231	2400	49.3	4	428	4913	51.8
03	96	2272	54.0	125	2525	51.9	0	284	5197	54.8
04	402	2674	63.6	526	3051	62.7	63	928	6125	64.5
06	280	2975	70.7	329	3409	70.1	0	659	6784	71.5
07	261	3236	76.9	253	3662	75.3	0	514	7298	76.9
08	294	3530	83.9	227	3889	79.9	0	521	7819	82.4
09	27	3557	84.6	26	3915	80.5	0	53	7872	82.9
10	7	3564	84.7	14	3929	80.8	0	21	7893	83.2
11	18	3582	85.2	27	3956	81.3	0	45	7938	83.6
12	113	3695	87.9	115	4071	83.7	2	230	8168	86.1
14	145	3840	91.3	159	4230	86.9	0	304	8472	89.3
18	184	4024	95.7	261	4491	92.3	11	456	8928	94.1
20	84	4108	97.7	153	4644	95.5	4	241	9169	96.6
21	35	4143	98.5	62	4706	96.7	0	97	9266	97.6
24	49	4192	99.7	102	4808	98.8	2	153	9419	99.2
27	6	4198	99.8	14	4822	99.1	1	21	9440	99.5
29	3	4201	99.9	4	4826	99.2	0	7	9447	99.5
July 04	3	4204	100.0	25	4851	99.7	0	28	9475	99.8
10	2	4206	100.0	13	4864	100.0	0	15	9490	100.0
18	0	4206	100.0	1	4865	100.0	0	1	9491	100.0

[1]Prior to May 26 and subsequent to June 12 the trap was serviced at greater than daily intervals and the reported counts are totals for the time period.
[2] No-Mark counts include fish with marks unknown.

Table 3. Mean Fork lengths (L), and Weights (W) and Condition Factors (K) where available, and associated numbers (n) for Coho migrants from Jasper Lake, by Date in 1986.

		CONTROL [RV RM]					STERILE [RV LM]				
DATE		n	L(mm)	n	W(g)	K	n	L(mm)	n	W(g)	K
May	16	18	109.6	0	-	-	6	98.0	0	-	-
	19	111	107.4	0	-	-	111	106.6	0	-	-
	23	27	112.7	26	11.35	0.787	21	106.6	21	9.60	0.786
	26	25	106.3	0	-	-	20	106.2	0	-	-
	27	24	106.8	0	-	-	23	106.7	0	-	-
	28	24	107.1	0	-	-	20	108.6	0	-	-
	29	21	110.8	0	-	-	24	106.3	0	-	-
	30	29	109.1	29	10.38	0.793	20	109.9	20	10.47	0.779
	31	24	111.8	0	-	-	25	106.3	0	-	-
June	01	19	109.8	0	-	-	28	105.9	0	-	-
	02	17	110.2	0	-	-	33	106.4	0	-	-
	03	22	113.8	0	-	-	28	106.5	0	-	-
	04	24	113.6	0	-	-	26	109.5	0	-	-
	05	21	113.2	21	10.95	0.753	29	107.9	29	9.37	0.739
	06	24	110.3	0	-	-	26	110.0	0	-	-
	07	26	112.4	0	-	-	23	108.9	0	-	-
	08	24	112.8	0	-	-	25	106.1	0	-	-
	09	27	110.2	0	-	-	26	107.0	0	-	-
	10	7	104.6	0	-	-	14	107.8	0	-	-
	11	18	111.5	0	-	-	27	104.6	0	-	-
	12	27	111.5	0	-	-	40	108.6	0	-	-
	14	35	108.1	0	-	-	26	105.8	0	-	-
	18	21	111.6	21	10.01	0.714	26	109.6	26	9.56	0.725
	20	22	114.6	22	11.15	0.734	27	108.5	27	9.59	0.742
	21	20	114.1	20	11.06	0.741	30	110.4	30	10.20	0.754
	24	16	114.8	16	11.03	0.727	34	109.6	34	10.00	0.752
July	04	3	116.0	0	-	-	25	116.6	0	-	-

Table 4. Statistics on Lengths (L in mm), Weights (W in g), and Condition (K) on the combined samples from six dates of Jasper Lake Coho smolts in 1986; where Mark/S = finclip and statistic; N = number; TrMean = trimmed (mid-90%) mean; and Q1 and Q3 correspond to 1st and 3rd quartiles.

MARK/S	N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN	MIN	MAX	Q1	Q3
RM L	155	112.6	113.0	112.7	6.22	0.50	96	131	109	117
RM W	155	10.83	10.80	10.82	1.847	0.148	6.6	17.2	9.4	12.1
RM K	155	0.754	0.760	0.755	0.065	0.005	0.548	0.899	0.717	0.797
LM L	187	109.0	110.0	109.0	6.54	0.48	95	125	105	113
LM W	187	9.82	9.70	9.77	1.873	0.137	5.5	14.7	8.4	11.1
LM K	187	0.752	0.762	0.754	0.069	0.005	0.560	0.933	0.714	0.800

RM = Control, LM = Sterile fish.

Table 5. Two-way Analyses of Variance on selected samples of Coho fingerlings from Jasper Lake. Factors are Dates, from May 23 to June 24 1986, and Marks, distinguishing treatments, i.e. sterile fish (1) and controls (2).

Factor	Levels	Values						
DATES	7	5.23	5.30	6.05	6.18	6.20	6.21	6.24
MARKS	2	1	2					

Analysis of Variance for Length

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	6	225.01	363.73	60.62	1.52	0.169
MARKS	1	1268.06	1268.03	1268.03	31.88	0.000
DATES*MARKS	6	463.56	463.56	77.26	1.94	0.074
Error	328	13045.21	13045.21	39.77		
Total	341	15001.84				

Analysis of Variance for Weight

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	6	24.122	22.529	3.755	1.10	0.364
MARKS	1	86.087	85.418	85.418	24.94	0.000
DATES*MARKS	6	32.075	32.075	5.346	1.56	0.158
Error	328	1123.256	1123.256	3.425		
Total	341	1265.540				

Analysis of Variance for K (condition)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	6	0.180805	0.178929	0.029821	7.26	0.000
MARKS	1	0.001190	0.001375	0.001375	0.34	0.563
DATES*MARKS	6	0.014337	0.014337	0.002390	0.58	0.745
Error	328	1.346542	1.346542	0.004105		
Total	341	1.542874				

TABLE 6. Daily (ND), cumulative (NC), and cumulative percent (CUM%) counts of coho smolts leaving Burnt-out Lake in 1986. Fish were of five sources: NO MARK, hatchery outplants 2+ and older; LV LM, sterile outplants to Burnt-out Lake; LV RM, control outplants to Burnt-out Lake; RV LM, sterile outplants from Jasper Lake; and RV RM, control outplants from Jasper Lake.

	NO MARK			LV LM			LV RM			RV LM			RV RM		
DATE	ND	NC	CUM%	ND	NC	CUM%	ND	NC	CUM%	ND	NC	CUM%	ND	NC	CUM%
Jan.24	1	1	0.2	2	2	0.4	0	0	0.0	0	0	0.0	0	0	0.0
Feb.03	3	4	0.9	22	24	4.4	16	16	4.3	0	0	0.0	0	0	0.0
10	18	22	4.8	37	61	11.2	16	32	8.7	0	0	0.0	0	0	0.0
Mar.24	2	24	5.2	19	80	14.7	6	38	10.3	0	0	0.0	0	0	0.0
Apr.03	0	24	5.2	25	105	19.3	14	52	14.1	0	0	0.0	0	0	0.0
22	34	58	12.6	90	195	35.9	50	102	27.7	0	0	0.0	0	0	0.0
27	55	113	24.5	148	343	63.2	112	214	58.2	0	0	0.0	0	0	0.0
30	21	134	29.0	29	372	68.5	12	226	61.4	0	0	0.0	0	0	0.0
May 07	30	164	35.5	24	396	72.9	7	233	63.3	0	0	0.0	0	0	0.0
16	24	188	40.7	6	402	74.0	3	236	64.1	0	0	0.0	0	0	0.0
Jun.01	23	211	45.7	23	425	78.3	21	257	69.8	36	36	3.6	33	33	4.7
10	4	215	46.5	4	429	79.0	5	262	71.2	0	36	3.6	0	33	4.7
13	10	225	48.7	11	440	81.0	6	268	72.8	0	36	3.6	0	33	4.7
18	2	227	49.1	1	441	81.2	2	270	73.4	56	92	9.2	27	60	8.5
20	156	383	82.9	67	508	93.6	74	344	93.5	280	372	37.0	190	250	35.6
21	4	387	83.8	2	510	93.9	2	346	94.0	25	397	39.5	14	264	37.6
24	51	438	94.8	29	539	99.3	18	364	98.9	449	846	84.2	325	589	83.9
27	1	439	95.0	0	539	99.3	1	365	99.2	17	863	85.9	10	599	85.3
29	1	440	95.2	1	540	99.4	0	365	99.2	2	865	86.1	2	601	85.6
Jul.04	19	459	99.4	3	543	100.0	2	367	99.7	139	1004	99.9	99	700	99.7
10	1	460	99.6	0	543	100.0	1	368	100.0	1	1005	100.0	2	702	100.0
18	2	462	100.0	0	543	100.0	0	368	100.0	0	1005	100.0	0	702	100.0

Table 7. Mean Lengths (L), and Weights (W) and Condition Factor (K) where available, and sample sizes for Coho migrants of two treatments from Burnt-out Lake, by Date in 1986.

	CONTROL [LV RM]				STERILE [LV LM]			
DATE	n	L(mm)	W(g)	K	n	L(mm)	W(g)	K
Jan. 5	-	-	-	-	2	65.0	2.40	0.865
*Feb. 3	16	76.6	4.83	1.067	22	75.3	4.45	1.030
10	13	77.0	3.36	0.725	34	80.2	3.82	0.717
Mar.24	6	80.3	4.25	0.828	14	83.4	4.71	0.801
Apr. 3	14	84.6	5.00	0.815	25	85.2	4.81	0.771
22	50	80.7	4.08	0.766	89	83.6	4.51	0.763
30	12	82.2	4.51	0.808	29	84.5	4.80	0.790
May 7	7	83.3	4.39	0.750	24	83.7	4.50	0.766
16	3	84.7	4.67	0.763	6	82.7	4.37	0.767
June 1	13	91.2	-	-	19	87.5	-	-
10	5	86.4	-	-	4	81.0	-	-
13	6	85.3	-	-	11	82.0	-	-
20	3	91.0	5.50	0.730	0	-	-	-
21	2	93.0	5.20	0.641	2	92.0	5.05	0.647
24	1	87.0	5.00	0.759	4	95.8	5.63	0.633

* measurements obtained on formalin preserved sample.

Table 8. Statistics on Length (L, in mm), Weights (W, in g), and Condition (K) on combined samples from 11 dates for Burnt-out Lake (LV) and 5 dates for Jasper Lake (RV) smolts. The three treatments were NM = 2+ hatchery production; RM = Control; and LM = Sterile Coho. N = number of fish; TRMean = trimmed (mid-90%) mean; and Q! and Q3 are first and third quartiles.

GROUP		N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN	MIN	MAX	Q1	Q3
NM	L	152	107.0	102.0	104.7	18.54	1.50	77.	192.	96.	111.
NM	W	124	11.8	8.2	9.6	12.70	1.14	3.2	97.5	6.9	10.2
NM	K	124	0.824	0.814	0.817	0.110	0.010	0.512	1.378	0.770	0.861
RM.LV	L	125	83.8	84.0	83.7	6.46	0.58	69.	102.	79.	89.
RM.LV	W	98	4.4	4.4	4.4	0.92	0.09	2.5	6.5	3.6	5.0
RM.LV	K	98	0.777	0.777	0.780	0.067	0.007	0.511	0.913	0.741	0.822
LM.LV	L	227	84.4	84.0	84.1	6.10	0.41	70.	112.	80.	88.
LM.LV	W	193	4.6	4.5	4.6	0.93	0.07	2.8	7.9	3.9	5.2
LM.LV	K	193	0.767	0.771	0.769	0.058	0.004	0.504	0.912	0.734	0.807
RM.RV	L	85	109.6	110.0	109.6	6.91	0.75	92.	130.	104.	115.
RM.RV	W	63	7.9	7.6	7.7	1.65	0.21	5.1	15.5	6.8	8.8
RM.RV	K	63	0.599	0.596	0.598	0.050	0.005	0.510	0.706	0.570	0.622
LM.RV	L	123	106.1	106.0	106.0	5.73	0.52	90.	122.	102.	110.
LM.RV	W	101	7.3	7.0	7.2	1.15	0.12	5.3	11.8	6.5	8.0
LM.RV	K	101	0.603	0.603	0.602	0.050	0.005	0.441	0.797	0.570	0.627

Table 9. Two-way Analyses of Variance (GLM) on Burnt-out Lake smolts. Factors are Dates, from March 24 to June 24, and Marks, i.e. Sterile (1) and Control (2) treatments.

Factor	Levels	Values								
DATES	12	3.24	4.03	4.22	4.30	5.07	5.16	6.01	6.10	6.13
		6.20	6.21	6.24						
MARKS	2	1	2							

Analysis of Variance for Length

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	11	2262.35	2315.20	210.47	6.34	0.000
MARKS	1	78.97	78.97	78.97	2.38	0.124
Error	339	11257.78	11257.78	33.21		
Total	351	13599.09				

Factor	Levels	Values								
DATES	9	3.24	4.03	4.22	4.30	5.07	5.16	6.20	6.21	6.24
MARKS	2	1	2							

Analysis of Variance for Weight

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	8	19.1843	19.9456	2.4932	3.07	0.003
MARKS	1	4.6099	4.6099	4.6099	5.67	0.018
Error	281	228.4531	228.4531	0.8130		
Total	290	252.2473				

Analysis of Variance for K (condition)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	8	0.206110	0.209467	0.026183	8.35	0.000
MARKS	1	0.009596	0.009596	0.009596	3.06	0.081
Error	281	0.880932	0.880932	0.003135		
Total	290	1.096639				

Table 10. Two-way Analyses of Variance (GLM) on Jasper Lake smolts leaving Burnt-out Lake. Factors are Dates, from June 1 to July 7, 1986, and Marks, i.e. sterile (1) and control (2) treatments.

Factor	Levels	Values				
DATES	5	6.01	6.20	6.21	6.24	7.04
MARKS	2	1	2			

Analysis of Variance for Length

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	4	371.00	258.82	64.71	1.69	0.154
MARKS	1	536.08	538.24	538.24	14.05	0.000
DATES*MARKS	4	166.69	166.69	41.67	1.09	0.364
Error	198	7583.99	7583.99	38.30		
Total	207	8657.76				

Analysis of Variance for Weight

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	3	47.717	37.539	12.513	7.61	0.000
MARKS	1	7.960	9.724	9.724	5.91	0.016
DATES*MARKS	3	3.627	3.627	1.209	0.73	0.533
Error	156	256.626	256.626	1.645		
Total	163	315.930				

Analysis of Variance for K (condition)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
DATES	3	0.037675	0.033434	0.011145	5.56	0.001
MARKS	1	0.002004	0.001473	0.001473	0.73	0.393
DATES*MARKS	3	0.006884	0.006884	0.002295	1.14	0.333
Error	156	0.312832	0.312832	0.002005		
Total	163	0.359395				

Table 11. Statistics on Length (L, mm), Weight (W, g), and Condition (K) on Coho fingerlings obtained from Burnt-out Lake on October 29, 1986. The five groups in the lake were NM = 1+ and 3+ hatchery production; RM = Control; LM = Sterile; RV = Jasper Lake plant; and LV = Burnt-out Lake plant. N = number of fish; TRMean = trimmed (mid-90%) mean; and Q1 and Q3 are first and third quartiles.

Group		N	Mean	Median	TrMean	StDev	SEMean	Min	Max	Q1	Q3
NM	L	50	77.02	75.00	76.23	7.66	1.08	66.00	103.00	72.75	80.00
NM	W	50	4.55	4.35	4.41	1.47	0.21	2.20	10.30	3.70	4.92
NM	K	50	0.970	0.991	0.974	0.081	0.011	0.731	1.139	0.924	1.021
RM.RV	L	38	105.87	105.00	106.09	7.90	1.28	81.00	120.00	100.75	110.50
RM.RV	W	38	9.19	8.30	8.99	2.68	0.44	5.00	17.50	7.30	10.22
RM.RV	K	38	0.762	0.731	0.752	0.129	0.021	0.587	1.166	0.678	0.815
LM.RV	L	49	103.39	103.00	103.38	6.03	0.86	91.00	119.00	98.00	108.00
LM.RV	W	49	8.17	7.90	8.01	1.91	0.27	5.60	14.70	7.00	8.60
LM.RV	K	49	0.733	0.729	0.728	0.105	0.015	0.541	1.019	0.656	0.779
RM.LV	L	50	93.66	93.00	93.57	5.82	0.82	82.00	105.00	90.00	97.25
RM.LV	W	50	7.25	6.90	7.21	1.37	0.19	4.30	10.40	6.27	8.02
RM.LV	K	50	0.876	0.894	0.874	0.085	0.012	0.723	1.073	0.799	0.934
LM.LV	L	37	91.41	90.00	91.09	5.69	0.94	82.00	106.00	88.00	94.50
LM.LV	W	37	6.56	6.20	6.48	1.36	0.22	4.70	10.20	5.40	7.80
LM.LV	K	37	0.852	0.863	0.846	0.098	0.016	0.695	1.184	0.781	0.901

Table 12. Two-way Analyses of Variance on October 29, 1986, sample from Burnt-out Lake. Factors are Lake of Origin (V) and Sterile versus Control (M).

Analysis of Variance for Length

Source	DF	Seq SS	Adj SS	Adj MS	F	P
V	1	6026.3	6242.0	6242.0	154.32	0.000
M	1	239.2	239.2	239.2	5.91	0.016
V*M	1	0.5	0.5	0.5	0.01	0.908
Error	170	6876.1	6876.1	40.4		
Total	173	13142.2				

Analysis of Variance for Weight

Source	DF	Seq SS	Adj SS	Adj MS	F	P
V	1	120.334	135.037	135.037	38.20	0.000
M	1	31.128	31.089	31.089	8.79	0.003
V*M	1	1.191	1.191	1.191	0.34	0.562
Error	170	600.961	600.961	3.535		
Total	173	753.614				

Analysis of Variance for Condition (K)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
V	1	0.62148	0.57330	0.57330	52.86	0.000
M	1	0.02976	0.02974	0.02974	2.74	0.100
V*M	1	0.00033	0.00033	0.00033	0.03	0.862
Error	170	1.84379	1.84379	0.01085		
Total	173	2.49536				

Table 13. Mean Lengths, Weights, and Condition factors and their change (Gain,%) on different Dates for Sterile (Stl) and Control (Ctr) groups of Coho in Jasper (JAS) and Burnt-out (BRN) Lakes. All gains are based on the Sept.'85 data.

		L (mm)		W (g)		K	
Date	Lake	Stl.	Ctr.	Stl.	Ctr.	Stl.	Ctr.
Sept.'85	JAS	76.6	77.1	5.06	5.09	1.107	1.096
June '86	JAS	109.0	112.6	9.82	10.83	0.752	0.754
(Gain,%)		(42.3)	(46.0)	(94.1)	(112.8)	(-32.1)	(-31.2)
Oct. '86	JAS	103.4	105.9	8.17	9.19	0.733	0.762
(Gain,%)		(35.0)	(37.4)	(61.5)	(80.6)	(-33.8)	(-30.5)
Sept.,85	BRN	80.2	78.5	5.76	5.37	1.104	1.083
Nov. '85	BRN	82.6	81.2	5.20	5.01	0.907	0.927
(Gain,%)		(3.0)	(3.4)	(-9.7)	(-7.7)	(-18.8)	(-14.4)
May '86	BRN	84.4	83.8	4.63	4.39	0.767	0.777
(Gain,%)		(5.2)	(6.8)	(-19.6)	(-18.2)	(-30.5)	(-28.3)
Oct. '86	BRN	91.4	93.7	6.56	7.25	0.852	0.876
(Gain,%)		(14.0)	(19.4)	(13.9)	(35.0)	(-22.8)	(-19.1)