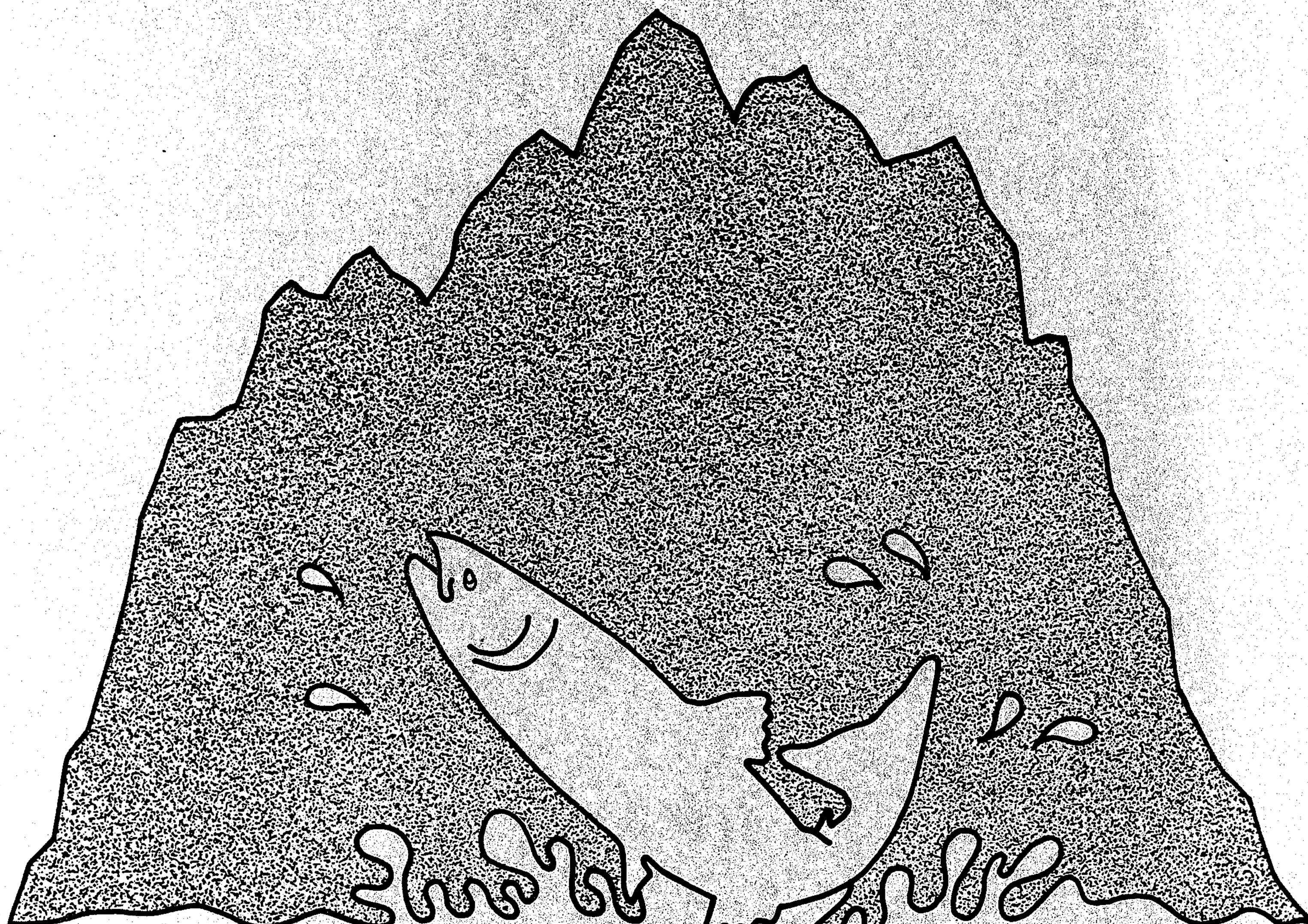
1991
SOCKEYE CULTURE WORKSHOP



ALASKA DEPARTMENT OF FISH & GAME
Division of Fisheries Rehabilitation, Enhancement, and Development*

*As of July 1, 1993, F.R.E.D. Division will be known as Commercial Fisheries Management & Development Division

Proceedings of the 1991 Alaska Sockeye Salmon Enhancement Meeting

Sitka, Alaska

24 and 25 October 1991

The Annual Alaska Sockeye Salmon Enhancement Meeting is an informal forum for the exchange of information about sockeye salmon enhancement. The Proceedings from this meeting are informal records and are not to be interpreted or quoted as a juried publication. In order to make the information as timely and useful as possible, presentations were sometimes made from original data and field notes while others were project updates using preliminary or incomplete data from ongoing work. The contents of these proceedings are a combination of materials provided by the speakers as well as narrative reconstructed from notes (in italics) taken by Katherine Aschaffenburg, Terry Ellison, and John Burke.

MEMORANDUM

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME

TO: Distribution

DATE: September 6, 1991

PHONE NO: 465-4230

FROM: John Burke
Regional Supervisor
FRED Division - Douglas

SUBJECT: 1991 Sockeye Enhancement Workshop

The annual sockeye enhancement workshop will be held in Sitka on 24 and 25 October. The workshop will begin at 8AM on 24 October in the NSRAA meeting room at 1308 Sawmill Creek Rd. It is possible to get to Sitka on Alaska Airlines and the Alaska State Ferry System (if you are creative with your travel plans). Because of airline schedules, some of you may arrive in Sitka on the morning of the 23th. If this is the case, and there is sufficient interest, we will try to organize a tour of local enhancement sites for Wednesday afternoon. Please notify NSRAA if this is something that might interest you.

Limited lodging is available in Sheldon Jackson College Dormitories at $20/night and there are several nice hotels in Sitka (Westmark Shee Atica, (907) 747-6241; Super 8, 747-8804; and the Potlatch, 747-8611). If you are interested in staying at Sheldon Jackson please notify Bruce Bachen at NSRAA (907) 747-6850 by the 18th of October and tell him if you have a room mate in mind as most rooms are double occupancy. These rooms will be filled on a first come first reserved basis.

There will be a $25 registration fee this year to help defray the cost of the meeting and publication of the proceedings. Please address these fees to NSRAA (check to NSRAA), or pay them on 24 October.

If you are on the agenda, bring a one page abstract of your presentation to the meeting. These will be included in the proceedings. If you plan to make a brief presentation during the open forum, or otherwise have information you wish to share, an abstract would also be helpful.

As in the past, the goal of the workshop is to share knowledge and experiences in sockeye salmon enhancement. It is the consensus among participants that the meeting is most valuable if it remains somewhat informal with frequent open discussion. The new questions and problems are often the most remembered topics. In order to address this, we have scheduled a number of fairly short presentations meant to fuel an open forum at each day's end. All present are invited to join the forum as they see fit; with questions to the group, by requesting others go back before the group, or perhaps with brief prepared presentations.

Sockeye Enhancement Meeting
Agenda

October 24; Sockeye Culture

8:00; Coffee

8:10; Welcome, Moderator, Terry Ellison

8:20; Keynote address, Robert Burkett

Yearling smolt production

8:40; Main Bay Hatchery update, John Burke

9:10; Pitt River Hatchery update, Dave Harding

9:30; Adult ripening at Main Bay Hatchery, Karen Robinette/Tony Carter

9:50; Yearling smolt and presmolt at Snettisham, John McNair

10:10; Break

10:25; Wenatchee River sockeye project update, Kathy Hopper/Mark Babiar

Underyearling Smolt

10:50; SSRAA underyearling smolt program update, Don Amend/Bill Halloran

11:20; Auke Creek underyearling smolt research update, Bill Heard/Jerry Taylor

11:40; Kodiak underyearling smolt programs, Lorne White/Steve Honnald

12:00; Lunch

Fry production

1:15; Snettisham CIF update (thermal tagging), Carol Coyle

1:40; In-Lake incubation of sockeye salmon at Redoubt Lake, Steve Reifenstuhl

2:00; New spawning containers for isolation and disinfection, Jeff Hetrick

2:20; U.V. Disinfection, Mike Blake

2:40; Break

3:00; Open forum on sockeye culture, Ken Roberson

Sockeye bioenhancement, rehabilitation, life history, and IHNV

8:00; Coffee

8:15; Introduction to Day 2, Terry Ellison

8:25; Snake River sockeye rehabilitation, Keith Johnson

8:55; Current status of Cedar River sockeye enhancement, Bob Gerke

9:25; IHN update for Alaska (Chenik Lake), Jill Follett

9:45; IHN, recent developments, overview, Ted Meyers

10:05; Break

10:20; Early marine life history of sockeye (Auke Bay), Joe Orsi

Case Histories

10:40; Hugh Smith Lake, enhancement and management, Doug Mecum/Phil Dougherty

11:00; Big Lake, sockeye coho interactions, Larry Peltz

11:25; Virginia Lake, fry plant timing and consequences, Mike Haddix

11:50; Esther Pass and Pass Lakes, fry and presmolt, Greg Carpenter

12:15; Lunch

1:30; Speel Lake, Ron Josephson/Scott Kelley

1:50; Sweetheart Lake, Rich Yanuze

2:10; Redoubt Lake, Don Dennerline

2:30; Break

2:45; Open forum, Ken Roberson

End of forum; Set next years meeting time and place, closing remarks, Terry Ellison

Season, Reason and Rhyme: Brother, Can You Spare

A Sockeye?

by

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Let's take a brief look at the 1991 salmon fishing season. By all accounts this was one of the strangest year's in the history of Alaska's salmon industry. Overall, the season was characterized by record harvests, poor prices, and a drop in average salmon weights. The shear number of adult returns was massive. Approximately 187 million salmon were captured in the statewide commercial fisheries. This is a new all-time high exceeding last year's record of some 162 million salmon. Pink salmon dominated the catch both by number and by poundage. The harvest of 61.5 million pink salmon in SE Alaska broke the previous record high of 60 million established in 1941.

1991 Alaska Commercial Salmon Catch

Chinook	615,000	fish
	9,978,000	pounds
Sockeye	44,827,000	fish
	264,502,000	pounds
Coho	5,124,000	fish
	33,885,000	pounds
Pink	127,325,000	fish
	349,891,000	pounds
Chum	9,235,000	fish
	66,654,000	pounds
All	187,127,000	fish
	724,911,000	pounds

This large volume of fish wreaked havoc with markets, prices and processing capability around the state. Bristol Bay fishermen went on strike to protest prices for sockeye salmon that were only about one third of what they had received the previous season. The most aggravated situation developed around pink salmon returning to Prince William Sound. There, prices paid to fishermen for pinks collapsed to fifteen cents per pound and then to nothing when processors refused to buy pinks because processing lines in local canneries plugged due to heavy commercial catches of returning hatchery fish. Meanwhile, big catches of pinks in Southeast were flooding markets in advance of the fishery in the Sound. Generally, fishermen earned much less this season compared to 1990. Preliminary estimates of the exvessel value of the 1991 commercial salmon catch should fall between $300 and $320 million, well below the estimated $550 million earned last year.

What are the reasons underlying all this commotion? Why so many fish, especially pink salmon? Why such low prices? I am confident that no one has the complete answer to either of these questions, but let me speculate a bit on each.

Why are there so many salmon around, especially pinks? A decade or so ago when salmon harvests first exceeded the 100 million mark, most everyone thought that a miracle had been witnessed. Sure, a decade ago we did not have the significant contribution of hatchery produced pinks that we have today. Hatcheries do work. Still, wild stock production has steadily risen. Look at southeast Alaska, for example. Only a minor amount of the record production in 1991 was from hatcheries - say less than a million fish. To what should we attribute this massive production?

Some might argue that what we are witnessing is due to good resource management. While I would be the first to agree that it takes spawners to make new recruits, an explanation is not to be found in a simple consideration of escapements. No, what we are seeing is a bit more encompassing to the totality of the life cycle of these animals than what can be found in a stock-recruitment analysis done along the traditional and dogmatic Ricker pathway.

What about favorable ocean conditions? Frequently one hears mention of this combined with good management as the underpinnings of record salmon harvests. We have been hearing this one for about a decade, what makes one or two years out of ten so special? What happens?

I believe that a great deal of insight can be obtained by examining the life cycle of the animal (pink salmon) in the context of about 10,000 years of experimentation by Mother Nature resulting in what we see as an animal adapted to the environment in which we find it.

In this process of adaptation, certain mortality events influencing the reproductive success of the animal (population) remain random. And because these events are random, the animal cannot adapt so as to minimize the impact of the event. Other mortality events are linked to significant stages in the life cycle. Let's view it this way. There is nothing random about the tactics and strategies that comprise the life cycle of these beasts we call salmon. Through the process of natural selection, the life cycle is tuned or synchronized to major events occurring in the natural world in which and to which salmon have adapted and to which they continue to adapt.

Take seasonality, for example. The life of a salmon is played out following a seasonal pattern because the environment to which it has adapted undergoes seasonal change throughout the course of a calendar year. My thesis here is that the extent or degree to which the life cycle is tuned or synchronized in any given year greatly influences the mortality/survival of the recruits from preceding parent years much more so than events random to the life cycle adaptation such as floods and periods of freezing temperatures. I distill all of this to random versus synchronized survival events.

Let's look more closely at pink salmon. An egg is in a gravel bed. A heavy rain occurs and the egg is scoured from the gravel and dies. A random event. An egg is in a gravel bed and lives to become a fry. The fry moves downstream from freshwater or intertidal water to the nearshore marine environment. This event is not random - it is synchronized. It is and must be synchronized more often than not (asynchronous) to events occurring in the near-shore marine environment to ensure survival of the fry and its cohorts - inshort, the species population. The principal event to which this phase of the life cycle must be synchronized to in the near-shore marine environment is the production of food. For pink salmon, I hypothesize that this taking up of estuarine residence is the primary driver determining year class success or failure.

Let's follow this further. In the spring when this event of taking up estuarine residency occurs, water temperature thresholds once exceeded triggers the production of food, and production is then driven by solar insolation which is randomly present or absent depending upon daily weather. The "hospitality index" and subsequent survival of fry reaching the near-shore marine environment is greatly affected by water temperatures there. If "you" as a fry haven't coincided your uptake of marine residency with the water temperature threshold having been reached or exceeded, then you are unlikely to hit the food trough - you die. If on the otherhand you "make" your arrival at or above the temperature plateau, then your chances of hitting the food trough are much improved. If you hit both the temperature plateau and the food trough, good things are definitely in store for you. And if you and your mates had a "good winter", your year class will make history as adults. I am betting that stock fluctuations in pink salmon are primarily a reflection of the synchrony-asynchrony continuum secondarily modified by random mortality events, parent stock size, and predators.

So, why then are there so many pink salmon around these days? It must be because synchronized events are, indeed, very well tuned these days and that random mortality events are insignificant. Can I prove this? No.

Let's turn to an easier question. Why did salmon prices drop through the floor this year? Flood the market with product and soon the product price drops. Many forces are at play not the least of which is the expanding production from wild stocks and hatcheries in Alaska. Farmed fish are making a major market impact. Obviously Alaska has to develop new markets and new products, all the while improving upon the quality, packaging and presentability of its present fish products.

This past salmon fishing season has a lot of people worried about the health of the industry. Actually, the worry began early last spring (1991) while the state legislature was still in session. Fishermen, processors, and others were contacting their respective representatives and expressing a great deal of concern. Coincident with all this was a special report from the Alaska Seafood Marketing Institute that revealed that the state had lost over the past decade a large share of the salmon market supply. In 1980, harvest of Alaska salmon accounted for 41 percent of the world supply. Presently, our harvest accounts for only 29 percent of the world's supply of salmon. Many people were asking serious questions about the state's salmon enhancement program. The Legislature responded with what it calls the HATCHERY RESEARCH PROJECT. This effort is being spearheaded by legislative staffers.

Briefly, the HATCHERY RESEARCH PROJECT has four thrusts.

1. History and Development of Hatcheries:
   - legislative history and intent
   - appropriations and bond authorizations
   - world salmon production
   - national policies and trends
   - role of hatcheries in treaties

2. Marketing and Economics:
   - review economic and marketing studies
   - assess additional information needs
   - compile production and price information
   - develop proposals to fill informational gaps

3. Fisheries Management
   - identify issues and conflicts
   - carrying capacity, genetics, disease, policies
   - legal issues
   - identify and review current tagging techniques
   - review hatchery production and harvest
   - review role of regional aquaculture associations

4. Roles and Responsibilities in Statewide Enhancement Program
   - state role in hatcheries
   - state planning process
   - review hatchery funding-revolving loan fund
   - review environmental regulations

This is a very ambitious undertaking with a short time-line. Work is to be completed and reports issued by March, 1991.

I do not know what the outcome(s) will be from this activity and what it will mean to the enhancement program in Alaska. It does occur to me, however, that the progress we have made with regard to sockeye salmon enhancement positions Alaska very well into the future. Still, we need to watch closely worldwide developments with sockeye. Some people are already speculating that the Japanese will soon commence to shift from enhancement of chum salmon to enhancement of sockeye salmon. Stay tuned.

Some of you in the audience know the Alaska sockeye enhancement story. My personal bias is that it ranks as one of the great accomplishments in the history of fisheries biology - anywhere, anytime. Collected in this room are many of the people responsible for what has been achieved. The first stage of the sockeye play in Alaska dealt with the power of having an artificial fry delivery system combined with an understanding of the rearing capacity of the pastures we call lakes. Now we are witnessing new acts added to the play: things like production of yearling and underyearling sockeye smolts.

The cast of characters and topics listed on the agenda constitute the ingredients for an exciting and productive two-day encounter. Terry Ellison and John Burke have done an outstanding job of putting this workshop together. LET'S GET BUSY!

Yearling Smolt Production

Main Bay Sockeye Smolt Program

by

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Main Bay Hatchery is located in 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 a significant risk. The rearing fry were then mixed with other lots of fish in raceways and reared until the following spring when they were released as yearling smolts. We used each year class of smolts as a 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. Though some of the results are still preliminary, as the last groups of three-ocean adults will not return until 1993, it appears that each manipulation may have had significant consequences.

Seawater and freshwater rearing. These treatments were compared with both the 1986 and 1987 broods. All survival estimates were based on tag recoveries, and should be considered conservative. This is particularly true of the 1986 brood, when there were relatively small numbers of smolts released. An estimated 4.9% of the 1986 brood reared in seawater survived to adult, while only 1.8% of those released directly from freshwater survived. An estimated 17.1% of the 1987 brood seawater reared fish survived to adult, while 18.3% of those released directly from freshwater survived. Though rearing a smolt in seawater prior to release could affect its chance of survival, it appeared that this was not the only parameter influencing the survival of these fish.

Large and larger smolts. Smolts were reared to two sizes; one group at a mean of 8 g and the other at twice that size, 16 g. Both groups of smolts would be considered large when compared to most wild populations in Alaska. An estimated 17.0% of the 8 g smolts survived to adult, while 16.4% of the 16 g smolts survived to adult. Limnologists working with wild smolts in Alaska suggest that the threshold above which the influence of smolt size on survival decreases is 6 g. Future work with hatchery produced smolt will be directed at determining this threshold.

Perhaps of more interest than survival to adult, was how the size of a smolt influenced the age of adults at return. Wild smolts from the same stock weigh only 1 to 2 g. An estimated 15% of these fish return as two-ocean adults while 85% are three-ocean adults. When the smolts were 8 g, 52% of the fish returned as two-ocean fish and 47% as three-ocean adults. If the smolts were 16 g at release, 88% returned as two-ocean adults and only 12% as three-ocean adults. Somewhat unexpectedly, a number of one-ocean "jacks" returned from the group of 8 g smolts, while not a single one-ocean fish was recovered from the group of 16 g smolts.

At present it is not possible to make conclusions related to **rearing density in freshwater** and **time of release** studies. The three-ocean adults from these studies will not return until 1993. Preliminary results could be used to suggest that rearing densities as high as 67 kg/m^3 did not diminish survival to adult; and that the time of release, even within a fairly narrow window (15 May through 5 June), made a significant difference in the survival of the smolts. It is apparent that smolts from the 1988 brood will survive to adult at a greater rate than smolts from either the 1986 or 1987 broods.

Note that some of the results from the 1992 harvest, since the meeting, have been added to the following tables.

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 (7-9 g), 1,209,517 smolts;
2. Size at release, larger (14-18 g), 617,475 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.
2. Release timing, smolts released on 15 May, 22 May, 29 May, and 5 June.

Release from Freshwater or Seawater Rearing

1986 Brood - Contributions to Commercial Fisheries

Treatment	Smolts released	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean adults (%)	Total harvest
Released FW	187,982	250 (0.1)	1800 (1.0)	1300 (0.7)	3,400 (1.8)
Released SW	142,043	2,300 (1.6)	3,050 (2.2)	1600 (1.1)	7,000 (4.9)

1987 Brood - Contributions to Commercial Fisheries

Treatment	Smolts released	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean adults (%)	Total harvest (%)
Released FW	949,000	160 (0.0)	104,000 (11.0)	70,000 (7.3)	174,000 (18.3)
Released SW	1,150,000	1,800 (0.2)	120,000 (10.5)	75,000 (6.5)	197,000 (17.1)

Smolt Size at Release

1987 Brood - Contributions to Commercial Fisheries

Treatment	Smolts	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean adults (%)	Total
Smaller smolts (7-9g)	1,210,000	1,000 (0.1%)	108,000 (8.9%)	97,000 (8.0%)	206,000 (17.0%)
Larger smolts (14-18g)	618,000	0 (0%)	86,000 (13.9%)	15,000 (2.4%)	101,000 (16.4%)

% of Total Commercial Contribution by Years at Sea

Treatment	% return as 2-ocean adults	% return as 3-ocean adults
Smaller smolts (7-9g)	52%	47%
Larger smolts (14-18g)	88%	12%
Wild Coghill smolts (1-2g)	15%	85%

Rearing Densities

1988 Brood - Contributions to Commercial Fisheries

Treatment (Peak RW density)	Smolts released	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean return in 1993	Total through 1992
1,000,000/RW ($88 Kg/m^3$)	848,544	23,300 (2.8)	97,800 (11.5)	?	121,100 (11.8)
800,000/RW ($67 Kg/m^3$)	642,752	11,400 (1.7)	102,800 (16.0)	?	114,200 (17.8)
600,000/RW ($48 Kg/m^3$)	461,915	11,800 (2.5)	63,700 (13.8)	?	75,500 (16.3)
400,000/RW ($33 Kg/m^3$)	317,793	6,000 (1.9)	54,400 (17.1)	?	60,400 (19.0)

Time of Release

1989 Brood - Contributions to Commercial Fisheries

Date of Release	Smolts released	1-ocean "jacks" (%)	2-ocean adults (%)	3-ocean return in 1993	Total through 1992
15 May	90,775	1,600 (1.8)	11,600 (12.8)	?	13,200 (14.5)
22 May	76,935	2,000 (2.6)	13,400 (17.4)	?	15,400 (20.2)
29 May	96,027	1,200 (1.4)	18,700 (19.5)	?	19,900 (20.7)
5 June	87,147	300 (0.3)	16,700 (19.2)	?	17,000 (19.5)

Pitt Lake Sockeye Project Update

by

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The history of sockeye enhancement in B.C. and at the upper Pitt River site on Corbold Creek have been covered in the proceedings of previous sockeye workshops by Al Stobbart and myself and Al described the Pitt Lake basin.

Dr. Mike Henderson et al (1991) described the geography and limnology of the basin in detail. They also discussed their own and previous studies on the feeding and behaviour of sockeye and competing species in the lake. In summary, they rate Pitt Lake as one of the more productive lakes of the coastal region but point out that Daphnia, one of the most common food organisms of sockeye, is missing from the lake. In mid-summer sockeye feed heavily on the large cladoceran, Leptodora spp., which seem to be little utilized by the competing species, three-spined stickleback and long-finned smelt, which are numerous in the lake. Little data is available on sockeye feeding at the lake entry and a very heavy mortality (80+%) occurs at that time.

After June sockeye numbers remain relatively constant and emigrating smolts are large (12 g) suggesting underutilization of the lake. Other data quoted by the authors indicate a density dependent relation between fry recruitment and adult return. We are trying to obtain funding for continuance of their studies on the early period of sockeye residence in the lake.

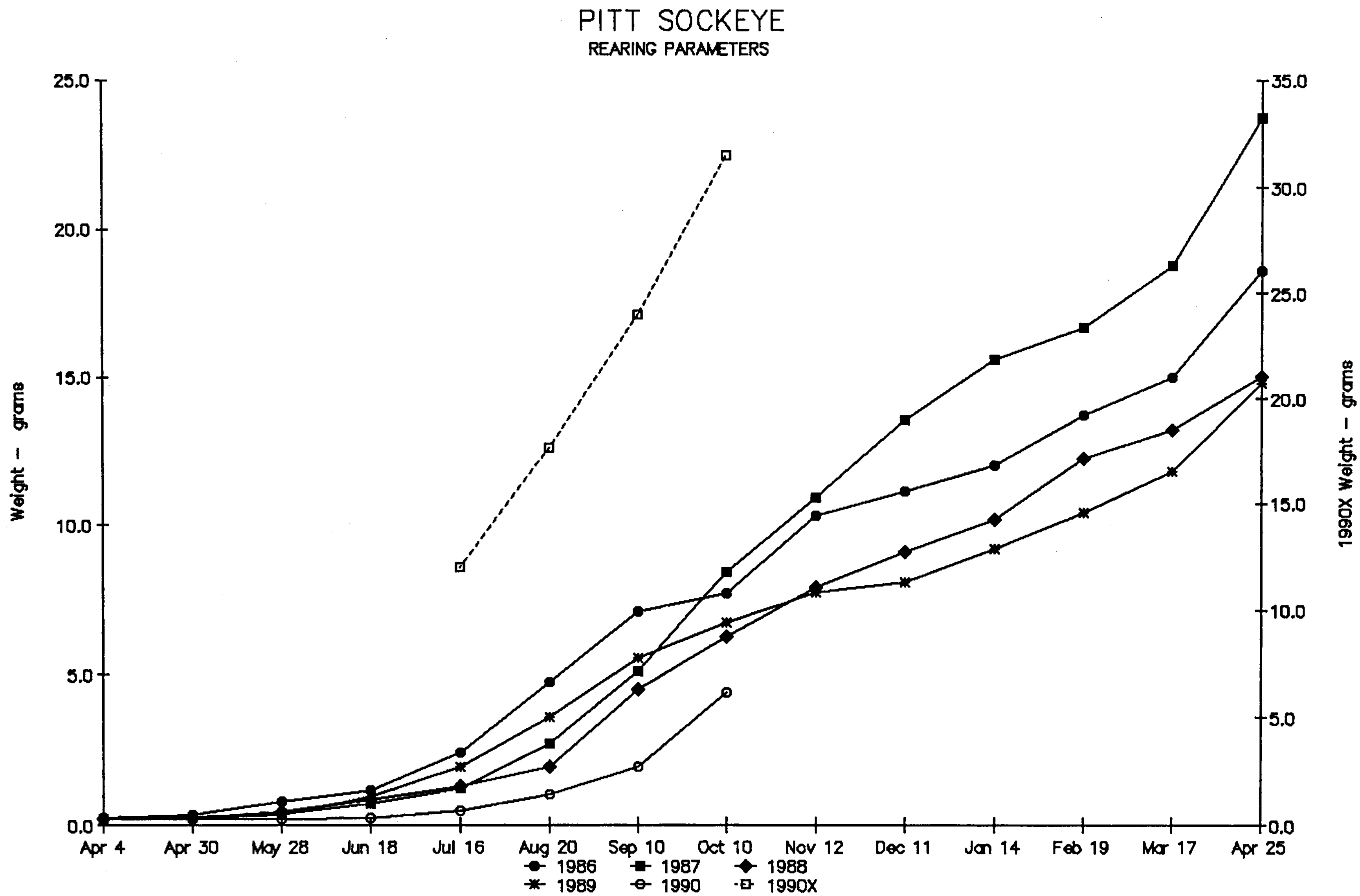
The following tables and charts summarize growth and other rearing parameters for the Corbold Creek site and the lake pens in recent years. Also releases by number, stage and size are reported along with numbers marked. This fall completed the return from the first fall fry and spring smolt releases from the hatchery. Both groups were marked and appear to have survived equally well, however preliminary indications are that survivals are below expectation.

A strike resulted in only obtaining 60% of the egg capacity this September. Incubation is in Atkins cells again, but we plan to have Kitoi boxes for some of the eggs by the eyed stage. A flood at the end of August, worse than anything seen in 60 years, damaged the water intake from the creek but an experimental 'surface' well saved us from disaster. The well was dug in an attempt to avoid problems similar to those encountered with the 1990 brood from a flood on Remembrance Day 1990. Silt from the flood caused a large mortality from smothering and the health of the survivors was poor until early summer. Because of small numbers and short funds the remainder of this brood was released this fall.

PITT RIVER HATCHERY
SOCKEYE RELEASE HISTORY

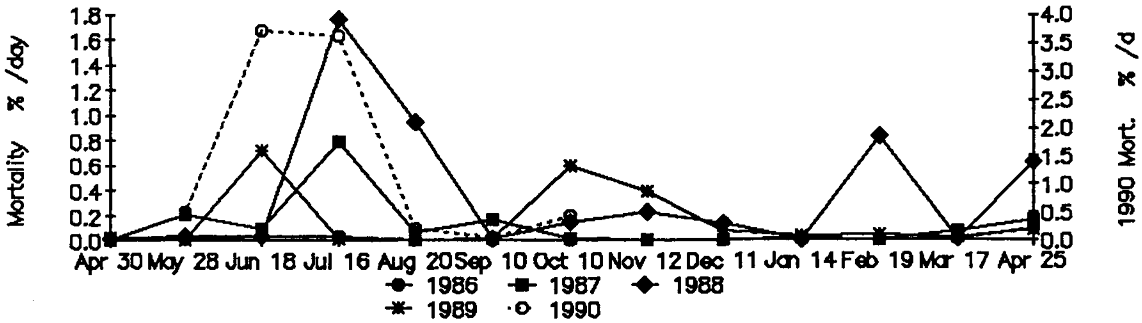
BROOD YEAR	GROUP	UNFED FRY	REL. WT. (g)	FED FRY	REL. WT. (g)	FALL FINGER.	REL. WT. (g)	YEARLING SMOLTS	REL. WT. (g)
1982	CORBOLD	2,135,705	0.25						
1983	CORBOLD	3,736,188	0.25						
1984	CORBOLD	3,582,137	0.25						
1985	CORBOLD	1,462,576	0.25						
1986	CORBOLD	3,713,000	0.23	231,504	1.10	27,850	7.3	28,440	18.6
	-marked					27,850	LV	28,440	RV
1987	CORB.PITS	1,525,000	0.23						
	CORB.INC.	1,891,000	0.22	315,623	0.68			19,276	23.7
	-marked							19,276	LV
	LAKEPENS			12,900	0.98	1,073	3.1		
	BOISE			73,900	0.85				
1988	CORB.PITS	2,219,937	0.22						
	CORB.INC.	2,012,868	0.21	120,410	0.79			24,340	15.0
	-marked							23,750	LV
	LAKEPENS							44,843	14.5
	-marked							43,525	RV
	BOISE			120,381	0.76				
1989	CORBOLD	2,693,204	0.22	235,828	.90+	34,073	6.8	28,443	14.8
	-marked			129,644	TMO	31,334	CWT	19,022	CWT
	-marked			51,844	CWT	639	Ad	388	Ad
	-marked			897	Ad				
	LAKEPENS			107,404	1.3+	46,568	13.5	44,150	23.4
	-marked			53,167	CWT	29,520	CWT	24,415	CWT
	-marked			875	Ad	298	Ad	498	Ad
	BOISE			45,000	0.90				
1990	CORBOLD	2,154,723	0.21			17,300	4.4	1990 Brood no.s prelim, all to be marked	
	CBLD/X-AQCLTR					5,723	31.5		
	LAKEPENS					47,800	7.0		

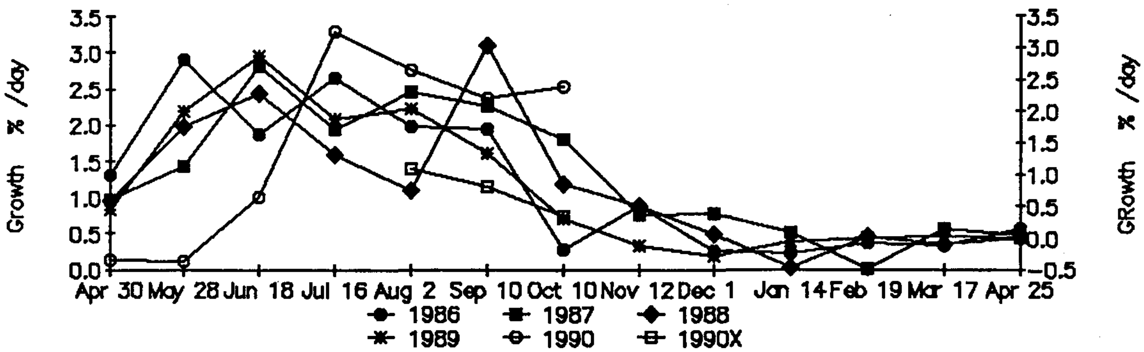
\+ in release weight column indicates mean weight for group of smallest fish released.

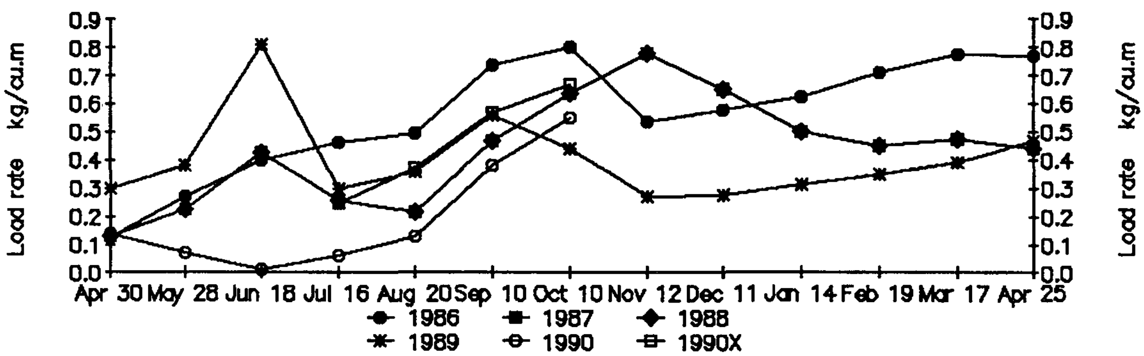


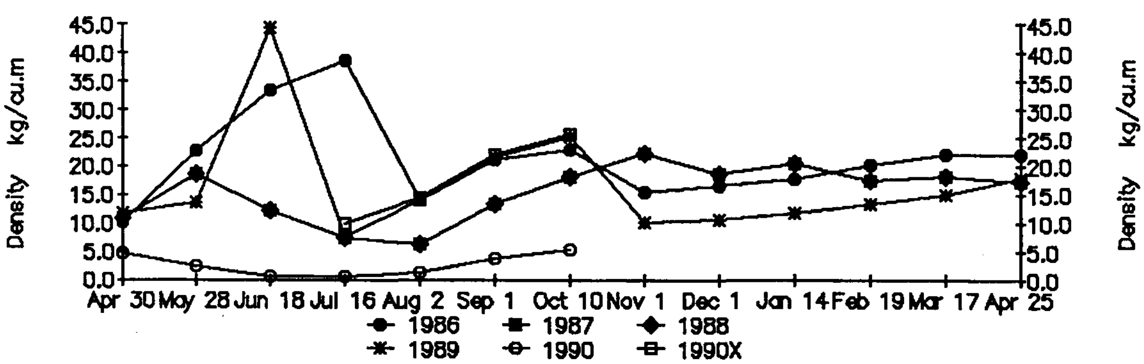
PITT SOCKEYE
REARING PARAMETERS
Weight - grams
1990X Weight - grams
25.0
20.0
15.0
10.0
5.0
0.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Apr 4
Apr 30
May 28
Jun 18
Jul 16
Aug 20
Sep 10
Oct 10
Nov 12
Dec 11
Jan 14
Feb 19
Mar 17
Apr 25
1986
1987
1988
1989
1990
1990X

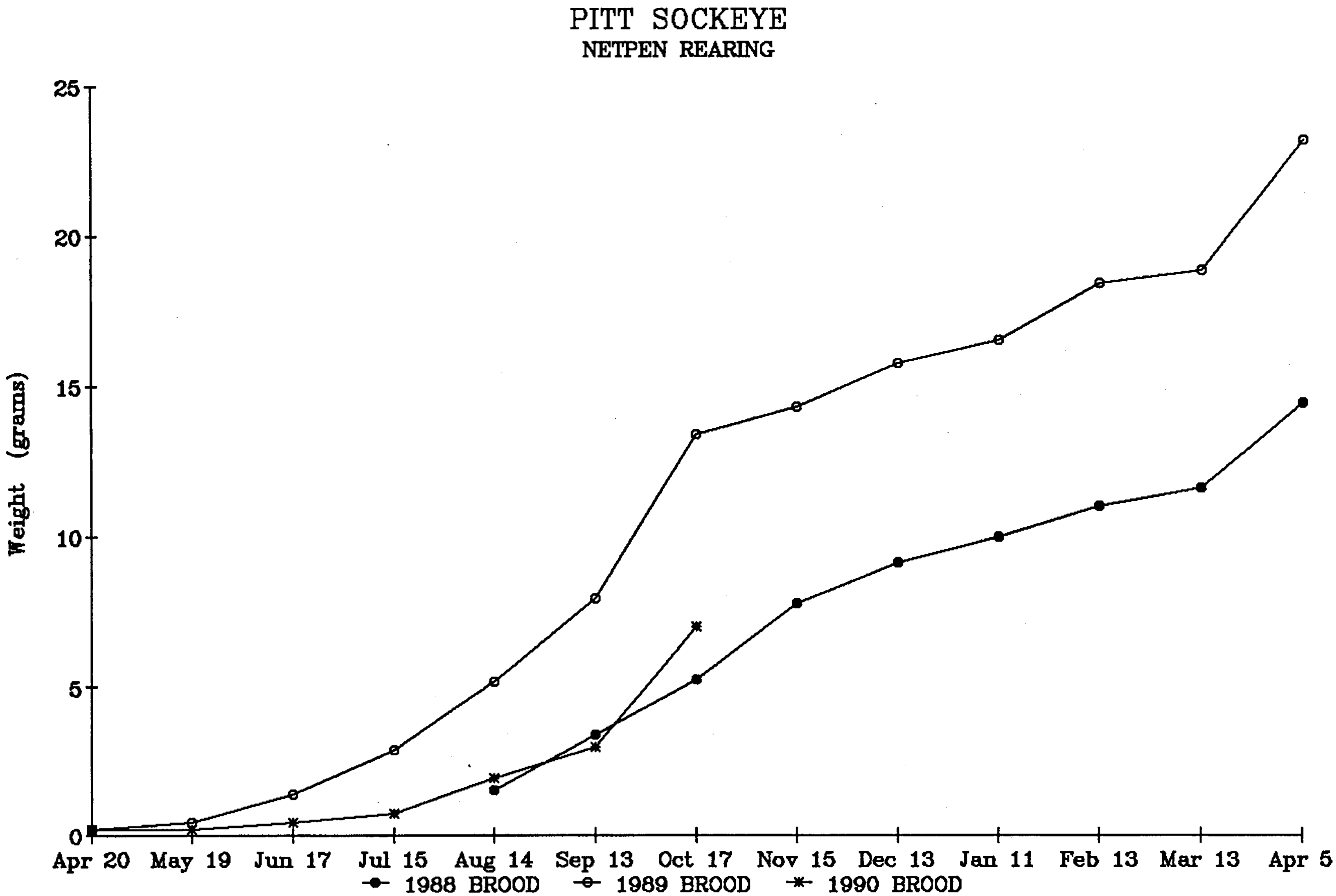
PITT SOCKEYE
REARING PARAMETERS







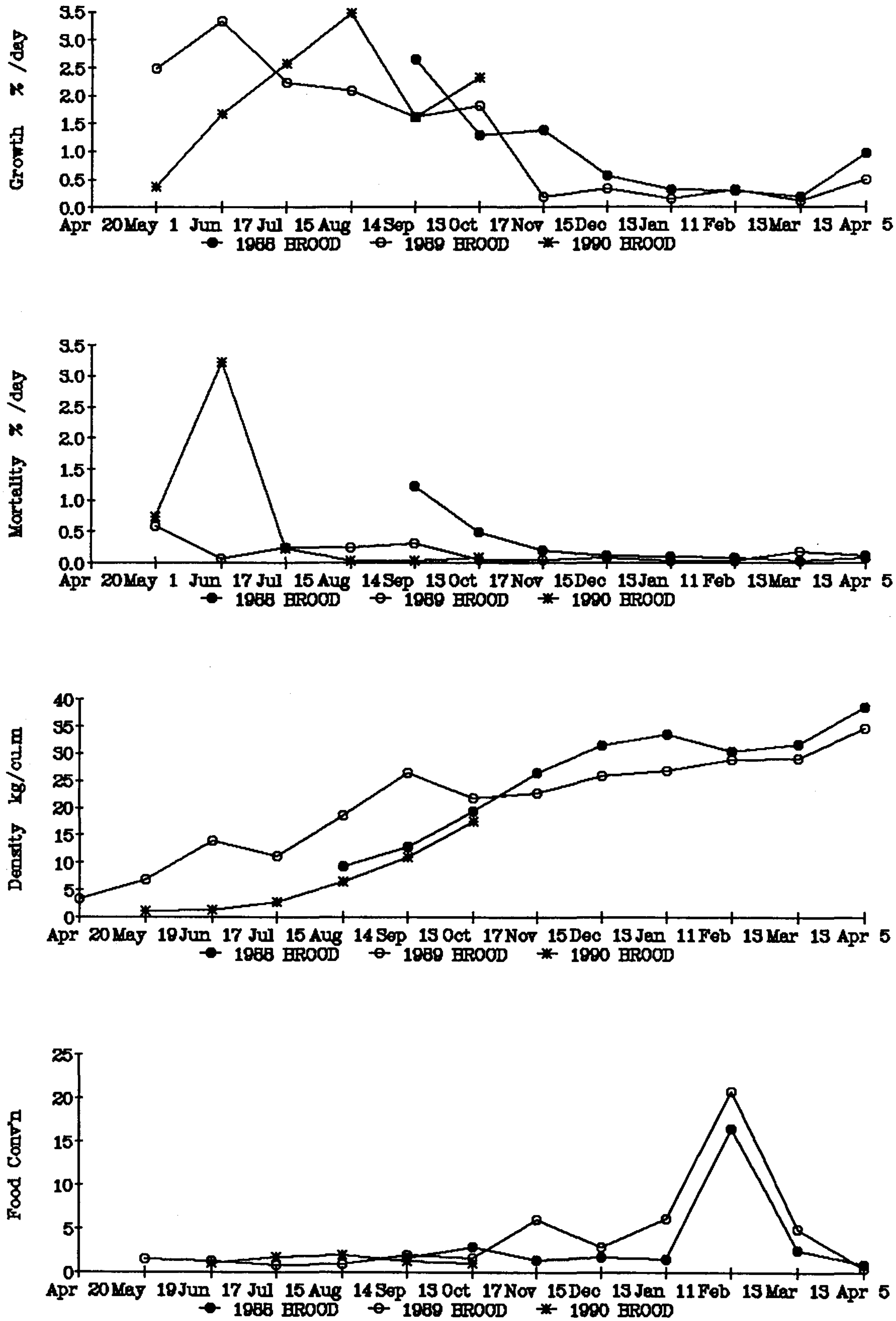




PITT SOCKEYE
NETPEN REARING
Weight (grams)
0
5
10
15
20
25
Apr 20
May 19
Jun 17
Jul 15
Aug 14
Sep 13
Oct 17
Nov 15
Dec 13
Jan 11
Feb 13
Mar 13
Apr 5
1988 BROOD
1989 BROOD
1990 BROOD

PITT SOCKEYE

NETPEN REARING



Dave Harding; Pitt River Sockeye Salmon Project Update. *The hatchery capacity is 5.5 million eggs. The major production from the hatchery is unfed fry. Pitt Lake is a productive Lake, but is unique in that Daphnia is missing from the lake. In midsummer juvenile sockeye feed heavily on a large Cladoceran.*

There is an extreme mortality, about 80%, of sockeye fry as they initially take up residence in the lake. The cause is unknown, though there is some speculation it may be related to competition with stickleback.

Emigrating smolts are large, about 12 g, which suggests the lake may be underutilized by sockeye. Normally both four and five-year-old adults return to the hatchery. Adult returns (survival to adult) are similar from fall fingerling (presmolt) and spring smolt releases.

Maximum rearing densities ranged from 35 to 45 kg/m^3 at the hatchery. The maximum rearing density in a net pen in Pitt Lake was 35 kg/m^3.

Karen Robinette (PWSAC, P.O. Box 1110, Cordova, AK 99574); Adult Ripening at Main Bay Hatchery. *A small portion of Main Bay, directly below the hatchery, was dammed to make a freshwater pond for holding and ripening adult sockeye. Only one sockeye stock (Coghill Lake) is returning to the hatchery to date, though a second stock will also return in 1993.*
Some salmon were caught and placed in a net pen. These fish were held in mixed water below the hatchery effluent to acclimate to fresh water. Unfortunately when they were released they were harvested by commercial fishers before they entered the holding pond. There was no problem with the ripening of fish that entered the pond. Some of these fish tried to spawn in the pond before entering the hatchery tailrace where they could be captured. The ripe fish tended to move into the tailrace during daylight hours, and backed out (into the pond) in the dark.

Cool water (4-5 C) from a deep lake intake was being used in the hatchery during brood collection. This may have set up a thermal barrier that made adult fish reluctant to enter the holding pond and vulnerable to the adjacent commercial fisheries.

Smolt and Presmolt at Snettisham

by

John McNair
Alaska Dept of Fish and Game
P.O. Box 240020
Douglas, AK 99824

Snettisham is a remote salmon hatchery run by the State of Alaska. The facility is located 50 Km east of Juneau in southeast Alaska. The hatchery was originally built to grow chum and chinook salmon. A sockeye incubation program was begun in 1988 to meet obligations of the US/Canada treaty. We discontinued the chum program this spring due to poor ocean survivals. This summer hatchery staff removed the R-48 incubators and headboxes to make room for indoor raceways to rear sockeye smolt. Chinook incubation was consolidated to one end of the hatchery building.

Why do sockeye? We had room inside, John Burke had already set precedent of being able to grow smolts at Main Bay, this fish was more suited physiologically to our cold water, sockeye are gillnet fish, and a smolt program complemented our existing incubation program.

At about the same time the incubation room was being emptied, a planned 28 million egg permanent sockeye central incubation facility (CIF) was scrapped because of lack of funds. The temporary CIF currently being used had to be replaced, so FRED Division decided to move the sockeye incubation into the space previously allocated to chum. Enough money was available to do the remodel project on a scaled down basis. Our plans are now for six incubation modules of three million eggs each: four modules for Canadian eggs and two modules for U.S. sockeye eggs. By moving modules indoors, the smolt rearing area originally available was reduced. Additional smolt rearing capacity was planned by using vertical raceways or "silos", 17 feet tall by 7.5 feet in diameter. Other than a small number for broodstock, all sockeye smolts would be taken to Doty Cove in Stephens Passage for imprinting to a non-conflict fishing area. Up to 300,000 presmolts, or juveniles weighing 2-3 grams would be stocked into nearby Port Snettisham lakes. This group of juveniles would have to be removed from raceways anyway to reduce rearing densities. Stocking presmolts helps speed up development of depressed stocks and optimizes hatchery rearing capacity. With presmolts, we hope to get 3.5 times the in-lake survival rate of unfed fry.

This October we coded wire tagged 70,000 1.2 gram presmolts to be stocked into Crescent Lake about November 1. These presmolt already have an otolith mark in addition to the tag and adipose clip. We found the sockeye easy to rear. The fish would have been much larger but they were incubated on chilled water and were ponded later than desired on July 2. We are presently incubating 1991 brood eggs for presmolt on ambient water which should produce fry about April 15. David Barto of Limnology Section is trying to get money to put in a smolt weir at Crescent Lake in 1992 to monitor the emigration of these presmolt.

A major liability to culturing sockeye and chinook next to each other is the risk of infecting chinook with IHNV. We must completely seal the floor of the hatchery building to prevent the organisms from dripping into raceways filled with chinook. One raceway will probably be used as a depuration holding tank.

We have to do a lot of things to our water to grow sockeye. We have to heat it to otolith mark the fry, chill it to delay emergence matching late ice-out, degas it to remove low level nitrogen supersaturation, add minerals to reduce white spot incidence, and depurate the outfall to kill IHN virions.

We hope to begin construction next year.

John McNair; Yearling Smolt and Presmolt at Snettisham. *Snettisham Hatchery began as a chinook and chum salmon facility. The sockeye rearing program began in 1990 when chum production at the facility was acknowledged a failure.*

There are two stocks of sockeye in Port Snettisham that are utilized for enhancement. The hatchery is also used to incubate about 11 million eggs a year that are collected in Canada from the Stikine and Taku River systems (transboundary rivers). At present the capacity of the hatchery is 18 million eggs, though the original hatchery building is being refitted to incubate about 30 million eggs and fry.

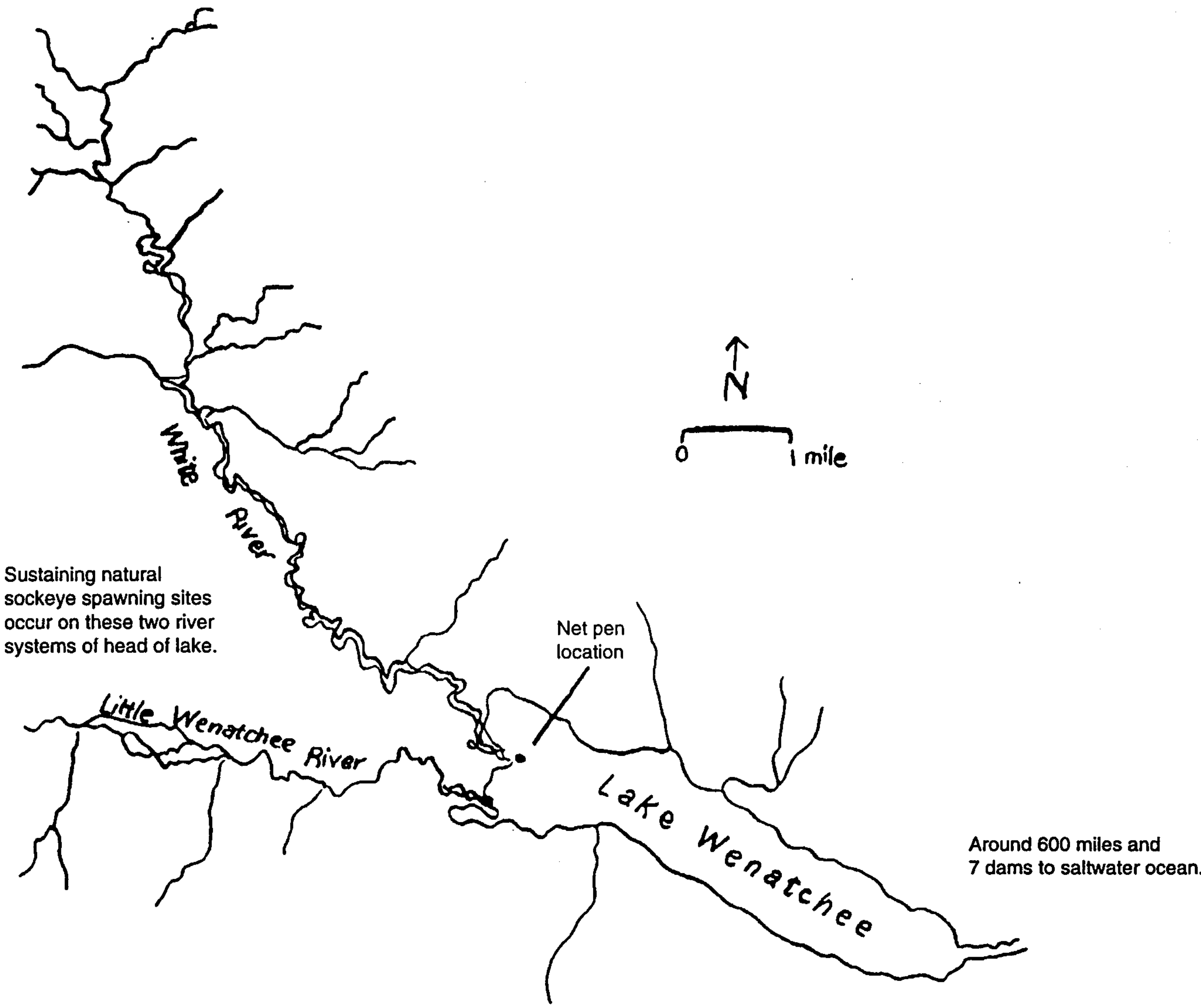
There are some unique requirements at the hatchery. The eggs from Canada come from relatively high elevation lakes that remain ice covered until late spring or early summer. The incubation water at the hatchery is chilled so that development of the eggs is retarded to match emergence with ice-out at the recipient lakes. In addition, calcium chloride is added to increase the hardness of hatchery water to moderate the problems (white spot) caused by the extremely soft hatchery water.

Because both sockeye and chinook salmon are in the hatchery at the same time, the hatchery follows very strict procedures related to isolation of stocks against the transmission of IHN. The water coming into Snettisham is IHNV-free.

We are looking for several release sites for sockeye smolts that will not complicate commercial fisheries management and will provide a terminal cost-recovery fishery.

LAKE WENATCHEE NET PENS, REARING, RELEASE AND ADULT BROOD STOCK COLLECTION DATA AND STRATEGIES FOR SOCKEYE

WASHINGTON STATE DEPARTMENT OF FISHERIES
CHIWAWA PONDS
2640 KINNIKINNICK DR.
LEAVENSORTH, WA 98826
BY MARC BABIAR



Sockeye salmon have declined in numbers from past levels. In the mid-1900s, construction and operation of hydroelectric dams resulted in the blocking of adult passage and in the mortality of outmigrating juveniles. Recently, the power companies are helping to renew the historical levels of runs.

Our goal at the Lake Wenatchee net pens is to enhance the already natural sustaining runs. This project started in 1989, and hence are the data and strategies used at net pens. All the funding is provided by Chelan Co. Public Utility District.

Lake Wenathcee Sockeye
1989 to 1991 Data
Data complied by W.K. Duplaga

Adults	'89	'90	'91
Arrivals	July/Aug.	same	same
Trapping	3rd July	same	4th July
M/F ratio	1:1.12	1:1.01	2.68:1
Spawn. ratio	1:1	same	1.23:1
Ave. wt.	3 lbs	same	3-3.5 lbs
No. trapped	291	333	357
% prespawn survival	66m/41f	96m/96f	91m/92f
Female spawned	57	150	89
Male spawned	58	152	110
% held at once	100	100	100

SPAWNING/INCUBATION			
Take dates	9-26,28	9-17,24,27	9-23,25,30
	10-2	10-1,4	10-2,6
M/F ratio	1:1	same	same
Pools/incubator	2f	4f	3f
Incubator type	Iso. buckets & Vert....................................		
	43/38F	same	same
	2600	2255	est. 2300
% loss			
fert. to eye	13.9	12.9	
eye to ponding	5.5	2.8	
ponding to release	1.3	1.95	

RELEASE		
Date	10-24-89	10-19-91
No./size	107000wdf/25fpp	270802 wdf/24fpp
	153400nmfs/25fpp	1011000 nmfs/63fpp

REARING AND SPLITS

Initial Population	fpp	Mess	Cuft.	Starting density	fpp	Ending density
92000	3500	1/16"	1900	.014	800	.06
	3500	1/16"	1900	.014	800	.06
92000	3500	1/16"	1900	.014	800	.06
First split ---roll over into 3 pens						
92000	800	1/8"	7400	.016	100	.12
Second split * TAGGING TO OCCUR * split into 6 pens						
46000	100	3/16"	7400	.062	50	.12
Final split ---roll over into 6 new pens						
46000	50	1/4"	7400	.12	25	.25

FOOD CONVERSIONS AND LAKE TEMPS.
Overall conversion 1.2:1

FEEDS	CONV.	FPP
Bio. #2	.9	3500--1200
Bio. #3	.9	1200--600
Bio. 1mm	1.01	600--400
Bio. 1.3mm	1.06	400--250
Bio. 1.5mm	1.06	250--150
CMP 3/32	1.25	150--50
CMP 1/8	1.34	50--25

TEMPS	
April	41-45
May	41-50
June	45-55
July	50-60
Aug.	55-65
Sept.	58-65
Oct.	50-58

DISEASE
---Inoculate adults (Ery) BKD
---Columnaris juveniles (TM)
Note: The success that we have is attributed to net pen managment tech. and low densities.

Contact for: net pens
FischTechnik -Fredelsloh
Dr. Gerhard Mueller
D-3413 Moringen W. Germany
Tele. # +49/55-55-5288

nets
LFS Inc.
(206) 789-8110   1-(800) 647-2135

Mark Babiar (WA Dept. of Fisheries, 115 GA Bldg., Olympia, WA 98504); Wenatchee River sockeye project update. *Lake Wenatchee is 575 miles from the ocean. The net pen site at the lake is 0.75 miles off-shore. Adult sockeye enter freshwater in May/June. They are trapped about 20 miles from the lake in July, and are held in pens that are 20' deep. The adult fish are still bright when they are trapped. After capture they were injected with antibiotics against BKD. The stock is infected with IHN. About 8% of the adults were lost while being held for ripening.*

Eggs and milt (oxygen added) were put in plastic bags, packed in ice, and transported 50 miles to the hatchery for egg fertilization and incubation.

The fry were started on BioDiet #2 starter. The initial rearing density was (low) 0.014 lbs/ft^3*. The temperature of rearing water varied from 50 F to 65 F. The density of fish immediately prior to release was 0.25 lbs/ft*^{3}*. Overall conversions were about 1.2 lbs of feed / 1 lb of fish. The total loss of fish from ponding to release was only 1.95%. A number of the fish were tagged in August when they weighed about 3 g. The fish were released in October (371,000 presmolts).*

Net mesh sizes during rearing: 3500/pound, 1/16" mesh; at 800/pound, change to 1/8" mesh; at 100/pound change to 3/16"; and, at 15/pound, 1/4".

About 8,000 of the adult sockeye were captured in a one month sport fishery. The adult fish weighed between 3 and 3.5 pounds each. The daily limit per fisher was 3 fish.

Underyearling Smolt

Bill Halloran (SSRAA, 1621 N. Tongass Ave. Room 103, Ketchikan, AK 99901). SSRAA Underyearling Sockeye Smolt Program Update. *The hatchery is functionally IHN-free. The underyearling smolt program was started in 1985 with several families of fish. The outmigrants of the wild stock (donor stock) were predominantly yearling smolt.*

The larger smolts proved to have a better chance of surviving to adult to a certain point. Was it size or age that influenced survival? Looking at what had happened, it appeared to be size more than age.

Initially, sockeye fry were placed in seawater at 1.5 g. The hatchery was short on freshwater rearing space so we began to place the fry in seawater at 0.6 g, and the fish did much better.

The next step was the introduction of a heat exchanger, that raised the water temperature from 2 C to 4 or 5 C. We refined our goals and have attempted to release 6 g underyearling smolts. In 1989, 1990 and 1991 smolt were released at what we feel is the optimal window, just prior to June 7. We assume a 6% survival from optimally released smolt to adult. the first adult returns that can be used to evaluate the assumptions will occur in the summer of 1992.

Bill Heard (N.O.A.A. P.O. Box 1155, Auke Bay, AK 99821). Auke Creek Underyearling Smolt Research Update. *Auke Creek is a small coastal system. The Auke Creek Hatchery and weir are operated as an interagency effort of about 18 separate research projects including all five species of salmon and cutthroat trout. The sockeye run got very low, to about 250 fish in 1985. Age-0 smolt culture was started with the 1986 brood.*

The Age-0 Program. The water in Auke Lake is cold through the winter (3-4 C). Accelerated development depends on warmer creek water in the fall and spring. Three strategies have been used: rear fish in seawater, rear fish in freshwater, release presmolts (August) in Auke Lake. Growth rates on 0's is slower in seawater than in freshwater.

Salient points:

- *Feel it is critical to release smolts by June 21.*
- *No difference in the timing of adult returns between 0's and wild fish.*
- *Have tried a late summer smolt release, but the adults are still at sea.*
- *In 1991, the returns from 3-ocean adults and wild fish were about the same.*
- *(Question whether) Is it really better to produce age-0 or yearling smolts.*

Kodiak Underyearling Sockeye Investigations and Broodstock Development

by

Steve Honnald and Lorne White
Alaska Dept of Fish and Game
Commercial Fisheries Management and Development Division
211 Mission Road
Kodiak, AK 99615-6399

The Kodiak underyearling sockeye program was initiated in 1988 after investigations revealed a significant portion of the late-run sockeye at Upper Station Creek were underyearlings. Historically, approximately 24% of the total late run at Upper Station have been underyearlings. Broodstock development, the objective of the Kodiak underyearling program, began in 1988 when 227,000 Upper Station underyearling eggs were collected and incubated at Kitoi Bay Hatchery.

In mid July 1989, 150,000 smolt, ranging from 2.0 to 2.8 grams, were released at Big Kitoi. Underyearlings were reared in salt water net pens prior to release. Release timing paralleled the wild underyearling smolt outmigration at Upper Station. Preventative booms were in place in response to the Exxon Valdez oil spill, creating a fresh water lens in the area of net pen rearing. Fry performed well when reared in salt water net pens and may have been aided by the fresh water lens created by the oil booms.

In 1989, 5.3 million Upper Station underyearling eggs were collected. In July of 1990, approximately 800,000 smolt were released into Little Kitoi Bay. Minimal boom material was employed to retain a fresh water lens during the 1990 rearing period. Consequently, survival decreased.

In 1990, 2.1 million underyearling sockeye eggs were collected from Upper Station. Fry were reared in fresh water until reaching 0.35 grams and then salt water reared until release into Little Kitoi Bay. Release size ranged from 2.4 to 3.7 grams. Three booms were used in Little Kitoi estuary to retain fresh water and maintain moderate to low salinities (< 20 ppt @ 0.5 m depth). The fresh water lens created by the booms appeared to enhance rearing survival which was 99.5% in 1991.

To date, returns from BY 1988 have not occurred, however small release numbers and species mixing may have masked the small expected returning adults. Returns expected at Little Kitoi Bay from BY 1990 and 1991 underyearling smolt releases should be approximately 55,000 in 1992 as well as in 1993.

Finally, initial results from study of the marine environment at Olga Bay donor system and Kitoi Bay recipient system indicate differences in temperature and salinity. Mean temperatures at Olga Bay were slightly warmer than those at Kitoi Bay in 1990. Salinities at Kitoi Bay were approximately 8 ppt higher than at Olga Bay in 1990.

Kitoi Bay Hatchery Incubation and Rearing Information

BY 1988: 227,000 Upper Station sockeye eggs;
150,000 fry ponded at 0.20 to 0.42 g;
99.3% survival to release into Big Kitoi Bay at 2.0 to 2.8 g;
Oil spill booms created a fresh water lens, 7 ppt to 19 ppt at 1 foot depth and 24 ppt to 25 ppt at 3 to 6 feet in depth; and,
No returns observed to date.

BY 1989: 5,300,000 Upper Station sockeye eggs;
2,000,000 fry ponded without freshwater rearing @ 0.15 to 0.18 g; and
15% survival at release into Little Kitoi Lake.
1,150,000 fry ponded after 29 to 40 days of rearing in freshwater @0.42 to 0.47 g;
70% survival at release into Little Kitoi Bay; and
Little Kitoi Bay not fully boomed off, salinity 14 ppt at surface and 25 to 31 ppt at 3 to 6 feet in depth.
250,000 fry released into Spiridon Lake; and
No smolt outmigration from Spiridon Lake in 1990.

BY 1990: 2,100,000 Upper Station sockeye eggs;
1,500,000 fry ponded after 23 to 35 days of rearing in freshwater @ 35 g; and, 99.5% survival through 15 to 29 days of saltwater rearing to release into Little Kitoi Bay @ 2.4 to 3.7 g.

Significant events for BY 1990 fish:

- late emergence (30 May 1991),
- eggs received later,
- lower water temperatures than previously experienced (2.2 C in April and 4.5 C in May),
- excessive rainfall,
- three oil booms deployed in Little Kitoi Estuary to a three foot depth, inside the booms there was an 18 to 20 inch lens of <20 ppt while outside the booms the similar lens was only 6 inches deep and was nonexistent when normal storm winds were active,
- the lens of <20 ppt water decreased to a depth of 6 inches inside the booms after 7 July, and,
- the pens were placed inside the booms with an initial net depth of 4 feet, and the net was gradually lowered through rearing.

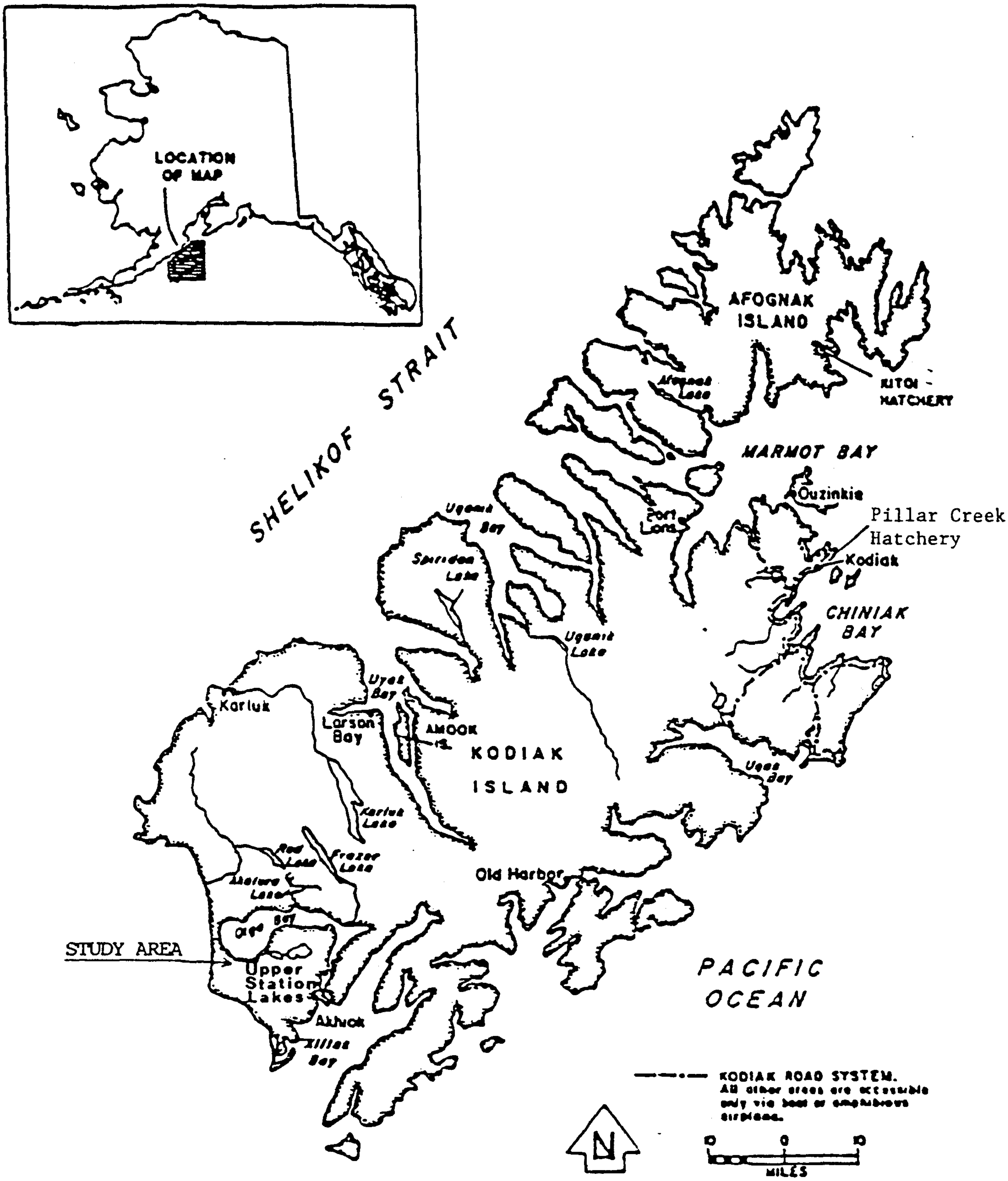
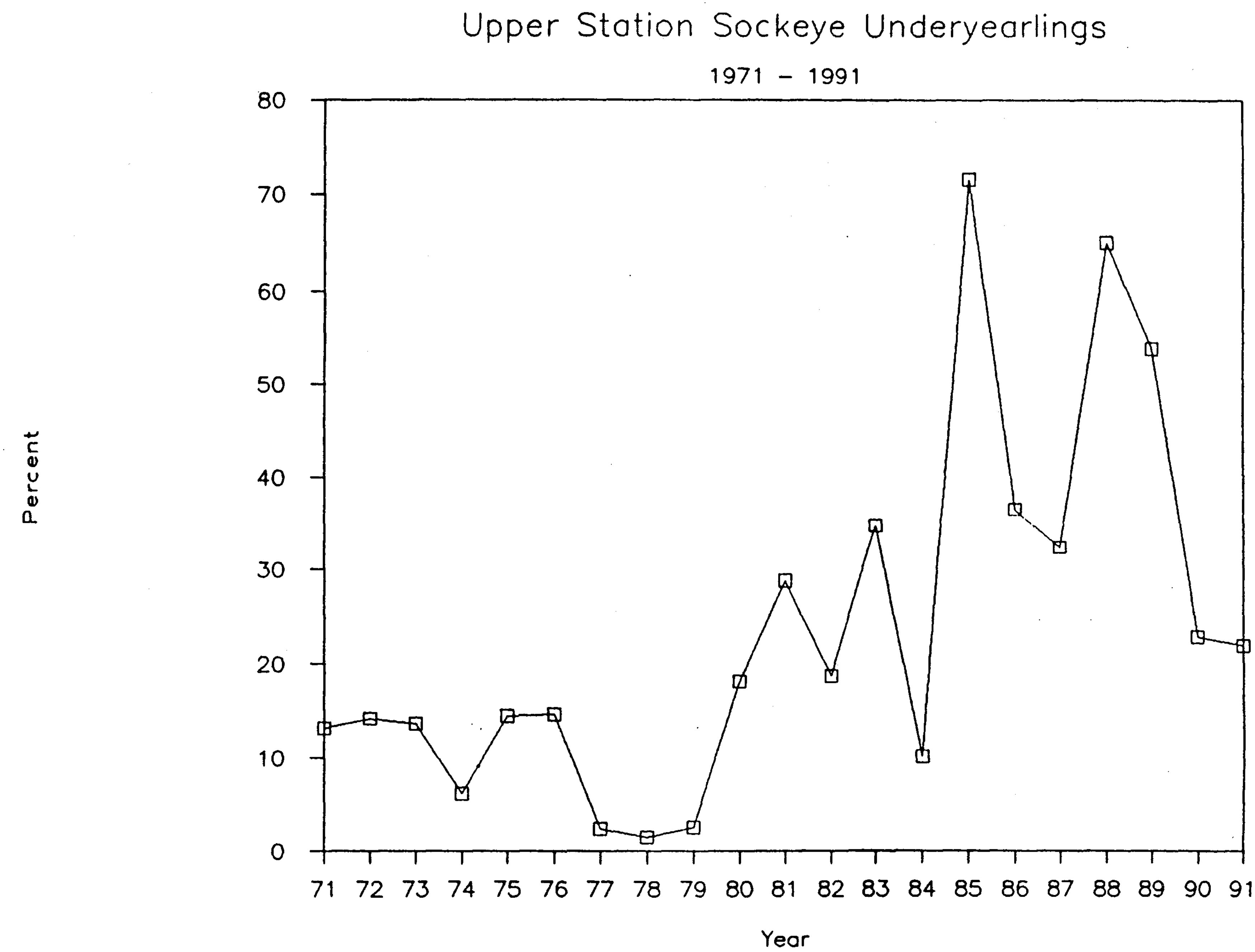
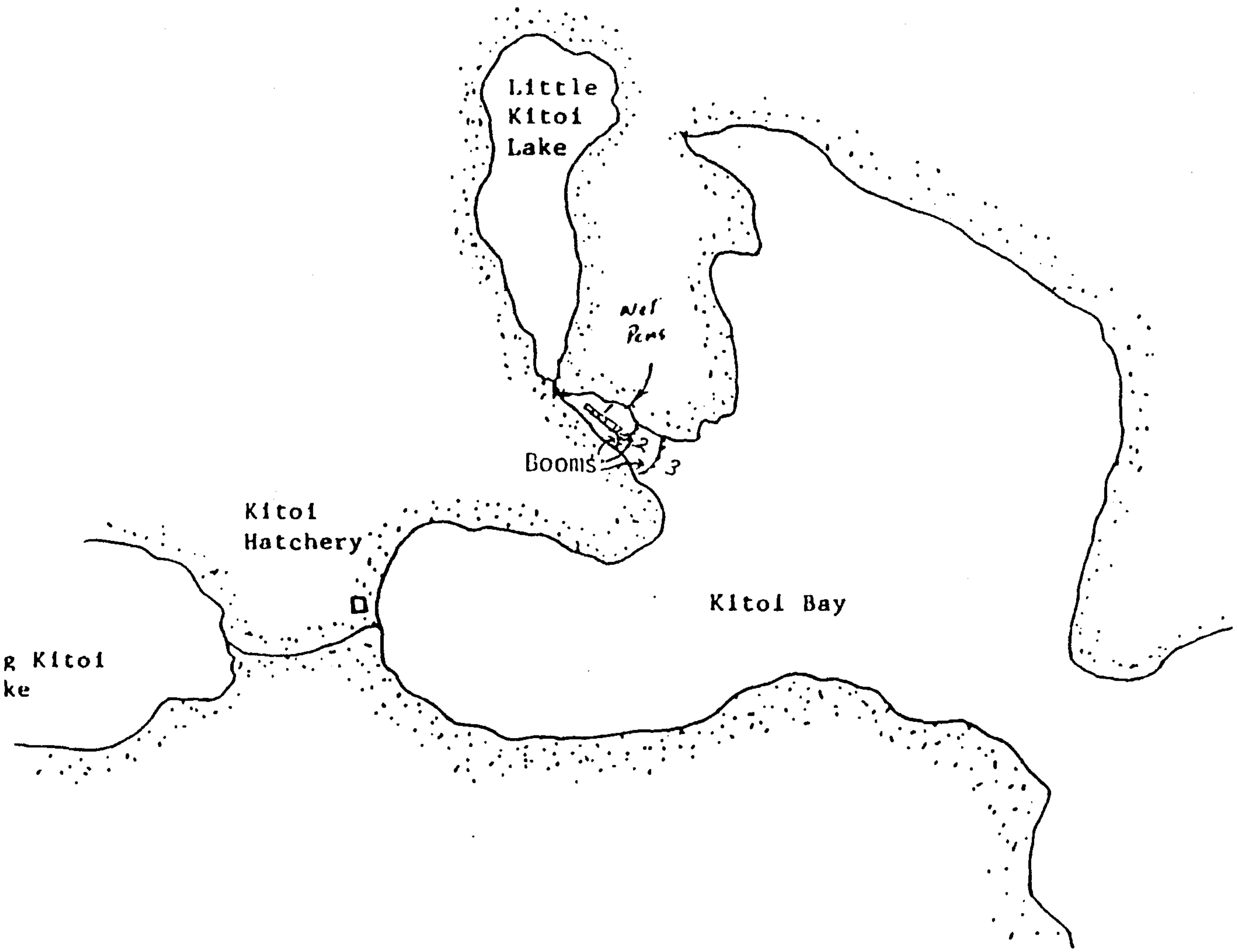


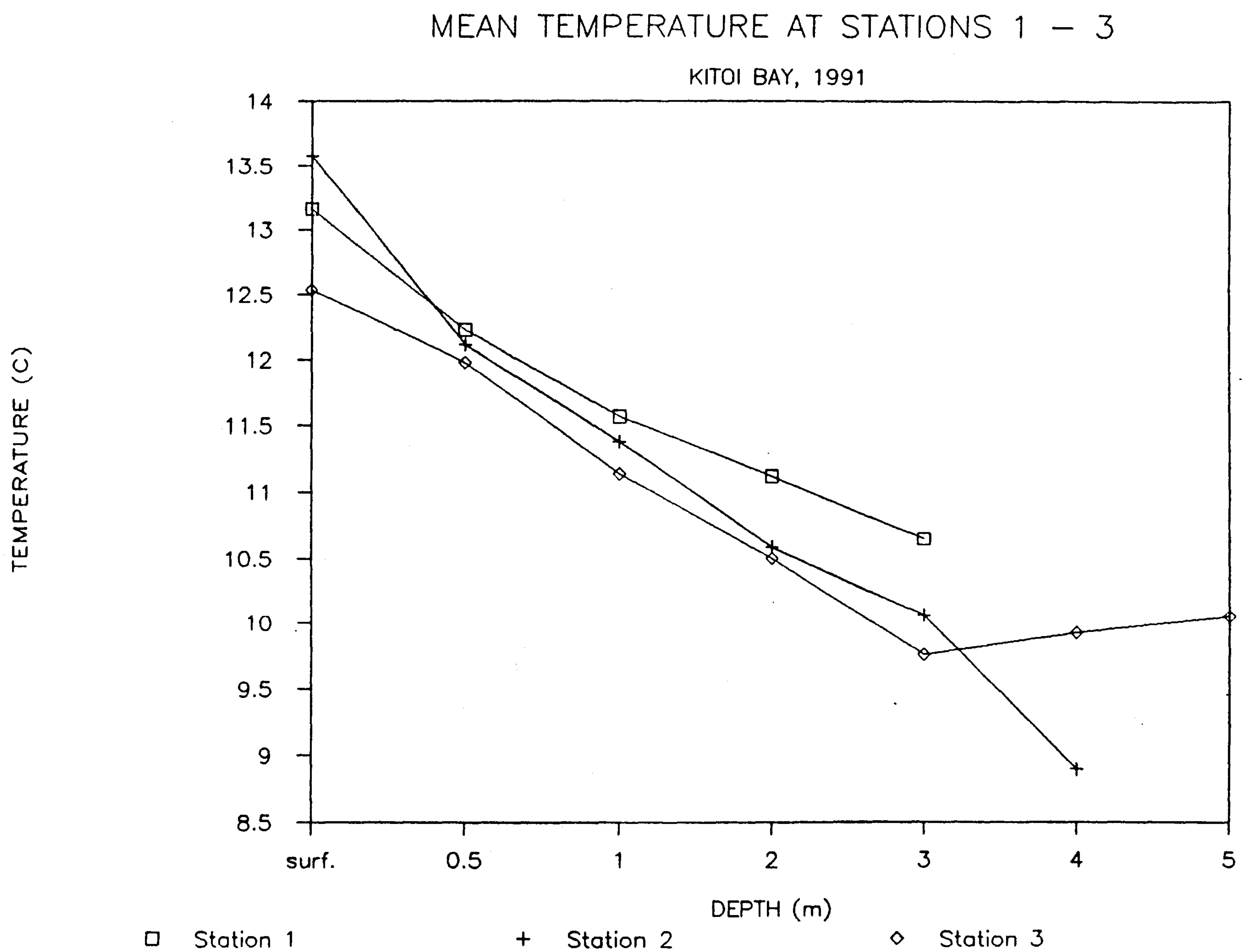
Figure 1. Area map of Kodiak and Afognak Islands showing location of Olga Bay, Upper Station Lakes, Kitoi Bay Hatchery, and Pillar Creek Hatchery.

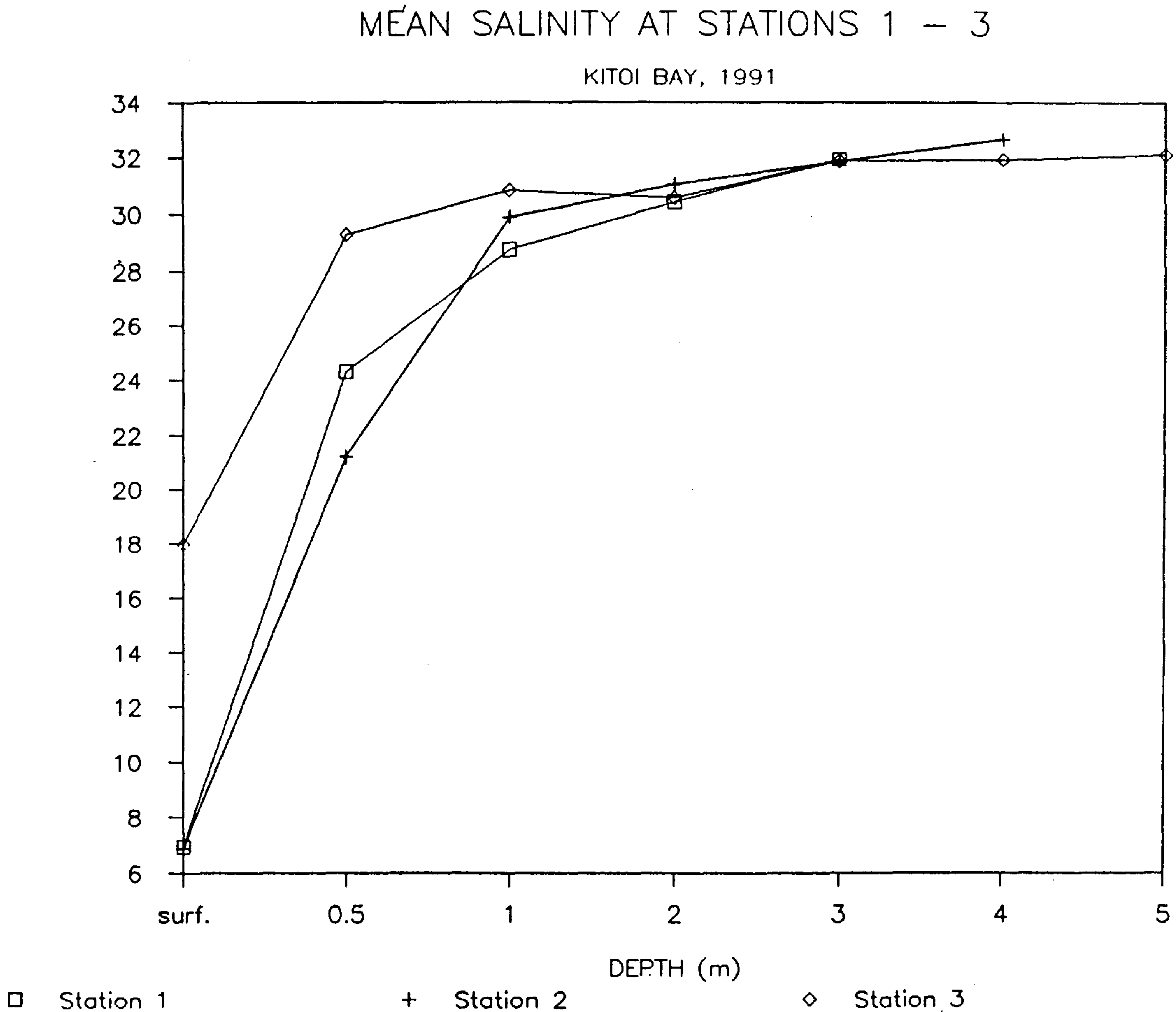


Upper Station Sockeye Underyearlings
1971 - 1991
Percent
0
10
20
30
40
50
60
70
80
71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
Year



KITOI BAY, AFOGNAK ISLAND - 1991


MEAN TEMPERATURE AT STATIONS 1 – 3
KITOI BAY, 1991
TEMPERATURE (C)
14
13.5
13
12.5
12
11.5
11
10.5
10
9.5
9
8.5
surf.
0.5
1
2
3
4
5
DEPTH (m)
Station 1
Station 2
Station 3



MEAN SALINITY AT STATIONS 1 - 3
KITOI BAY, 1991
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
surf.
0.5
1
2
3
4
5
DEPTH (m)
Station 1
Station 2
Station 3

UPPER STATION LAKES, KODIAK ISLAND

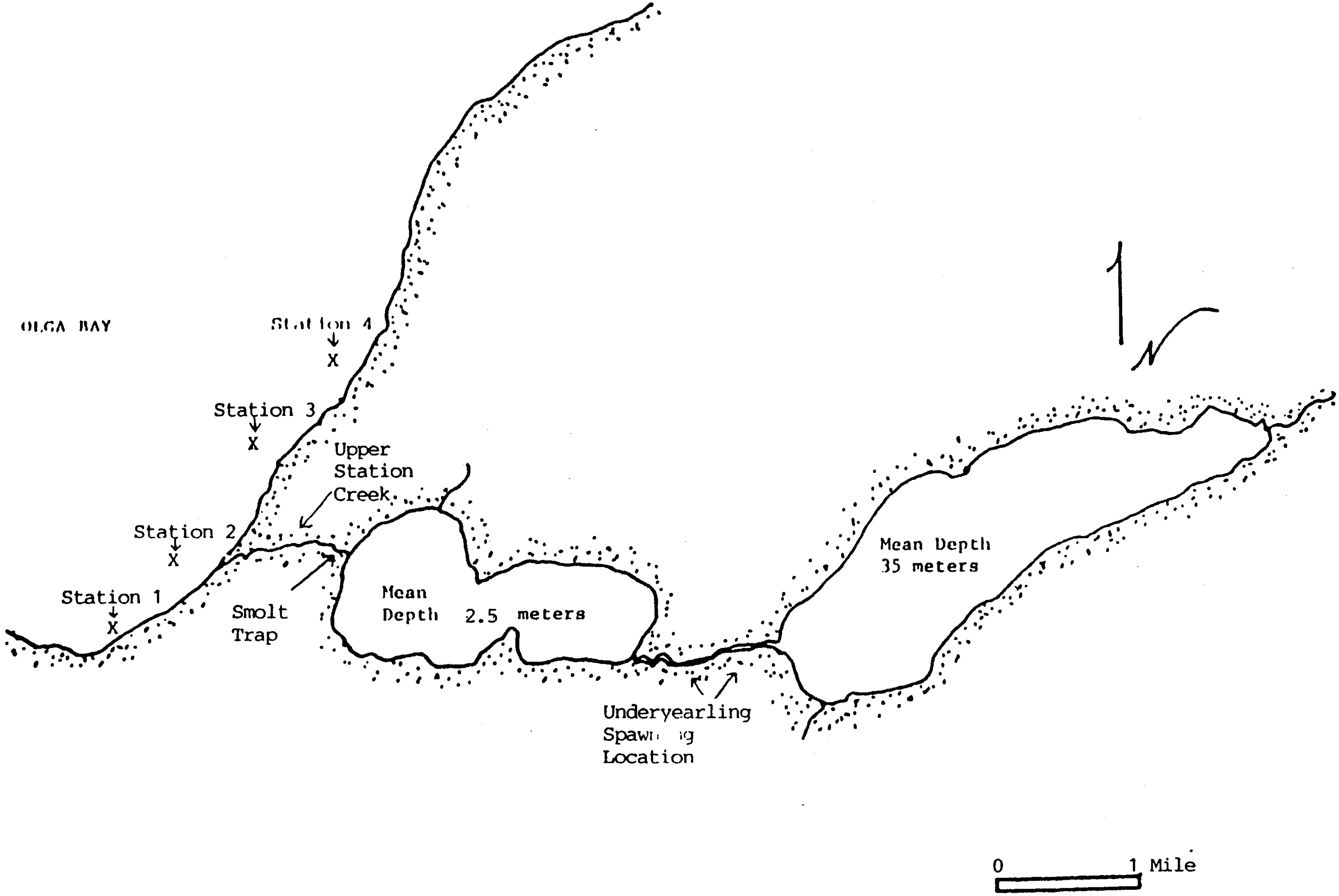
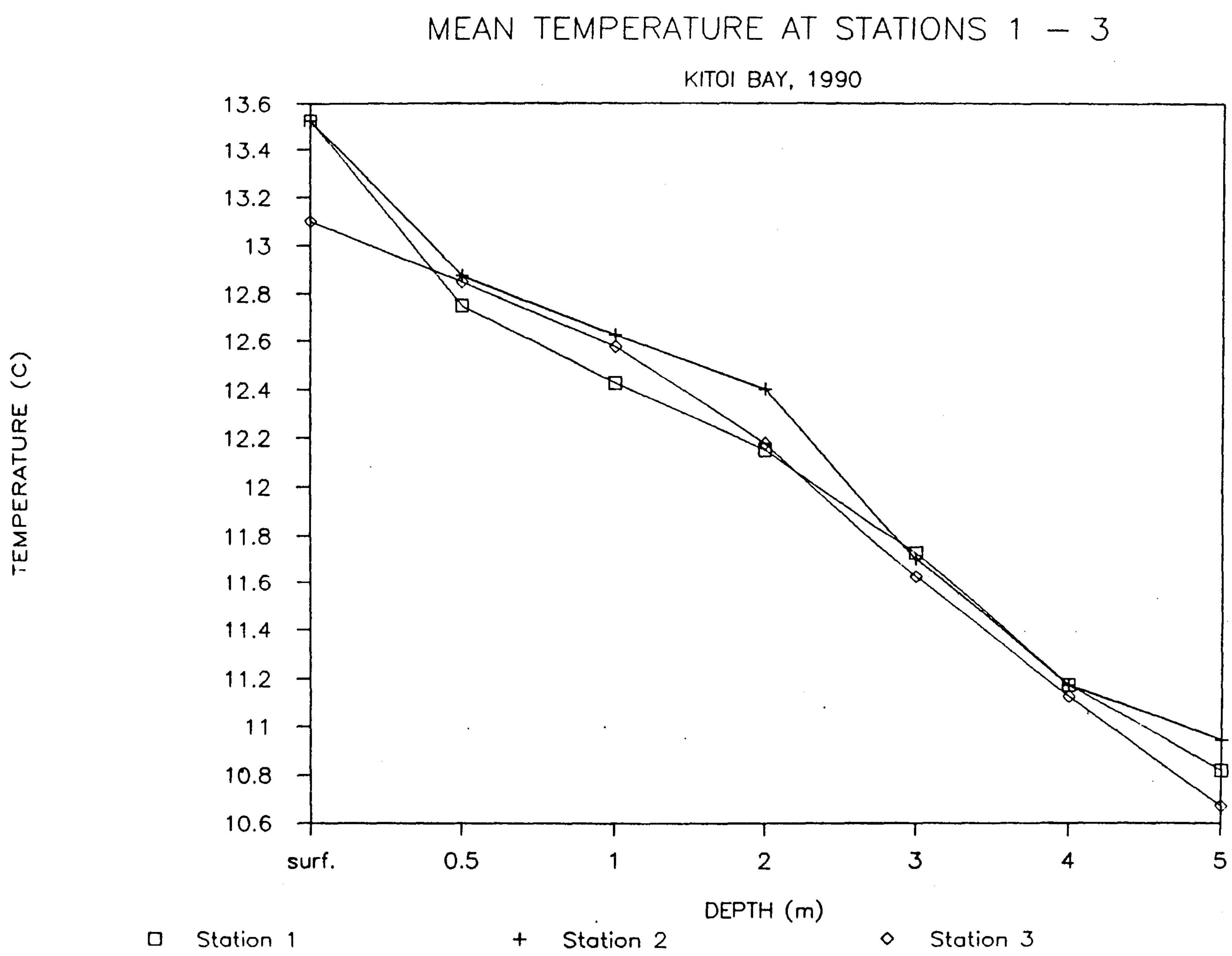
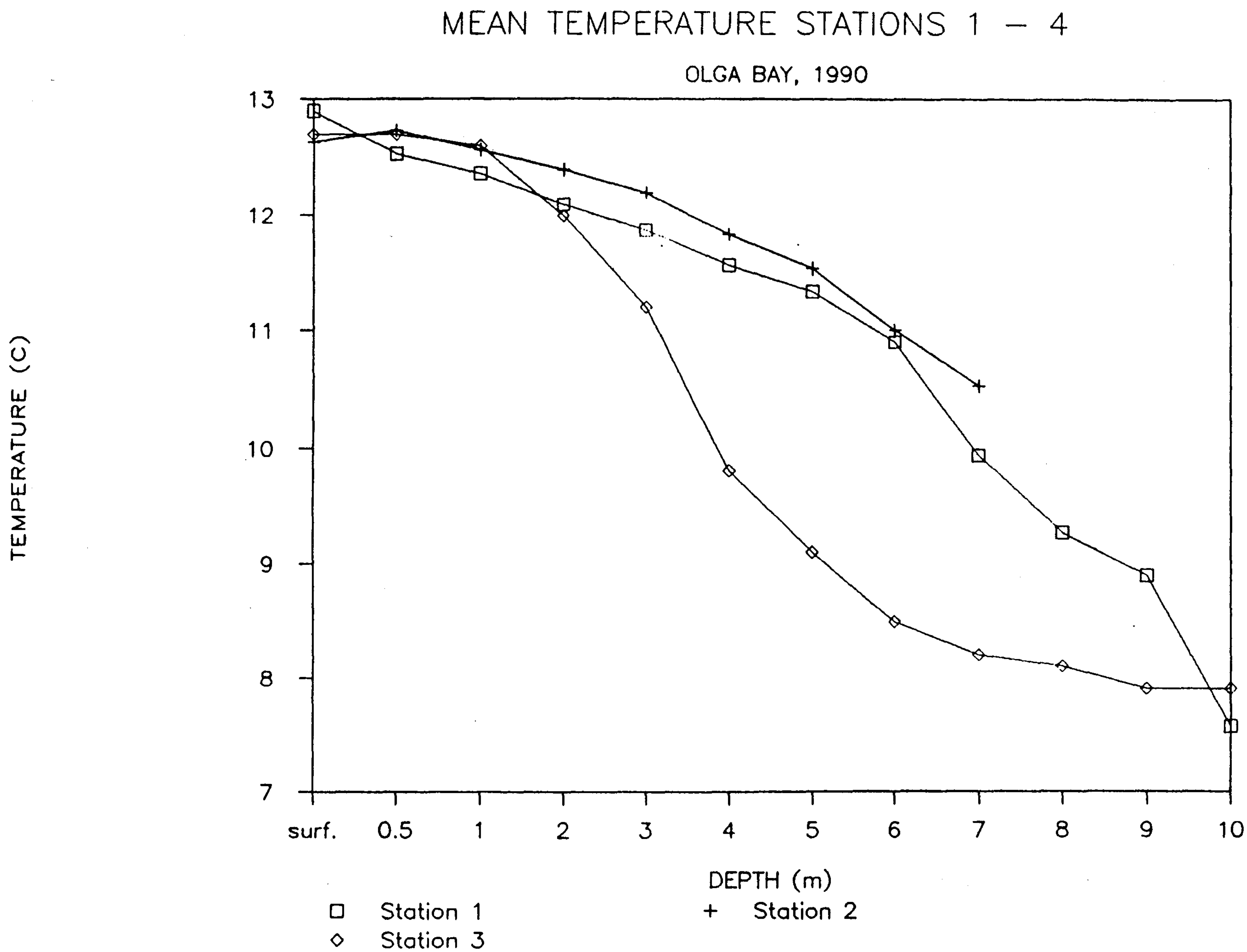
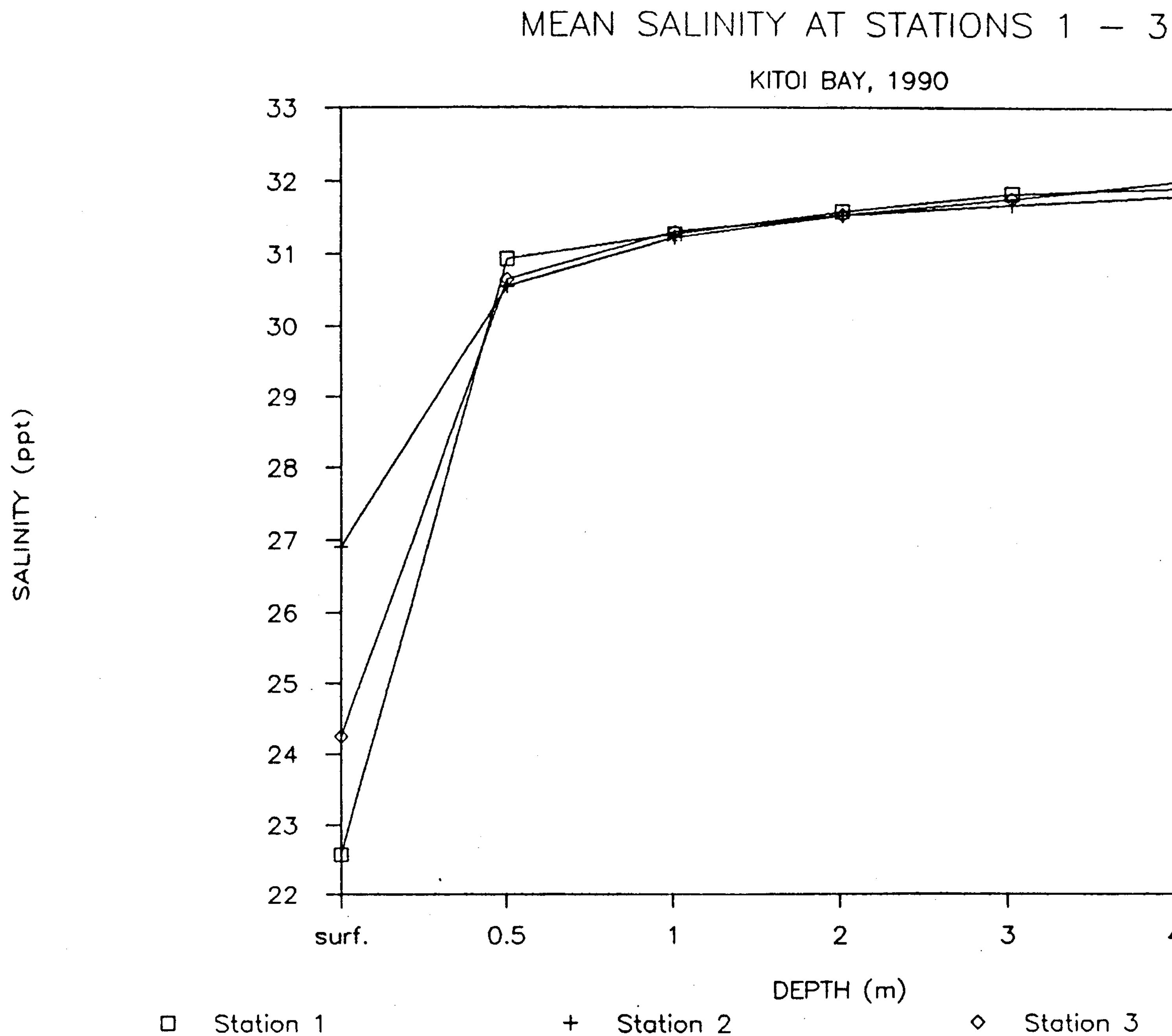


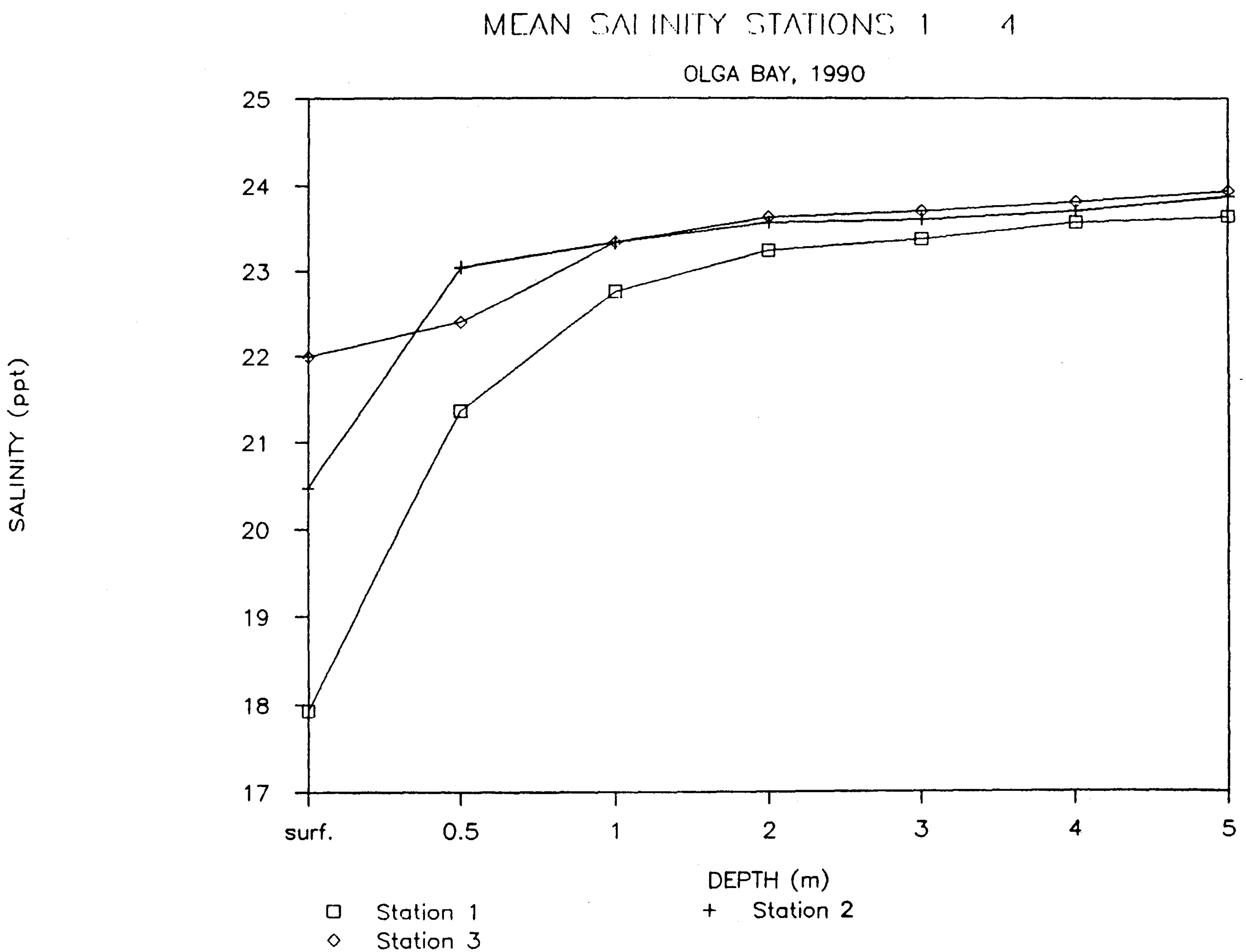
Figure 2. Upper Station Lakes, Upper Station Creek, Olga Bay showing sampling stations, smolt trapping site, and underyearling spawning location.

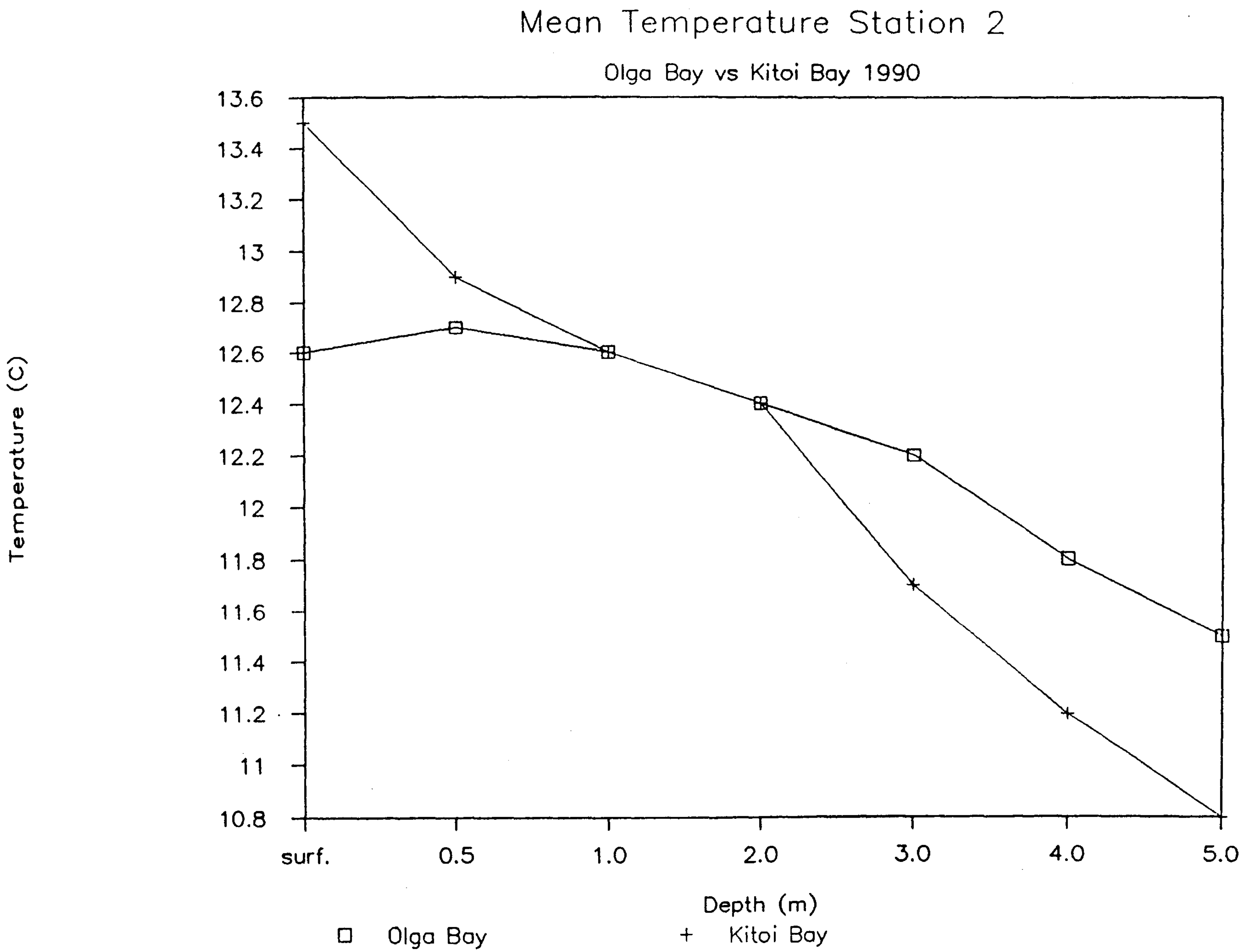


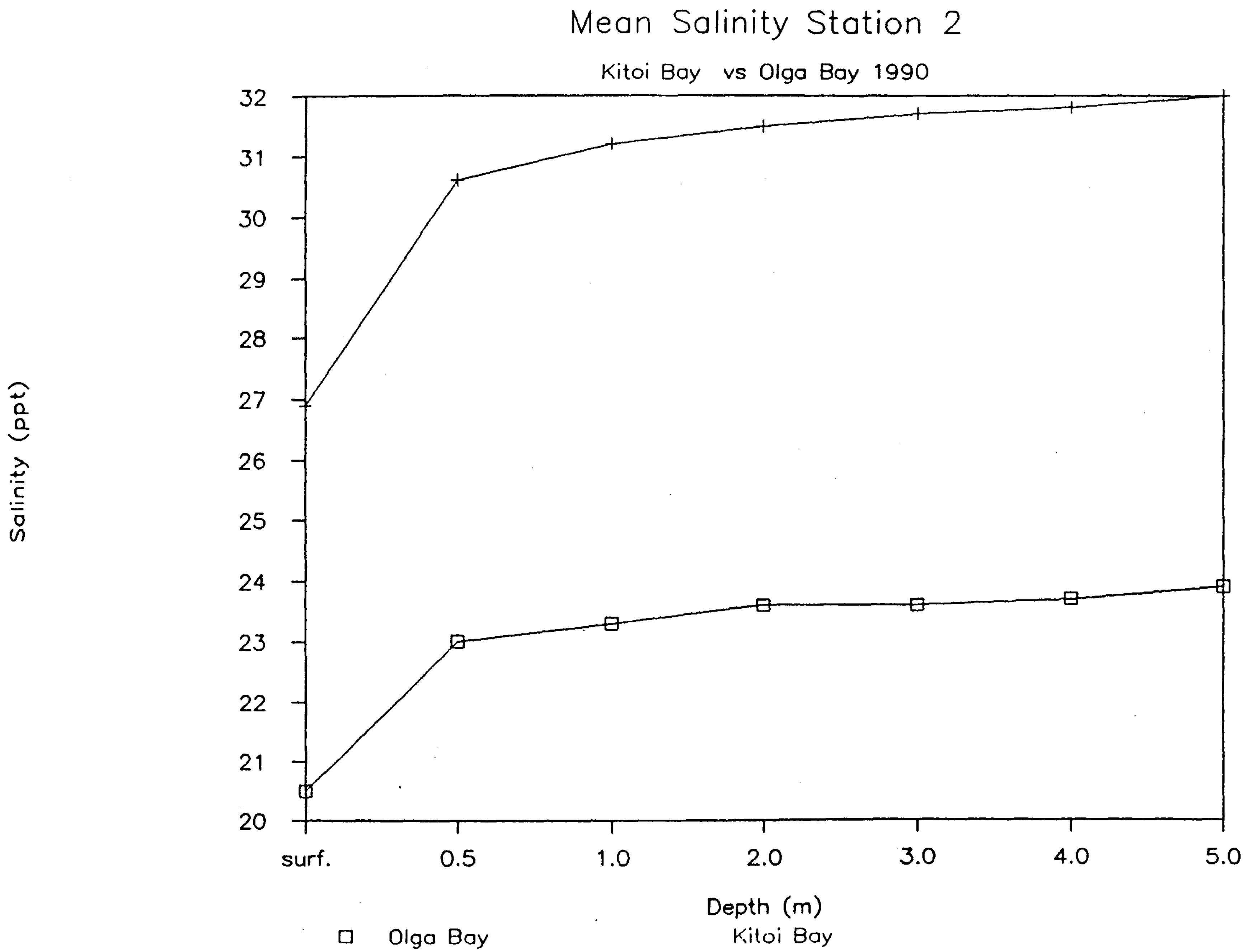
MEAN TEMPERATURE AT STATIONS 1 – 3
KITOI BAY, 1990
TEMPERATURE (C)
13.6
13.4
13.2
13
12.8
12.6
12.4
12.2
12
11.8
11.6
11.4
11.2
11
10.8
10.6
surf.
0.5
1
2
3
4
5
DEPTH (m)
Station 1
Station 2
Station 3


MEAN TEMPERATURE STATIONS 1 – 4
OLGA BAY, 1990
TEMPERATURE (C)
13
12
11
10
9
8
7
surf.
0.5
1
2
3
4
5
6
7
8
9
10
DEPTH (m)
Station 1
Station 2
Station 3


MEAN SALINITY AT STATIONS 1 – 3
KITOI BAY, 1990
SALINITY (ppt)
33
32
31
30
29
28
27
26
25
24
23
22
surf.
0.5
1
2
3
4
5
DEPTH (m)
Station 1
Station 2
Station 3


MEAN SALINITY STATIONS 1 4
OLGA BAY, 1990
SALINITY (ppt)
25
24
23
22
21
20
19
18
17
surf.
0.5
1
2
3
4
5
DEPTH (m)
Station 1
Station 2
Station 3


Mean Temperature Station 2
Olga Bay vs Kitoi Bay 1990
Temperature (C)
13.6
13.4
13.2
13
12.8
12.6
12.4
12.2
12
11.8
11.6
11.4
11.2
11
10.8
surf.
0.5
1.0
2.0
3.0
4.0
5.0
Depth (m)
Olga Bay
Kitoi Bay


Mean Salinity Station 2
Kitoi Bay vs Olga Bay 1990
Salinity (ppt)
32
31
30
29
28
27
26
25
24
23
22
21
20
surf.
0.5
1.0
2.0
3.0
4.0
5.0
Depth (m)
Olga Bay
Kitoi Bay

Sockeye Fry Production

Carol Coyle (Alaska Dept of Fish and Game, Commercial Fisheries Management and Development Division, P.O. Box 240020, Douglas, AK 99824). Snettisham Central Incubation Facility (CIF) Update (Thermal Tagging). *The CIF is involved in the enhancement of two US/Canada transboundary river systems, the Taku and Stikine. Up to 6 million eggs will be taken from each system. The enhanced adults will be harvested by both US and Canadian fishers (50/50 split).*

Programs at Snettisham have also been designed to enhance or maintain local Port Snettisham stocks at Speel and Crescent Lakes.

Program challenges:

- *To delay the development of eggs and alevins so that emergence at the hatchery will correlate with ice-out at high elevation Canadian lakes. Incubation water was chilled to retard development, which still results in a guessing game as to when the lakes will open.*

- *The mass marking of fry so that enhanced fish can be identified in mixed stock fisheries--the application of thermal tagging. The fish have been successfully tagged with thermally induced bands on the otolith. All of the fish have been marked.*

- *The high altitude, 6,000 to 7,000 ft, aerial transport of fry to Canadian lakes. Lots of oxygen is applied at the start of the transport. The flow is turned down as the plane ascends. The rate of ascent is 100 ft/min. The flow of oxygen is once again increased as the plane levels in flight. Fry are transported at densities of 0.5 to 1.0 lbs/gal.*

- *Poor quality hatchery water at Snettisham. We encountered low DO's and silt as one of the water supply lakes was drawn down for the first time by the powerplant at the site. This lake (Crater Lake) was situated so that it did not seasonally "turn over" and deeper water had very little oxygen. The water was mixed with water from a second lake to moderate the situation. The hope is that once the lake refills, it will be closer to normal (water quality).*

Time and temperature are both important to developing fry. If the water temp is held at 4 C, 900 CTU's are required for emergence. If the water temperature is 2 C, 600 CTU's are required.

Sockeye Salmon Maturation at Redoubt Lake

by

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Adult sockeye salmon were collected at a weir on Redoubt Lake, Baranof Island, and held at the lake in net pens for sexual maturation. Two capture dates were selected (1 August and 15 August) within the escapement period of 15 June through 7 September. Each group from the two capture dates was divided equally (males and females held together) and placed in individual n et pens. Treatment for half the sockeye from each entry date was injection of Luteinizing Hormone Releasing Hormone antigen (LHRHa); the remaining sockeye received no injection of LHRHa (control groups). Injections of LHRHa were given on 12 and 16 September to 100 males and females from the 1 August captive group and 50 males and females of the 15 August captive group.

The fish were checked for condition, mortality and ripeness at 2 and 3 week intervals. On 12 September, mortality varied from 16% to 32%, with the sockeye from the latter entry date showing the highest mortality (x = 32%). By 30 September, sexually mature fish occurred in all four groups but was more prevalent in the 1 August groups; however, numbers were small (30 fish) and represented only 10% of captive sockeye. Greater numbers of males reached sexual maturity than females, 25 and 5, respectively. No difference in sexual maturity appeared between the control and treatment groups for the 1 August or the 15 August cohorts. Cumulative mortality through 30 September was 31% (range 22% to 46%).

The sockeye were not graded for sexual maturity again until 21 October, at which time an additional 47 sockeye (35 males and 12 females) were ripe. The cumulative total for sexually mature fish through 21 October was 77 sockeye or 25.7% of the initial 300 fish held captive. Again, greater numbers of males ripened than females; 60 and 17 respectively. Little mortality occurred during the 3 week period from 30 September to 21 October. During this period, as before, there appeared to be no difference between the control and treatment groups with regard to sexual maturation and mortality.

Differences in mortality and sexual maturity do become apparent when comparing the entire 1 August cohort with the 15 August cohort. Mortality (43%) was higher in the 15 August group than in the 1 August group (29%). By 21 October, a greater percentage of the sockeye reached sexual maturity in the 1 August group (29%) than the 15 August group (19%), which may be due to their additional 2 weeks of ripening in the lake rather than other variables.

Final observations were made on 6 November, at which time an additional 57 sockeye (32 males and 25 females) were found to be sexually mature. The remaining 51 green fish were comprised of 48 females and 3 males. The majority of these fish were near ripe, that is, 2 to 3 weeks from full sexual maturity. However, because of the time of year, it was decided to release the remaining 51 sockeye.

Cumulative sexual maturation by 6 November was 48%, of which 92 were males and 52 were females. No difference existed between the injection groups and the control groups. However, more males ripened than females, a trend that became apparent early on in the experiment. By 6 November only 3 males were judged to be green of the original 150 males.

During the period from 21 October to 6 November an additional 5 sockeye died, of which 4 were form the hormone injection groups. Cumulative mortality at the time of release was 35.7% (range 30% to 48%). Mortality was highest in the 1 August group (46%).

Conclusions: Holding sockeye at Redoubt Lake for 3 months or more yields unacceptable levels of mortality. However, this mortality occurs in the early stages of holding (first 45 days). If the early mortality could be eliminated it may be feasible to hold and ripen adequate numbers of sockeye. Several things can be attempted to lessen this mortality, such as prophylactic treatments, lesser net surface area to net volume and selecting blush fish from bright fish if possible.

The hormone LHRHa did not appear to induce sexual maturation in the Redoubt Lake sockeye. No significant difference appeared between the control and injection groups for either entry date.

Using deep nets appears to be important, as the sockeye selected a holding depth between 30 and 40 feet from the surface in both 1990 and 1991 experiments. Sockeye were observed coming to the surface for air but were never seen to reside there.

Sockeye from the 1 August entry date survived better and ripened sooner than the 15 August group, and therefore the fish from the mid-date of escapement or earlier should be used for captive maturation.

Recommendations: Capture sockeye between 15 July and 1 August for use in broodstock maturation. This will likely increase survival and move the spawning date earlier in the season.

Use a blocking net that is at least 40 feet deep and some 300 feel long to contain the sockeye. The location for deployment will need to be exacting so as not to catch the net on debris. A blocking net will provide 2 elements which should promote maturation and decrease mortality - a natural bottom and less net surface area to volume. Experiment with holding sockeye in saltwater with a freshwater lens. This may reduce problems with fungus, yet still allow fish to seek freshwater. However, this eliminates the possibility of the sockeye holding in cooler, deep freshwater.

Maturation of Sockeye

Pen #	30 Sept cumulative %	21 October cumulative %	06 November cumulative %	06 November green sockeye %
1 control	11	34	56	18
2 LHRHa	13	24	52	16
3 LHRHa	6	20	34	18
4 control	6	18	38	16
Total	$\bar{x} = 10$	$\bar{x} = 32$	$\bar{x} = 48$	$\bar{x} = 17$

Table 2. Percent of Redoubt Lake sockeye reaching sexual maturation at selected dates, 1991.

Mortality (cumulative)

Pen #	Total Numbers Male	Total Numbers Female	12 Sept Percent	21 Oct Percent	06 Nov Percent
1 control	11	19	23	29	30
2 LHRHa	15	17	16	29	32
3 LHRHa	6	16	32	42	48
4 control	11	11	32	44	44
Total	43	63	23.7	33.7	35.7
					% mort

Table 3. Mortality of Redoubt Lake sockeye, cumulative and as percent for August 1 to November 6 holding period, 1991.

Sockeye Maturation

Pen #	Date of capture	Captive Number	Mortality		Sexually Mature		Green as of 06 Nov	
			number	%	number	%	number	%
1 control	1 Aug	100	30	30	56	56	18	18
2 LHRHa	1 Aug	100	32	32	52	52	16	16
3 LHRHa	15 Aug	50	24	48	17	34	9	18
4 control	15 Aug	50	22	44	19	38	8	16
			$\bar{x} = 35.7$		$\bar{x} = 48$		$\bar{x} = 17$	

Table 1. Sexual maturation and mortality of Redoubt Lake sockeye from August 1 to November 6, 1991.

New Spawning Containers for Isolation and Disinfection

by

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Trail Lakes Hatchery conducts 5-6 remote sockeye eggtakes per year utilizing delayed fertilization. Survivals to eyeup have ranged from 62% to 88% with a mean of approximately 75%. Many factors contribute to the mortality including rough handling of broodstock, warm temperatures of the rivers and lake systems, lengthy transport time to the hatchery, and excessive handling during fertilization and water hardening in adhering to procedures outlined in the ADFG sockeye culture guidelines.

AquaSeed Corporation (*) markets a container for transport of eyed eggs which has been modified for use at remote eggtakes for Trail Lakes Hatchery. A colander insert with removable ends, is placed in a plastic jar with a screw top lid. Females are spawned into the containers which are then placed into the jars and sealed, keeping individuals separate for transport. Ovarian fluid is decanted from the jars prior to closing. Eggs are easily cooled and moisture maintained in the containers.

Fertilization is conducted at the hatchery. Sperm is poured onto the eggs and water added to the container for activation. After fertilization the colander is removed from the jar, the water and sperm drained and the jar refilled with 100 ppm iodophor. The colander is placed back into the jar for hardening.

This procedure was tried at several eggtakes during the 1991 field season. Results to eyeup will be available in January 1992.

(*) AquaSeed Corporation, 1515 Dexter Ave N, Suite 406, Seattle, WA 98109, (206) 283-4345

Ultraviolet Disinfection

by

Mike Blake

Ultraviolet disinfection is no stranger to most of us in the aquaculture industry. UV disinfection systems have been used for many years, with varying degrees of success, to control bacteria and pathogens in aquaculture installations.

Until recent technological developments were made all UV systems essentially shared the same technology using 60 watt Low Intensity, Low Pressure UV lamps arranged in bundles of as many as 24 amps in a single chamber. These systems are not always practical owing to the maintenance requirements and the difficulty of validating the system with UV intensity monitoring. In addition, the system requires internal cleaning periodically to maintain peak performance.

UV systems using High Intensity, Medium pressure UV lamps operating at 2500 watts require about 90% fewer lamps, provide accurate validation, and include automatic internal cleaning mechanisms to maintain the system in prime condition with little "Hands On" requirement. These systems are relatively simple to maintain and are physically smaller than their Low Intensity counterparts.

High intensity lamps show their full benefits at higher flow rates in excess of 250 gpm. High intensity lamps have allowed UV technology to be considered seriously when compared against other disinfection method.

Currently ozone is proving quite popular because of its effectiveness against viruses. Based on current information High Intensity UV is also proving effective against viruses provided the UV dose in maintained at a high level. Aquionics is currently recommending 175 mj/cm2 as a suitable UV dose to treat for viruses. Even at this higher dose UV is very competitive when compared with ozone and may be as little as 50-60% of the capital cost with lower operating costs an added benefit.

Open Forum

Ken Roberson, chair
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Adult Maturation.

M. LaRiviere. *Anadromous fish were collected and held in a 13' by 13' by 15' net pen in Lake Ozette. About 33% of the fish died prior to ripening (results similar to those reported earlier by Steve Reifenstuhl). There are lots of kokanee in the lake. The sockeye production of Lake Ozette is recruitment limited. There are many small streams around the lake with spawning populations of kokanee. Could those kokanee be used as a brood source to produce anadromous sockeye?*

The fish were successfully crossbred with anadromous sockeye. The offspring have grown well in water temperatures from 12 to 14 C.

B. Halloran. *SSRAA staff has been able to ripen adults in net pens.*

Editor. *There were numerous comments from the group. The general feeling was that in order to ripen adults in captivity it was probably important to mimic the natural behavior of the fish as much as possible. Don't leave net pens filled with adult fish out in the middle of a lake for several months. If possible place the fish near an inlet stream over gravel. The presence of spawning substrate may promote ripening.*

Egg Collection Methods.

J. Hetrick. *The concentration of iodophor required in the Alaska Sockeye Culture Policy is much greater than people use elsewhere. Water hardening of eggs with iodophor in an incubator may not give the full 100 ppm, but the dose may be sufficient.*

T. Meyers. *We must look at where the success has been. The sockeye work in the lower 48 has not had this success. We chose an initial 100 ppm (iodophor concentration) because it would allow the concentration to remain up and some significant amount of disinfectant would reach all eggs and spaces. The iodophor must kill or disable all virions (IHNV) prior to the virus reaching the micropyle and entering the egg.*

B. Halloran. *Has anyone rinsed eggs with artificial ovarian fluid to clean them?*

Clayton Brown. *Had tried an experiment with that several years ago.*

T. Meyers. *Ovarian fluid is loaded with virions. Anything you can do to get rid of the ovarian fluid will reduce your chances of IHN problems.*

T. Ellison. *The Broodstock Development Center (at Ft. Richardson Hatchery in Anchorage) successfully used a saline sperm extender. Also, there are many different commercial products that contain iodophor. They are not all the same. The staff at Klawock Hatchery (Prince of Wales Island, Alaska) had a bad experience disinfecting coho eggs (significant mortality) with one of these products.*

Dan Rosenberg. *That is correct.*

T. Ellison. *You should use care when selecting a product. Use what has been used successfully elsewhere.*

T. Meyers. *Some state procurement systems go to the lowest bidder, which can cause this sort of problem.*

D. Harding. *Buffering the iodophor is very important on soft water systems.*

K. Roberson. *Cut corners and you can end up with an iodophor only suited to clean gear. The cost can be significant. Can we afford to cut corners?*

B. Burkett. *I hope we are continuing to communicate the health hazards associated with the use of iodophor.*

D. Moore. *Use gloves. Iodophor is not used in foot baths. Do not spray iodophor. Provide as much ventilation as possible. Do not heat iodophor solutions. Some employees are so sensitized they cannot even be on station during an egg take.*

K. Hopper (WA Dept of Fisheries, 115 GA Bldg., Olympia, WA 98504). *We bought a cheaper iodophor to disinfect gear. People had so many health problems with it that we gave up on it. Also, 25 ppm will kill the virus, but we chose to use 100 ppm as the disinfectant concentration varies within containers and lots of iodophor will insure disinfection. We water harden eggs (in iodophor) in the largest container that can be effectively used and move that to the incubator.*

K. Roberson. *If you deal in a large enough scale there will be some occurrence (of IHN) regardless of iodophor strength. None-the-less, we can "farm around" IHN and have successful egg takes.*

Sockeye Bioenhancement, Rehabilitation, Life History, and IHNV

Snake River Sockeye Salmon Restoration

by

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Historically, the five Stanley Basin Lakes in Idaho produced thousands of adult sockeye salmon which migrate 900 miles from the marine environment. These populations were unique in their distance of migration, spawning at 6000 ft elevation, and occur at the most southerly latitude in the northern hemisphere. Construction of dams on the Columbia, Snake, and Salmon Rivers have dramatically reduced adult sockeye numbers. Currently eight reservoirs are in the migration route to and from the ocean. Loss estimations for outmigrating smolts is 97% and about 50% for adults counted over Lower Granite Dam. These constraints and run numbers below 10 fish prompted a petition to list the Stanley Basin Sockeye as an endangered species. NMFS has ruled that adequate data exists for ESA listing and a final decision is expected soon. In anticipation of listing, IDFG, Bonneville Power Administration, NMFS, and the Shoshone Bannock tribes have developed a recovery plan.

This recovery plan was initiated in May, 1991 with the trapping of outmigrant smolts in Redfish Lake Creek and in the Salmon River below Alturus Lake. A total of 768 Redfish Lake and 139 Alturus smolts were trapped and transported to the Eagle Hatchery (IDFG). These were converted onto Biodiet and are currently about 100 grams. Most mortalities have been attributed to mechanical damage in trapping and transport or to bacterial gill disease. Isoenzyme analysis indicated a difference between RFL outmigrants and the kokanee population in Redfish Lake. There was also considerable difference between the *Oncorhynchus nerka* of Stanley Basin and its nearest stock from the Wenatchee River (Columbia River Basin). The recovery plan calls for rearing the outmigrants in a captive broodstock program with the resulting progeny used to rebuild the sockeye populations in Redfish, Alturus, Petit, Stanley, and possibly Yellowbelly Lakes.

The second phase of the recovery plan is to capture, spawn, and rear progeny from returning adult sockeye. Four were trapped in Redfish Lake Creek in August, 1991. A mating matrix was used to maximize genetic diversity from three males and the single female. These fish were spawned October 21. No hard numbers will be available until they eye. These also will be used in a captive brood program to be done both at Eagle and Mountlake (NMFS). Surplus milt has been cryopreserved.

The third phase of the recovery plan is the responsibility of the ShoBan Tribes. This will be to evaluate carrying capacity for sockeye for the five lakes and the potential for fertilization. They will also improve spawning habitat and remove migration barriers where they exist. If in-lake rearing is considered, it will be their responsibility also.

This recovery plan is designed to buy time over the next few years until the effect of ESA listing is realized in terms of the real problem: smolt mortality through the reservoirs and loss of adults through their 900 mile river migration. Current plans call for increasing in-river velocities through a combination of reservoir draw-down and release of water from reservoirs. We should learn over the next few years what price society is willing to pay for an endangered stock of sockeye.

Cedar River Sockeye

by

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Background. The Cedar River flows into the southern end of Lake Washington which is located east and adjacent to Seattle, Washington. The lake empties through the Lake Washington Ship Canal and Lake Union into Puget Sound. The Chittenden Locks are located at the entrance to the ship canal. The locks have a fish ladder with a viewing area from which fish can be counted. The lock count is used to estimate the number of adult sockeye annually returning to the lake. The majority of the sockeye returning to the lake spawn in the Cedar River, however there are populations that spawn in other tributaries, and some beach spawners. The Cedar River presently has 21 river miles available to spawners. Prior to the construction of the diversion dam for Seattle's water supply there were an additional 13 miles available to Cedar River spawners.

Sockeye salmon were introduced into Lake Washington in 1935 and several times thereafter. Since then, the population gradually increased until 1988, when slightly more than 600,000 adult sockeye returned to the basin. Prior to 1980, approximately 16 pre-smolts were produced by each adult sockeye spawning in the watershed. However, from 1980 on this value has averaged scarcely more than six pre-smolts/spawner. In some years less than three smolts/adult were produced. The 1989 brood year experienced the lowest survival rate so far observed (1.8 pre-smolts/spawner). These low survival rates are far below what is needed for Lake Washington sockeye to replenish themselves, and the run is now precipitously declining.

When there are harvestable sockeye the Lake Washington run provides important opportunities for tribal and sport fisheries. The sport fishery is within a one hour drive of half of Washington State's population. The significance of this and the declining size of the sockeye run has not been lost on our state legislators. In 1989 the state legislature passed a bill that calls for a spawning channel to be built and ready to accept adult sockeye by October 1993. The bill also set up policy and technical committees to design and oversee the construction of the channel. Seattle has been asked to fund the construction and operation of mitigation measures (hatchery and/or spawning channel) for the lost spawning area above the diversion dam. The city does not want fish spawning above their intake because of requirements of the federal Clean Water Act.

Presently there are two processes going on:

1) Mitigation for lost spawning area (chinook, coho, and sockeye)
2)Interim Relief program

Mitigation. Several options have been considered for mitigation of the loss of sockeye spawning habitat above Seattle's diversion. Two options have been followed. These options are a sockeye spawning channel and/or a sockeye hatchery. The hatchery option ran into some problems with permitting. The site that was selected was above Seattle's diversion and water quality standards would not allow hatchery effluent to enter the Cedar River above Seattle's intake (Clean Water Act).

The site allowed for the option of discharging the effluent into another watershed. This option raised objections from an affected tribe and a commercial fish farm, based on the possibility of introducing IHN or other pathogens. These problems resulted in the hatchery option being put on hold.

The spawning channel option is going forward as scheduled for operation in October of 1993. The State Environmental Protection Act process and predesign work is done, and the water right is being applied for. The goal of mitigation is to increase the sockeye run by 406,000 adults. This is the estimated production potential for the 13 miles of habitat above the diversion. The channel is scheduled to be ready in 1993 to accept enough spawners to produce an estimated 200,000 adults. The channel will be evaluated over several years at this size to determine if it is successful and what the final size of channel needs to be to increase the run by 400,000 adults. To evaluate the channel all of the fry will be marked, by using otolith banding.

Interim Relief. The interim relief program goals are to evaluate production and survival. This will be accomplished using fish produced eggs collected from sockeye returning to the Cedar River. In 1991 2 million eggs have been collected. These eggs will increase production by avoiding flood induced mortality that the eggs would otherwise be subjected to in the river. All of the 2 million fry will be otolith marked. Some of the fry will also be marked with a dye (Bismark Brown) for trap calibration.

Three to four incline plane traps will be set up at the mouth of the Cedar River. The traps will be used to estimate the number of fry (wild and marked) entering the lake, and survival of the marked fish. Survival to presmolt will be estimated from hydroacoustic surveys and examination of the otoliths from fish collected during the hydroacoustic surveys. When the adults return, survival will be estimated based on the number that return and data from otolith samples.

Table 1. Lake Washington sockeye brood year data, 1967-1990[1].

Brood Year	Parent Escapement	Peak Cedar River Flow <cfs> Renton	Pre-smolt Population X (10^6)	Freshwater Survival (Pre-smolts per spawner)	Age 3 Returns (Jacks)	Age 4 Returns	Age 5 Returns	Total Brood Return	Percent Marine Survival	Return Per Spawner
1967	383,000	2,910	7.50	19.6	6,612	527,206	11,978	545,796	7.28	1.43
1968	252,000	3,720	3.19	12.7	20,686	272,838	19,048	312,572	9.80	1.24
1969	200,000	2,290	3.80	19.0	14,644	433,857	5,986	454,487	11.96	2.27
1970	124,000	2,730	2.00	16.1	23,286	136,343	13,967	173,596	8.68	1.40
1971	183,000	8,160	1.70	9.3	7,318	122,679	14,565	144,562	8.50	0.79
1972	249,000	4,000	3.58	14.4	7,344	146,557	3,253	157,154	4.39	0.63
1973	330,000	4,220	4.56[2]	13.8	18,765	567,404	3,927	590,096	12.94	1.79
1974	126,000	3,520	1.96[2]	15.6	16,015	305,253	4,697	325,965	16.63	2.59
1975	120,000	8,800	1.14	9.5[3]	2,397	199,499	21,605	223,501	19.61	1.86
1976	159,000	1,340	3.96	24.9	25,635	473,928	44,549	544,112	13.74	3.42
1977	275,000[4]	5,670	2.93	10.7	1,848	69,563	3,626	75,037	2.56	0.27
1978	290,000	1,840	6.80	23.4	5,192	311,713	97,433	414,338	6.09	1.43
1979	206,000	3,080	3.64	17.7	8,649	189,135	79,000	276,784	7.60	1.34
1980	361,000	3,020	3.78	10.5	3,832	397,766	57,225	458,823	12.14	1.27
1981	107,000[5]	5,320	1.14	10.7	2,011	197,107	44,949	244,067	21.41	2.28
1982	289,000	3,250	2.02	7.0	6,736	209,142	75,615	291,493	14.43	1.01
1983	227,000[5]	5,540	1.32	5.8	3,329	143,941	59,141	206,411	15.64	0.91
1984	372,000	1,610	4.99	13.4	4,286	585,802	109,526	699,614	14.02	1.88
1985	254,000	2,480	0.95	3.7	1,037	61,315	30,321	92,673	9.76	0.36
1986	249,000	5,070	0.73	2.9	610	66,274	---	---	---	---
1987	207,000	1,820	0.60	2.9	1,299	---	---	---	---	---
1988	376,000	2,000	2.47	6.6	---	---	---	---	---	---
1989	166,000	5,240	---	---	---	---	---	---	---	---
1990	93,000	---	---	---	---	---	---	---	---	---
Ave.	233,250	3,810	2.94	12.0	8,644	270,866	36,864	327,952	11.43	1.48

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[1] Source: Washington Department of Fisheries.

[2] Accurate pre-smolt estimates not available. Values used are estimated from the relationship between freshwater survival (pre-smolt per spawner) and peak floods on the Cedar River.

[3] Freshwater survival of those sockeye impacted by December 1975 flood equals 5.6 pre-smolts per spawner.

[4] Actual escapement 435,000. Pre-spawning mortality reduced effective escapement to 275,000 sockeye.

[5] Escapement plus freshwater catch estimate significantly lower than Ballard Locks adult sockeye counts.

Table 2. Estimated catches and escapement of Lake Washington sockeye in numbers of fish, all groups combined, 1967-1990.

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Convention waters catch											
British Columbia	1593	4737	9193	107	10023	7537	11912	7781	10038	17532	30244
United States	851	3210	10302	504	12254	4434	64050	1520	7672	212	56758
Discovery Bay											
Treaty	0	0	0	0	4	0	0	0	22	1	2
Non Treaty	442	76	3098	39	59067	615	3	0	407	139	1186
Admiralty Inlet											
Treaty	0	0	0	0	0	0	0	0	13	2	0
Non Treaty	68	3179	22637	781	72	994	0	0	22	66	2
Seattle Area											
Treaty	0	1464	456	14	632	0	0	0	142[2]	673[1,2]	2600[1,2]
Non Treaty	2947	9499	21652[1]	3128[1]	264376	1944[1]	524[1]	398[1]	0	3	5
Marine Sport	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	80	39	0	352
Freshwater											
Lake Washington											
Treaty	0	0	0	0	9257	6653	29364	5182	354	37	35932
Non Treaty	0	0	0	1061	0	0	0	0	0	0	0
Lake Sammamish treaty	0	0	0	0	0	0	0	0	5070	811	0
Lake Washington sport	0[3]	0[3]	0[3]	5590	20389[6]	28284	40338[6]	8655	0	0	12769
Lake Sammamish sport	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	0[3]	31	20	184	6
Subtotals											
Convention catch	2444	7947	19495	611	22277	11971	75962	9301	17710	17744	87002
Marine Treaty	0	1464	456	14	636	0	0	0	177	676	2602
Marine non-treaty	3457	12754	47387	3948	323515	3553	527	478	468	208	1545
Freshwater treaty	0	0	0	0	9257	6653	29364	5182	5424	848	35932
Freshwater non-treaty	0	0	0	6651	20389	28284	40338	8686	20	184	12775
Total catch	5901	22165	67338	11224	376074	50461	146191	23647	23799	19660	139856
Cedar River Enhancement	0	0	0	0	0	0	0	0	200	1231	11816
Escapement	383000	252000	200000	124000	183000	249000	330000	126000	120000	159000	435000[8]
Actual run size	388901	274165	267338	135224	559074	299461	476191	149647	143999	179891	586672

Includes East/West passage catch
Includes Duwamish River and Elliot Bay catches
Sport catches occured but species cannot be apportioned to total catch
Includes all of Catch Area 6B
Preliminary data; subject to change
Expanded sport samples (Haw, Barnaski, Nye)
Includes ceremonial and subsistence illegal sales
Actual escapement 435,000 fish. Pre-spawning mortality reduced effective escapement to 275,000
Includes test fishing catch
Total catch was test fishery
Pacific Salmon Commission (preliminary)

Table 2. Estimated catches and escapement of Lake Washington sockeye in numbers of fish, all groups combined, 1967-1990. (Continued)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989[5]	1990[5]
Convention waters catch													
British Columbia[9,11]	2807	5972	3630	1919	2533	2413	2177	1035	1355	1401[10]	3445[10]	651[10]	604[10]
United States	1977	1750	1217	4207	399	1101	427	544	633	268	3464	2577	84
Discovery Bay													
Treaty	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Treaty	204	2	0	0	0	0	0	0	0	0	0	0	0
Admiralty Inlet													
Treaty	0	1	1	0	0	9	0	0	0	0	0	0	0
Non Treaty	17	128	0	0	0	0	0	0	0	0	0	0	0
Seattle Area													
Treaty	75[2]	101[1,2]	1534[1,2]	21[1,2]	125[1,2]	112[1,2]	2092[1,2]	553[1,2]	130[1,2]	144[1,2]	25612[1,2]	159[1,2]	884[1,2]
Non Treaty	142	314[1,2]	6823[1,2]	5[1,2]	186[1,2]	6[1,2]	14[1,2]	8[1,2]	4[1,2]	3	39276	258	350
Marine Sport	105	47	56	0	0	294	0	17	1	0	0	0	0
Freshwater													
Lake Washington													
Treaty	0	34	67487	1805	18780[7]	33902[7]	57684[7]	4556[9]	5752[9]	12480[9]	97469	1783	2748
Non Treaty	0	0	908	33	0	0	0	0	197	19	0	0	224
Lake Sammamish treaty	1076	2466	52	77	110	74	1087	349	336	109	4258	0	0
Lake Washington sport	0	0	43051	0	12462	25851	43400	0	12	3117	95000	0	0
Lake Sammamish sport	106	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals													
Convention catch	4784	7722	4847	6126	2932	3514	2604	1579	1988	1669	6909	3228	688
Marine treaty	75	102	1535	21	125	121	2092	553	130	144	25612	90	884
Marine non treaty	468	491	6879	5	186	300	14	25	5	3	39276	259	350
Freshwater treaty	1076	2500	67539	1882	18890	33976	58771	4905	6088	12589	101727	1627	2748
Freshwater non treaty	106	0	43959	33	12462	25851	43400	0	209	3136	95000	0	224
Total catch	6509	10815	124759	8067	34595	63762	106881	7062	8420	17541	268524	5204	4894
Cedar River enhancement	15068	13017	10662	4203	0	0	0	0	0	0	0	0	0
Escapement	290000	206000	361000	107000	289000	226815	372000	254000	249000	207000	376000	166247	93000
Actual run size	311577	229832	496421	119270	323595	290577	478881	261062	257420	224541	644524	171451	97894

Update on Alaskan Infectious Hematopoietic Necrosis (IHN) Outbreaks in 1991

by

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Since the initiation of the Sockeye Culture Policy in 1980, the percentage of sockeye salmon fry loss to IHN disease in hatcheries has decreased over the years with it usually averaging less than 4% of the sockeye salmon eggs taken. Three hatcheries lost sockeye fry to IHN this year, totaling 2.4 million fry. The facilities were Trail Lakes Hatchery, Gulkana River I, and Snettisham Hatchery. The losses were isolated in the affected incubators and did not spread to other units within the facilities. Compartmentalization and good disinfection procedures were essential elements in reducing fry losses.

This year an unexpected smolt mortality due to IHN disease occurred at Chenik Lake, located on the west side of Cook Inlet in the Kamishak Bay area. When the crew arrived to monitor smolt outmigration, large numbers of dead fish were noted around the shore of the lake. When moribund and dead fish were sampled from the fyke net collection box, they were found to be positive for IHN virus. No other pathogenic agents were found. Sampling efforts were often hampered by weather but 70% of moribund fish and 33% of apparently healthy fish were positive for virus during the middle of the run, primarily after the peak of the mortality. When the fyke net was pulled in early July, approximately 32,000 smolt had outmigrated out of an expected 1-1.5 million. this outbreak is one of the few documented outbreaks in wild smolt and the first one we have observed in Alaska since the occurrence at Hidden Lake in 1981. Chenik Lake is stocked with Tustemena Lake sockeye fry from Crooked Creek Hatchery and supports a run of wild sockeye salmon. The Tustemena Lake fry have never experienced an epizootic in the hatchery and are a low prevalence, low titer stock. The most likely source of the virus is the wild returning adults but cost and logistics prevented obtaining a sample from them this year.

Another interesting finding this year was the number of IHNV positive adults in the Coghill Lake sockeye salmon returns to Main Bay Hatchery. This is the first return of sockeye that were solely incubated, reared and released at Main bay. Of the marked fish sampled, 47/58 females were positive and 1/5 of the males. Of the unmarked fish sampled, 33/120 were positive. It was suspected that these returns might be negative for virus as they were incubated and reared on a virus-free water source and there was no natural run of sockeye into Main Bay other than strays returning to Eshamy Lake.

IHN VIRUS IN COGHILL SOCKEYE RETURNS TO MAIN BAY HATCHERY

	# pos/total		% positive in parents
	marked fish	unmarked fish	
1990 RETURNS:			
Total	1/89	0/120	30.0%
Females	0/68	0/60	
Males	1/21	0/60	
1991 RETURNS:			
Total	48/63	33/120	98.5%
Females	47/58	24/60	
Males	1/5	9/60	

IHNV PREVALENCE
MAIN BAY SOCKEYE RETURNS

Date Collected	Sex	# positive	Total collected	% positive
8-23-91	F	2	6	33.3%
8-26-91	F	2	3	66.7%
8-28-91	F	7	8	87.5%
8-30-91	F	10	11	90.9%
9-02-91	F	18	20	90.0%
9-03-91	F	8	9	88.9%

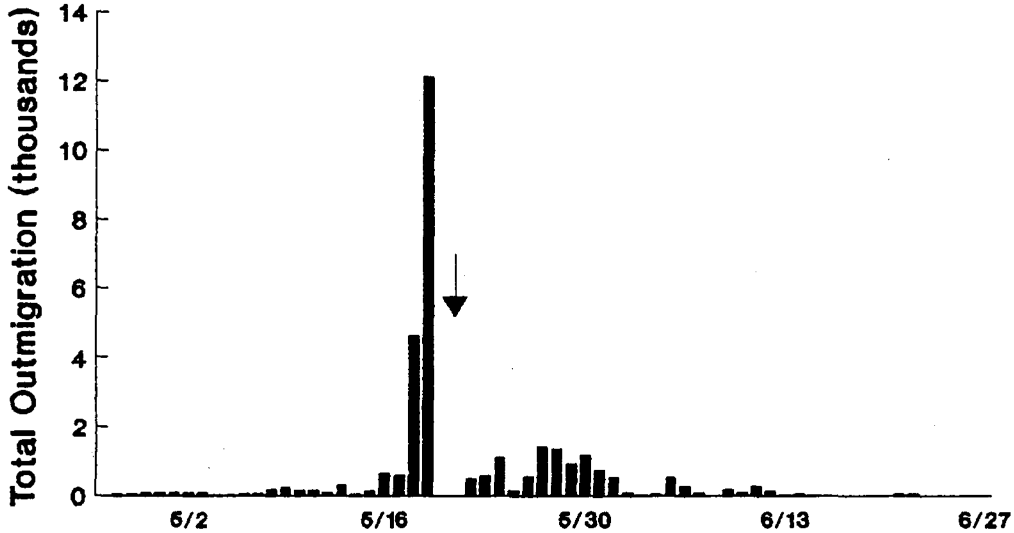
IHNV OUTBREAKS IN SOCKEYE SALMON
ALASKA 1991

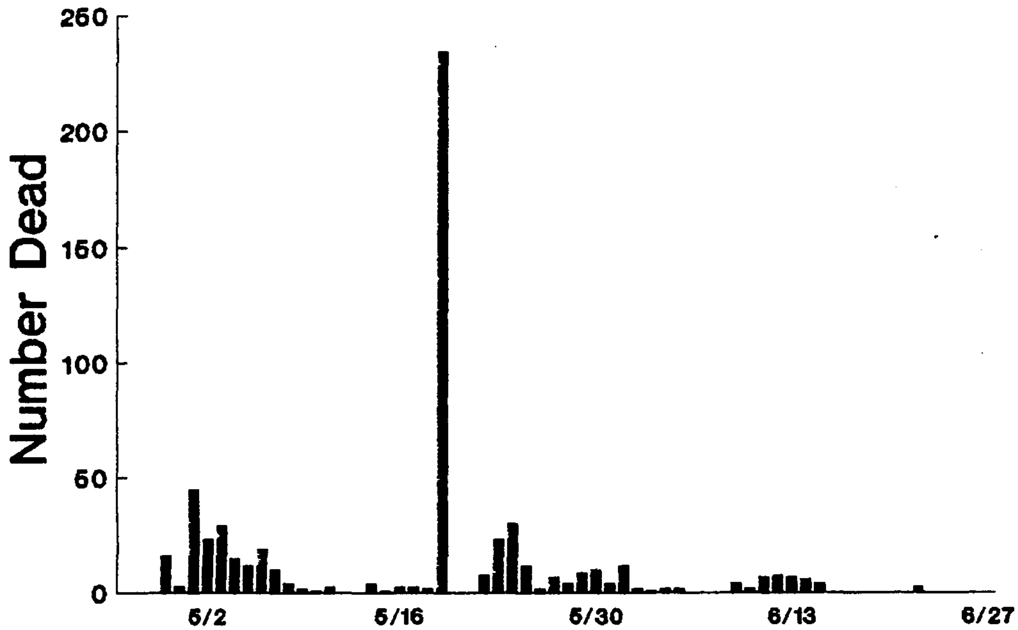
Location	Stock	# Of Fish Lost
Trail Lakes Hatchery	1990 Packers Lake	200,000 sacfry
Gulkana Hatchery	1990 Gulkana River	2,000,000 sacfry
Snettisham Hatchery	1990 Speel Lake	200,000 sacfry
Chenik Lake	Wild/1989 Tustemena Lake	Unknown **

**Expected outmigration 1-1.5 million. Actual outmigration was approximately 32,000.

Chenik Lake

Sockeye Smolt - 1991





Recent Advancements in the Detection and control of IHNV

by

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Much of the recent advancements in IHNV research have been made in the field of molecular virology. This information has given greater insights into the biochemical nature of IHN virus that has provided more sensitive and effective methods of virus detection as well as control. Examples of improved viral detection methods include DNA probes enhanced by the polymerase chain reaction (PCR) and monoclonal antibodies used for FAT or immunoblot identification of the virus as well as strain typing of the various IHNV isolates.

Techniques in molecular virology have also provided a very promising subunit vaccine that can now be synthetically manufactured by E. coli bacteria. This vaccine has been very successful in field trials and should be a significant tool for the future prevention of IHN disease in various hatchery circumstances.

Outside of molecular virology, previous research in fish genetics has produced rainbow trout X coho salmon and chinook X coho salmon hybrids to increase resistance to the virus. This work is being looked at again as a potential for controlling the virus in certain hatchery situations.

Additionally, work continues in identifying potential vectors and/or reservoirs of IHNV in the environment, but with little success.

In summary, many of the tools above are still in various stages of study and refinement, but clearly they will be useful in the future control as well as study of IHNV.

Early Marine Life History of Sockeye Salmon in Auke Bay

by

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The early marine life history of juvenile sockeye salmon in Auke Bay, Alaska, was studied from May to September in 1990 and 1991. The littoral and pelagic zones of the Bay were sampled weekly with beach seines and surface trawls, respectively. Up to ten beach seine sets sere made diurnally at five sites and nine surface trawl tows were made nocturnally at three stations. Juvenile sockeye salmon were present from late May to late August with peak abundances in June and July. In both years combined, 1,393 juvenile sockeye salmon comprised less than 2% of the fish abundance in both the littoral and pelagic habitats. Pacific Herring and Capelin constituted over 80% and 95% of the catch in the littoral and pelagic zones, respectively. Freshwater age composition of the sockeye salmon changed seasonally; age-2 and age-1 fish were prevalent late May to early July while age-0 fish were most abundant from early July to mid-August. Sockeye salmon had an estuarine residence period that extended later than that of pink, chum, and coho salmon. Mean fork length (FL) of unmarked sockeye salmon was consistent between years; sizes ranged 43-123 mm FL in 1990 (mean=75.2; n=445) and 44-137 mm FL in 1991 (mean=75.7; n=641). Mean FL of age-0 sockeye salmon was 72.8 mm FL in both years and ranged 43-123 and 49-137 mm in 1990 and 1991, respectively. Over the course of the season, the mean FL of unmarked sockeye salmon was similar within each habitat. There was a difference between habitats; in both years unmarked juveniles were larger in pelagic than the littoral habitats. This size difference and the seasonal pattern of catches indicates that habitat utilization in the estuary is size specific. Smaller fish utilize the littoral habitat and move offshore as they get larger. A total of 307 CWT recoveries of juvenile age-0 sockeye salmon were made in Auke Bay from freshwater and marine release sites near Auke Creek. Recoveries from twelve different size and times of releases indicated similar growth trajectories but dramatically different residence times in Auke Bay. the longest resident times were 41 and 59 days in 1990 and 1991, respectively. Few CWT fish over 100 mm FL were recovered, suggesting that most juvenile sockeye salmon migrated out of Auke Bay before reaching this size.

***Joe Orsi**. In both years of the study the sockeye remained in Auke Bay after pink, chum, and coho had left. Chinook left the bay after the sockeye.*

Results and conclusions:

- *There is extensive use of estuarine waters by all age-classes of smolts.*
- *There is size-specific movement of fish between habitats.*
- *There is a later residency among age-0 smolts compared to age-1 or age-2 smolts.*
- *The age-0 smolts were seawater-tolerant at 51 mm and 1 g.*

Case Histories

Sockeye Salmon Rehabilitation and Enhancement in Southern southeast Alaska - Its Success Relative to Present Salmon Management Strategies

by

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Many existing southern Southeast Alaska sockeye salmon (Oncorhynchus nerka) stocks are depressed and efforts to rehabilitate and/or enhance them began in the early 1980's. Lake fertilization and fry stocking have been the primary methods used. Projects on several systems have resulted in varying degrees of success. Present salmon harvest management strategies have resulted in both under-harvest and overharvest of enhanced sockeye stocks. Rehabilitation of some stocks may not be possible due to excessive harvest levels and continued enhancement of other systems may not be cost effective without increases in harvest.

The Hugh Smith Lake system is an excessive harvest scenario. The system has been fertilized and stocked to enhance the population. The potential production of this system is in excess of 40,000 adult sockeye. The fertilization project was discontinued in 1984 because of under-utilization of existing zooplankton stocks due to low sockeye rearing densities. Lake stocking was initiated to raise the sockeye rearing densities due to low escapements. Lake stocking has been successful in producing adult sockeye. However, the commercial harvest rate has consistently been in excess of 80% of the total adult return which leaves a remnant population to continue on.

The McDonald Lake system is an under-utilized system. This system has been enhanced by lake fertilization since the early 1980's. McDonald Lake has an escapement goal of 85,000 to sustain a peak population. In the past five years the total adult return has averaged over 200,000 adults. The commercial harvest rate varies between 20-40%. The escapement has ranged from 70, to 175,000 adults leaving as much as 90,000 excess adults which could have been harvested.

Changes in present harvest strategies will be necessary to achieve a maximum sustained yield of southern Southeast sockeye salmon stocks.

Mike Haddix. Hugh Smith Lake; the relationship between management and enhancement/rehabilitation.

Hugh Smith Lake is located southeast of Ketchikan. sockeye adults returning to Hugh Smith Lake are intercepted in the major pink salmon seine fisheries, gillnet fisheries, and fish traps. Hugh Smith was a major sockeye producer in the 1920's, when two canneries were located near the lake. By the 1940's sockeye runs had been depleted for most of SE Alaska. In the late 1960's people started tagging fish and some concern was generated over the status of sockeye runs. In 1978, FRED Division of ADF&G got involved and decided to rehabilitate the lake. Initially the lake was fertilized. Fertilization was discontinued and fry were released in the lake and smolt numbers and adult escapement monitored in a multi agency joint project. The harvest rates were excessive. The main problem for rehabilitation was getting enough adults back through the adjacent commercial fisheries to collect a sufficient number of eggs. The lake is capable of producing 80,000 to 100,000 adult sockeye. Hugh Smith is no longer a rehabilitation project, but is more of a put-and-take enhancement effort.

Local commercial fishers would have to forgo the opportunity to harvest about 400,000 pink salmon a year in order to get sufficient spawners back to Hugh Smith Lake to sustain an optimal level of natural production. This continues to be a dilemma in pink salmon management and we continue to place as many fry as we can in Hugh Smith Lake.

McDonald Lake has the opposite problem. Lake fertilization has been a success. the escapement goal of 80,000 adult sockeye was met in 1988 and exceeded in 1990. Escapement in 1991 was about 180,000. Harvest is down and needs to be increased.

It is important to plan rehabilitation projects with resource managers. Management of the fisheries generated from these projects has not been easy.

Larry Peltz (Alaska Dept of Fish and Game, Commercial Fisheries Management and Development Division, P.O. Box 520509, Big Lake, AK 99652-0509). Big Lake sockeye coho interactions. *There has been a hatchery on Big Lake in northern Cook Inlet since the 1970's. There are a number of fishes in Big Lake: stickleback, sculpins, longnose sucker, round whitefish, burbot, arctic lamprey, rainbow trout, and five species of salmon. We have looked at smolt outmigration for the last 15 years. The biomass of coho has been stable while that of sockeye fluctuates annually. There is no relationship between the biomass of each species and the size of smolts. There is a relationship between the size of sockeye compared to coho. Big sockeye are coupled with big coho.*

Almost all sockeye rear in the lake. Meadow Creek and other tributaries to Big Lake are productive, and most coho come from these streams.

Virginia Lake, Fry Plant Timing and Consequences

by

M. H. Haddix and Tim Zadina

A fish pass was constructed by the U.S. Forest Service on Mill Creek, the outlet of Virginia Lake in 1988. In order to expedite the development of a sockeye salmon (Oncorhynchus nerka) population into the lake, a fry outplant program was initiated by ADF&G, FRED Division and the Southern Southeast Regional Aquaculture Association (SSRAA). In April 1989, approximately 1.9 million emergent sockeye fry were stocked in Virginia Lake. Survivals from planted fry to smolt were much lower than expected and attributed to low zooplankton densities during the earlier than desired release timing. As a result, fry outplants in 1990 were reduced to 889,000 emergent fry and releases were made in May closer to the desired stocking period when zooplankton densities are higher. Lower fry densities and more favorable rearing conditions resulted in increased freshwater survival over the 1989 plants, but still well below the expected results. The lower than expected fry to smolt survivals were attributed to asynchrony between peak zooplankton levels and timing of the fry release and a low forage base. In order to resolve this problem two treatments were initiated in 1991. Fry outplants were done in July with 736,000 fed fry released. In addition, a lake fertilization program was initiated in May to rehabilitate the depressed zooplankton populations prior to fry planting. The 1991 zooplankton populations rebounded to a level higher than pre-stocking populations. The stocked sockeye survival rates to smolt are incomplete.

Sockeye Salmon Fry and Pre-smolt Stocking at Pass and Esther Pass Lakes in Prince William Sound

by

Greg Carpenter

This program is an experiment to determine the best method of utilizing excess fry production from Main Bay Hatchery to produce adult salmon in the small barriered lakes of Prince William Sound. The program was initiated in 1988 to compare the ability of two barrier lakes to effectively rear sockeye salmon to smolt. Pass and Esther Pass Lakes are two small oligotrophic lakes located on Esther Island in Prince William Sound. Sockeye salmon (Oncorhynchus nerka), fry reared at Main Bay Hatchery in Prince William Sound were released into both lakes in 1988 and 1989 with presmolt being stocked in 1990. both lakes were stocked with equivalent densities of fry per euphotic volume based on the sockeye production capacity model by Koenings and Burkett. The model indicates stocking at levels of 110,000 fry per euphotic volume of the lake to reach rearing limitation. In 1988 and 1989 Pass Lake was stocked with approximately 600,000 fry and Esther Pass with around 154,000 sockeye fry. The sockeye smolts emigrating from both lakes were captured with fyke nets attached to live boxes. A subsample of 40 smolts were collected daily for weight, fork length and scales taken for age composition. No fry were stocked in the spring of 1990 so both lakes lay fallow during the growing season except for the holdover fish. Survival rates were low from both lakes when sockeye fry were stocked. In 1990 fish were stocked at a later date than the two previous years to allow the food source to build up sufficiently during the growing season. Of the estimated 100,000 sockeye pre-smolt stocked in Pass Lake approximately 63,159 smolts were produced with 63.3% survival rate while Esther Pass Lake stocked with an estimated 25,000 pre-smolt produced approximately 16,326 smolts with a 63.5% survival rate. Previous survival rates for Age 1.0 and 2.0 fish combined from Pass Lake in 1989 was 12.2% and 6.6% in 1990 while Esther Pass Lake had 8.5% survival in 1989 and 9.8% in 1990. Survival rates from pre-smolt stocking were much higher than the two previous years mainly due to stocking larger fish, stocking lower total numbers of fish into each lake, and stocking later in the year preferably just before freeze up.

Speel Lake Sockeye Salmon Smolt Studies as They Relate to Snettisham Hatchery Production

by

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The primary purpose of this presentation is to report on results of smolt studies at Speel Lake. A little background to explain our interest and history at the site is appropriate first. Snettisham Hatchery was sited and the program developed based on the production of chum salmon. We have developed the sockeye salmon program in response to: an improved technology, desire for mitigation of lost harvest opportunity for S.E. gillnetters as a result of US/Canada Treaty, desire for a support facility for joint US/Canada enhancement, and of course the availability of funding.

Speel Lake is located in Port Snettisham, 30 miles south of Juneau. It is a clear water system that drains into the glacial Speel river. It is the only sockeye system on the river.

Heightened interest and funding for investigations of sockeye salmon systems developed in the early 1980's and a sockeye weir was placed at Speel Lake in 1983. The weir has been operated by Commercial Fisheries Division since that time.

Escapements have been highly variable during the 9 years of weir counts. Ranging from 327 to 18,064, with an average of 8,236. total production is only available for 5 years and has ranged from 3,700 to 23,000 with an average of 15,000.

Speel Lake was an obvious candidate for brood stock and rehabilitation purposes when the Snettisham Hatchery began sockeye culture in 1988. It is located about 6 miles from the hatchery and is accessed by river boat or float plane. Escapement goals at that time were 10,000 adults annually.

Speel Lake is 167 hectare lake 8.5 meters at its deepest point. The euphotic volume projects a potential production of 27,000 adult sockeye.

In 1988 Snettisham began their sockeye program with an eggtake at Speel Lake. The escapement that year was the lowest observed to that time. As the Speel eggs were the only sockeye eggs collected they were used to verify two conditional hypothesis for the Snettisham Central

Incubation Facility (CIF). The first was the ability to successfully mark production groups of salmon with otolith bands; the second was the ability to delay emergence into June through chilling of the water. Ambient temperatures would result in April emergence requiring rearing and added expenses, risks, and space.

The CIF successfully demonstrated the otolith mark and the ability to delay emergence Two marks were placed on the 1988 brood Speel Lake sockeye and emergence was delayed until late June.

In the spring of 1989 the fry resulting from the 1988 eggtake were stocked into Speel Lake. Because of the late emergence stocking dates were June 25 and July 2, 1989. Target stocking date would normally be June 1.

The Speel Lake smolt weir study was conducted to aid in evaluating the success of our release of fry into Speel Lake. Primarily we wished to determine the portion of the smolt production originating from the hatchery stocked fish. Secondarily we wished to demonstrate persistence of the otolith mark. Overall goals for the smolt weir were:

1. To recover otolith-marked sockeye salmon.
2. To sample smolt for age composition, weight, and length.
3. To determine the timing of the emigration of sockeye salmon smolt.
4. To determine the magnitude of the emigration of wild and stocked sockeye salmon smolt.
5. To gather information on other emigrant species.

Because we were operating on a short budget our operating plan was to sample the emigration on a weekly basis during the period from May 9 to June 6. In 1990 we weired off the entire width of the stream for these sampling events. All fish were counted by species and representative portions of sockeye salmon were individually weighed, measured and scales collected. Up to 125 individual fish were retained for otolith analysis per period.

In 1991 we again sampled smolts from Speel Lake. In this case we were looking for presence of the otolith mark in age 2.0 smolts. We selected two sampling periods, May 28 and June 4, based on the previous years results and other schedules.

Results of our efforts were as follows:

Sockeye salmon smolt counts. In 1990, peak emigration was on May 23 with 8,047. No sockeye salmon smolts were counted on May 9 and very few n May 16. In 1991 the peak of emigration was missed. Results of work at Sweetheart Lake by Limnology Section indicate that emigration was delayed in 1991 and the peak was in Mid-June.

Sockeye smolt estimate. Results from 1990 were used to estimate the magnitude of the total sockeye salmon emigration by calculating the area under the curve. That method yields an estimate of 81,364. I suppose the range would be from 60,000 to 95,000 smolts but no statistical analysis was run on this data. For 1991 no estimate of total emigration was attempted. We do not think the 1991 results suggest anything about the total emigration that year, except that it probably was delayed.

Smolts in neither year were especially large and in 1991 the 1.0 smolts were below the FRED assumption for threshold size.

Smolts were significantly smaller in 1991 as shown in the length frequency and box plots.

Worksheet for projecting smolts. Based on the counted escapement and the hatchery eggtake we assumed the natural spawning population was 306 females which should yield 830,000 eggs. We assumed 5% survival to fry, 20% to smolt and 95% age 1.0 smolt. We further assumed that the stocked fry would survive at 22% to smolt. Based on those assumptions we expected 85% of the emigrant smolts to be of hatchery origin. We expected to verify this with otolith mark detection. An independent lab looked at otoliths from 120 age 1.0 smolts from 1990 emigration; no otolith marks were detected. In 1991 Kris Munk with ADF&G Commercial Fish Division detected 6 marks in 24 age 2.0 smolts from the 1991 emigration.

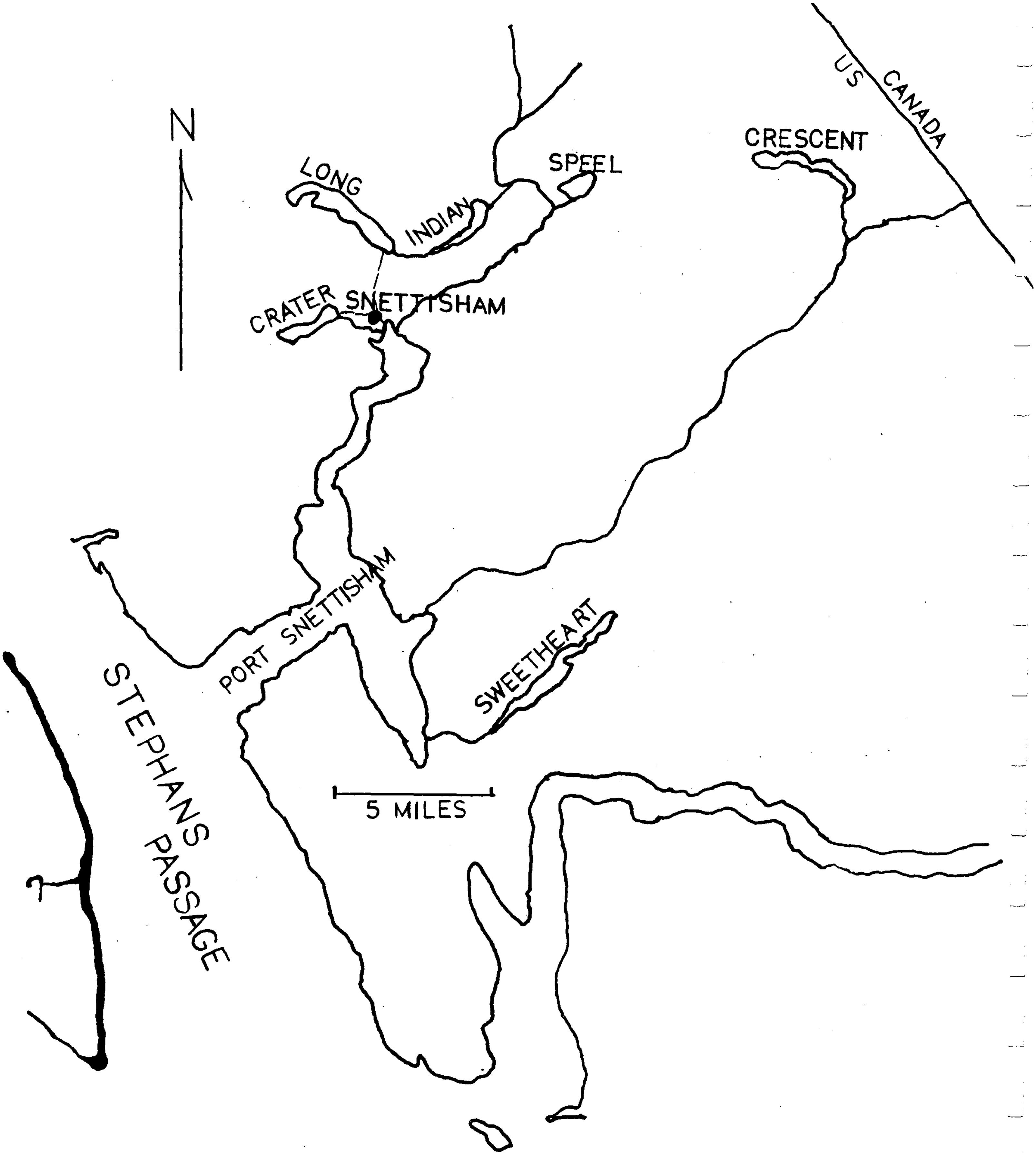
Based on the above results we concluded that only a very small portion (if any) of the 1990 emigration of an estimated 73,000 age 1.0 smolts could have been of hatchery origin. We suspect that the fish did not emigrate because they were not able to reach a threshold smolt size. The late stocking date (end of June and early July) put the hatchery fish behind natural fry. Furthermore, Limnology section plankton sampling indicates food (plankton) is very limiting in Speel Lake. It seems likely that lack of food contributed to the apparent slow growth and/or poor survival of hatchery stocked fry. The detection of otolith marks in the 1991 emigrants suggests that the mark was persistent in hatchery fish and readable, and not detecting it in 1990 emigrants was not due to "mark loss".

Recommendations for future work in Speel Lake are to:

- Refine the estimated capacity of the lake based on Limnology's plankton model.

- Refine the escapement goal downward based on smolt size and numbers form known escapements.

- Stock 10 days after ice off when stocked fry should best take advantage of plankton bloom.

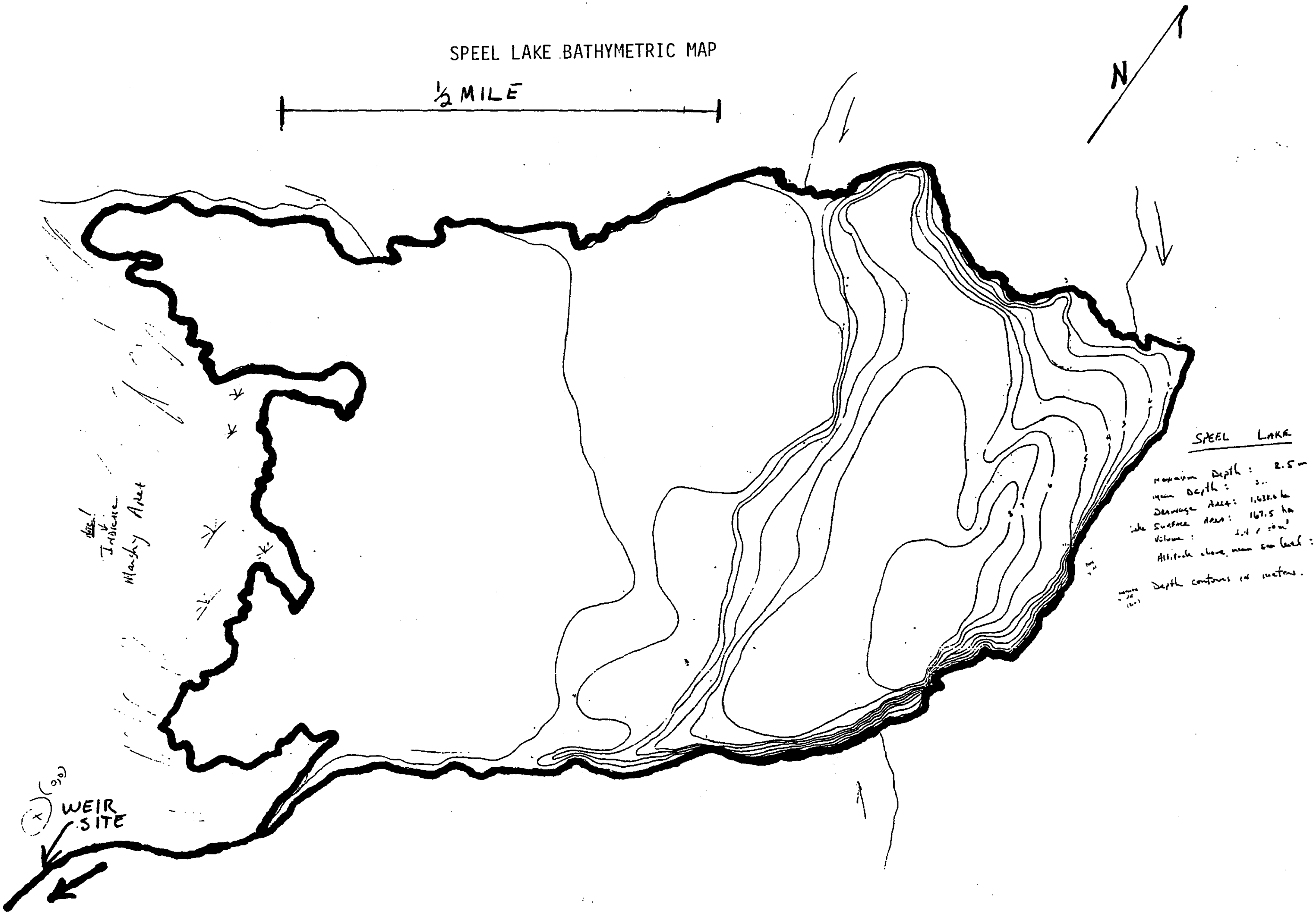

N
US
CANADA
CRESCENT
SPEEL
LONG
INDIAN
CRATER
SNETTISHAM
PORT SNETTISHAM
SWEETHEART
STEPHANS PASSAGE
5 MILES

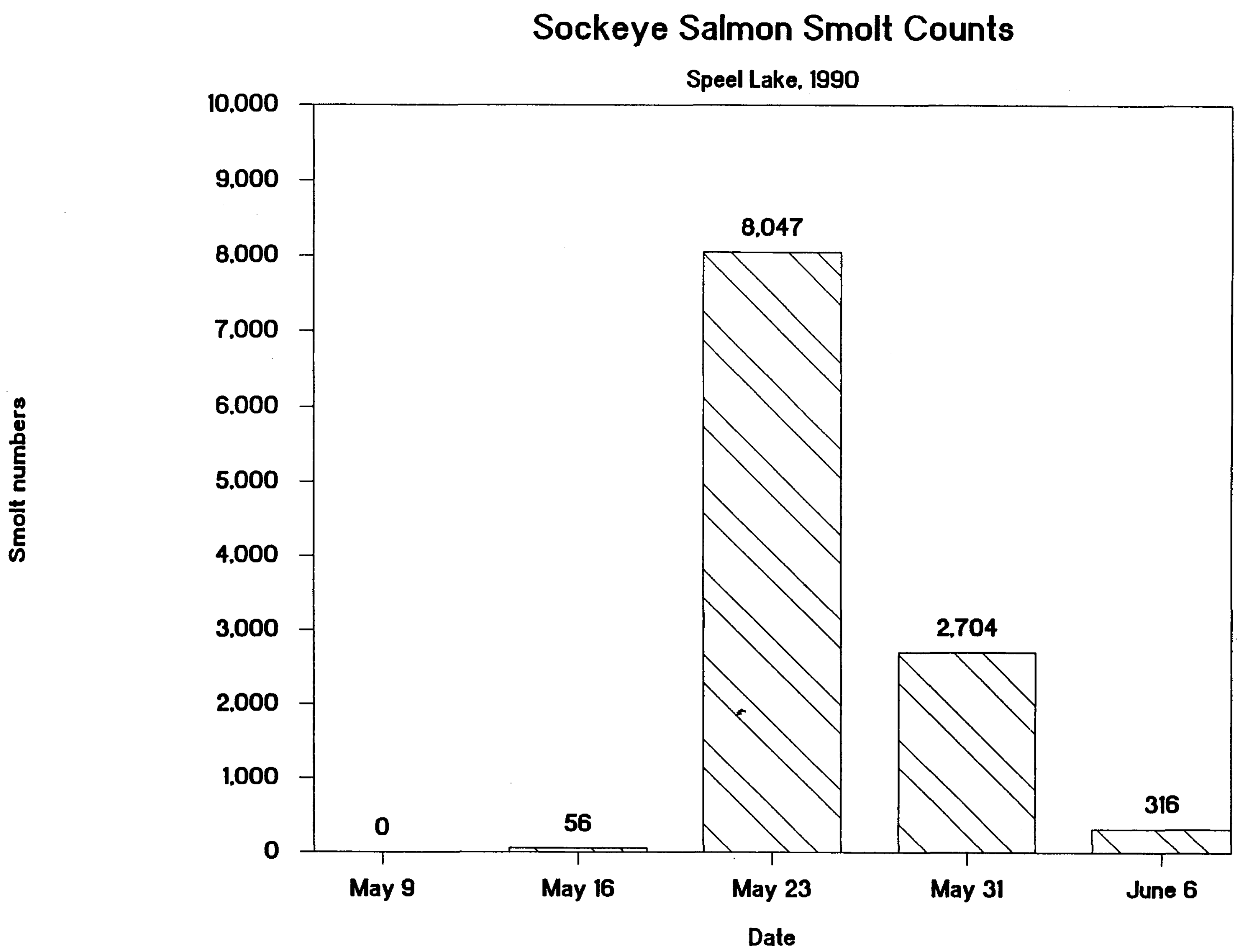
SITE MAP

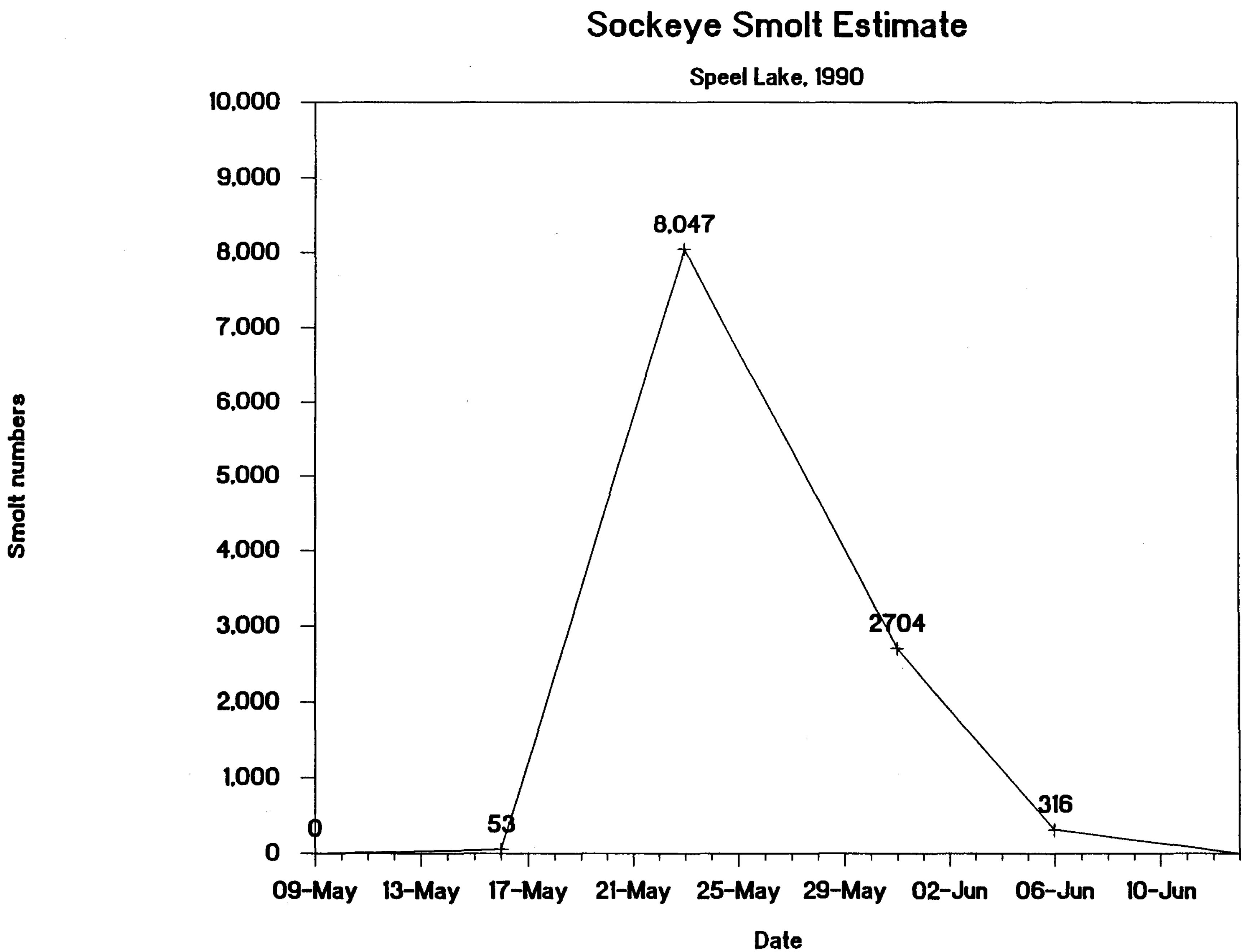
Table. Catch, escapement and total run of Speel Lake sockeye salmon.

Year	Escapement	Catch	Total Run
1983	10,484	NA	NA
1984	9,764	NA	NA
1985	7,073	NA	NA
1986	5,857	5,495	11,352
1987	9,353	9,252	18,605
1988	969	2,765	3,734
1989	12,229	7,425	19,654
1990	18,064	4,832	22,896
1991	327	NA	NA
AVERAGE	8,236	5,954	15,248

SPEEL LAKE BATHYMETRIC MAP




Sockeye Salmon Smolt Counts
Speel Lake, 1990
Smolt numbers
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
56
8,047
2,704
316
May 9
May 16
May 23
May 31
June 6
Date



Sockeye Smolt Estimate
Speel Lake, 1990
Smolt numbers
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
8,047
2704
316
53
0
09-May
13-May
17-May
21-May
25-May
29-May
02-Jun
06-Jun
10-Jun
Date

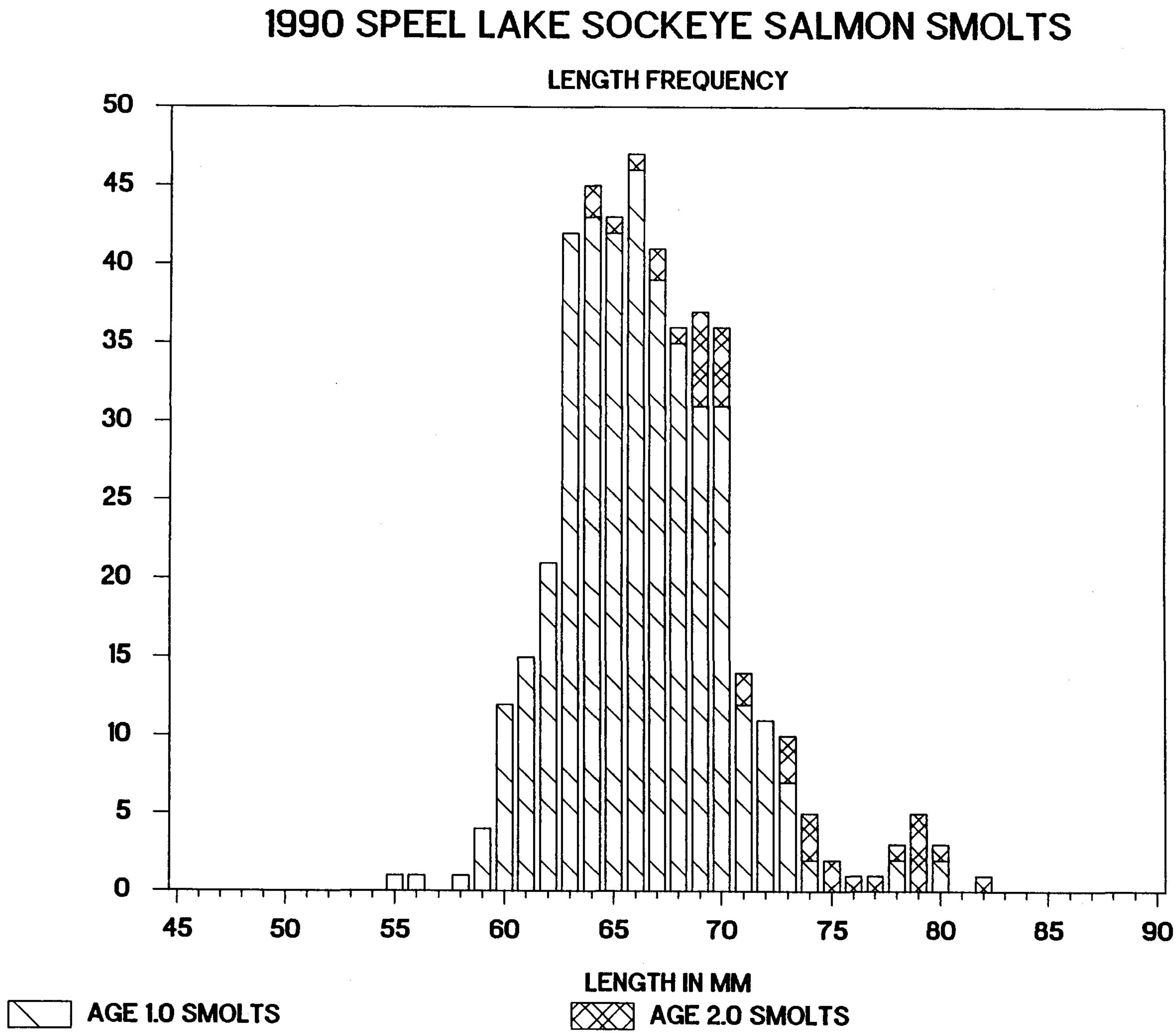
Table . Summary of Speel Lake sockeye smolt samples for 1991 and 1992.

1990 SPEEL LAKE SOCKEYE SALMON SMOLTS

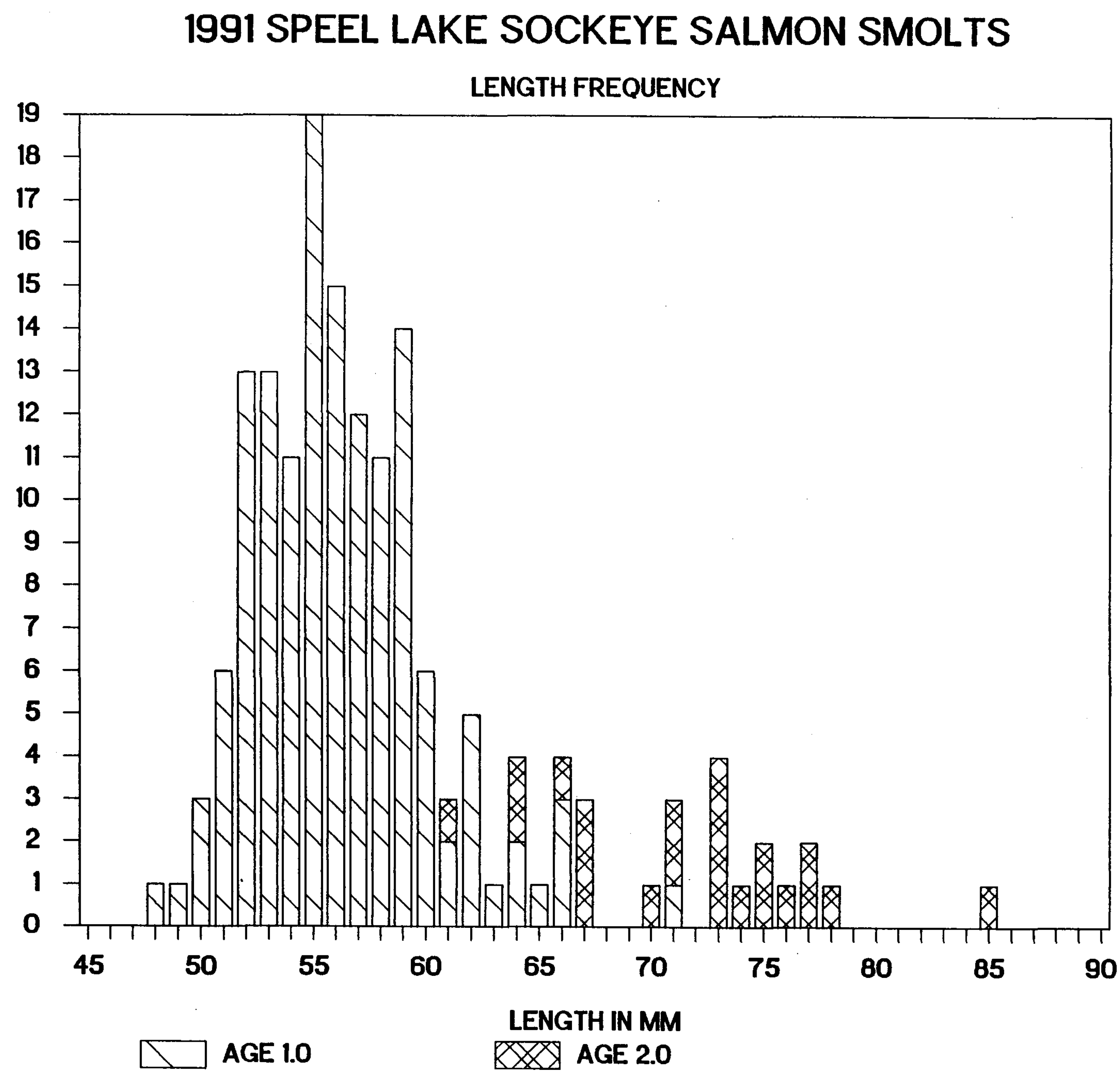
	DATE					
	May 6	May 16	May 23	May 31	June 7	Total
AGE 1.0						
Number		49	167	122	62	400
Avg ln		69	66	65	66	66
Avg wt		2.5	2.5	2.1	2.5	2.4
percent		94.2%	85.2%	97.6%	95.4%	91.3%
AGE 2.0						
Number		3	29	3	3	38
Avg ln		78	72	69	71	72
Avg wt		4.1	3.4	2.4	3.3	3.4
percent		5.8%	14.8%	2.4%	4.6%	8.7%

1991 SPEEL LAKE SOCKEYE SALMON SMOLTS

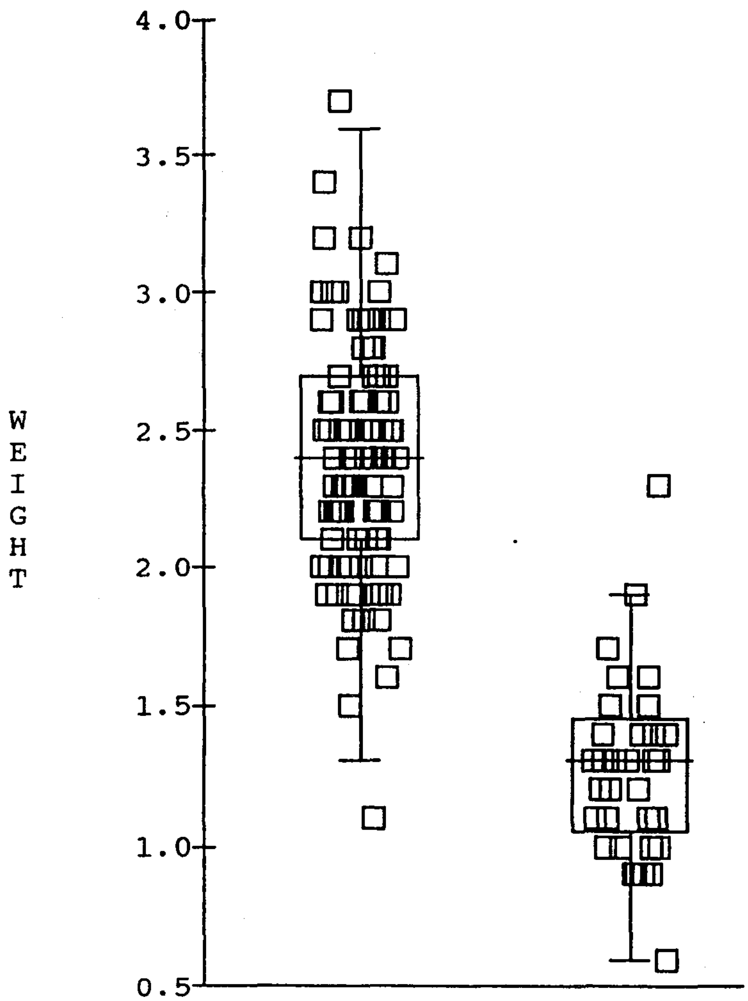
	DATE		
	May 28	June 4	Total
AGE 1.0			
Number	64	76	140
Avg ln	55	57	56
Avg wt	1.2	1.4	1.3
percent	91.4%	82.6%	86.4%
AGE 2.0			
Number	6	16	22
Avg ln	73	71	72
Avg wt	3.1	2.8	2.9
percent	8.6%	17.4%	13.6%



1990 SPEEL LAKE SOCKEYE SALMON SMOLTS
LENGTH FREQUENCY
50
45
40
35
30
25
20
15
10
5
0
45
50
55
60
65
70
75
80
85
90
LENGTH IN MM
AGE 1.0 SMOLTS
AGE 2.0 SMOLTS


1991 SPEEL LAKE SOCKEYE SALMON SMOLTS
LENGTH FREQUENCY
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
45
50
55
60
65
70
75
80
85
90
LENGTH IN MM
AGE 1.0
AGE 2.0

SPEEL SMOLT WEIGHTS 1990-1991



YEARS	1990	1991
# Pts	400	140
Mean	2.39075	1.306429
IQR	0.6	0.4

EACH DATA POINT=4 POINTS

WORKSHEET FOR PROJECTING 1990 SOCKEYE SALMON SMOLT EMIGRATION FROM SPEEL LAKE

WILD FRY		CIF FRY	
1988 Escapement	969		
45.2% Females	438♀		
54.8% Males	531♂		
Hatchery Removal	132♀		
	127♂		
Natural Spawn	306♀	Hatchery Removal	132♀
	404♂		127♂
Fecundity	~2,700		
Potential Egg Deposition (PED)	826,200	Green Eggs	295,245
		Eyed Eggs	251,400
Survival Assumptions:			
PED to Fry = 5%	41,310	Stocked Fry =	226,622
Fry to Smolt = 20%	8,262	Fry to Smolt = 22%	49,857
% 1.0 Smolt = 95%	7,849	% 1.0 Smolt =	47,364

PROJECTED AGE 1.0 SOCKEYE SALMON SMOLT FOR 1990

Hatchery	47,364	85.8%
Wild	7,849	14.2%

RESULTS OF 1990 SOCKEYE SALMON SMOLT EMIGRATION FROM SPEEL LAKE

ESTIMATED MAGNITUDE OF EMIGRATION	≈80,000
AGE COMPOSITION	
AGE 1.0	91.3%
AGE 2.0	8.7%
AGE 1.0 PORTION OF EMIGRATION	73,000

ENHANCED VS WILD COMPOSITION OF AGE 1.0

WILD	100%	73,000
ENHANCED	0%	0

WILD PRODUCTION

PED	826,200
PED to Fry = 20%	165,240
Fry to Smolt = 44%	73,000

HATCHERY PRODUCTION

Fry Stocked	226,622
Fry to Smolt = 0%	0

In-lake Production and Emigration Mortality of Sockeye Salmon Smolt from Juvenile Stocking of Sweetheart Lake, Southeast Alaska

by

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Sweetheart Lake is a 509 hectare, oligotrophic lake located near Juneau, Alaska. The outlet stream consists of a series of falls that form a natural barrier to anadromous fishes. An empirical sockeye salmon (Oncorhynchus nerka) production model for coastal Alaskan lakes estimated that, based on the observed limnological characteristics, the lake carrying capacity is 7.0 million juvenile sockeye salmon. Fishery and limnological investigations conducted in 1989 indicated that the lake rearing potential was under utilized. As a result of these investigations a project to plant juvenile sockeye salmon was initiated to fully utilize the lake rearing potential and create a terminal-harvest salmon fishery.

In June 1990, 2.47 million juvenile sockeye (average fork length = 30 mm, average weight = 0.2 g) were planted in Sweetheart Lake. Hydroacoustic and tow net sampling in October 1990 estimated the population at 959,000 juvenile sockeye salmon (average fork length = 74 mm, average weight = 4.9 g). Using the sockeye salmon production model predictions this population would produce approximately 676,000 smolts the following spring.

Because of the high velocity and turbulence of the lake outlet, some degree of smolt mortality during emigration was anticipated. A smolt-trapping project operated on the lake outlet stream during spring 1991 indicated a relatively high (40%) stream-induced mortality rate. The trapping project estimated a total smolt emigration of 779,000 smolts (average fork length = 89 mm, average weight = 6.1 g).

Despite stream-induced smolt mortality, the total juvenile-to-smolt survival rate of 32% was 12% higher than predicted by the production model. Based upon an empirical sockeye salmon smolt-adult survival model, the total emigration estimate and the size of the smolts, these fish have the potential to produce approximately 140,000 adults.

Rehabilitation of a Natural Sockeye Salmon Population Through Lake Enrichment, Redoubt Lake 1982-1991

by

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Historically, adult sockeye salmon escapement into Redoubt Lake exceeded 100,000 fish, but declined steadily over the last century. The initial decline is most likely the result of over harvest, with subsequent declines theoretically resulting from decreased nutrient inputs to the system through the reduction in the number of adult carcasses available for decomposition.

As a result of a feasibility study conducted in 1980, which revealed low numbers of zooplankters (781/m^3) and nutrient levels (total phosphorous <2.8 ug/l), Redoubt Lake was included in the ADF&G-FRED Division lake enrichment rehabilitation program. A detailed pre-enrichment study initiated in 1982 to assess the physical, chemical and biological production characteristics of the lake confirmed the results of the 1980 study. In 1984, applications of inorganic fertilizer were initiated to stimulate primary and secondary production, consequently increasing food available to lake rearing sockeye juveniles. Fertilizer was applied to the lake during 1984-1987, 1990 and 1991.

Mean smolt length increased significantly (P<0.001) after fertilization. Mean length of age I and age II smolts increased from 72.3 to 78.8 mm, and 76.3 to 103.3 mm respectively. Adult sockeye salmon escapement averaged 7,440 fish/year (N=7, range 442-13,581) for fish produced from years with no fertilizer added and 49,326 fish/year (N=3, range 29,945-72,781) for fish produced from years when fertilizer was added.

The empirical sockeye salmon production model developed for coastal Alaskan lakes, estimates that Redoubt Lake is capable of producing 325,000 adult sockeye annually. Observed smolt sizes and expected survival rates for various life stages, has allowed the reasonable prediction of the number of adults that will return. Returns exceeding 150,000 are expected in 1995 and 1996. Future studies planned at Redoubt Lake to relate in-lake and marine survival rates with limnological parameters will provide information to refine the production model and evaluate the success of the enrichment project.

Hybrid Kokanee Culture
Lake Ozette, Washington

by

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Hybrid kokanee (kokanee females x sockeye males) crosses were begun in Lake Ozette, Washington in an attempt to produce a smolt with genetic characteristics native to the Ozette system. Expected results are anadromy from the hybrid kokanee the following spring, returns as sockeye adults at age 4 or 5 and spawning contribution to the sockeye population.

The hybrid program, initiated in 1990, is an experiment to determine the feasibility of utilizing a local kokanee population as an egg source for rebuilding the sockeye population. Viral sampling (1988-1990) of the Lake Ozette kokanee stocks has revealed no IHN virus, thus a successful hybrid could result in an IHN-free egg source. Kokanee eggs were collected November 16 and 20 from Siwash Creek from 81 ripe or partially ripe females. Fish were collected with dipnets and beach seines from the spawning grounds. Kokanee eggs were fertilized with the milt from 5 sockeye males collected from the shoreline spawning areas of Lake Ozette. The eggs from the two spawning dates were incubated in an isolation unit at the Umbrella Creek Hatchery.

Incubation: Both sockeye (PS) and hybrid kokanee (HK) eggs were incubated in bulk incubators - upwelling for sockeye and downwelling for HK. Fry containment upon emergence was foremost in incubation design. Silt accumulation and poor quality eggs resulted in a 30% survival rate to eyed egg for HK. We also observed a differential mortality rate for the two HK egg takes - a lower mortality with a 50ppm iodophor treatment on November 16 and higher mortality at 100 ppm for the November 20 egg take. The PS had a 95% survival rate to eyed egg under the same water quality conditions.

Rearing: We experienced difficulty starting the KH on 000 Moore Clark starter mash. Ultimately we had to grind it in a mill and hand feed the resultant flour to get the HK to start on feed. Starvation, a high mortality rate and pinheads occurred during this period. Pure sockeye had none of these problems. Emergence sixes; PS - 0.14 g, HK - 0.09 g. Target release size of 1.0 g was achieved by June 28, however variation in size was unacceptable and mortalities minimal at this time, thus the fish were reared until all were > 1.0 g.

Release: The PS were released into Lake Ozette on July 19 at 1.9 g. The HK were released into the lake on July 30 at 2.0 g. Releases were made in the southern part of the lake, an area of higher zooplankton densities noted in biweekly limnetic surveys.

Evaluation: Each stock was given a unique fin clip at release. PS - 10,000 released with an ADLV clip, HK - 2,900 released with an ADRV clip. Recoveries are expected in the 1992 smolt outmigration trap. Previous years' trap operations have captured large (age 2+) kokanee outmigrating from Lake Ozette.

Open Forum

Ken Roberson, chair

Cedar River sockeye enhancement.

M. LaRiviere. *The proposed spawning channel on the Cedar River was legislatively mandated.*

J. Burke. *This project could put sockeye enhancement in a poor light. Until very recently sockeye culture was considered impossible. We have now been successful in the public eye. When sockeye enhancement was initiated on the Cedar River in the late 1970's, we found the broodstock heavily infected with IHNV. The virus was even found in the substrate under these fish.*

In our early sampling we simply wanted to determine if IHNV was present in a stock of fish. We found we could most often find it in spawned out fish. It is most probable that only several of the first fish on the spawning grounds are infected with IHNV, but then the virus moves from these fish to the fish that follow them to the spawning areas. The virus is also usually less prevalent in the early part of the run. If spawned out fish and carcasses are not removed, the area will get "hotter and hotter".

G. Sprague. *The idea that it is best to take eggs from the central part of the run could be a misconception.*

D. Harding. *In Canadian sockeye spawning channels the gravel is cleaned every year. For two years following an epizootic the production from the channel was contaminated.*

M. Haddix. *The most efficient way to accomplish Cedar River enhancement is through a hatchery.*

G. Sprague. *There is a large movement in the state (Washington) against hatcheries.*

D. Harding. *I feel spawning channels are oversold.*

L. Peltz. *The AFS Chapter could write a letter to WDF with suggestions based on Alaska hatchery experiences with sockeye.*

K. Roberson. *We should never leave all the eggs in one compartment. A spawning channel does not meet these standards.*

Streamside Incubation.

S. Reifenstuhl. *We have been experimenting with in-lake incubators for the last five years at Redoubt Lake. It was difficult to find high quality water. We found a way to use a downwelling system through the box. The incubator were held on the surface until they were seeded with eggs, then we put them on the bottom. This procedure achieved about 60% survival using biorings as substrate.*

B. Bachen (NSRAA, Sitka). *The eggs are spread over the substrate and do not have too much egg- to-egg contact. They are not treated for fungus.*

M. Haddix. *If you use palm trays, Vexar, and saddles, the holes are large enough for emergent fish to escape. We had about 80% survival, but predators can also reside in these incubators. When we used these trays in nonanadromous lakes, predators ate all emerging fry. Not much has really been evaluated. We have fed fry in net pens and tagged them. These fish were the same size as the wild fish. They had a good start.*

R. Josephson. *What about English Bay?*

D. Moore (Alaska Dept of Fish and Game, Big Lake Hatchery). *The English Bay project started three years ago. The project was designed to enhance a subsistence fishery. Initially the eggs were taken to Tutka Hatchery for incubation, then released in a bay full of arctic char. Last year the eggs were incubated at Big Lake Hatchery. Emergent fry were reared in net pens in the lake. The lake surface temperature was 60 F. Half a million eggs were collected this year. They will be incubated at Big Lake and the fry transferred to the lake and released.*

D. Rosenberg (Alaska Dept of Fish and Game, Klawock). *We have used net pen rearing in Klawock Lake. The water surface does not freeze when fish are in the pens. The fish were reared to a density of 2 pounds per cubic foot.*

Genetics. *There were several questions, but the general consensus was that we could not make a point without geneticists at the meeting.*