M. MAUSER

1993

SOCEK

CULTURE WORKSHOP

ALASKA DEPARTMENT OF FISH & GAME
DIVISION OF COMMERCIAL FISHERIES
MANAGEMENT AND DEVELOPMENT

Proceedings of the 1993 Alaska Sockeye Salmon Workshop

Kenai Princess Lodge
Cooper Landing, Alaska
November 2-3, 1993

The Alaska Sockeye Salmon Workshop is an informal meeting for the exchange of information and ideas concerning all areas of sockeye culture.

These proceedings are a combination of the unedited reports and materials made available by the speakers and narrative reconstructed from notes taken by Jana Geesin, Joan Thomas and Keith Pratt. Much of the material concerns progress of incompleted studies or projects. However, the intent is to disseminate information as rapidly as possible. **These informal records are not to be interpreted or quoted as a publication. Any reference to these contents should be approved by the author (s) and cited as a personal communication.**

Chairman's Remarks

Close to 100 people attended and participated in the Sockeye Workshop held at the Kenai Princess Lodge, Cooper Landing, Alaska on November 2 and 3, 1993. People came from all over the State of Alaska, Washington, Oregon and British Columbia.

I would like to thank all who attended, those that made presentations, panelists, our panel moderator and those that allowed me to use their notes from the meeting.

One of the workshop goals was to schedule a number of presentations meant to fuel an open panel discussion at the end of the day. As expected, the discussion was active and lively with a good exchange of information and ideas. Hopefully, we can all learn not only from each other's successes, but also from the set backs as well.

What further promoted discussions at the end of the day were the accommodations at the lodge. It was an easy place for people to meet and network.

Thanks to the staff at Trail Lakes Hatchery for providing tours of their facility before and after the workshop.

The cost of the meeting room, coffee service, and the printing and mailing of the Proceedings was provided for by the registration collected.

ENGLISH BAY SOCKEYE SALMON FRESHWATER NET PEN REARING AND SMOLT PRODUCTION, 1991 - 1993

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THE ENGLISH BAY RIVER IS LOCATED NEAR THE SOUTHWESTERN TIP OF THE KENAI PENINSULA ON LOWER COOK INLET, APPROXIMATELY 40 KM SOUTHWEST OF HOMER, AK. THE VILLAGE OF NANWALEK IS SITUATED ON THE BASE OF A NARROW SPIT OF LAND AT THE HEAD OF ENGLISH BAY. A 14 HECTARE TIDE WATER LAGOON BEHIND THE SPIT FORMS THE MOUTH OF THE ENGLISH BAY RIVER.

THE ENGLISH BAY DRAINAGE IS 11.3 KM IN LENGTH. THE WATERSHED ENCOMPASSES 63 SQUARE KILOMETERS. THERE ARE FIVE LAKES WITHIN THE DRAINAGE WITH A TOTAL SURFACE AREA OF 154 HECTARES. THE LAKES ARE ASSIGNED ASCENDING NUMERICAL NAMES AS YOU MOVE UP THE DRAINAGE FROM THE RIVER'S MOUTH. THE PROJECT FOCUSES ON SECOND LAKE, THE LARGEST LAKE IN THE DRAINAGE OCCUPYING 60.7 SURFACE ACRES, MEAN DEPTH OF 10.9 METERS AND MAXIMUM DEPTH OF 26 METERS. (total volume of 7.6×10^6 m^3). THE HYDRAULIC RESIDENCE TIME FOR SECOND LAKE IS 15 DAYS.

SOCKEYE, PINK AND COHO SALMON UTILIZE THE DRAINAGE ALONG WITH DOLLY VARDEN AND RAINBOW TROUT.

SOCKEYE ESCAPEMENT WAS MONITORED BY WEIR BETWEEN 1927 AND 1941, AND BY AERIAL SURVEY FROM 1947 UP TO 1991 (TABLE 1). IN 1984, THE ESCAPEMENT WAS 11,000 AND PLUMMETED TO 5,000 IN 1985. ADF&G CLOSED THE COMMERCIAL AND SUBSISTENCE FISHERIES IN 1985. THE CLOSURES WERE UNSUCCESSFUL IN REBUILDING THE FISHERY AND THE FISHERY REMAINS CLOSED TODAY.

TABLE 1. HISTORICAL RECORD OF SOCKEYE SALMON ESCAPEMENT IN THE ENGLISH BAY DRAINAGE.

SOCKEYE ESCAPEMENT IN ENGLISH BAY RIVER

Period	Range	Average	Method
1927-1941	14,000-40,000	21,542	WEIR
1947-1979	1,200-18,000	6,700	AERIAL
1980-1984	10,500-20,000	13,120	AERIAL
1985-1991	2,000 -7,000	4,585	AERIAL
1992-1993	6,400 -8,927	7,663	WEIR

IN 1990, THE CHUGACH REGIONAL RESOURCES COMMISSION, A NATIVE TRIBAL ORGANIZATI CONCERNED WITH NATURAL RESOURCES ISSUES IN THE CHUGACH REGION OF SOUTH CENTR ALASKA, PROVIDED FUNDING FOR ADF&G F.R.E.D. (Fisheries Rehabilitatic Enhancement and Development) DIVISION TO DEVELOP A FRY STOCKING PROGRAM TH WOULD SUPPLEMENT WILD FRY PRODUCTION. THE INTENT OF THE PROJECT WAS TO REBUI THE FISHERY SO THAT BOTH THE COMMERCIAL AND SUBSISTENCE FISHERIES COULD RE-OPE

IN 1990, APPROXIMATELY 1/3 OF A MILLION FRY WERE DIRECTLY RELEASED INTO SECO LAKE. IN 1991 SMOLT WERE SAMPLED. THE AGE 1 SMOLT WERE AT THRESHOLD SIZE OF mm & 2.9 g, INDICATING REARING CONDITIONS WERE NEAR CAPACITY. ZOOPLANKT SAMPLING SHOWED SMALL SIZED ZOOPLANKTON AT LOW DENSITIES, SUGGESTING INTEN COMPETITION FOR FOOD.

LAKE FERTILIZATION WAS NOT AN OPTION FOR INCREASING ZOOPLANKTON PRODUCTION D TO THE RAPID FLUSHING RATE OF THE ENGLISH BAY DRAINAGE. F.R.E.D. CONCLUDED T BEST WAY TO BALANCE WILD STOCK PRODUCTION WITH A STOCKING PROGRAM WAS TO PEN RE FRY TO PRESMOLT SIZE. PEN REARED FRY WOULD HAVE MINIMAL IMPACT ON T ZOOPLANKTON COMMUNITY AND PROVIDE A SAFE ENVIRONMENT FOR FRY TO REACH PRESMO SIZE.

THE GOALS OF THE PROJECT EVOLVED INTO:

1) DEVELOPING PEN REARING TECHNIQUES FOR A 1 MILLION SMOLT PRODUCTION MODULI THAT COULD BE EXPANDED OR DUPLICATED TO PRODUCE A RETURN OF 200,000 TO 400,000 ADULT SOCKEYE. A RETURN OF THIS SIZE WOULD SUPPORT SUBSISTENCE AN COMMERCIAL FISHERIES ALONG WITH AN OPPORTUNITY FOR THE VILLAGE OF NANWALE TO PROCESS AND MARKET THEIR FISH.

2) PRODUCING 4 - 5 g PRESMOLT, ASSUMING A 21 % OR BETTER SMOLT TO ADULT SURVIVAL, TO MEET THE ESCAPEMENT GOAL.

3) TRAINING THE RESIDENTS OF NANWALEK TO RUN ALL ASPECTS OF THE PROJECT.

TO ACCOMPLISH AND EVALUATE THESE GOALS FOUR INTERRELATED ENHANCEMENT TECHNIQUE WERE INITIATED. THEY INCLUDE:

1) MONITORING THE SOCKEYE SMOLT OUT-MIGRATION AND ADULT ESCAPEMENT

2) SUPPLEMENTING FRY PRODUCTION THROUGH LAKE PEN REARING

3) EVALUATING PEN REARING THROUGH CODED WIRE NOSE TAG RECOVERY

4) ANNUAL IN SYSTEM EGG COLLECTION

1991 PEN REARING

IN JUNE OF 1991, 98,943 FRY WERE PLACED IN ONE (12x12x12') NET PEN LOCATED IN SECOND LAKE. TWELVE PERCENT OF THE PEN REARED FRY WERE CODED WIRE NOSE TAGGEL AND ADIPOSE FIN CLIPPED FOR FIELD IDENTIFICATION. AN ADDITIONAL 155,931 FRY WERE DIRECTLY RELEASED IN THE LAKE, FIVE PERCENT WERE CODED WIRE TAGGED.

PEN REARED FRY SUFFERED HIGH MORTALITIES (14,186) DUE TO POOR FEEDING TECHNIQUES

AND THE COMBINED OUTBREAK OF FURUNCULOSIS AND THE GILL PARASITE TRICHOPHYRA. TO PREVENT FURTHER HORIZONTAL TRANSMISSION OF BOTH AGENTS IN THE CROWDED NET PEN, THE REMAINING 84,757 FRY WERE RELEASED ON SEPTEMBER 18. DESPITE HIGH MORTALITIES, THE PEN REARING RESULTS WERE ENCOURAGING. AT RELEASE, FRY AVERAGED 4.6 GRAMS (range 1.6-11.4 grams) AT A DENSITY OF 8 Kg/m^3.

1991 AND 1992 SMOLT MIGRATION

SMOLT WERE ENUMERATED IN 1991. THE TRAP WAS IN PLACE BETWEEN MAY 24 - JULY 14 AND CAPTURED APPROXIMATELY 67 % OF THE RIVER CHANNEL. IT WAS MONITORED 24 HRS PER DAY AND WASHED OUT PERIODICALLY - 16,597 SMOLT WERE ENUMERATED - AT THAT TIME, ADF&G FELT THEY MIGHT HAVE MISSED A PORTION OF THE SMOLT OUT-MIGRATION THAT OCCURRED PRIOR TO MAY 24.

IN 1992, LARGER SMOLT TRAP WAS SET UP ON APRIL 11 (5 WEEKS EARLIER THAN 1991). WE DESIGNED THE TRAP TO CAPTURE THE ENTIRE STREAM CHANNEL IN ORDER TO GET A TOTAL COUNT ON SMOLT AND EFFICIENTLY SAMPLE FOR RECOVERY OF CODED WIRE TAGGED SMOLT. TRAP LEADS WERE 30.5 METERS LONG, AND POSITIONED AT A REDUCED ANGLE TO THE RIVER'S FLOW TO MINIMIZE THE DAMMING EFFECT.

ON APRIL 29 WE HAD TO PULL THE TRAP BECAUSE LARGE NUMBERS OF PINK SALMON SMOLT WERE IMPINGING ON THE TRAP'S PERFORATED PLATE. FIFTY SOCKEYE SMOLT HAD BEEN COUNTED UP TO THAT POINT IN TIME. THE TRAP WAS REINSTALLED ON MAY 13, AFTER PINK SMOLT HAD EMIGRATED. ON MAY 28 HIGH WATER WIPED OUT THE TRAP. TRAP LEADS WERE SHORTENED TO 12 METERS WITH THE TRAP POSITIONED IN THE THALWEG. A TOTAL OF 43,409 SMOLT WERE ENUMERATED BETWEEN MAY 13 AND JULY 15. THE RUN PEAKED BETWEEN MAY 26 - JUNE 11. WATER TEMPERATURES DURING THE PEAK FLUCTUATED BETWEEN 9-10 C.

SOCKEYE SMOLT MIGRATED DURING THE NIGHT SO THE TRAP WAS MONITORED NIGHTLY FOR 12 HRS BETWEEN 5PM and 5AM. SMOLT WERE RANDOMLY SAMPLED FOR AWL's (TABLE 2) AND EXAMINED FOR ADIPOSE FIN CLIPS (CODED WIRE TAGS).

Table 2. WEIGHTED NUMBER, PERCENT, AVERAGE LENGTH (mm) AND AVERAGE WEIGHT (g) OF SOCKEYE SMOLT, BY AGE CLASS, FROM ENGLISH BAY, 1991-1992.

	1991			1992		
	Age 1	Age 2	Combined	Age 1	Age 2	Combined
Number	10,456	6,141	16,597	42,107	1,302	43,409
Percent	63	37	100	97	3	100
Length	68	75	69	75	74	75
Weight	2.9	3.8	3.0	3.8	3.5	3.7

AWL SAMPLES INDICATED THE PEN REARED FRY CONTRIBUTED TO SMOLT PRODUCTION. THE AVERAGE SIZE OF AGE 1 SMOLT WERE ALMOST A GRAM LARGER (3.8 GRAMS IN 1992 COMPARED TO 2.9 IN 1991) AND THE PERCENTAGE OF AGE 1 SMOLT INCREASED FROM 63% IN 1991 TO

TO 97% IN 1992. AGE 2 SMOLT WERE SIMILAR IN SIZE FOR BOTH YEARS.

125 CWT SMOLT WERE RECOVERED DURING THE PEAK OF THE RUN (TABLE 3). ALL WERE TRACED BACK TO THE NET PEN. THE CODED WIRE TAGGED SMOLT AVERAGED 5.7 GRAMS (RANGE 1.9 - 9.3 GRAMS).

TABLE 3. COMPARISON OF AGE 1 SMOLT SIZE IN 1991 AND 1992 TO RECOVERED CODED WIRE TAGGED (CWT) SMOLT IN 1992.

	AGE 1 SMOLT		
	1991	1992	1992 CWT
Number	10,456	42,107	125
Length	68	75	88
L Range	51-90	56-117	50-104
Weight	2.9	3.8	5.7
W Range	1.2-6.0	1.2-10.7	1.9-9.3

INSUFFICIENT NUMBER OF CWT WERE RECOVERED AND COULDN'T BE USED TO STATISTICALLY EVALUATE OVER WINTER SURVIVAL OF PEN REARED FRY. HOWEVER, WE KNEW THAT THE 84,757 FRY RELEASED IN 1991 AVERAGED 4.6 GRAMS. IF YOU LOOK AT 4 GRAM SMOLT AND LARGER IN THE AWL SAMPLE, 35 % OR (14,737 FRY) FALL INTO THIS CATEGORY. BASED ON THEIR SIZE, ONE COULD ASSUME THESE FRY WERE FROM THE 1991 NET PEN (TABLE 4). FROM TABLE 4 YOU CAN SEE THAT THE WILD SMOLT (2.9 g) FALL IN LINE WITH THE SIZE OF AGE 1 SMOLT SAMPLED IN 1991, PRIOR TO PEN REARING ACTIVITIES.

TABLE 4. AVERAGE LENGTHS (mm) AND WEIGHTS (g) OF AGE 1 SMOLT 4.0 g + COMPARED TO CWT AND WILD SMOLT SAMPLED IN 1992.

	AGE 1 SMOLT		
	AWL's	CWT*	Wild
LENGTH	86	88	68
RANGE	68-117	50-104	56-75
WEIGHT	5.4	5.7	2.9
RANGE	4.0-8.7	1.9-9.3	1.2-3.9

* 84,757 FRY RELEASED IN 1991 AVERAGED 4.6 GRAMS (RANGE = 1.6 - 11.4 g)

IF WE ASSUME THE 14,737 SMOLT THAT WERE 4 GRAMS AND LARGER WERE FROM THE NET PEN, THE OVER WINTER SURVIVAL WAS 17 PERCENT. (14,737/84,751 = .17).

EXPLANATIONS FOR LOW OVER WINTER SURVIVAL OF 1991 PEN REARED FRY:

1) THEY WERE RELEASED EARLY TO PREVENT FURTHER SPREAD OF FURUNCULOSIS AND GILL PARASITES. HOWEVER, IT IS POSSIBLE THE TWO AGENTS CONTINUED TO SPREAD AFTER THE FRY WERE RELEASED.

2) AT RELEASE, THE WATER TEMPERATURE WAS WARM AND PROMOTED FEEDING ACTIVITY. GIVEN LOW ZOOPLANKTON DENSITIES FRY MAY HAVE WENT INTO THE WINTER WEIGHING LESS THAN THEY DID AT RELEASE

3) FRY COULD HAVE BEEN PREYED ON BY DOLLY VARDEN.

1992 PEN REARING

IN JUNE, 290,000 FRY WERE TRANSPORTED TO SECOND LAKE FROM THE ADF&G BIG LAKE HATCHERY. THE PEN REARING WAS EXPANDED TO 171,398 FRY WHICH WERE APPORTIONED INTO SIX PENS OF APPROXIMATELY 30,000 IN EACH PEN. TEN PERCENT OF THE PEN REARED FRY WERE ADIPOSE FIN CLIPPED AND CODED WIRE TAGGED. AN ADDITIONAL 118,900 FRY WERE DIRECTLY RELEASED INTO SECOND LAKE, NONE OF THESE FRY WERE TAGGED.

IN 1991, WE LEARNED THAT IT WAS POSSIBLE TO RAISE FRY UP TO 4.0 - 5.0 grams. SO OUR GOAL WAS TO PRODUCE 5.0 gram FRY BUT KEEP DENSITIES AT OR BELOW 4 Kg/m^3 TO MINIMIZE ANOTHER VIRAL OR PARASITIC OUTBREAK. INITIAL AVERAGE WEIGHT OF THE FRY WAS .25 g. FRY WERE FED EVERY 1/2 HOUR BETWEEN 6 AM AND 10 PM. PENS WERE CLEANED 2 TIMES PER WEEK.

BY AUGUST 10 FRY RANGED BETWEEN 2.2-3.2 grams AND WERE DIAGNOSED TO HAVE TRICONDIA. ON AUGUST 16 FRY WERE DIAGNOSED TO HAVE COSTIA. TREATMENT FOR BOTH PARASITES INVOLVED IMMERSING THE FRY IN A FORMALIN BATH CONTAINING 1 PART FORMALIN TO 6,000 PARTS WATER FOR 1 HOUR (29.5 ML FORMALIN : 177,600 ml WATER). WE USED A FISH TOTE TO HOLD THE FORMALIN BATH. OXYGEN WAS DELIVERED TO THE BATH AT 2 LITERS PER MINUTE. APPROXIMATELY 6,500 FRY WERE IMMERSED IN THE BATH AT ONE TIME. NO IMMEDIATE MORTALITIES WERE ASSOCIATED WITH THE TREATMENT.

ON SEPTEMBER 8, FURUNCULOSIS WAS DIAGNOSED. FRY WERE FED MEDICATED FEED FOR 10 DAYS BEGINNING SEPTEMBER 18. MORTALITIES DECREASED BY 75%.

TOTAL MORTALITY THROUGHOUT THE PEN REARING WAS ESTIMATED AT 10,118 fry (6 %). ON OCTOBER 14, A TOTAL OF 161,280 FRY WERE RELEASED. THEY AVERAGED 8.0 g (4.0 - 9.4 g). DENSITIES RANGED BETWEEN 4.8

and 6.9 kg/m³.

1993 SMOLT OUT MIGRATION

SMOLT TRAP WAS IN PLACE BETWEEN MAY 6 AND JULY 8. WE EXPECTED TO SEE 80 TO 100,000 SMOLT (assuming 50% or better over-winter survival of 161,000 released from 1992 pens). TOTAL NUMBER OF SMOLT WAS 45,553. THE TRAP WASHED OUT FOR 12 DAYS BETWEEN MAY 13 AND 24 DURING WHAT APPEARED TO BE THE BEGINNING OF THE PEAK OF THE OUT-MIGRATION. WATER TEMPERATURE DURING THE WASH OUT PERIOD AND PEAK OF THE RUN WAS 8 - 9 C. BY JUNE 7, THE PEAK OF THE RUN WAS OVER. AGE 1 SMOLT AVERAGED 6.6 GRAMS AND RANGED BETWEEN 1.5 AND 13.0 g. NO AGE 2 SMOLT WERE SAMPLED (TABLE 5).

TABLE 5. LENGTH (mm) AND WEIGHT (g) OF AGE 1 SMOLT SAMPLED IN 1993

	AGE 1 SMOLT	
	AWL's	CWT
LENGTH	91	96
RANGE	52-120	76-120
WEIGHT	6.6	7.3
RANGE	1.5-13.0	3.5-11.7

A TOTAL OF 431 SMOLT WERE EXAMINED FOR CODED WIRE TAGS; 85 OF THESE SMOLT WERE TAGGED AND AVERAGED 7.3 GRAMS (RANGE 3.5-11.7 g). ALL RECOVERED CODED WIRE TAGS WERE TRACED BACK TO THE 1992 PEN REARED FRY. GIVEN THE SMALL SAMPLE SIZE OF RECOVERED CWT SMOLT, THE OVER-WINTER SURVIVAL IS BIASED LOW AT 24 % (TABLE 6). IF YOU COMPARE THIS ESTIMATE TO THE NUMBER OF 5 GRAM AND LARGE SMOLT (ASSUMING THEY CAME FROM THE 1992 PENS) THE OVER WINTER SURVIVAL WAS ESTIMATED AT 22 %. WITH 6 GRAM AND LARGE SMOLT THE ESTIMATE WAS 17 %.

TABLE 6. ESTIMATE OF OVER WINTER SURVIVAL OF 1992 PEN REARED FRY OBTAINED FROM RECOVERED CWT SMOLT, COMPARED TO OVER WINTER SURVIVAL ESTIMATE BASED ON AGE 1 SMOLT 5.0+ AND 6.0+ g IN 1993.

	AGE 1 SMOLT		
	# of Smolt	# of Fry Released	Over-winter Survival (%)
5.0 g +	35,075	161,289	22
6.0 g +	26,876	161,280	17
CWT est	38,491	161,280	24

EXPLANATION FOR LOW OVER-WINTER SURVIVAL OF 1992 PEN REARED FRY:

1) FURUNCULOSIS AND GILL PARASITES MAY HAVE WEAKENED FRY

2) PREDATION BY DOLLY VARDEN (PRIMARILY ON THE SMALLER FRY)

3) SMOLT TRAP FAILURE AND INADEQUATE CWT SAMPLE (PROBABLY THE MAIN REASON FOR LOW OVER WINTER SURVIVAL ESTIMATE).

1993 PEN REARING

PEN REARING WAS EXPANDED TO 751,370 FRY. APPROXIMATELY 600,000 WERE TRANSPORTED FROM BIG LAKE HATCHERY IN 4 TRIPS BETWEEN JUNE 12 AND 25. EACH TRIP CARRIED BETWEEN 115,000 - 170,000 FRY WEIGHED .20 g. 150,000 FRY WERE TRANSPORTED FROM THE PORT GRAHAM HATCHERY IN ONE TRIP ON JUNE 29. PORT GRAHAM FRY WEIGHED .33 g (150,000 eyed eggs from Big Lake were transported to incubators at Port Graham as a "shake down" run for the Port Graham Hatchery - in 1993 all eggs will be incubated at Port Graham). FRY WERE PLACED IN 5 INDIVIDUAL NET PENS MEASURING 12X12X12 FEET. TRANSPORT MORTALITY RANGED FROM 446 TO 2,800 FRY PER TRIP. TOTAL MORTALITY FOR THE MONTH OF JUNE WAS ROUGHLY 10,000 FRY.

BIOMASS CALCULATIONS FOR AVERAGE WEIGHTS AND FEED QUANTITIES WERE CONDUCTED APPROXIMATELY EVERY TWO WEEKS THROUGHOUT THE PEN REARING. FRY WERE FEED BETWEEN 1.3 AND 3 % OF THEIR BODY WEIGHT PER DAY INITIALLY, FRY WERE FED SMALL AMOUNTS OF FOOD EVERY 1/2 HR - 16 HOURS A DAY UNTIL THEY REACHED 1 GRAM. AT THAT TIME THE FEEDING SCHEDULE WAS CHANGED TO A LARGER AMOUNT OF FEED 5 TIMES EACH DAY. WE DID THIS TO MAXIMIZE FOOD AVAILABILITY TO ALL FRY IN THE PEN. BY FEEDING FRY LARGE AMOUNTS OF FEED LESS OFTEN THROUGHOUT THE DAY, FRY NEAR THE SURFACE BECAME SATIATED AND ALLOWED MORE FEED TO FILTER DOWN TO THE FRY BELOW. THIS MINIMIZED A LARGE SPREAD IN THE SIZE RANGE OF THE FRY.

WATER TEMPERATURES WENT FROM 10 TO 17 C BETWEEN JUNE AND MID-AUGUST. DISSOLVED OXYGEN RANGED BETWEEN 12 AND 8 MG/L THROUGHOUT THE PEN REARING.

WHEN THE FRY REACHED 1 GRAM WE SPLIT 626,748 OF THEM INTO 11 PENS - EACH PEN CONTAINING APPROXIMATELY 56,000 FRY. WE KEPT THE

REMAINING 114,482 FRY IN ONE PEN (PEN #7) TO COMPARE FRY GROWTH WITH THE OTHER PENS CONTAINING ROUGHLY HALF THE NUMBER OF FRY PER PEN (TABLE 7).

TABLE 7. SUMMARY OF FRESH WATER PEN REARED FRY GROWTH AT ENGLISH BAY, 1993

		--------11 Pens--------			--------Pen #7-------		
		NUMBER OF FRY	AVG WT (g)	DENSITY (Kg/m³)	NUMBER OF FRY	AVG WT (g)	DENSITY (Kg/m³)
June	30	626,748	0.48	0.58	114,482	0.39	0.91
July	12	623,178	0.90	1.05	114,023	0.61	1.42
Aug	9	480,961	2.13	2.20	113,252	1.00	2.32
Aug	25	450,828	3.37	3.48	113,192	1.79	4.14
Sept	7	450,541	4.27	4.37	113,109	2.53	5.85
Sept	25	449,599	5.81	5.96	112,879	3.59	8.29
Oct	11	448,515	7.25	7.43	112,661	4.66	10.74
Oct	18	448,341	7.64	7.72	112,651	5.06	11.66

PRECAUTIONARY MEASURES TO PREVENT ANOTHER VIRAL AND/OR PARASITIC OUTBREAK INCLUDED: 1) CLUSTERING THE PENS IN GROUPS OF 4 AND 5 TO MINIMIZE SPREAD OF EITHER AGENT; 2) CLEANING THE PENS EVERY OTHER DAY WITH A HONDA PUMP AND 2" DIA HOSE; 3) FEEDING 2% MEDICATED TETRACYCLINE FEED FOR 14 DAYS BETWEEN AUGUST 10 AND AUGUST 24 (IN THE PAST, FRY WERE VULNERABLE TO FURUNCULOSIS DURING THIS TIME PERIOD). IT HELPED, ESPECIALLY CONSIDERING THE WARM WATER TEMPERATURES. THERE WASN'T AN OUTBREAK OF FURUNCULOSIS THIS YEAR. THE GILL PARASITE TRICHOPHRYA WAS OBSERVED HOWEVER, THE MORTALITY ASSOCIATED WITH THE PARASITE WAS LESS THAN .001%.

IN MID SEPTEMBER, FRY WERE CODED WIRE NOSE TAGGED ON SITE. IN

PRIOR YEARS TAGGING WAS DONE AT THE HATCHERY. 20,000 FRY WERE TAGGED IN 9 DAYS.

BY OCTOBER 18, NINE PENS HELD 448,341 FRY (~ 50,000 EACH) AND PEN #7 CONTAINED 112,651 FOR A TOTAL OF 560,992 FRY. THE INITIAL NUMBER OF FRY IN MID-JUNE WAS 751,370. TOTAL MORTALITY WAS 25%. THERE WERE SEVERAL REASONS FOR THE HIGH MORTALITY (MORTALITY MEANING THE NUMBER OF FRY NOT IN THE PENS). WE LOST ~ 50,000 FROM A HOLE IN ONE PEN. HOWEVER, THESE FRY MINGLED AROUND THE PENS BUT THERE WAS NO WAY TO ESTIMATE THE NUMBER THAT SURVIVED. THEY WERE 2.0 GRAMS WHEN THEY ESCAPED. IN MID-JULY ANOTHER 50,000 WERE LOST TO NEGLECTED PEN CLEANING. THESE FRY DIED FROM LACK OF OXYGEN. ANOTHER 50,000 WAS LOST TO PREDATION BY OTTERS (THERE WERE 7 OTTERS SIGHTED AT ONE TIME). THE NUMBER OF MORIBUND FRY COUNTED AND REMOVED FROM THE PENS WAS 35,000.

THERE WAS A DIFFERENCE IN FRY GROWTH FOR FRY IN PEN #7 COMPARED TO FRY GROWTH IN THE OTHER PENS. ON OCTOBER 18, AVERAGE WEIGHT OF FRY IN PEN #7 WAS 5.0 g, AT DENSITY OF 11.6 KG/M^3. COMPARED TO AN AVERAGE WEIGHT OF 7.6 g AT A DENSITY OF 7.7 KG/M^3 FOR THE FRY IN THE OTHER PENS (TABLE 7). ALL OF THE FRY WERE RELEASED ON OCT 30. WATER TEMP WAS 5.2 C.

IN THE FUTURE, WE PLAN ON KEEPING THE NUMBER OF FRY PER PEN AT 50,000 FOR SEVERAL REASONS: 1) GET LARGER PRESMOLT; 2) SMALL PEN SIZE (12X12X12) EASIER TO MAINTAIN AND; 3) IT IS EASIER TO ISOLATE A SMALL PEN WITH DISEASED FISH)

DURING THE 1994 SMOLT OUT-MIGRATION WE HOPE TO SEE HIGHER OVER WINTER SURVIVAL OF PEN REARED FRY BECAUSE:

FRY WERE HEALTHY AND LARGE (7.6 g) AT RELEASE

FRY WERE RELEASED IN COOLER WATER TEMPERATURES COMPARED TO PREVIOUS YEARS

LESS PREDATION GIVEN THEIR SIZE

WE WILL MODIFY THE SMOLT TRAP SO THAT IT IS NOT PRONE TO WASH OUT DURING THE PEAK OF THE SMOLT OUT-MIGRATION. THIS MAY ASSURE BETTER RECOVERY OF CODED WIRE TAGGED FISH

ADULT SURVIVALS OF THREE BROODS OF AGE-0 (UNDERYEARLING) SOCKEYE SALMON SMOLTS REARED IN FRESH AND SEA WATER AT AUKE CREEK, ALASKA

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The life history of sockeye salmon usually includes 1 or 2 years of freshwater residency before the smolts migrate to the ocean, although smaller components of some stocks in certain situations do migrate naturally to sea as age-0 smolts. Enhancement methods for sockeye in Alaska usually follow one of two strategies. The first involves stocking fry in appropriate lake environments where the juveniles then spend 1 or 2 years rearing to smolt stage before migrating to the ocean. The second method is to rear sockeye fry in a hatchery for 1 year before release as yearling smolts.

Auke Bay Laboratory scientists initiated a series of studies in 1987 to investigate the feasibility of rearing age-0 sockeye smolts in a hatchery as a possible alternative enhancement procedure for this species. The studies were conducted at the experimental Auke Creek Hatchery, Auke Bay, Alaska and were part of a broader enhancement effort to rehabilitate a badly depressed sockeye salmon run in the Auke Lake system. Basic strategy of the research was to attempt accelerated egg and juvenile development so that age-0 smolts could be released within the normal temporal windows of seaward migration 1 to 2 years earlier than their wild cohorts. This report covers results of research on the first three broods of Auke Lake sockeye tested.

Sockeye salmon eggs were collected in August from spawners in Lake Creek, the major tributary to Auke Lake, in 1987, 1988, and 1989, and incubated at Auke Creek Hatchery at the head of tidewater on Auke Creek. Lake Creek sockeye are endemic to Auke Lake, and normally produce only yearling and older age smolts.

Development of eggs and juvenile fish in the hatchery was accelerated by using a dual water intake system that allowed the mixing or independent use of surface water from Auke Creek and subsurface water below the thermocline in Auke Lake. Surface water in Auke Creek often exceeds 20°C in August, when sockeye eggs were placed in hatchery incubators, and is usually warmer than subsurface water through mid November. Subsurface water, 7-m depth from Auke Lake, seldom exceeds 8°C. In August, eggs were incubated in a mixture of surface and subsurface water to maintain temperatures <14°C, and then on surface water until the

occurrence of the fall temperature inversion of Auke Lake, approximately mid November of each year. Subsurface water was used throughout the winter and early spring until surface water temperatures exceeded subsurface ones.

All water for incubation and rearing in the hatchery passed through an in-line filter (200 micron, multi-filament polyester mesh) that removed plankton and debris. Filtered water then entered an ultraviolet disinfection unit before passing to the incubation and rearing tanks.

Within 5 months from spawning, the fry had completed development, and were placed in fresh water rearing tanks and fed several times each day. Culture of sockeye to produce age-0 smolts involved two approaches. One group of fish was reared entirely in fresh water, while another group was reared in fresh water until they could survive in salt water, approximately 1.5-2 g, then were transferred to seawater net pens in Auke Bay near the mouth of Auke Creek. Fish cultured in sea water received 4 to 6 weeks of rearing in net pens.

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Eight groups of age-0 sockeye salmon smolts were released in this study; two groups of fish, one each freshwater and seawater reared, were released on June 21, 1989, 1989, and 1990 and on July 6, 1990. Freshwater reared smolts were released in Auke Creek and emigrated about 50 m downstream to Auke Bay. Seawater smolts were released directly into Auke Bay at the net pen site. Two months before release all fish were marked by excision of the adipose fin and tagged with coded wires; a different tag code identified each culture group. A final size inventory was made the day before release.

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those reared entirely in freshwater (Figure 1).

Smolt-to-adult survivals ranged between 3.3 and 11.3% for seawater reared sockeye, and 1.5 and 5.6% for those reared in freshwater (Table 1). These percentages represent minimal survival values because no adjustments were made for undetermined levels of fishery harvest. While no systematic fishery sampling for tagged adult sockeye was possible in the region, several Auke Creek sockeye tags were recovered in each of the adult return years coincidental to sampling programs for other species.

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This project has demonstrated that culture of underyearling sockeye salmon is a feasible enhancement method. Underyearling smolts can be successfully reared from a stock that naturally produces only yearling or older age smolts. Juveniles reared in seawater net pens for 4 to 6 weeks were larger than fish reared entirely in fresh water, and survived at a higher rate.

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87-sw	6/21/88	19,888	84	6.2	1,235	0.95	53.2	6.2
88-fw	6/21/89	15,991	65	2.7	239	0.79	51.3	1.5
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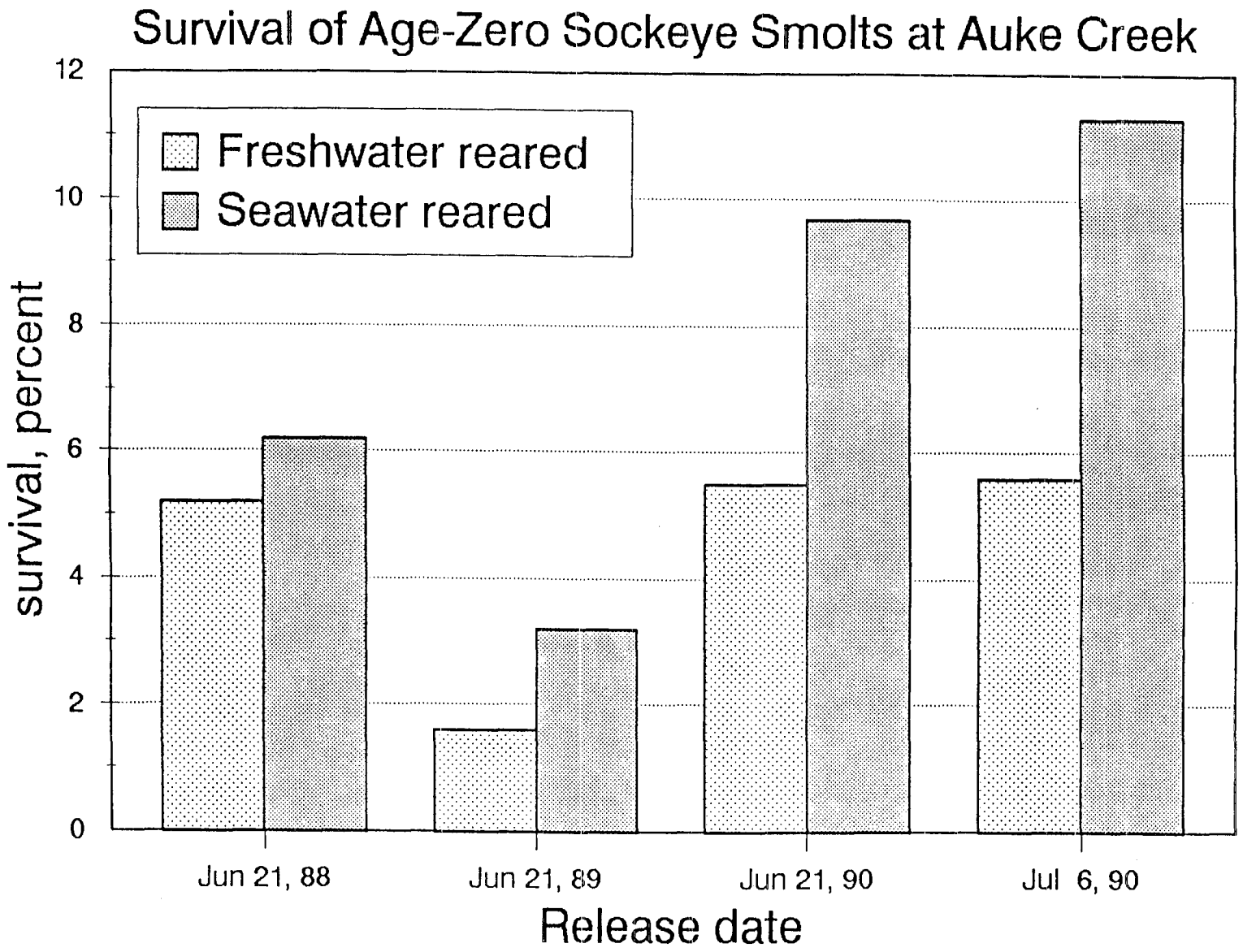
89-fw	7/6/90	12,077	76	4.3	669	0.97	54.1	5.5
89-sw	7/6/90	11,655	103	11.9	1,318	0.96	53.3	11.3



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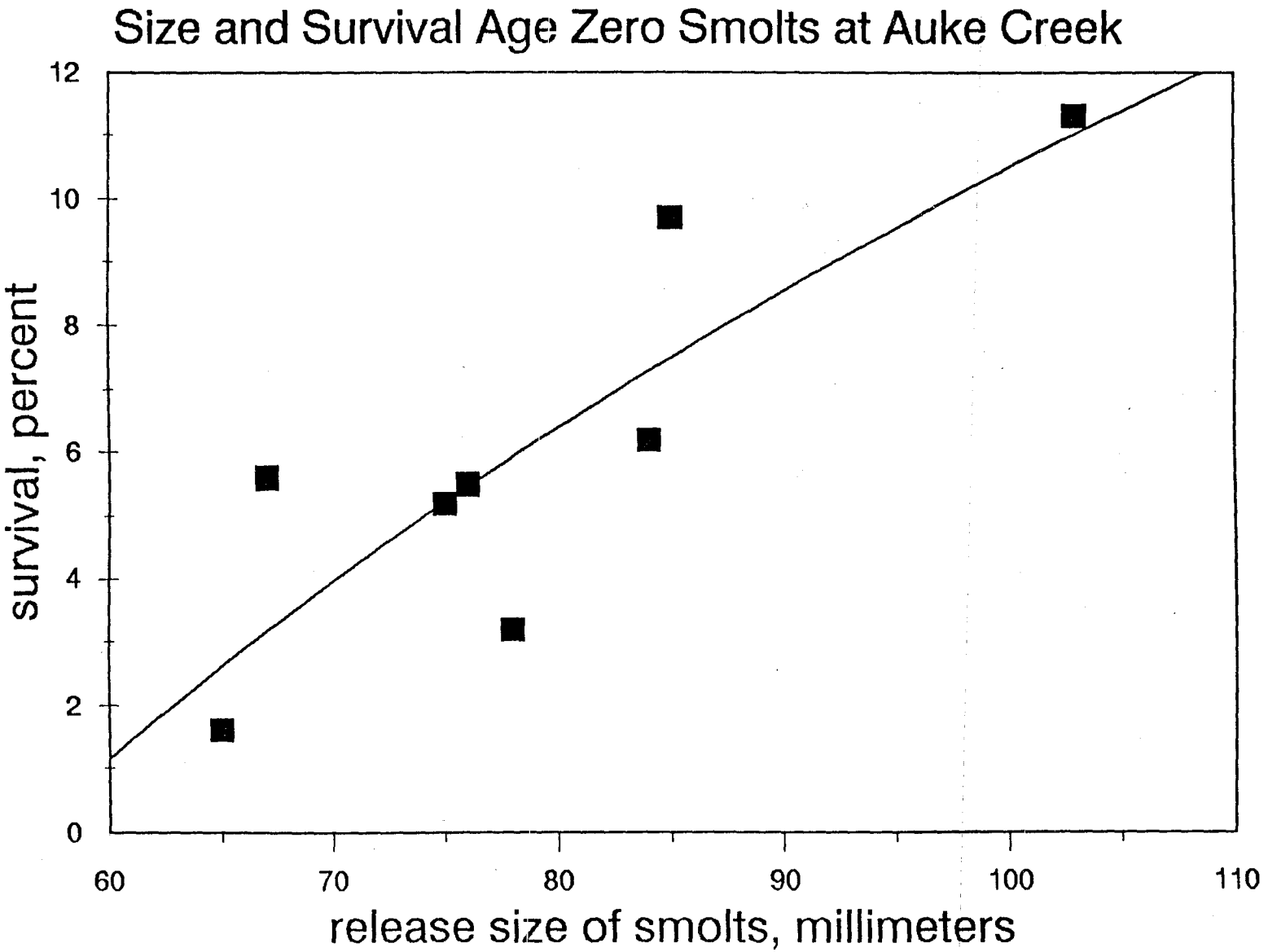

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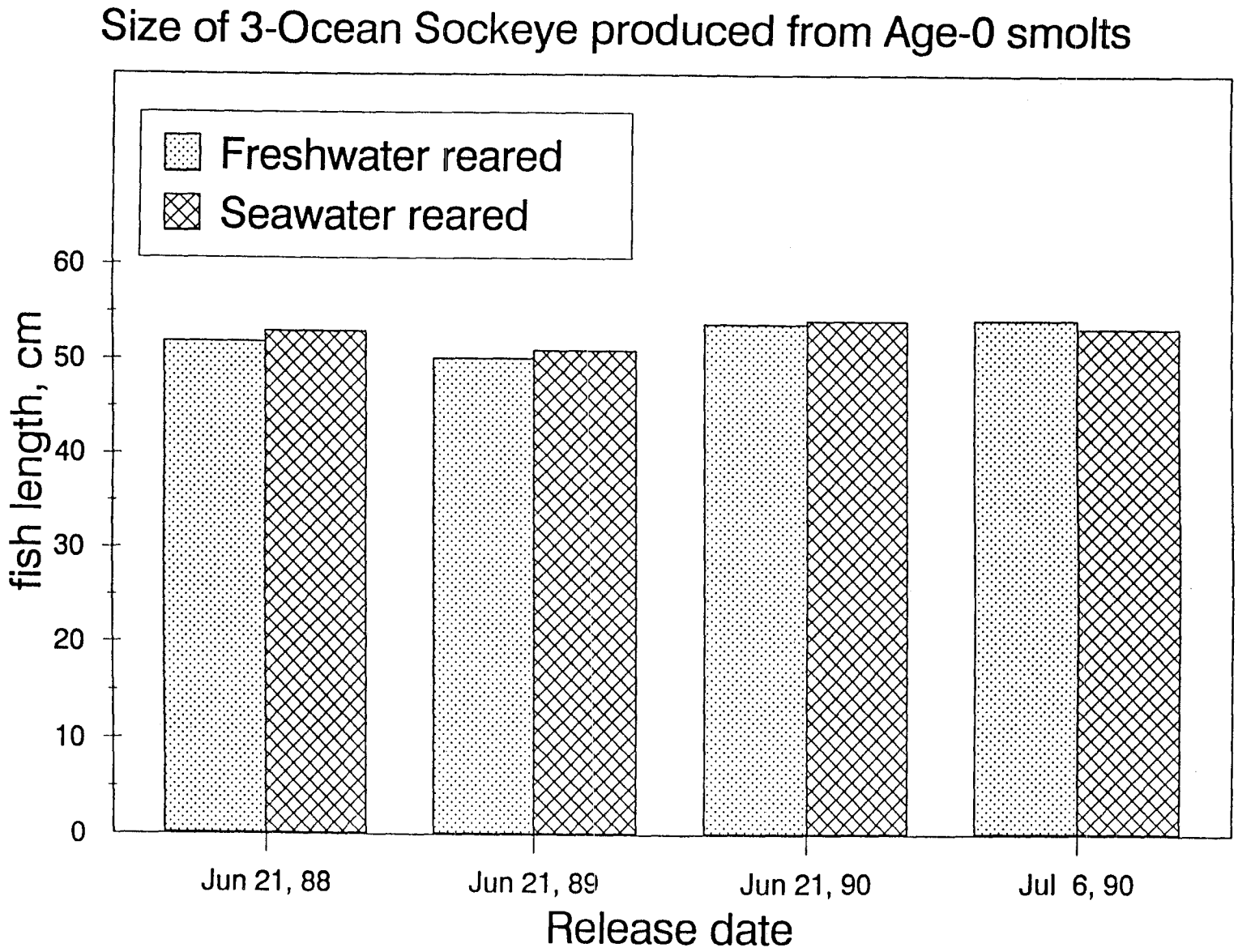

Figure 3. Average lengths of 3-ocean sockeye salmon resulting from releases of hatchery-produced age-0 smolts reared in fresh- and seawater.

ADULT SURVIVALS OF THREE BROODS OF AGE-0 (UNDERYEARLING) SOCKEYE SALMON SMOLTS REARED IN FRESH AND SEA WATER AT AUKE CREEK, ALASKA

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The life history of sockeye salmon usually includes 1 or 2 years of freshwater residency before the smolts migrate to the ocean, although smaller components of some stocks in certain situations do migrate naturally to sea as age-0 smolts. Enhancement methods for sockeye in Alaska usually follow one of two strategies. The first involves stocking fry in appropriate lake environments where the juveniles then spend 1 or 2 years rearing to smolt stage before migrating to the ocean. The second method is to rear sockeye fry in a hatchery for 1 year before release as yearling smolts.

Auke Bay Laboratory scientists initiated a series of studies in 1987 to investigate the feasibility of rearing age-0 sockeye smolts in a hatchery as a possible alternative enhancement procedure for this species. The studies were conducted at the experimental Auke Creek Hatchery, Auke Bay, Alaska and were part of a broader enhancement effort to rehabilitate a badly depressed sockeye salmon run in the Auke Lake system. Basic strategy of the research was to attempt accelerated egg and juvenile development so that age-0 smolts could be released within the normal temporal windows of seaward migration 1 to 2 years earlier than their wild cohorts. This report covers results of research on the first three broods of Auke Lake sockeye tested.

Sockeye salmon eggs were collected in August from spawners in Lake Creek, the major tributary to Auke Lake, in 1987, 1988, and 1989, and incubated at Auke Creek Hatchery at the head of tidewater on Auke Creek. Lake Creek sockeye are endemic to Auke Lake, and normally produce only yearling and older age smolts.

Development of eggs and juvenile fish in the hatchery was accelerated by using a dual water intake system that allowed the mixing or independent use of surface water from Auke Creek and subsurface water below the thermocline in Auke Lake. Surface water in Auke Creek often exceeds 20°C in August, when sockeye eggs were placed in hatchery incubators, and is usually warmer than subsurface water through mid November. Subsurface water, 7-m depth from Auke Lake, seldom exceeds 8°C. In August, eggs were incubated in a mixture of surface and subsurface water to maintain temperatures <14°C, and then on surface water until the

occurrence of the fall temperature inversion of Auke Lake, approximately mid November of each year. Subsurface water was used throughout the winter and early spring until surface water temperatures exceeded subsurface ones.

All water for incubation and rearing in the hatchery passed through an in-line filter (200 micron, multi-filament polyester mesh) that removed plankton and debris. Filtered water then entered an ultraviolet disinfection unit before passing to the incubation and rearing tanks.

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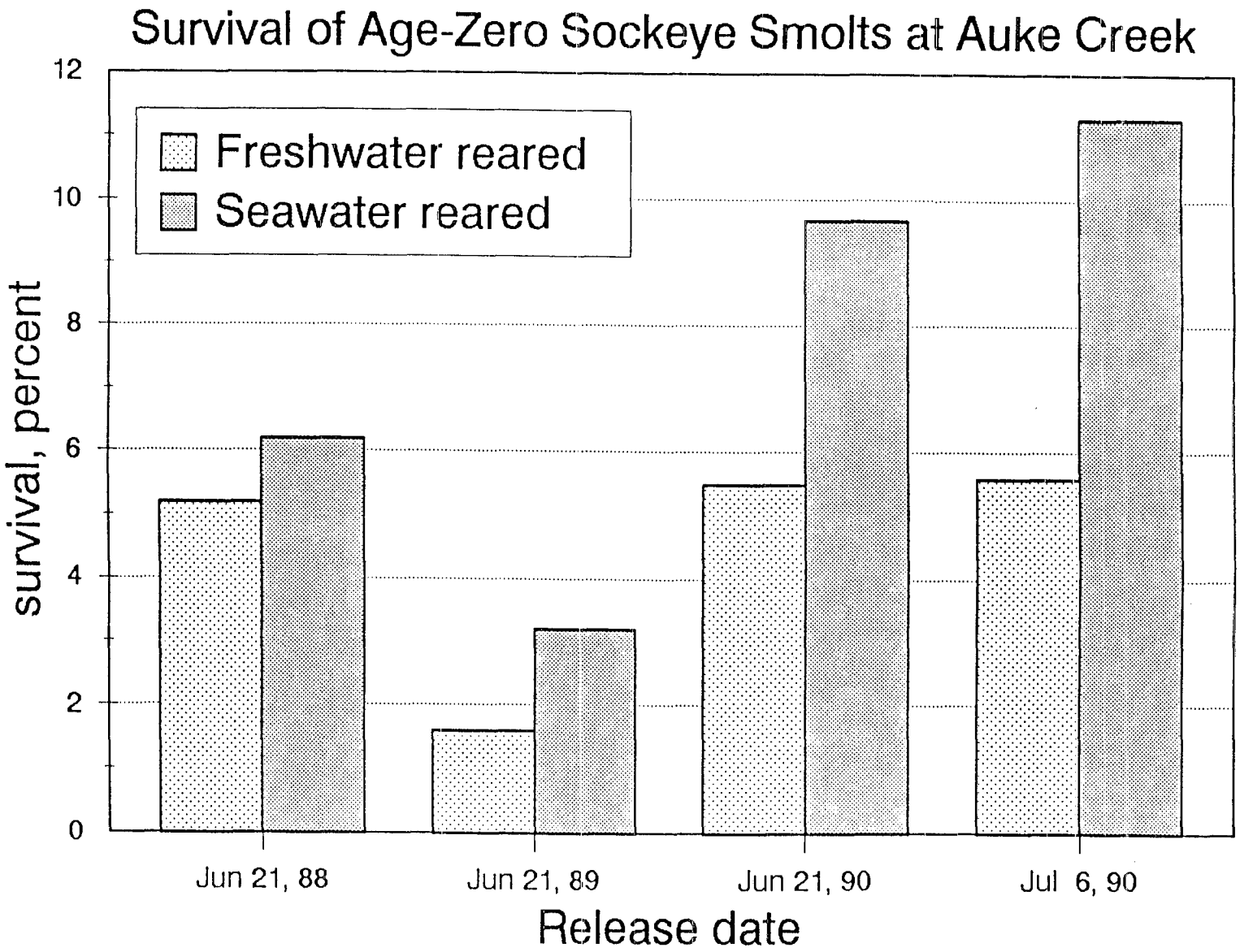

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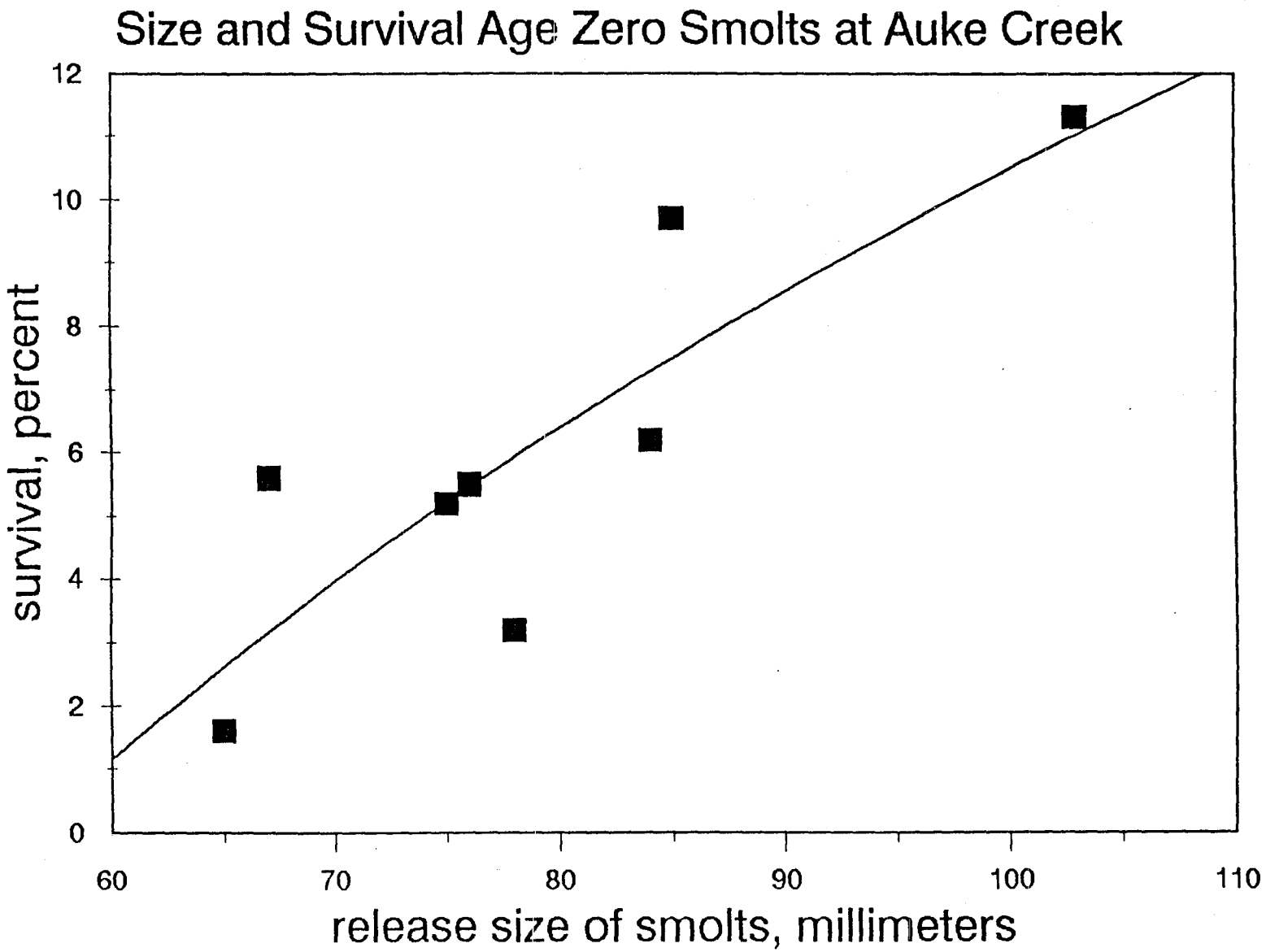

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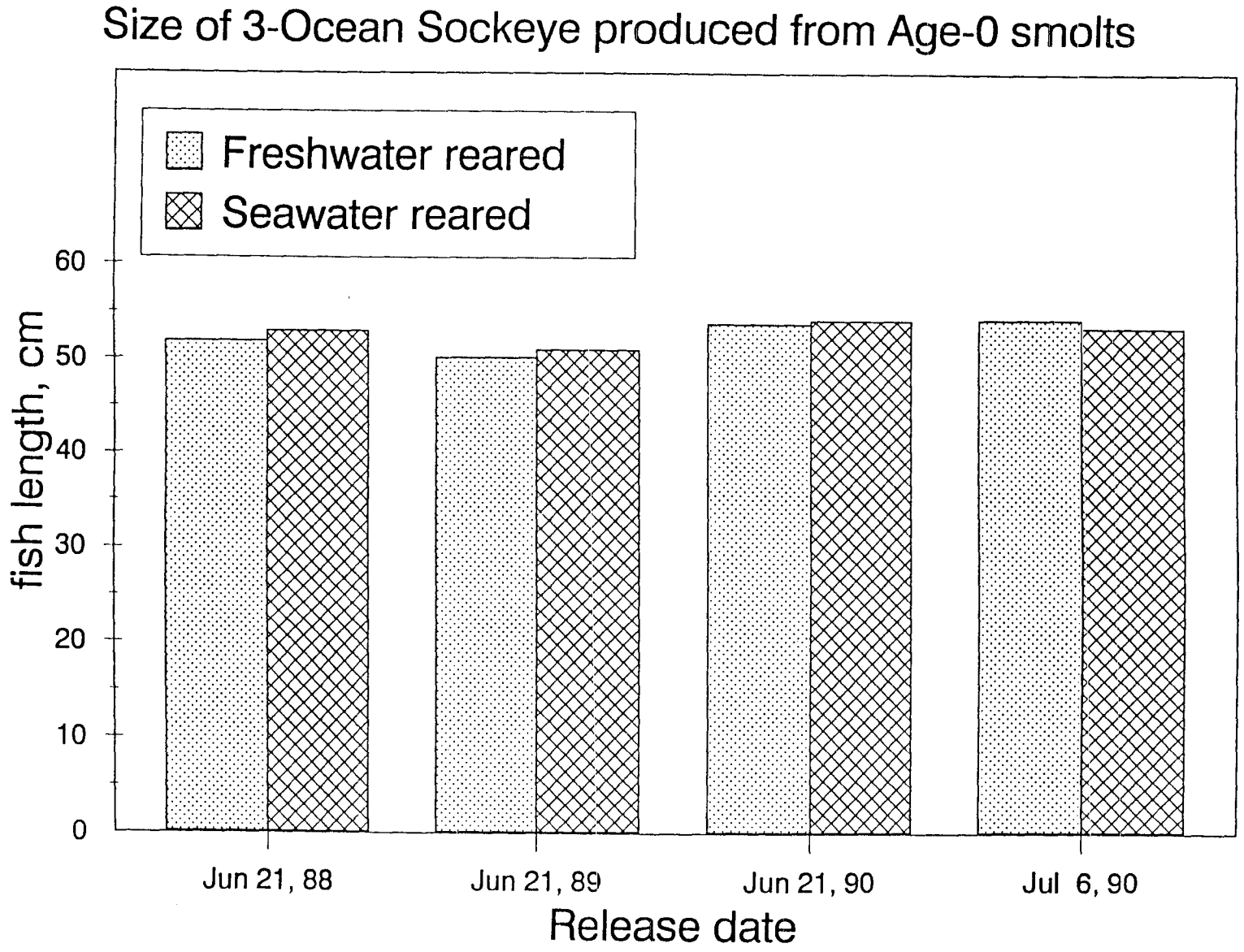

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Some conclusions from sockeye smolt experiments at Main Bay Hatchery (1987 through 1990; adult returns through 1993):

by

John A. Burke
Alaska Department of Fish and Game
Sportfish Division
P.O. Box 25526
Juneau, AK 99802-5526

Main Bay Hatchery is located Prince William Sound. It is a large facility by Alaska Standards, with a consistent supply of IHN-free water; and subsequently the potential to produce a large number of sockeye salmon smolts, perhaps as many as 20 million. We felt the risk associated with sockeye culture at Main Bay was acceptable if three key elements were stressed in the culture practices: 1. an IHN-free water supply; 2. appropriate isolation; and, 3. rigorous disinfection at appropriate points in the process.

In 1987 Main Bay began producing sockeye smolts. Eggs, sac fry and emergent fry were kept isolated in single-incubator lots until the fry had been feeding for at least three months, after which time we felt vertically transmitted virus was not significant risk to the fish. The rearing fry were then mixed with other lots of fish in raceways and reared until the following spring when production scale experiment to determine the most efficient way to produce adult sockeye salmon. The parameters evaluated were; release of smolts directly from freshwater or release after rearing for at least two weeks in seawater; differing rearing densities in raceways; size of smolts at release; and, time of release. The results from the final adult return numbers in 1993 are preliminary.

It appears that each manipulation had significant consequences.

1. **Freshwater vs seawater rearing prior to release.** It appears that sockeye need not be reared to achieve maximum survivals from smolt to adult. Smolt released at 10g directly from freshwater in 1989 had a greater survival rate to adult (17.8% vs 16.6%) than 9.9g smolt released from net pens in seawater.

2. **Smolt size and survival to adult.** Sockeye smolts above 8g do not necessarily have a greater chance of surviving to adult. Smolts released at 8g in 1989 had a greater survival rate to adult than smolts released at 15.1g (16.5% vs 15.7%).

- The **age of an adult sockeye** is strongly related to the size of a smolt. About 50% of the 8g smolts returned as 2-ocean adults, where greater than 80% of smolts larger than 14g returned as 2-ocean adults. There was a strong correlation in a simple linear regression between smolt size and age at maturity.

3. Rearing density and survival to adult. It is probable that rearing density is related to adult survival, though this experiment was somewhat influenced by the time of release of each of the treatment groups. The greatest survivals were achieved at the lowest rearing density (maximum density reached in the lowest density raceway was 33kg/m^3).

- Though the greatest survival came from the smolt reared in the least dense rearing environment, **the greatest adult production for a single raceway was from the smolt group reared at the highest rearing density** (maximum density attained during rearing was 88kg/m^3.

- A higher % of the returning adults were 1-ocean "jacks" from the groups of smolt reared at higher densities.

4. Time of release. Survival to adult is greatly influenced by time of release within a fairly small time window. We found that time of release had the strongest influence on survival among the parameters that we measured. As little time as a week, between the release of two groups of similar smolts, may make a substantial difference in survival to adult.

- The optimal release time in 1990 was the last several days in May and the first several days in June.

- The later smolt releases in 1990 tended to produce fewer 1-ocean "jacks".

- The later smolt releases in 1990 tended to produce relatively more 3-ocean adults.

Yearling Sockeye Smolt
Main Bay

Treatments:

1986 brood; 1988 release; 330,025 smolts:

1. Moist feed, released from freshwater, 110,900 smolts;
2. Moist feed, released from seawater, 40,270 smolts;
3. Dry feed, released from freshwater, 77,082 smolts; and,
4. Dry feed, released from seawater, 101,773 smolts.

1987 brood; 1989 release; 3,576,600 smolts:

1. Size at release, smaller (7-9g), 1,209,517 smolts;
2. Size at release, larger (14-18g), 617 smolts;
3. Released from freshwater, 948,027 smolts; and,
4. Released from seawater, 1,148,287 smolts.

1988 brood; 1990 release; 2,616,498 smolts:

1. Rearing densities @ 1,000,000; 800,000; 600,000; and 400,000 smolts per raceway, and
2. Release timing, smolts released on 15 May, 22 May, 29 May, and 5 June.

1987 Brood; Total Return from Smolts Released from Freshwater or Seawater Rearing

Treatment	Smolts released	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean adults (%)	Total return (%)
Released freshwater (@10.0g)	949,000	278 (0.0)	98,591 (10.4)	70,334 (7.4)	169,203 (17.8)
Released seawater (@9.9g)	1,150,000	2,323 (0.2)	113,459 (9.9)	74,871 (6.5)	190,653 (16.6)

1987 Brood; Total Return from Smolts Released at Two Different Sizes (7-9g and 14-18g)

Treatment	Smolts released	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean adults (%)	Total return (%)
"Smaller" smolts (@ 7-9g)	1,210,000	2,300 (0.2)	100,053 (8.3)	97,343 (8.0)	199,696 (16.5)
"Larger" smolts (@14-18g)	618,000	0 (0.0)	82,098 (13.3)	15,096 (2.4)	97,194 (15.7)

1988 Brood: Return from Smolts Released after Rearing at Different Densities

Treatment (peak den.)	Smolts released (date @ wt)	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean adults (%)	Total 2's & 3's (%)	Total return (%)
1,000,000 (88kg/m^3)	848,544 (5/26 @ 15.0g)	25,907 (3.1)	98,130 (11.6)	21,565 (2.5)	119,695 (14.1)	145,602 (17.2)
800,000 (67kg/m^3)	642,752 (5/24 @ 13.4g)	12,746 (2.0)	103,576 (16.1)	10,341 (1.6)	113,917 (17.7)	126,663 (19.7)
600,000 (48kg/m^3)	461,915 (5/28 @ 17.0g)	12,109 (2.6)	64,138 (13.9)	5,595 (1.2)	69,733 (15.1)	81,842 (17.7)
400,000 (33kg/m^3)	317,793 (6/6 @ 16.9g)	6,043 (1.9)	54,618 (17.2)	16,140 (5.1)	70,758 (22.3)	76,801 (24.2)

1988 Brood: Return from Smolts Released on Different Dates

Treatment release date	Smolts released (@ wt)	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean adults (%)	Total 2's & 3's (%)	Total return (%)
15 May	90,775 (@13.5g)	1,745 (1.9)	11,670 (12.9)	1,706 (1.9)	13,376 (14.8)	15,121 (16.7)
22 May	76,935 (@15.6g)	2,083 (2.7)	13,475 (17.5)	891 (1.2)	14,366 (18.7)	16,449 (21.4)
29 May	96,027 (@16.1g)	1,185 (1.2)	18,745 (19.5)	3,805 (4.0)	22,530 (23.5)	23,735 (24.7)
5 June	87,147 (@16.5g)	287 (0.3)	16,770 (19.2)	3,652 (4.2)	20,422 (23.4)	20,709 (23.8)

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