MIGRATIONAL CHARACTERISTICS, BIOLOGICAL OBSERVATIONS, AND RELATIVE SURVIVAL OF JUVENILE SALMONIDS ENTERING THE COLUMBIA RIVER ESTUARY, 1966-1983

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Final Report of.Research
Funded by
Bonneville Power Administration
U.S. Department of 'Energy-
Division Of Fish-and Wildlife
P.O. Box 3621
Portland, Oregon 97208
Contract DE-A179-84BP39652
Project Nb.. 81-102

and

Coastal Zone and Estuarine Studies'Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
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2725 Montlake Boulevard East
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April 1986

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During our initial research.(1966-1972),. various .fishing methods (fyke, trawl, gill, and seine nets) were`•used at_many locations. throughout the estuary. Procedures and sites used from 1977-1980 and 1981-1983 were. adopted from earlier work with the extension of sampling sites into marine waters adjacent. to the-mouth. Of the Columbia River.

The specific objectives of the overall. study with juvenile salmonids were as follows. (objectives were :expanded with time, Objectives 1-4 apply to research from .1966 through 1972.,.and Objectives 1-10 apply. to research from 1977 through 1983):

1. Evaluate sampling equipment, develop procedures,'and establish. suitable sampling sites which could provide :the' of representative samples of juvenile salmonid 'migrants from each fish stock passing. through the estuary.

2. Document recovery dates for all marked fish, define migration timing for each species, and examine the differences between identifiable races and stocks in relation to biological, cultural, and .migrational variables.

3. Document movement rates between release and sampling sites and evaluate effects from environmental and biological variables.

4. Examine diel movement patterns at'Jones Beach.

5. Evaluate consistency of recovery percentages and determine the effects of river flow.

6. Provide capture percentages of marked groups to estimate relative .survival of juvenile migrants in relation to:'

a. Fish production at mitigation hatcheries.

b. Juvenile bypass systems at dams.

c. Transportation programs.

d. Fish size, release Site, and date.

e. Survival to adulthood.

f. River' flows and electrical. power production.

7. Compare recovery data of marked wild fish to recovery data of hatchery. stocks.

8. Examine stomach contents of 'tagged salmonids to determine the extent of inter-. ant intra-specific competition for food throughout the 1979-1983 migration period-and' relate stomach fullness, to variables - which may have affected feeding habits. .Compare observed feeding rates to-those of fish from other areas.

INTRODUCTION

Natural runs of salmonids in the Columbia River basin have decreased as a' result .of . hydroelectric-dam development, poor land- and forest-management, and over-fishing (Raymond 1979; Netboy 1980). This has necessitated increased salmon culture to assure adequate numbers of returning adults. Hatcheries are.now the primary source of salmon for the Columbia River; in the late 1970s, they annually produced about 100 million fall chinook,salmon, Oncorhynchus. tshawytscha; 21 million spring and summer chinook salmon; 30 million coho salmon, R. kisutch; and 10 million steelhead,' Salmo gairdneri. Even with hatchery production at this level, management agencies agree that, in general, .salmonid harvests have deteriorated.

Hatchery procedures and: facilities are continually . being modified to improve. *both* the efficiency. of production and the quality . of juveniles. produced. Initial efforts to evaluate changes in hatchery procedures were dependent upon adult contributions to the fishery and• returns to the .hatchery. Since salmonid survival depends on river, estuarine,. and :_ ocean habitats, the variations in adult return data'are. difficult to..evaluate and. unknown. factors. may overshadow the. impacts of changes in hatchery culture techniques--s better system of evaluation was needed.

From 1966-1972, the National 'Marine Fisheries Service (NMFS), Northwest and .AlaskaFisheries Center, Coastal Zone and Estuarine Studies Division,, developed and refined. procedures for sampling juvenile salmon and steelhead entering the Columbia River estuary and ocean plume (Fig. 1)., The sampling of hatchery fish at 'the terminus of their freshwater migration assisted in evaluating hatchery .production techniques and identifying migrational or behavioral .characteristics that influence survival to and through the estuary.

Because of a lack of funds, no sampling was done from 1973. through 1976. .From 1977 through. 1983, the Northwest Regional Council and the Bonneville Power Administration (BPA) funded the estuarine sampling program to provide assessment-of salmonid outmigrations from wild stocks.. and from mitigation hatcheries experimenting with. enhanced cultural procedures. The facilities or procedures implemented for safe juvenile salmonid passage at dams and through reservoirs were also evaluated.. Extensive fish marking programs by state and' federal fishery agencies'provided the capability to assess migrational behavior and' relative survival of identifiable hatchery and wild stocks. Fall Chinook salmon (subyearlings),' particularly,- provided a consistent. and thorough index because of Intensive marking programs. to assess contribution. (Vreeland 1984)..

The Columbia River estuary sampling program was uniquein attempting to estimate survival of different stocks and define various aspects of migratory .behavior In a large river, with flows during the spring freshet. from. 4 to 17 thousand. cubic meters per second' (m^3/second). Previous knowledge of "estuarine sampling for juvenile' salmonids was limited. to several small river systems and. the evaluation of movement behavior, residence times, and feeding behavior, e.g., Chehalis River, Herrman 1971; Siuslaw River, Nicholas et. al. '1979; Sixes River, Reimers 1973, and Bottom 1981; Nanaimo River' Healey 1980; and Yaquina River, Myers 1980.

GENERAL STUDY AREA

For the purposes of this .study, the Columbia River estuary is defined as *75 km of the* lower 'river between the narrows at Jones' Beach to the ends of the jetties at the river mouth (Fig. I). The estuary. is approximately.2 km wide at the mouth and nearly *15 km* wide at its ' broadest expanse near `the ..middle. For the most part, it is a shallow (<5 m in depth) system ' of shifting sand bars, extensive mud flats, and numerous islands. ; A ship channel is maintained at a depth of 14 in . by .periodic dredging by the U.S. Army Corps of Engineers. Tides normally .reverse. river flow as far as 115 , km upstream (to -Rainier, Oregon), but - .the seawater intwion is generally limited to about 38 km upstream from the river mouth._' By this- definition, the Columbia River estuary consists of an upper freshwater and a lower brackish water component.

Marine waters sampled were near-shore areas from thesurfline (4'in deep) to 24 km offshore .0125 m deep) north and south.: of the Columbia. River mouth. Surface water salinity varied from 17.to 27 °/oo.

The sampling sites varied during. the various time periods of the study. During the initial a taxes of the estuarine study (1966-1977) , 33 sampling sites were evaluated for providing representative catches Of'most salmonid stocks :migrating into the es tuary (Fig. .. 2). During 1978-1980, there were two primary sampling sites:., (1) the upper extreme of the estuary at Jones Beach, River Kilometer (RKm) 75 and -(2) near the lower margin of the estuary, in brackishwater, at McGowan;, ,WA (RKm .16). Additional sites throughout the. estuary,..tiver mouth, and in the Columbia River coastal near-shore plume were sampled intermittently.:to. provide additional information about movement through the estuary. From 1981. to 1983, only the. Jones. Beach .site was - sampled; evaluation was limited to factors impacting fish during their migration to the. estuary, e.g.., cultural treatment .'prior to release, fish size., distance-And date of migration, and river flow.

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[1]/ U.S. Army Corps of Engineers. 1960. Interim report on 1959 current measurement program, Columbia River at mouth, Oregon and Washington. Portland, Oregon.

9. Provide samples and.make biological observations to assist other investigators working on related research projects. (Appendix A)

10. Document catches' of non-salmonids collected during sampling.

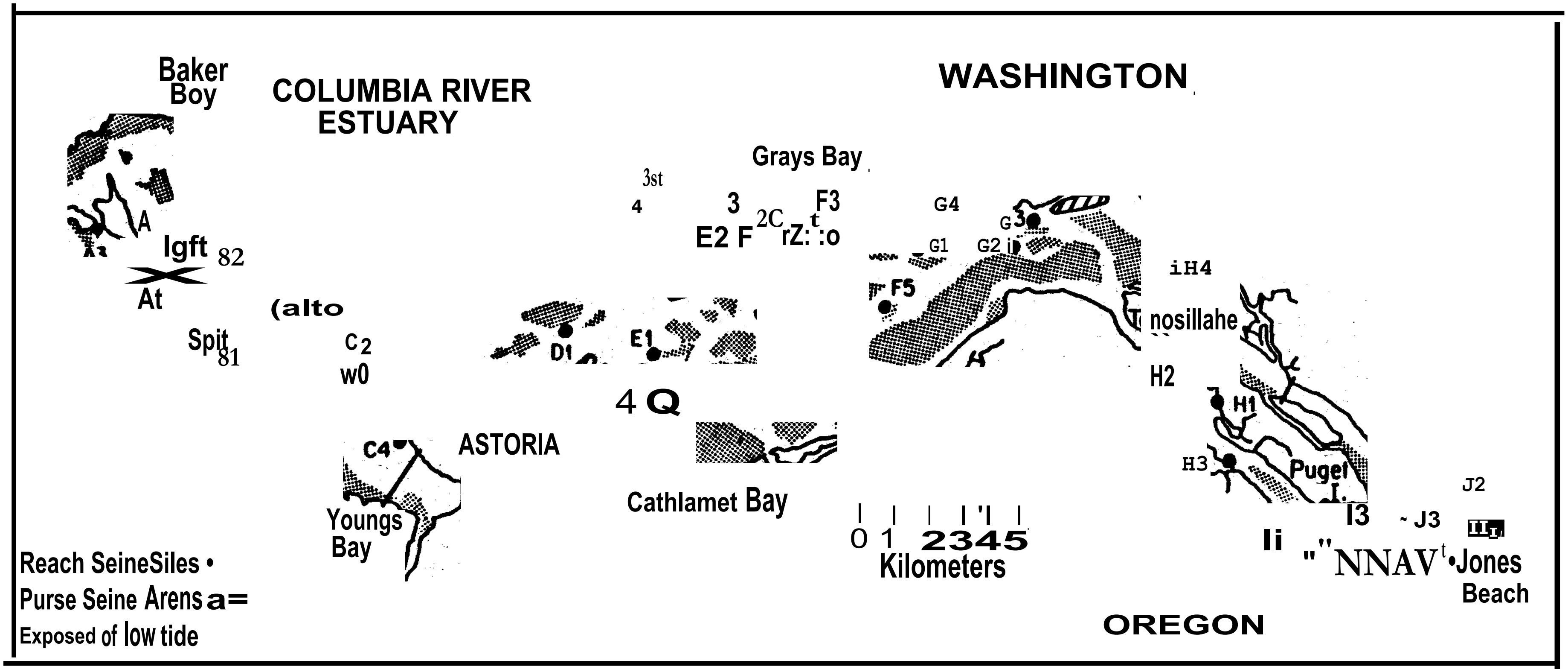

Figure 2.--The Columbia River estuary showing beach seine .sampling sites and purse seine_ sampling areas,

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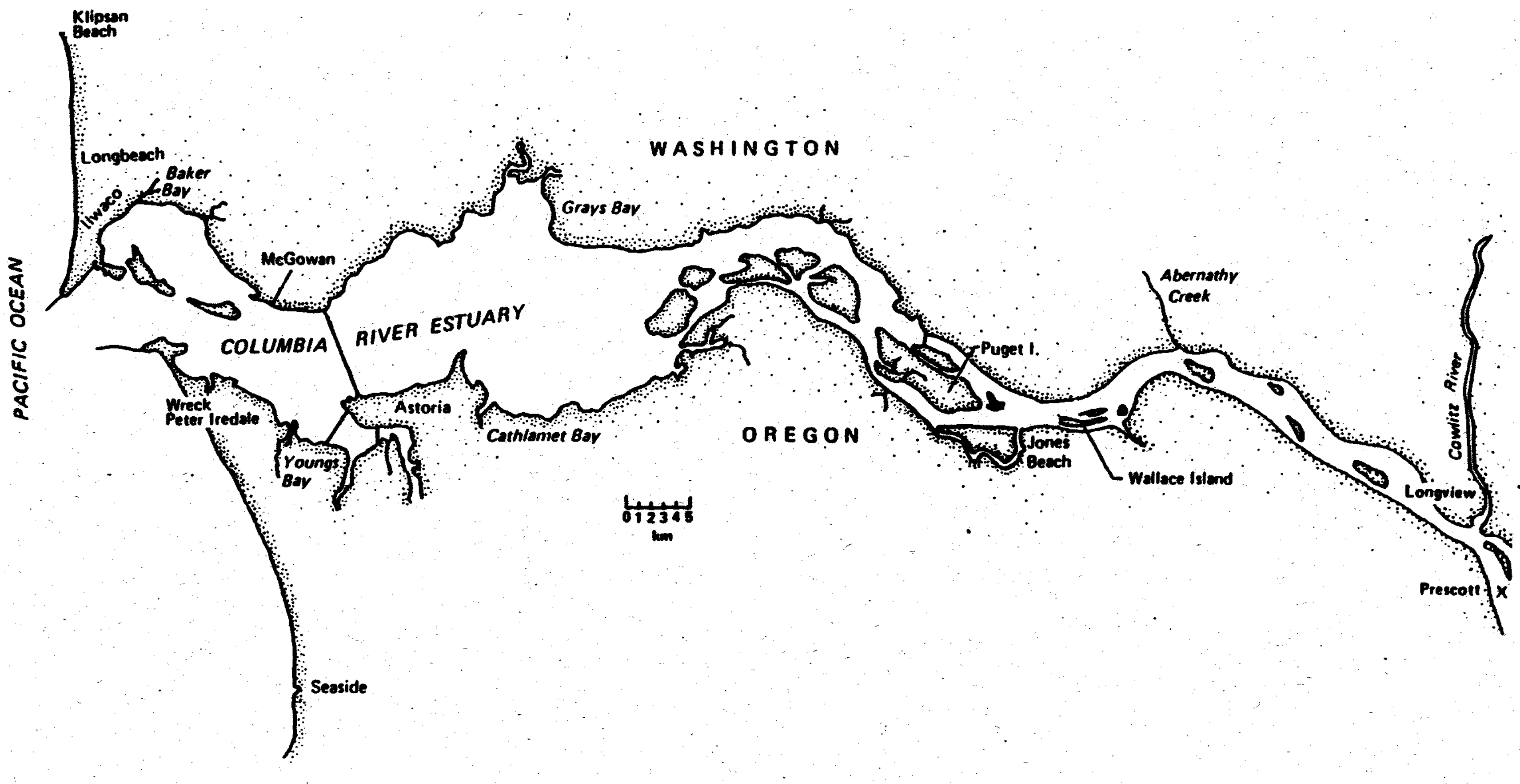


Figure 1.--Hap of lower Columbia River and estuary.

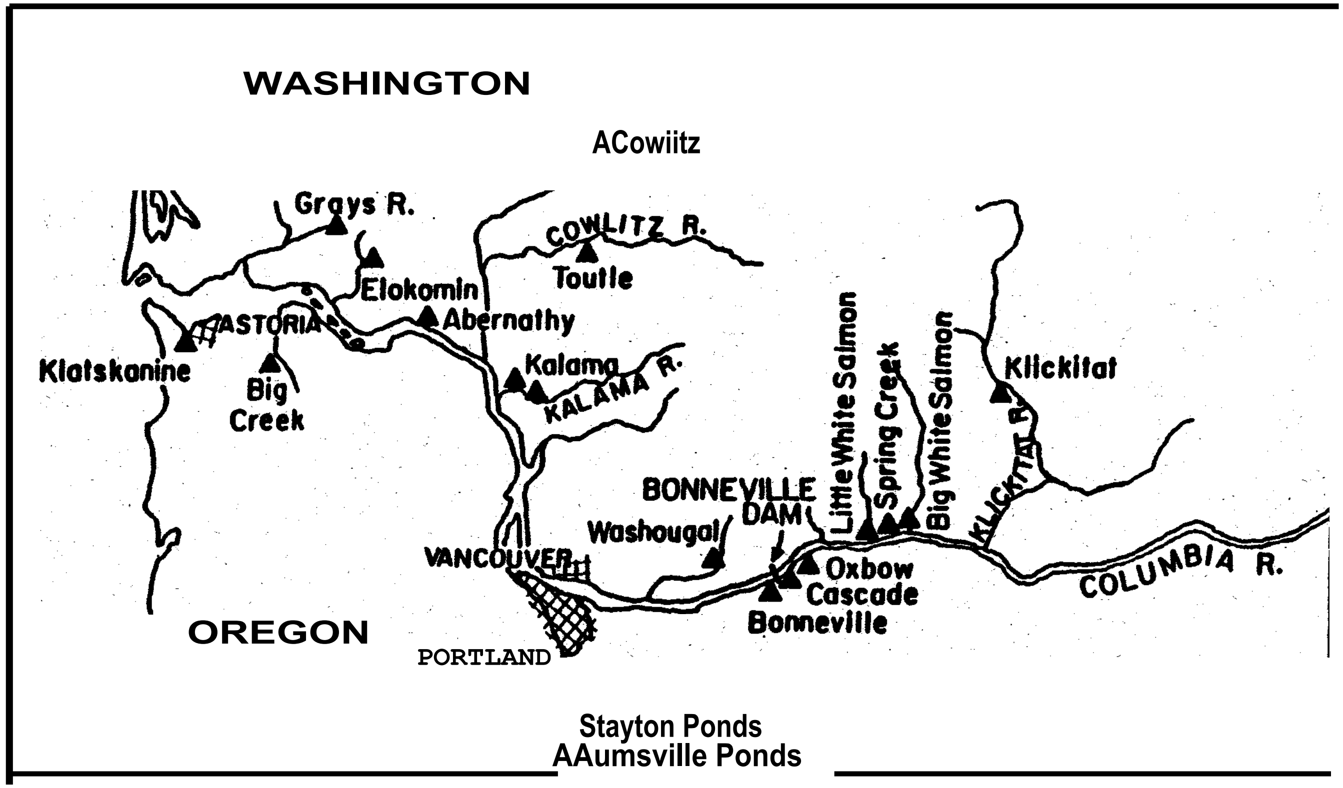


Figure 3.--The lower Columbia River and major fall Chinook salmon producing hatcheries.

SECTION I--FALL CHINOOK SALMON, 1966-1972

Introduction

Fall chinook salmon are an important fishery resource in the, Pacific Northwest. The Columbia River has long been recognized as the largest producer of fall chinook salmon in the world. Hydroelectric and. other development, however, has seriously reduced the natural production of the Columbia River system. To compensate for this loss, natural production of fall chinook salmon is now supplemented by an extensive' system of state and federal hatcheries (Fig. 3). The, effectiveness of this hatchery system is dependent upon the continuing development of new and improved management and production techniques. This in turn requires biological and fishery catch studies to evaluate the impact of various production techniques. Cleaver (1969a). provided significant information on the life history and ocean survival of Columbia River fall chinook salmon, and .recent papers have examined the contribution of Columbia River hatchery fish to the fishery (Worland et al. 1969; Lander 1970). However, information relative to the migrational behavior of juvenile fall chinook salmon to and through the Columbia-River estuary is limited.

Heretofore, most assessments of the effectiveness of hatchery production techniques were based on evaluations of adult returns to the various fisheries and/or hatcheries. Such evaluations must await the return of adult. fish which normally spend from 2 to 5 years in. the ocean. Although it may .be -conceded that the ultimate measure of the effectiveness' of fish culture operations should be .in terms of adult catch and escapement to. the hatcheries, assessments of juvenile survival to the estuary could be of distinct help to fishery managers. Relative survival of marked juveniles to the estuary could, for 'example,. provide ,initial clues to the success or failure of a particular rearing or release technique in relation to the prevailing hatchery and in-river. environment. This information would be available to managers within -weeks instead of years..

The specific objectives of this study were to provide information on movement rates and survival of juvenile fall'chinook salmon during migration to the estuary and to examine migration timing, movement patterns, and residence time in the estuary.

Methods

The downstream migration of juvenile fall chinook salmon was sampled in. the Columbia River estuary from 1966 through 1972. The primary sampling gear was a 95-m variable-mesh beach seine developed and described by Sims and Johnsen (1974). This net fished to a depth of 3 m and was set from the beach with a small outboard-powered boat. Thirty-three beach seine sampling sites were used during the study (Fig. 2). Sampling effort varied as to site and intensity each year, but was primarily concentrated at Jones Beach, Oregon, (Site J-1 in the upper estuary). ' The Jones Beach Site is. located approximately 75 km upstream from the river mouth and about 50 km above the

.Releases of Marked Hatchery Fish

About 6.5 million freeze-branded juvenile. fall Chinook. salmon were released at various .,hatcheries, and other *locations* by cooperating agencies .during 1968, 1969,. and. 1970. Migrational . timing and rates of...downstream' movement were determined from recoveries of these. marks at Jones Beach.

Some releases of .branded fish were also designed to examine relative survival of_hatchery-reared fallchinook salmon. Groups offishwere divided into duplicate or multiple lots (each .lot identical in size distribution to all others). Each lot of .fish was given a separateidentifying brand. and released at various locations -upstream from. the Jones Beach sampling site. Estimates of relative survival of the various lots were based on ..the percentage of brands recovered at Jones Beach, assuming that survival from those releases closest to Jones Beach was 100x. Survival rates estimated in this manner were subject to two . additional assumptions: (1) that. the distribution of all lots of..marked fish from a given subdivided group was the same, at- the point of sampling and (2) that each lot of fish within a subdivided group was equally vulnerable to .capture by the .sampling gear. Comparisons of relative 'survival rates compiled in this manner were'validonly for lots within a. given subdivided group. Comparisons" of groups of fish from different hatcheries-or from. groups. of different . size. from the same hatchery. were not valid because the sampling recovery rate maybe variable.

Results and Discussion

Sampling in the Columbia River estuary, from 1966 to 1972 captured more than a million juvenile fall chinook salmon'(Table'1), included were more than 30,000 marked fingerlings, representing' 59 separate marked releases. The beach seine was by far the most effective sampling gear used to capture fall Chinook salmon in the estuary and accounted for almost 98% of the total sample. The beach seine was adaptable to near-shore areas throughout the estuary, and fish taken by this gear were generally ,in good' condition and suffered little mortality. Beach seines were also effective in capturing yearling coho salmon, but took relatively few juvenile spring chinook salmon or steelhead trout.

From 6 June to 19 July 1968, 18 groups. of juvenile fall Chinook salmon were taken from the beach seine catches at Jones Beach, marked with s thermal brand, and released at Beaver Terminal about '4.5 km above the Jones Beach site (Table 2). .Analysis of. the recovery data from these releases indicates that the sampling variability of the beach'' seine was closely related to size of fish--the smaller the fish the higher the rate of capture (Fig. 4)-7and was not significantly affected by river flow (Fig. 5).

Distribution

Juvenile fall chinook salmon were found concentrated in. the. shallow, near-shore areas throughout the estuary. *The* concentration of fall chinook salmon along the beaches is illustrated by comparing~.adjacent beach and purse normal upper limit of saline intrusion. Site H-1 on nearby Puget Island and Site J-2 on .the Washington shore immediately across 'the river from Jones Beach were also sampled frequently during various phases of the study. Host beach seining effort in. the lower estuary was concentrated in the Clatsop Spit area (Sites A-1 and B-1).

In 1967, .1968, and 1969, purse seines were used to sample deep-water channels and 'other areas where beach seining was not practical. Purse. seines of varioussises were used depending on the physical characteristics of the area to be .sampled. The basic purse seine was 229 m, long by 10 m deep.. A 152- by 3-m net was used *in shallow* or `restricted areas.. Net design' and operational techniques are described by Johnsen *and* Sims (1973). .

A 'two-door mid-water trawl was. used in 1966 *to* define vertical distribution of juvenile fall chinook salmon in deep water areas. This net had an opening 0V3... by 6, m and could *be* fished from surface to bottom by Adjusting door angle and *towing* speed.

During the. first 2 years, beach and purse seine sampling crews Processed their catches. and recorded all data where -the fish were caught. Fish holding and processing facilities were constructed at Jones Beach in 1968.: After 1 May 1968, beach and purse seine samples.fras.nearby areas -were transported to the beach facility for examination. All juvenile salmonids were anesthetized, identified, enumerated, examined. for marks and' brands, and a subsample measured. *to*- determine length frequencies. Marked or branded fish were given an additional mark by freeze branding (Mighell 1969).. Following' recovery from effects.of the anesthetic, all fish were returned to *the* 'river.

Definition of Stocks,

Because of, their extended 'freshwater residence, juvenile spring chinook salmon are generally at'least 10 to 20 mm longer than fall. chinook salmon when they enter the estuary (Mains and Smith 1964). This characteristic size difference was .used to separate fall ,chinook salmon from spring stocks. Because there is a slight overlap at times in length frequencies of the fall and spring stocks, a small percentage of the fish could have been erroneously identified. Occasionally, small numbers of fall, chinook salmon may also hold. over for various reasons in fresh water until the following spring. These fish—because of their extended growth—would be *classified* as spring chinook salmon unless they bore. some special identity (fin *clip or* brand) clearly signifying their fall chinook salmon origin.

Like fall. chinook salmon, juvenile summer chinook salmon stocks from the'' mid-Columbia also migrate downstream *as* "0" age fish and, therefore, *can not* be differentiated. from fall -chinook salmon by *size.* The relative number of juvenile summer chinook salmon reaching the estuary is small in comparison to fall chinook salmon; for. the purpose of this study, they, 'hive been classified as fall chinook salmon.and included in the fall chinook salmon catch :totals.

Table 2. Beach seine recoveries of-marked fallchinook salmon at Jones Beach, Oregon, from 18 groups of marked fish seined in the estuary and released upstream at:-Beaver,'Oregon, 6 June.- 19 July 1965.

Date released	Number released	Number recovered	Percent recovered	Mean length at recovery (mm)	River flow 1V (cfs x 1000)
6 June	847	7	0.83	68.0	352
10 June	712	5	0.70	70.5	391
13 June	1,019	7	0.69	74.1	416
18 June	1,377	10	0.73	72.1	406
21 June	1,791	13	0.73	74.7	396
24 June	1,235	8	0.65	74.4	388
26 June	2,557	19	0.74	69.3	346
27 June	2,524	21	0.83	69.4	321
1 July	4,597	29	0.63	74.7	301
3 July	4,935	34	0.69	72.5	301
5 July	6,750	41	0.61	74.2	299
8 July	5,186	27	0.52	76.2,	309
10 July	13,504	63	0.47	78.5	325
11 July	6.302	27	0.43	77.0.	348
15 July	10,797	46	0.43	79.9	322
16 July	3,565	15	0.42	79.4	291
18 July	5,715	28	0.49	80.1	283
19 July	3,519	19	0.54	79.9	260

a/River flows at Bonneville Dam from Annual Fish Passage Report 1968, North Pacific Division, U.S. Army Corps of Engineers processed report.

Table 1.-- Sampling effort and catches of juvenile fall Chinook . .salmon in the Columbia River estuary, 196.6-72.

	Type of gear.					
	Beach seines		Purse seines		Trawls	
Year	No. sets	Catch	No. sets	Catch	No. sets	Catch
1966	1,867	.139,058	0		465	4,171
1967	1,425	76,988	100	1,716	0	
196.8	2,359	314,334	.439	9,323	0	
1969	2,460	283,386	164	4,038	0	
1970	2,509''	'229,880	0		0	
1971	1,242	131,425	0			
1972	945	97,299,	0		0	
Totals	12,807	1,272,370	703	15,077	465	4,171

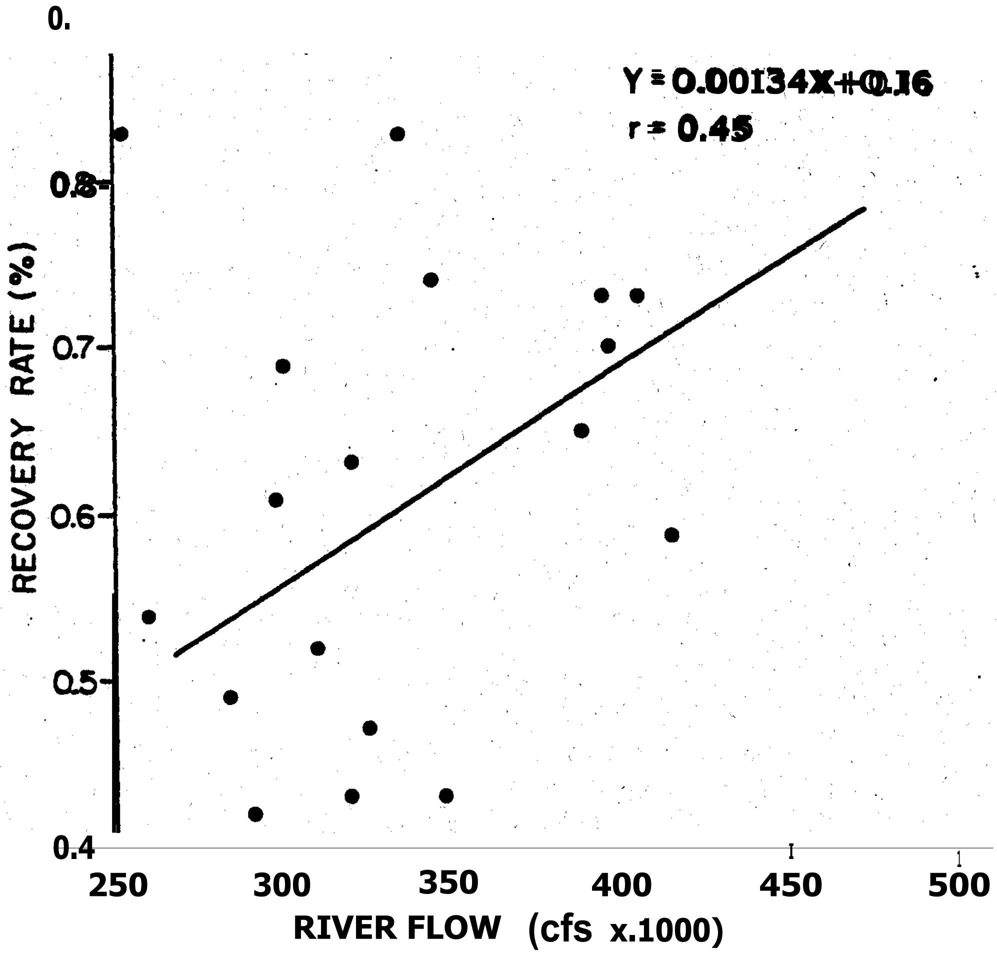


Figure 5.--Relationship of river flow to rate of beach seine recapture at Jones Beach, Oregon, for 18'groups of marked juvenile fall Chinook salmon released at Beaver, Oregon, 6 June-19 July 1968.

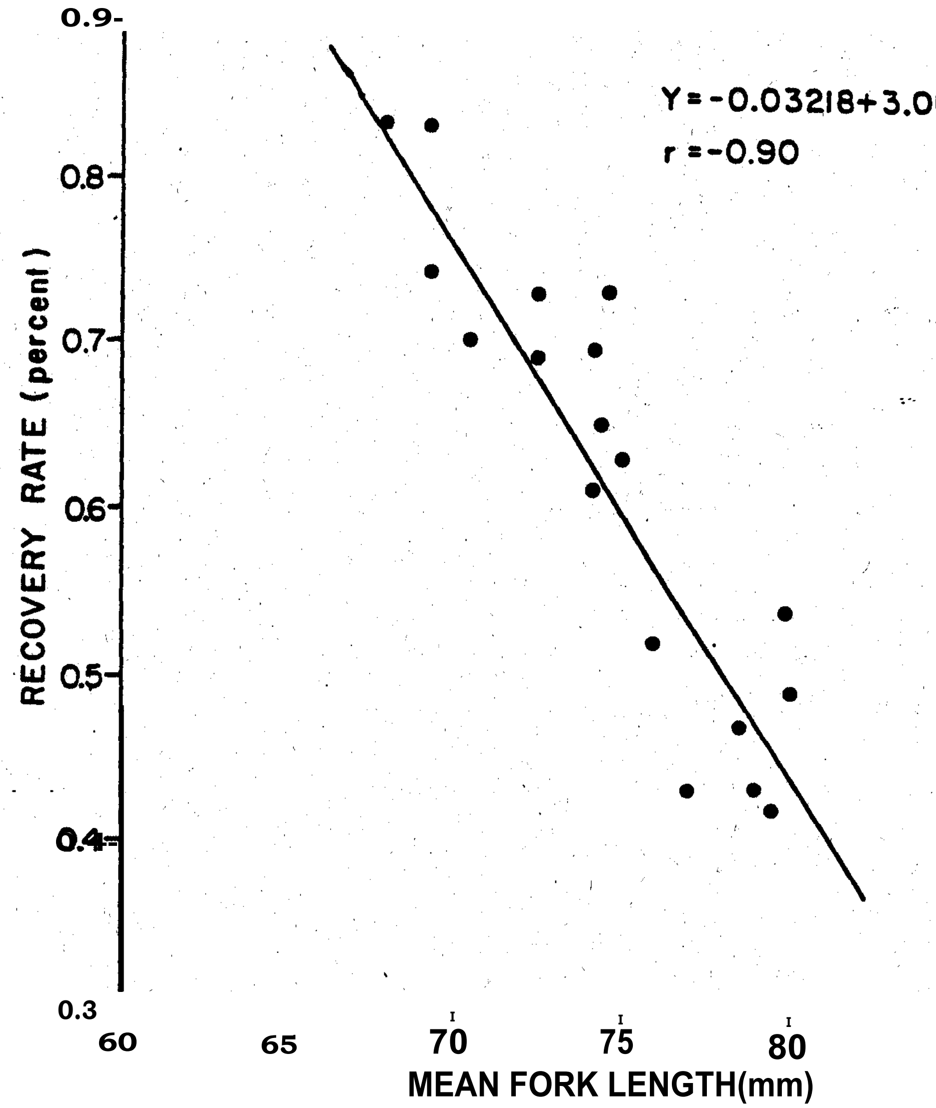


Figure 4.--Relationship of fork-length to rate of beach seine recapture at Jones Beach, Oregon, for 18 groups of marked juvenile fall Chinook salmon released at Beaver, Oregon, 6 June-19 July 1968.

Table 3.-- Beach seine and purse seine catch per effort (average number of fish per set) at Jones Beach, Oregon, 1 May-31 July 1968.

Type of fishing gear and month	;lumber of sets	Catch per set: Fall Chinook	Yearling Chinook	Steelhead	Coho
Beach seine					
May	139	177.6	2.1	1.1	25.1
June	178	164.4	0.1	0.0	0.6
July	147	497.0	0.0	0.0	0.2
Average		274.0	0.7	0.3	7.8
Purse seine					
May	120	15.7	12.1	31.3	61.3
June	100	24.9	0.4	1.4	1.5
July	114	14.1	0.1	0.1	0.2
Grand Average		17.9	4.5	11.7	22.6

seine catches (Table 3). Relative abundance of fall chinook salmon was about 15 times greater in near-shore **waters** at Jones Beach than in the adjacent channel area during the 1968 sampling season. By contrast, yearling chinook salmon, coho salmon, and steelhead were most abundant in the offshore channel areas.

When in deep water, juvenile fall chinook salmon were found **to** concentrate near the surface. Trawl samples from the channel off Tongue Point, Clatsop' ***Spit,*** and Jones Beach (Fig. 2) in 1966 showed that more than 95% of **'all** juvenile fall chinook salmon were ***within*** 3 m of the surface (Table 4).

Diel Movement. Patterns

Two tests were -made in. 1966 to examine diel . movement patterns of migrating fall chinook **salmon** fingerlings in. the Columbia River estuary. The first/test ran from 26 to 29 May At. Site H-1 on lower **Puget** Island **(Fig.** 2). A single beach seine set **was made** each .hour,..' **on** the hour, for the duration of **a** 30-h test period,. This procedure was repeated at, the Jones Beach site on 13 to 16 June. To compensate for possible tidal influence on movement patterns,. the Puget Island **test** was started on a flood tide cycle and the Jones Beach test on **an** ebb tide cycle. About 90% **of** the fall. chinook salmon taken'during both tests. were caught during daylight **hours.** (Fig. **6).** The pattern. of movement was almost identical at both sites--peak. movement **in** the morning between 0800 and 1100 h, followed by an afternoon. decline and a second, though smaller, peak. in the evening between 1800 and 2000 h. Tidal conditions did not affect this movement pattern. **Purse seine** fishing in the ship. channel adjacent to Jones Beach in 1968 and 1969 substantiated ***this*** daytime-movement.

An additional experiment was made during 1 day of each test.. Groups of fall chinook salmon fingerlings from the beach seine catches were marked and released back into the seining area at 0800 and 2200 h. Recaptures of these marked fish. showed that fish released in darkness remained in the area much, longer than those released during daylight (Table 5). Both experiments indicated little movement of fall chinook salmon in the estuary after dark.

Migration Timing

Timing of the juvenile fall chinook salmon migration into the estuary from 1966 to 1972. is shown **in** Figure 7. This information is based upon morning (0550-1200 h) beach seine catches each year at the Jones Beach site from 28 April through 2 September. /Sampling over the entire year showed that approximately 80% of the juvenile fall chinook salmon entering the estuary do so during this period.

Movement into the estuary is generally bimodal--an early " peak in May and early June, a ...decline later in June, and a' secondand usually higher peak in late **July** or early August. ,. The .seaward migration remains heavy to September and then gradually declines. The . decline in'the number of fall chinook salmon entering .the estuary in June **is** unexplained but could be associated with the :high river flows that generally occyr.during this period,

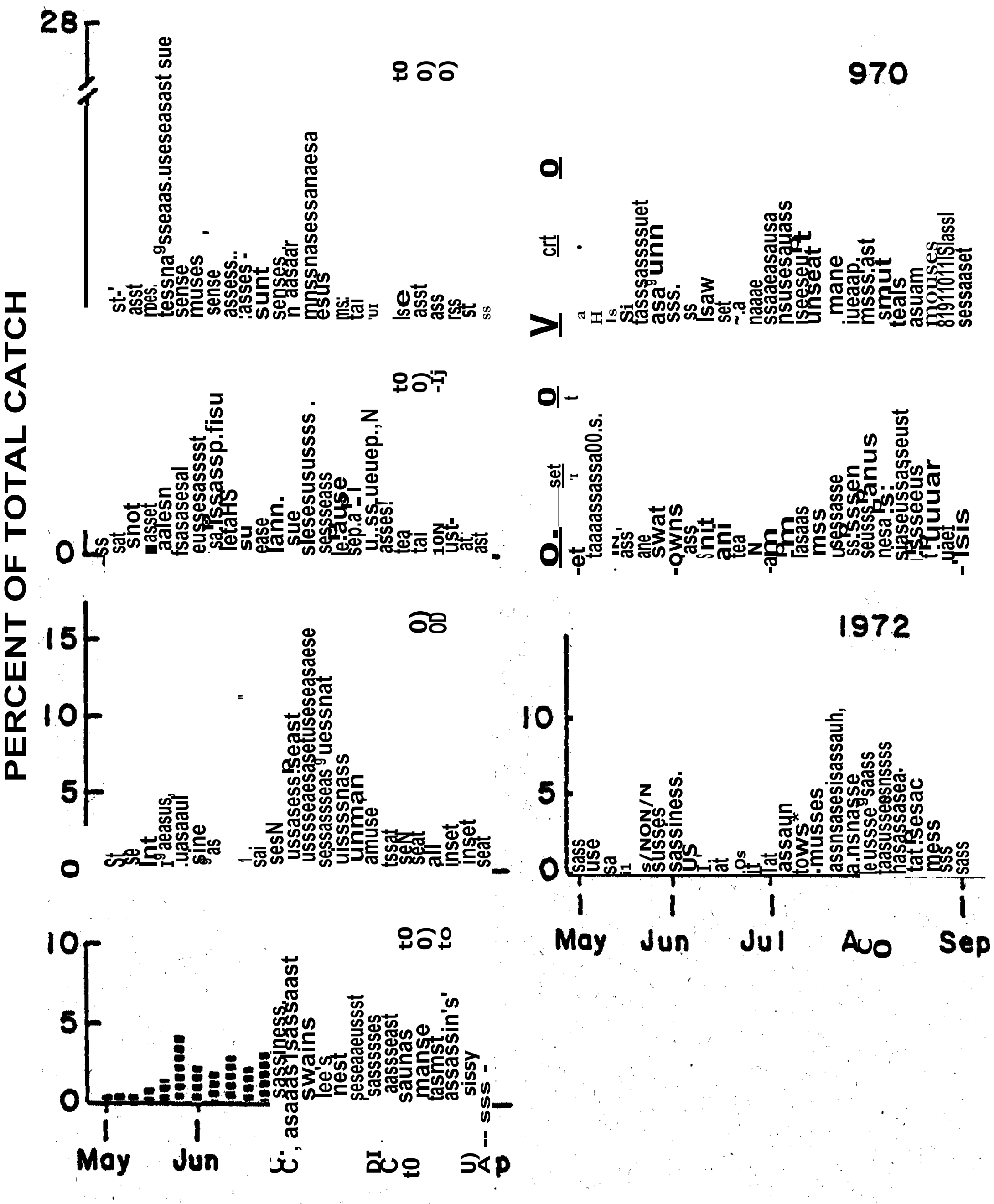
Table 5.--Beach seine recoveries of marked fall chinook salmon released-during daylight and darkness at Puget Island (26 May 1966) and at Jones Beach (14 June 1960.

Area and time of release	No. of fish released	No. hours from release to recapture 1	2	3	4	5	6	7	8	9	Total recaptures Number	Percent
		Number of fish										
Puget Island												
0800 hours	500	5	1	2	0						9	1.8
2200 hours	500	53	36	17	18						134	26.8
Jones Beach												
0800 hours	500,	3	0	0	1						4	0.8
2200 hours	500	61	33	27	21						153	30.6

Table 4.- Mid-water trawl catches of juvenile fall Chinook salmon at various depths and locations in the Columbia River estuary, 1 June - 31 July 1966.

Fishing depth	Jones Beach[a]		Tongue Pointe		Clatsop Spit[a]	
	No. fish	Percent	No. fish	Percent	No. fish	Percent
Surface (0 - 3 m)	1,510	96.3	662	95.2	321	97.9
Mid-depth (3 - 6 m)	57	3.6	33	4.8	6	1.8
Bottom (below 6 m)	1	0.1	0	0.0	1	0.3

a Catch represents 10 trawl hauls at each depth at each location.



e 7.--Temporal catch distribution of juvenile fall chinook salmon entering the Columbia River estuary from 1 May through 1 September, based on beach seine catches at Jones Beach, Oregon, 1966–1972.

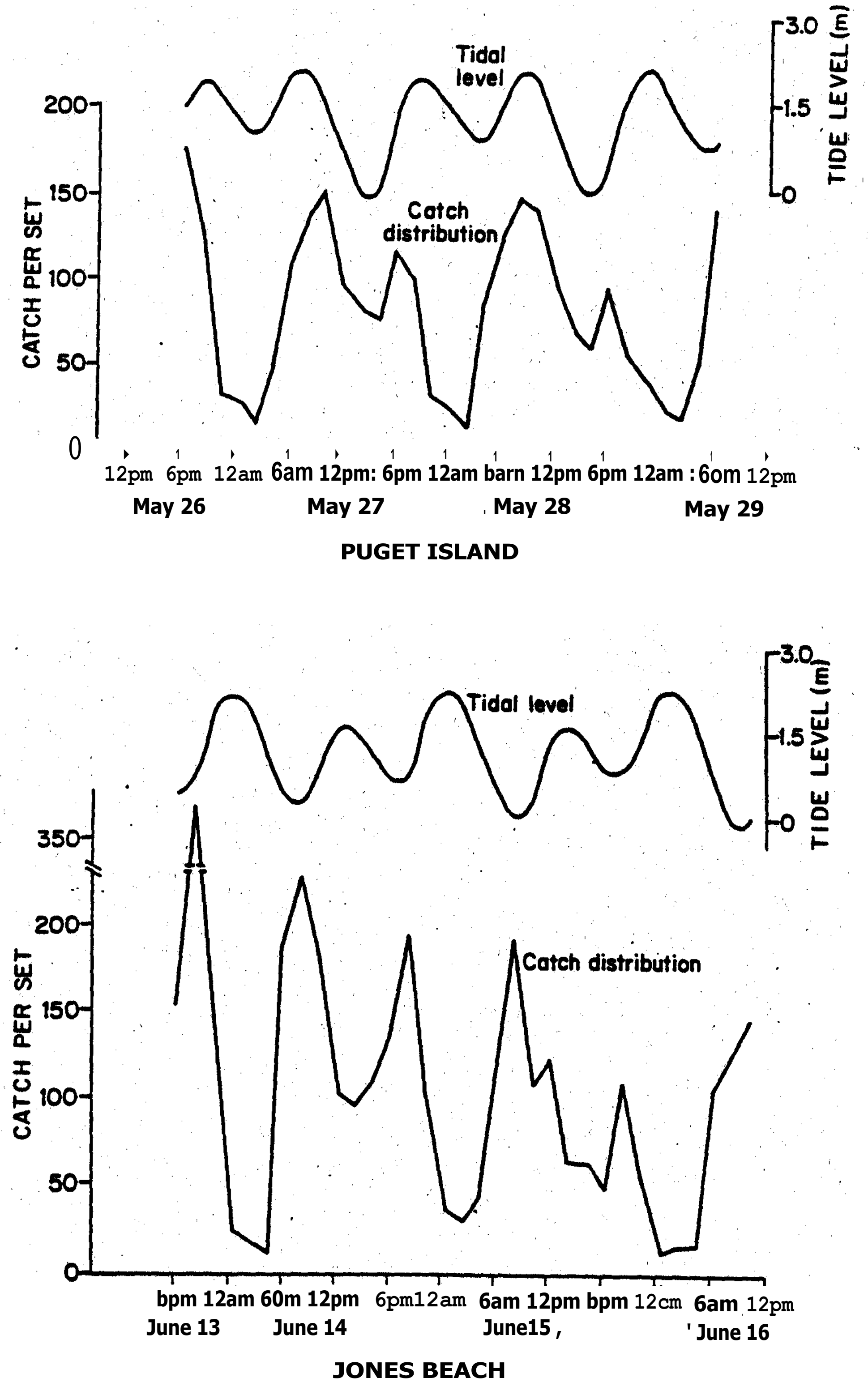


Figure .--Beach seine catch distribution of juvenile..fall chinook salmon at Puget Island-(26, and 29 May 1966) and Jones Beach, Oregon,. (13-16 June 1966) and corresponding tidal levels. during the, catch period.

Table Rate of downstream movement of various groups of marked hatchery fall'chinook. salmon based on beach seine catches at Jones_ Beach, Oregon, 1968.

Hatchery of origin	Release Information: Place	Daae	Number of fish	Recovery information: Number of fish	Distance traveled (km)	Travel time (days)	Rate of movement (km/day)
Ringold (WDF)	Hatchery	14 May	90,000	7	490	15.0	32.7
Ringold	Below Bone-ville Dam	16 May	90,000	144	162	8.1	20.0
Kalama (WDF)	Hatchery,	17 June	78,850	62	46	8.7	5.3
Kalama	Hatchery	12 July	80,000	73	46	6.4	7.2
Washougal (WDF)	Hatchery	17 June	77,900	97	132	11.4	11.6
Washougal	Hatchery	17 June	78,700	101	132	11.0	12.0
Washougal	Camas Slough	17 June	76,500	144	120	9:2	12.5
-Washougal	Below Camas Slough	17 June	77,704.	237	115	9.1	13.1
Spring Creek (FWS)b/	Hatchery -	13 June.	-159,000	80.	192	9.3	2Q.6
Abernathy (FWS)	Hatchery	15 May	:200,300	2,276	15	3.1	4.8
Abernathy	Hatchery	15 May	2200 0 4.00	559	15	3.0	5.0
Little White Salmon (FWS)	Cook, Wa.	22 June.	2.17,200	402	190	9.3	20.4
Little White-:Salmon	Drano Lake	22 June	107,500	295	188	10.9	17.2
Little.White Salmon	Below Bonne-ville Dam	24 Jane	101,10.0	558	162	8.6	18.8
Little White Salmon	Mouth of Willamette R.	25 June	102,000.	551	91	7.4	12.3
Little White Salmon	Prescott, Or.	26 June	99,700	505	36	5.7	6.3
Little White Salmon	Beaver, Or.	27 June	192,700.	1,170	14	2.5	5.6.
Oxbow (ODFW) c/	Hatchery	4 June	128,000	64	171	7.5	22.8
Oxbow	Below Bonne-ville p	5 June	110,000	116	162	5.2	31.1
Bonneville (ODFW)	Hatchery	17 June	116,300	63	162	8.1	20.1

a/ Washington Department ' of Fisheries

b/. Fish "and Wildlife Service

c/ Oregon Department-of Fish 'and Wildlife

Fall Chinook salmon fry began to enter the Jones leach area in late February. These fish were not actively migrating but were apparently moving out of the smaller tributary streams and utilizing the upper estuary as a rearing area. Reimers and Loeffel (1967) reported very short residence periods by fall chinook salmon fry in certain tributary streams of the lower Columbia River. Based on Jones Beach sampling, the total number of fry residing in the estuary is very small in comparison oto the total number that migrate.

Beach seine catches at, Jones Beach from 1966 to 1972 indicate a trend toward later entry of juvenile fall, chinook salmon into the estuary (Fig. 8). Over the study period, the percentage of seaward migrants entering the system during May and June declined, ' whereas the number of fish entering in. August increased significantly. This apparent shift in the time of migration is not well defined, but may result from variation of seasonal river flows during the study period.

.The effect of hatchery releases on the timing of the fall'chinook.salmon migration in the estuary can be seen by comparing the temporal catch distribution in 1971 with that'of other years sampled (Fig. 7). In 1971, almost 90% of the total production of hatchery fall chinook salmon mere ,released prior to 5'May. With the exception of a single 5-day period in early May, the effect of these early releases on,the overall distribution. of the migration in the estuary was negligible.

Rates of Downstream Movement

Releases of marked fall chinook salmon fingerlings were made in 1968, 1969, and 1970 at hatcheries of the Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries (WDF), and the U.S. Fish and Wildlife Service (USFWS) in cooperation with this study. Recovery of these marked fish at Jones Beach provided considerable information on passage times and rates of-movement of hatchery-reared fall chinook salmon to the estuary. Variation in rate of movement of fish from the various hatcheries was considerable (Tables 6, 7, and 8). The time `required for individual groups to reach Jones Beach ranged from 3 to 24 days. Rate of' downstream movement varied from 5 to 36 km Per day.

<u>Effect of Size at. Release.--A</u> multiple release of branded fall-chinook salmon at Little White Salmon National` Fish Hatchery (USFWS) in .1969 Illustrates.. the effect of. size on the rate of downstream movement. Three groups of fish (average fork lengths 77, 64, . and 56 sm, respectively) were released at the hatchery (Fig. 3) on 24 June 1969, and a fourth group (average fork. length 67 mm) was released on 25 June approximately 28 ke downstream from the hatchery. The relationship of the sire of these: 'fish and their rate of downstream movement to the estuary •is shown in Figure 9. A..strong positive correlation of increased rate of movement with an increase in fish size is evident... The largest migrants,(77 mm) moved 12 km per day faster than the smallest (56 mm).

Table 8. Rate of downstream movement of. various- groups of marked -hatchery fall chinook salmon based on. beach seine catches at Jones Beach, Oregon, 1970.

	Release information			Recovery information			
Hatchery of origin	Place	Date	Number of fish	Number recovered	Distance traveled (km)	Travel time (days)	Rate of movement (km/day)
Spring Creek	Hatchery	14 April	152,000	1,441	192	2-3.8	8.1
Spring Creek	Hatchery	22 June	144,600	131	192	8.8	21.8
Spring Creek	Hatchery	22 June	152,100	284	192	8.7.	22.1
Oxbow	Below Bonne-ville Dam	15 May	75,700	85	162	7.3	22.2
Oxbow	Below Bonne-ville Dam	15 Hay	75,000	55	162	6.8	23.8
Little White Salmon	Hatchery	22 June	1183,900	646	190	10.5	18.1
Little White Salmon	Hatchery	22 June	187,000	914	190	13.8'	13.8
Little White Salmon	Below Bonne-ville Dam	23 June	156,000	594	162	8.2	19.8

Table 7.-- Rate of downstream movement of various groups of marked hatchery fall chinook salmon based on beach seine catches at Jones Beach, Oregon, 1969.

	Release information			Recovery information			
Hatchery of origin	Place	Date	Number of fish	Number recovered	Distance traveled (km)	Travel time (days)	Rate of movement (km/day)
Ringold	Hatchery	12 May	201,200	60	490	14.3	34.3
Ringold	Below Bonneville Dam	16 May	66,800	75	162	4.6	35.2
Oxbow	Below Bonneville Dam	19 May	152,000	481	162	6.2	26.1
Oxbow	Below Bonneville Dam	19 May	151,100	1,271	162	5.9	27.5
Oxbow	Below Bonneville Dam	19 May	154,800	395	162	5.9	27.5
Oxbow	Rainier, Or.	20 May	155,900	485	36	2.5	14.4
Spring Creek	Hatchery	3 June	199,700	417	190	5.4	35.6
Little White Salmon	Hatchery	24 June	198,500	252	190	13.0	14.6
Little white Salmon	Hatchery	24 June	196,800	215	190	7.0	27.1
Little White Salmon	Below Bonneville Dam	25 June	76,000	148	162		23.5
Little White Salmon	Hatchery	24 June	114,800	156	190	8.3	22.9
Little White Salmon	Rainier, Or.	27 June	41,300	228	36	4.3	8.4

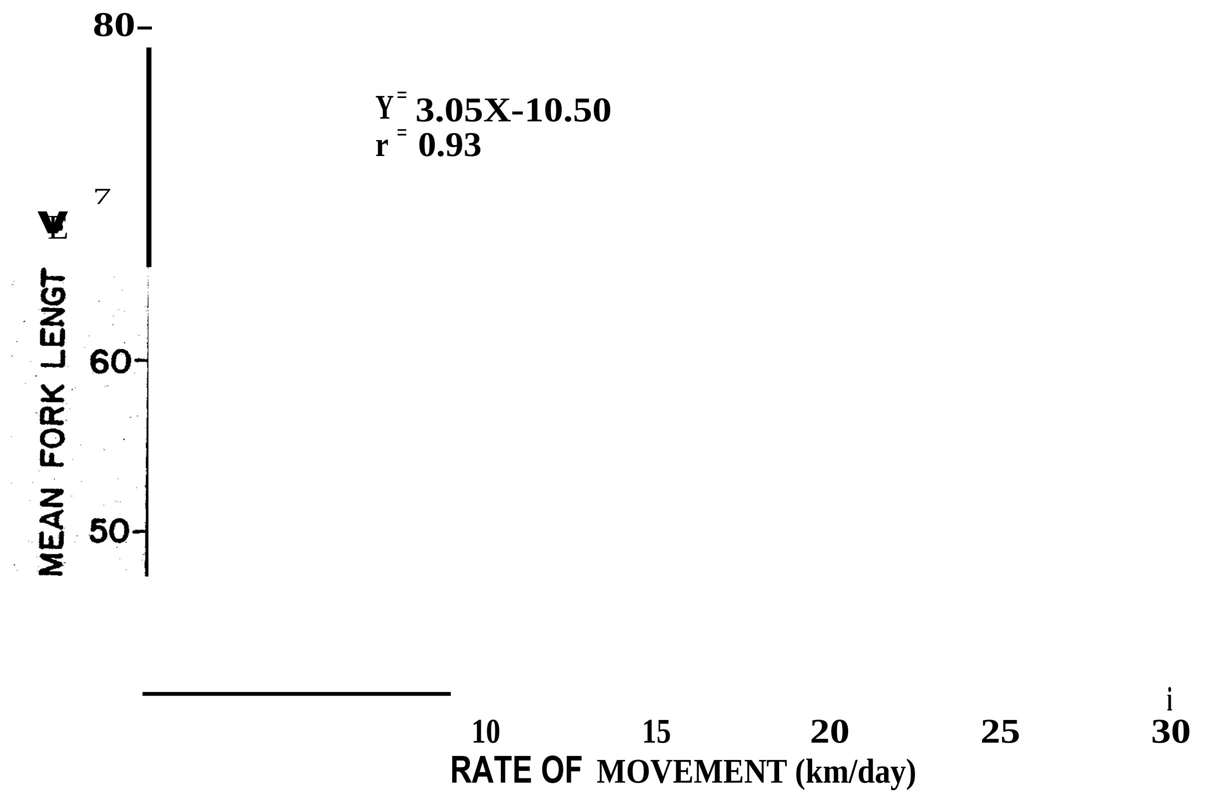


Figure 9.--Relationship of size. at release and rate of downstream movement to the estuary of four size groups of branded fall chinook salmon released-from Little White Salmon Hatchery on 24-25 June 1969.

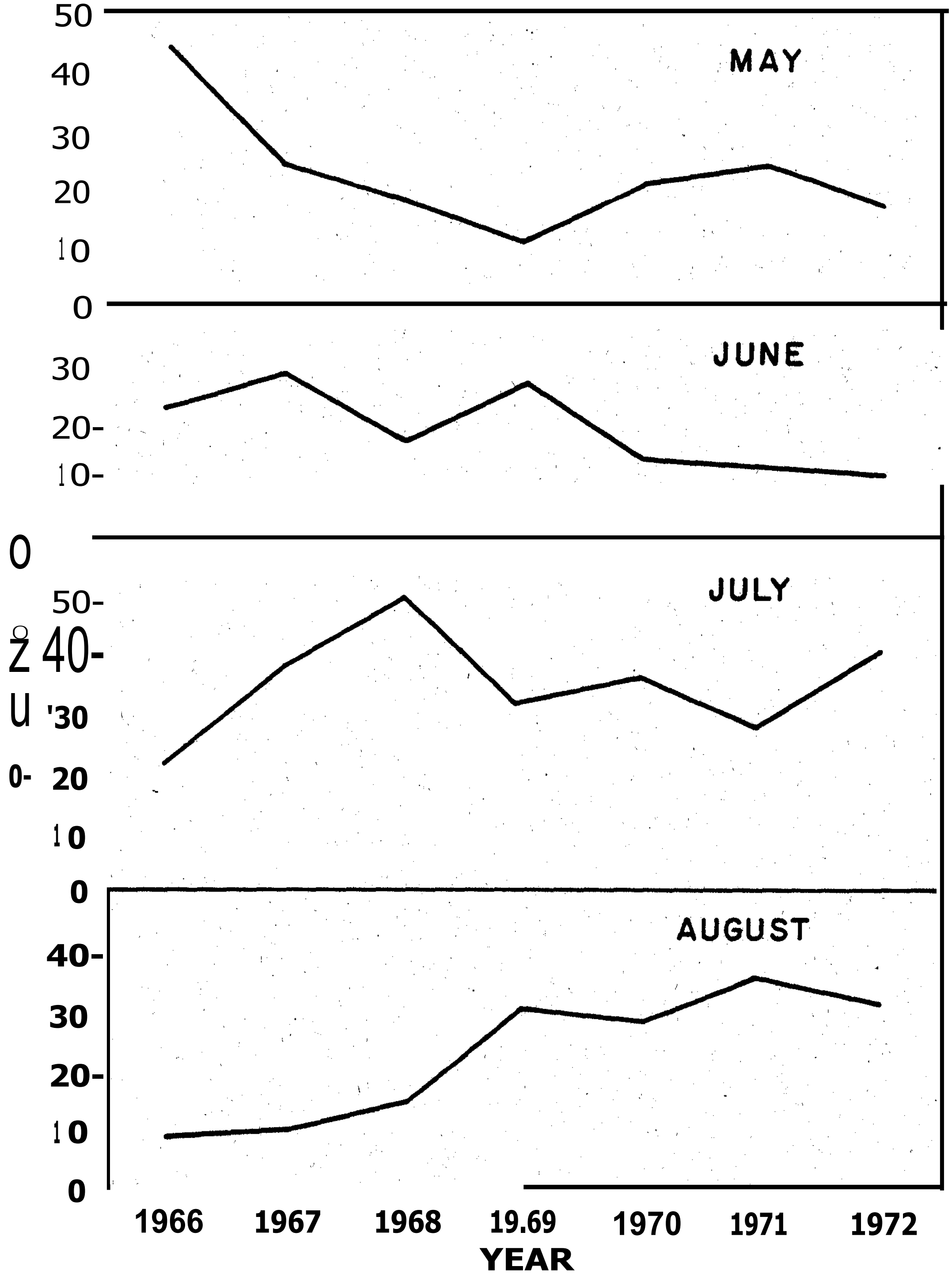


Figure 8.--Annual. variation *in* the migrational timing of juvenile fall chinook salmon at Jones leach, Oregon, 1966-1972.

Table 9.-- Rate of downstream movement and average river flow at time of release of six groups of similar sized marked. fall chinook salmon released into the Columbia River during 1968,-1969, and 1970.

Hatchery and year of release	Number of fish released	Date of release	Number of marks recovered	Average rate of movement (km/day)	River flow a/ (m /s x 1000)
Spring Creek					
1968	159,000	13 June	80	20.6	10.6
1969	199,716	3 June	417	35.6	10.1
1970	152,079	22 June	284	22.1	7.9
Little White Salmon					
1968	217,000	22 June	402	20.4	9.8
1969	196,800	24 June	215	27.1	8.4
1970	186,950	22 June	914	18.1'	7.9

a/ Average daily flow at Bonneville Dam. for 20-day. period. after release. Flow data from Annual Fish Passage Reports, 1969-70, North Pacific Division U.S.'.Army Corps. of Engineers processed report.

Effect of Release Location.--Mark recovery data' also indicated that the rate of downstream movement of hatchery juvenile chinook salmon may be associated with point of release (Fig. 10). Fish reared and released from hatcheries near the estuary moved downstream at a slower, rate than those from hatcheries farther upstream. For example; fall chinook salmon from Abernathy Hatchery (USFWS), about 15 km above the Jones Beach sampling site, moved downstream at an average rate of about 5 km per day; whereas fish released at Ringold (WDF), 490 Ian above the estuary, moved downstream at'almost 33 km per day (Table 6).

Effect of River Flow.--Raymond (1968) showed a positive correlation between water flow and rate of downstream movement of yearling chinook salmon in upper Columbia and Snake Rivers . A similar correlation is difficult to. demonstrate in relation to juvenile fall chinook salmon in the lower Columbia River. Releases of marked fall chinook salmon of comparable body lengths at two Federal hatcheries (Little White Salmon and Spring Creek) failed to show a clear relationship between river flow and rate of downstream movement '(Table 9). This is probably the result of variations' in *the* number of smolting fish within the release groups.. Some groups of fish released during periods-of high river flow moved downstream at a slower rate than other groups released during lower river flows. If all fish were actively migrating seaward at the time of release, the effect of river flow on downstream movement might be more evident (samples from later years suggested a 'relationship).

Size and Estuarine Residency

Fork-length measurements were taken each year from May- to September to examine.-size characteristics of juvenile fall chinook salmon in the estuary. Mean. fork-lengths of juveniles entering. the estuarine system .. at Jones Beach from. 1966 to 1972 are shown in Figure 11. Average sizes of fall chinook salmon entering (Jones Beach) and - leaving (Cla tsop . Spit) the estuary are compared in. Figure 12 .- These relationships show that the average length of fall chinook salmon in the estuary approaches 75 mm by mid-- to late-May each year and does not increase significantly until late July.

There are two hypotheses that would account for. the constant 'size of 'juvenile fall.chinook salmon 'in the estuary over such an extended period:. (1) growth rate of fall. chinook salmon rearing in the estuary is substantially reducedor (2) juvenile fall chinook salmon rear to smolting size in areas above the-estuary. and pass quickly through the es tuary once they enter the system. Reimers (1973) reported a similar size pattern for fall: chinook salmon in the Sixes River estuary in southern Oregon and. related this pattern to. decreased growth rates during an extended,period of estuarine residence. He further hypothesized that this . reduction in growth rate resulted in high population densities. in the estuary during: this' period.

Mark recoveries during, this' study suggest that the majority of juvenile fall chinook salmon entering the 'Columbia River estuary remain within the system for - a relatively short - period of time. Recoveries from 16 groups of marked hatchery fall. chinook-salmon in 1970.showed that these fish began to

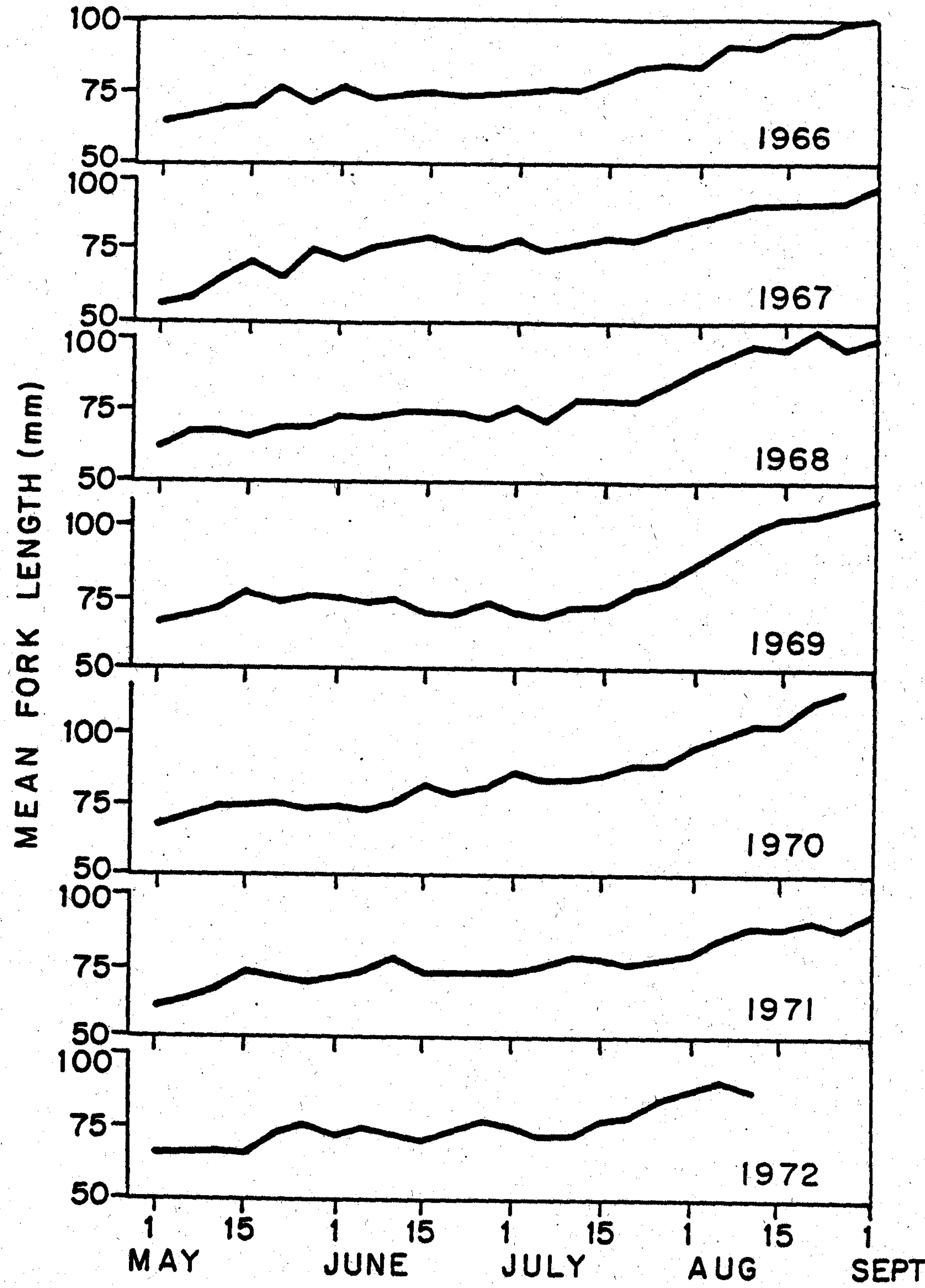
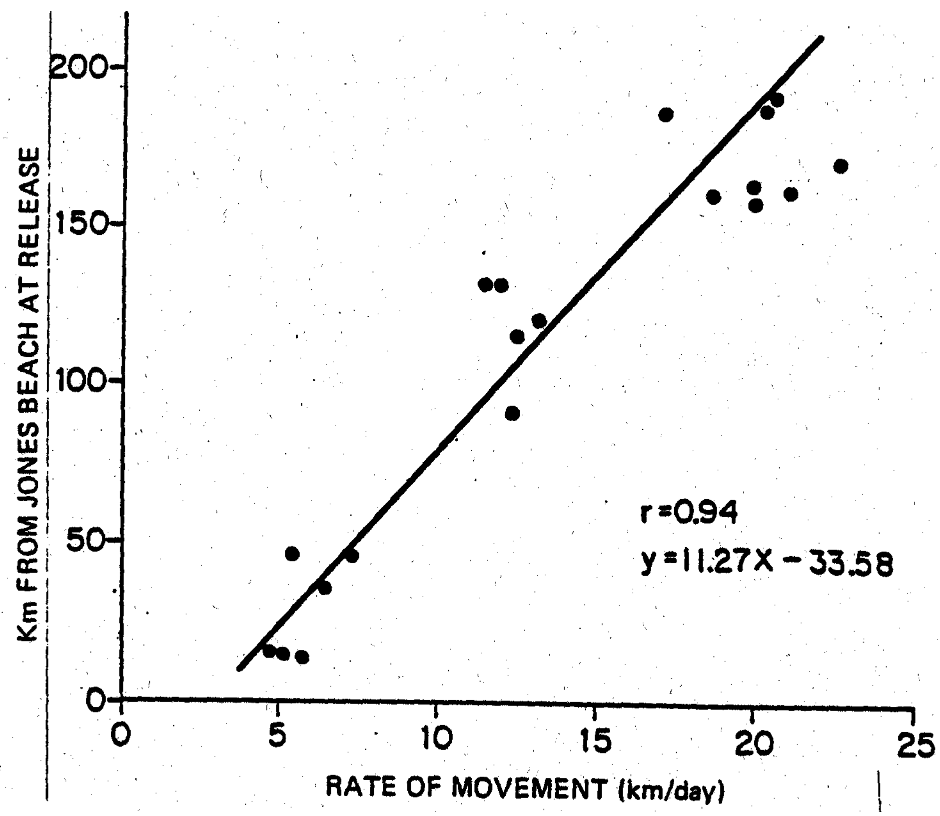


Figure 11.-Mean fork-length of juvenile fallchinook salmon captured with beach seines at Jones Beach, Oregon, 1966-1972.



'Figure 10.--Relationship of distance from the estuary at' release to rate of downstream movement of 12 groups of branded fall chinook salmon released from various hatcheries on the Columbia River in May and June 1968.

leave the estuary within 6 days or less after entering the estuary (Table 10). In addition, five branded fall chinook salmon fingerlings were taken by purse seine in the ocean several miles south of the river mouth in 1969. Two of these fish had been released 14 km_ above .the Jones .Beach site duly 6 days earlier. The other three fish had been released at the same.site from 9 to 15 days earlier. .Although few in number, these ocean. recoveries further suggest a - rapid movement of juvenile fall chinook salmon through the. estuary.

Additional mark recoveries indicate that when fall chinook salmon stay in the estuary for. an extended. period, their size. increases rapidly. Recoveries from six groups of marked fall chinook salmon fingerlings transported from the Washougal Hatchery (WDF) and released at six separate locations- in the lower river,. 16-18 June 1969, showed that the behavior of these fish was.different .from that of any other groups of marked fish sampled during this study...These fish weresmall when released (approximately 200/lb) and obviously not 'ready to migrate. They: be8an to enter the beach seine catches. at Jones Beach on 21 June,' and significant numbers were still being caught in mid-September. Recovery rates from the Washougal. releases were 10 times greater than for any other groups of marked. fish. Moreover, 10 times. as many multiple mark recaptures were made. Many individual fish from these releases. were . caught four and five times during' a.10-week. period. Inasmuch as these fish remained in the estuary for a .substantial period of time, their' growth rate during, this time is a valid indication ofgrowth during residency in the estuary. Average size of these fish increased rapidly during their estuarine residence; whereas, the average; size of all other groups of fish taken a t.Jones Beach 'during the same time period remained relatively constant (Fig. 13).

The .evidence supports the. Conclusion that in the Columbia. River, the majority of fall chinook, salmon fingerlings retain in.. the. estuary for a relatively short period and that they reside *in* the main river or. tributaries upstream fray the estuary until they reach :a size range Of about 1 to 8 *cm*.. This would account for the similarity in, *size* range of fall chinook salmon entering the estuary. during the late spring. and early summer. The, rapid increase inthe' size. of fish- entering the estuary after mid-July i's probably due to improved conditions (such as warmer water temperatures) for growth in the upriver rearing areas.

Relative Survival of Hatchery Fall Chinook Salmon'

.Ebel (1970) reported a significant increase in survival of hatchery fall chinook salmon fingerlings transported from an upriver hatchery and released below Bonneville' Dam. over survivals from conventional .. releases at the. hatchery.

Estimates of relative survival during passage to the estuary of hatchery fall chinook salmon released at various points in the 'river from 1968 to 1970 are shown in Tables 11, 12, and 13. In each instance, the relative survival was increased by transporting the fish to a point below Bonneville Dam for release.. Relative survival rates of seven experimental groups of branded fall chinook salmon released below Bonneville Dam are compared to a duplicate.

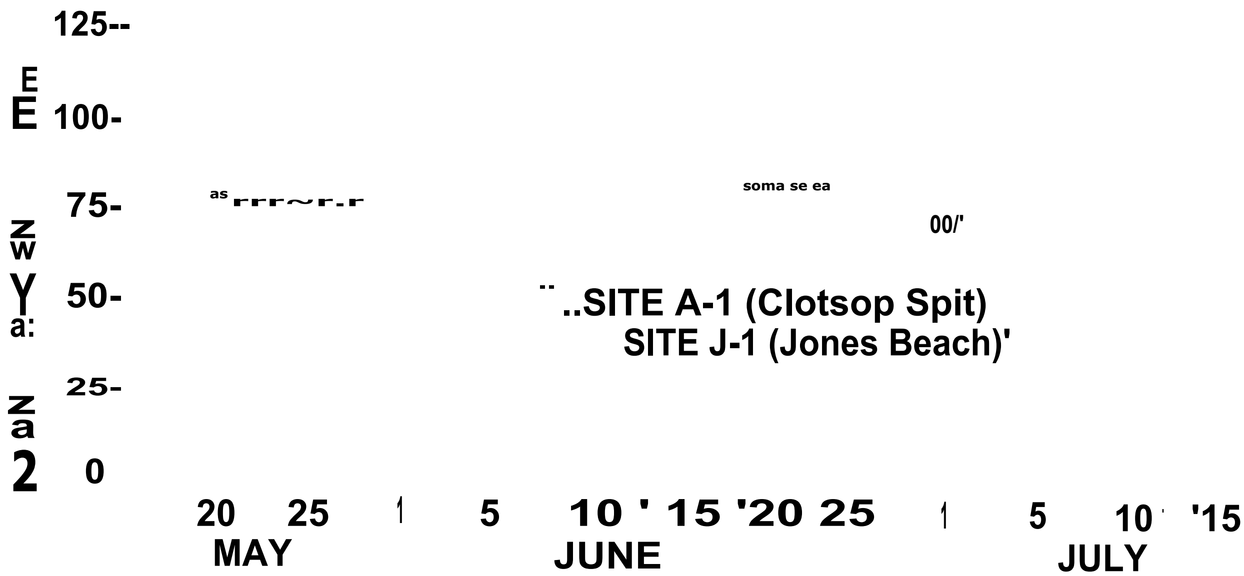


Figure 12.--Mean fork-length of juvenile fall chinos* salmon in the upper (Site J-1) and lower (Site A-1) Columbia River estuary, 20 May-15 July 1970.

Table 11.-- Recovery rate and relative survival of branded groups of hatchery fall chinook salmon at Jones Beach, O egon, 1968.

Hatchery of origin and release point	Size at release	Release date	Recovery rate (X.	Relative survival" rate (X)
Little White Salmon a/				
Hatchery	110/lb	22 June	0.27	.45
Below Bonneville Dam	107/lb	24 June	0.56	93
Beaver, Oregon	103/lb	27 June	0.60	100
Oxbow				
Hatchery	.72/lb	'4 June	0.05	45
Below Bonneville Dam	72/lb	5 June	0.11 .	100
Ringold				
Hatchery	62/lb	14 May	0.01	6
Below Bonneville Dam	62/lb	16 flay	0.16	100

a/ Data reported by Ebel (1970).

Table 10.-- Passage time of 16 groups of marked hatchery fall chinook salmon from Jones Beach to Clatsop Spit, Oregon (74 km) 1970.

Hatchery of origin	Date of first arrival at Jones Beach	Date of first arrival at Clatsop Spit	Passage time (days)
Oxbow	18 May	22 May	4
Oxbow	18 May	22 May	4
Oxbow	20 May	26 May	6
Oxbow	23 May	27 May	4
Spring Creek	25 June	29 June	4
Spring Creek	25 June	29 June	4
Spring Creek	25 June	28 June	3
Spring Creek	27 June	30 June	3
Little White Salmon	25 June	29 June	4
Little White Salmon	26 June	28 June	2
Little White Salmon	25 June	28 June	3
Little White Salmon	25 June	1 July	6
Little White Salmon	26 June	2 July	6
Little White Salmon	26 June	30 June	4
Little White Salmon	28 June	29 June	1
Little White Salmon	28 June	30 June	2

Table 13.-- Recovery rate and relative survival of branded groups of hatchery fall chinook salmon et Jones Beach, Oregon, 1970.

Hatchery of origin and release point	Size at release	Release date	Recovery rate (%)	Relative survival rate (%)
Little White Salmon				
Group 1				
Hatchery	65/lb	22 June	0.35	40
Below Bonneville Dam	69/lb	23 June	0.38	44
Rainier, Oregon	69/lb	25 June	0.87	100
Group 2				
Hatchery	110/lb	22 June	0.49	66
Below Bonneville Dam	126/lb	23 June	0.59	80
Rainier, Oregon	126/lb	27 June	0.74	100
Spring Creek				
Group 1				
Hatchery	109/lb	14 April	0.94	91
Rainier, Oregon	92/lb	20-21 April	1.03	100
Group 2				
Hatchery	43/lb	22 June	0.09	31
Rainier, Oregon	39/lb	24-26 June	0.29	100
Group 3				
Hatchery	67/lb	22 June	0.19	86
Rainier, Oregon	68/lb	24-26 June	0.22	100

Table 12.-- Recovery rate and relative survival of branded groups of hatchery fall chinook salmon at Jones Beach, Oregon, 1969.

Hatchery of origin and point of release	Size,at release (no.`/lb)	Release date	Recovery rate(%)	Relative survival rate (2)
Little White Salmon				
Hatchery	109	24 June	0.13	57
Below Bonneville Dam	109	25 June	0.20	87
Rainier, Oregon	109	27 June	0.23	100
Oxbow				
Bonneville Spillway	85'	19 May	0.31	,38
Below Bonneville Dam	85	19 May	0:29	35
Rainier, Oregon	85	20 May	0.82.	100
Ringold				
Hatchery	65	12 May	0.02	18
Below Bonneville Dam	65	16 May	0.11	100

hatchery. release in Table 14. .The increase in survival of transported fish over those released at the hatchery ranged from 4 to 96%. ' Transporting fish from Ringold Ponds (490 km-from river mouth) forrelease-below Bonneville Dam resulted in survival increases of 96%:in 1968 and 73%..in x,969. Transporting fish '.below the dam from hatcheries Iodated on the Bonneville pool (160 to 192 km from, the river mouth) increased survival' by 51% in 1968 and 30% in 1969.

Conclusions

1. Juvenile fall chinook salmon concentrate in shallow near-shore areas of the estuary, and when _ in deep water areas are generally found within 3 m of- the surface.

2. Most movement of juvenile fall chinook salmon through the estuary occurs during daytime.

3. Tidal conditions or direction of flow does not appear to influence . diel movement patterns of juvenile fall chinook salmon in the estuary:

4. Timing of the' juvenile fall chinook salmon migration into. the estuary is generally bimodal,. characterized by ,An. early peak in May *and* early June, followed by a' general decline later in June and .a second, _ usually' larger, peak in July or August.

5. A trend toward later entry of juvenile fall chinook salmon into the estuary was noted. During the period of this study, the percentage of fish entering the estuary in May and June declined, whereas portions entering in August increased significantly.

6. The early release of. hatchery. fall chinook salmonin 1971 had little affect on -temporal distribution of the overall outmigration' through the estuary.

7. Larger fall chinook salmon migrants generally move downstream at a faster rate than smaller fish.

8. Juvenile fall' chinook salmon released from hatcheries near the estuary generally move downstream at a slower rate than those released from'. hatcheries more distant. from the estuary.

9.'.Average sizes. (7 to 8cm) of juvenile fall chinook salmon. entering the estuary remain relatively constant from mid-May to.late July.

10. The majority of juvenile fall chinook salmon rear to smolting size in the river areas above the estuary.

11. Most juvenile fall chinook salmon migrate rapidly, through the estuary.

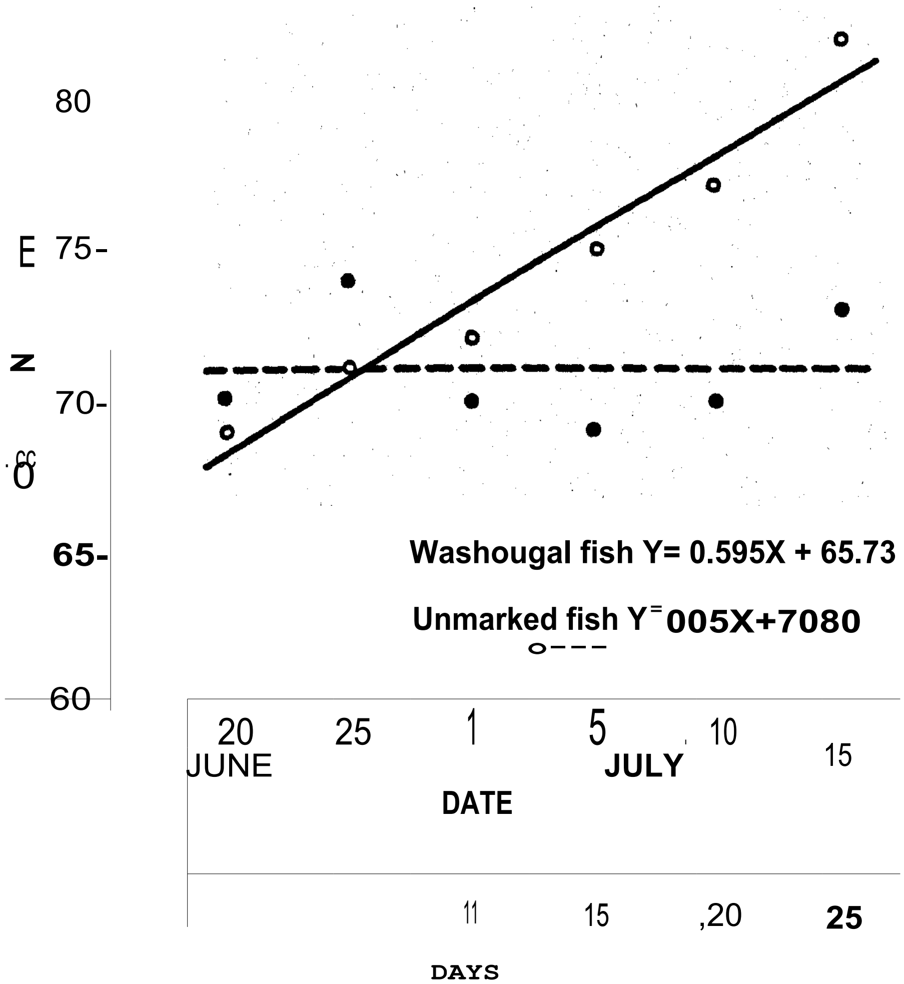


Figure 13.--Size comparison of branded Washougal *Hatchery* fall chinook salmon and the unmarked fall chinook salmon catch at Jones Beach, Oregon, 20 June-15 July 1969.

12.. Transporting. juvenile fall chinook salmon from hatcheries above Bonneville Dam to release sites.below the dam increases fingerling survival to the estuary. Generally, fish. transported from. more distant rearing areas show greater survival benefits than those transported from hatcheries nearer the estuary.

Table 14.-- Increases in survival of juvenile hatchery reared fall chinook salmon resulting from transporting fish to release sites below Bonneville Dam, 1968-70.

	1968		1969		1970	
Hatchery of origin	Size. of fish	Increased survival (2)	size of fish-	Increased- survival (X)	Size of fish	Increased survival (2)
-Little White Salmon	107/lb	48	109/lb	30	69/lb	4
	-	-	-		126/lb	14
Oxbow	72/lb	55				
Ringold	62/lb	96	65/lb	73	-	

Methods

Beach seines were used to capture samples of juvenile coho salmon in. the Columbia' River. A detailed description of' the net and technique used to make sets is given by .Sims and Johnsen (1974)..

Sampling sites for .. the: study are shown in-Figure' 14. The locations varied during 1966 . and 1967, but from. 1968 through 1971, the primary site was at Jones Beach..Sites at nearby.Puget-IslandandCape. Horn, Beach on the Washington shore were sampled frequently during the first 3 years. of the study (Table 15)., Seining atthose, locations consistently resulted a smaller catch per set than at Jones Beach. Size range,. species .composition, and other catch characteristics were similar at all sites.

Until April 1968, ,the seine crew examined and-recorded their catch. Beginning in May 1968, a separate crew wasused to process fish and record data. In both situations, all juvenile salmon and trout were anesthetized with MS-222 (tricaine methanesulfonate),, identified, enumerated byspecies, and examined for marks; individuals from a subsample were measured for fork length.. Fish were'. held until they completely recovered from the anesthetic and then were returned to the river.. Use of a separate processing crew. resulted in a. greater number of sets being made at a site-40. reduced the time that the fish were held under stress.

Juvenile coho salmon were also taken.- by purse seining in the navigation channel of the river adjacent to Jones Beach (Johnsen and Sims 1973). Purse seining effort was consistent for only 2 years in the area and for that reason little. information . from that effort is included in, this report. Coho salmon data from purse seine.. catches were in agreement with those from the beach seine catches.

Results and Discussion

Annual and Monthly Catches

Juvenile coho .salmon are abundant in the. Columbia. River estuary from mid-April to early June. and are present in small numbers. through 'the remainder of. the year. Beach *seining* captured 110,421 juvenile coho between 1966 and 1971.- Monthly and. annual catches are-presented in Table 16. Our largest annual catch was in 1970 when 45,146 fish were caught and the least was, in 1967 'when we took only 5,792 coho salmon. Sampling effort, inseine sets per month, provides a basis for annual. comparison, but caution is advised in interpreting 'these results. Catch alone should not be construed as an annual indexof abundance. Major considerations in .*this* study are the variation in seine sites in 1966 and 1967 and the frequency of seine sets during the period of maximum availability. Monthly averages show that most-coho salmon were ' caught in May followed by April and June in that order. .The large monthly catch-in August 1969 was a

SECTION II--COHO SALMON, 1966-1971

Introduction

The coho salmon.is. an important commercial. and recreational species the Columbia River and its tributaries for spawning . and. presmolt rearing. Drawing from . severalsources,. Pruter (1966) devised a table 'which showed the annual average coho-salmon landings in terms of pounds from 1893 to 1963. The peak landings 'of coho salmon occurred'between 1921 and.° 1930 with an average of 6,000,000 pounds (2,722,000 kg) taken annually. Landings decreased progressively until 1956-60, when ....an average of only 300,000 pounds (136,000 kg)'were. taken. Assuming an approximate average .weight of 10 lb (4.5 kg).per fish, coho salmon landings were reduced from 600,000to 30,000 fish.

Many factors together with the commercial harvest, affected the Columbia River coho salmon stocks. Silt¯choked gravel beds and log`j ams in streams from early forest harvesting reduced the spawning areas and limited food. production during the rearing period. Low -head hydroelectric dams impaired adult. and juvenile migrations directly and. indirectly, whereas some multipurpose high head storage dams completely blocked adult spawning migrations. Commercial trolling and recreational ocean fishing contributed to losses, since many immature, sublegal fish are caught and mortally" injured before being released .(Parker et al.. 1959, Milne and.. Ball 1956)- Additional causes .for the decline in the number of coho salmon include municipal .and industrial pollution, pesticide usage, nitrogen 'supersaturation,. and .hydrothermal conditions. Despite these negative factors, the decline in coho salmon .numbers was reversed in the early 1960s. The un has subsequently averaged 265,000 fish. landed..from'1964 to' 1974,.with a high of 521,000 in 1970 and a low of 125,000 fish in 1968.

An improved hatchery diet which sustained the juvenile fish until their yearling migration is credited as the single most important factor . in the improved coho salmon runs. .Cleaver (19-69b) determined' the .benefits from various coho hatcheries in the Columbia River system appeared to be well in excess of their costs. .Haw and Mathews (1969) reported that the technological advances in the rearing of coho salmon .resulted in returns far exceeding the rearing' capacity of the hatcheries.

Since the early 1960s, the number of coho salmon returning to hatcheries has increased substantially, while their presence. in selected .natural spawning tributaries .has decreased according to tables prepared by Gunsolus and Wendler (1975). Pollution control, restricted use of pesticides, improved forest harvesting techniques, updated designs for fish passage facilities at dams, and reduction in. supersatuation of dissolved atmospheric gas in the water downstream from dams are all continuing improvements that should result in increased survival of coho salmon. However, while coho salmon have increased . numerically-from their low point in the 1950s, they . have not reached the magnitude of earlier, runs. One .possibility for the apparent leveling off of the coho resurgence might..be, attributed to problems encountered by smolts'during their migration to the sea. , This section presents data collected from 1966 through 1971 on juvenile coho salmon migrations.

Table 15.--Sampling effort in the upper Columbia River estuary,'Aprll through June, 1966-71.

Year	Principal sampling sites	Secondary sampling sites	No. of work shifts	Daily'. sampling period	Sampling days per week	Sets per day
1966	West. Puget Is.	Westport Beach Jones Beach Unnamed Sand Spit_	2	0800-1600	'5	3to 10
1967	West. Puget Is. Jones Beach	East Puget Is. Bradwood Beach Westport Beach Wuana Cape Horn Beach		0800-1600		3 to 10
1968	Jones Beach Cape Horn Beach	West. Puget Is. East. Puget Is.		(0800-1600 until mid-May) (0500-1100 after mid-May)	5 7	
1969	Jones Beach	Cape Horn Beach		(0800-1600 until mid-May) (0500-1100 after mid-May)	5 7	12 12
1970	Jones Beach	Cape Horn Beach		0500-1200 1300-2000	7	24
1971	Jones Beach-	None		0500-1200		12

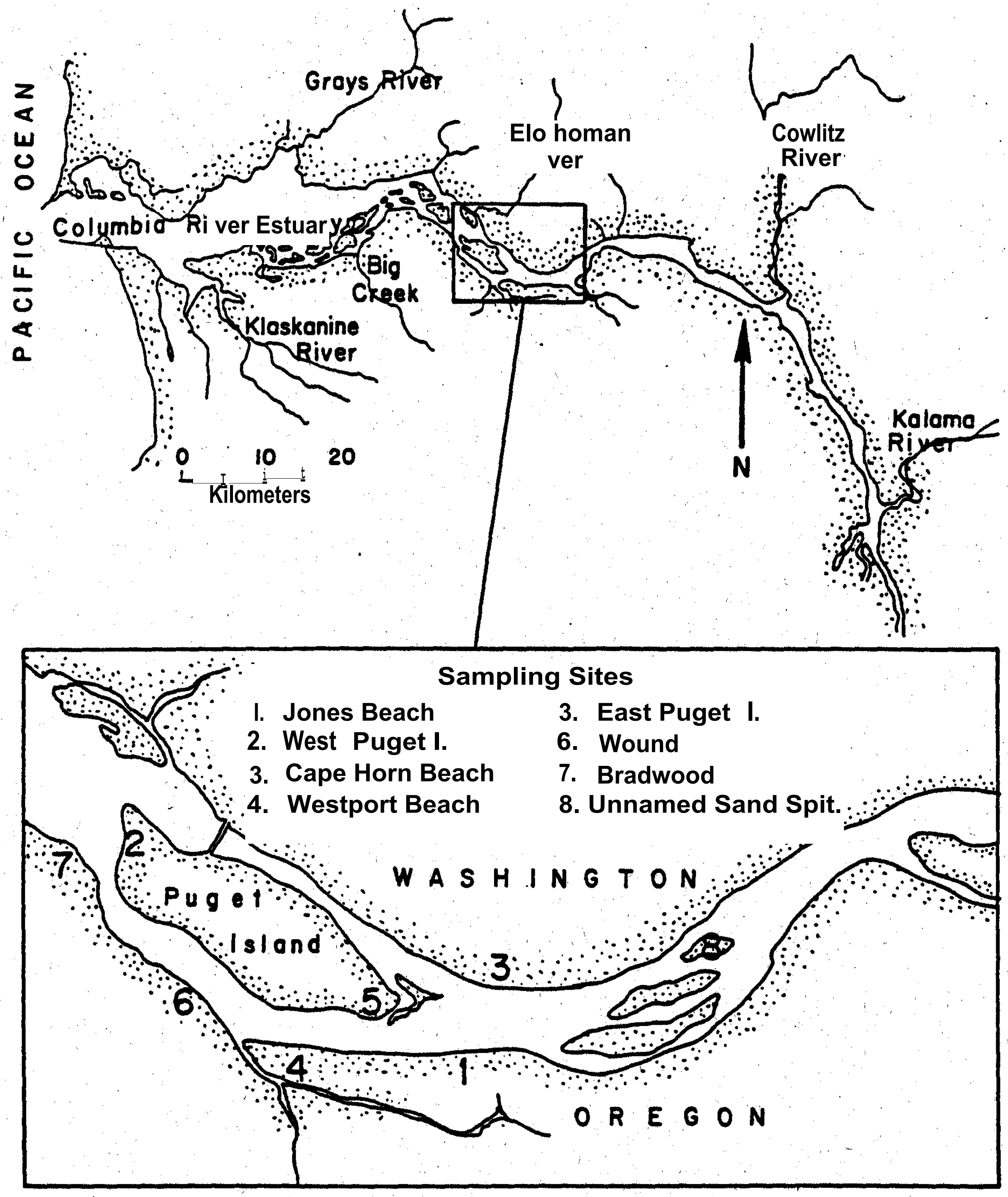


Figure 14 .--Map of lower Columbia River with inset, showing location of sampling sites used in the upper estuary between 1966 and 1971.

result ,of a large release" of hatchery.' fish (subyearling coho salmon) .. in late July by the Washington Department of Fisheries into the Columbia River above our sampling site. With this exception, our. catch records show consistently .high captures relative to expended effort in the spring of each year, but relatively insignificant numbers during. winter, summer,'and fall.

Timing of Annual Migration

The annual peak in the daily catch per set (CPS) of coho salmon (averages of all seine sets in that day) occurred within a 12-day period over the 6-year study (Fig. 15). Peak CPS occurred in the upper estuary of the Columbia River 'between 5 and 16 May of each year; 10 May most likely approximates: the average, as all annual peaks occurred within 6 days before or after this date.

The date of peak migration may be determined on a basis other' than. CPS. Figure 16 shows daily total catches in percentages of the annual total catch. Less than 5% of the coho salmon reached the estuary before 17 April.,Each year the midpoint of the migration was reached between 2 and 13 May. The yearling smolt migration was 95% complete between 19 and. 31 May. Thus, both the daily percentage of the total CPS and the average daily catch Indicated that the annual 'migration of coho salmon sn'olts in the Columbia River was compact, consistent, and comparable through the 6-year investigation.

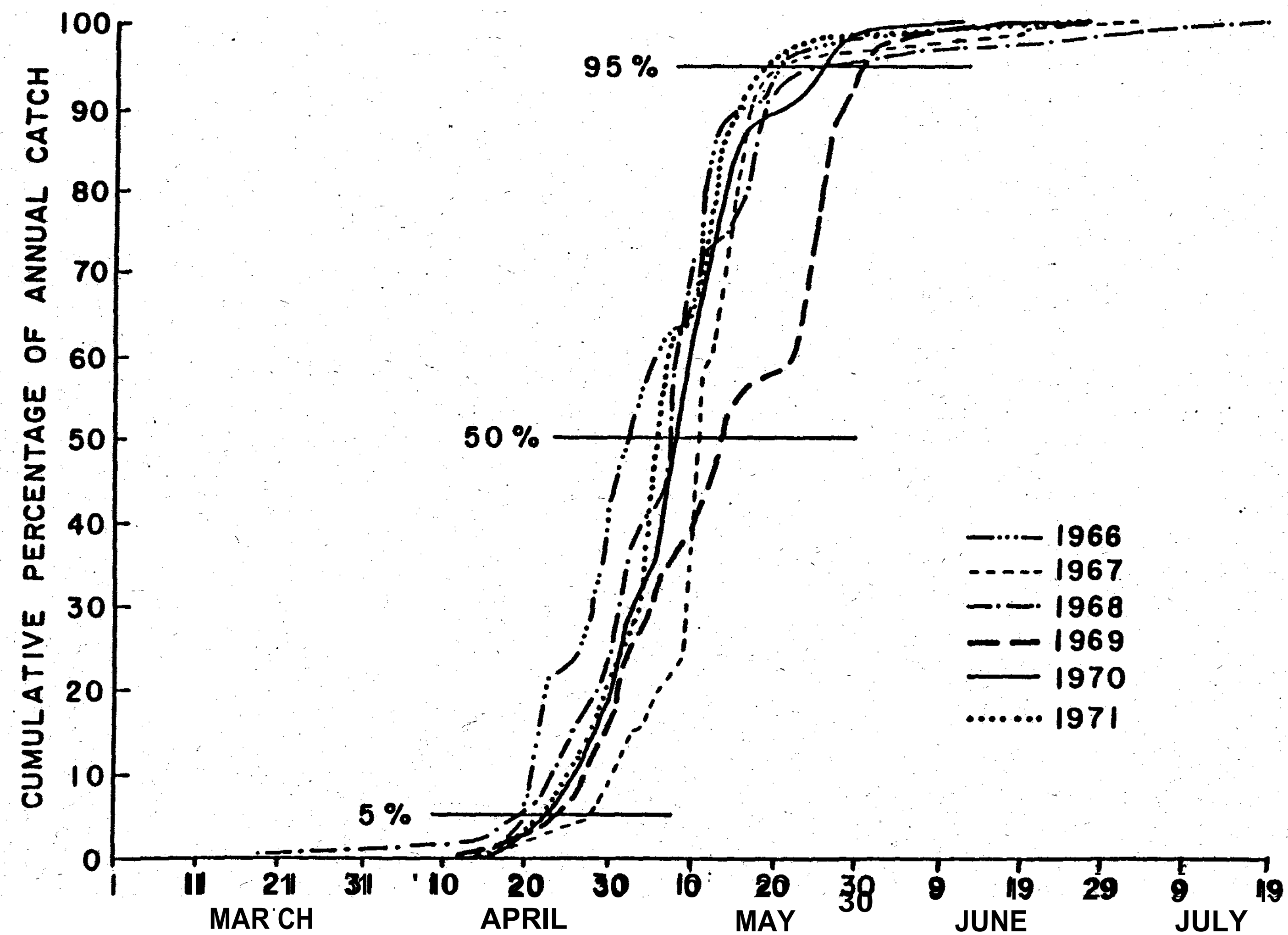
The chronological similarity of annual peak catches in the upper estuary is, particularly interesting since many widely 'separated hatcheries and tributaries contribute tothe total migration. Fulton (1970) listed 39 Columbia River streams and' 62 of their tributaries that now have or have had spawning runs of coho salmon. He also reported that 78 of these presently have spawning areas. More important numerically are coho salmon reared at as many as, 19 different Columbia River hatcheries, though not all of these hatcheries produce coho salmon every year. Considering the number . of diverse systems contributing to the migration, and differences in river discharge between years,it is remarkable that coho salmon smolt, migrations' into the estuary were so consistent in their timing.

The timing of migrations - of juvenile coho salmon coincides with movement reported in other widely. separate geographic areas. Shapovalov. and Taft (1954) presented' tables showing that the peak migration of juvenile coho salmon occurred from 6 to 12 May during a9-year study of Waddell Creek, California. Chamberlain (1907) reported a heavy migration of yearling coho salmon into seawater in May of 1903 and 1904 in southeastern Alaska. Peck (1970) found that most coho salmon smolts left a Lake Superior tributary within a week of planting on 16 and 17 May.' Salo (1955) reported the peak seaward migration .of juvenile coho salmon in Minter Creek, a tributary of Puget Sound' in Washington, occurred in early May.

Table 16.--Results of bench seine sampling for juvenile lobe salmon in the Columbia River estuary, 1966.

Month	1966 No. sets	1966 No. coho	1966 CPS![a]	1967 No. sets	1967 No. toho	1967 CPS	1968 No. sets	1968 No. coho	1968 CPS	1969 No. sets	1969 Na. coho	1969 CPS	1970 No. sets	1970 No. lobo	1970 CrS	1971 No. sots	1971 NO. litho	1971 CNS
Jan	--	--	--	--	--		4	O	0.0	19	0	0.0			--			
Feb	--	--	--	50	1	0.0	12	1	0.1	31	3	0.1						
Mar	66	0	0.0	92	14	0.2	69	78'	1.1	60	3	.0.1						
Apr	217	3,547.	16.3	104	271	2.6	227	1,831	8.1	165	4,831	29.3	386	9,826	25.3	AO	3,017	37.7
May	324	3,851	12.0	104	5,283	30.S	3)2	6,172	16.6	320	18,973	59.3	673	34,771	51.7	168	10,484	62.4
Jun	398	86	0.2	405	185	0.5	525	255	0.5	637	1,114	1.7'	674	510	0.8	240	11R	0.5
Jul	83	7	0.1	315	37	0.1	589	68	0.1	697	79	0.1-	397	. 29	0.0	187	55	0.3
Aug	--	--	--	17	1	0.1	214	1.	0.0	406	4,745	11.6	178	10	0.1	--		
Sep	--	--	--	--	--	--	--	--		163	67	0.4	--	--	--	--	--	--
Oct	--	--	--	--	--	--	--	--		78	27	0.3	--	--	--	--	--	--
Nov	11	3	0.3	--	--	--	48	25	0.5	33	0	0.0	--	--	--	--	--	--
Dee	9	38 .	4.2	--	--	--	34	4	0.1	12	0	0.0	--	--	--	--	--	--
Total	.1,104	7,132	6.8	1,087	5,792	5.3	2,094	8,433	4.0	2,,621--	29,842	11.4	I,508	45,146	18.0	675	13,674 '	20.3

e CPS - cath per set.



Figure'16 .--Daily total seine catch of juvenile coho salmon in the upper Columbia River estuary (expressed in percentage of the annual catch), 1966-71.

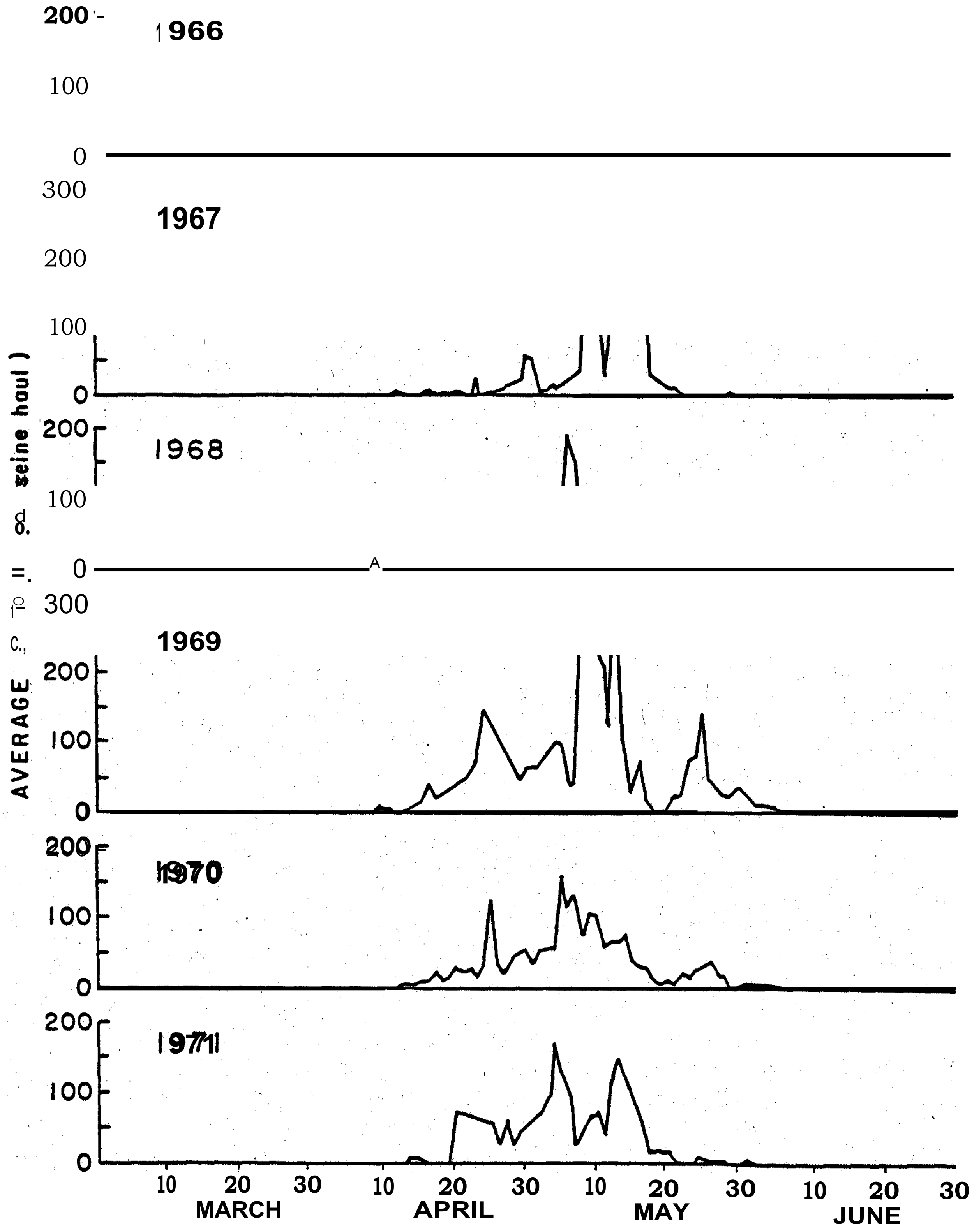


Figure 15 .--Average daily beach seine catches of juvenilecoho salmon at sites in the upper Columbia Diver estuary (1966-71).

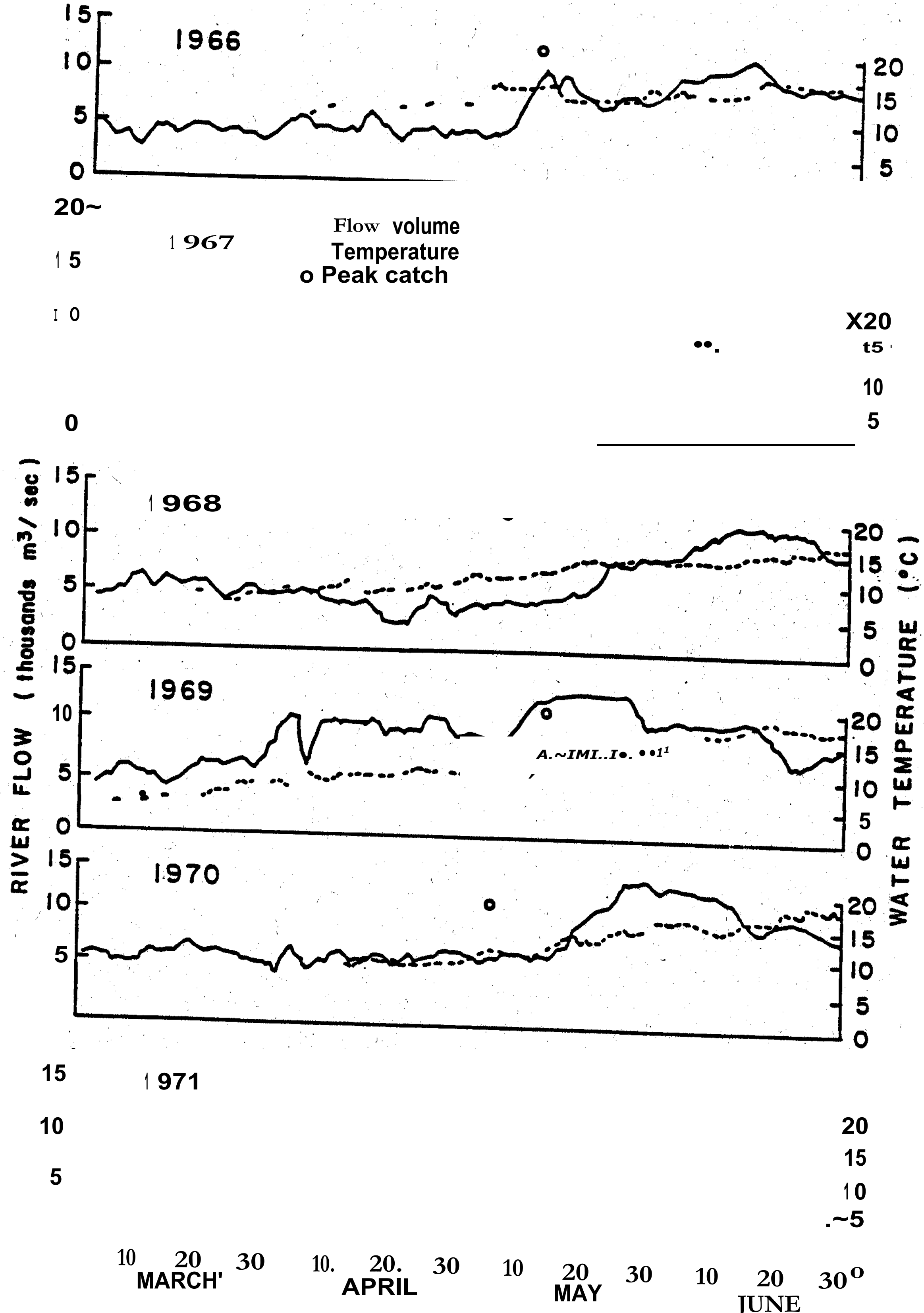


Figure 17.--Columbia River flows (U.S. Geological Survey 1965-1971), water temperatures at Jones Beach, and dates of peak catch for the spring migration, 1966-1971.

Hartman et al. (1967) compared timing of sockeye salmon,, _O. nerka,_ smolts with the latitude. of their nursery areas and determined photoperiodism to be an overriding stimulus for downstream migration. Such a relation for coho salmon smolts is .not apparent because their migration seems to occur at a similar. time.. irrespective of latitude.

Water. temperature may be .a factor that influences the timing and movement rate of. coho smolts (Fig.. 17). .During the .study, water temperatures would generally rise from approximately 10° C in early April to 16°-18° C. inlate June.' Temperatures at.peak migrations ranged from 11.3°C'(1970) to 14.7° C (1967). .Water:temperatures in 1969 generally lagged behind those in other study years; coincidently, progression of the smolt migration in that year was somewhat later than in other years of this study (Fig. 16). The. relation of temperature to timing. of migration, however, is not precise and can only be suggested.

No consistent relation was found between flow 'volume of the Columbia River and 'timing of juvenile coho salmon (Fig. 17). In 1966, 1969, and 1971, the period of peak arrival of coho generally corresponded 'with increasing river flows. In.1967,. 1968, and 1970, however, increased river flows began after the migratory peak. had passed. Recovery of marked coho salmon released from'Cowlitz Hatchery in 1969,. 1970, and .1971 indicated a variation in rate of movement of only 2 ' km per day for seven separate groups of coho salmon. Itappears, therefore, that since the timing of'the coho salmon migration was generally consistent' over the study period and the volume of river flow was substantially different during the 6-year investigative. period, timing of. the migration is not dependent upon volume of 'river flow.

The possibility' that the time of release of coho.salmon from the various. hatcheries influenced the time of peak migration into the estuary also was examined. Timing of releases from the 19 coho. salmon hatcheries varied oonsiderably within and between years.. Major releases ranged from January to May. March was the principal 'month for juvenile releases in 1966 and 1967, whereas the major releases from 1968 to 1971 were in April. Based on recoveries at Jones Beach, early release of coho salmon .from tht hatcheries failed to result in a'correspondinglyearly seaward migration. For this reason, the March to May release. time suggested by Wallis (1968) for hatchery coho salmon might be .modified to a mid-April to May - schedule if direct seaward migration is desired.

Zaugg (1970) discussed the migratory timing of juvenile coho. salmon in several Pacific Northwest streams and found a corresponding seasonal change in gill Na^{+}-K^{+} ATPase. He interpreted increases of Na^{+}-K^{+} ATPase (in late March) as an indication. of biological readiness for seawater and decreases (July) as indicative of a loss of urge to move seaward. The timing data from our catches of yearling coho salmon entering the Columbia River estuary are generally in agreement with this observation. However, subyearling coho salmon. reared in a hatchery and released in late July also moved toward the estuary in large numbers. On 28 July 1969, the Washington

Table 17.-?Releases and recoveries of marked coho salmon yearlings moving upstream to Jones Beach.

Hatchery and release point!!	Km from Jones Beach (approx.)	Release date	No. marked fish		Type of finclip markb/
			Released	Recovered	
Grays River-WDF	75	23 April 1967	35,068	1	D-LV
Grays River-WDF	75	23 April-1967-	36,344		D-RV
Elochoman-WDF	75	23 April.1967	107,227	18	AD-RM
Grays River-WDF ,	20	1 January 1967	118,365		
Big Creek-ODFW	35	27 February 1968	123,343	69'	
Clatskanine-ODFW	80	7 March 1968	113,316	69	AD-RM
Grays River-WDF	75	15 April 1968	63,150	69-	
Elochoman;WDF	20	16 April 1968	88,515	69	
Cathlamet-Trans. from Cowlitz-WDF	10	14 April 1969	314,639	9	AD-LP
Big Creek-ODFW,	35	15 April 1969	80,957	121.	AD and wire: tag
Big Creek-ODFW	35	15 March 1970	73,920	123	AD
Grays River-WDF	75	2 April 1970	232,081	123	
Youngs Bay-Trans. from Little White Salmon-FWS	60	23, 29 April 1970	100,662	13	LV

a1 WDF designates Washington Department of Fisheries, ODFW the Oregon Department of Fish'and Wildlife,.and FWS the U.S. Fish, and Wildlife service.

b/ AD designates that the adipose fin was removed, D the dorsal fin, RM the right maxillary bone, LP left pectoral, fin, LV left ventral fin, RV the right ventral fin.

Department of Fisheries released 742,218 subyearling coho salmon at Rainier, Oregon, 28 km above Jones Beach. We captured 4,817'of these'fish during the following few weeks (although,they were'not marked, individuals from this group were easily identified from size and. dates of recovery). The fish' averaged 80 mm in length and were from 50 to 100 mm long. Since these fish were not marked and were ,released directly into the Columbia River, evaluation of adult'contribution'to the fisheries was not possible.

Since many hatchery releases of yearling coho salmon made before mid-April apparently did not move directly and 'rapidly to the estuary, their behavior during the interim period is of- interest. Chapman (1962) found that aggressive behavior caused some wild coho salmon (i.e., nonhatchery fish) in small streams to migrate downstream early. ' Chapman (1965) also noted' that relatively 'large freshets in small streams caused downstream movement of wild coho salmon. Continuance of such movement to the estuary was not indicated at Jones Beach. We did learn. that some hatchery reared coho salmon released before May' in tributary streams downstream from, Jones Beach moved. upstream. Recovery of these marked fish at Jones Beach is shown in' Table 17. Unfortunately,' there were no distinctively marked fish released after 1 May below Jones 'Beach. Jones Beach is from 10 to 80 km.upstream from the indicated release °sites of the hatcheries. No marked coho salmon' were released below our sampling sites in 1966, but from'1967 through 1970 marked fish were released in the lower area, and upstream movement was indicated,each year. 'Although coho salmon were released .in the lower estuary in 1971, no assessment was made since the only fin-clip:release made below our site also coincided with similarly marked who salmon released upstream.

Rates of Movement

Many groups of juvenile coho salmon were marked. and released at various state and federal hatcheries during this study. Average rates of movement to the estuary based on distance traveled and time of release have been determined from the analysis of recovery data at the Jones Beach sampling site (Table 18). Releases of identifiable fish ranged from about 63,000 to 742,000 fish. The largest release was the group of unmarked subyearling coho salmon from Lower Kalama Hatchery of the Washington Department of Fisheries. Their distinctive size and time of release in late July 1969 made it possible to readily identify these fish upon recovery. Recoveries of groups of marked fish ranged from 5 to 4,817 individuals. Average travel time. to Jones Beach among the 24 specific groups ranged from 3 to 81 days. Average rate of travel ranged from 3 to 26 km per day. Rate of movement was associated with distance traveled. Generally, we found that who salmon released above Bonneville Dam moved more rapidly than those released at sites below the dam. In an unusual example of travel rate over an extended distance, Witty (1966) found juvenile coho salmon moved from the Wallowa River to Bonneville Dam (about 700 km) at an average rate of 71.3 km per day.

Time of release :was another factor influencing the movement rate. Releases of a single stock of marked juvenile coho salmon. made in the spring over a 2-month period-at Ice Harbor Dam in 1967 and 1968 provided examples of changing rates of movement in relation to'time of release. Subsequent recovery of ,these fish at Jones Beach enabled determinations of travel time. Scientists studying the effects of turbines on. salmonsmolts released 643,123 marked juvenile coho salmon during an 8-week period' in 1967. These coho salmon were. released atvarious times (Table 19) at four sites. near Ice Harbor Dam, 461 km above' Jones Beach,.. Recoveries of marked fish indicate that the average number of days required to reach'Jones Beach decreased by 30 days from late March to-mid-May, resulting in an increase in rate of movement-from 11.5. km/day, to 46.1 km/day.[2] Therefore,..; the average coho salmon released in late March at Ice Harbor Dam would. have arrived at Jones Beach in early May; coho salmon released' in mid-April would have arrived in mid-May; and those released in mid-May would have arrived in late May. The range of the recovery period was broad for early release-groups.and narrow for late releases.

An additional 505,840.. marked coho salmon were released at Ice.:Harbor Dam 14 1968 (Table 20). Though fewer fish were released, our beach seine effort doubled. and,. as a result, more marked fish were recovered than in 1967. The release schedule 1;1 1968 began... slightly later, was interrupted for 13 days in mid :April, and was completed 2 weeks earlier than in 1967. The average late-March releases , appeared at Jones Beach. in early May, whereas releases in. late April and early May arrived in. late May. The range of travel time for each group was again broad for early releases and narrow for late releases.. Once again, the. rate of movement to the estuary .increased as the migratory season progressed, . but in 1968 the change was more abrupt between early and late April. The overall average. rate of movement decreased slightly in 1968 (15.7 km/day).compared'. with 1967 (17.7 km/day)... Completion of the John Day Dam in spring 1968 impounded over 100 km of free-flowing ; river: and perhaps accounted, in part,' for the apparent slower movement of the migration in 1968. ..Raymond (1968) indicated that rate of movement of yearling chinooksalmon through McNary Reservoir was. about one-third the rate of: movement in free-flowing. reaches of the river.

Movement.. of the 1967 and 1968 releases at Ice Harbor Dam is compared in Figure 18. Plotting the time of 'release against the. average . number of days to reach. Jones Beach for each of the groups of. coho salmon . indicates a close agreement between the 2 years of travel times that apparently nre a... function of time of release.

2/ Krcma, R. F., C. W. Long, and W. M. Marquette, Fishery Biologists, Northwest and Alaska Fisheries Center, Coastal Zone and Estuarine Studies Division, NMFS, NOAA, Seattle, WA 98112, pers. commun. and unpubl. data.

Table IR.--Rate of movement (from area of release to the Jones Reach sampti'ng site) for various releases of marked ***hatchery-reared*** juvenile colo salmon,1967-71.

Origin of stock	Agency![/]	Km. to Jones Beach	Mark	Release date	No. released	No. recovered	Rate of recovery per 10,000	Average no. days to Jones Beach	Movement rate km/ day
Leavenworth	FWS	730	D-AD	3/1/67	200,000	5	0.25	81	9.0
Ringold Ponds	VHF	490	LV-LM	3/24-27/70	80,215	6	0.75	22	20.0
ice Harbor	I9fFS	461	BRAND	3/24-5/15/67	643,123	90	1.40	26	17.7
Ice Harbor	HMFS	461	BRAND.	3/28-5/1/68	505,840	152	3.00	29.	15.7
Little White	FWS	190	RV	5/12/70	100,367	112	11.16	12	15.8.
Cascade	ODFW	166	1/2 D-LP	4/5/71	88,000	41	4.66	36	4.6
Cascade	ODFW	166	1/2 0-P	4/5/11	81.000	36	4.44	34	4.7
Leavenworth (Trans. to Bonn. Dam)	FWS	162	D-AD-LN	3/10/68	97,000	41	4.23	53	3.1
Cascade (Trans. To Tanner Cr.)	ODFM	162	RV-RM	3/29/11	100,000	28	2.80	37	4.4
Eagle Creek	FWS	140	AN	4/1/68	87,000	39	4.48	46	3.0
Sandy River	OO1W	138	D-LM	2/20-24/67	171,435	19	1.11	40	3.5
Sinnott! Ponds (Trans. to Washougal)	VHF	132	LV-RM	4/14/70	63,293	93	14.69	5	26.4
Washougal	Viii	132	RV	4/9/71	87,876	65	7.40	26	5.1
Washougal	WDF	132	LV	4/9/71	87,824	47	5.35	26	5.1
Cowlitz	WDF	110	AD-RV	4/14/69	335.681	308	9.18	32	3.5
Cowlitz	VHF-	110	AD-LV	4/15/69	348,754	422	12.10	22	5.0
Comfits	WDF	110	A0-LV	4/6/70	285,000	428	15.02	27	4.0
Cowlitz	**NOF**	**110**	***60-RV***	4/6/70	326.000	527	16.17	31	3.5
Cowlitz	WDF	110	AD-RP	4/1/71	303,365	63	2.08	37	3.0
Cowlitz	WDF	110	A0-LP	4/1/71	266,695	117	4.39	34	3.2
Cowlitz	WDF	110	0	4/1171	302,695	89	2.94	37	3.0
Ralama (Trans. to Rainier. OR)	VHF	36	b/	7/28/69	742,218	4,817	64.90	7	5.1
Abernathy	FWS	28	AD	5/28/69	78,1000	1,540	197.44	3	9.3

!/ FWS designates the U.S. Fish and Wildlife Service, WDF the Washington Department of Fisheries, *MFS the National Marine Fisheries Service, and ODFW the Oregon Department of Fish and Wildlife.

Not marked but readily identifiable because of small size (0-age). All other releases mere yearling fish.

Table 20.--Rate of movement and recovery of marked coho salmon fingerlings released at Ice Harbor Dam between 28 March. and 1 May 1968 and subsequently recovered at Jones Beach.

Release aeriod	Number of coho released	Number recovered at Jones Beach	Recovery rate per 10,000 released	Range of days recovered	Days to Jones Beach	Standard deviation	Average km/day
28 March	41,987	13	3.1	13 to 59	36.2	13.5	12.8
1 April	34,744		2.3	32 to 53	39.9	7.9	11.2
2 April	34,776		1.4	21 to 48	35.6	10.5	13.2
3 April	34,786		1.1	30 to 51	39.0	9.2	11.8
4 April	34,744	11	3.2	27 to 48	36.7	8.5	12.8
5 April	34,779	7	2.0	31 to 45	35.9	5.5	12.8
9 April	34,789	5	1.4	36to 45	39.2	3.8	12.5
10 April	33,966		1.5	34 to 44	40.8	4.2	11.8
23 April	62,587	16	2.6	22 to 35	28.9	3.8	15.9
25 April	35,971	17	4.7	19 to 33	26.0	3.9	17.7
26 April	35,935	20	5.6	18 to 32	24.0	36	19.2
20 April	32,344		3.4	21 to 25	22.7	1.6	20.0
30 April	11,982	2	1.7	23 to 24	23.5	0.7	20.0
1 May	42,450	28	6.6	19 to 28	21.9	1.9	21.0
Total	505,840	152					
Grand avg.			3.0		29.4•		15.7

Table 19.--Rate of movement and recovery of marked cohosalmon fingerlings released at Ice Harbor Dam between 24 March and 15 May 1967 and subsequently recovered at Jones Beach.

Release period	Number of coho released	Number recovered at Jones Beach	Recovery-rate per-10,000 released	Range of days recovered	Days to Jones-Beath	Standard deviation	Average km/day
24-27 March	37,790	5	1.3	31-54	40.2	8.4	11.5
30 March-3 April	87,770	15	1.7	32-53	38.9	7.2	11.8
6-10 April	97,051	21	2.2	20-46	32.3	7.5	14.9
14-17 April	87,295	10	1.1	23-40	31.2	5.6	14.9
21-24 April	91,304	12	1.3	17-41	23.4	6.9	20.0
28 April-1 May	89,895	5	0.6	16-25	19.0	3.5	24.3
5-8 May	84,574	7	0.8	12-17	13.9	1.9	32.9
12-15 May	67,444	15	2.2	3-13	9.7	2.7	46.1
Totals	643,123	90					
Grand avg.			1.4		26.1		17.7

Variation in Hourly Seine Catches

It was.. apparent . from the sampling at Jones Beach that coho salmon smolts were present in greater .numbers during .midday than dawn or dusk--there was nosampling at night. In 1970, it was possible to assess hourly variations in the catch from 0600'to 1930-h each day.. throughout the coho salmon migration. The coho salmon were separated from other salmon and the total averaged for each 30-minute seine haul ,during the principal 3 weeks (26 April-16 May) of the outmigration (Fig.. 19). During these 21' sampling days, 34,537 coho salmon were captured,.. which .was .76.5X. of the 1970 total catch of that species. Coho salmon'were the dominant species of. salmon taken in the 3-week period, comprising.65.2% of'all.salmon captured. Inspection of Figure 19 indicates that. coho salmon smolts..were captured most 'frequently between 0830 and. 1430 h, and the largest catches occurred at midday. Samples of 'coho salmon. were marked and released . in the area with negligible recoveries.. We assume,. therefore, that coho salmon :smolts are not milling- in the. area but are .actively. migrating seaward during midday.

Fish Length in Relation to Seaward Migration

Fork length samples of coho salmon 'were taken daily and 'averaged for each year from 1966 through 1971 (Fig. 20). The trend of increasing smolt size is very likely a reflection of the changing rearing techniques at state and federal hatcheries.

Differences. in the average length of early. and. late migrating coho salmon smolts were also apparent..Larger fish (>125 mm) consistently migrated earlier than the smaller migrants ..(Fig. 21). Shapovalov and Taft (1954), in a '9-year.. study . of Waddell Creek, reported a similar gradual decrease:. in the average- size of coho'. salmon migrants as the season progressed.. Salo and Bayliff (1958), in a coho salmon life. history study on Minter Creek, also found large, individuals migrating'earlier than small fish. Apparently this characteristic is..not confined to one species since Shapovalov and Taft noted a similar phenomenon for juvenile steelhead of. a given. age class, and Hartman et al. (1967) reported that they'and other investigators .observed a tendency' for larger juvenile sockeye.salmon to migrate earlier in the season than smaller sockeye salmon.

The trend toward. releasing larger coho salmon. in. recent years. has resulted in earlier timing of the peak migrations as well (Fig. . - 21). For example, fish migrating in 1971 (mean annual fork length, 138 mm) peaked .00 5 May, 10 days earlier than those migrating in.1967 (122 mm). Similar relations. were also evident in the other. years as shown in Figure 22. The strong. relation (correlation coefficient,.r =.. 0.85).suggests that the mean annual fork length of coho salmon is a factor in the time that they migrate seaward.

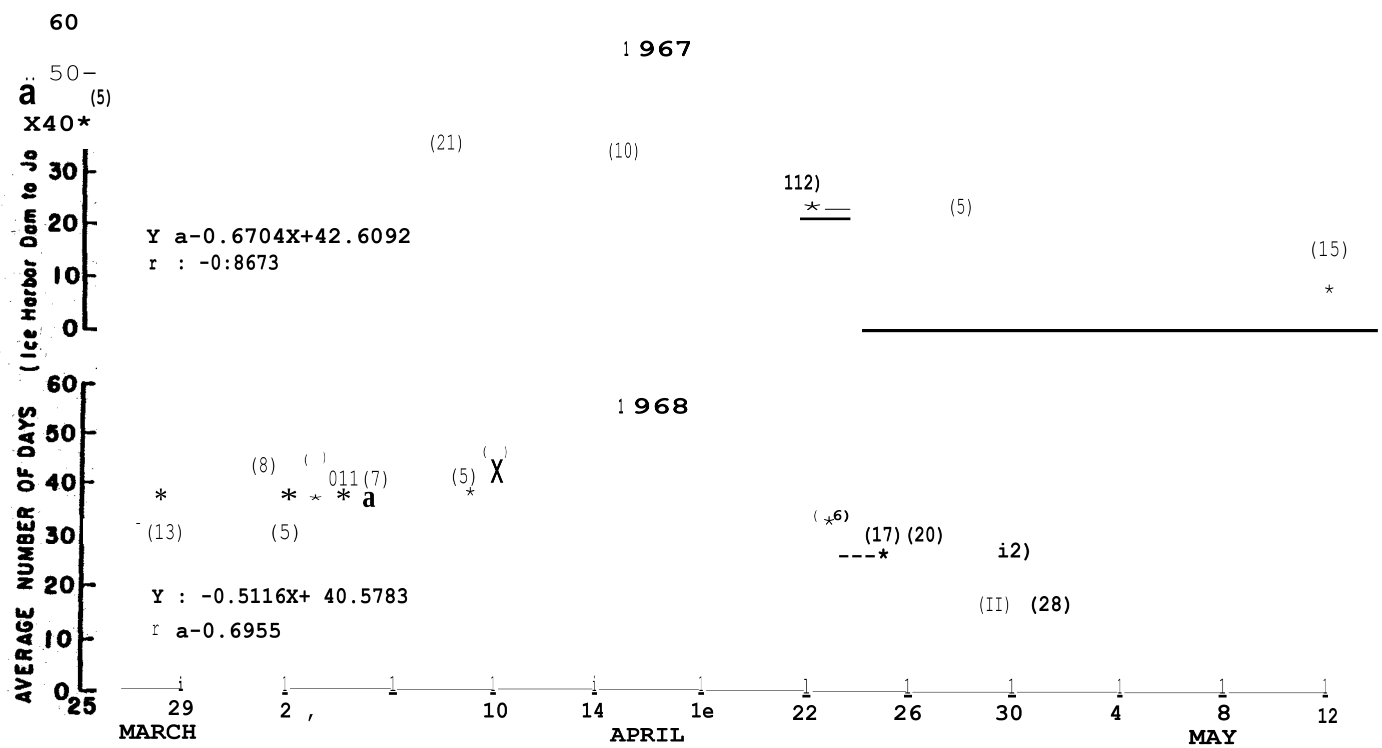


Figure 18•--Relat ion between rate of migration (i.e., the average number of days from time of release at Ice Harbor Dam to time of recovery at Jones Beach)-of juvenile coho salmon and the date of their release at Ice Harbor.Dam, 1967-66. The number of coho salmon recovered from each release group is shown in parentheses; their average travel time is marked with an asterisk.

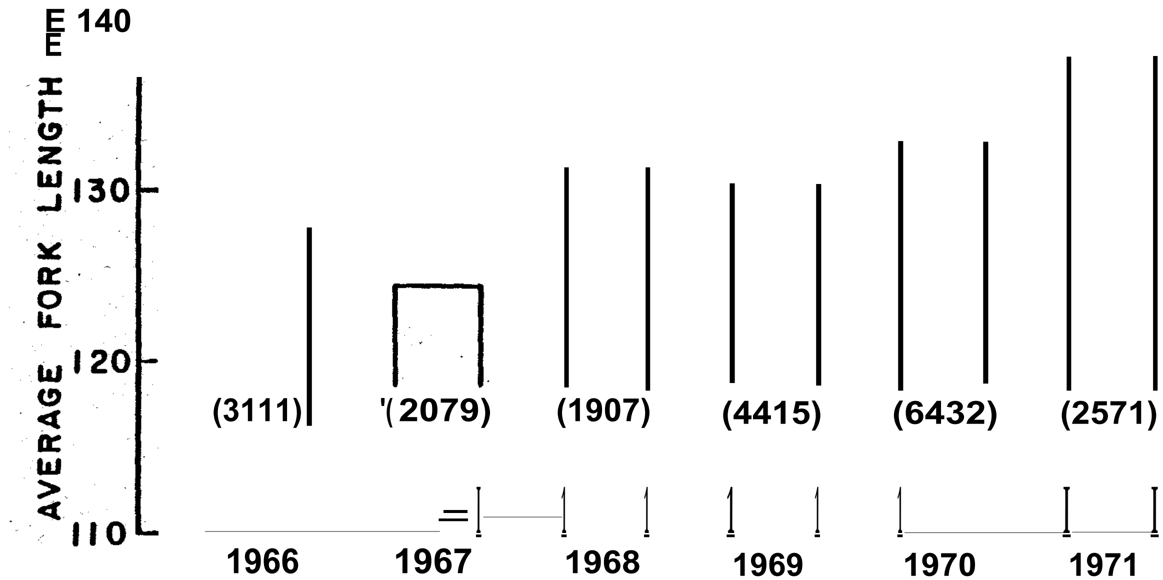


Figure 20 .--Average fork lengths of juvenile coho salmon at time of migration through the upper Columbia River estuary, 1966-71 (sample size in parentheses).

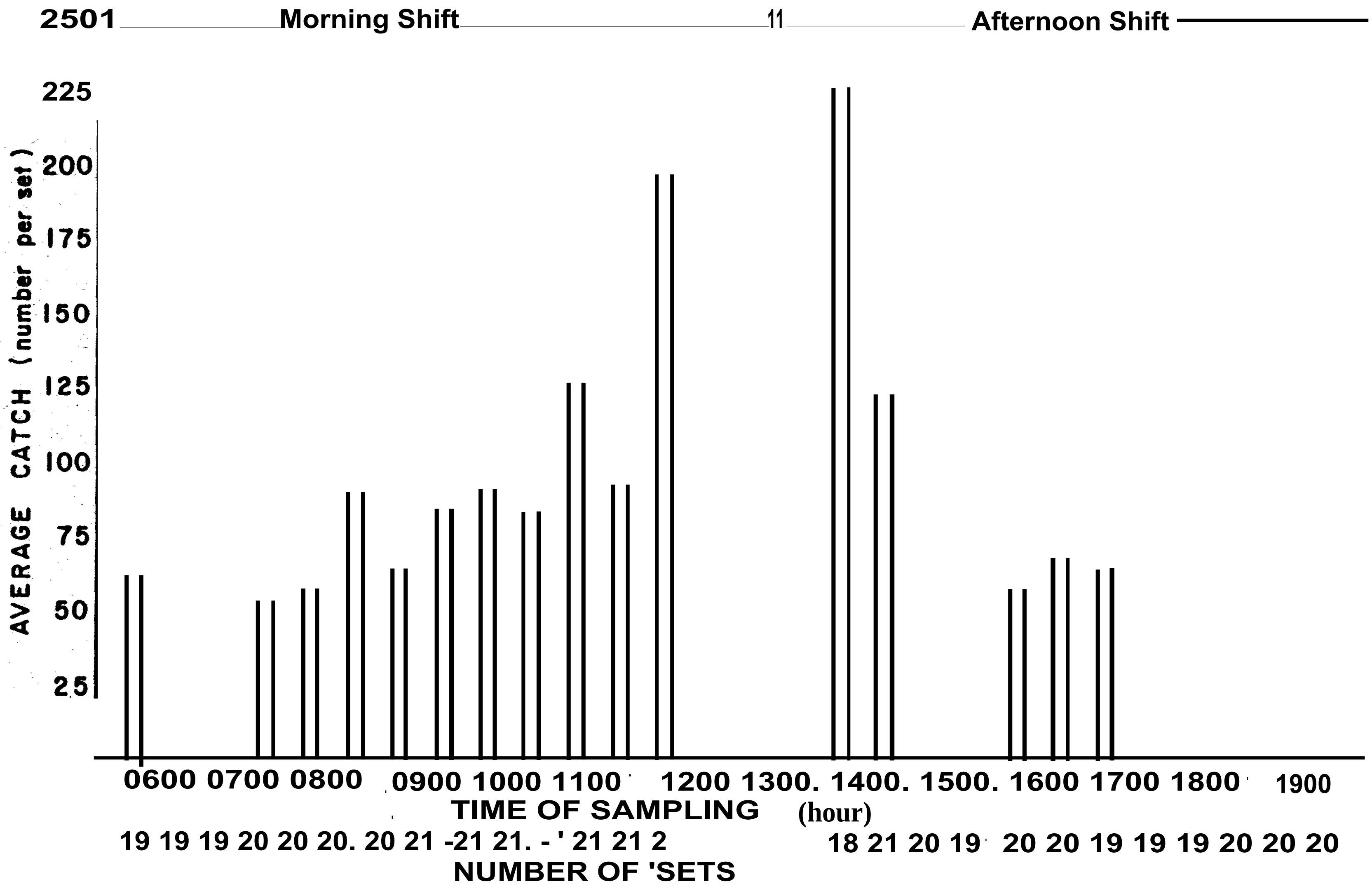


Figure 19 .--Average seine catches of juvenile coho salmon per half hour for the 3-week period of maximum availability between 26 April and 16 May 1970.

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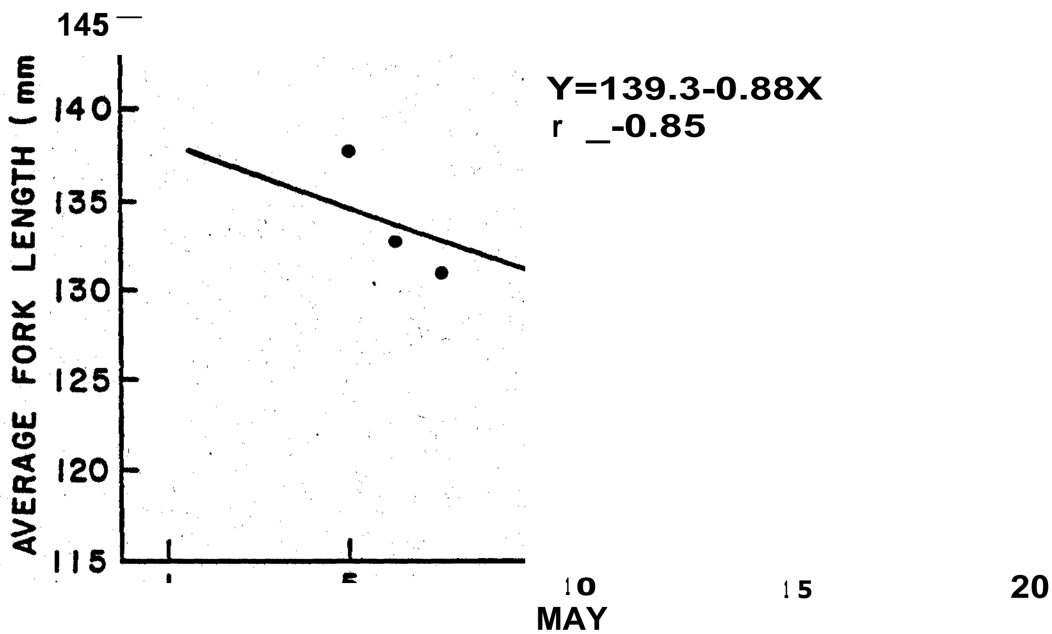


Figure 22 .--Relation between annual average fork length of coho salmon molts and date 'of annual peak:catches at Jones Beach (1966-71).-

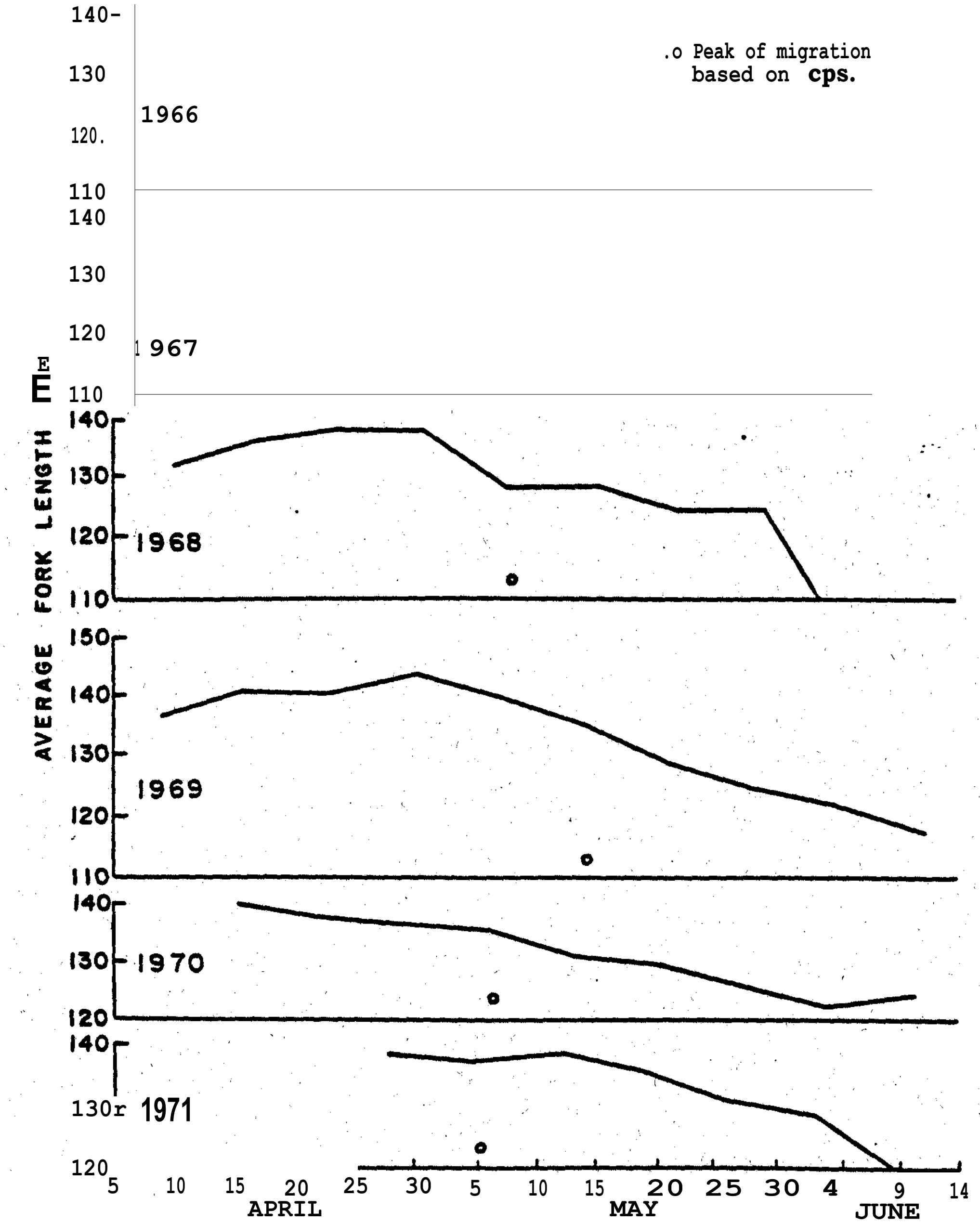


Figure 21.--Average fork length of juvenile cohosalmon captured in the upper Columbia River estuary for each weekly period of the annual smolt migration, 1966-71.

SECTION III--SALMONIDS, 1977-1983

Introduction

From 1977 through. 1983, millions. of juvenile salmonids were marked and released from sites throughout the Columbia River basin. (Fig. 23 and Table 21).. From 2.3 . to 5.0% of'the migrating juveniles were marked each year to evaluate cultural practices,. bypass systems at dams, ocean. distribution,. contribution , to the fisheries,'and other factors. Marked fish also provided data to compare timing, movement rates, physical. condition, and relative survival differences between stocks following migration to the estuary..

The objectives of Jones Beach sampling varied somewhat from , year to year depending on fishery agency requirements and fish groups/stocks..released. The general objectives .of research. from 1977 through 1983 were as follows : (1) define vari abler affecting. timing and movement. of juvenile. salmonids: to' and. through the estuary; (2) evaluate' recovery rates in relation: to river flow, release site, release date,•cultural treatment, physical traits of migrants, and effects. of the 18 May 1980 eruption of Mount St. Helens; (3) .evaluate trends of relative survival and relate to survival of adults;. and (4) compare wild and hatchery fish stocks.

Methods

Sampling

From. 1977 through 1983, beach and purse .seines were used to sample .juvenile salmonids at Jones Beach, '(RKm 75) near Woodson, Oregon, .(Fig. 24). In some years,, additional sites were sampled. In 1978, beach seines. were used at Sand Island *(RKm 9)* and Clatsop Spit (RKm 7); from 1978. to 1980 purse seines were used at McGowan (Urn 16), at incidental sites throughout the estuary, and in the . Columbia River ocean' plume (24 km radius of. the river mouth)..,

Each year. sampling was intensive during spring and summer (7.h/day; 5-7 days/week); additional .limited .sampling was conducted during .fall and winter. Sampling procedures, levels of..effort, and catches of marked and `unmarked fish are listed and summarized by Davie)' et al..(1985a and .b).'

Beach and purse seine sampling and :subsequent examination of- juvenile salmonids caused ,mechanical injury and stress which resulted in immediate. (0-20%) and delayed (0-5%) mortality. Delayed. mortality.. was assessed by retaininga random sample of about 50 fish in a'net-pen for 24. h, 3 days/week in. May and June 1983 and occasionally during other years.

Weather, river, and tidal conditions during saipling,affected catches of 3uvenile salmonids. At Jones Beach, ' our.ability to sample was unimpaired; however,. sampling. efficiency . changed with variations in river flow. .Columbia:. River flow (measured at Bonneville Dam by. the U.S. Army Corps of Engineers,. 1977-1983) .varied widely within and. between years (Fig. 25). During. the

Conclusions

1. Juvenile coho salmon migrate into the upper estuary between mid-April and late May.

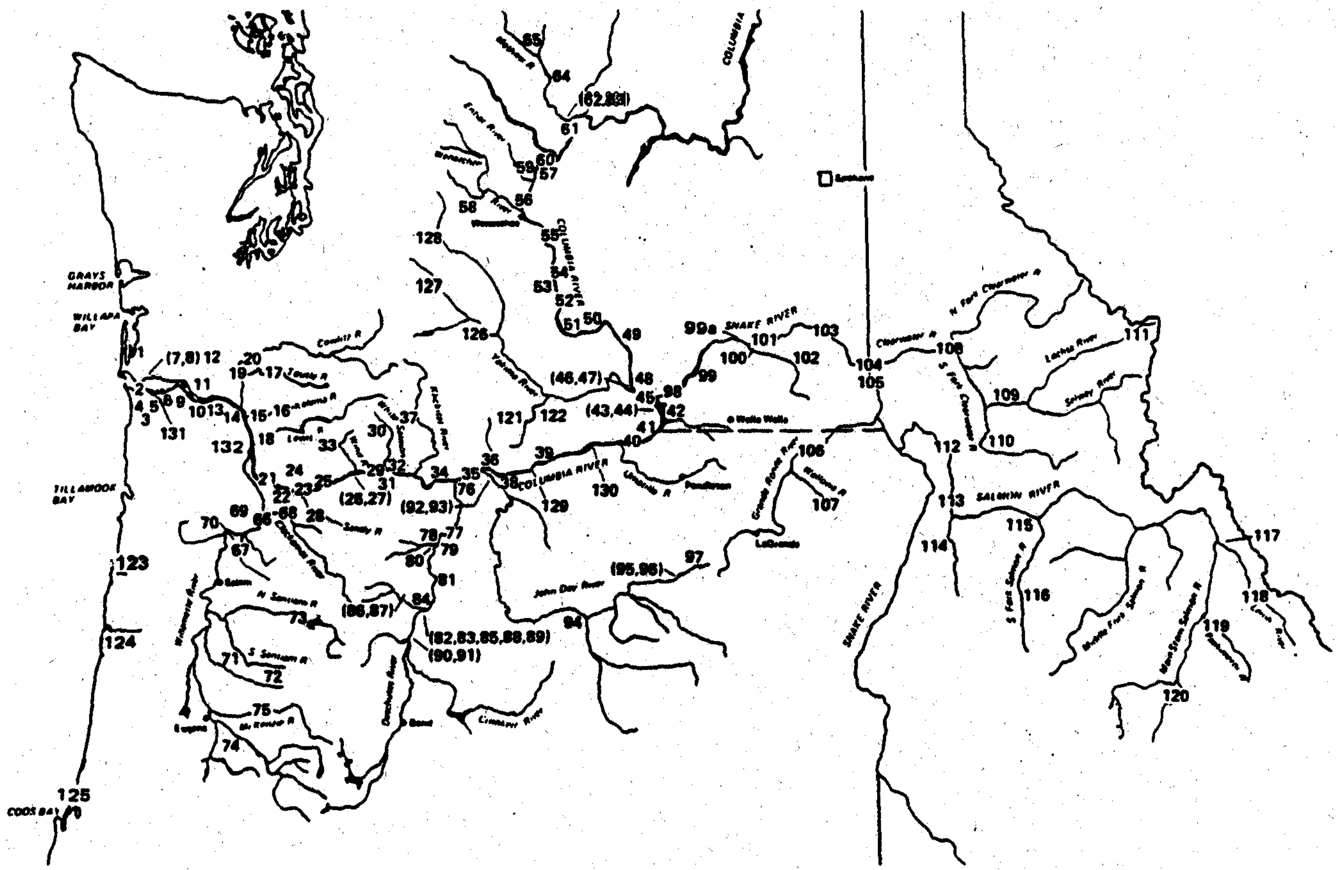
2. A relationship exists for yearling coho salmon between their rate of seaward movement and the time of their release and the distance migrated to the estuary. Generally, coho salmon released in upper reaches of the Columbia River system moved downstream more rapidly than those released near our sampling site. Also, fingerlings released before mid-April moved at a slower rate than those released in late April or May.

-3. Maximum catch` abundance occurs. around midday (0600 to 2000 h).

4. Improvements in rearing technique. and diet at .Columbia River hatcheries during the study period appears to have caused an increase in average annual' fork. length of coho salmon smolts entering the .upper estuary; about 10% during this study.

5. Average size of-migrants characteristically increases .through. the migration period; larger coho salmon smolts (> 125 mmfork'length) were the- first to arrive in the' 'upper' estuaryand were followed by smaller individuals ("< 125 mm).

6. Timing of the annual peak of migration for coho salmon varied in association with annual mean fork length; overall average size for the migrating population increased through the 6 years of study., and the peak of migration came progressively earlier.



LEGEND

Rheas site	Rkm
LOWER COLUMBIA R.4 TRIES.	
1. Chinook R Pd	11
2. Hammond Ora	13
3. Tucker Cr	29
4. Stavebolt Cr	34
5. Klmkanine R	37
6. Bis Cr	49
7. Grays RPRM 13	57
8. Grays RPRM 21	68
9. Jones Beach	75
10. Beaver Terminal	84
11. Abernathy Cr	91
12. Elokomin R	94
13. Rainier Ore	109
14. Prescott Ore	115
15. Kalamai RPRM 6	127
16. Kalams RPRM 15	141
17. Crean R	160
18. Lewis R	163
19. Cowlitz RPRM 47	184
20. Cowlitz RBRM 50	189
21. Daiwa Ft	206
22. Washougal RPRM 10	213
23. Skomnia Light	219
24. Washougal RIRM 1S	221
25. Beacon Rock	227
26. liv Bonn 0	230
27. Tanner Cr	231
28. Sandy R	235
29. Lit Wh Sal R1RM 2	261
30. Lit Wh Sal RPRM 5	268
31. Spring Cr Hat	269
32. Big Wh Rear Pd	273
33. Wind R	275
34. The Dallas D	306
35. John Day D	347
36. Tavel Wash	351
37. Klickitat R	358
38. Blalock Shore	375
39. Patterson Slough	448
40. NcHary 0	470

Reli six site	Rkm
41. Port Kelly Wash	501.
42. Walla Walla RP.Mo	507
'43. Casey Pd	516
44. Villlard Slough	521
MID COLUMBIA R f TRIES.	
45., Pasco Wash	522
46. Yakima RPMo	5)9
47. Richland Wash	540
48. Ringold Pd	568
49. Wh Bluffs	596
50. Vomits Brld	629
51. Pr Rapid Spam Ch	639
52. Crab Cr	660
53. Wampum D	669
54. Vantage Brid	674
55. Rock Island D	725
56. Rocky Reach D	761
57. Turtle Rock Pd	768
58. Icicle Cr	789
59. Entiat R	790
60. Chelan Nat	813
61. Wells Spam Ch	828
62. tathov RPMO	838
63. 'Maros Ferry	839
64. Minims RVM 28	893'
65. Methow Rlgat	911.
W1L.LAIMTTE R 6 TRIES.	
66. Willamette Falls	207
67. Nellalla R	220
68. Clackamas R	247
69. Tualatin RPSoogg	304
70. Mill Cr	308
71. S Ssntiam$Spt Ld	411
72. S SantlamlPoster	416
73. N SantlaelMinto	452
74. N Ph WilliamODexter	491
75. McKensislLeaburg	492

Release site	Rkm
DESCHUTES R 6 TRIBS.	
76. Deschutes RPMo	330
77. Shersrs Falls-No	363
78. DeschutesPRH 43	395
79. Oak Springs Nat	404
80. Maupin Trap RM SO	408
81. WmSp R-Sher Fall	425
82. Ory Cr-Wm Sp R	446
83. DesrhuteaPNM 84	461
84. Warm Spring Trap	464
85. Pelton O-Wm Sp R	473
86. Warm Spring R	479
87. Warm Spring RPl1at	485
88. DeschutesIRM 100	489
89. Beaver Cr-14n Sp R	694
90. Rnd Butte Ladder	503
91. Rnd Butte Hat	506
JOHN DAY R	
92. John Day RPMO	349
93. John Day RIIRM 16	374
94. John Dey$SRray Ore	623
95. N Fk John DPRM 60	744
96. H Fk John DPRM 32	749
97. John DPGranits Cr	788
SNAKE R 6 TRIIS.	
98. Ice Harbor n	537
99. Fishhook Park	557
99e. Lyons Parry	600
100. Texas Rapids	630
101. Lit Goose D	634
102. Tucennon R	691
103. Lo Granite D	693
104. Clarkston Wash	742
105. Asntin Wash	754
106. Grand Ronde R	793
107. Wallowa Net	940

RNase sits	Rkm
CLEARWATER R 6 TRIES.	
108. N Fk Clearwater R	804
109. Clear Cr	868
110. S Pk Clearwater R	941
111. Lochsa R	1026
SALMON R 6 TRIES.	
112. Whllrhird Trap	9ON
11). RIRRinm Trap	959
114. Rapid R Rat	967
115. Lit Snl R	974
116. S Fk Salmon R	1151
117. Lm hl RPMO	1239
118. Izmhl R	1294
119. Pahsimcroi R	1311
120. Upper Salmon R	1446
YAKIMA R	
121. Satin; Cr	651
122. Dry Cr	681
OUTSIDE COLUMBIA RIVER BASIN	
123. Suets R	
124. Yaquina Bay	
125. Cool 9 ay Ore	
YAKIMA R	
126. Nelson Sp Pd	734
127. Nile S' Pd	771.
128. Ellensburg	716
LOWER COLUMBIA RIVER	
129.. Rork Cr	1611
110. 81ggs	335
191, Tongue Pt	76
1132.. Coal. E. Fork Levis	146

Figure 23.--Map and list of release sites for marked fish in the Columbia River system with index numbers for location.

Table-21.--Origins of marked juvenile salmonids captured during estuarine or ocean. sampling, 1977-1983.'.. Footnotes identify organizations responsible ' for marked fish groups.-

---

Abernathy SCUC a/
Alsea Hat. b/
Anodromous Inc. c/
Aumsville Pd. b/
Big Creek Hat. b/
Bonneville Hato b/
Cascade Hat. b/
Casey Pd. a/
Carson Hat. o/
Chelan Hato d/
Chinook R. Pdo e/
Cowlitz Salmon Hato f/
Cowlitz Trout Hat. d/
Decker Flats Pd. g/
Deschutes R. b/
De>:ter Pd. b/
Dry Cr. h/
Dworshok Hat. a/
Eagle Cr. Hato a/
Elokomin Hot, f/
Entiat Hat. d/
Gnat CT , Hat, b/
Grays R. Hat. f/
Hagerman Hato a/
Hayden Pd. g/
Ice Harbor D. i/
John Day D. i/
John Day R. b/
John Lay Reservoir i/
Jones Beach i/
Kaloma Falls Hato f/
KiaskonineHato b/
Klickitat Hut. f/
KOoskia Hot. a/
Leavenworth Hato a/
Lewis R. f/
Lewis R. Hato f/
Lit. Goose D. i/
Lit. Who Sal. Hato a/
Lo. Granite D, i/
Lower Kal'oma Hato f/
Lyons Ferry Hat. a/
Marion Fks. Hat, b/
McCall Hat. g/
McKenzie Hato b/
McNary D. i/
Naches Hato d/
Neholem Hato b/
Nelson Sp. Pdo h/
Niagara Springs Hato g/
Oakridge Hat, b/
Oak Springs Hato b/
Oregon Aqua .j/
Oxbow Hato b/
Pahsimeroi Rearing Pd. g/
Patterson Slough a/
Pr. Rapid Spow. Cho f/
fuinalt Hat. f/
Rapid R. Hato g/
Red R. Hato g/
Riggins Trap i/
Ringold Rearing Pd. f/
Fuld. Butte Hat. b/
Rnd. Butte Ladder b/
Roaring River Hato b/
Rocky Reach Dam k/
S. Santiom Hat. b/
S.Fk. Kiaskanine Pd. 1/
Sandy Hat. b/
Satus Cr. h/
Sawtooth Hat. g/
Metz R. b/
Skamania Hat. d/
Speelyai Hato f/
Spring Cr. Hot. a/
Stayton Pdso b/
The Dallas D. b/ 1 i/
Toutle Hati f/
Tuconnon Hato d/
Turtle Rock Pd. k/
Upper Kalamo Hat. f/
Vanderveldt Pd, 1/
Villiard Slough a/
Wallowa Hat. n/
Warm Spring R. 8 Hat. a/
Warm Spring R. b/
Worm Spring Trap b/
Washougal Hato f/
Wells Spow. Cho d/ i_f/
Weyco Pd. f/
Whitebird Trap i/
Willard Hat. a/
Winthrop Hato a/

a/ U.S. Fish and Wildlife Service, Fisheries Assist. Office, 2625 Parkmont Lane, Bldg. A., Olympia, WA 98502.
b/ Oregon Dept. of Fish I Wildlife, P.O. Box' 3503, Portland, OR 97208.
c/Anadromous Incorporated, Rt. 2 Box 2013, Deer Island, OR 970540
d/ Washington Dept. Game, 600 North Capitol Way, Olympia WA 98504.
e/ Sea Resources, P.O. Box 187, Chinook, WA 98614.
f/ Washington Dept. Fisheries, 115 General Admin. Bldg., Olympia, WA 98504.
g/ Idaho Dept. Fish t, Game, 1540 Warner Ave., Lewiston, ID'83501.
h/ Yakima Indian Nation, Fish Resources Management, P.O. Box 151, Toppenish, WA 98948.
i/ Natl. Mar. Fish. Servo, 2725 Montlake Blvd. E., Seattle, WA 98112.
.j/ Oregon Aqua . FoodsInc., 88700 Marcola Rd., Springfield, OR 97477
k/ Chelan County P.U.D., P.O. Box 1231, Wenatchee, WA 98801.
1/ Clatsop Economic Dew, Comm., O.S.U. Seafoods Lab., 250 36th., Astoria, OR 97103.

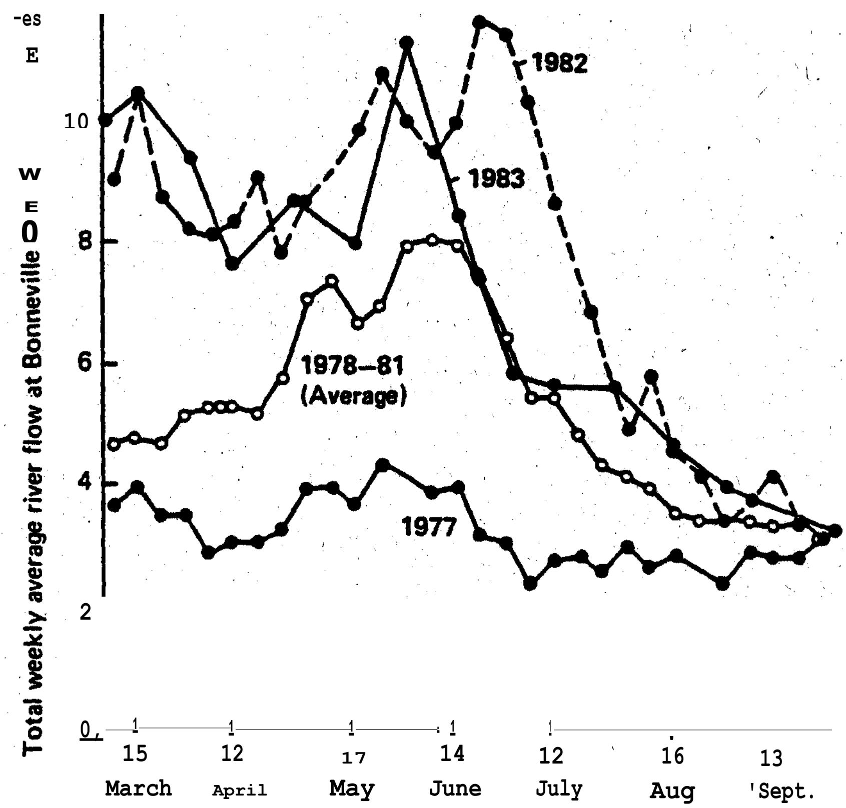


Figure 25.--Weekly average Columbia River. flows for 1977, mean of .1978-1982, 1982, and 1983; collated from data supplied by U.S. Army Corps of Engineers, Portland, Oregon.

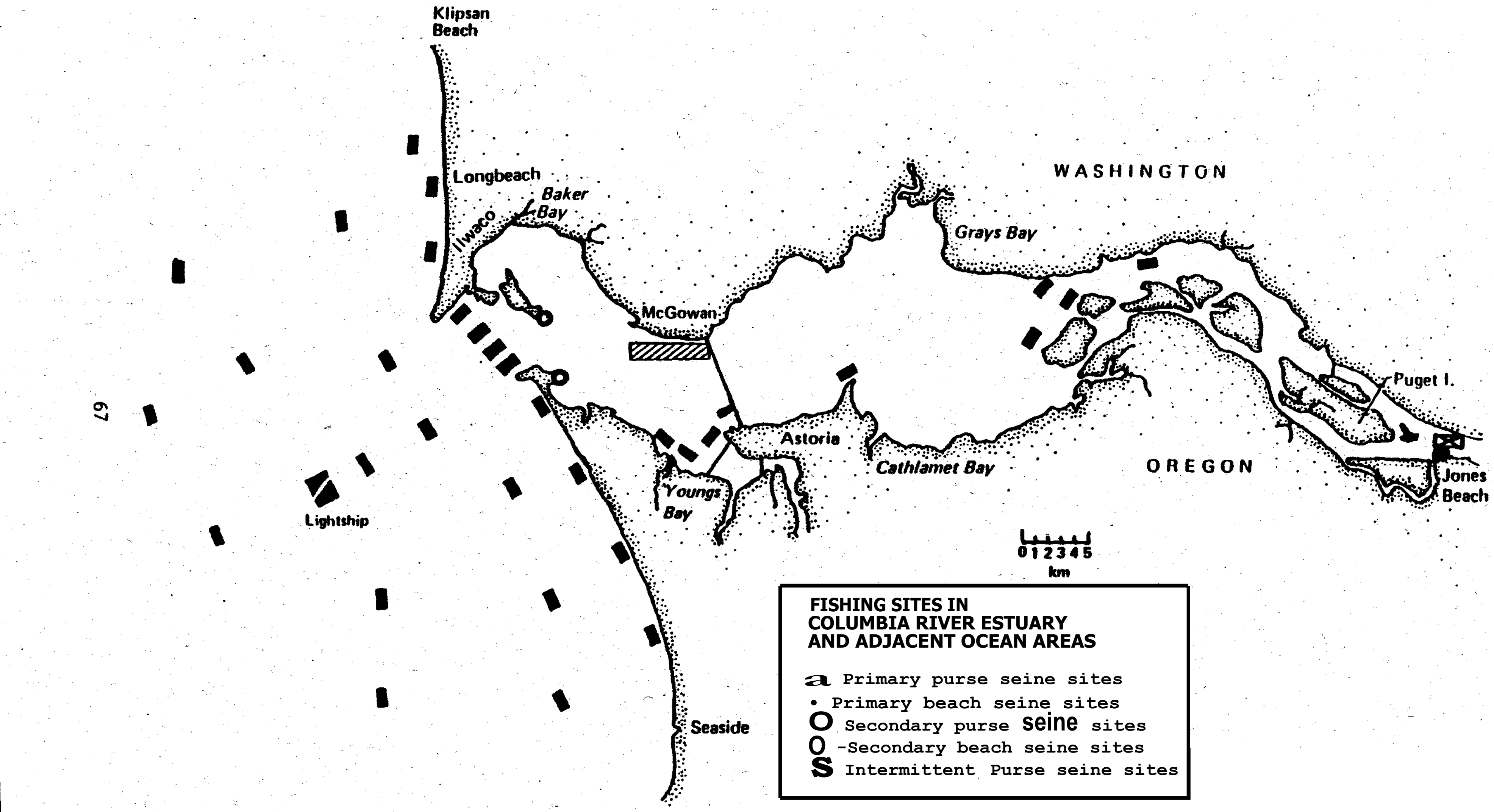


Figure 24.--The Columbia. River estuary and adjacent Pacific Ocean-showing sampling sites.

The empirical method.. Was used for detecting. significant differences between catch ratios for 'treatment and control groups. Differences were plotted in Figure 26 to discern if they were greater ''than those. observed between replicate groups with similar numbers of recoveries at Jones Beach. If any of the .plotted points fell outside the range .observed for:replicate groups, significant differences existed between ..the catches of treatment and control groups. For example, to evaluate the difference between two. stocks of steelhead from Hagerman Hatchery released in the upper Salmon River, we use the following data:

a

Stock	Size (no./lb)	No, released	No. captured Actual	Adjusted	U	X	Y
A	2	38,800-	84	109	0.00320	84	12.
A	5	39,100	.104	142`		104	13
	4	37,600	102	119		102.	1

All data points for X and Y fall' inside the range of replicate groups (Fig. ,26); consequently, we conclude there was co detectable difference . in. survival to the estuary for Stocks A and B. Statistical evaluation using the ,G statistic (Sokol and Rohif ,1981), provides a similar-conclusion but takes longer to calculate and in some Instances may provide erroneous ,conclusions because no adjustment .for sampling effort is _included. .The empirical evaluation accounts for variation (including random).. that has affected previous sampling; consequently, it provides a more. precise evaluation (Efron and Morris 1975).

Assessments of -statistical differences 'among adult recoveries from mark groups, were made using the G statistic at $P < 0.05$ rejection, of the null hypothesis (no difference).

Relative survival estimates for mark groups given various treatments were made by comparing catch percentages of control and treatment groups by the following formula:

$$\frac{(\%\ \text{catch treatment} - \%\ \text{catch control})}{\%\ \text{catch control}} \times 100 = \%\ \text{difference in survival}$$

Results and Discussion

Numbers of marked and unmarked fish captured during estuary sampling varied .from a .high of 370,000. in 1977 of to a low of 170,000 .in 1980 (Fig.' 27).' The variation was related to numbers of juveniles released from culture facilities,. sampling effort, and river flow which may .have altered. .catch efficiency. In 1980, decreased..catches also resulted from the - effects of the 18 May eruption of..Mount St. Helens.

period of spring outmigtations, April-June, 'river flows in,1977 were extremely low. '(2,900 to 4,400 e/second); flgws in 1978, 1979, 1980, and 1981 were moderate (averaging 4,700 to 8,900 ..m /s!cond); and in 1982 and 1983 were high (8,100 to 11,700 and 5,900 ' to 11,300 m /second, respectively).' We evaluated the'change relative to river flow and for certain analyses adjusted catch data to compensate. Water .temperatures at Jones .Beach .fluctuated in a fairly consistent pattern; during. winter from ' 1° to 5°C, during spring frail 6° to 17°C,'and during summer from.18° to 21.°C.(Dawley et al. 1985a).: In the lower estuary (RKm 1-16) and the ocean plume, conditions encountered affected catch efficiency and out ability to sample. Consequently, data pertaining to juveniles in the lower estuary and ocean were used primarily ;. for timing and movement rate analyses and not for survival estimates.

.Analysis

Subyearling chinook salmon were predominantly fall and summer. races, whereas yearling chinooksalmon were predominantly a' spring race (Van Hyning 1973); they wete separated for analyses .and presentation. Marked fish were classified from mark,. release information .provided by the fishery organizations, whereas unmarked fish .were classified on the basis of fork length [error rates.' varied '. from 0 to 4% (Dawley et al. 1985a)].. Jones Beach mark recovery ,data were expanded to represent a standard effort of. 10 beach seine sets. and 5 purse seine sets per day, 7 days per week. Details of -expansion formula are in Dawley et al. (1985b). Sampling . from; other sites. was notadjusted.

Marked fish movement rates were calculated using' distance traveled and time between first .date of release and the 10% fish recovery or'.-the median fish recovery at Jones Beach.

Juvenile . catch. percentages were compared with adult recoveries from the fisheries, hatcheries, and spawning grounds. The adult recovery data include recoveries from the fisheries, spawning surveys, and hatcheries which were obtained from the Washington , Department of Fisheries (WDF), Oregon Department of Fish and Wildlife (ODFW), Idaho. Department of Fish and Game (IDFG), U.S. Fish and Wildlife Service (FWS), and the Pacific Marine Fisheries Commission (PMFC). Comparisons between groups released at different times . or locations may result in .erroneous interpretations because -of. differences in ocean distribution, unequal fishing,,or sampling , effort.

Relative Survival

To assess the statistical validity of estimated survival differences- between treatment and control groups, `catchdifferences,' wereevaluatedin relation to observed differences between replicate groups previously captured 'at Jones Beach (Appendix Table BI). To simplify the evaluation,. an 'empirical power of the test curve was developed where catch 'ratios (no. caught/no.. released) of 'replicate' mark groups were averaged (U); the percent difference between this average and each individual catch ratio was then calculated .(Y) and plotted versus the number of .fish .captured (X). The curve. in Figure '26 represents the 95% confidence level ($P<0.05$) for the hypothesis' that. no difference exists between groups.

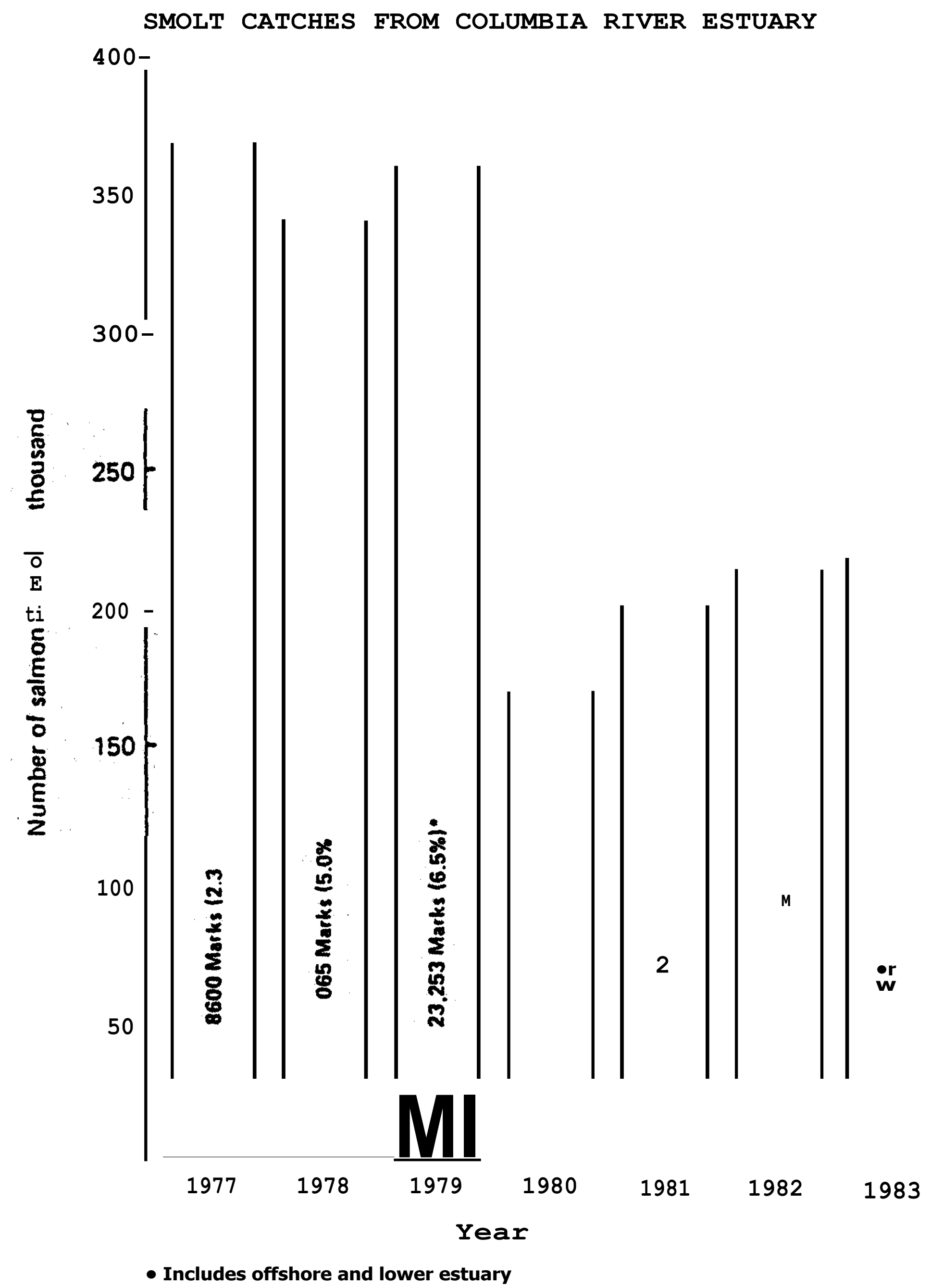


Figure 27.--Numbers of marked (darkened'area). and unmarked salmonids .captured at' Jones Beach, 1977-1983. Percentage of marked fish in total *catch is* shown'in *parenthesis.*

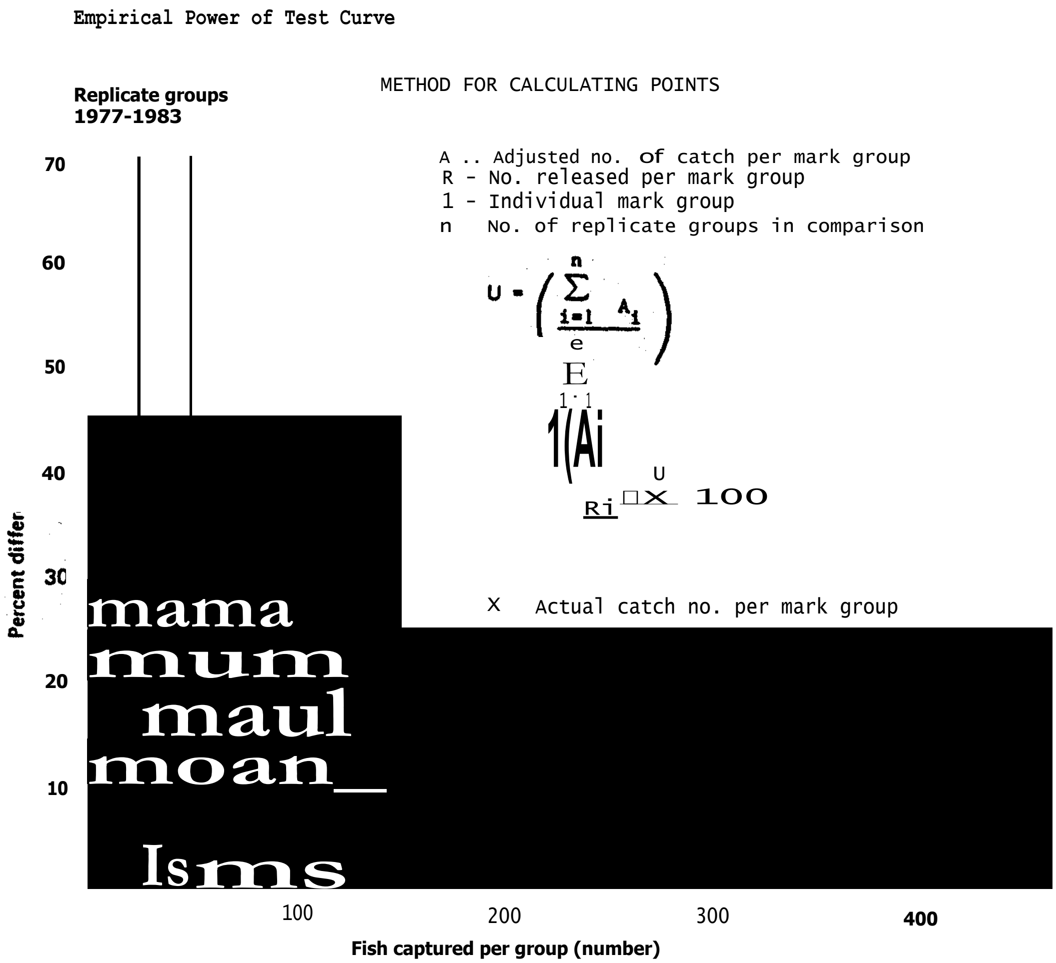


Figure 26.--Empirical power of the test curve developed by comparing differences between catch percentages for replicate mark groups to number caught. * = treatment groups from example in text.

Table 22.--Dates of migrational peaks for juvenile salmonids at Jones Beach indicating migrational overlap, 1977-1983.

	Week of peak migration[a]			
	Chinook salmon		Coho	
Year	Subyearling[b]	Yearling[c]	salmon[c]	Steelhead[c]
1977	21-27 May			
1978	11-17 June	7-13 May	14-20 May	14-20 May
1979	2-8 July	14-20 May	28 May-3 June	14-20 May
1980	11-17 June	7-13 May	14-20 May	7-13 May
1981	6-10 June	7-13 May	14-20 May	7-13 May
1982	11=17 June	21-27 May	21-27 May	21.27 May
1983	4-10 June	14-20 May	21-27 May	21-27 May

a/ From the date of median fish recovery; not adjusted for river flow.
b/ Timing based on beach seine catches.
c/ Timing based on purse seine catches.

Migrational Timing

Migration patterns of juvenile salmonids into the estuary, depicted by catch per set (CPS) averages, were similar between years. Few fish were captured in January and February (less than 10 fish captured per set). A small CPS peak of yearling and subyearling chinook Salmon (25 to 95) occurred in March, followed by a decline in early to mid-April. Steadily increasing numbers of yearling and subyearling chinook salmon, coho salmon, and steelhead occurred after mid-April with peak catches in May and early June (100 to 200 CPS for yearlings and up to 1,000 CPS for subyearlings). Yearling fish catches declined rapidly during June to less than 10 CPS by early July and almost none were captured through the end of the year. Variable numbers of subyearling fish were captured in July and August (25 to 350 CPS), catches then declined in September (15 to 75 CPS). Small peaks of subyearling chinook salmon were recorded in November (10 to 40 CPS) and decreased in December (less than 5 CPS). The catch per set pattern of 1983 (Fig. 28) depicts a migration pattern similar to most years; catch patterns for other years are presented in Dawley et al. (1985a).

Spring and Summer Migrations.--In general, timing for upriver stocks migrating through reservoirs and past dams is characterized in reports by Sims et al. (1978-1983) and by the Water Budget Center.[31] At Jones Beach, peaks of migration for yearling chinook salmon, coho salmon, and steelhead were generally in the latter part of May (Table 22); subyearling chinook salmon showed a wider variation of migration pattern than yearlings, but generally the peaks were directly related to release dates of major hatcheries and river flow.

Fall and Winter Migrations.--Attempts to decrease rearing costs and/or increase adult returns prompted renewed efforts in the 1970s and 1980s to determine the effects of releasing salmonids during fall (Smith 1979a; Hansen et al. 1979). Preliminary recoveries of adults indicated benefits in some instances (Smith and Zakel 1981) and none in others (Hansen 1982). Researchers were concerned that some of the fall released juveniles would overwinter in tributaries and compete with wild stocks. Observations demonstrating residualism were made at the Pelton Ladder on the Deschutes River (Hart et al. 1980) and at Jones Beach (Dawley et al. 1978).

At Jones Beach, sampling was extended into the fall, winter, and early spring of 1978-79, 1981-82, and 1982-83 to examine the timing and migration success of fall released fish. Most fish released in the fall migrated past Jones Beach before 15 December; the remainder passed primarily in late February, March, and April (Table 23). Large portions of a few groups, however, wintered upstream from Jones Beach and migrated during the spring. In 1982-83 when the effort at Jones Beach was substantial throughout most of

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31 Water Budget Center, 2705 E. Burnside, Suite 213, Portland, OR. 97214.

Table 23.--continued.

Tag code	Release site	Hatchery/Stock	Recovery date	No.	Release date
[illegible]	[illegible]	[illegible]	7-8 No 79	9	Mr-29
[illegible]	[illegible]	[illegible]	08 No 79	10	Ap-04
10/21/12	Red Riv.	@ S.Ft.Clea	25-7 Se 79	27	My-08
07/20/20-22	S.Santiam	@ Foster	5-6 No 79	9	Ap-22
07/20/18-19	S.Santiam	@ Blu.Will	5-6 No 79	9	Mr-18
1980					
07/17/34	Bonn. Hat.	Bri	05 No 80	14	[illegible]
07/22/47-48	Marion Fks	[illegible]	05 No 80	20	[illegible]
07/22/18	McKenzie	[illegible]	05 No 80	11	[illegible]
[illegible]	McKenzie	@ [illegible]	05 No 80	15	[illegible]
[illegible]	Oakridge H. @	[illegible]	5-6 No 80	28	[illegible]
[illegible]	Oakridge H. @	[illegible]	5-6 No 80	11	[illegible]
[illegible]	Red R.	@ S.FK	[illegible]	25	[illegible]
[illegible]	Ware Spr. Hat.	[illegible]	[illegible]	9	[illegible]
1981					
[illegible]	Bonn.	@ Hat. Tule	[illegible]	[illegible]	[illegible]
[illegible]	Bonn. Hat.	@ Hat.	[illegible]	[illegible]	[illegible]
[illegible]	Dexter	@ Dexter	[illegible]	[illegible]	[illegible]
[illegible]	Marion Fks.	@ Minto	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Large	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Medium (Oakridge Stk)	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Large	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Ungraded	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Medium	[illegible]	[illegible]	[illegible]
07/23/63	Bonn	@ Hat. Tule/Well	[illegible]	[illegible]	[illegible]
07/25/46	Bonn	@ Hat. Tule/Tenner	[illegible]	[illegible]	[illegible]
07/25/48	Bonn	@ Hat. Bright/Well	[illegible]	50	[illegible]
07/25/45	Bonn	@ Hat. Bright/Tenner	[illegible]	48	[illegible]
05/09/52, 53, RA PI 1	Cowl	@ Big White	[illegible]	295	[illegible]
63/24/50, 2603	Cowl	@ Hat.	[illegible]	59	Mo-19 No
LB SU 3	Dworshak Hat.	@ Hat.	[illegible]	28	[illegible]

Table 23.--Cat.thes of markedjuvenile Chinook salmon at Jones Beach (RKm 75) released in fall and late summer 1977-1983.

Rel141L1n.3r!41 n 4										pKYY1x1 n r		tro ~Y		r~9Yhne ti	
Teq (Ag,01,02)	Source	Site	Treetoeet stock	Mo. (thou)	Mote ¢/	Size (no./lb)	seer C/ code	leo.)	h I' M lno.)	2	Date !/ range	(no.)	ieo.)	T	Tote 4/ rage
							---- 19770/								
63/17/15	Cowlitz	0 Not.		04.4	28 Se 77 ,	12	1 P	0,	0	0	—	1 0	1 0	0.002 0	03 Ap
09/16/27	S.Sestiae	0 Hot.		28.7	07 No 77	13	P	0	0	0	—	1	1	0·08	11 0-02 k
09/1 /2 = 29	S.Suntioo	I Not.		36.3	07 No 77	11	1	0	0	0	--	I	1	0. 0005	20 Ap
09/16/30, 3:-32	S.Sostiao	I Not.		84.5	08 No 77	11	1 P	0 -	0 -	0 -	— .	7 0	13 12	0.015 0.014	27 Nr-28 Ap
							--- 1970								
07/16/56	$onsevill e	I Dean.	Tole	08.7	30 Oc 78	13	P	19	95	.107	06 No-12 De	10	18	0.032	20 Mr-12 Ap
07/16/58	Ioneeville	1 loon.	Dwight	89.2	30 Oc 78	22	1	22	79	0.089	06 No-17 No	10	44	o 0.049	15 Fe-03 My
1 60 07/16/26, 19/17-18	lonneville	1'Mill Cr.		150.8	"I" 78	23	P	1	0	0015	"e	17	622	0:01	05 Mr-04 My
07/17/37	Dexter	1 Dexter	Tole	23.0	07 No 78	7	/ P	0 3	0 30	0	27 Ms-05 De	0000 2	5	0 0067	22 Mr-05 Ap
63/17/47	S. Fells	I Oet.		140.9	15 Se 71	34		1111	368	0.26 1	120 Se-OS No	8	10	0.012	02 Ap'21 Op
05/03/52, 53-54	Lewis	1 Lewis	F.Chia.	108.2	01 No 78	39	P	o	1$	0.051	12 Oe	4	35	0. 32	15 Fe-04 Ap
07/17/27	Notion FKS	1 Monte	Corso	92.9	06 No 70	23	I	0	0	0		0	O 0	0	21 Mr-11 JA
07/17/38	/otridge	/ Dexter		24.0	07No 71	8	P	0	~0	a 0	04+05 6	1	3	0.031 0 11	29 Mr-30 Mr
07/17/39	Dokridge	1 Dexter		28.9	07 No 7/	15	{	I	0	0		1	0	0.029 0.004	10 Mr1/ Ap
07/17/40	Dotridge	1 Dexter		29.4	07 No 78	25	P	0	0	0		i	3		04 Ap-01 Mr
10/03/28	Red R.	SFR Clearwater		37.0	21 Se 71	34								0104	03 Mr 06 Jo
07/19/26, 27-28	S.Santiw	1 Not.	Nilliw	85.4	07No71	D	P	0	0 0	0	05 De	6 3	1 30	0.019 0.035	27 Fe-02 My
07/19M	S.Sentia	M1w.Nilloo Fall		65.4	07 No 78	/	P I' P	1	15	0 044 o.	10 No-05 De	5	2 10 7	0.002 0.015, 0	04 Ap-30 Ap
							--- 1979f/								
07/17/35	lonneville	1 Net.	Irights	51.2	20 No 79	12	1	-	-			4	7	0.013.	23 Mr-17 My
07/19/14	lonseville	I Net.	Tole	48.7	20No79	9	P P					0	15	0.01	09-30 Mr
63/19/42	Cowlitz	I Not.		23.4	16 Oc 79	85	1 /	-					0	0.015	09 Mr23Ap
63/19/51	Cowlitz	1 Not.		7.8	16 Oc 79	85	P'					0	2t.	0.194	11 Mr-0$ .My
07/20/49	Mckenzie	P Leebvrg		31.6	09No79	6	P					1 0	0	4.048 0	27 Mr
07/20/50	McKenzie	I leeburg		28.4	09NO79	7	P						0	0.014	11 Mr1S Ap
07/20/52	IkKenzie	1 Lisbon		33.8	09 No 79	15	P						1	0.022	19 Mr-30 Ap
63/11/20	Lewis	Speelrai		51.7	05 Se 79	28	P 1	1e	8 t	0.156	11-25 Se	1 9	2. 0	0.04 0	27 Ap
07/20/47	Ootridge	1 Dexter	Urge	31.3'	03 No 79	9	$ P		-			2	. 3	0.011	24 Mr02 Ap
07/20/45	Oakridge	1 We	IMgreded	30.9	05 No 79	14	P					2 3	1	0.022	24 Mt-23 Ap .
07/20/43	IkUridge	1 Dexter	Medias	31.3	05N079	16	P					4	11	0.036	12 Nr09 Ap
07/20/41	OAAridge	1 Dexter	Snell	30.8	05 No 79	29	P					2. 0	4 0	0.0014 0	11 Mr25 Mr

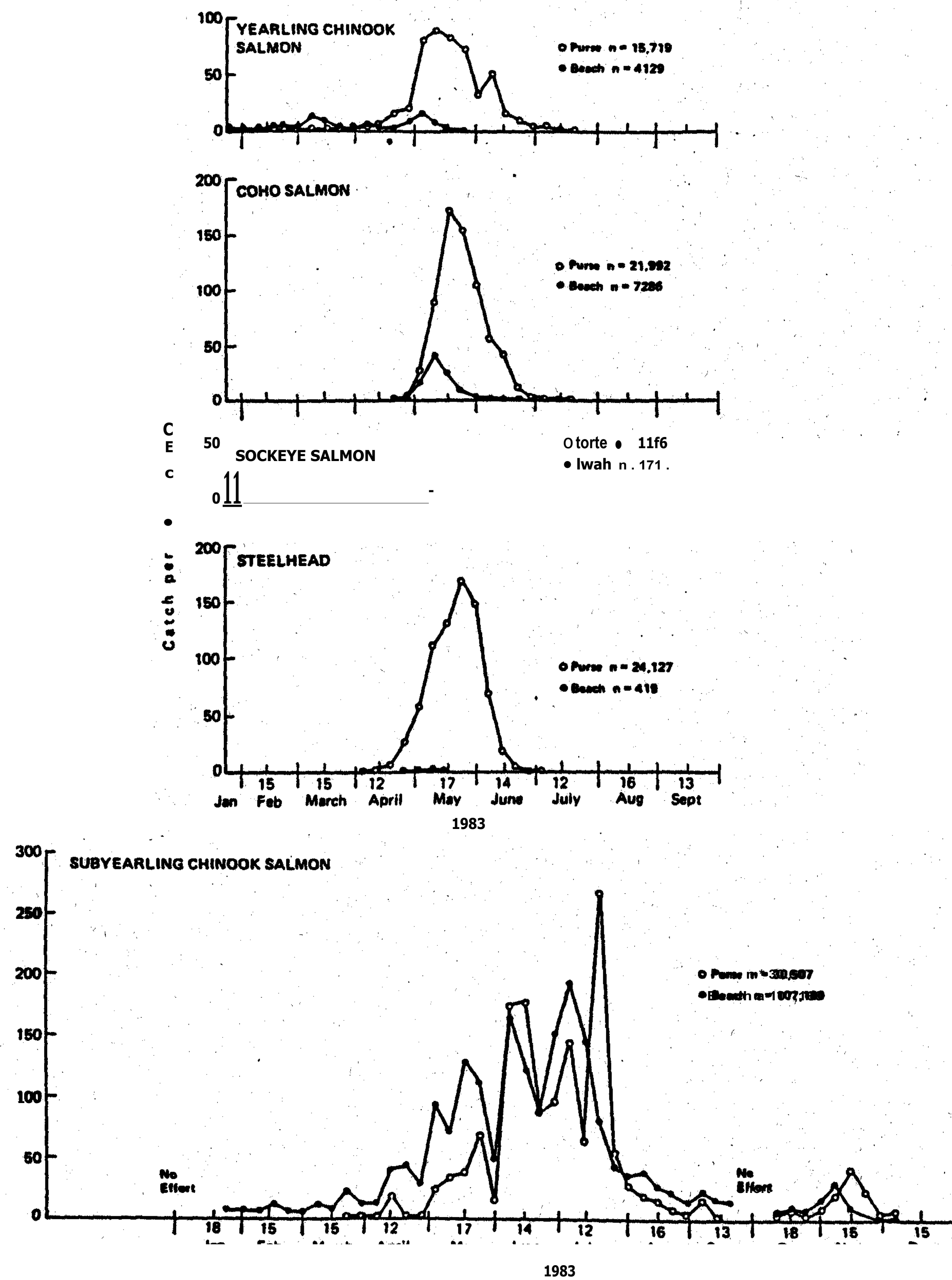

Figure 28....-Weekly 'catch per set'averages forsubyearling chinook,.yearling. chinook, coho,_ and sockeye salmon and steelhead caught by beach and purse seines at Jones-Beach,. 1983:

Table 23.--continued.

07/25/21	McKenzie Net. 1 leoberq	lhyraded	32.3	08 No 82	11	0		0	00 26 No	7 '	9	0.029	11 Mr
07/27/19	McKenzie Net. I. Kosberg	lane	32.0	08 No 82	7	(P	0 2 2'	s, 5	0.014 30 No•10 De 0.014	9 0	11 0	0.033 0	24 Jo-10 Mr
07/17/21	McKenzie Net. 1 leobarg	tidies	31.9	08 No 82	16	I	2	5	0.014 30 No-O9 De '0.107	7	15 h	0.045	12 - 28 Mr
07/27/15	And. Butte Not..0 Not.	Noes.lncu.	56.2	11 Oc 82	24	B	1	0	0	1	2	00 4	25 - 30 Ap
07/25/20	And. Batts Not., t Net.	Fest.lacu.	26:8	11 Oc 82	6	1 P	0 2	0 4	0 .06 No-10 De 0.016	0 0	0 0	0 0	
63/26/10	Cowlitz Hat. P Nota	F. Chin.	146.4	02 No 83	20	/	23 7	177 14	0.121 04 - 18 No 0.010				
10/13/20	Eagle Cr. Net. t Net.	Stress	36.4	17 Oc 83	9	1	2 3	3 16	0.008 02 Ne-22 No 0.04				
10/13/21	Eagle Cr. Net. t Nat.	Control	36.6	17 Dc 83	8	1	1.	2 0	0.004 10 No-11 No				
10/13/22	Eagle Cr. Net. t Net.	Csetrol	35.8	17 Oc 83	8	/	1		0.006 08 No-22 No				
10/13/23	Eagle Cr. Nat. I Not.	Csstrol	38.5	17 Oc 83	9	0 P	2	1	0.0 i 02 22 No				
07/20/43	Rnd.Wtte Not. t Nat.	Nors.lscub.	53.6	06 Oc 83	14	1	5 1	10 2	0.025 0.003 10 No				
07/28/37	Rnd.Wtte Nat. I Not.	Fast latW.	20.2	06 Oc 83	6			10	0.047 24 Oc-07 No				
63/22/59	8asbougal Not. t Not.	F. Chia.	101.2	31 As 83	28	1	101 15	280 153	02216 06 Se-05 Oc 0.134				
3/22/39	Nashougel Nat. 'Not.	F. Chia.	100.6	11 Oc 83	23	P	39	307	0.05 16 Oc-06 No				
3/2?38	Neshougal Net. t Net.	F. Chu.	100.3	02 No 83	22	1 r	71	495 =	Oi 1 4 1 002 06 - 15 No				

a/ Only groups with recoveries at Jones Beach are listed. More complete information available from Dawley et al. 1985b or releasing agency Table 1. Binary coded wire tags: Ag-Agency .ode, D1-Data 1 code, and D2•Data 2 code. Color coded wire tags begin with WM and each two digits thereafter represent a color. Brands are represented by the following: Loc-Location on fish. Sym■Brand symbol, and Rot-Rotation of symbol. For abbreviations, symbol, and descriptions see Dawley et al. 1985b. Abbreviations are listed: Blwmdownstream of, Bonn-Bonneville, Bright-Stock of fall chinook salmon which changes color only after extended residence in fresh water, F. Chin-Fall chinook salmon, Fk•Forks, HaceHatchery,. Incu•Incubation, K-Kalama, Large-Fish selected for largest size, McKen•McKenzie. Medium-Fish selected for medium size. Rd•Round, R-River. S-South, Small-Fish selected for smallest size, Spr•Springs, Stk-Stock, Tanner-Reared in Tanner Creek water. Tule-Lower river stock of fall chinook salmon, Ungraded-No selection for size, Well-Reared in well water, Willam-Willamette, and @•Released at.

b/ Two'.letter abbreviation for months, Se..oc. No, De, Ja. Fe, Mr. Ap, My. Jn represent September through June.

cl B = beach seine and P = purse seine.

d/ Range of dates for beach and purse seine recoveries combined.

e/ No purse (low B effort).

f/ No fall and.winter sampling.

J! No fall and winter beach seine.

h/ No winter and spring sampling.

Table 24.--Annual average and range of movement. rates for selected groups of marked juvenile salmon andsteelhead.from release site to Jones Beach, from .Jones Beach to the- lowerestuary, from Jones Beach to-the ocean plume, 1977-1983.

	Release Site to Jones Beach (Rh 75)5/							Rite 75 to Rkm 16 II/			Rks 75 to Plume c/		
	1177	197	1979	1980	19$1	1 8 2	19Q3	1978	979	9M	197	1979	1980
Subyearling chinook salmon													
Average (km/doy)	7	16	21	19	18	16	22	4	11	25	6	10	21
Range (km/day)	2-27	5-39	2-48	2-48	4-32	2-41	4-31	2-59	1-59	2-49	1-20	1-50	1-99
No, mark group	10	13	14	10	12	12	3	14	9	33	23	31	26
Yearling chinook salmon													
Average (km/day)		20	17	23	20	16,	18	15	15	28	1	S	13
Range (kh/day)		6-35	5-37	7-44	9-46	8-25	10-24	8-59	6-59	5459		1-13	1-68
No. mark group		11	13	10	7	9	5	8	5	38	1	10	18
Cabo salmon													
Average (km/day)		16	20	18,	23	14	17	26	22	28		25	11
Range (km/day)		6-26	7-57	8-37	7-53	5-25	7-29	16-59	12-59	20-30			2-44.
No. mark group		6	8	7	5	8	7	4	3	8			12
Steelhead													
Average (km/day)		21	32	29	34	36	35	44		43			21
Range (km/day)		3-39	10-61	12-43	18-52	26-45	27-53	31-59		20-:59	-		1-62
No, mark group		7.	6	4	3	3	5	3		24	0	0	10

A/ Narked groups representing large releases 010,000) and released of similar sites 1977-1983. Not all groups used as indicies were represented all years; several groups are missing for steelhead in 1982 and yearling and subyearling chinook in 1983,

h/ Average from mark groups captured in substantial numbers in 1978 and 1979 but all groups weighted by catch for 1980; calculated using dates of median fish recapture excluding groups which passed in periods with low effort.

j/ Average for all groups recaptured in the ocean, calculated from date of 1st recapture in the ocean within 24 km of the river south.

the year, catch data indicated' that -nearly, 50% of thG fall released spring chinook salmon from the Big hite Rearing Facility ; the Cowlitz, Round Butte, anc,McKenzie Hatcheries.[th]; and all fish from the Dworshak National Fish Hatchery overwintered in the river. in 1982-83 then migrated in the ,spring of 1983. The smaller fish of ' most stocks showed the greatest. tendency to residualize.

Movement Rates

Raymond (1979) related increased river flow to faster movement rates and higher survival of juvenile salmonids migrating through the Snake and Columbia Rivers to The Dalles Dam. He also linked ,decreased river flows to slow movement rate and low survival.

At Jones Beach, observations of movement rates and dates of passage, for individual mark groups indicate that movement rates of lower, river hatchery-reared subyearling chinook salmon were strongly correlated with river flow, but movement rates of subyearling chinook salmon and yearling salmonids migrating downstream from McNary Dam were not well correlated with river flow. A relationship between movement rate and adult survival was, not attainable because of the diversity of the fish groups examined.

Annual averages for movement rates of each species during migration from release sites to Jones Beach ranged from 7 to 36 km/day (Table 24). Movement rates of individual tag groups ranged from 1 to 80 *km/day.* The fastest movements from release site to Jones Beach were measured for groups *of* steelhead captured and tagged at Lower Granite, Little *Goose,* and, McNary Dams and subsequently transported to various release sites downstream from Bonneville Dam (Park et al. 1984). The slowest movement rates resulted from: (1) individuals that resided in the Columbia River or its tributaries overwinter and migrated in the spring; (2) yearling chinook salmon released in March and April; and (3) groups of fall chinook salmon released at a small size (100/lb or greater). during May, June, and July.

Little or no cessation of migration was observed for juvenile salmonids in the Columbia River estuary which is substantially different from observations from estuaries of smaller northwest rivers (Reimers 1973; Bottom 1981; and Healey 1980). The average movement rates of subyearling chinook salmon decreased 30% between Jones Beach (RKm 75) and McGowan (RKm 16) compared to the average rate from upstream release sites to Jones Beach. Movement rates of yearling chinook salmon, coho salmon, and steelhead through' the estuary compared to rates to the estuary showed no difference, a 40% increase, and a 50% increase, respectively (Table 24). The period of, capture for individual mark groups at McGowan was'generally equal to, or shorter than, the duration observed for the same groups, at Jones Beach.. Similar dates of recovery were noted for marked fish captured'in the beach seine at Sand Island

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4/ Fisheries Assistance Office, USFWS, Vancouver, WA .986.65; pers. comma.
E. M. Smith, ODPW, 3150 E. Main St., Springfield, OR 97477, pers. commun.
/ T. C. Bjornn, Co-op Fish Res. Unit, Moscow, ID 83843, pers. commun.

Table 25.—Release information and Jones Beach recovery information for marked subyearling chinook salmon groups used in correlation analyses of movement rate, and catch percent to variables of fish size, recovery date, river flow, and spill volume, 1977-1983.

Release information: Tag a/ (Ag,D1,D2) Brand (Loc Sym Rot)	Site b/ description (Rkm)	Size (mm/lb)	Recovery dates c/ 10th percent (da,mo)(jul)	Recovery dates c/ 50th percent (da,mo,yr)(jul)	Movement Rate d/ (km/day) (10%) (50%)	Recovery (no)	(%)	River flow @ Jones Beach (kcms)e/	Flow adjust. recov. (%) f/	Flow @ Bonneville Dam: Total @ 10% rec (kcms)	Total @ 50% rec (kcms)	Spill: total ratio g/
Salmon [illegible]												
05/04/20	ds Bonn. Dam 230	84	20MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.4	[illegible]	[illegible]
05/04/21	Austin 754	92										
05/03/20	ds Bonn. Dam 230	59										
05/03/27	Austin 754	60										
10/22/11	ds Bonn. Dam 230	51	5JUN	156								
10/22/10	Lo. Granite Res. 699	34										
05/10/23	" 699	38										
05/10/22	Austin 754	37										
10/25/15	Clear Creek 868	25										
63/18/02	Hatchery 109	133	30JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
63/19/42	" 109	85	15JUL									
63/22/55	" 109	77										
63/21/56	" 109	86	1JUL									
63/24/62	" 109	90										
63/20/32	" 109	98	8JUL									
63/25/03	" 109	72										
[illegible]	[illegible]	[illegible]	15MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.7 6.2 6.9 7.8 7.8 9.3	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	12MAY 8JUN	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]	4.0 7.3	[illegible]	[illegible]

(RKm 7) and Cla tsop.Spit (RKm 9) as were observed from the purse seine at McGowan. .The dates of capture at McGowan closely represent; the dates of migration through the estuary into marine waters. Movement 'patterns for groups released-directly into the estuary were not evaluated.

The grand average movement rate from Jones. Beach to ocean sampling sites for all mark groups' of subyearling chinook salmon observed .. from 1978.to **1980** was 7% slower than the grand average movement rate through the estuary, **1978-80..** The. estimated movement rates for individual mark groups from Jones Beach to seawater were often affected by low sampling effort and catch rates. in the ocean. Marked fish from other salmonid groups were rarely captured in the **plume** area;' consequently, movement rate calculations were not meaningfull., Data for. mark groups are listed in Dawley et al. (1985b).

There is a large data base available..descgibing movement rates for *the* .various species migrating to Jones Beach. Intraspedies differences were . better defined by sepa.ra ting stocks released upstream from John Day Dam from those released downstream from. the dam (RKm 347)..

<u>Stocks Downstream from John Day</u>:Dam.--In 1977,` below .average flows apparently caused. decreased movement. rates which. increased the duration ***of*** migrations between release site and Jones ; Beach.. **For** example, the migration period (total days from date-Of release to' date of median catch) for marked groups of subyearling chinook salmon captured **in** August **1977** averaged 170% greater than the longest migration period observed' for each. group from **1978** through 1983 (Table 25); average. river . flows during August **1977** were 21% less than the least **flow** during August 1978-1983:(Dawley et al. 1985b).

In.1982 and 1983,.above average river flows produced significantly higher movement rates of subyearling chinook salmon '($P<0.01$,'t - 2.87 at 74 df; Table 25) than near normal flows during **1978-1951.**

During normal and. high flow years **front 1966 to: 1972,** we found that,. subyearling Chinook salmon which migrated the greatest. distance moved the fastest (Section I). Data. from **1978** to 1983 confirm this; however, in 1977, when river flow was below average, the marked group that migrated the farthest (fall chinook salmon from Klickitat Hatchery—283 km) displayed the longest migration period and had -a very slow movement rate. (4 km/day)--apparently related. to the exceptionally lbw 'river flow.

..Four factors appear correlated. with increased movement rate from. release site to Jones Beach for marked .subyearling chinook **salmon** released 'at **sites** - downstream from John Day Dam:'size, distance of migration, river flow, and Na^+-K^+ ATPase enzyme levels- in the blood (Zaugg 1981). To eliminate effects on movement rate results from variability ' in the stage of smol of ica tion, as indicated by blood Na±K# ATPase, without Using actual Na^+-K^+ ATPase values (necessary, .because data were available fora few Marked-groups only),. we calculated movement rates based on timing of the first 10%. Of ..the migrants. captured, assuming that those rates. represented 'highly- smolted'-fish.

Multiple linear regression of movement :rates for the tenth percentile fish ,recovery (Table 25), with size, distance traveled, and river flow for lower river subyearling Chinook salmon provided the relationship:

Table 25.—cent.

._ RI111IL1If!!!!11!^.~_..._

lag !/ I6q,D1,02) 1 rand floc Sys Rot)	§11!.41 description	Inks)	Ino/111	le4ov➔ Site 10th permit Ida,eo11iul)	!t!1_r,/ _.. 30th percent Ids,so,yr1liull(10l1(5021	Ino)	Remold late I/ (2)		1teL4l1!-	balm	River flee I Jones hack licsle/	Floe plant. recon. 13) L/	_Fipe i_ total 0 101 rem 14c0417	1tote! lots! 1 502 rbc liens)	its 1te total ratio
Iuau Falls Mstchery															
63/16/55	Hatchery	141	76	270. 103	14JUL77	195	1	3	131	0.207	3.1	0.138	2.4	2.1	
63/16/39	▪	141	113	SJUI 116	26JUL71	207	6	2	697	0.711	2.9	0.430	2.4	2.6	
63/17/46	▪	141	101	19701 199	3111671	215	10	3	541	0.631	4.5	0.417	5.3	4.2	
63/19/51	▪	141	110	'JUL 111	27JUL79	208	4	2	2229	1.429	3.1	1.040	3.7	3.4	
63/21/05	▪	141	115	26JUN 171	12JUL/0	193	17	4	163	0.239	5.3	0.204	6.1	4.9	
63/20/36		141	119	26NRY 146	31111,11	151	17	1	175	0.117	1.0	0.137	1.2	10.1	
63/24/60	▪	141	130	443111 165	77112	111	17	3	115	0.153	11.0	0.205	10.0	10.4	
Matcher'															
63/16/05	Matcher'	350	92	4711 115	1911177	23	10	4	31	0.0511/	3.2	0.040	2.4	2.9	0.00
63/16/63		358	17	21JUN 172	7JUL71	118	21	12	97	0.169	6.1	0.156	7.4	5.7	0.42
63/19/49	•	358	10		1JUN71	151			224	0.127	4.2	0.097	-	5.6	0.35
63/11/47	•	350	83	33181 154	971(80	161	42	24	64	0.066	1.0	0.071	8.2	8.3	0.50
63/20/01	:	351	11	1231M 163	11318101	lit	47	30	30	0.032	11,2	.0.043	10.1	1.9	0.59
63/21/57	•	351	13		1311112	164			214	0.111	10.1	0.141	-	10.0	0.31
leookle Matcher'													«•.	..• -•.	
05/04/27	ds !oat.. las	210	40	16MAY. 136	2110179	141	14	9	11	0.117	1.4	0.131		7.3	
05/01/24	Gear Creel	III	40		1671/4179	161			31	0.012	S.5	0.054		S.0	
10/22/1/	'	161	36		11JUN11	161			11	0.043	11.2	0.031		1.1	
little Mite Saloon Matcher'															
05/47/01	Matcher'	261	122	114111 162	21711177	112	7	4	267	0.1274/	3.6	0.010	4.0	3.2	0.00
0503/46,47,41	•	261	115	31110' 151	7JUM71	151	32	14	330	0.351	7.9	0.315	6.7	7.3	;0.45
05103/43,44,45	▪	261	133	13110 132	1717817/	151	27	13	334	0.341	7.9	0.375	6.1	7.3	0.45
05/03/55,56,37	▪	261	100	2170. 203	31JU171	212	17	11	41	0.109	4.5	0.016	4.7	4.1	0.21
05/04/41	•	xl	,105	29JIM 110	3JUL 79	114	21	17	254	0.2104/	4.2	0.140	4.4	3.7	0.02
05/04/49	▪	261	123	IJUI 112	4JUL79	115	22	16.	412	0.223	4.2	0.170	4.4	3.7	0.02
05/06/43	▪	261	101	164U1 161	19318M0	171	32	22	94	0.073	1.1	0.016	1.4	1.5	0.51
05/07/47,49,50		261	94	9JUI 157	11JUMI	162	31	28	164	0.072	12.4	0.105	11.1	10.1	0.57
05/04/35,36		261	93	7JIM 151	IOJUMI2	161	31	21	267	0.136	10.2	0.173	9.5	9.5	0.31
Law Malars Hatchery h/															
63/17/42	Hatchery	127	61'	31107 151	5JUN71	156		11	136	0.136	7.9	0.146	6.7	7.3	
63/20/06	'	127	130	73111 158	13JU110	166		/	209	0.195	1.1	0.230	1.3	1.1	
63/22/54		127	100	43(11 155	19JUN11	170		4	175	0.133	11.2	0.110	11,1	9.1	
63/24/63	'	127	117	153111 166	2571/482	176		6	191	0.162	.12.6	0.239	10.0	11.5	
Priest Rapids Spada' Channel															
63/17/41	de Priest Rap. lae	639	124		26JUL71	207			20	0.055	5.1	0.046		4.7	
63/11/21	;''	631	74		17JUL79	191			12	0.045	4.1	0.034		2.7	
63/20/17		611	77		30JUL79	211			6	0.025	3.6	0.011		3.3	
63/19/41		639	'18		4JUL110	116			it	0.028	5.7	0.025		5.2	
43/22/61		139	67		7JUL11	111			13	0.013	7.1	0.019		7.2.	
63/21/55	•	631	115		101(801	221			33	0.01	5.5	0.064		5.1	
63/24/36	▪	639	67		23711182	174			35	0.011	12.6	0.146		11.1	
63/22/52	•	631	17		5JUL82	217			93	0.073	'11.0	0.091		10.4	
63/26/11		639	14		17JUN13	168			141	0.096	9.3	0.115		1.5	
63/26/12	•	639	63		20JUL13	201			16	0.103	7.5	0.107		6.1	

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log (movement rate) 1.034 - 0.0106(size--no/lb) + 0.00646(distance' iIn of release site) + 0.133 (flow.—1,000.m^3/second) and - 0.66, F '77.03 at 2, 74 df with P < 0.001.

The equation is given in the original data units but the'statistics were calculated using normalized units. , Movement rates for groups which migrated through Bonneville reservoir were poorly correlated with both date of recovery (r • 0.06) and with the proportion of spill volume to total discharge at Bonneville Dam (r 0.10).

Though movement rates for subyearling chinook salmon generally increased with fish size, the largest -fish within a mark group did not necessarily migrate more rapidly than smaller fish. . Increasing and decreasing trends of daily mean length were observed within various mark groups; examples' of each are presented in Figure 29; coho salmon data are presented in Figure 30. Previous observations of smolt behavior indicated that the larger fish within a population migrated faster than the smaller fish . (Shapovalov and Taft-1954; Salo and Bayliff 1958;-and earlier data on coho and subyearling.chinook salmon in this report).

.From 1977 to 1983,- lower river stocks of yearling fish were not well represented by marked groups. Marked fish were, released. for specific _tests of: culture treatment, structural bypass effects, and/or dte and release-sites. Therefore, trends in movement rates could not be examined for. the general salmonid population..

<u>Stocks. Upstream from John Da</u>'Dam.--In 1977, many juvenile steelhead and chinook salmon,-(possibly 50% of the run) stopped their seaward. migration upstream from Lower Granite Dam on .the Snake River because of low river flows and no water spill at dams (Park at al. 1978). Recovery of. marked fish during estuarine' sampling in the fall, winter, and spring of 1977-1978.indicatedthat few individuals successfully migrated in the fall or -endured overwintering to migrate the' following year, only 13 marked fish. released in - the Snake River during 1977 were captured, in late 1977 or 1978.

Evaluation of the influence of river flow on movement rates of the fish that migrated from the upper river in 1978-83 .was limited to subyearling and yearling fish captured, marked., and released .in the tailrace. of. McNary Dam (RKm 470). -Other groups were. not. included because of: (1) extensive migration in tributaries. or areas .of the Columbia .River where. asingle river' flow would not accurately represent the conditions of migration or (2) effects of transportation from Lower Granite, Little Goose', or McNary Dams (Park et al. 1984).. Flow measurements at Bonneville Dam generally. represent. conditions from McNary through Bonneville. Dams,. bet have little relations hip to-flows in the Columbia River above MCNary Dam or in the Snake River...

Movement rates of yearling. fish from 'McNary Dam to Jones Beach were higher than those of aubyearling- fish ,.(means 62 and ''32 .kn/day,. respectively), therefore, the data' could *not be* combined. Movement rates of steelhead and yearling chinook., salmon were not statistically different (P<0.05).and were combined for analysis.

Table 25.--continued.

a/ More complete information available from Dawley et al. 1985b or releasing agency Table 21. Binary coded wire tags: Ag=Agency, D1=Data 1 code, and D2=Data 2 code. Color coded wire tags begin with WH and each two digits thereafter represent a color. Brands are represented by the following: Loc=Location fish, Sym=Brand symbol, and Rot=Rotation of symbol. For abbreviations, symbols, and descriptions see Dawley et al. 1985b.

b/ Abbreviations are listed: Bonn=Bonneville, Br=Bridge, D=Dam, ds•downstream,, Lo=Lower, R=River, Rap=Rapid, Res=Reservoir, Vari=Various, and Will=Willamette:

c/ Julian date that 10th percentile or 50th percentile (median) fish were captured at Jones Beach; calculated from adjusted daily recovery. Assessment limited to. groups showing data.

Movement rate from release site to Jones Beach for 10th percentile and 50th percentile fish captured at Jones Beach; calculated from adjusted daily recovery. Assessment limited to groups showing data.

e/ Flow at Bonneville Dam (from CofE)- and Willamette, Lewis, and Cowlitz Rivers (from U.S. Geological Survey); average for week of median fish recovery.

f/ Adjusted to represent flows at 7,000 m^3/second (7.0 kcros); Z flow adjusted ,catch = % catch x [1 + (kcms at Jones Beach - 7.0) x 0.085]. Assessment limited to groups showing data.

2/ Spillway flow at Bonneville Dam; total flow at Bonneville Dam; averages from week of median fish recovery at Jones Beach.

.Close proximity to the sampling site caused anomalous movement rate .observations--datanot used .in correlation.

1977 catch data'are beach seine expanded to represent beach seine plus purse seine by using the average ratios of purse seine:to beach seine catch. of that fish'stock from years 1978-1983.

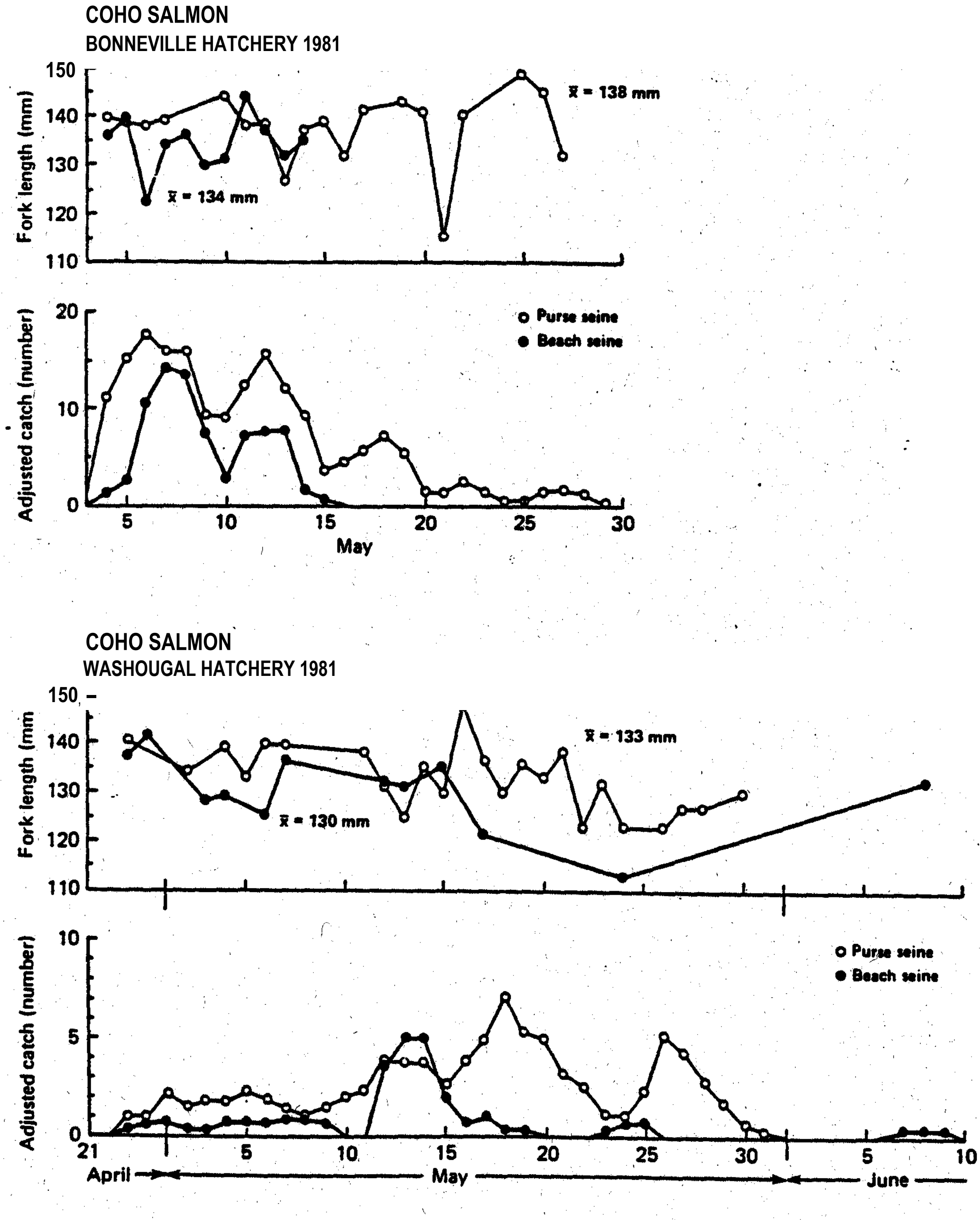
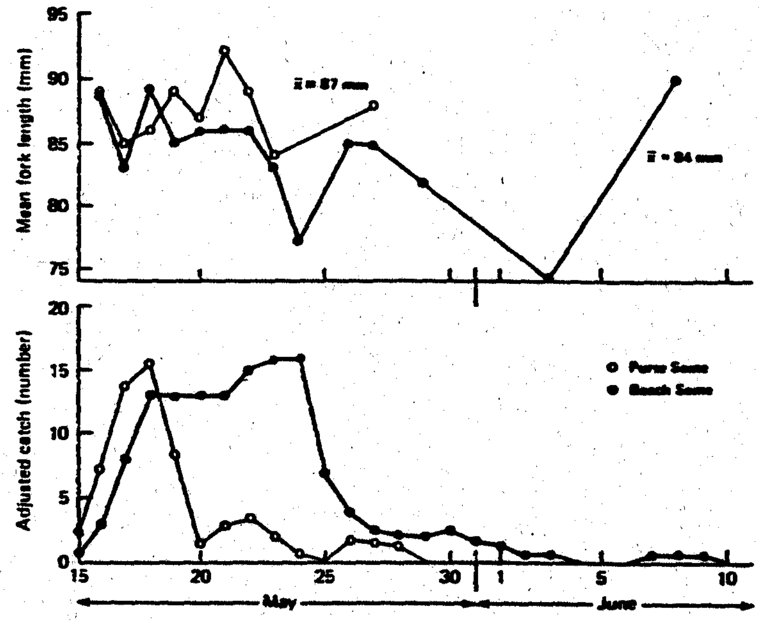


Figure 30.--Daily beach and purse seine catches and mean fork lengths for two marked groups of coho salmon at Jones Beach; one showing decrease and the other increase in fork lengths with date.

FALL CHINOOK SALMON
1901 OonwiYe Hatchery



FALL CHINOOK SALMON
1IN1 Little Whim Salomon Hatchery

Figure 29.--Daily beach and purse seine catches and aceta fork lengths for two narked groups of subyearling chinook.salnon at Jones Beach; one showing decrease and the other increase in fork lengths with date.

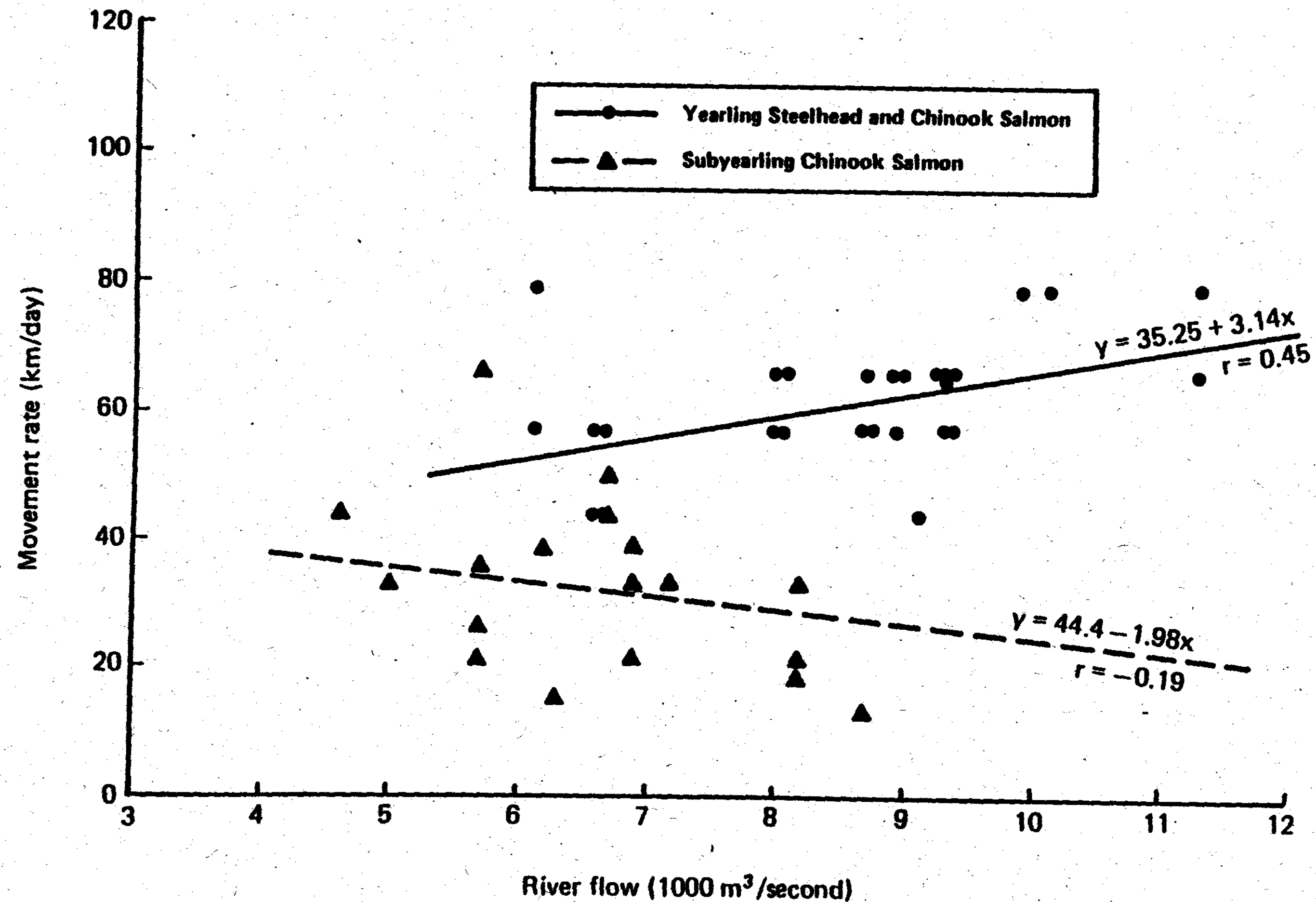


Figure 31.--Movement rates in relation to river flow for mark groups of yearling and subyearling salmonids released in the tailrace of McNary Dam and recovered at Jones Beach, 1978-1983.

Movement rates of yearling and subyearling salmonids were not well correlated with river flow. A linear model was developed for cta from yearling fish [movement rate (km/day) 1· 35.25 + 3.1 x flow (1,000 e/second) (Fig. 31); however, correlation was not high for the 27 groups evaluated, r - 0.45. Movement rates for subyearling chinook salmon (mostly summer chinook salmon from the mid-Columbia River which migrate during July-September) showed little correlation (r -.0.19) with flow (Fig. 31). Variability between the 20 marked groups examined was high, and the slope was not significantly different from zero ($P<0.05$). Likewise, no correlation of movement to flow was observed by Miller and Sims (1983) for subyearling fish migrating between McNary and John Day Dams.

Variability. of Catch

To make conclusions regarding differences in catch' rate between. time periods or between fish groups, it is necessary to understand the variables. affecting each. Catches at Jones.Beach were examined. in relationto: time of -day, river flow, and size of. fish;. also,..catch percentages of replicate groups were compared to develop a base line of expected variation from -sampling marked fish.

<u>Diel Patterns-.--Diel</u> movement patterns were examined to partially assess the consistency of catch data to determine if morning sampl ing ' (7 h beginning 4 t sunrise) was representative of juvenile migrations throughout the day.

We evaluated catch per, set in .relation to hour and tidal fluctuation during.five 24-h periodsin 1978 and 1980. Catches indicated. that movement patterns of juvenile salmonids were generally consistent -(Fig.32). .However , patterns were different than reported for other. river :sys tems.and different portions of the Columbia River. (Thrower et ai. 1985).

Diel sampling indicated' that the periods during the day and the lateral locations 'in the 'river which grossed the largest catches 'of migrating salmonids were as follows: sunrise `to..early of ternoon near shore , for subyearling chinook.salmon, sunrise to early afternoon in mid-river for yearling chinook salmon (catches fluetua ted in relation to the. origin of the fish .and other variables), mid-morning to late afternoon near shore and early morning to early afternoon in mid-river for coho salmon, noon. to early ,evening in mid-river for steelhead, and daylight in mid-river for sockeye salmon. (too few were captured to :discriminate between .. hours. of catch).. Decreased movement during.darkness was indicated for all salmonids. No relationship ' between tide cycle and catch .was apparent for either beach or purse. seine sampling; detailed analysis ispresented by Thrower et al: (1985).

.Catch patterns observed during the .five 24-h ..sampling periods' were compared with patterns from. 7 h/day .sampling from 1979 .through 1983. .Generally, the curves representing percent of total catch per. day by set were similar in shape (Fig. 33). More fluctuation-is apparent for diel sampling than for morning sampling,. primarily because of sample size. Initial beach seine sets during morning-only sampling captured a greater. proportion of fish

CUMULATIVE YEARS

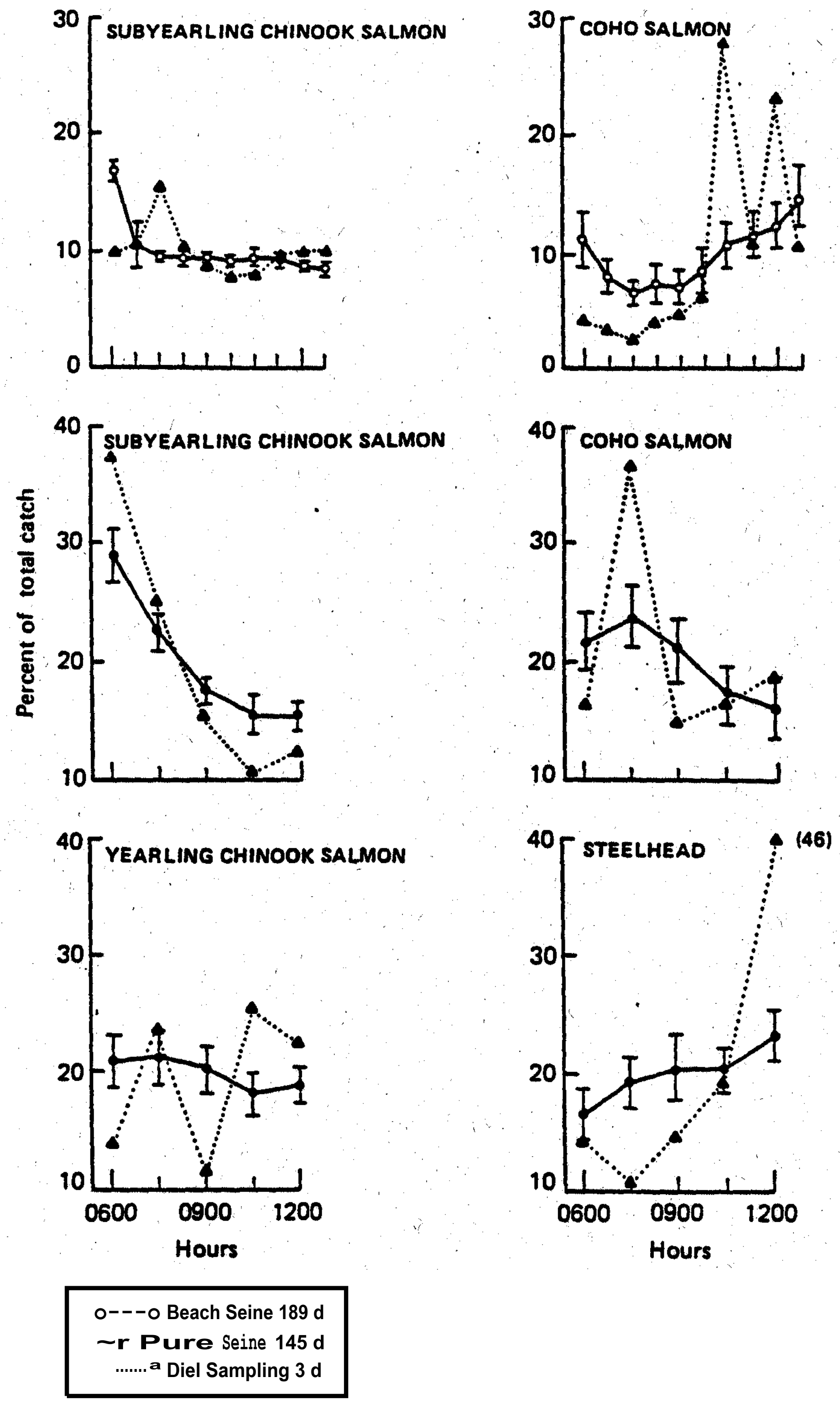


Figure 33.--Means and 95X confidence limits for percentage of total catch by 45- or 90-minute intervals from morning sampling, 1979-1983, compared to mean percentages from diel sampling at the same time of day, 1978-1980; chinook and who salmon and steelhead captured with beach and purse seines at Jones Beach.

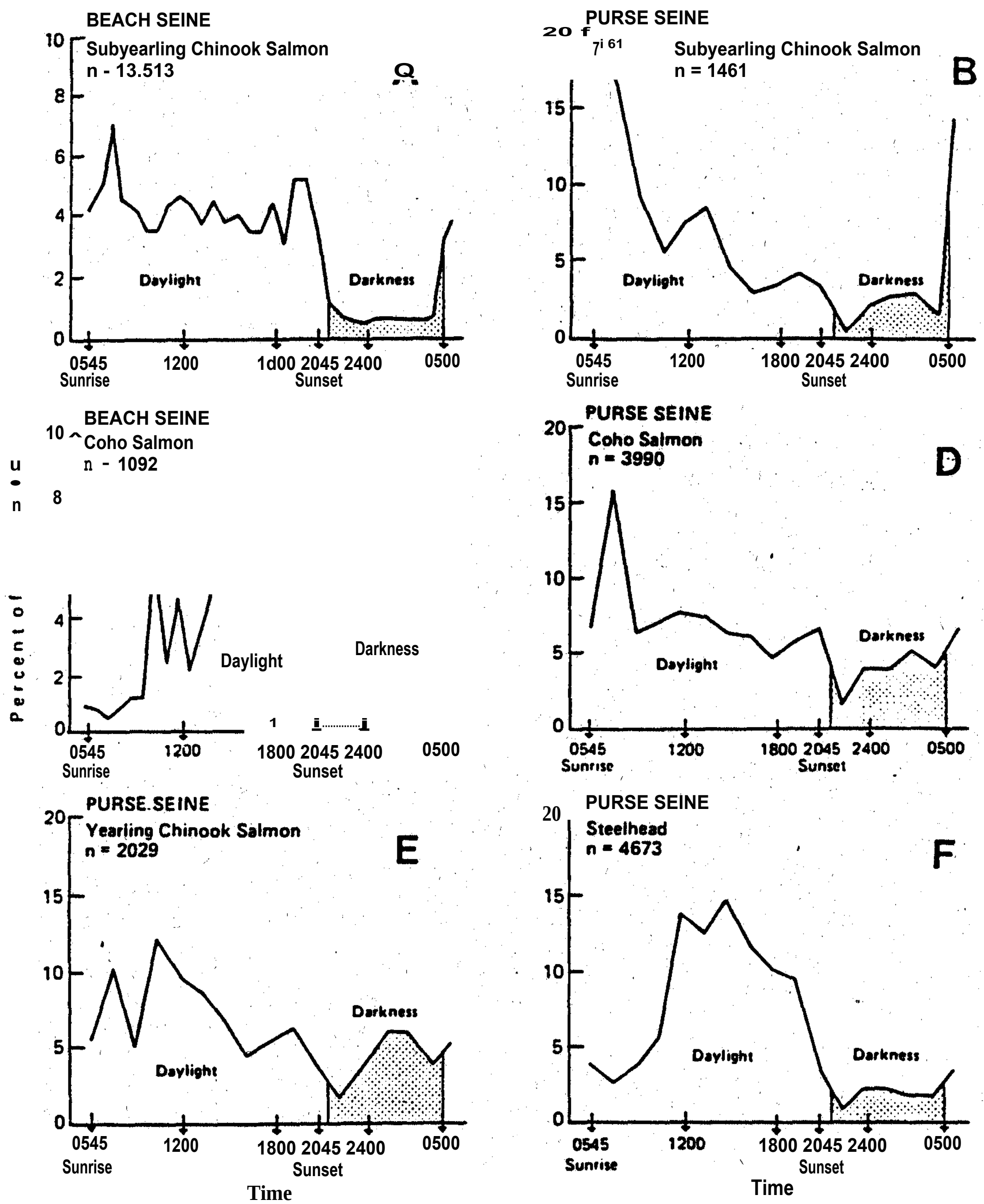


Figure 32.--Diel catch patterns. for chinooksalmon, coho salmon, and steelhead from beach and purse seine sampling at Jones Beach, 19.78-1980,

Table 26.--Numbers of subyearling chinook salmon, reared annual.ly at hatcheries in the Columbia River basin, numbers and percent of total subyearling chinook salmon captured in the beach seine at Jones Beach, and seasonal average river flows, 1977-1983.

	1977	1978	1979	1980	1981.	1982	1983
No. released froma[r] hatcheries (millions)	82.3	75.7	81.1	63.1	66.4	64.5	63.9
No. captured at Jonesbf Beach (thousands)	381	263	303	131	139	154	122
Percent captured°.	0.46	0.36	0.39	0.23	0.22	0.25	0.19
River flow thou.m4[g/]	4.0	8.0	7.0	8.5	9.5	11.1	9.8

a/ Data obtained from Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and Washington Department of Fisheries. Only fish released upstream from Jones Beach were included. Those from Priest Rapids spawning channel, Ringold, Wells spawning channel, and Hagerman Hatchery were omitted as these groups are almost exclusively purse seine captured.

IV The following adjustment of catches was used to standardize effort levels between ,years; (weekly average catch per set x 70 cumulative for the period 9 April-30 September each year. Catch per set numbers are listed in Dawley et al. (1985a).

I A constant percentage of wild fish within the catch year was assumed, and the error from not including an estimated number was ignored,

dI " Average from daily measurements of the Columbia River at Bonneville Dam, Willamette River, Lewis River, and Cowlitz River, 30 April-1 July (calculated from data provided by: U. S. Army Corps of Engineers, NPD, P.O. Box 2870, Portland, OR 97208, and U.S. Geological Survey, P.O. Box 3202, Portland, OR 97208.

(relative percent catch per time interval) than in diel sampling because fish accumulated in the sampling area at night and increased morning-only catches, but were cleared out in earlier sets during diel sampling. Only data' from days with maximum effort (10 beach seine or 5 purse seine sets) during the peak. of migration (May and June) were used for evaluation. -Means and 95% confidence bands for percent of daily catch *by* time interval were. computed for each year, 1979-1983. These catch patterns were then . compared witha pattern developed from the aggregate of 1979-1983 data. Variations within. years were not large;,. thus confidence bands of catch percentages for daily set intervals were small enough to show significant differences.. between sets for each species (Fig. 33).

It appears that..'dial movement behavior of fish at Jones Beach was consistent, and that representative samples of most fish groups passing.Into the estuary were obtained during one.. 7-hour portion (morning) of the -day. Exceptions that showed.. erratic patterns of migration were fish groups that passed the site in 3 days or less (discussed: later).'

<u>River</u>Flow.—Two indirect evaluations were made to assess effects of river flows on juvenile catch percentages from 1977 to 1983: (1) the ratio of subyearling chinook salmon captured to the number released from hatcheries each year was compared to :seasonal average river flow and (2) catch percentages *from* mark groups of similar fish released at different dates were compared to differences of flow at recovery.

The first evaluation of effects from river 'flow indicated that 76% of the variability of. catch percentage between groups was attributable to river flow (Table 26). The linear.relationship (Fig. 34) fzom,regression analysis was: Y (catch percent) aw 0.622 - 0.039 '(Flow--1,000 m'/second) r = -0:87. Using this model, an increase in flow from 6,000 to 7,000 m /second results in a 10.1% decrease in catch. Assumptions are:.. (1) survival for'the subyearling chinook salmon population reared at hatcheries was the same' for all years, (2) average. river flow for the season appropriately represented the conditions encountered by most fish, and (3) wild subyearling chinook salmon populations immigrating from tributaries downstream from *Bonneville* Dam were a constant percentage of the catch during all years. 'River flow data were'an average of the daily cumulative flow for the Columbia River at Bonneville Dam obtained from the U.S. Army pores of Engineers (1977-1983), and the Willamette, Lewis, and Cowlitz Rivers.[7] , `30 April-1 July.

The second evaluation involved comparisons between catch percentages of similar fish groups (same body size and stock) released at the same site on' different dates. To limit variations from survival differences related to passage conditions at dams, only groups which did not pass through Snake *River* or Columbia River dams were selected for comparison. . The aggregation of data

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21.Data obtained from.the U.S. Geoglogical Survey, 847'N.E. 19th Ave., Suite 300, Portland, OR .97232.

(Table 27) shows ate inverse correlation between river flow and catch percentage. Increased flow resulted in decreased catch percentages in 59% of marked groups (276). ,Groups which showed changes of catch percentage greater than 99% per 1,000 m '/second were assumed to be erroneous and were deleted from thgdata base. The overall mean (R) decrease of catch percentage for a 1,000 m^3/second increase of river flow was 243%. These data produced a relatively large standard; deviation (SD) of 28%. Data were reexamined to determine if variance could be decreased by separating the data into categories of low, medium, and high flow or small, moderate, and large changes of flow and/or by species. Categorizing had little effect on variation. M ans and standard deviation for decrease of percentage catch for a 1,000 me/second flow increase were almost identical for subyearling chinook, yearling chinook, and coho salmon (R 1.6, 2.8, *and* 2.5%, and SD • 28.2, 2847, and 26.8%, respectively). A single linear relationship over the entire range of flow was' used because change of catch percentage per incremental flow change was not correlated with range of flow volume.

Limiting the data set to include only catches from ,similar mark groups captured under conditions of large flow changes (> 3,000 m /second) produced a more consistent data set for evaluation of effects *of* flew on catch percentage; mean 6.8% decrease of catch percentage per 1,000 m^3/second flow increase with a SD of 13.7% from 70 comparisons (Table 28). Differences of means among species using the more limited data set were not statistically significant at $P < 0.05$.

At this time, adult recovery data available for these comparison groups (23 sets) show high variability (Table 28) and are insufficient to evaluate precision of flow relationshipto juvenile catches.

The two evaluations indicate that increased river, flow causes decreased catches of subyearling chinook salmon'and yearling migrants in the beach and purse ,seines._ No difference could be detected between species or between Afferent flow ranges. We used a linear catch decrease of 8.5% per 1,000 m /second increase of flow (average of 10.1 and 6.8%) to standardize catch data for comparison of.mark groups of fish captured under different flows.

<u>Fish Size and Location .of Samplin:.</u>--Most yearling salmonids were captured.' in mid-river during purse seine sampling, and the majority of subyearlings were captured near shore during beach seine sampling. However, there were exceptions: (1) through mid-April each 'year, .yearling .chinook salmon. were captured primarily in' the beach seine, (2) coho salmon released in early May at sites close to Jones -Beach. (<100 km) were often captured in the beach seine, and (3) large (<:50 fish/lb) .subyearling chinook salmon and those which migrated long distance '(> ,250 km)`were often captured in .the purse seine. The ratios of beach seine to purse seine catch in May, June, and July at Jones. Beach were 1:3 for yearling chinook salmon, 1:35 for coho salmon, .1:41 for *steelhead,* and 1.7:1 for subyearling chinook salmon. The average size of marked-and unmarked fish recovered in the beach seine were smaller than those captured with the purse seine--5 to 10 mm for. yearling fish and 10 to 20 mm for subyearling fish (Dawley et 'al. 1985a and b).

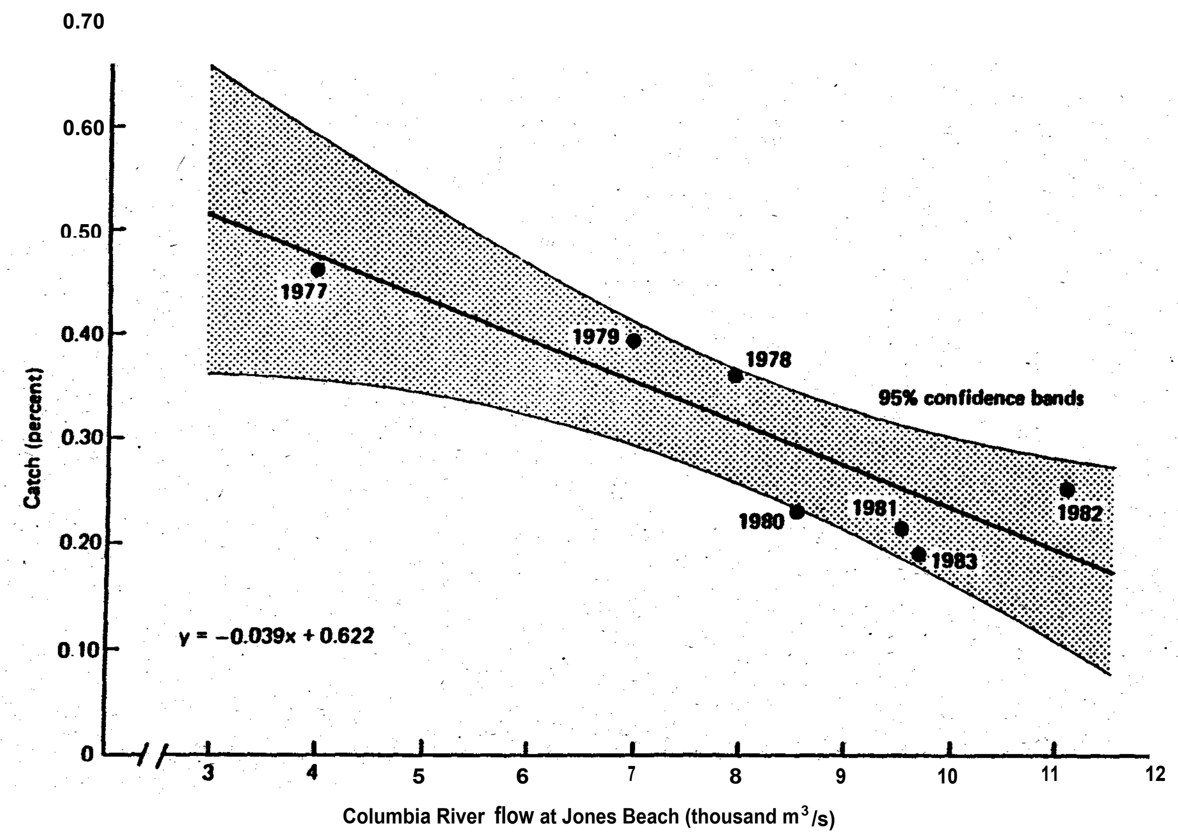


Figure 34.--Subyearling chinook salmon catch at Jones Beach as percent of total hatchery release number by year, plotted against seasonal average flow, 1977-1983.

Table 27.--continued.

WHLBGH 1 (LA AH 4) 05/04/37	20 19	Carson Hot (hosing)	41.0 82.1	03 May 79 28 Apt 80	28 38	0.48 0.07.	9.7 8.8.
63/17/11 63/17/12 63/18/17 63/18/18 63/21/34 63/23/11 63/25/05 63/25/06 63/26/09	5 6 8 6	Cowlitz Hot (Density 6.1b/gal/.in) (Erythrooyin control 8 5-6 lb/gal/sin) (Adult arrival timing a 5-6,lb/gal/sin)	58.3 57.0 24.1 24.3 24.0 2404 73.0 77.5 58.3	08 Marie 23 Apr 79 01 Apr 82 04 Apr 83	77 34 11 26 11	0.45 0.19 0.06. 0.05	7.2 _6.4. 10.4 9.1
09/16/58 07/17/47 07/17/48	15 13	Eagle Creek Hat (.production)	97.2 46.2' 48.3	24 tr 7p 01 y 19	53 39 51	0.07 0.11	8.1 8.1
09/16/61 09/16/62 09/16/63 07/17/25 07/17/26 07/17/29 07/22/49 07/22/50 07/22/51 07/25/25 07/25/26 07/25/27	16 16 14 16	Marion Fits. Hat B Minto/ Carson stock	48.6 45.9 50.2 X9.6 45.330 49.7 4701 50.6 50.7 49.5	13-15 Mor 78 03-05 Apr 79 16-230u 81 15-17 Mar 82	17 22 17 R 37 7 12 13 26	0.07 0.08 0.04 0.04'	7.2 9.7 6.5 9.4
04/17/01 09/17/02 09/17/03 07/17/31 07/17/32 07/22/52 07/22/53 07/25/28 07/25/29 07/25/30	12 17 14. 15	Marion Fks. Hat 1 Minto/ Santini stock (12-17/lb)	49.1 49.6 501 49.4 50.6 39.7 42.2 50.0 49.5 49.2	13-15 Mar 78 03-05 Apr 79 16-24 Mar 81 18-22 Mar 82	28 22 45 10 14 20	0.08 0.09 0.055 0.05	8.0 9.7 6.5 10.0
07/17/30 07/22/54	19 20	Marion FRS. Hat 1 Minto/ Santini stock (19-20/lb)	48.2 48.3	03-05 Apr 79 16-18 Mar 81	29 7	0.08 0.03	9.7 7.9
07/20/53 07/22/22 07/25/18 07/27/20.	11 9 11 10	McKenzie Hot (Graded-medium)	34.9 36.0 34.2 30.0	15 Mar 80 16 Mar 81 15 Mar 82 14 Mar 83	13 12 15	0.08 0.0 0.10	6.2 9.4 7.7
07/20/48 07/22/20 07/25/16 .07/27/18	3 4 '3 4	McKenzie Hat (Graded-large)	31.1 35.6 36.3 36.2	15 Mor80 16 Mar 81 15 Mar 82 14 Oar 83	18 11 2 9	0.15 0.07 0.01 0.06	5.8 6.2 10.0 12.0
. 07/20/51 07/22/17 07/20/54 07/25/22	4 6 4 6	McKenzie Hat (Ungraded)	29.4 30.2 32.5 32.1	15 Mar 80 16 Mor 81 15 Mar 82 14 Mar 83	13, 4 4 4	0.11 0.03 0.03 0.02	5.8 6.2 9.6 9.1
07/17/41 07/20/40 07/24/20	14 16 14	Ookridge Hat a Dexter (Graded-wall)	32.0 30.9 29.5	19-20 Mar 79 10-11 Mar 80 15 Mar 82	40 18. ..6	0.17 0.13 0.04	6.9 5.8 11.6
07/17/42 07/20/42 07/23/07 07/23/05 07/24/22	8 '9 8 9	Oakridge Hot B Dexter (Graded;medium)	29.5 30.7 31.7 29.9 30.9	20 Mar 79 10-11 Mar 80 16 Mar 81 15-16 Mar 82	50 20 17 14 5	0.26 0.14 0.10 0.03	'6.9 5.8 5.6 11.6
07/17/44 07/20/46 07/23/03 07/24/19	6 4 4 5	Oakridge Hat 8 Dexter (Graded-large)	32.8 29.0 31.2 30.7	20 Mor 79 10 Mor 80 16 Mar 81 15 Mar 82	36 15 12 8	0.31 0.15 0.11 0.10	7.3 4.9 6.2 9.6

Table 27.-• Marked groups used to evaluate catch percentages of marked fish in relation to flow, 1977-1983.

Tag 1 (og/D17D2) Brand (Loj. Rot)	Size no/1b,	Source/stock c/ ((treatgent)-	Number ttA	Dote _tda/roo	Jones Bench catch d/ (nor,,)	(z)	Flow e/ tkasl
		Rglegle_Infor!otion b/					
		Subyearling Chinook Salmon					
07/25/07	35	Bonneville Hat/ Late fall (Well W.35-44/lb.)	10202	30 Jul 81	58	0.16	5.5
07/24/26	40		105.0	03 Aug 82	91	0.20	6.3
07/28/28	44		99,0	01 Aug 83	39	0.13	5.2
09/16/05	78	Bonneville Hat. Tule (Well, water production)	183.2	05 May 77~	409	0.47 f/	4.5
07/16/08	78		9606	'01 May 79	128	0.17	9.7
07/21/56	76		130.0	24 Apr 81	148	0.12	7.9
07/24/07.			105.9	23 Apr 82	262	0.25	10.0
07/27/29'	74		52.6	04 May 83	40	0.09	10.4
07/27/30			47,4				
07/18/42	88	Bonneville Hat g/ Tule (Tanner Cr.)	287.9	01-29 May 79	499	0.21	7.6
07/23/29	85		75.7	12 May 81	57	0.09	7.7
07/24/08..	80		9608	21May-04Jun 82	182	0.19	11.0
63/18/02	133	Cowlitz Hot/ (production)	146.0	19 Jun 78	311	0.42	6,8
63/19/42,	85-		120.4	27 Jun 79	78	0.39	3.6
63/21/56	84		53.2	12-28 Jun 81	195	0.40	7.8
63/22/55			121 3				
.63/20/32,	94		41.3	24Jun-08Ju1 82	136	0.37	7.3
63/24/62'			199.2		S23		
63/25/03.	72		150,2	06-25 Jun 83	522	0.49	7.2
63/16/39	113	Kalama Falls Hat (production)	145.7	22 Jun 77	697	0.72 f/	2.9
63/17/46	108		150.5	12 Jul 78	541	0.66 "	4.5
63/19/57	180		209.7	22Jun-13Ju179	2229	1.40	3.8
63/21/05	115		100.4	13-24 Jun 80	163	0.34	5.3
63/20/36	119		175.4	22-28 May 81	175	0.12	10.9
63/24/60	130		163.2	10Jun-17Jul 82	185	0.16	10.0
63/17/42	61	Lo. Kolana Hat (production)	129,7	30 May 78	136	0.13	7.9'
63/20/06	150		144.5	06 Jun. 80	209	0.20	9.1
63/22/54	100'		155.3	01-11 Jun 81	175	0.14	11.2
63/24/63	117		139.4	13-25 Jun 82	191	0.17	12.2
05/50/01: RD D4	83	Spring Cr.Hat.2 ds Bonn.D. (79-83 lb.).	76.1	11, Apr 77	304	0.63	f/ 4.7
05/54/01	79		98.2	20 Apr 78	201	0.24	8.8
63/16/40	117	Tootle Hat (production)	132.5	29 Jun 77	606	0.74 f/	3.4
63/17/63			142.8	19 Jun 78	457	0.57	6.1
63/19/41	160		132,1	17 Jun 79	794,	0.82	4.0
63/16/41	64	Washougal Hat (production)	128.6	28 Jun 77	188	0.23 f/	3.0
63/18/03	62		151.4	26 Jun 78	212	0.26	5.7
63/19/38	95			14 Jun 79	296	0.45 '	4.8
63/19/46			158.8				
63/21/53	80		319.2	30 Jun 80	609	0,34	4.8
63/22/51	71		277.3	26-30 Jun 81	417	0.25	7.8
63/24/61	90		167.9	28. Jun 82	427	0.41.	9.7
		Yearling Chinook Salmon					
07/16/57	7	Bonneville Hat/ Tule (Well water)	47.9	13 Mor 79	105	0.38	7.3
07/17/36	6		48.1	13 Mor 80	52	0.22	4.9
07/21/40	7		51.9	17 Mar 82	52	0.43	9.3
07/27/01 Lar	7		37.5	08 Mar 83'	44	0.23	13,9
07/16/61	8	Bonneville Hat/ Late foil (Well water)	32.7	13 Mar 79	62	0.41	7.3
07/17/33	7		49.3	13 Nor 80	70	0.33	.4.9
07/21/43	7		5006	17 Nor 82	48	0.38	12.1
07/25/47	6		49.9	23 Mar 83	13	0.05	10,0

Table *27.--continued.*

07/20/31	18	Sandy Hat. (nutrition)	25.2	'01 May '80	16	0.12	7.6
07/20/33			25.2		15		
07/20/32			25.4		16		
07/20/34			25.2		211		
07/20/35			25.9		12		
07/20/36			24.5				
07/20/37			26.0				
07/20/38			26.5		20		
07/22/59	18		29.9	'01'May 81		0.09	7.2
07/22/62			27.8				
07/22/63			297		18		
07/22/61			29.8		20		
07/23/01			28.9		22		
07/22/56			27.3.		20		
07/22/58			2800		12		
07/ 7			27 28.9		16		
07/25/53	18		26.0	30 Apr 82	3	0.15	10.9.
07/25/55			28.3				
07/25/50			26.4		50		
07/25/58			27.9		36		
07/25/51			27.3		34'		
07/25/54			27.6		46.		
07/25/52			26.9		20		
07/25/56			27.6		6		
07/25/57			28.1		43		
07/27/31	17		54.7	21 Apr 83	9	0.07	9.2
07/27/33			54.1		34		
07/27/34			54.7		36.		
07/27/35			54.6		37		
07/27/36			54.9.		46		
63/19/11	18"	Toutle Hat (May release)	31.7	07 May 79	46	0.13	8.1
63/19/12							
63/19/31	19		38.6	07 Nay 80	43	0,28	'7,6
63/20/58			39.5		31		
63/19/23	16	Washougal Hat (Late April-Early May)	4.4	07 May 79	87	0.13	8.4
63/19/24			86				
63/20/39	18		88	08" May 80	81	0.13	7.6.
63/20/40			98		6		
63/21/50	18			30 Apr '81	46	,0.11	6.7
63/22/02			52,0-				
63/26/45	18		50.9.	15-30 Apr 83	40.	0.08	9.6
63/19/25	20	Washougal Hat --_ -~ (Late May-Early June; Density 13.5-16 lbigol/ain)	73	07 Jun 79	lee	006h/	5.5
63/19/26			824		149	fl/	
63/20/37	18		97.3	09 Jun 80	53	0.10	9.1
63/20/38			97.8		65		
63/21/51	.20		524	27 May 81	35	01091/	10.9
63/22/03			5244		35	0.10	
63/25/13	21		10.2	25 May 82	9	0.09	11.0
63/25/14			9 10		14		
63/25/16			9.3				
63/25/17			9.8		6		
63/27/13	19		10.0	27 May 83	7	0.09	12.2
63/27/14			10.9		8		
63/27/15			10.3		8		
63/27/16			10.3		3		
63/27/17			10.6		12		
63/19/27	20	Washougal Hat (July release)	81.0	06 Jul 79	197	-0.49	4.0
63/19/34			82.1		191		
63/19/54	18		106.7	07 Jul 80	126	0.25	5.3
63/19/55			107.0		118		

Table 27.--continued.

07/17/43	12	Oakridge Hat 0 Dexter	30.2	20 Mor 79	32	0.06	6.9
07/20/44	8	(Ungraded)	30.7	10 Mar 80	25		5.8
07/22/25	7		26.6	16 Mar 81			
07/25/13	7		27.4	15 Mor 82	7	0.07	9:3
09/16/21		S. Santios Hat	25.0	13-15 Mar 78	10	0.09	7.9
09/16/22		(production)	29.5				
09/16/26			14.9		11		
07/19/45			29.4	14 Mar 80		0.19	4.9
07/19/46			29.9		33		
09/16/23		S. Santias Hat	26.9	13-15 Mar 78	30	0.24	7.9
09/16/24		(Below Williams hills)	24.6		25		
09/16/25			13.4				
07/19/47			32.1	13-14 Mar 80	36	0.28	4.9
07/19/48			28.5		30		

Cobb Salmon

07/19/08	23	Cascade Hat 0 Tanner Cr.	29.2	07 May 79	13	0.07	8.1
07/19/11		(May release)		[illegible]			
07/19/63	24						7.6
07/21/27			24.9		24	0.11	6.7
07/21/30			26.7		28		
07/19/07	23	Cascade Hat 0 Tanner Cr.	27.2	07 Jun 79	37	0.14	5.5
07/19/10		(Late May-June release)	25.9		36		
07/21/28	17		27.9	08Jun81	21	0.10	12.4
07/21/31			26.1		25		
07/24/29.	18		27.7	25 May 82	255	0.10	11.0
07/24/33			28.2		30		
07/27/47	18		43.1	24 Mor 83	21	0.06	12.2
07/19/09	23	Cascade Hot O Tanner Cr.	24.6	06 Jul 79	50	0.44	4.0
07/19/12		(July release)	25.2		56		
07/21/29	17		27.7	06 Jul 81	13,	0.14	7.6
07/21/32					19		
63/24/30	20	Cowlitz Hat	10.6	03 May 82	17	0.16	11.9
63/24/31		(Density 11.6-11.7 lb/gal/sin)	10.6		17		
63/24/32			10.2,				
63/24/33			10.4		17		
63/24/34			10.5		18		
63/26/28	20		10.2	03 May 83	19	0:18	9.9
63/26/29			10.3,		16		
63/26/30			10.4		17		
63/26/31			10.2		17		
63/26/32			10.6		17		
09/16/57	15	Eagle Creek Hat	74.7	24 Apr 78	95	0.17	8.7
07/17/46	18	(Density 0.45 lb/cu ft/in)	[illegible]	22 nay 79	128	0.22	6.2
05/08/26	14		[illegible]	22hp r 81	[illegible]	0.18	6.7
05/10/39				06 May 82	115	0.18	11.0
05/10/40	16		68.6				
05/11/33	15		60.5	04 May 83	78	0.13	9.2
05/11/34			62.8				
63/23/03	17	Lower kolosa Hot	52.8	03 Mar 82..	89	0.17	10.9
63/26/05	17	(Density 11-11.5 lb/gal/sin)	52.0	04 May 83	53	0.10	9.2
09/16/49	15	Sandy at)	33.3	04 May 78	2	0.08.	8.1
09/16/50							
09/16/51			34.4		19		
09/16/52					22		
07/17/49	19		27.5	01 May 79	28	0.13	8.1
07/17/550			27.4				
07/17/51			27.5		32		
07/17/52			27.9				

Table 28:--Adult recovery data plus differences of juvenile catch related to river flow difference during downstream migration for mark groups used in evaluating effects of flow on beach and purse seine sampling efficiency; biologically similar mark groups captured at Jones Beach during river flows which were different by 3,000 m /second or more.

Group captured 8 low flow tag codes/ (AgDID2)	Group captured ! high flow tog code 9/ (AgD102)	Low flow (kcns) b/	pflow; c/ hi-low (Aces)	catch 2 g/ per 1 kces increase	.Adult recov. e/ from low flow group no.		Adult recov. e/ from high flow group (no.) 3	
				Subreorling chinook saloon				
091605	071608	4.5	5.2	-12.3	101	0.06	350	0.36
091605	072729	4.5	5.5	-8.5	8	0.00	13.	0.00
091605	072407	4.5	5.9	-1307	53	0.03	120	0.11
091605	072156	4.5	3.4	-21.9	99	,0.05	145	0.11
071842	072408	7.6	3.4	10.8	380	0.13	11	0.01
072329	072408	7.7"	3.3	-2.8	69	0.09	11	0.01
631942	631802	3.6-	3.2	2.4	144	0.12	182	0.12
631942	632503	3.6	3.6	7.1				
631942	632032,2462	3.6	3.7	-1.4				
631942	632156,2255	3.6	4.2	0.6	54	0.04	200	0.07
631639	632036	2.9	8.0	-10.4	61	0.04	27	0.02
631639	632460	2.9	8.1	-9.6	1	0.00	0	0.00
631746	632036	4.5	6.4	-1208	20	0.01	27	0.02
631746	632460	4.5	6.5	-11.7	2	0.00	0	0.00
631957	632036	3.8	7.1	-12.9	7	0000	27	0.02
631957	632460	3.8	7.2	-60.6	1	0.00	0	.0.00
632105	632036	5.3	5.6	12.3 ,	25	0.02	27	0.02
632105	632460	5.3	5.7	-11.6	1	0.00	0	0.00
631742	632254-	7.9	3.3	2.3	16	0.01	53	0.03
631742	632463	7.9	4.3	7.2	1	0.00	1	0.00
632006	632463	9.1	3.1	-4.8	2	0.00	1	0.00
055001	055401	4.7	4.1	-15.1	355	0.47	479	0.49
631641	632461	3.0	6.7	.11.7	4	.0.00	1	0.00
631641	632251	3.0	4.8	1.8	222	0.17	63	0.02
631803	632461	5.7	4.0	4.2	5	0.00	1	0.00
631938,46	632251	4.8	3.0	-14.8	54	0.02	63	0.02
631938,46	632461	4.8	4.9	-1.8	2	0.00	1	0.00
632153	632251	4.8	3.0	-8.8	170	0.05	63	0.02
632153	632461	4.8	4.9	14.4	5	0.00	1	0.00
				Yearling chinook saloon				
071657	072701	7.3	6.6	-6.0				
.071736	072701	4.9	9.0	0.5				
:071736	072140	49	4.4	21.7	58	0.12	38	0.07
072140	072701	9.3	4.6	-10.1				
071661	072143.	7.3	4.7	-1.5	98	1,30	20	0.04
071733	072143	4.9	7.1	2.1	27	0.06	20	0.04
.071733	072547	4.9	5.1	-16.6				

Table 27.--continued.

a/ Only groups released downstream from Bonneville Dam were used due to variation in survival associated with changing spill to turbine discharge rate at dams; only groups of the same stock released at similar size from the same site. Assumed no variation in affect from Willamette Falls on survival or catch percentage. Groups with rapid movement rates which were not dispursed and . 50% past Jones Beach in 2 days or less were not used due to variable catch rates. Nutrition treatment groups with no statistical difference (trend over the years) were combined into one observation per year.

b/ More complete information available from Dawley et al. 1985b or releasing agency Table 21. Binary coded wire tags: Ag-Agency code, D1=Data 1 code, and D2=Data 2 code. Color coded wire tags begin with WH and each two digits thereafter represent a color. Brands are represented by the following: Loc=Location on fish, Sym=Brand symbol, and Rot=Rotation'of symbol. For abbreviations, symbol, and descriptions see Dawley et al. 1985b.

c/ Abbreviations are listed: Bonn=Bonneville, Cr=Creek, D-Dam, ds■downstream, Fks-Forks,Gal=Gallon, Graded-Fish mechanically selected by size, Hat=Hatchery, lb=pound, Lo-Lower, Min=Minute, S-South, Tule=Lower river stock of fall chinook salmon, Ungraded=No fish selection by size, W-Water, and @•Released at.

d/ Actual catch; catch percent adjusted for effort.

e/ Seven-day average of river flow at Jones Beach during the week of median fish, recovery; including Columbia River above'Bonnevi}.le Dam, Willamette River,. Cowlitz River, and Lewis, River; 1 kcms - 1,000 i'/s.

Inconsistent purse seine effort in 1977, consequently, yearling fish not used for evaluation. Catch adjustments were made for subyearling fish to equate with other years (8, 11, 8, and 15% increase, respectively, for Bonneville Dam, Kalama Falls, and: Spring Creek fish released downstream from Bonneville, Toutle, and Washougal Hatchery fish); obtained from average purse seine contribution to those groups from 1978-1983.

A/ Did, not use 1980 due to effects of Mount St. Helens.

h/ Diseased fish at release; not used in the analysis.

i/ Higher density; not used in the analysis.

Differences in sampling efficiency related to fish size were not apparent. for groups captured exclusively in *purse* seine, sampling. .Fork length distributions. of. marked fish from purse seine." samples ,of *some* groups showed close ' agreement with length distributions obtained prior *to* release (see examples in Fig. 35); we'assume.that survival for small and large fish within .*such* groups was'similar. Substantial numbers of fish Aas small as. 60.mm in fork length were captured in the . purse *seine,* thus we believe the purse seine was reasonably efficient at capturing smaller fish.

..Sampling efficiency . was affected by fish size for those groups which were captured in the. beach seine. Catch rate. of subyearling chinook salmon captured *in* the beach seine is inversely.'related tobody *size* (Section I, Fig. *4);* the same relationship may'applyto yearling fish. Location of fish in the cross section of the river, not gear efficiency, seems to. have created the size related alteration of catch rate, Catch' rate. comparison between mark groups of subyearlings that were not the same body. size ,are therefore inappropriate. Catch rate comparisons. between marked groups ofyearling fish released at 'different sizes were. only made *when* the ratio of beach seine to purse seine catch was the same for both 'groups.

<u>Replicate Groups of Marked</u>Fish.--From 1977', to 1983, juvenile and adult recovery data (fisheries. and escapement) for 120 sets of -replicate groups were examined for consistency -(Appendix Table B1). We. found the following: (1) juvenile. catch variations among replicates were random in relation to adult recoveries--juvenile catch and adult recovery percentages varied in the same direction (positive *or* negative) among replicates 54% of the 'time; (2). juvenile recoveries for 14 (12%) of the 120 sets of replicates showed significant -differences; between replicates (P < 0.10,. from G statistic analysis)--by definition 10% of the .sets.. of true replicates should fall' outside the boundaries of no difference between groups; (3) adult recoveries. for 42 (35%) of the 120 sets of replicates showed *signif*scant differences between replicate groups at P < 0.10, and the .direction.of variation among groups within the. sets was the same *as* observed for juvenile catches in 50% of the 42 sets—as expected of replicate groups, .and (4) 82% of the replicates showing statistical difference as adults, which is *15%, of. the.* 'total sets of replicates, had differences-'greater than 20% between, groups.. Some sets of replicate groups provided very consistent adult recovery data, e.g., five. sets *of* replicate groups of coho salmon released in .1981 at, .Sandy Hatchery (Westgate .et al . 1983b) _: produced , from 363 to 535 adult recoveries per *group* with from 0 to 4% difference between replicates. However, other sets of replicates - had large deviations from theoretical catch probabilities, e.g.', four sets ' of replicate groups of coho salmon released from Sandy . Hatchery. in 1980 (Westgate et al.. 1983b) produced from .152 to 377 adult recoveries per • ' group with 8 :to 34% difference between groups,

It appears that juvenile catch ..data are normally distributed with expected variation, *however,*. adult recoveries show greater than expected .deviation which we assume represents survival differences. Differences of *survival* to adulthood,, among replicate groups, may have resulted from subtle differences of environmental'. conditions, culture methods, or migratory behavior that did not substantially affect survival. during freshwater. rearing

Table 28.--continued.

631711,12	632134,2311	7.2	3.2	-27.1	1640	1.42	20	0.04
631817,18	632134,2311	6.4	4.0	-17.1	.344	0.71.,	20	.0.04
072249-51	071725,2629	6.5	3.4	31.3:'	49	0.03	26	0.02
072252,53	071731,32	6.5	3.2	.25.0	69	0.08	205	0421
072252,53`	072528,2930	6.5	35	0.0				
072053	072518	5.8	3.6	-2403	0	0.01	0	0.00
072222	072518'	6.2	3.2	-27.3	2	0.01	0	0.00
'072048	072516	5.8	402	-2242'	3	0.01	0	0.00
072048	072718	5.8	6.2	-9.7				
072220	072516	6.2	3.8	-22.2	4	0.01	0	0.00
072220	072718	6.2	5.8	-2.5				
072051.	072054	5.8	308	-19.1	0	0.00	2	0.01
072051	072522	5.8	3.3	-24.8				
072217	072054	6.2	3.4	0.0	2	.0.01.	2	0.01
071741	072420	6.9	4o7	-16.3.	2	0.01	2	0.01
072040	072420	5.8	5.8	-11.9	9	0003	2	0.01
071742	072422.	609	4.7	.-18.8	25	0.08	2.	0.01
072042	072420_	5..8	5.8	-13.5	22	0.07..	2	0.01
072305	072422	5.6	6.0	-11.7.	11	0.(4	2	0.01
072303	072419	6.2	3.4	-2.7	13	0.04	7	0.02
072046	072419	4.9	4.7	-7.1.	20	0.07	7	0.02
072044	072513.	5.8	3.5	-18.0	17	.0.06 '	3	0.01
071945,46	091622,26	4.9	300	-17.5	77	0.13	276	0.62
071947,48	091623-25	4.9	3.0	-4.8	54	0.09	493.	1.22
				Coho salmon				
071907,10	072429,33	5.5	.5.5	-5.2	643	1.21.	310	0.55'
071907,10	072747	5.5	6.7	-8.5				
071907,10	072128,31	5.5	6.9	-4.1	643	1.21	1771	3.28
071909,12	072129,32	4.0	3.6	-18.9	440	0.88	1451	2.56
07170,	051133,34	6.2	3.0	-13.6				
071746	051039,40	6.2	4.8	-3.8	1053	1.52	766	0.57
050826	051039,40	6.7	4.3	0.0	1524	1.20	766	9.57
072031-38	072549-58	7.6	.3.3	5.5	2128	1.04	3719	'1.38
072255-2301	072549-58	7.2	3.8	7.5	811	1.44	3719	1.38
632037,38 "	632713-17 '	9.1	3.1	-3.2				

.g/ Binary tag **of** groups captured at the lowest river flow or at the highest **river flow** of the comparison; Ag[a]agency code,D1=dato 1 code, and D2 dota 2 code, Separations by cotta or hyphen indicate data ore averaged **for** multiple tag groups. two or four digits following a cotta represent on additional tag nuober with the some agency and data 1 codes or the sate agency code, respectively. Two or four digits following a hyphen represent a series of tags with the same agency code and data 1 code or agency code, respectively.

4/ One thousand m^3/second = 1 kces ª 35,000 ft^3/second+

S! Difference of river flow, **in** thousand m^3/second during the week of eedien fish recovery for groups in comparison.

.d/ [i2 catch hi flow - 2 catch **low** flow) 4- 2 catch low flow] x 100 + (kcus hi flow Ices low flow).

.t/ Observed recoveries, limited to age of youngest tog group returning **in** each comparison, and data which are available for both sets of groups, or migration. Consequently, treatment versus control evaluations. made from adult recovery data may be affected, and researchers comparing adult return data must consider the degree of error among replicates.

Relative Survival in Relation to Controlled Treatments

Treatment. and control groups used to evaluate effects of fish .size, stock, transportation, rearing density, nutrition, and release date on adult survival were. examined for inter- and intra:-specific .trends in relative survival to' the estuary. Weassume from. the .assessment of variability in catches that . significant differences .between catch percentages of treatment and control groups generally. indicate relative survival differences if recovery data are adjusted for sampling :effort. and_ rives flow. .The conclusions reported herein are. based on..ccatches at Jones .Beach only. Individual researchers' may draw different conclusions based on knowledge of other factors relating to their research..

Estuarine catch data, for treatment and. control groups were compared with adult recovery data to determine if relative survival. trends were similar and to identify the types of treatment groups from which juvenile catch rates may provide erroneous inferences of survival.

Fish Size.--Increased body size.at release for hatchery reared salmonids has been equated with greater.' survival in downstream migration 'and. to adulthood (Conte et al. 1966; Salo 1955, Salo and Bayliff 1958; and Wallis 1968). .Also, minimum-size thresholds. for survival have been hypothesized (Reimers. and Loeffel."1967; Buchanan at al. 1981; and Washington. 1982). Fork length .measurements of marked individuals from many groups captured at' Jones Beach provided the opportunity to observe size-related survival. differences during freshwater migration'in the Columbia ..River.'.

'Estuarine catch data. indicate a positive relationship, between survival during migration to the estuary and. increased body site at the time of release for chinook and coho salmon and steelhead. The smaller. individuals from particular release groups were missing from the migrant population captured at Jones Beach. .Examples of length frequency .distributions for mark groups representing each species comparing sizes of fish prior to release to sizes after, mmigration . show loss of smaller fish from the population prior to arrival at Jones. Beach (Fig.. 36). Not all ., groups. of fish were measured 'prior to release. Consequently, ` we. were unable to determine the extent of the loss of smaller individuals for the overall migratory population.

Comparisons were made among mark groups.. captured between 1977 and 1983 which were similar in . stock, treatment,. and release characteristics but showed differences in site at release' (Table 29). The majority of comparisons were for. spring.chinook salmon' graded and marked for sizelsurvival..research from a multiyear study at various 'hatcheries in. the Willamette River system (Smith 1979a and. b; Smith. and Zakel 1980 and 1981, and Smith-et al. 1982, 1983, and 1984).

.The aggregate of groups showed a trend Of higher catch percentages at Jones Beach for increased sizes (measured as no./lb) at release (Table 29); 20

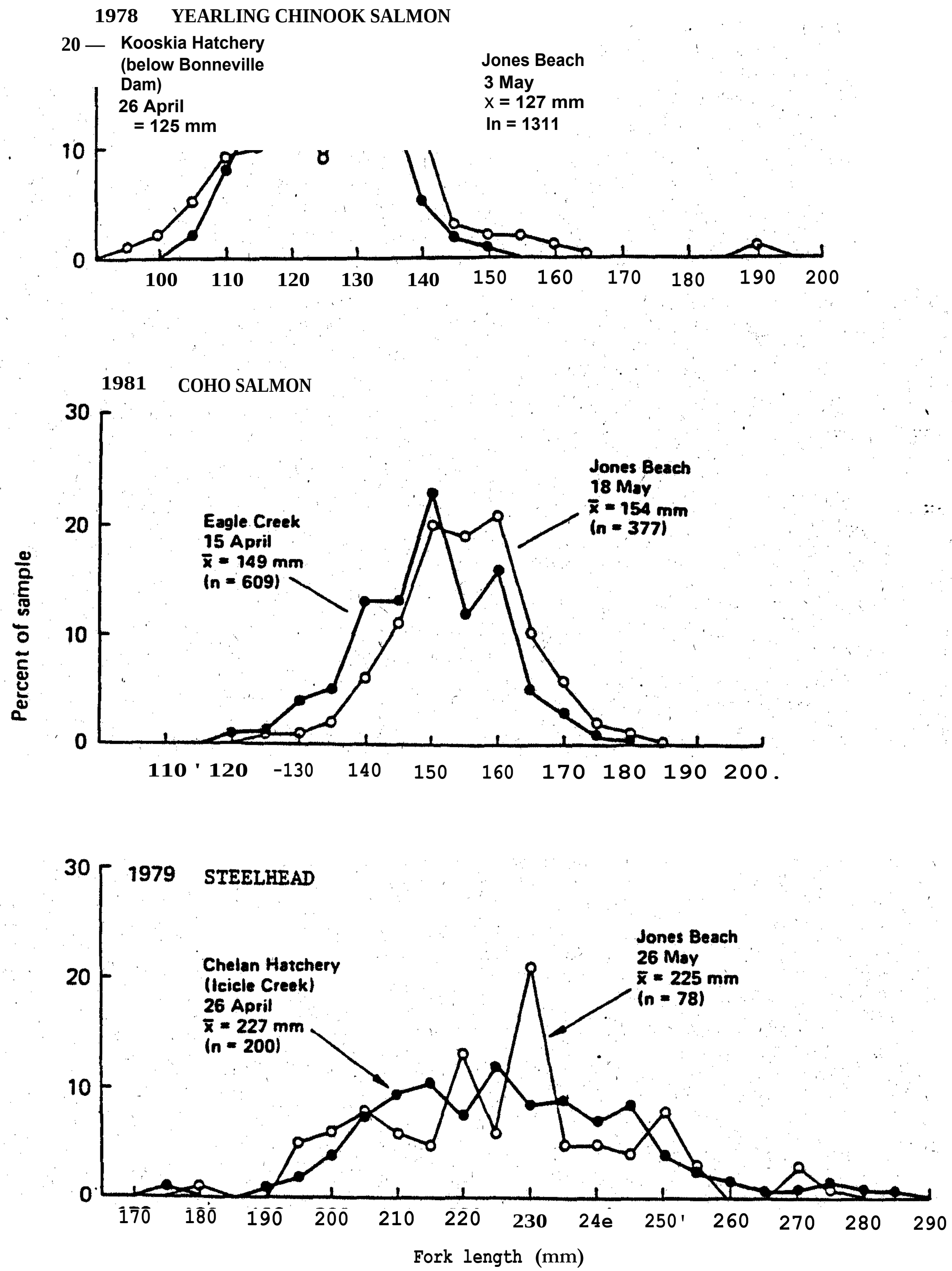


Figure M.—Fork lengths of marked fish groups before and after migration showing little change in length; frequencies within the population.

Table 29.--continued.

a/ More complete information available from Dawley et al. 1985b or .releasing agency Table 21. Binary coded wire tags: Ag-Agency, .D1=Data 1 code, and D2=Data 2 code.. Color coded wire tags begin with. WB and each two digits thereafter represent a color.- Brands are represented by..the following:' Loc=Location on fish, Sym Brand symbol, and Rot=Rotation of symbol. For abbreviations, symbol, and descriptions see Dawley et-al. 1985b.

b/ More complete information available from,Dawley et-al. 1985b or releasing agency Figure 21. Abbreviations used are listed: Fks=Forks, Rat=Ratchery, Lit-Little,.Pd Pond, Rear=Rearing, Sa]iSalmon, Wh White, and @=Released at..

Actual number recovered and effort adjusted'Z catch--effort not consistent during fall and winter periods, thus total recovery. percentages are. not comparable between different studies:

d/ Observed recoveries; may provide erroneous comparisons between studies. not migrating at the same time or between stocks because of possible difference associated with unequal fishing effort and sampling effort.

Table 29.--Jones Beach catches and adult recoveries for marked fish from size at release studies, 1977-1983.

Tag o; (Ag/011D2) Brand Ags SY! Rot)	Source ./	Treatment/ stock	Release nueber (thou)	Release dote (do/eo/yr)	Size (no./lb)	a (no.)	Juvenile catch c/ a ges Beach rin er1Fing (no.)	(X)	Adult recoveries d/ b ned--cueul5tve (no.)	2yr (2)	(X)	(2)	rr (II
				SOBYEARLING CHINOOK SAIMON									
05/41/01	Big White Rear. Pd	norpholene	8707	18 Apr 77	77		358	0.555	202	0.02	0.17	0.23	-
05/42/01		control	91.4		82		333	0.487	166	0.02	0.11	0.18	-
				Y RL INO CHINOOK SALMON									
63/18/50	Cowlitz Hat.		23.0	25 Apr 79					719		0.74	2.50	3.13
63/18/16			24.5				,36	0.195			0.58	2.44	2.88
63/18/17	Cowlitz Hot.		24.3	T.T Apr 79			35	0.200	829		0.15	2.75	3.44
63/18/18			24.1				34				0057	2018	2.60
05/06/59,RD I0 3	Kooskia Hot.		49.5	16 Apr 82	S						0.00	-	
05/05/30,RD IU 1			54.2		2		17	0.031	0		0.00	-	
07/222/552,53	Marion FKs. Not.	sizeitise	8k.9	16-24 Nor 81	14		20	0.046	59'		0.02	0.07	-
			48.3				'7	0.025	14	'	0.01	0.03	-
07/20/48	McKenzie Hot.	sizeitise	31.1	15 Mor 80	3				48	-	0403	0.12	0.15
07120/51			29.4		4		13	0.112			0.01	0.05	0.07
07/20/53			34.9		11		13	0.0079	6		0.00	0.01	0.02
07/2?20	McKenzie Not.	sizeitise	35.6	16 Nor 81	4		11				0.03	0.19	-
07/22/17			30.2		6		4	0.078	9	-.	0.01	0.04	
07/22/22					9		11	0.075	71		0.03	0.20	-
07/27/19	McKenzie Nat.	sizeitise	32.0	08-18 Nov 83	7	4	9	0.088					
07/25/21			32.3	08 Nov 83	11.	2	7	0.046					
07/27/21			3109		16	3	8	0.072					
							9						
07/27/18	McKenzie Not.	sizeitise	36.2	14 Nor 83.	4			0.07					
07/25/22			32.1		6								
07/27/20			30.0		10		14	0.095					
07/17/43	Oakridge Not.	sizeitise	30.2	20 Mor 79	12				292		.0007	0.73	0.97
07/I7/41			3200		14		2	0.178	229		0.01	0.40	0.72
07/17/44	Oakridge Hot.	sizeitise	32.8	20 Nor 79	6		36	0.299	223		0.06	0.56	0.68
07/17/42			29.5		8		50	0.282	313		0.08	0.74	1.06
07/20/46	Oakridge Hat.	sizeitise	29.0	10 Nor 80	4		15	0.145	246		0.07	0.67	0.85
07/20/44			30.7		8		25	0.202	272		0.06	0.54	0.89
07/20/42	Oakridge Hot.	sizeitise	30.7	10 Nor 80			20	0.148			0.07	0.67	1.10
07/20/40			30.9		19				228		0.03-	0.36	0.74
07/23/03	Ookridge Hot.	sizeitise	31.2	16' Nor 81	4		12				0.04	0.45	-
07/22/25			26.6		7			0.096	139		0.02	0.34	-
07/73/05	Oakridge Hot.	sizeltise	29.9	16 Mor 81			,14				0.04	0.48	-
07/23/07			31.7		7		17	0 133	106		0.02	0.33	-
07/16/15	Round Butte Hat.	lgo grade	26.1	.31Mar78	24			0.183' /			0.00	0.00	0.00
07/16/11		vibrio vac.	46.4		28		33		0		0.00	0.00'	0.00
07/16/12		vac. control	46.2				34	0.121	1		0.00	0.00	0.00
				CQHO SA,90N									
63/17/58	Tootle Hat.		39.8	07 Jun 79	18		107.	0.310	' 955	0.00	2.40	-	
63/17/13			40.5		20,		103	0.287	799	0.00	1.97	-	
66729/31	Tootle Not.		38.6	07 Nov 80	18				204	'0000	0.53		
			39.5		20		31	0.165		0.00	0.34		
				STFIJ AD									
05/13/33	Hogereon Hot. 8	A stock	38.8	18-20 Apr 83	2		84	.281					
05/13/34	Solna River	size	39.1		S		104	0 63					

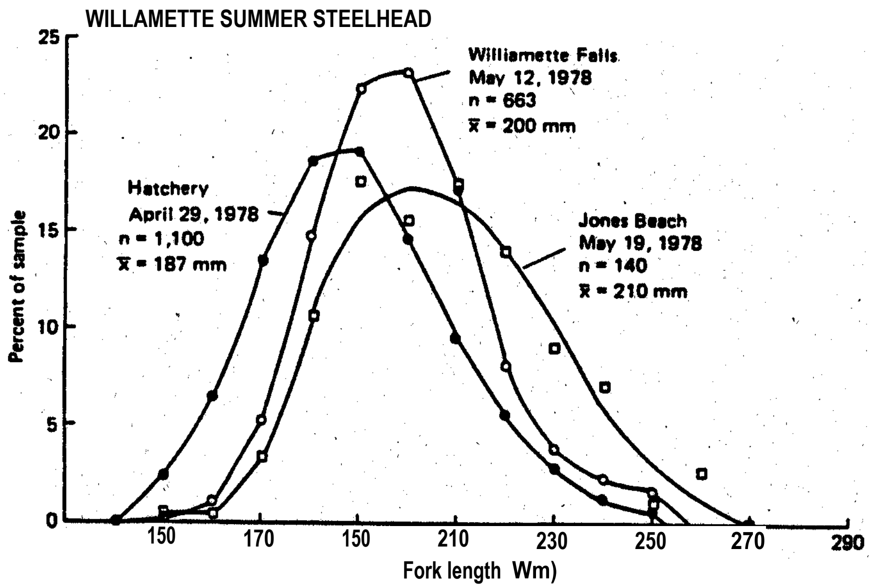


Figure 37.--Fork length measurements' of Skamania summer steelhead smolts prior to hatchery release, from catches at Willamette Falls, and-from catches at Jones Beach, 1978. Hatchery and Willamette **Falls** length frequencies from Buchanan et **al.** (1979).

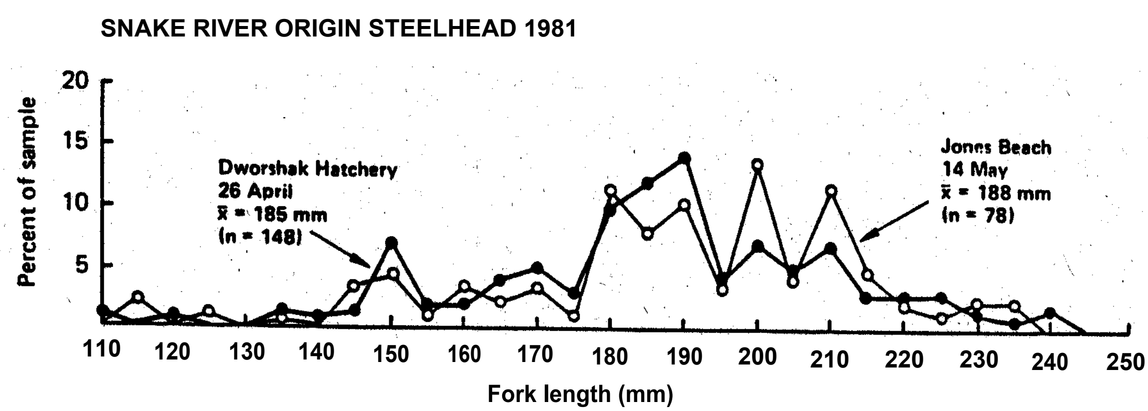


Figure M.—Fork lengths of Snake River s teel.head before and after mi ^{g}ration showing little change in length frequencies for the portion of the population **less** than 180 mm.

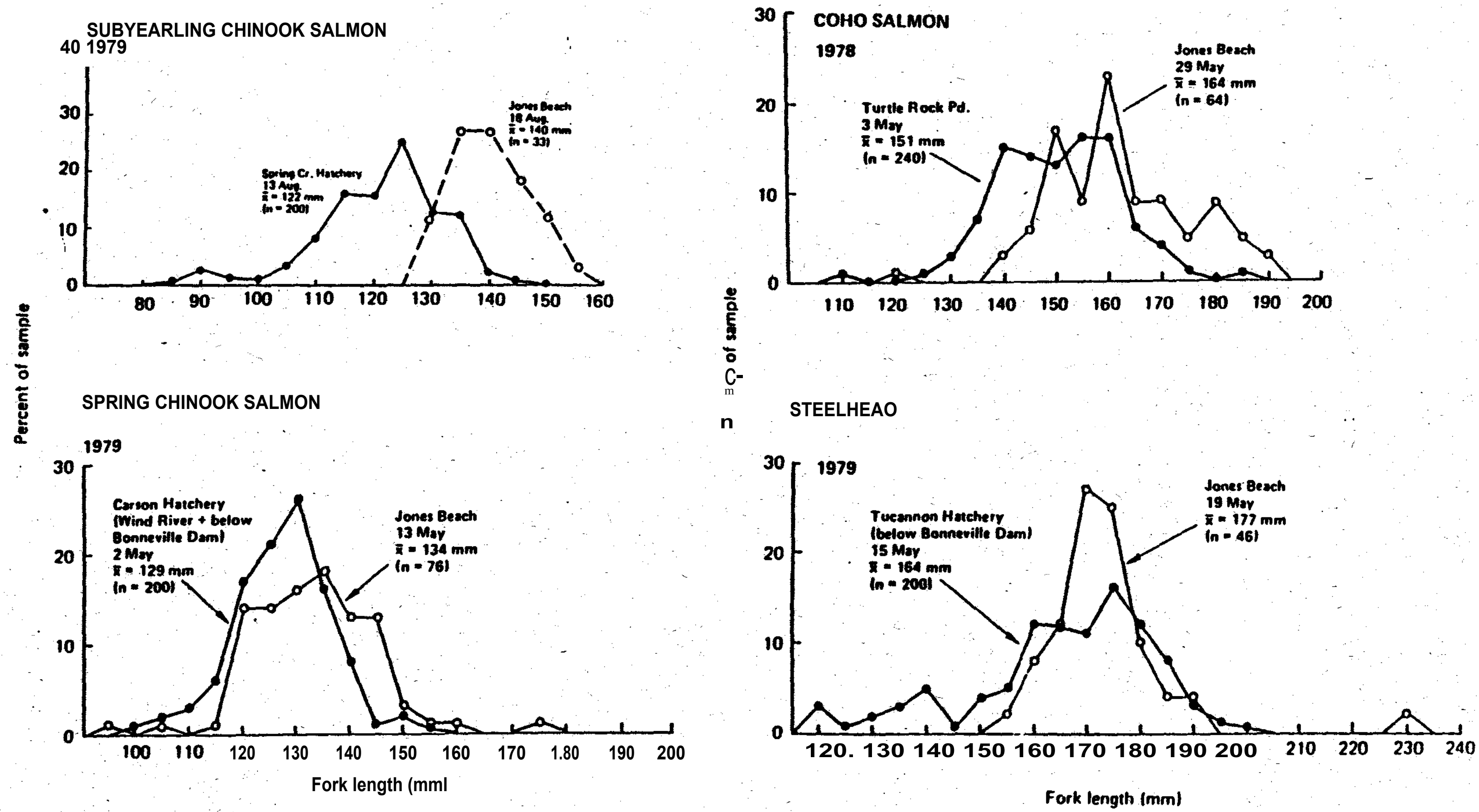


Figure 36.--Fork lengths of subyearling chinook, yearling chinook, and coho salmon and steelhead before and after migration, showing an upward shift in size of the population at Jones Beach.

A large range of 'catch percentages was observed for transported groups which moved rapidly past Jones Beach (50% of the catch in 2 *days* or less), and marked groups behaving in this fashion were not used *in* the assessment of effects from transportation. We hypothesize that these particular transported fish migrated rapidly from release sites to Jones Beach and did not disperse widely in the'river. *Low* catch percentages, unrepresentative of abundance, resulted when the, majority of individuals within such a group *passed* during nonfishing hours, and high catch percentages, also unrepresentative of abundance, resulted when the majority passed during fishing hours. In either instance, the comparison *to* control groups was erroneous.

Calculated survival estimates generally increased with the number of dams bypassed (Fig. 39); the average increased survival estimate' for one dam bypassed was 44%, (12 *transport* groups) and for eight dams 236% (9 transport groups). Data (Table 30) were transformed to *stabilize the* variance of the dependent variable for linear regression. The hypothesis that the slope - 0 was rejected at P<0.01 (t 2.72, 49 df). Average . survival increase from bypassing dams was 50, 33, 20, and 11% per dam, respectively, for subyearling chinook salmon, yearling chinook salmon, coho,salmon,'and steelhead.

Adult recoveries for transport versus control groups. were evaluated' to. determine **if** survival changes from transportation *were, similar* to those observed from estuarine recovery estimates (Table 30).' A positive 'correlation exists between change in adult-survival and numbers of dams bypassed *as* juveniles (average no increase.for one dam and 121% increase'for eight dams) (Fig. 39); however, the slope of the linear regression (transformed data) was not significantly different from zero (t • 0.4, 35 df). Comparison of adult survival increases to estuarine estimates of juvenile survival increases provided the. following correlation coefficients (r)s 0.42, 0.14, 0.72, and 0.77 for subyearling chinook salmon, yearling chinook salmon, coho salmon, and steelhead, respectively. In general, *adult* recoveries showed the same survival benefits from transportation as estuarine sampling, **but**, as observed from evaluation of replicate groups, the variation was greater within' adult data. Not *all* adult recoveries of mark groups are avaliable at this time, thus these conclusions regarding adult recoveries are preliminary.

Estuarine catch data for 'some species and/or stocks may provide a more accurate estimation of effects, of transportation of juveniles past dams than adult data.

<u>Serial</u>Releases.--Delayed releases of coho salmon (June and July) from Cascade, Toutle, and Washougal Hatcheries, generally showed increased juvenile catch percentages that often were significantly greater than.catch percentages of groups released *at* the normal release time *in* early May (Table 31). Adult recoveries showed increased returns from late' May and June releases *as* expected on the basis *of* juvenile recoveries,, but *July* releases displayed *an* erratic pattern (Westgate et *al.* 1981, 1982, and 1983a; Schneider and Foster 1981).

In July, high. water temperatures in the river and the ocean May have affected the survival of coho salmon groups during transition to seawater. '

of 28 comparisons showed a positive relationship. A two-way ANOVA was calculated to compare the catch percentages according to size at release (similar groups were paired according to difference in'size at release). The ANOVA was conditioned on the marked groups, and the F-value for size at release was used to determine significance. The ANOVA table is:

Source of variation	DF	SS	MS	F	Probability of F-value
Size at release	1	0.002929	0.002929	3.972	0.0565
Mark group	27	0.573188	0.021229	28.791	0.0000
Remainder	27,	0.019908	0.00073735		

The probability value of 0.0565 for size at release indicates significance at the a - 0.06 level. The only comparison available for effects of -size on steelhead groups from the Snake River showed reversed recovery rate and was not included in the statistical analysis.

Adult recoveries (Table 29) showed greater survival for groups released at a larger size in 13 of 19 comparisons and were statistically greater in 11 comparisons.

Minimum-size thresholds for successful migration.to the 'ocean have been suggested by several investigators. Buchanan (1981) hypothesized a minimum-size threshold of 180 mm for steelhead of"Willamette River origin. Our observations of Willamette River steelhead support Buchanan's hypothesis (Fig. 37). Observations of steelhead from the Snake River, however, do not show this relationship; individuals as small as 110 mm migrated successfully from the Snake River to Jones Beach, e.g., Dworshak steelhead ranging from 100 mm to 240 mm (Fig. 38). Washington (1982) hypothesized a minimum-size threshold for survival of 130-140 mm for coho salmon from Columbia River Hatcheries--developed from fork length measurements of migrants at Jones Beach. Reimers (1967) hypothesized that the minimum-size threshold for wild subyearling chinook salmon in the Columbia River varies between tributaries.

<u>Transportation Past Dams</u>.--'Rely tive survival differences for marked fish groups transported''' by truck or barge past' dams in the Columbia River' system (1977-1983) were calculated from catch percentages at Jones 'Beach. Comparisons between. catch- percentages of..transported and. control. fish were limited to two data sets: (1) juveniles transported directly from hatcheries, upstream or downstream, were .compared to controls released at the hatchery, and (2) juveniles captured at McNary Dam subsequently marked and. transported downstream: past three dams were. compared to controls released in the tailrace of McNary Dam.

', **Table 30.--continued.**

LAN1.2(23/16/09)	NcNorr Dam(tsilrace control)	5.6	24-26 Jun 82		26Ja1	6.0	0.071						
LAIFI.3(23/16/09)		3.0	29pM.0301.41 82				0.000						
LAIC1.33/16/11)							0 228						
tAIN1.3(23/16/11)		1.3	15-17 Wl 82	1	6w1	6.6	0.048						
LAS2.4t23/16/11)		7.0	20-22 Jul 82	1	02Auq	5.4							
		7.A	2 -21 Jul	2	09Auq	6.3	04003						
AM2 4cc23 1d 11)			982	2 p									
~i~ Tailrace Control Groupesi/		38.6	29Jon	2	IIJu)	5.4	0:072	2	0.01				
AAVI(3h16/10)	ds Boon. bu (trod(10114.)	5.4	25Junn 02Ja 82		OlJul	12.2	0.185						
			12- 1 1 82 82			3	0.176						
RW3(23/'6l/1,	'	15 5	26 e1-06	6	D6M'	1.J	0.181						
All Troch Transport Groups t/		39.7	25Jun OdMuq 82	23	24141	4.6	0.179	5	0.01	3	6.9	123	143
LA2LI.3i1521 (23/16/71)	AcAsrr Ms !tailrace control	15.0	08 15 Jul 03	10	22Ju1	7.5	0.153						
LA211.3N.S2T (23/16/30)	•	14.7	20-27 Jul 83	0	-		0.000						
LA2X1.3(23/16/33)		10.6	29Jl-45Aug 83	0			0400						
All Tsslroce Control i/•		69.3	16.1on-02Sp 83	10	22Ju1	7.3	0437						
RAIJI(23/16/25)	ds Non. Dan (trod trams.)	15.1	07-14 Jul 13		20Ju1	7.	O						
RAIJ3(21/16/28)		1440	19-25 Jul 83	5	21Jul	7.5	0.066						
RAIJ2t23/16/31)	'	6	30Jol-02045 83	8	Olluo	6.222	0*256						
All Truck Transport Groups i/		35.3	07Ju1-02Auq 83	16		6~		•	•		6.7	66	-
RA31(23/16/24)	ds Dao. Dan ammo trams.)	15.0	10-15 Jul 83	7	11ht1	6.S	0.073						
8633(23/16/29)		15.2	15-26 Jul 83	3	24141	6.7				3			
RA32(23/14/32)		8.6	28k1 Ol0Uq 83		0	6.	0.0399						
All Haw Transport Groups i/		30.8	10. rl-0lAsq 01	1	#914	7s	0.069	—	–	3			
05/49/01.881	Spring Cr. Not. (control)	75.8	08 Apr 77	215	29Ap	3.9	0.4D4	334	0.44				
05/50/014184	ds lons. lmo (trams.)	76.0	08 Apr 77	304	30Apr	4.7	0460	355	0.47	1	3.1_	29	6
05/62/01	... Spline Cr. Not. (control)	92.3	18 Apr 78~	1175		+ Si		500	0.54				
05/54/01	Is lmo. Don ltrsos.)	98	20 Apr 78	201	iOAj	8.8	0211	479	0.49	1	6.7	6	-0
1	Seri Cr. Net. (control)	76	ISApr-CSIMy 81	228	29(ar	7.9	0.126	126	0.07				
05/07/42 M7/43 05/07/46	Rod Cr. (upstream trans.).	43.4 25.7 150.5	21 Apr 81 21 Apr 81		k 29er	10.9	0.045	360	0.20	4	46.5	-73	-64
05/10/51 100	Sprinsqq Cr. Net.(control) Umttilis R.(pstrw trans.)	38.8 1022.1	15 Apr 82 08-13 Apr 82	84 153	25Apr O0lhr	9.4 10.0	0.103	16	0.1	.-2	9.1	-40	-1
07/17/08	Upstros Villas. Folls/Stsrtan Pd. (contra)	50.9	3lNa9-OlJun 78	96	12Joo	8.3	0.151	102.	040				
07/17/10		51.2											
07/17/09	ds Villa. Fells (trios.)	51.2	31Nar-01Jun 78	100	IlJoo	84	0.157	63	0.12	1	0.3 b/	2	23
			TEARLINO CNINOOI($ALNOI										
07/25/47	loon. Nat.(control/late fell)	41.9	23 Nor 83	13	00Apr	12.1							
07/27/41	Usstills R.(upstrw trans.)	994	24Nor-IBApr, 53	19	14(00	10.4	0.019	-		-3	8.5		
1161011 LAAN4	Corson Not. (control)	41.0	03 Nor 79~	25	IUor	9.7	0.	3	0.01				
VM.IGN.LAAN1	Pasco (upstream trans.)	39.1	23 Apr 79	7J	14Na9	84							
IM~LI~RATI	ds loos. Dan (trans.)	38.3 34.	2)Apr-07Nor 79	126	O9Nsr	9.7	0.107	1	000	-4	7.6	13	-91
NR.IT-XT,8612	•	396											
3/17/25	Enlist Not. (control)	87 0	25-26 Apr 78	43	2CNar	9.2	0.149						
LDAN4•	Vomits Iridge(trans.)	16.4	02 Nov 78	13	23Ner	8.7	0.102				7.4	117	-
09/16/21	S. $wtiSO N. (control)	23.5 29	13 Nor 78	26	00Apr	7.9	'0.004.	451	0.65				
09/16/26 09/16/23	ds Villas. Falls (teams.)	14.9 26.`	13 Nor 70	67	07Apr	7.9	0.717	786	1.21	1	0.4 R/	182	06
09/1—		13.4											

Table, 30.--Survival differences between fish groups transported past dams and those not transported; from catch percentages at Jones Beach, 1977-1983..

Tog o/ (A /[1702) YreMs~t) Fi9s 3Y!	RELEASE INFORMATION Slklsarcfansatest)b/	Number (thou)	Date Ih/se/yr)	IES !EAr Fish titch (no.)	RFMIERT Median fish reccv. date	HFQRMAi1~i1 Flew [Jaen Nacf t/ Ikcas	Adj. nt.g/ (2)	Amt! NtLW. I FORIMTION Observed t/ (mo.)	()	Goss pined Imo.)	Floe f (ann. Du f/ (kcal)	Estis. sm. ckamge eF ~ropseo ()	(2)
	BUOTEARI.ING CHINOOK SAUI)N												
09/16/12	Uptrem Willa. Falls/husville Pd.	4406	04 Mr 77	209	I91ar	'4.5	0.434	35	0.14	-			
09/16/13	(control)	43.1											
09/16/11	h Willis. Falls (trios.)	46.4	04 Apr 77	504	I4Ney.	4.5 ,	0.557	59	0.03	1	0.4h/	28	-23
09/16/06		92.0											
09/16/07		43.5											
07/24/07	Dannevrlle Not. (control)	105.8	23 Apr 82	262	01Nkv-	10.0							
07/26/63	Weitiile R./loaneville blot. Nostreu trans.)	102.3	14-20 Apr 82	137	10kv	10.2	0.		-	-3	7.8	-47	-
07/28/27	loss. Not. (Control)	100.3	I6 An 83	111	10Ner	10.4							
07/28/26	Vernita Ir.(pstreos trans./tule)	100.2	.02 .No 83	47	16Jel	7.5	0.078	-	-	-4	7.2	-42	-
05/04/26	,RASUI Kosko Not. (control) '	55.7	29 Nor 79	31	17Jen	5.5	0.058	5	0.01				
05/04/27	ds loon. On (Woos.)	46.3	03-20 Nay 79	38	23Nn	8.4	0.102	.5	1.01	8	5.6	33	- 20
05/04/21.	Asotio IA/Nageraon H. (control)	44.0	21 Bay 79	3	03Jul	4.2							
05/04/20	OS ionm. Jan (trans.)	51.0	20 Nsy 79	74.	31May	7.6	0.177 aft.	192	038	',1	5.0	949	150
05/05/27	Asotis NA/Negersae N. (control)	58.1	03 Na, 80	6	24Ao	9.1	0.023	719	0.48				
05/05/28	ds loon. Dom (tress.)	.56.0	06 An 80	34	15.0.1	9.1	0.014	.43	1.01	.8	/.2	245	♦4
10/22/10	*satin NA/Nsgerem N. (control)	55.4	26' Mr I1	21	1lke	11.2	0.066	196	0.35	-			
10/22/11	ds loon. Dan (treni.)	55.7	28 Nov 81	67	07Jw	12.4	0.132	201'	0.36	S	11.1	80	3
WNPUONIL,LAIF)	NcNery lou (resevoir control)	15.1	29Jrn-14A1 78	3	21A1~	5.7	0.108						
MITWXYON'		23.0	17Ju(9tSp 78	0									
All Reservoir Control f:/		17.0	29Jun-015 71	3	21JU	5.7	Q:	54	0.14				
NNORBNLG.RAIC1	ds loam. Don (truck trans.)	17.0	1 78		3dJul	.f							
WNLG.RAIC3		3.4	19AlAttg A		1	J.							
All Truck Transport 11		20.4	28Jun-30Mg 78	14	16Jul	5.7	00.191	298	1.46	3	5.7	355	942
MIYWBLU.LAIP1,3	MdNry Daa(reservoir control)	19.8	05Jal-13Aug 79	4	10hul	3.7	0.101			-			
WNRDTNPK/	NcM4ry Doa(tailroce control)	54.7	12Jun-17Jul 79	16	15.Jul	4.0	0.077			-			
WHRDPKOR.LAIN1.3 ,j/				2									
MLBTWU LAIN2		40.4	24k1-06MA 79		03Avig	3.6	0.013						
ILACK.LA51		0.3	IIAr03,M179	2	OlJul	4.1	0.948						
WNRDLIPK.LAIN4		19.9	00-24 Mlq 79'	0						-			
WIRDLGYW,LA52,3		0.6	1411ay-21Jw 79	0			0.000			-			
All Tailrace and Reservoir Control i/		135.7	IIApr-241oy 79	24	23Jul	3.8		13	0.06				
AR1*GPK.RA32.2	ds Donn. Doe (trucE-trans.)	3.4	1411ey-2)Joe 79	7	22Jun	7.0	0.012			7			
WNRDPKU.RA141		43.5	12-29 An 79	141	26Jus	6.9	0.424.			3			
1IILOY11LG.RAI42		41.2	24k1 O48uq 79	29	04Auq	4.5				3			
INROLBYW.RAIN *RAI43		18.	08-24 Aug 79	20	1504	3.9	O.~						
WtR 1			t 02 02,M179	24	i	5.7	0.000..						
All truck Transport Groups		132.9	16 Mr24Aaq 79	220	15Ju1	6.8	0.301	548	0.41	.3	I.7	331	583
CE AIF	NcNerr Om! (tailrace control)	9..	1.11i 80	4	25AI	4.2	0.03						
%g Y.LA F3		45.6	16-31 Jul 80	2	04A.a	4.0							
AI Tailrace Control 1/		14.1	09kn-31Jul 80	6	29Jul	4.2		111	0.13 '	3			
Ib.RAIC3	ds loss. Doe (truck-trans.)	40.7	18Je1-OiMt 80	34	21Jul	4.1	a0						
LA RAIC1		39.5	13Jkn-17Ja 00	40	10JU1	S.3	0.274						
All Truck Transport Group t/		80.2	13Jun-OlAuq /0	74	15AI	.3	0.271	331	0.41	6	5.7	810	213
03/17/32	,1A(NI«1 NCNary Dom(kilroce control)	42.6	09-29 Jul 81	-10	PY ul	5.8							
03/17/33	ds louts. Du (truck trios.)	,42.9	09-31 AI 81	44	24Jul	6.2	o.27	66	0. S	3	5.7	202	275

Table 30.--continued.

07/18/26	Rnd. butte Net. (control)	48.8	23-31 Ray 79	240	05Jun	6.2	0.282	0	0.00				
07/18/25 07/18/27	ds Iona., Ma. (tans.)	9.d	30 Ils 79	.149	02Jun	7.6	0.338	0	0.00	2	6.8.	6	
63/18/12 43/10/1l 63/18/20	Winthrop N. (control) Retlou R (baulk 4 II ds Priest R. Om (trans.)	67.3. 86.2 77.6	20 Apr 78 24 Apr 79 16 Ney 79	16 34 73	3011ey 271., 0UJun	7.6 8.4 7.6	0.033 0.055 0.111	16 7 7	0.02 0 01	', 5	2.5	ZK	-40
	20MM												
BNORL6OR.LAPP2 VIGORXY.RALI 0NORIL0R,RAL2	Poses, VA/Carson Nat.(centrol) ds Ilona. Dos (trans.)	44.0 29.7 21.9	03 Noy 78 01-04 Nay 78	47 '23	19NOy 1S8ex	9.2 9.2	0.139 0.053	19 53	0.20 0.09		7,4	-62	-55 .
MMRRLFTM IOIORTIOR MNORTYON	Millard Nat. (control ds Iona. Des (trims.)	11.9 19.8 19.7 19.8	20ier-08Jw 78 08 .kin 78	13 21	11Jon . I4Ju.	14 84	0.053 0.004	43 60	0.21 0..20		6.7	58	-5 .a.
05/0313	Willard Not. icontrol)	'42.4 43.0	4-23 Nay 80.	21	301iey	9.0	0.033	618	0.45		7.2		
05/06/54 05/06/60 06/55	ds Bonn. Des (trks.)	B.7 47.9 51.4	24-25'(My 10	29	3111o1	9.0	0.039	511	0.31	1	' 7.2	18	-14
X													
*LITM.LAAN1 INLPK rLAAN2	Icicle Cr./Cbelu Nst.(control)	24.) 241	26 Apr 79	55	24Nov	8.4	0.106	356	0.53				
IINLIO R,RA13 A08IRI,R11	ds Donn. Du (treas.	2.8 22 23S	28 Apr 79	80	*Noy	9.7	0.139	543	1.77	1	7.1 '	17.	45
05/04/55	Ouonhot list. (rostral) 8/11 6/lb ,	59.1 46	17-25 Apr 80	124	07Nor	8,8	0.144 '	561	037				
10 21/61 10/21/19 4 4841	ds Iona. Doe (treas.) 6/lb	49.2 40.0	298sr-021My 80	95	0558ey	8.8	0.510	453	1.13	8	5.9	269	205
23/06/06.1A1 2 /06/07,RAL 23/16/05,561.2	Duorshat Net. (control)~ Skokie Light (trans.) '	ii.0 2 32.9	19 A r 82 2211pr-03tlar A2	13 37	1 x 2SApr	10.2 9.4	0.039 0.067				8.7		
23/16/04.LAK2 23/16/03.RAPP1 23/16/01,RAL1	Worshat Nat. (control) Somme Light (trans.)	31.0 29.6 31.9	30 Apt 82 2211sr-03JA 82	21 195	20Mev 291iay	*0.8 11.0	0.064 0.319	-	~ -	1	9.2		
63/28/384481 63/28/39,RA51 43/28/40,RAS2	Lyons Ferry (control) Mellow Net. (upstrees,tress.)	54.6 33.0 32.0	.01-20 Rev 83 09-13 Nay. 83	68 96 78	20Ray alloy	12.2 12.2	0.14411 0.305			-2	2.9.J/	116	
MNORORRD.RAL3 0NORL014 0A.2 1010RORX14APP1	RiMo Id Nota ontrol) !lethal R./Mels ehonrel *stress teas.)	17.6 19.9 20.3	OS Mer 78 27Apr-0811ar 18	1 17	18Roy 26Rsr	4. S.7	0.079 ' 0.058	207	0.69 .0.51	-S	4.01/	-23	-26
YNL/PKLG,LAIJ3 MILIPKTY.RAIJi 1ILIL10RAT1	liethow R.Aklls cMoesel (control) ds km. Deeltrans.)	8.3 20.1 9.7	` 09-14 May 79 12 Nov 79	13 12	2811., 151iay.	7.6 8.1	0.042 . 0.155	50 60	.0.13 0.62	`9	6.9	253	377
M11100	ds Priest Rapids Des/Yelis damsel		28-24 Ap r 82	25	Allay	'10.2	0.108		-				
YN11YN	Rethow R. lis channel t lujstrses trees.)		19-23 Apr 82	23	2(INar	10.9.'	0.096.			.5	4.0 R/	-16	
RA 52 1	ds Priest Rapids D./cells charnel ldsws ress control)	22.4	., 19-27 Apt 83	49	121er	10.4	0.224						
RA 17 1	Netbow R. tupstress trans.)	20.0	19-27 Apr 83	23	151er.	9.2	0.122						

Table 30.--continued.

07/29/2	S. Santa. N. (control)	17	07 Na 78	8	OlNor	5.7	0.009	170	0.18				
/26 07/1 /30		3201			!Up	7.7	0.018	182	0021'	1	NA	66	56
07/19/20 07/19/21	S. Samuels N.10otrid0e N.lContro1)	52.8 32.4	21 Ner 71_ 94		13Apr	7.7	0.168	127	0.13				
07719/ 07/19/24	ds Yi11u1 Foils (crus.)	34.2 35.3	23 Not 78	151	13Apr	7.7	0.265	60	1.06	1	0.4 h/	58	-54
07/19/45; 07/19/46	- S. Soatian N. (control) —	29.4 2 9	14 Per 80	42	05Apr	4.9	0.184	84	0.14				
07/19/48 07/19/47.	ds hilbs.t'ells (treas.) ,	28.5 32.1	14 Not 80	66	30Ner	4.9	0.271	63	0.10	1	0.9 tl/	47	-24
10/03/30,LAPP2 4NRDXY,RAL4 011ABLCNAL.I	Mashie Not. (control) ds Bona Oea (trans.)	83.1 337.1 3700	12 An 78^ 41 26-20APr 71	79	i1Mev 05Mer	0.1 8.8	0.073 0.064	1	0.03 0.00	8	tJ		
MISDPK,MLL23		_36.9											
05/05/32 05/05/29	--- Mahn Not. (control) ds Bona. Dee (frons.)	61.3 62.3	16 Apr 00 14 Apr 80	14 26	048et ^ 0511et	t03 8.3	0.044 0.07	9 3	0.01 0.00	8	7.3	43	-67
63/17/02 63/17/03 63/17/04	Leovennorth Net, (control)) LeaveneortP Net. (holed 4 Al ds Priest A0p. (trans.)	95.2 94.3 94.6	25 Apr 78 08 Nay 78	67 47 80	22Not 23Net 2411ev	'8.7 8.7 8.7'	0.090 0.070 0.115	90 8 7	0.09 0.01 0.01	3	3.11/	28	42
63/18/09 63/18/10 63/18/08	Leevenoorth Not. (control) Leovmonrth Net. lhaolrd 4 hl ds Priest Rep. (hoes.)	97.5 100.3 94.1	26 Apr 79 15 Not 79	104 164	29Nev 2880' 301Nr	7.6 7.6 7.6	0.142 0.115 0.209.	55 S 2	0.04 0.00 0.00	3,	208 t/	47	-96
03/46/02,LAPI1 03/47/02,LAPI2	Losveiworth Net. (control)	32.1 32.9	24Apr-OlNer 80	30	26Mer	8.1	0.032	4	.0.00				
03/51/02,LAPI4 03/18/02,LAPI3 03/49/02,LAPPI	(Mite Bluffs (treas.)	33.1 32.0	241e-OlNor $0	41	IBMer	7.6	0.085	6	0.01	3	3931/	177	48
03/50/02,1,451 03/43/02,RA91 03/44/02,049 03145/02,049 03/52/02,RAIK1 03/53/020RAIK2 03/54/02,041113	Deltas Pont (trans.).	4 1 3.1 2.9 32.6	24Apr-OlNet 80	141	05Nar	14	0.115	2	0.00	7	6081/	253	-75
ROF1	Postern-Forty/Leavenworth N. (gstteao. contra1l	14 15.3 16.1	05-13 NO 80	23	07Jen	9.0	0.041						
RDIY3 LOIY3 88IL2		W., 15.3 13.9 15.0											
RDF IOF2 08113	Is Priest Awls B. (treas.)	142 14.1	22-27 Nov BO	48	0 Wn	9.0	0.090	-	-	5	3.8 1/	120	-
RD1T2 18IT2		13 2 15.3 15.8											
RDF3	_ ~ Richland,, A (trans.)		22-2914'40	40	05Jea	9.0	0.074	—	—	5	3.t1/	80	-_
RDDIT1 10I71		13.9 15.4											
LOILI		15.9						—	—				
07/16/09 07/16/10	1od. Lotte Net. (contro) ds tone. No. (trans.)	66.5 ' 71.5	22 Nov 78 30 Noy 78	91 110	114on 034in	1.3 7.5	0.211 0.215	1 5	0.00 0.01	2	6.7	5,	365

iaDie.i.--Jones beacn catches and adult recoveries for serial releases or coho salmon, 1977-1983.

	Reteosèinfongtion				Recovery infor~ntion n ttJones Beach					Adult recoveries g/ ob erved cusulctive			
Tog a/ (Ao/017D2)	Source hi	Number (thou)	Dote (do/so/yr)	Size c/ (no./IB)	Juvenile catch (no.)	effort adj. if/ (4)	Date of median fish recovery	Flow 8 Jones Bench.e/ Rees.'	Flow adj. catchP 7 kcss 2) f/	totl (no.)	2 yr (4)	3 yr (2)	4 yr (2)
07/26/06	Bonneville Hat.	26.9	02/Noy/83	15'	22	0.081	14 Noy	902	0.096				
07/26/07		27.3	31/Nor/83	16	28	0.112	3 Jun	12,2	0.162				
07/19/08,11	Cascade Hot.	54.8	07/Nor/79		36	0.082	18 Nay	8.1 '	0.090	312	0.01	0.57	
07/19/07,10		53.1	07/Jun/79	23		0.147	14 Jun	5.5	0,128	637	0.00	1.20	
07/19/09,12		49.8	06/Jul/79	23	106	00444	13 Jul	4.0'	0.331	439	0.00	0.88	
07/19/63	Cascade Hat. (for reference)	29.2	28/Apr/80	24	13	00082	17 Nay	.7.6	00086	42	0000	0.04	
07/21/27,30	.Cascade Hat.	51.6	06/Noy/81	17	52	0.109	171ay	6.7	0.106	987	0.00	1091	-
07/21/28,31		5400	08/Jun/81	17	46	0.102	10 Jun	10.2	0.130	1760	0.00	3.26	
07/21/29,32		56.6	06/Jul/81	17	32	0.131	10 Jul	1.6	0.138	1447	0.00	2.56	-
07/24/29,33	Cascade Hat, (for reference)	55,9	25/Nay/82	18	55	0.106	31 Nay	11.0	0.142	310	0.00	0.55	-
07/27/47	Cascade Hat. (for reference)	43.1	24/Noy/83	17	21	0.059	31 Noy	12.2	0.085				
63/19/11,12	Toutle Hot.	77.1	07/Nay/79	18	86	0.136	19 Noy.	8.1	0.149	1062	0.02	1.38	-
63/17/58,19/13		80.3.	07/Jun/79	19	210	0.296	13 Jun	5.5	0.258	1754	4.00	2.18	-
63/19/28,29		80.9	06/Jul/79	18	-205	.0.525	13 Jul	4.0 '	0.391	836	:0000	1.03	-
63/19/31,20/58	Tootle Hot. (for reference)	78.1	07/Hoy/80	19	74	0.192	17 Noy	7.6	0.202	335	0.00	0.43	-
63/19/23,24	Washougal Hot,	155.1	07/Nor/79	17	168	0.139	20 Noy	801	00152	2340	0.02	1.50	
63/19/25 h/		73.0	07/Jun/79	"20	120	0.187	16 Jun	5.5	0.163	687	0.00	0.94	
63/19/26 -		82.9	07/Jun/79	20.	119	0.162	14 Jun	5.5	0.141	1430	0.00	1.72	
63/19/27,34		163.1	07/Jul/79	20	388	0.503	13 Jul	4.0	0.375	2056	0.00	1.26	
	Washougal Hat.	198.3	08/Noy/80	18	150	0.135	17 Noy	7.6	0.142	1368	0.01	0.79	-~
63/20/37,38i/		195.1	09/Jun/80	18	118	0.104	15 Jun '	9.1	00123	4692	0.00	2.40	
"63/19/54,55		213.7	07/Jul/80	19	244	0.262	12 Jul	5.3	0.224 --	8981	0.00	4.20	
63/21/50,22/02	Washougal Hot.	103.8	30/Aor/81	18	91	0.110	15 Nov	6.7	0.107	602	0.01	0.58	-N
63/21 51,22/03		105.3	27/Nay/81	20	70	0.089	2 Jun	10.9	0,119	2485	'0001	2.36	-
63/25/13-17	Washougal Hot. (for reference)	50.1	25INoy/81	,21	91	0.182	2 Jun	11.0	0.244	183	0.01,	0.37	
63//27/13-17	Washougal Nat,	'1 12	30/Apr/8 3	19	40	0.081•'	6 Noy	9.6	0.099				
					38	0.086.	1 Jun	12.2	00124				

a/ Binary coded wire tag: Ag-Agency code, D1-Data 1 code. D2.Data 2 code.

1/ More complete infarmation is available from. Dawley it al. 1985b or the releasing agency-Table 2 1.Bat-Hatchery.

c/ Comparisons limited to groups with less than 20% difference in mean weight at release.

d/ Number is actual; 2 represents catch for effort adjusted combined replicates.

e/ Average flow including Columbia River at Bonneville Dam. Willamett5. Lewis, and Cowlitz Rivers on week of median fish recovery; kcros - 1,000 m /second.

Catch 2 additionally adjusted for river flow to represent• catch at 7 Items.

Percent of total release calculated from observed recovery. No data (-) means either adults have yet to return, were, not collected, or were not obtained from fishery agencies prior to analysis. Comparisons between groups released at different times may be erroneous because of differences in ocean distribution, unequal fishing effort, or sampling effort.

Bin and high pre-release mortality from low dissolved oxygen.

Poor health.

Table 30.--continued.;

a/ More complete information available from Dawley et al. 1985b or releasing agency Table 21. Binary coded wire tags: Ag=Agency, D1=Data 1 code, and D2=Data 2 code. Color coded wire tags begin with WH and each two digits thereafter represent a color. Brands are represented by the following: Loc=Location on fish, Sym=Brand symbol, and Rot=Rotation of symbol. For abbreviations, symbol, and descriptions see Dawley et al. 1985b.

Transport groups with time period from first to median fish capture at Jones Beach in 2 days or less were not included in analysis. Abbreviations: Bonn=Bonneville, Br=Bridge, D=Darn, ds = downstream, Hat=Hatchery, N=North, NA=Nonapplicable, R=River, S=South, Trans=Transported, andWillam=Willamette.

c/ Combined weekly average flow volume of Columbia River at Bonneville Dam, Willamette, Lewis, and Cowlitz3Rivers during week of median fish recovery at Jones Beach; kcms = 1,000 m /second.

Beach plus purse seine data adjusted for effort and flow at Jones 3Beach (catch Z of recovery at lowest flow increased by 8.5% per 1,00(In /second" difference). Comparisons not made for actual. catch less than 10 transport. fish. Mark groups were combined where possible to exceed .the minimum.

Preliminary observed data, . dashes. represent no'data available.'

Weekly average flow volume'of Columbia River. at Bonneville Dam during week of mean date between release and median fish recovery at Jones Beach—represents best flow during passage through dams.

1/ [(Percent recovery . transport group percent recovery control)] x 100.

h/ Weekly averageflow volume of Columbia River at,Bonneville Dam during week of mean date between release and median fish recovery at Jones Beach.

i/ Combined data comparison.

j/ WHRDPKOR also used for test group (Brand s RA I + 3). Tag not included in adult recovery information.

Weekly average flow volume of Columbia River at Priest Rapids Dam during the week-following, release.

1/ Weekly average flow volume of Snake River at Ice Harbor Dam during the week ,following release.

Delayed releases of subyearling Chinook salmon could not be compared'. because of effects of size differences.

Stocks.--Estuarine sampling showed some significant differences in catch ' betwedmarked groups from studies evaluating the success of various fish stocks (Table 32). In:1 of 4 years, yearling chinook salmon of tule stock showed a significantly greater - catch rate than late fall stock released from Bonneville Hatchery (Hansen 1982). Yearling chinook salmon releases from Klickitat Hatchery of wild stock and Wells stock were each different from the Klickitat.stock but not different from one another. Wallowa stock steelhead showed greater catches, than Wells stock released at Lyons..Ferry..' A few other stocks showed significant differences, but .fish size was unequal, and in each instance a greater percentage of the larger fish were cmptured. Comparisons were limited to groups with less than 20% difference in body -weight at release.

Juvenile catch percentages correlated well with adult recoveries. In 13 of 18 instances, juvenile `catches varied in. the same direction' as adult recoveries, . and. in 9 of.12 instances where adult recoveries were ..sigaificantly. different (Table 32).

Nutrition.--Estuarine recovery data of fish, from diet studies showed statistically significant differences which generally correlated with 'benefits of survival observed from adult recovery data. In 2 years of a 7-year study with coho salmon at Sandy Hatchery (Westgate At al.. 19830,, estuarine. recovery data showed. statistically *higher* recoveries, from individual .diet. groups, which correlated. with statistically higher adult. survival (Table 33). One diet group showed statistically lower recoveries,'. but showed no decreased survival in . adult recovery'data · Recoveries-of subyearling chinook salmon from a 4-year study at, Bonneville Hatchery (Westgate et al. 1983b) showed statistically higher. benefits for one diet in 2 of the 3 years for 'which it was-tested, and. adult recoveries also showed survival benefits for both,. however, only one was significant .(Table 33).' Recoveries of subyearling chino$. salmon from a high salt concentration diet at Spring Creek Hatchery (Leek_) showed statistical differences in.1983.and not in 1982.

Several diets showed statistically .significant, differences as adults *which* were'not.apparent from juvenile recovery data.

<u>Rearing</u>Density.--Differences in relative survival during migration to the estuary were examined for yearling Chinook and cobo salmon groups' cultured

· S. Leek, USFWS, Little White NFH, Cook, WA 98605; pers. commun.

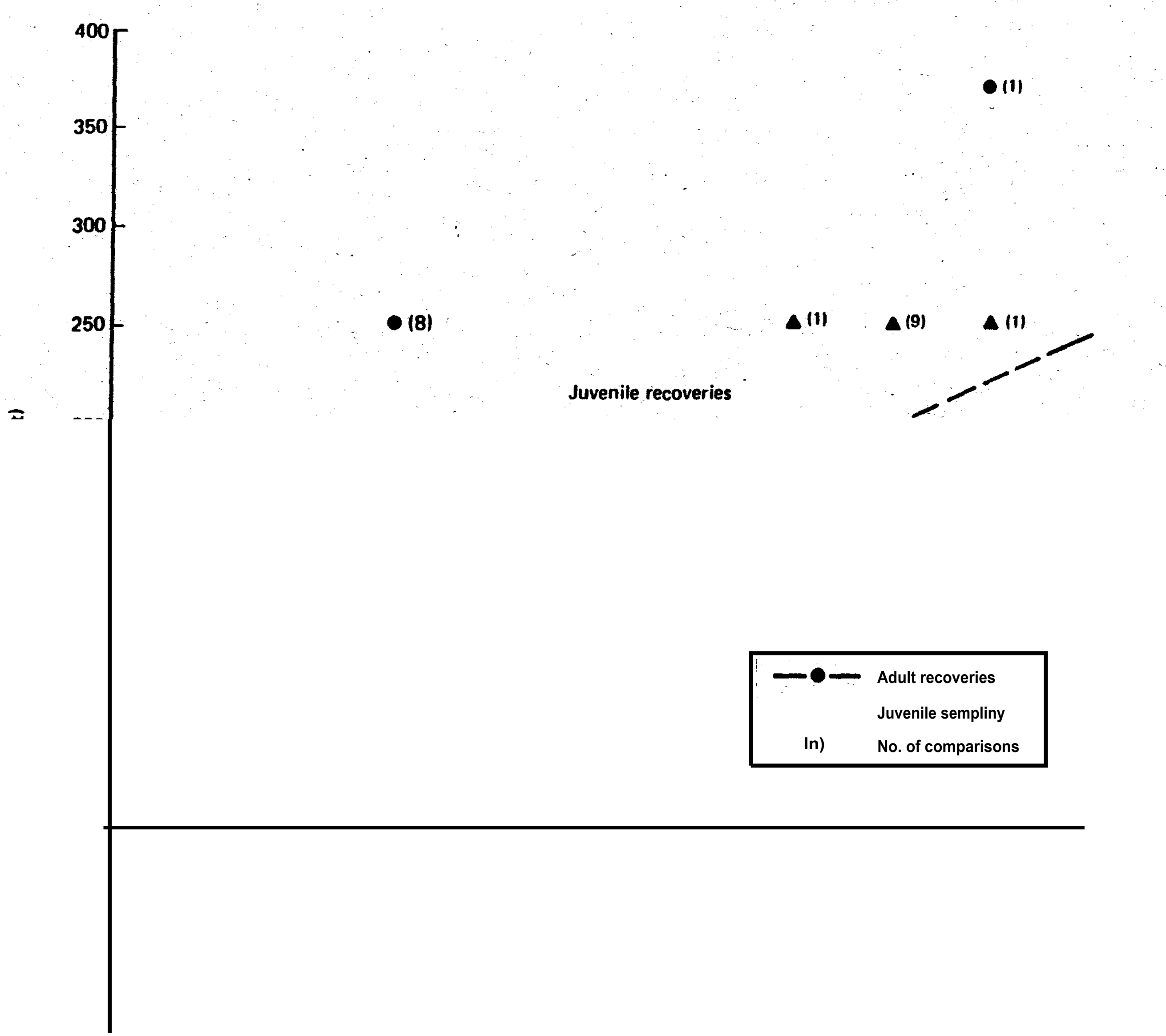


Figure 39.--Linear regression of mean.survival increase with number of dams bypassed in downstream migration;from Jones Beach recoveries and adult recoveries.

Table 32.--continued.

a/ More complete information available from Dawley et al. 1985b or releasing ;agency Table 21. .Binary coded wire tags: Ag=Agency code, Dl=Data 1 code, and D2=Data 2 code. Color coded wire tags begin with WH and each two digits thereafter represent a color. Brands are represented by the following: Loc=Location on fish, Sym=Brand symbol, and Rot=Rotation of'symbol. For abbreviations, symbol, and descriptions see Dawley et al. 1985b.

b/ More complete information is available from Dawley et al., 1985b or the releasing agency Figure 21. Abbreviations used are listed: Ch =Channel, EFk=East Fork,'Fks=Forks, Hat=Hatchery, Lit=Little, Pr-Priest,,R=River, Rap=Rapids, Sal=Salmon, Spaw=Spawning, Wh=White, and'@ = Released at.

c/ Only groups with average body weight < 20% difference were compared.

d/ Actual catch and'adjusted percentage catch, purse seine plus beach seine; combined replicates.

e/ Percent of total release calculated from observed recovery. No data (-) means either adults have yet to return, were not collected, or were not obtained from fishery agencies. prior to analysis. Comparisons between groups released at different times may, be erroneous because of differences in.ocean distribution, unequal fishing effort, or sampling effort.

Table 32.--Catch percentages of marked fish from stock comparison studies.

lagg ai (/D1JD2) Brand (Loc S Rot)	SourcLb/	Stock	!lusher	Date (do/eo/yr)	Size c/ (no/}6)	T tl wtnE (no.)	:!ones Degrh d/ Ifspprang (no.)	(Z)	t al (no.)	~vr (X)	3 rr (X)	rr	5r (X)
07/21/38	Bonneville Hat.	Tule	51.5	09 Nov 81	11	3	5	0.041	7		0.01		
07/21/42		Late fall	50.7		11	3	1	0.024	4	-	0.01		
07/21/39	Bonneville Hat.	Tule	50.0	09 Nov 81	9	5	4	0.085	8	-	0.02		
07/21/41		Late fall	49.8		9	3	1	0,013	12	-	0.02		
07/23/63	Bonneville Hat.	Tule	45.9	01 Nov 82	11	119	4	009					
07/25/48		Late fall	50.7		12	105	2	0.445					
05/61/01, 63/01.03/42	Lit.Wh.Sal.Hat.	Spring Cr.	151.2	24 Nay 78	119		328	0.343	25	0.00	.0.01	0.02	0.02
05/03/46-48		Lit.Wh.Sal.	148.8	25 Nay 78	115	---	334	0.358	10	0.00	0.01	0.01	0.01
63/26/11	Pr Rap *w Ch./	Production	204.1	24 May 83	84		141	0.096					
63/26/12		Mild	202.4	21 Jun 83	63		86	0.,103					
				if A UiUCHINQOA 1ALMON									
07/16/57	Bonneville Hat.	Tule	47.9	13 Nor 79	7		105	0.393	471		0.31'	0.97	0.98
07/16/61		Late fall	32.7		8		62	0.403	514	-	0.39	1.29	1.57
07/17/36	Bonneville Hat.	Tule	48.1	13 Mar 80	6		52	0.224	158		0.12	0.33	0.33
07/17/33		Late fall	49.3		9		70	0.322	140	-	0.07	0.26	0.28
07121/40	Bonneville Hot.	T,ule	51.9	17 Mar 82	7		52	0.435	38	-	0.07	-	
_07/21/43		Late fall	_50.6		7		8	0.377	20	-	0.04	-	
07/27/01	Bonneville Hat.	Tule	37.5	08 Mar 83	W7		44	0.226					
07/25/47		Late fall	49.9	23 Mar, 83	6		13	0.052	-	-	-	-	
63/17/32	Klickitnt Hat.	Klickitat	94.6	30 Mar 79	10		45	0.064	232	—	0.03	0.18	0.25
63/17/34		Wind River	103.3		10		80	0,109	269 '	-	0.01	0.18	0.26
63/17/50		Wells	94.2		10		87	0.131	361		0.15	0.35	0.38
09/16/63	Marion Fks. Hat.	Carson	50.2	13-15 Mar 78	15		17	0.056	18	~-	0.00	0.01	0.04
09/17/02	8 Minto	Sontia	49.6		13		22	0,089	3	-	0.00	0.01	0.01
07/17/25.26 0 29	Marion Fks.Hat.	Carson	144.3	03 Apr 79	16		90	0.078	67	-	0.00	0.02	'0.05
07/17/30-32	e Ninto	Studios	148.2		19		101	0.088	524	-	0.01	0.19	0.35
07/22/49-51	Marion Fks. Hat.	Carson	147,1	16-24 Apr 81	14		24	0.031	49	—	0.00	.0.03	
07/22/52,53	0 Minto	Santioe	81.9		14		27	0.036	59		0.02	0.07	
07/25/25-27	Marion Fks. Hot.	Carson	150.8	15-17 Mar 82	16		31	0.041	0	-	0.00		
07/25/28-30	8 Minto	Sciatica	148.7	18-20 Mar 82	14		56	0.053	3	-	0.00	-	
07/20/44	Oakridge Hat.	Oakridge	30.7	10 Mar 80	8		25	0.202.	272	-	0.06	0.54	0.89
07/20/42.		Dexter	30.7		9		20	0.148	'339	-	0,07	0.67	1.10
07/22/25	Oakridge Hat.	Ook ridge	26.6	16 Mar 81	7		9	0.063	91	-	0.02	0.34	
07/23/05		Dexter	29.9		7		14	0.104	145	-	0.04	0.48	
05/06/28	Ware Springs Hat.	Early Sus.'	10.9	07-14 Apr 80	19		5	0.086	126				1.15
05/06/27		Late Sue,	168.0		1?		51	0.059	1351				0.80
05/08/24	Warr Springs Hat.	Early Son.	32.2	02 Apr 81	8		4	0.027	0		0.00'	0.00	
05/08122		Late Sue.	66.7		8		20	0.062 -	2	-	0.00.	0.00	
05/08/25	Ware Spring Hat.	Early Sue.	186.0	09 Apr 81	20		16	0.027 .			0.00	0.00	
05/08/23		Late Sue.	170.2	09-16 Apr 81	18		48	42	10		0,00	0.01	
				STEELHEAD									
05/13/34	Hagereon Hot. B Upper Sal. R.	A stock	39.1	18-20-Apr 83	5		104	0.363					
10/24/60	No welt Hot. B R.	8 stock	37.6	12-13 Apr 83	4		102	0.316					
LA S I	Lyons Ferry Hot.	Wallowa	54.6	01-20 Hoy 83	4		68	0.104					
LDS 2		Wells	51.6		1		7	0.016	-				

Table 33.-continued.

		SUBYEARLING CHINOOK SALOON								
07/21/33,34	OHP 2	Bonneville Notal(	100.5	27 Nay 80	26	0.044	39	0.00	0.03	0.04
07/21/35,36	ONP 4		97.5		50	0.090	31	0.00	0.03	0.03
07/23/41,42	OMP 2	Bonneville Hot.	102.4	12. Nay '81	90	0,104	61	0.00.	0.06	-
07/23/43,44	OMP 4		105.0		114	0.137	95.	0.01	0.09	-
07/23/45,46	Presscake		101.9		99	0.121	42	0.00	0.04	-
07/24/14,15	OMP 2	Bonneville Hot.	104.1	04 Jen 82	84	0.081				
07/24/16,17	OMP 5 (presscake)		106.6		91	0.090				
07/27/29,30	ONP 2	Bonneville Hat.	100.0	04 May 83	171	0.171	-	-	-	-
07/27/27,28	ONP 4		100.8		172	0.171	-	-	-	-
05/10/55,56	7x Salt	Spring creek Hot.g/	89.6	15 Apr 82	135	0.173	-	-	-	-
05/10/53,54	Control		91.7		139	0.174	-	-	-	-
05/11/42,43	72 Solt	Spring Creek Hat.	100.0	28 Apr 83	136	0.136				
05/11/44,45	Control		104.0		171	0.164				

9/ Binary coded wire tag: Ag=Agency code, DI=Data I code, and 02=Bata 2 code.
p/ Number is actual catch; 2 catch adjusted for effort; combined replicates.
1/ Percent of total release, calculated from observed recovery. No data (-) aeons either adults have yet to return, or were not collected or were not obtained from fishery agencies prior to analysis. Caparisons between groups relapsed at different times may be erroneous. because of differences in ocean distribution, unequal fishing effort or sampling effort,
I/ Jean Levine, ODFY, Sandy Hatchery, 39800 SE Fish Hatchery Rood, Sandy, Oregon 97055.
g/ Steve leek, USFWS, Little White Saloon HFH, Cook, Washington 98605.

Table 33.--Jones Beach catches and adult recoveries for marked fish from studies of nutrition, 1977-1983.

Tags/	Releage Mnforeation Dint	Source	Number (thou)	Date (da/oo/yr)	Juvenile catches at Jones frock (no.)	(2)	Adult recoveries c/ _ar total (no.)	c ulo i rem 2 yr (t)	'3 yr t2)	4 yr (X)
				COHO SALMON						
09/05/13	Herring 81	Sandy Hat.d/	60.6	06 May 77	23	0,076	1060	0.00	1.75;.-	
09/06/06	Herring 4% soy 4%		57.2		24	0.086	1330	0.00	2.33	-
09/06/07	Herring 6% soy 2%		58.8'		26	0.091	.1245	0.00	2.12	
09/06/08	Soy 8%		60.0		25	0.085 ,	1212	0.00	.2.02	
09/06/09	Herring 22 soy 6%		60.2		24	00081	1238	0.00	2.06	-
09/16/44	Soy 6X herring 22	Sandy Hat.	33.2	02, Hay 78	25	0.091	900	0.09	2073	-
09/16/45	Herring 8%		34.0		14	0.051•	848	0.05	2.49	-
'09/16/46	Soy 41 herring 4%		32.5		16	0.063	832	0.07	2.56	-
09/16/47	Soy 22 herring 1%		33.6		26	0.102	865	0.09	2.57-	
09/16/48	Soy 8%		33.7		18	0.072	859	0.07	2.55	
09/16/49	Menhaden oil 6%	Sandy Hat.	34.0	04 Nay 78	21	00000	835	0.05	2.46	
09/16/50	Soy oil 1%		33.3		24	0.096	759	0.06	2028	
09/16/51	Herring oil 6%		3404		19	0.074	748	0.04	2017	
09/1.6/52	Anchovy oil 62		33.0		22	0.085	771	0.03	2034	
07/17/49,	Anchovy oil 6%	Sandy Not. ,	27.5	01 Noy 79	28	0.133	343	0.06	1.25	
07/17/50	Menhaden oil 61		27.4		25	0.114	521	0.07	1.90	
07/17/51	Soy 6X		27.5		32	.0.151 ..	622	0.07	2.26	
07/17/52	Herring 6%		27.9'		28	0.121	343	0.06	1.23	
07/20/31,33	OMP 4	Sandy Nat.	50.4	01 May 80	31	0.139	367	0.01	0.73	
07/20/32,34	OMP 2 Fresh 1 frozen		50.7		33	0.140	531	0.01	1.05	
07/20/35,36	OMP 2 Acid		50.4		32	0.131	446	0.01	0.88	
07/20/37,38	OMP 2 Frozen		52.5		33	0.129	541	0,02	1.03	
07/22/55,57	OMP 2 Frozen	Sandy Hat.	56.5	01 May 81	37	, 0.104	750	0.01	1.33	-
07/22/56,58	OMP 2 Acid		55.3		32	0.071	735	0.02	1.33	-
07/22/59,62	Pre:scake		57.7		59	0.144	1036	0.01	1.80	-
07/22/60,63	OMP 4		57.8		35	0.077	927	0.01	1.60	
07/22/61,23/01	(IMP 2 Frozen 1 fresh		58.7		42	0.091	900	0.01	1.53	
07/25/50,58	OMP 2	Sandy Hat.	'54.2	30 Apt 82	86	0.165	709	0.12	1.31	
07/25/51,54	01M 4 .,		54.9		80	0.151	642	0.13	1.17	
07/25/49,57	PC-6.		52.1		84	0.170	759'	0.20	1046	
07/25/53,55	PC-4		54.3		58	0.110,	726 ,	0014	1.34	
07/25/52,56	Abernathy		54.5 '		79	0.147	743	0,09	1.36	
07/27/31,34.	OMP.2	Sandy Hat.	109.6	29 Apr 83	78	0.071				
07/27/32,35.	Sal. Meal		109.5		67	0.062				
07/27/33,34	Abernathy		.108.8		73	0.068				

Table 34.--Jones Beach catches' and adult recoveries for marked fish from studies of rearing density, 1977-1983. '

Tag (Ag/D11D2) Brand (Loc sig Rot)	Source	Density	Number (1000)	Date (da/n .rr)	Juveniles Jones (No.)	%	Adult recoveries no.	2 yr (%)	3 yr (%)	(%)	(%)
			YEARLING SALMON								
13/09/11,12	Cowlitz Hat.	Higghd/	176.8	08 Mor 77	80	0.132	2008	-	0.35	0.90	1.14
13/09/14,11/04		Ned	123.5		55	0.107	2124	-	0.51	1.35	1,72
13/13/01,04		Low	56,7		24	0.111	896	-	0.74	1.09	1.58
63/17/09,10	Cowlitz Hat.	8.0 lbs/gal/sin	177.4	08 ROT 78	233	0.418	5626	-	1.14	2.70	3.17
63/17/17,18		6.5.lbs/gal/min	140.7		134	0.316	4418		1.32	3.23	3.83
63/17/11,12		6.0 lbs/gallain	115.3		162		4379	-	1.42	3028	3.80
63/16/12,13		3.0 lbs/gal/sin	56.0		61	0.305	2280	-	1.51	3,49	4.07
RA T 1	Kooskia Hat.	0.29 lbs/ft /in,/	14.7	04-12 Apr 83	11	0.075					
RA T 2		0.08 lbs/ft /in	8.2		4	0.050					
63/24/20-24	Cowlitz Hot.	20.0 lbs/gal/sin	51,0	03 Nay 82	95	0.196	436	0.15	0.85	-	
63/24/25-29		19.8 lbs/gal/sin	5209		72	0.142	591	0.315	1.26		
63/24/40-44		12.7 lbs/gal/sin	5342		101	0.19					
63/24/35-39		12.6 lbs/gal/sin	5102		92	0.182	656	0,27	1.09		
63/24/45-49		12.2 10s/ggal/sin	51.1		95	0.192	610	0.29	1.18	-	
63/24/30-34		11.6 1bglga1/sin	52.3		81	0.158	446	0022	0.85	-	
63/26/13-17	Cowlitz Hat.	22.9 lbs/gal/sin	52.4	03 Nay 83	84	0.174	-	-	-		
63/26/18-22		16.0 lbs/gal/sin	51.1		72	0.145	-	-	-		
63/26/38-42		15.0 lbs/gal/sin	51.5		80	0.159	-	-	-		
63/26/23-27		14.3 lbs/001lein	52.1		71	0.152	-	-	-		
63/26/28-32		11.7 1h/gal/sin	51.7		86	0,176					
63/26/33-37		9.2 lbs/gal/sin	5201		80	0.161	•				
05/08/26	Engle Cr. Hot.	0.45 lbs/ft ^{3}/inf/	127.8	22 Apr 81	180	0.185	1702	0.14	1.33	-	
05/08/28		0.30 lbs/ft in	83.7		136	0.219	1106	0.16	1.32		
05/08/27		0.15 lbs/ft/in	43.6		62	0.186	678	0.21	1.56	-	
05/10/39,40	Eagle Cr. Hat.	0.45 lbs/ft ^{3}/in	134.9	06 May 82	229	0.179	766	0.01	0.57	-	
05/10/37,38		0.30 lbs/ft in	85.0		139	0.178	509	0.02	0.60		
05/10/35,36		0.15 lbs/ft /in	39.1		71	0.203	279	0.14	0.71		
05/11/33,34	Eagle Cr. Hat.	0.45 lbs/ft ^{3}/in	123,3	04 hay 83	154	0.135					
05/11/35,36		0.30 lbs/ft ^{3}/in	80.2		110	0.155					
05/11/37,38		0.15 lbs/ft ^{3}/in	4102		68	0.187	-		-	-	
09/06/02,04	Sandy Hat,	High	43.5	27 Apr 77	16	0.076	888	0.08	2.04		
09/05/15,06/03		Ned	47.4		14	0.057	814	0.08	1.71		
09/05/14,06/01		Lowg/	50.7		15	0.063	808	0.06	1.59		
63/25/13-17	Washougal Hat.	13.6 10s/gal/mind/	50.1	25 Hay 82	44	0.101	483	0.01	0.35		
63/25/18-22		12.1 lbs/gal/sin	5008		34	0.084	194	0.00	0.38		
63/25/23-27		9.8 lbs/gal/sin	50.7		32	0.072	254	0.01	0.49		
6³/2⁵/²⁸/33-37		8.6 lbs/gal/sin	50,3		38	0.094	268	0.01	0.52		
		6.6 11s/gal/sin	48.3		40	0.094	143	0.01	0.33		
63/25/38-42		5.4 lbs/gal/sin	40.1		29	0.093	167	0.01	0.32		
63/17/13-1i7	Washougal Hot.	14.3 lbs/gal/sin	52,1	27 Noy 83	38	0.084					
63/7/08-12		12.5 lbs/gal/sin	52.0		32	0.073					
63/27/03-07		10.6 lbs/gal/nin	51.3		32	0.076					
63/26/61-63,27/01,02		8.8 lbs/gal/sin	49.4		30	0.071					
6 6/56-6~0		6.88 lbs/ el/sin	48.5		24	0.064	-				
/51.55		6.0 1h/gal/sin	39.8		29	00085	-				
05/09/34-37,44,45	Willard Hat.	200 gpi/pd	137.2	07 Jun 83	111	0.103					
05/09/28-31,42,43		400 gps/pd11/	135,3		112	0.099					
05/09/32,33,38-41		600 gps/pd	131.7		123	0.089					

at various densities of fish per volume of water -or per, rate of water exchange (Table 34). Estuarine recovery data for coho salmot,from Eagle Creek Hatchery over a 3-year test series 1981-1983 (Holway) showed statistically significant benefits .related to. lower rearing ' density. which were also correlated to. significantly increased survival to adulthood. However, estuarine recovery data of juveniles:. from single ' tests and series of tests from. Six other studies showed no correlation with density, even though adult recovery data showed strong- positive. correlation with' decreased rearing density, statistically significant for three of five studies: 'One of the two. groups which showed negative correlation was highly significant, whereas .the other was. poorly correlated.

Juvenile recoveries. showed differences. among study groups which varied in the same direction as adult recovery data less than 50X. Of the-time which suggests that estuarine. catch data are generally not .sensitive in the prediction of adult survival trends for rearing density studies.

Catch.Ra to Models for Subyearling Chinook Salmon

Marked fish representing all. the stocks of subyearling chinook salmon' cultured An the. Columbia River. basin from 1978 to 1982 (Environmental and Technical Services Div. 1983) allowed a detailed assessment of:.variables. affecting estuarine catch percentages and development of a. 'catch rate model. Future catch data: may be compared to model. predictions for examining the relative success of survival during migration. Correlations with several. variables were examined for upriver release groups (upstream from John Day. Dam; > RKm 347), downriver release group* '(downstream from John. Day Dam), combined groups, and individual stocks. Variab]es examined were fish size (no./lb), movement rate (km/day), river flow (m /second), date. of recovery. (Julian .date), and distance of migration [release sit. (RKm) capture site (RKm)). Catch percentages-were standardized to 7',000 t'/second river flow for all data,. 1977-1983 (Table 34). The equations are. given in the original data units but the statistics were calculated using.. normalized units. Catch percentages of upriver released fish showed a significant . linear. relationship with distance of.'migration, fish .size, and river flow. This relationship is: Y . 0.1645 $0.0001760X_1$ $0.0009868X_2$ + 0.01569X (in.normalized. units the equation.is: Y`- -o..$2103X_1$ -0.3428X2 +.0.5350X3,1g ~, 0.53 , F 12.76 at 2, 19 df with $P < 0.001$). Where $Y$ is catch percentage, $X_1$ is distance of` migration, X_2 is fishsize, and X_3 is 'river flow.

In some cases, catch.. percentages for individual 'stocks. showed a significant relationship to particular variables. Data from groups 'reared at Bonneville and Little. White Salmon 'Hatcheries (primarily downstream releases), Priest Rapids Spawning Channel,.and Hagerman Hatchery (primarily. upstream releases) provided the' following relationships:

9/ J. Holway, USFWS, Eagle Creek NFH, Rt. 1, Box 610, Estacada, OR 9.7205; pers.commun.

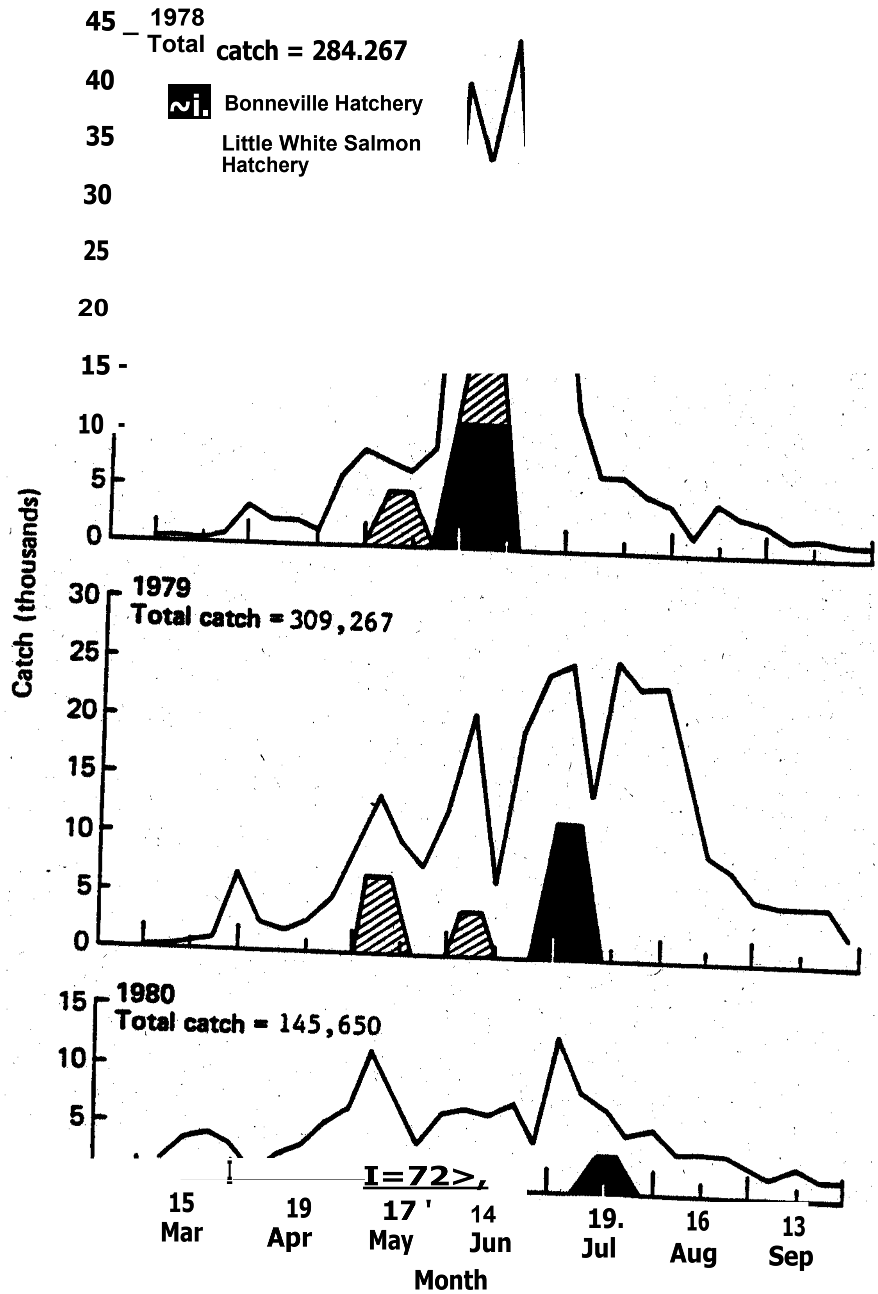


Figure 40.-Weekly beach seine catches of subyearling chinook salmon at Jones Beach, 1978.1980,: with shaded area representing fish captured. from Bonneville and Little White Salmon Hatcheries.

Table 34.--continued.

a/ More complete information available from Dawley et a1. 1985b or releasing agency Table 21. Binary coded wire tags: Ag=Agency, D1=Data 1 code, and D2=Data 2 code. Color coded wire tags begin with WH and each two digits thereafter represent a color. Brands are represented by the following: Loc=Location on fish, Sym=Brand symbol, and Rot=Rotation of symbol. For abbreviations, symbol, and descriptions see Dawley et al. 1985b.

b Actual number captured, beach and purse, seine; percent adjusted for effort; replicates combined.

Cumulative percent of total release calculated from observed recovery. No data (-) means either adults have yet to return, were not collected, or were not obtained from fishery agencies prior to analysis. Comparisons between groups released at different times may be erroneous because of differences in ocean distribution, unequal fishing effort, or sampling effort.

d/ Robert Foster, WDF, 115 General Administration Building, Olympia, WA 98504. Production densities about 20 and 14-18 lb/gal/min for Cowlitz and Washougal Hatcheries, respectively.

Ted Bjornn, University of Idaho, Idaho Co-op Fisheries Research, Moscow, ID 83843. Production density about 0.3 lbs/ft3/in.

Jamieson Holway, USFWS, Eagle Creek Hatchery Route 1, Box 610, Estacada, OR 97203. Production density about 0.45 $lbs/ft^3/in$.

Jean Legasse, ODFW, Sandy Hatchery, 39800 S.E. Fish Hatchery Road, Sandy, OR 97055.

Joe Banks, USFWS, Abernathy SCDC, 1440 Abernathy Road, Longview, WA 98632. Production density about 400 gal/min per pond

Table 35.--Summary of catches, migrational timing, and fork lengths of marked wild juvenile chinook salmon populations captured at Jongs Beach, 1977-1983.

River of origin	Age at capture	Marked arouos: Total groups marked	Number of groups captured	Total fish marked	Recoveries adjusted q/ (no.)	(2)	Dote range of 'median fish recoveries	Date range from 102 to 902 fish recovery	Mean fork length rouge by group lee)	Overall mean form length (mm)
John Day	subyeorling		0		-	-	-			-
	yearling	35 Q/	5 c/	90,305	13	0.0144	4 hay-17 Jun	30 Apr-17 Jun	115-129	118
Deschutes	subyeorling	16	10	121,656	84	0.0690	1 Jun-12 Jul.	1 Jun-17 Aug	97-115	106
	yearling	10	5	4,715	8	0.1186	4 May-16 May	4'May-16-heir	130-150	142
N.Fk. Lewis	subyearling	23	23	625,803	2,209	0.3530	22 Jul-23 Aug	25 May-18 Oct	76-97	91
	yearling	-	4 d/	-	10	-	17 Mor-25 Apr	17 Mor-30 hay	110-128	117
liars Springs	subyearling	-	0	-	-		-	-		
	yearling	12 b/		17,667 b/	4	0.0226	2 her-4 Jun	2 hay-5 Jun	107-145	122

g/ Adjusted for standard effort (10 sets beach seine, 5 sets purse seine 1 7 days/week). Number of fish recovered (adjusted for effort) 2 total number of fish released (including those of groups which were **not** recovered).

k! Includes fish groups marked as either yearlings or subyeerlings.

„c,/ Three groups coded-wire togged as subyeorlings were captured os yearlings the following season of Jones Reach.

.d/ Fish captured were from groups corked as subyeerlings. host fish from those groups were captured the previous year as subyearling.

Survival ofSubyearling Chinook Salmon to the Estuary

Measurement of survival from release site to the estuary was attemped for fall chinook salmon cultured at the largest hatcheries in the river system to examine variations in relation to river conditions and specifics of culture. Hatcheries more than 150 km from Jones Beach were used to provide a migration distance long enough for survival differences to become apparent. From 1978 to 1983, fish groups were branded at all hatcheries possible'and transported by truck to release sites about' 40 km upstream from Jones Beach.. Catches of the branded fish were compared to those of tagged fish which migrated from the respective hatchery to Jones Beach. The branded group was assumed' to have 100% survival due to the short distance of migration, and the difference of catch percentage between the tag and brand groups was assumed to represent survival difference.

Variation of survival estimates was high and seemed unrelated to. known variables. Adult recovery data were not correlated with survival estimates and as a result those estimates provide no data which at present appear relevant for analysis.

Decreased Catches Related'to the Eruption of Mount St.. Helens

Jones Beach catch data indicated a substantial. loss of subyearling .chinook salmon during the.period . immediately following the eruption. when the river was highly turbid (34 to 2,800 Jackson Turbidity Units) 'and an increase in. water :temperature occurred. In 1980, purse and. beach. seine catches (145,650 fish) were 51% .lower. than the average catch for the previous 2 years--284,267 in 1978 and 309,267 in 1979. In both 1978 and 1979, subyearling fall chinook salmon released from. Bonneville and Little White Salmon Hatcheries. provided .substantial peaks at Jones`Beach: during late May and June; catches were depressed even though -18.6. million fish were released from the two hatcheries (Fig. 40). .The recovery rates of. marked .fish from releases in. 1980 (0.083 and 0.072% for Bonneville .and Little. White Salmon fish, respectively) were less than. half. of the. 1978 and. 1979 . averages (0.169. and 0.280%, respectively). Adult , recovery rates for the marked groups' from Bonneville Hatchery were confounded by a mix of fish rearing conditions (Tanner Creek vs well water) which has in the, past caused different rates of survival to adulthood. ..Adult recoveries from groups of. Little White Salmon Hatchery were exceptionally low. for all- .years andno difference was detectable for groups which migrated in. 1980.

While dead. or moribund fish were not seen during sampling, observations' indicated-that 15 juvenile salmonids captured on 28'May 1980 had irritation of gill filaments, characterized by heavy mucus. secretions laden with particulate matter. The particulate matter and mucus observed may have been indicative of mortality in other individuals which would have contributed to..,decreased catch. ..Fourteen fish were examined- on. 2 June. and their gill filaments appeared normal..Other researchers performing bioassays found..that suspended ash from Mount St. Helens affected "salmonid gills and caused mortality (Stober et al. 1980; and Newcomb and, Flagg.1983).

2. Movement rates of subyearling chinook salmon increase with increases of river flow, fish size, distance of migration, And Na^{+}-K^{+} ATPase. Correlation to these variables was high for lower-river stocks, but low for upriver stocks. Increased river flow also increased movement rates of yearling fish, but other variables were not assessed because Individual stocks were not consistently marked each year.

3. Cessation of movement in the estuary did not. occur; 'yearling fish showed no slowing of movement' during passage through the estuary and into the ocean. plume,. but subyearling chinook'salmondid show a 30% decrease compared to rates from release. site to Jones' Beach. The Columbia River estuary is not used-as a rearing area by subyearling chinook salmon 'released upstream from Jones Beach.

4. Variability among estuarine catches of replicate marked groups is consistent with normal sampling statistics. Consequently, catch rate differences among replicates were used to evaluate differences between treatment and control groups to provide the greatest statistical precision. Variability of adult recovery data., from replicate groups appears higher than expected, which suggests that subtle differences in culture impact adult return rates but are not observable from estuarine catch data.

5. Diel movement behavior showed a generally consistent pattern for each species, thus comparable percentages of fish passing for the 24-h period were sampled during the 7-h morning period.

6. River flow alte sampling efficiency; catch rates decreased an average of 8.5% per 1,000 m^3/second of increased flow.

7. Sampling .date, fish size, and distance of migration sometimes affected the distribution of catch between the beach and purse seines; such catch-rate comparisons should only be made between dissimilar groups if the distributions of catch are nearly equivalent.

8. Estuarine sampling showed trends of significantly increased survival for migrants transported past dams, late releases of coho salmon (June and early July), and larger size at release for yearling chinook salmon. Smaller fish from some migrant populations disappeared prior to entering the estuary. Minimum-size thresholds for migration and survival of Columbia River coho salmon and wild fall chinook salmon and Willamette steelhead were supported with Jones Beach sampling data.

9. Particular groups from studies of fish stocks, rearing densities, and diets showed some survival differences, in estuarine catches, but generally differences among groups were not significant. Highly significant differences in adult recoveries observed in studies of density and nutrition were not predictable from juvenile catch data.

10. Catch rate models developed from the catch data for subyearling chinook salmon provided a reasonably good predictor for certain hatcheries, but a general model for lower-river fall chinook salmon was not possible due to differences between hatchery groups. Models were not developed for yearling fish because groups at individual hatcheries were not marked consistently through the years.

Characteristics of Wild Stocks

Detection of the various stocks of wild .fish was impossible. because they could not be identified unless. marked. Some wild fish, however, were tagged as part of various research projects; fish from the Lewis (Norman-1984),.. Deschutes (Lindsay et al. 1982), Warm Springs (Lindsay et al. 1982), and John. Day Rivers ,(Knox et al. 1984). were seined, marked, and returned to their natal stream for rearing. Recoveries. at-Jones Beach (Table 35). provided for some .assessment of timing, catch rates, and physical condition.

Timing, Size, and Catch Rates.—Migrational timing, size, and catch percentage data or marked wild migrants were comparable to data obtained from hatchery reared fish. Wild yearling migrants (35 total fish) had similar timing to hatchery stocks; March and April for Lewis River fish from the west side of the Cascade Mountains and May and June for John Day, Deschutes, and Warm Spring Rivers on the east side of the Cascades. Mean fork lengths ranged from 117 to 142 mm; catch rate averages for fish from each tributary ranged from 0.014 to 0.119%., Timing of wild subyearlings from the Lewis River'(2,209 total fish; date range of median fish recovery ms 22 .duly-23 August) was later than for migrants from the Deschutes River 184 fish; date range of median fish recovery - 1 June-12 July). Overall catch rates (0.069 to 0.353%) and mean fork lengths (91 mm to 106 mm) of wild subyearlings were similar to hatchery fish.

Timing observations of size-graded wild fish from the Lewis River in 1983 indicated that date of.passage at Jones. Beach was related to individual size. 'From :6 to 11 June, Personnel of WDF seined, graded into two size groups (45-54 am and > 54 mm), tagged, and returned to the Lewis' River 96,444 wild fall Chinook salmon (Norman 1984). Average fork: lengths of the two mark groups. at tagging were "49.3 and 58.4 mm. Recoveries of these fish at Jones Beach indicated a distinct timing difference (Table 36), the dates of median fish recovery were 20 July for. the. large fish and 9.August for the smaller fish. Mean fork lengths'at'recovery were nearly identical (84.4 and 84.3 mm, 'respectively). Reimers and Loeffel (1967) suggested that in the Columbia River tributaries, juvenile salmonids must reach a minimum . size before migrating--size varying in;,different streams. Our observationof the Lewis River fish. seems consistent with this' hypothesis.._

Movement Rates.--Movement rates for wild fish were generally not representative of hatchery fish movement rates past Jones Beach because dates for beginning of migration were unknown; comparisons were not made.

Conclusions

1. Migration timing of juvenile salmonids entering the estuary was affected by dates of release from hatcheries and other factors which altered movement rates. In some instances, fall-released fish groups overwintered upstream from Jones Beach and migrated in the spring; size of fish and stock differences appear to influence the migration timing.

SECTION IV ANCILLARY STUDIES'

Food Consumption of Juvenile. Salmonids Captured at Jones. Beach

Introduction

Quantity and/or quality of food consumed-during-the migration of juvenile salmonids is critical to their survival. Snyder (0980) found that inadequate nutrition reduced swimming stamina- in. juvenile..coho salmon which could inhibit their, ability to capture prey and avoid predators, thus. affecting their survival.

Interspecific interaction-between coho salmon .and ateelhead in small streams has resulted in agonistic behavior, influencing food consumption and growth (Stein et al. 1972); it may also influence stomach fullness values in Columbia River salmon smol ts, especially during years .with a high degree of migrational overlap of species (Table 37)4

Reduced `feeding rate may - be an indicator of poor health or s tress,-. which decreases. survival to adulthood even when food. is not limited. Nicholas et al. (1979) speculated that release trauma and unfamiliarity with the estuarine environment in the Sivalaw River (Oregon) resulted in atemporary inability of coho salmon to utilize Available food (50-90% empty stomachs).

Reimers (1973) hypothesized that. population density, was a major. cause.of. reduced growth rate for juvenile 'chinook salmon during a 3-month period of high population abundance in the Sixes River estuary '(Oregon) during 1969. Bottom (1981)' theorized a decline in carrying, capacity of the Sixes River estuary for young .salmon. in' mid-summer 1980 because of 'Increased ...foraging .. pressure when population density was maximum.

To .evaluate nutrition, interspecific interaction, and smolt quality, personnel of the the National Marine Fisheries . Service examined- the. feeding habits of juvenile. salmonids in, the upper freshwater reach of the Columbia River estuary. at Jones Beach (RKa 75) from 1979 to 1983.

Specific objectives were as ,follows: (1) document'.feeding rates (using stomach fullness. as an index) and diet composition for juvenile chinook and coho salmon and. steelhead,.(2) identify those. stocks with'. a large percentage of non-feeding individuals' indicated by low stomach.fullness values, (3) examine effects of interspecific interaction 'on feeding, (4) establish a relationship between visual - quantifications of fullness and. stomach content weights, and. (5) compare stomach content weights for juvenile fish at Jones Beach to those in other locations.

Differences of stomach fullness between fish. from .various stocks captured at the same. time (i.e., fish experiencing .similar food availability and digestion rate) are directly related to differences in feeding rate. The amount of food in a fish's stomach at any point in. time is related to food consumption and digestion rates. (Elliott and Perseon 1978; 'Dill .1983). Digestion rate is controlled primarily .by temperature (Elliott 1972) and by the composition of the food organisms (Elliott and Perason 1978)4

Table 36.-Recoveries of wild subyearling chinook salmon at Jones Beach from groups which were seined, size graded, marked, and returned to the Lewis River by Washington Department of Fisheries personnel, 6-11 June 1983.

Re1ssa21nfgrmr~11gn_			_ke gverY~ir~fgrm t g0					
Size group/ (tag code)	No. (thous)	Meah fork length (mm)	(No.)	Adjusted (X) n/	_,_Beg4v3rxiia e. (10%)	(50%)	(90%)	Mean fork length (mm)
k 54mm (63/27/37)	48.3	49.3	132	0.565	15J41	9Aug	30Aug	84.6
: 54mm, (63/27/38)	48.1	58.4	113	0.362	9Jul	20Jul	16Aug,	84.3

a/ Adjusted for sampling effort.

Methods

Salmonids'sacrificed for CWT identification were used in feeding behavior evaluations. Mark release information was used to. separate species and year classes of sampled fish. Subyearling chinook salmon are predominantly fall and'.summer races,. whereas. yearling chinook salmon are predominantly a spring race (Van Hyning 1973).

Stomach Fullness.--The subsamplesof CWT fish were killed by immersion .in a lethal concentration of ethyl p-aminobenoa te. Regurgitation during the killing. process was not apparent. Stomachs were excised (esophagus-to pyloric caeca) and cleaned of external fat (Appendix Tables B2-5). In 1979, stomach were classified as.full, partial, and empty. A fullness value was assigned to. represent the proportion of. the. total stomach length containing food .(externally visible). A 1-7 scale was .used to quantify the fullness observations as described by Terry (1977): 1-empty,, 2-trace of 'food,. 3=one quarter .full, 4-half full, 5athree quarters-full, 6=full, and'70distended full. Stomachs. appearing empty were. opened for examination,. and the Value 2 assigned when. traces of food were observed. For analysis, stomachs judged empty or trace (1 or 2) were termed non-feeding. Observations of stomach fullness were made from 3,500 .to 6,000 juveniles annually, and subsamples of stomachs ..containing food were individually preserved in 10%: buffered formaldehyde solution for weight measurements. and content analyses (Appendix Table B6).

Rcc9rds included: recovery date and location, net. set 'time, fish. weight._" and fork length (* 0.5mm), fullness value, holding' time (duration between capture and fullness observation), and tag identification information (Appendix Table B7). 11I}oldingi time prior to fullness observation was approximately 90 minutes...

Intraspecif ic. comparisons. of the proportions Hof non-feeding individuals'. Within mark groups were'. made using the G-statistic--a log likelihood -modification of Chi Square {Soleal and. Rohif.1981). Comparisons of stomach fullness means for fish ,groups with.. few non-feeding fish were made using analysis of variance. Generally,. comparisons were not made for groups with more than 7 days between' ..dates of median fish captur[illegible] Similar or replicate tag groups, .showing no significant differences (P<0.05) of mean fullness,. were combined ..for comparison to.,other groups.: When significant differences were found among three or more groups, .the Student's t-test was used to isolate differences and the significance level of t was adjusted to

4

10/ Weights of fish were obtained only for individuals collected in 1981, 182 (t 0.5 g), and 1983 (t 0.005 g).
11/ Holding times were kept as low as possible by selecting only fish that were processed soon after capture. Times were recorded for individuals examined in 1981 (after April), 1982, and 1983.
12/ Median data for stomachs observed may not correspond to the recapture mate of the median fish for the entire tag group due to non-representative subsampling required to minimize holding times of the fish selected for stomach observations.

11. Survival of subyearling Chinook salmon from release'' site to Jones Beach was evaluated for particular hatchery groups-released in ..1977-1983, but the ; precision of estimates was poor in relation to adult. recoveries.. Apparently, migration behavior. of fish transported and then released close to the. sampling site (controls) was inconsistent in relation to those that migrated downstream (test),' which caused substantial. catch-rate differences.

12. Losses of subyearling -Chinook salmon appeared to- be substantial during-the date range in 1980 when highly turbid water from Mount St. Helens was passing through the estuary.

13. Wild Chinook salmon are divers'e:intheir migration timing, site, and age structure-much the same. as . hatchery reared' fish.

Table 37. Dates of migrational peaks for juvenile salmonids at Jones Beach indicating migrational overlap, 1977-1983.

	Week of peak migration a/			
	Chinook salmon		Coho	Steelhead c/
Year	subyearling b/	yearling c/	salmon c/	
1977	21-27 May	--	--	--
1978	11-17 June	7-13 Moy	14-20 May	14-20 Moy
1979	2-8 July	14-20 May	28 May-3 June	14-20 May
1980	11-17 June	7-13 May	14-20 May	7-13 May
1981	6-10 June	7-13 May	14-20 May	7-13 May
1982	11-17 June	21-27 May	21-27 May	21-27 Moy
1983	4-10 June	14-20 May	21-27 May	21-27 Mny

a/ From the date of median fish recovery; not adjusted for river flow.
b/ Timing based on beach seine catches.
c/ Timing based on purse seine catches.

$$C_A = \frac{\sum_{i=1}^{s} X_i \cdot Y_i}{\sum_{i=1}^{s} X_i^2 + \sum_{i=1}^{s} Y_i^2}$$

Where: CA overlap coefficient

i individual food category'

s = total number of food category

X and Y = proportion. of the'total diet, for fish species X or Y, contributed by food category i.

Only food categories making up more than 1% of the total weight consumed were used for overlap calculations (Myers 1979). Values of C' range from 0 to with 0 indicating no overlap and 1 indicating complete diet overlap.

Proximate Analysis.--For each fish species, proximate analyses of stomach contents (percentage of protein, ash, and fat) were obtained from pooled subsamples collected in May and June 1982. Analyses were contracted to a private laboratory.

Stomach Content Weight.--In 1982,. stomach contents from about half of all marked, fish were removed, blotted dry, and weighed to the nearest 50 micrograms; 2,480 total. All weights were obtained within, 4 months of capture.

P<0.05/K; where K = number of means in the original F-test[3] (Kleinbaum and Kupper.1978).

Frequency curves of fullness value were developed for all discrete marks with seven or more recoveries. Ninety-five percent confidence intervals of mean stomach fullness values were plotted for each species by 3-day intervals (all tag groups combined); however, the data are not necessarily representative of the total migrant population during the time period depicted.

Diet Composition and Overlap.--Organisms were identified to the lowest practical taxon•, insects were further separated by 'metamorphic stage.., When dismembered prey were present, parts were weighed together, and counts were based upon the number of head capsules .present. Weightof unidentifiable material was not included in the total weight used, for ranking.'rela tive importance in the diet. Frequencies of occurrence (FO), numbers, and weights were recorded for each prey taxon (Appendix Table B8). Non-feeding fish were omitted from analysis." .The index of relative importance, IRI (Pinkas -et al. 1971) was modified to rank each taxon (IRI'):

IRI' - %W X %PO

'where,XW. -.percent of the total content weight frosi all stomachs

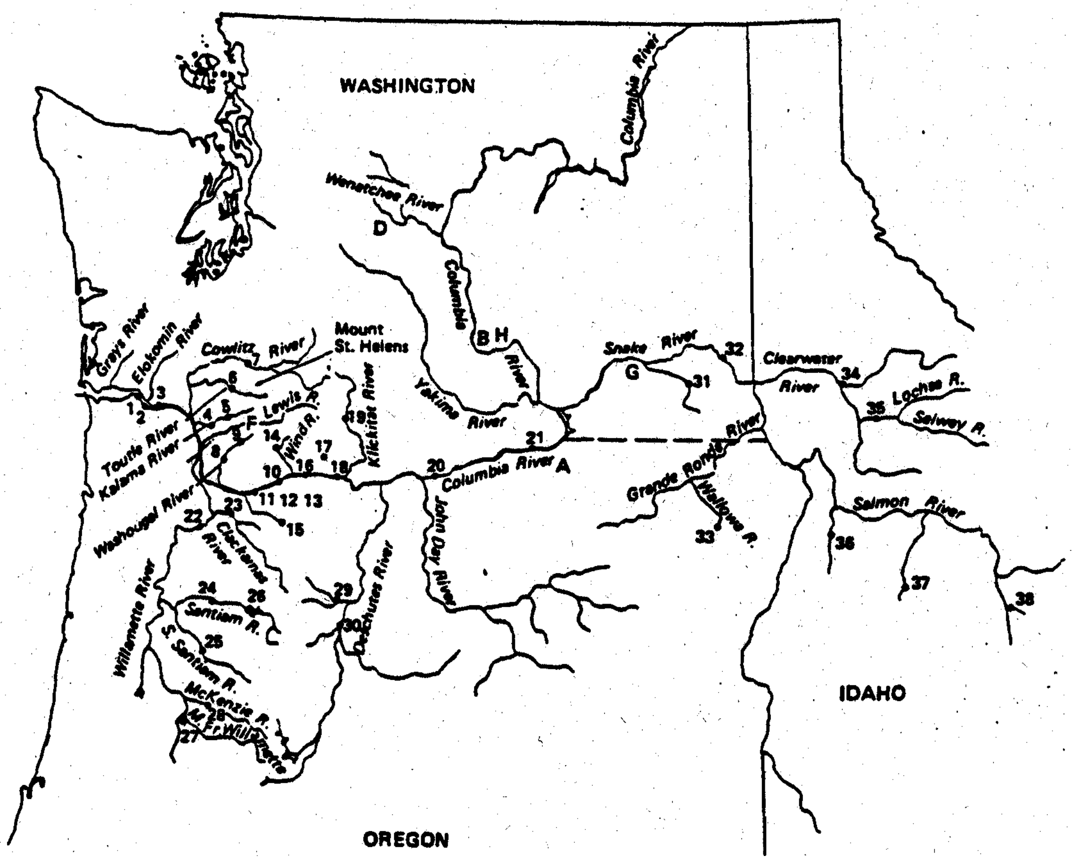
XFO - percent frequency of occurrence of all. salmonids which

contain the. designated taxon.

The modified IRI' was used to decrease bias: resulting from large numbers of small food items (MacDonald , and .Green 1983). Percent . IRI' from the total IRI' is presented.

The degree...of interspecific dietary overlap was assessed using biomass of food categories consumed using the formula developed by,Morisita 0959) and-modified by Horn (1966):

~ [3]The adjustment of the significance level is required to stabilize the standard error without increasing , the'probability-of a'Type I error for .aposteriori comparisons among individual means,



lode ,	Site	R)4
	LOVER COMM R. S TANS.	
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3.	AMrathr SCSC ii	11
4•	Lew^y Was Net. !i	127
5.	Kelaf fells Net.)/	141
4.	Tootle Neto j/	140
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8.	SkossM Net t V	213
1.	Neslegsl)Mt.)!	221
10.	losoeville In	230
11.	1esessille (Nt. !/	'231
12.	Ox1ie Net. !/	231
13.	tamed* Net. !/	232
14.	base V	233
15.	$s* Nst. ' V	235
U.	Lit.Mtt.Sel.Nst. i	211
.17.	M111or1 list. F	261
N.	Sprig Crest Nota V	2N
19.	K1i*iMt Net. V	35$
2D.	led Creel	34$
21.	Porten Slegh	440

Jo-ex	Site	No.
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25.	Footer (for S. belies Net.) V	414
24.	Mate (for Nub . Forts Net.) !/	432
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	$1505155 R. 1 TRIPS.	
21.	Men Metas Nit, t/	415
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	SALPON R. I TR118.	
34.	Amid Riser Not. !/	117
37.	S. Felt Selsun R. (for NtCeil Net.) _/	1133
31.	Psleteerei R. (for thole,., SOriigs Nit.)5/;	1311

e/ Witold Skin Fish a1 Villilfe Service.
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Figure 41.-Columbia River basin showing the major tributaries, fish release sites, hatcheries, Jones Beach sampling site, and. Mount St. Helens.

Non-Feeding Juveniles 1979-1981 and Some Effects from the Eruption of'Mount' St. Helens

This portion of the report focuses on the definition of the range of stomach fullness in samples taken throughout.. the spring migration and identification of biological and environmental factors which appear related to high incidences of ,non-feeding. Fish groups used in the. analysis were released in diverse:areas " .of' the Columbia River basin (Fig. 41).

In March-June 1979, 198(4' and 1981, water temperatures at Jones Beach. ranged. from.8° to 16°C,' and later in the summer increased to 21°C.. In July-September, high watertemperatures' and long.holding times possibly compromised the validity of stomach. fullness observations (Elliott 1972).' Presentation of fullness observations for groups captured. after. June. of each year is limited to, coho salmon captured in early July, 'which were processed more rapidly (about 60 minutes)...

The majority of juvenile salmonids were' feeding. when they entered the estuary (Fig. 42). In both 1980 and 1981, steelhead had the lowest average fullness values (2.8 and 3.1) and coho salmon the highest (4.1 and,3.9)..

The eruption of. Mount St..Helens produceda deluge of debris that arrived in the river at Jones Beach after. daily sampling was complete on 19 May 1980. Turbidity in the river rose to 3,000 Jackson Turbidity Units (JTU). which was 500times normal turbidity..W In attempting to determine the effect of this severe turbidity' on.feeding, behavior of

salmonids entering the estuary, species, stock' release location,'. and timing of releases had to be carefully considered because data from various release groups indicated all of these factors could have a bearing on indices of stomach fullness.

Subyearling ChinookSalmon.--Trends of changing stomach fullness during the migrations were not observed, however, the percentage of empty stomachs in subyearling salmon during late May and into June 1980 increased with the onset of the turbid water. A sudden increase in percentage of non-feeding fish was not observed in late May 1979 or 1981 (Fig. 43).

Observations from subyearling chinook salmon released at-Abernathy Salmon Culture Development Center (SCDC) were omitted from computations of non-feeding fish shown in 'Figure 43 because Abernathy 'fish showed a non-feeding characteristic, unrelated to the eruption. In 1980 and 1981, Abernathy fish had significantly higher proportions ; of non-feeding individuals (51 and 44%) than other fish groups captured during' similar periods-=0 and 9%, respectively, for Spring Creek Hatchery and Stayton pond fish in 1980 and 10 and 5%, respectively, for Spring Creek and Bonneville Hatchery fish in 1981 (Figs. 44.and 45). We believe the high percentage of'. non-feeding individuals among fish from Abernathy SCDC was associated with

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14/ Measurements adjacent to or 3 km downstream from the mouth of the Cowlitz River (RKm 106); collected by Robert McConnell, AMFS, P.O. Box 155, Hammond, OR 97121.

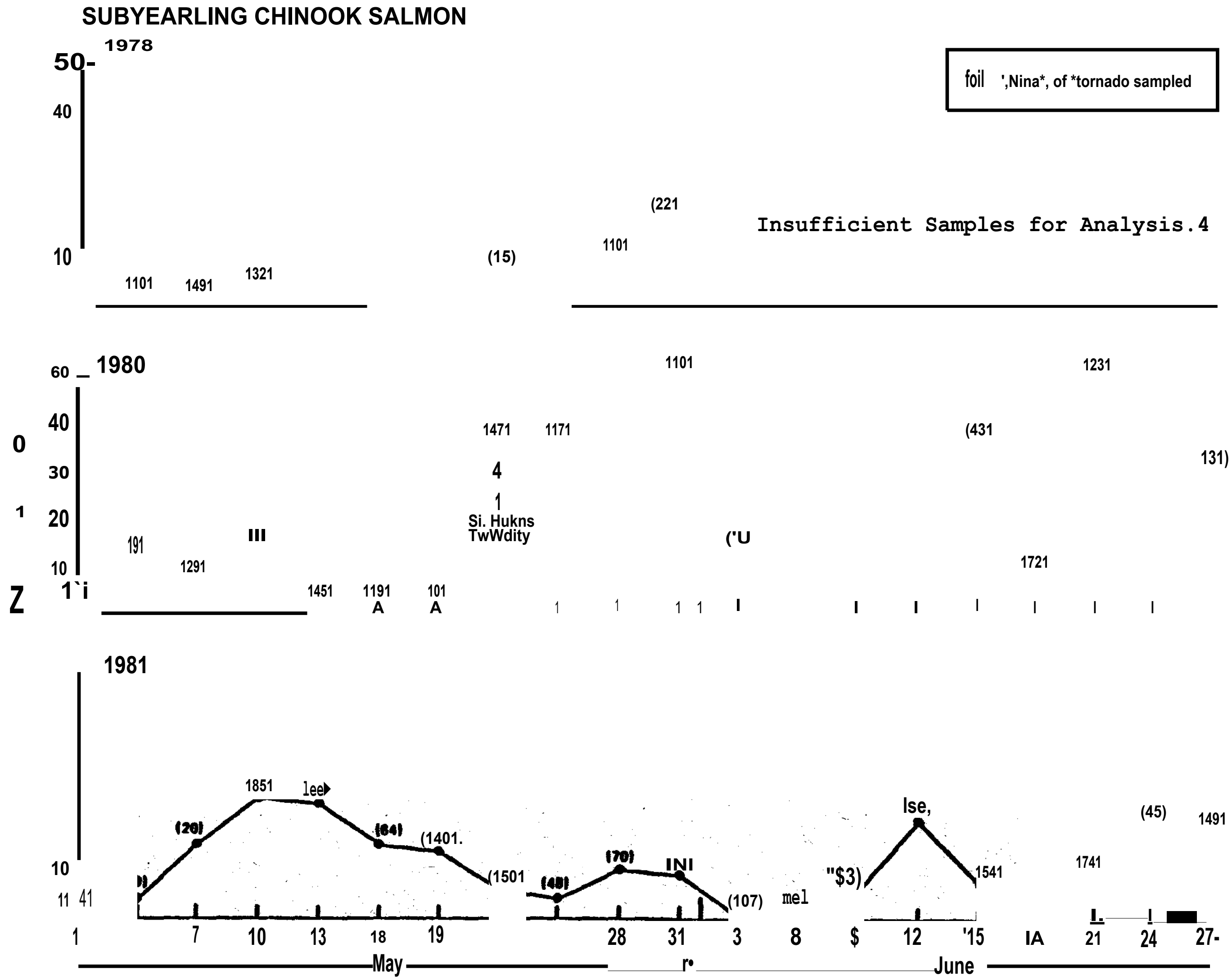

Figure 43.--Percentage of non-feeding subyearling chinook salmon captured at Jones Beach during May and June 1979, 1980, and 1981. Abernathy SCDC fish omitted.

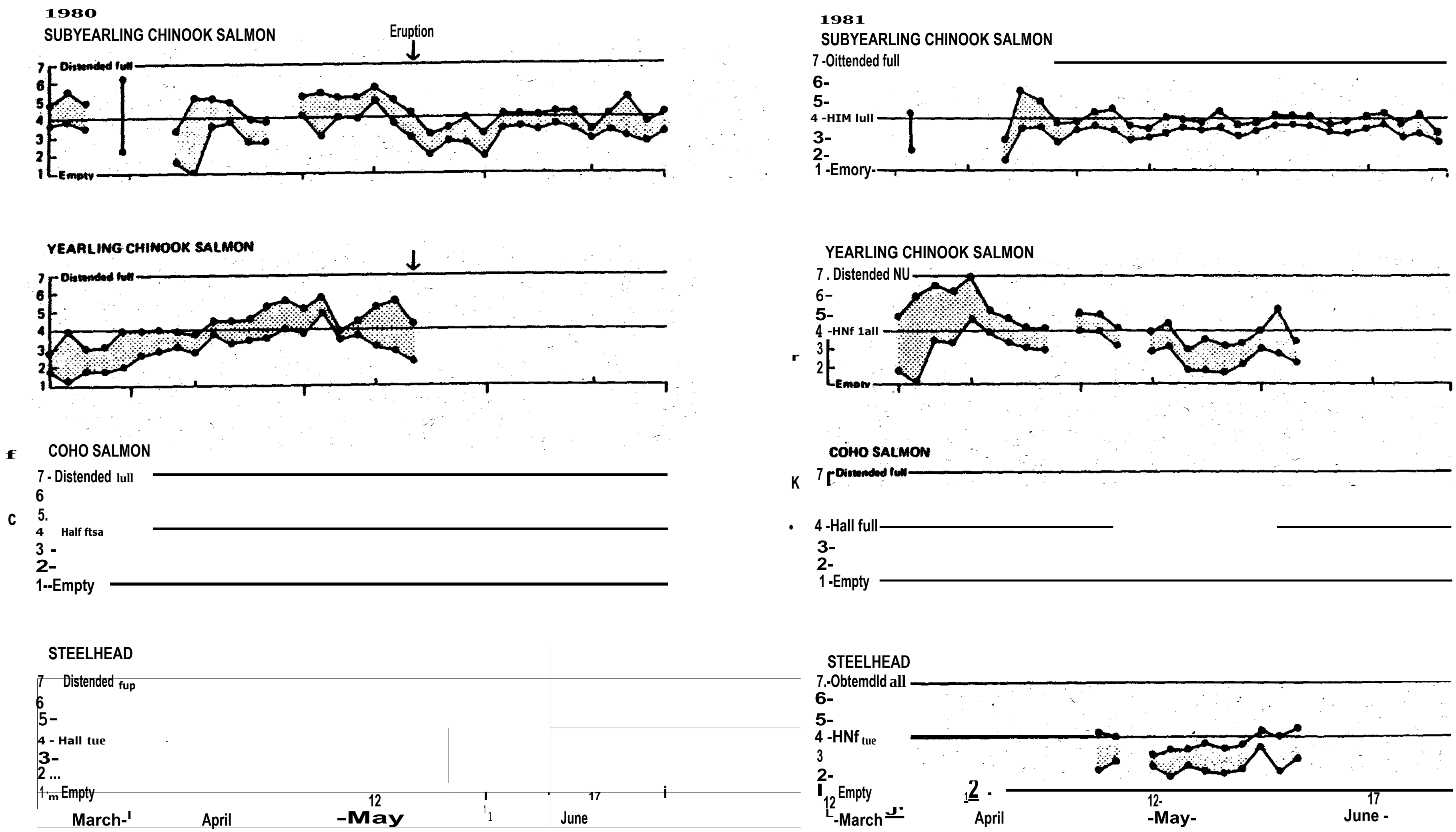

Figure 42.--Ninety-five percent confidence intervals of mean stomach fullness for salmonids captured at Jones Beach, plotted by 3-day intervals, March-June 1980 and 1981

the close .proximity of the release site (RKm.91). to .the recovery. site *(RKm 75).*

Individual stocks of subyearlingchinook salmon had high -percentages of non-feeding individuals following the eruption. .Prior to. the increase. in turbidity from the eruption, 3% of the Stayton Pond fish captured were not feeding (n - 34),, compared to 21% after the eruption (n = 19)--median recovery date at Jones Beach.-was 19 May, 11% non=feeding (n - 54) (Fig. 44). No other. group allowed direct before and after comparisons,. but some groups. passing Jones Beach following the eruption showed high proportions of non-feeding individuals. Spring Creek Hatcheryfish-.released downstream from Bonneville Dam had 30% non-feeding individuals and Bonneville Hatchery fish (production and diet study) had 21 and 24% non-feeding individuals, respectively; similar groups in 1981 had 10% non-feeding individuals (Figs. 44 and 45).

By early June 1980, food. consumption by subyearling. chinook salmon increased toward- average fullness levels observed in the pre=eruption *period.* and in. the following year (Fig. 42), even though water turbidity .during June and July (35 to 130..JTU) remained substantially higher than normal. Fish captured during June and.early July 1980' were primarily fish from Klickitat, Oxbow, Lower Kalama, and Little White Salmon Hatcheries. The non-feeding percentages for thesegroups. were: 10,.11, 23, and 26%, respectively, compared to 9%, no marked group to compare, 24, and .8X, respectively, in 1981 (Figs. 44 and 45).. Only fish from Little White Salmon Hatchery had significantly more non-feeding individuals in 1980 than in 1981.

The high percentage of empty stomachs in early May 1981 (Fig. 43) primarily resulted from an unexplained high percentage of non-feeding fish (27%) from Spring Creek Hatchery *(0%* for a similar release group observed in 1980).

Yearling Chinook .Salmon.--Percentages of. non-feeding individuals in marked groups of .yearling chinook salmon varied between years,. unrelated to proximity:of the release site or effects from.-the eruption. In 1980, migrants which passed Jones Beach from March through mid-April had lower, .stomach fullness values than later migrants.

From mid-March to mid-April. 1980, tagged yearling Chinook salmon had significantly higher numbers of non-feeding fish than in 1981 (Fig. 42). In 1980, these fish originated from South Santiam (two groups),. Bonneville, Oakridge, and . McKenzie Hatcheries.. The percentages of non-feeding fish in -eachgroupwere. 45, •33., 37, 24,. and 40%,. respectively.. In 1981, although sample' numbers were less,. only the. Cowlitz Hatchery group had comparable numbers of non-feeding fish. (31%);' McKenzie, and Oakridge Hatchery groups had only 6 and 14% non-feedingfish,respectively (Fig. 46)~

From late April to early May 1980, the aggregate fullness values of yearling Chinook salmon increased .(Fig.. 42) and percentages of non-feeding fish for most groups decreased (Fig.. 46). Yearling chinook salmon 'from Round Butte, Carson, and Warm Springs Hatcheries had 12, 11, and.18%

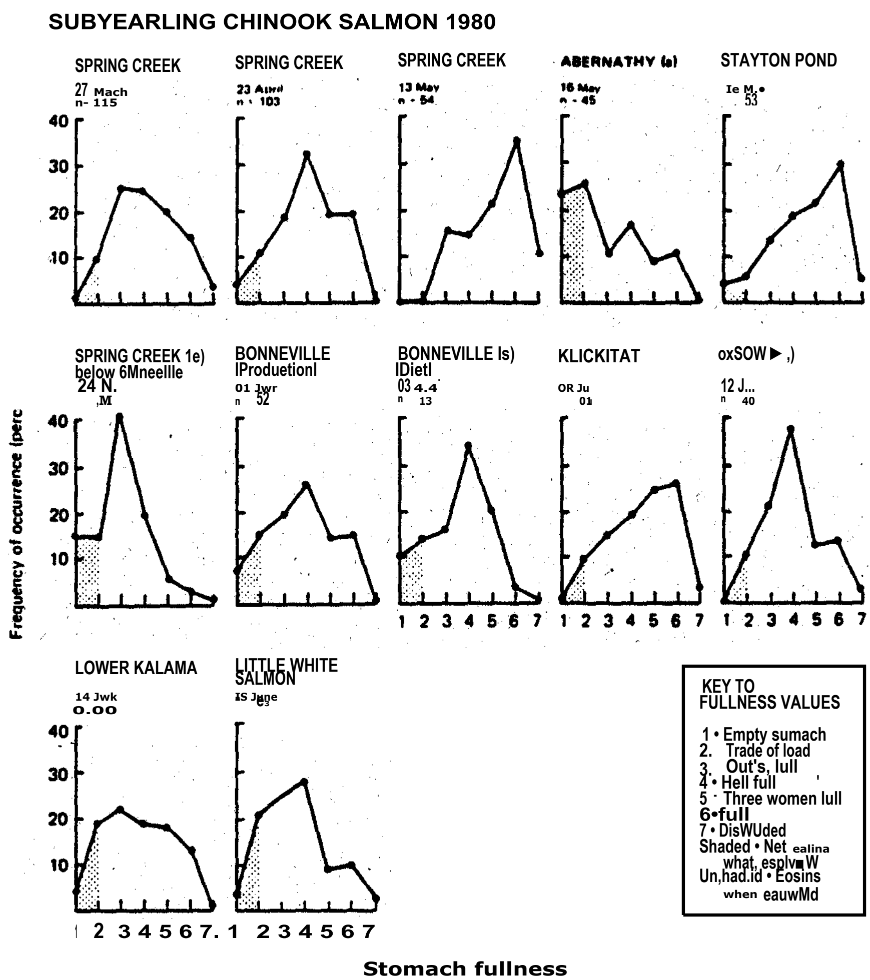

Figure 44:--Stomach fullness frequency curves' for tag groups of subyearling chinook salmon captured at Jones Beach, March-June 1980. Source and release site, date of median fish recovery, and number observed are included.

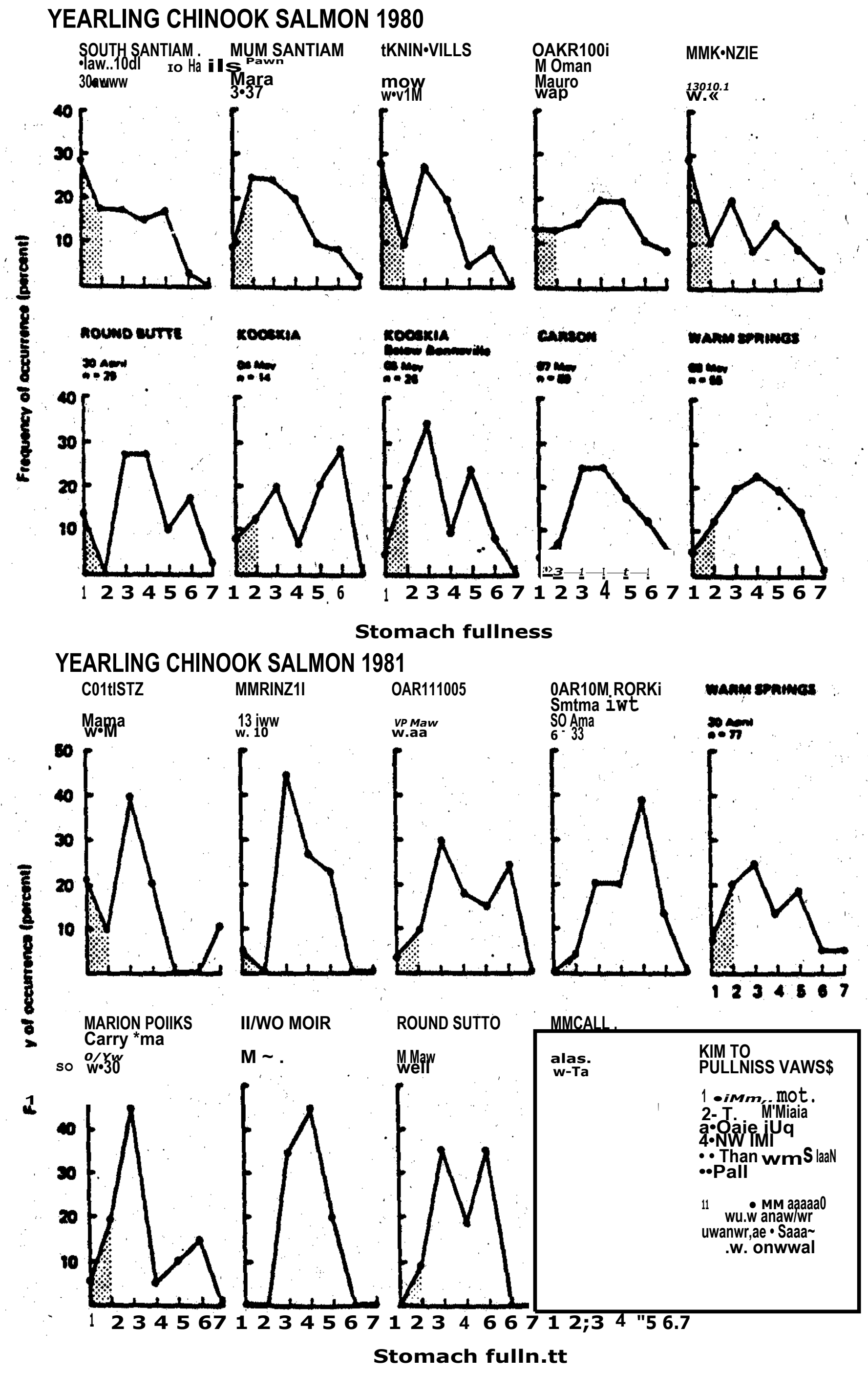

Figure 46.--Stomach fullness frequency curves for tag. groups of yearling chinooksalmon captured at Jones Beach, March-June 1980 and 1981. Source and release site, date of median fish recovery, and number observed are included.

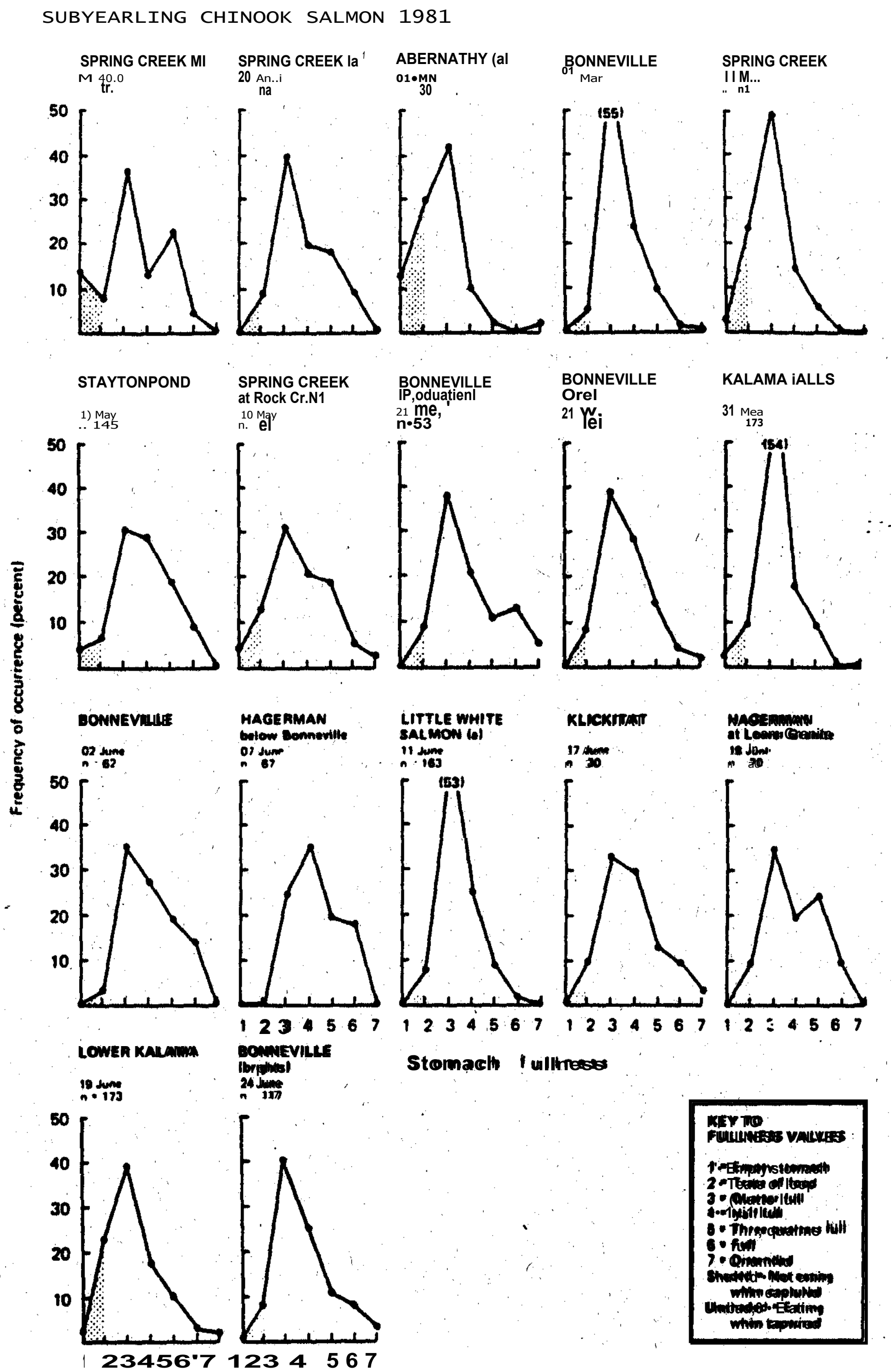

Figure 45.--Stomach fullness frequency curves for tag groups of subyearling chinook salmon captured at Jones Beach, March-June 1981. Source and release site, date of median fish recovery, and number observed are included.

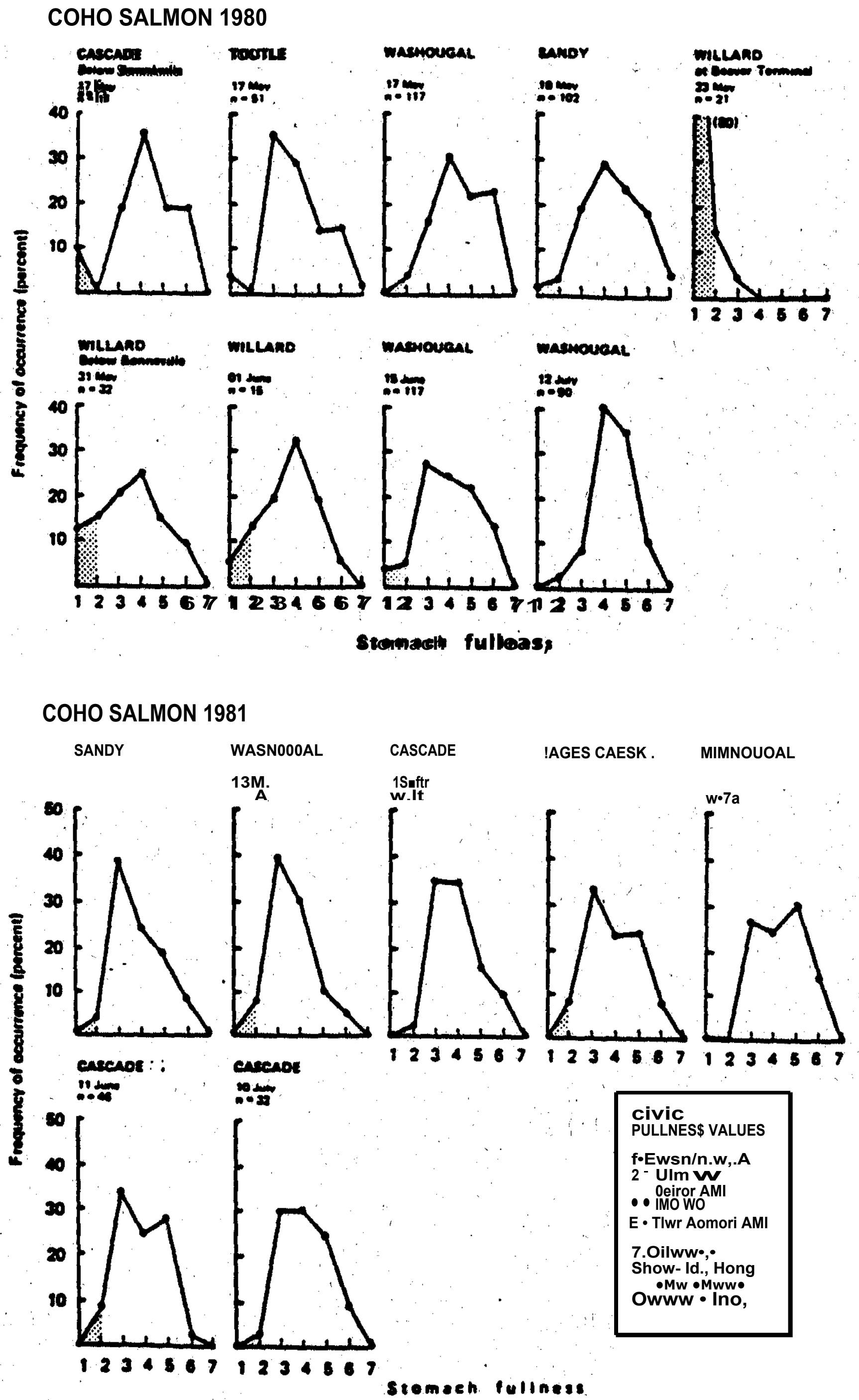

Figure 47.--Stomach fullness frequency curves for tag groups of coho salmon.captured at Jones Beach, March-June 1980 and 1981. Source and release site, date of•median fish recovery, and number observed are included

-non-feeding individuals, respectively. One exception was Kooskia Hatchery fish released below Bonneville Dam which had 27% non-feeding fish. During the same period in 1981, fish from Marion Forks (South Santiam stock), Rapid River, and Round.Butte. Hatcheries had 3,. 0, and 10% non-feeding individuals, respectively. In 1981, *two* groups had-a high percentage of. non-feeding individuals: Marion Forks (Gerson stock) and Warm. Springs Hatcheries--26 and 28% non-feeding, respectively. During this period in both years, the high . non-feeding rates could not be linked with environmental conditions (turbidity, water temperature, and water flow), biological, or migrational characteristics (fish 'health, stock differences, distance of migration, and release site).

From late May through June 1980, .after the eruption. of Mount St. Helens, too few tagged yearling...chinook salmon. .(12) were captured to evaluate differences in food consumption [the. migratory population normally decreases. during that period (Dawley et al. 1982)]. In 1981, one group from McCall Hatchery was captured during late May/early June, and-it had 18%-non-feeding individuals (Fig. 4"6).

.Cohn Salmon.--Cohn salmon generally had the fullest stomachs of the three salmonid species. It was unusual to observe. greater than 10%. non-feeding coho salmon within *any* population in 1980 or 1981 (Fig. 47). There were no significant differences in the percentages. of 'non,-feeding... fish'amonggroups recovered *in* mid-May 1980 or 1981..

Shortly after the eruption, three groups of coho salmon from Willard Hatchery showed significantly greater percentages of nonfeeding fish than earlier migrants. Percentages -of'. non-feeding fish were 95, 21, and 17%,. .respectively, for releases made. at Beaver Terminal (RKm 84)', downstream from Bonneville Dam (RKm 230), and at the hatchery (RKm 268). The close proximity- of Beaver Terminal to Jones Beach undoubtedly allowed insufficient time for the fish to begin feeding prior to capture (all captured within 2days). Excluding Beaver'Terminal fish, the non-feeding percentages for these groups in 1980.were about double that. of any other group in 1980 or 1981, which. suggested that food consumption by these coho salmon was adversely affected by the eruption.

By mid-June '1980,' food consumption. by coho salmon returned to pre-eruption levels (Fig. 42).

Steelhead.--Steelhead had the lowest average fullness values of the juvenile salmonids (Fig. 42). Percentages' of..non-feeding fish. within marked steelhead groups was almost always greater than 25% in.1980.and 1981 (Fig. 48). .Dworshak Hatchery' fish that were barged to a release site downstream from Bonneville Dam in 1980 had significantly higher numbers of non-feeding fish. (73%) than controls which migrated from Dworshak Hatchery *(34X).* We suspect that the short-time between. release at Bonneville.Dam and. recovery at Jones Beach (88% captured within 3 days) *was* ,insufficient for fish to develop aggressive feeding. behavior *in* the river: environment.

No single group of • steelhead was captured in large numbers following the. eruption in 1980, but 59%'.of the '34. tagged fish :observed. Were not feeding.

Diet of.Subyearling.Chinook Salmon and Effects of the Eruption of Mount St. Helens

This portion of the report documents, the diet of subyearling chinook salmon at the upstream extremity of the estuary (RKm 75) from 1979 through 1982 and 'discusses the impact of the eruption of .Mount St. Helens on that diet.

The stomach contents from 492 subyearling chinook'salmon collected from March through June of 1979-1982 and 74 collected from July through September 1980 were examined. Data from each year were grouped into 14-day intervals. The 14-day intervals were selected to separate pre-eruption from post-eruption (excessive turbidity) sampling periods at Jones Beach. Comparisons between years were limited to the March-June period.

During March-June, 1979-1982, Insecta and Crustacea comprised the .major food items found in subyearling chinook salmon--54 and 41% IRI','respectively (Table 38). The most important order of insects was .Dip tars, 16% IRI'; however,. unidentifiable .Insecta represented. 35X. IRI'. The most important crustaceans were Amphipoda and Cladocera,..which represented 19 and .13% IRI' , respectively. Mysidaceawere'important only in 1982..(32% IRI'). In'July 1980, insects were themost important source of food (62% IRI'), but during August and September of .that year, Cladocera became the.. most. important constituent of the diet, about 94% IRI' (Table 39).

Insecta.--Insecta were of major importance in the diet March-June in all years, part cularly in 1981 185% IRI'; Table 38)when the availability of amphipodsappeared to.. be limited..

The types of insects found in the stomachs showed. no apparent differences between years, consequently the data. for all years were combined 'by .14-day periods (Table 40). Diptera were the most numerous insects identifiable to order--80.8%. There was no .seasonal pattern of Diptera consumption for the various metamorphic stages; frequencies of larvae, -pupae, and adults were similar. Homoptera and. Hymenoptera (mostly adults) were the next most numerous insects--4.7 and 3.7% Of the. total insects, respectively. Insects representing 10 additional orders were identified; however, each represented less than 3% of the total insect'count.'

Crustacea.--The consumption of amphipods varied from year to year. In 1979, wpea onsumptionof amphipods occurred in late March-early April (71% IRI') and. in June (85% IRI').(Fig. 49). In 1980, an early April peak at 39% .IRI' was apparent; however, the June peak observed in 1979 was not repeated in 1980 after. the eruption when the IRI' was only 6%... In . 1981',. minimal amphipod consumption was observed, averaging 3% IRI' March-June. In 1982, amphipods again increased in importance with, peaks in early April:(33% IRI') .and in June (20% IRI'). Meyer et al. (1981) observed a similar bimodal peak of amphipod consumption by juvenile chinook,. salmon in. the lower. Duwamish 'River, Washington.

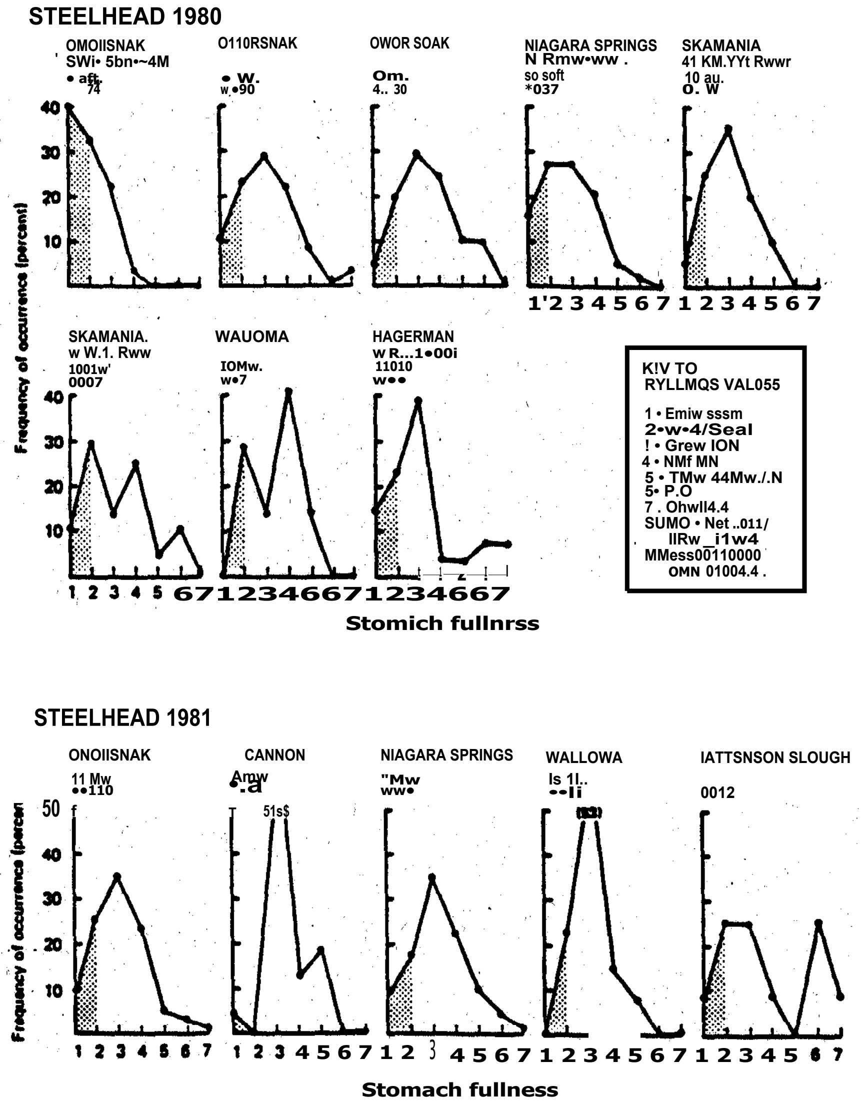

Figure 48.--Stomath.fullness frequency. curves for tag groups of steelhead captured at'Jonet.. Beach, March-June 1980 and 1981. 'Source and release site, date'of median fish recovery, and,number observed are included,

Table 39.--Percent modified index of relative importance (IRI')[a] of food items identified in. stomach contents from subyearling chinook salmon captured at Jones Beach (Um 75); 1 July to 8 September 1980.

Diet	1 Jul to 14 Jul	1,5 Jul to 28 Jul	29 Jul to 11 Aug	12 Aug to 25 Aug	25 Aug to 8 Sep
Total Insecta	57	68	9	2	0
Diptera	24	24	5	0.8	0
Total Crustacea	41	32	91	98	100
Cladocera	35	18	87	96	99
Miscellaneous prey					

a/ IRI' = % weight X X frequency of occurrence.

Table 38.--Percent modified index of:relative importance (IRI')[1/] of diet items identified. in stomach contents from subyearling chinook salmon' captured . at Jones. Beach, Oregon (RKm 75), March-June,. 1979-1982.

Diet item	1979	1980	1981	1982	'Average
Insecta					
Unidentifiable	38	33	54	14	35
Diptera	6	12	27	18	16
Misc. Insecta					
Total	46	48	85	37	54
Crustacea					
Amphipoda	40	16			
Cladocera		25	8	9	12
Mysidacea		1	1	32	9
Misc. Crustacea		2	1	0	1
Total		44	12	58	41
Miscellaneous total					

IRI' - weight x % frequency of occurrence.

Table 40.--Insect orders and percent of total insects observed in stomach contents from subyearling chinook salmon during 14-day intervals, 25 March to 30 June 1979-1982.

Insect order	25 Mar to 7 Apr.	8 Apr to 21 Apr	22 Apr to 5 May	6 May to 19 May	20 May to 2 Jun	3 Jun to 16 Jun	17 Jun to 30 Jun	Average of intervals
	Percent [a]							
Collembola	4.1	4.8	1.5	0.3	1.2	0.9	1.1	2.0
Ephemeroptera	7.8	2.6	4.8	2.3	1.0	1.3	0.0	2.8
Odonata	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Plecoptera	0.0	0.0	0.5	0.0	0.0	0.9	0.0	0.2
Psocoptera	0.0	0.0	0.2	0.0	0.0	3.6	8.1	1.7
Thysanoptera	0.0	0.0	0.1	0.0	0.2	0.0	0.1	0.1
Hemiptera	3.8	1.1	0.3	0.0	0.1	0.0	0.1	0.8
Homoptera	0.0	0.6	15.4	2.3	4.1	7.0	3.2	4.7
Coleoptera	4.0	2.2	3.2	2.4	3.2	3.4	0.5	2.7
Trichoptera	1.4	0.5	0.5	0.4	0.0	0.0	0.2	0.4
Lepidoptera	1.3	0.0	0.2	0.2	0.0	0.4	0.2	0.3
Diptera	75.4	83.5	69.8	91.3	81.7	79.0	84.8	80.8
Hymenoptera	2.6	4.2	3.2	1.3	8.1	3.9	2.3	3.7
Total no. insects	77	180	589	604	836	240	918	3,444
Total no. stomachs	44	58	102	78	71	65	74	492

a/ Percent of total number of insects identified.

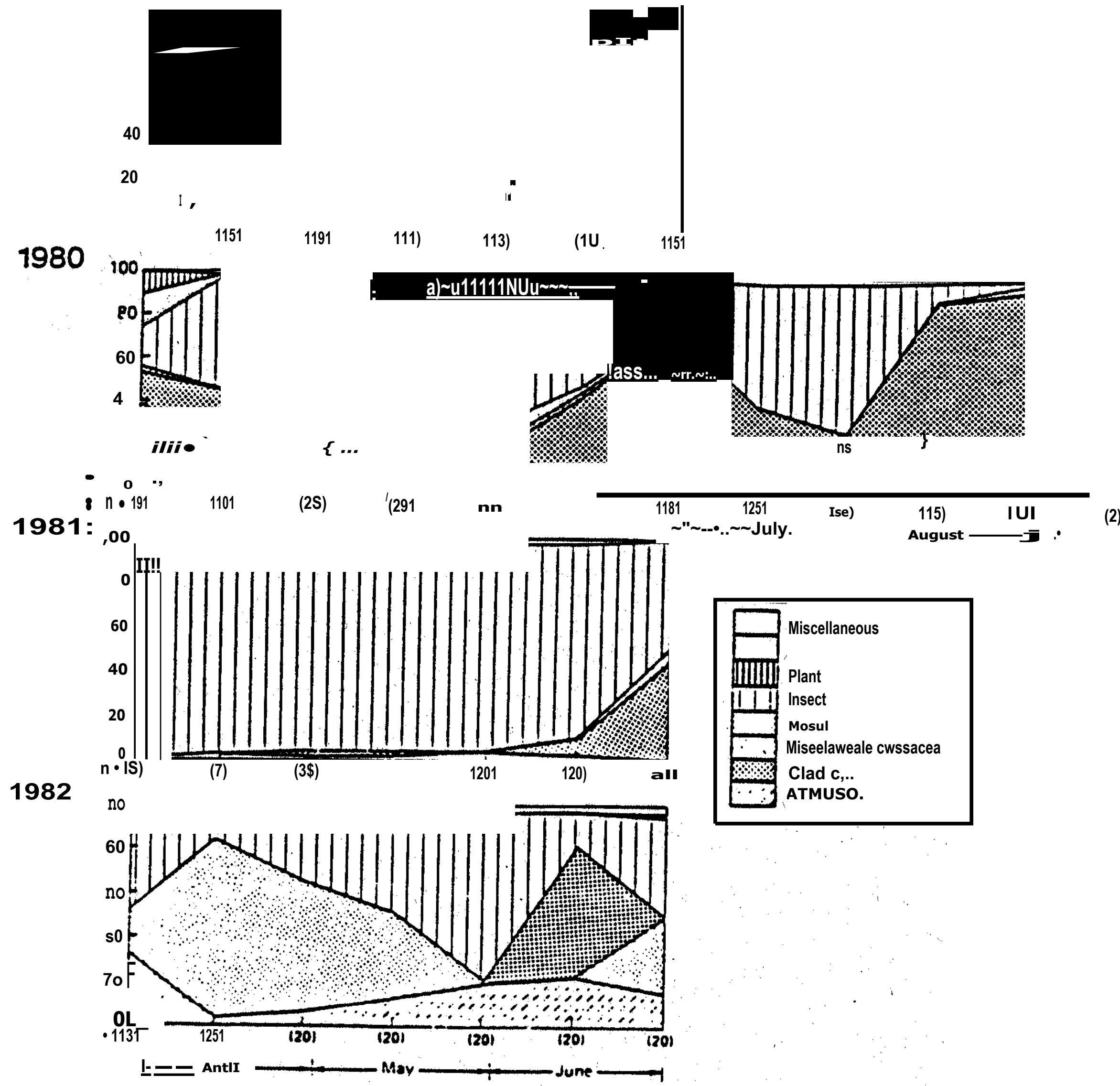

Figure .49.--Modified index of• relative importance (IRI')'for food. items consumed by subyearling chinook salmon collected. at` Jones Beach, Oregon, 1979-1982.

Three species of Amphipoda were found in the stomachs: Corophium salmonis, C..spinicorne, and Eogammarus confervicolus. Diet composition after the eruption (Table 41) indicated that the population of C. salmonis was more severely reduced than that of the other two species. Before the eruption, C. salmonis comprised 74% of all amphipods identifiable to species, compared to 38% after the eruption. A substantial reduction of C. salmonis the diet of juvenile salmonids following the eruption was also observed in the lower Columbia River estuary by McCabe et al. (1981). and Emmett (1982). The greater reduction of 'C.. salmonis could be a function of different substrate requirements (Hazel and Kelley 1966; Chang and Levings 1976; Brzezinski and Holton 1981; Turk et al. 1980; Turk and.Risk.1981, Meyer et-a1., 1981; Albright 1982; Wilson 1983). Brzezinski and Holton. (1981) found that amphipod abundance (primarily C. salmonis)`was. decreased after the 'eruption in areas of the estuary that had a benthic layer of ash.

In the Columbia River estuary, C. salmonis' exhibit a bivoltine life cycle (Davis 1978; Wilson 1983).. The previous fall generation .produces a spring brood in May which matures throughout the summer and subsequently produces a fall brood. It appears that the 1980 spring brood, upstream from Jones_ Beach, was disrupted by the .heavy deposition of sediment from the eruption. Substrate characteristics created upstream. from Jones Beach appear to have inhibited the recovery of the amphipod population. in "1981 as well, as indicated. by their low percent IRI' in the diet of subyearling chinook salmon.

In March-June, Cladocera were of major` importance in the'diet only. during 1980, averaging 25% IRI' (Table 38). Coincident with the decrease of amphipods (Fig. 49),. the consumption. of cladocerans increased sharply following the eruption. In. other years,.. Consumption of cladocerans in March-June. was .greater than 10% IRI' during only one. 14-day interval each year:... 56%,22 April-5.May 1979; 51%,.17-30 June 1981; and 58x,.3-16. June 1982. In August and September 1980,' cladocerans ' were -the major item in the diet {Table: 38). Craddock et al. (1976) observed that. cladocerans were an important portion of the .diet' for chinook salmon. captured during August-October in the Columbia River at RKm 118.

Mysids (Neomysis mercedis) were rare except in 1982 when they were the dominant food from mid-April to mid-May.

Fluctuations in the abundance of cladocerans-andmycids in the diet was apparently unrelated to effects from the eruption (Fig. 49). Cladoceran populations are known to exhibit extreme variability in-..their seasonal and annual,.abundance (Ward and Whipple 1918; Pennak 1978). N. mercedis abundance and distribution has been associated. with a number of environmental. factors. including salinity, temperature, .dissolved oxygen, light, and river flow (Hopkins 1958; Heubach 1969;. Orsi and . Knutson 1979; Siegfried et. al....1979, 1980. However,. extreme variations in population abundance from. one year to the next, unrelated to. environmental changes, have been reported (Hopkins 1958; Turner and Heubach 1966; Heubach 1969). It is possible. that increased mycid availability in 1982 masked the true extent of amphipod recovery.

Table 41.--Amphipod species and percent of total amphipods observed in stomach contents from subyearling chinook salmon before and after the eruption of Mount St. Helens--March-June, 1979-1982.

Species	Before eruption[a] (%)	After eruption[b] (%)
Corophium salmonis	74	38
Corophium spinicorne	22	45
Eogammarus confervicolus	4	17

a/ 25 March 1979 to 19 May 1980.

b/ 20 May 1980 to 30 June 1982 (excluding data from July to September 1980).

Miscellaneous Prey.--Fish larvae (Osmeridae) were of minor dietary importance in late March and early April 1979 and 1980, 6 and 15% IRI, respectively; none were present in 1981 or 1982.

Immediately following the eruption (20 May-2 June 1980), consumption of plant material increased from 0 to 12% IRI. Relatively high consumption of plant material also occurred from 25 March to 8 April in 1980 and 1981, 9 and 17% respectively, and from 6 to 19 May 1982, 10X.

Geographical Differences.--From March through June, during years prior to the eruption, subyearling chinook salmon captured at Jones Beach consumed similar proportions of insects and amphipods, whereas upstream from Jones Beach in the reservq r,of McNary Dam (RKm 470-521), fish consumed insects and cladocerans and further upstream in the free flowing Hanford reach (RKm 591-629) fish consumed primarily insects (Becker 1973). Fish captured downstream from Jones Beach (RRm 4-40) consumed primarily amphipods (Durkin at al. 1977, 1981).

Feeding Characteristics of Juveniles Entering the Estuary.

This portion of the report focuses on the examination of feeding rate differences between stocks, species interaction, dietary overlap, and comparisons to other geographical areas. Proximate analysis of stomach contents are also presented.

Stomach Fullness Comparisons.-Differences in mean fullness for groups captured in 1982 and 1983 (Fig. 50) were evaluated statistically and some differences were related to biological or release characteristics. Researchers familiar with groups exhibiting increased or decreased rates of food consumption may be able to make additional correlations.

1. Subyearling chinook salmon: Subyearling chinook salmon were captured in all months of the year, and tagged fish showed great variability in mean fullness (Pigs. 51-53). In 1982 and 1983, during peak migration (May and June), the majority of fish captured had higher fullness values than fish captured in 1980 and 1981 (Fig. 42).

Temporal trends in variation of stomach fullness between years (1980-83) are not apparent, but fish from three different culture stations and wild fish exhibited variations that were apparently related to rearing environment, release site, or pre-release disease incidence.

A higher feeding rate was observed for fish from Stayton Pond which may be a result of the earthen pond environment. In 1982, the mean fullness value

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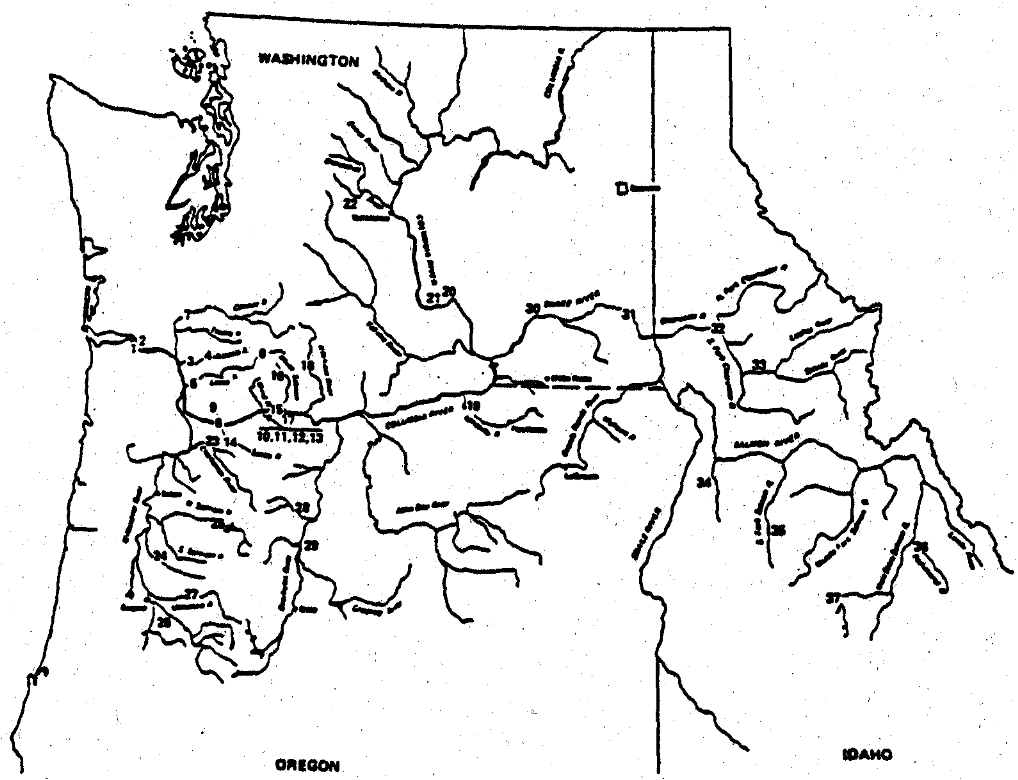
[5] R. Fairly, U.S. Fish and Wildlife Service, National Fishery Research Center, Willard Substation, Star Rt., Cook, WA 98605; pers. commun.



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15. Lit. Hat. Isl. Net. q/	261						
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.Figure 50.--Columbia River basin. showing locations of release sites, hatcheries, and Jones. Beach.

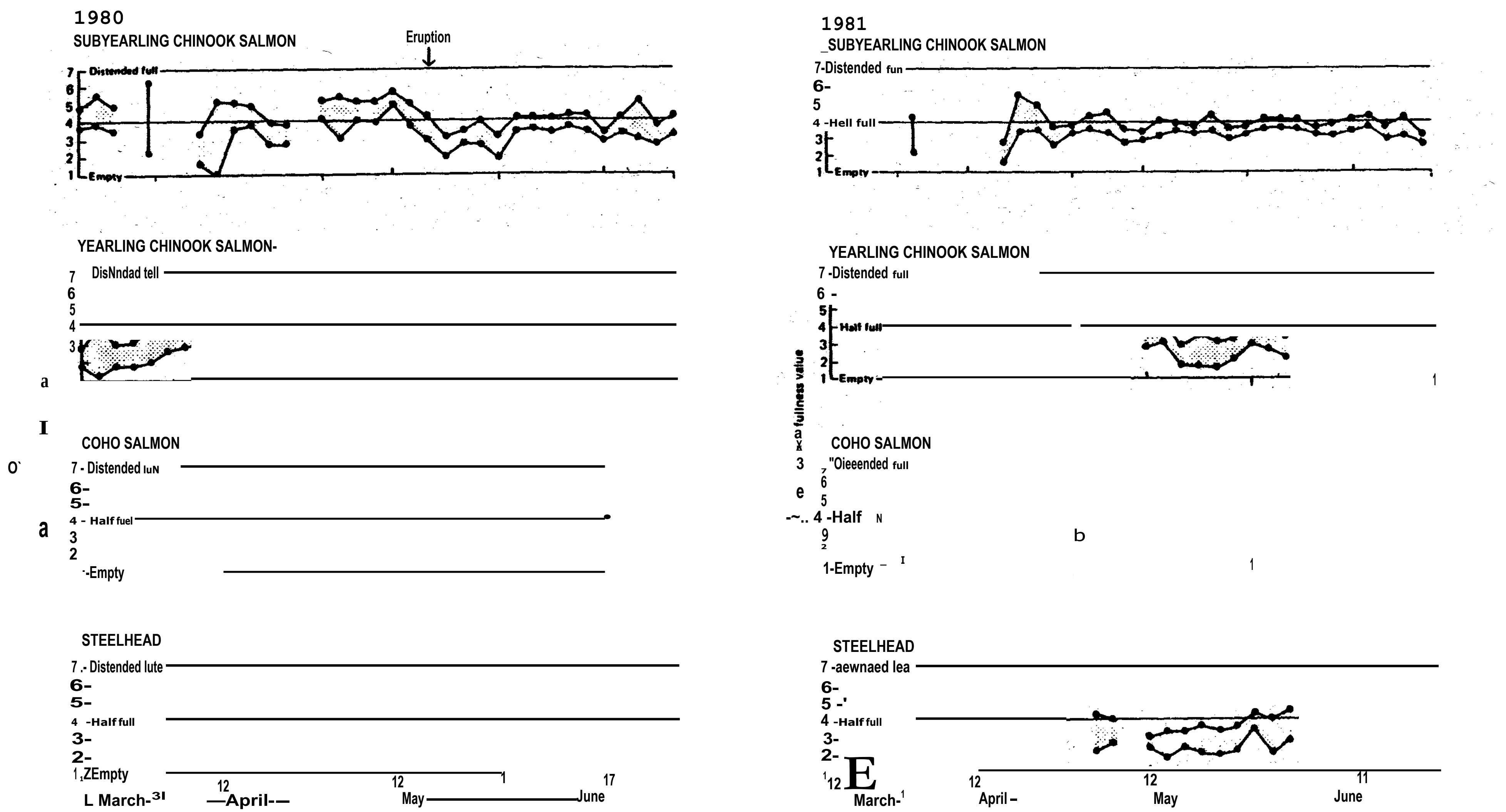
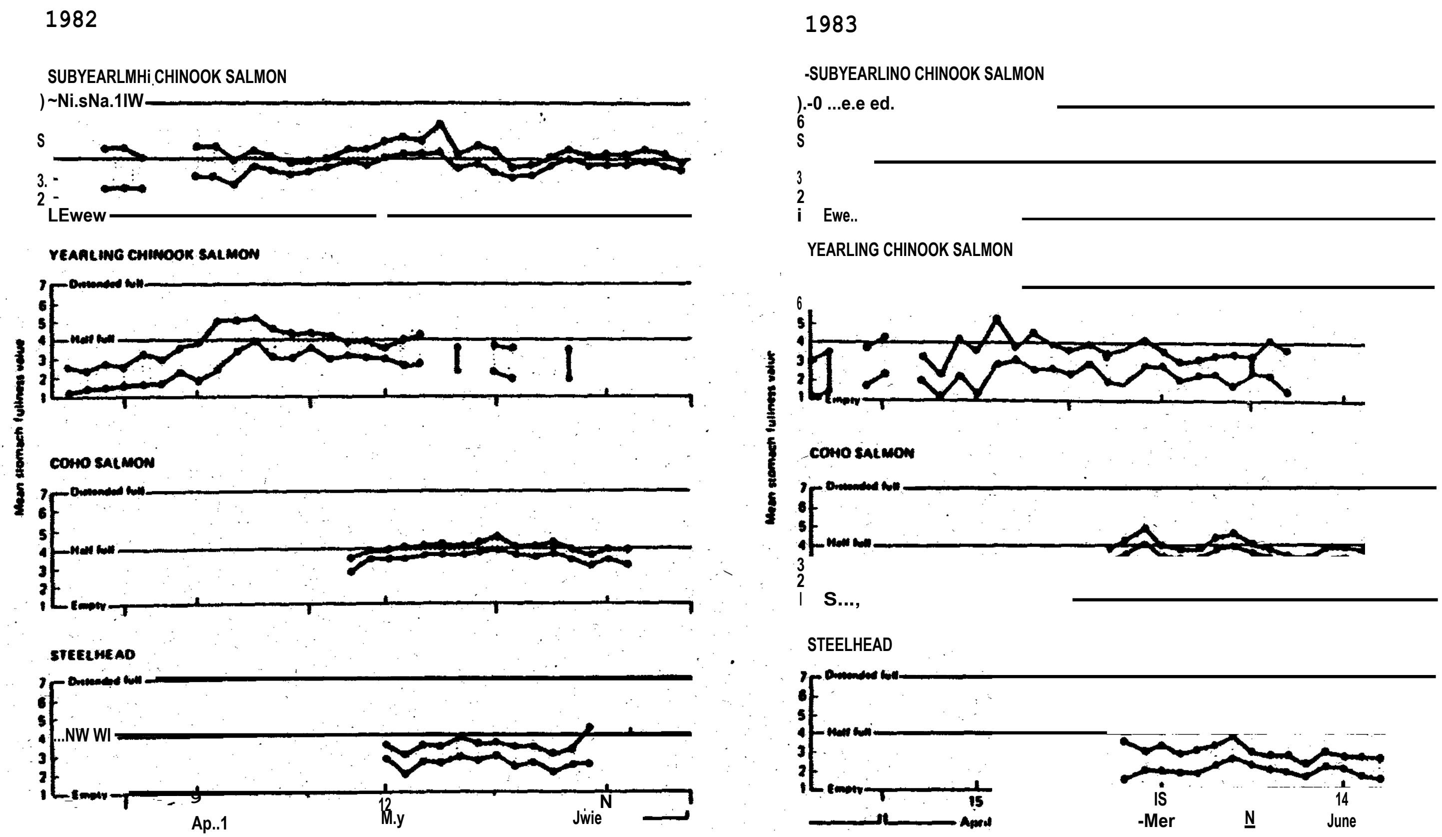


Figure 51.--Ninety-five percent confidence intervals of mean stomach fullness for salmonids captured at Jones Beach, plotted by 3-day intervals, March-June 1980 and 1981.



Figure'52.--Ninety-five percent. confidence. Intervals of mean stomach **fullness for** Juvenile salmonids captured in beach and purse seines at - Jones Beach, plotted by 3-day: -intervals,-March-June, 1982-and 1983.

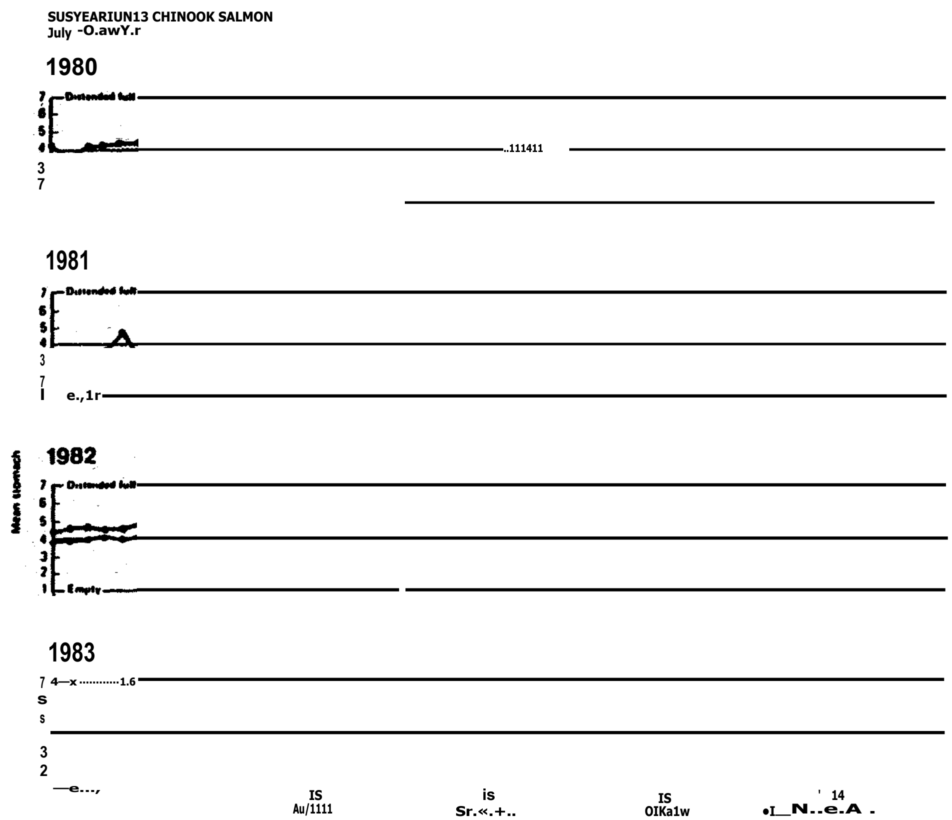


Figure 53.--Ninety-five percent confidence intervals of mean stomach fullness for subyearling chinook salmon captured in beach and purse seines at Jones Beach, plotted by 3-day intervals, July-December, 1980-1983.

for the Stayton Pond fish (5.0, early migrants) was significantly higher than, that for fish from Spring Creek Hatchery (4.0) Fig.' 54. In 1983, the mean fullness value for the Stayton Pond fish (4.8) was significantly higher than Bonneville Hatchery diet study fish (3.8) and higher (not significant) than Little White Salmon Hatchery fish (4.4) (Fig. 55). In 1980 and 1981, higher than average feeding rates were also observed from Stayton Pond fish. Estuarine recovery percentages for Stayton Pond fish (1980-1983) showed no difference from other g9gps, but adult return rates appear substantially greater than average (Day!!'.!).

As mentioned previously, fish from the Abernathy Salmon Culture Development Center (SCDC) have a low feeding rate when captured at Jones Beach. We believe. that the lower feeding rate for these fish is associated with the short time period between re;$,se and recapture at Jones Beach; release site is 16 km from Jones Beach.,_ In May 1982, fish from Abernathy SCDC had significantly lower mean fullness value than fish from Spring Creek Hatchery. and two groups from Bonneville Hatchery (2.9 versus 4.0, 3.7, and 3.8, respectively).

During November and December 1982, one of four tag groups released from Bonneville Hatchery had a significantly lower mean fullness value (Fig. 55) which probably resulted from factors affecting the fish during hatchery rearing. The lower river stock (tule) reared in well water (mean fullness 2.6) a high pre-release mortality- and were in poor health at release (Hansen), whereas tule stock reared in Tanner Creek water, upriver late fall stock (bright) reared in Tanner Creek water, and bright stock reared in well water were unaffected by disease (mean fullness 3.1, 3.1, and 3.3, respectively).

In 1983, aver 200 tagged wild fish from. the Lewis River (seined, tagged, and released same day) were captured and their stomach fullness observed at. Jones Beach .-(Fig. 55). The.dates of median fish recovery. for the two tag groups were outside of the 7-day range used for comparing mean. fullness values.. with other groups; however, the. wild fish appeared to feed ata similar rate as most cultured fish captured during the. sa ga: months. An exception, however, was a comparison : with fish reared 'at -the Cowlitz Hatchery; :where changes,

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16/ W. Day, . Oregon Department of Fish and Wildlife, 17330 S.E. Evelyn St. lackamas, OR;<pers. commun.

17/ In 1980 and 1981, fish from Abernathy Hatchery had 51 and 44% non-feeding fish compared, to 24% in 1982. Non-feeding. rates among these' 3 years are significantly different (P.< 0.01),'but mean. fullness values ,were not. significantly different (range 2.90to 3.10; P < 0.05). Diseases. incurred during culture also may have increased the proportion of non-feeding fish observed in 1980 and 1981..(L. Fowler, U.S. Fish and Wildlife. Service, Abernathy Salmon Cultural Development Center, 1440. Abernathy Road, . Longview, WA 98632; pars. commun.

14/ H.. Hansen, Oregon Department of. Fish and Wildlife, 17330 S. E. Evelyn St., Clackamas, OR, pers. commun.

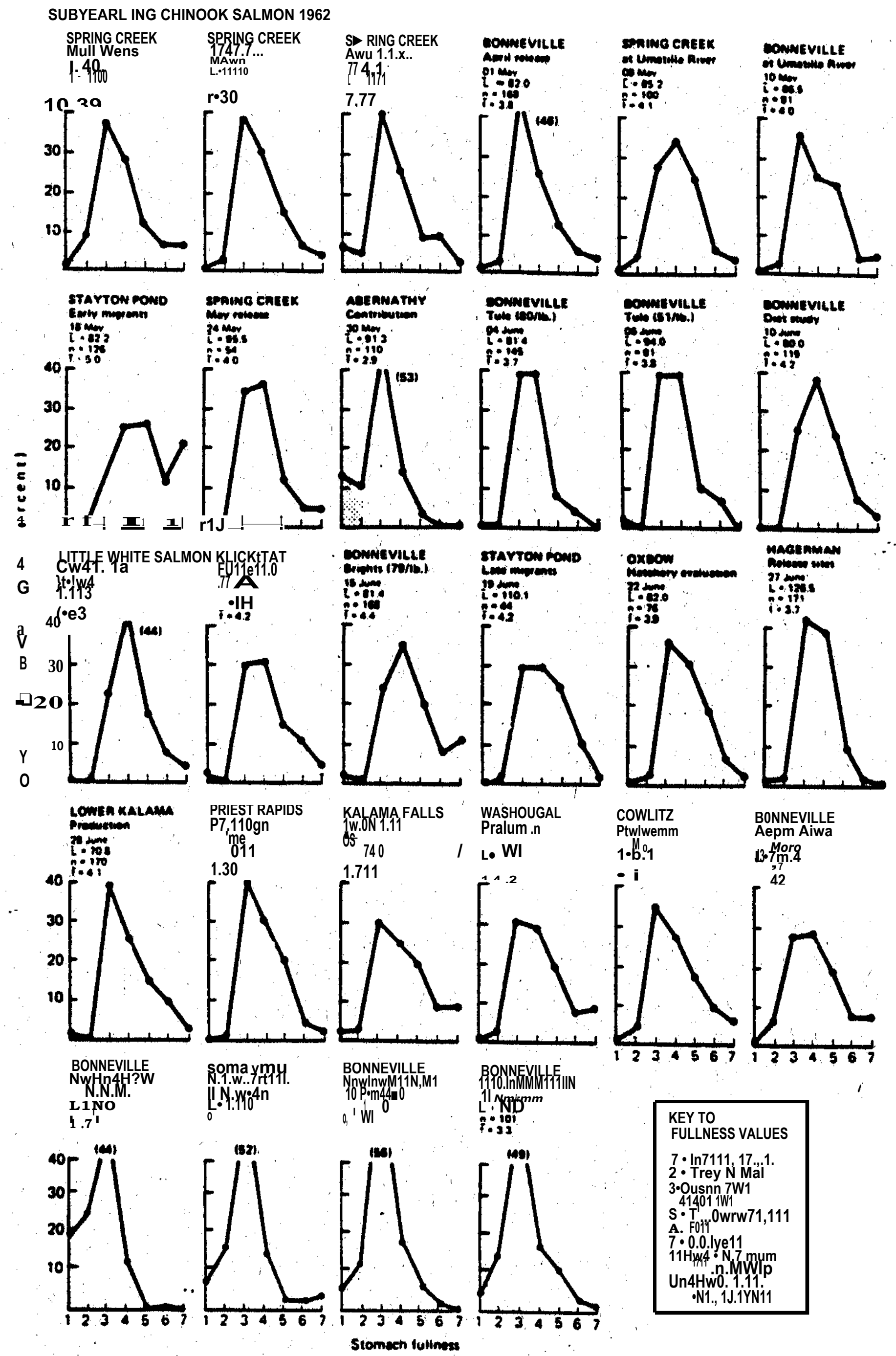

Figure 54.--Stomach fullness frequency curves for tag groups of subyearling chinook salmon captured at Jones Beach during 1982. Source, study descriptor, date of median fish recovery, mean length (mm), number observed, and mean fullness value are included.

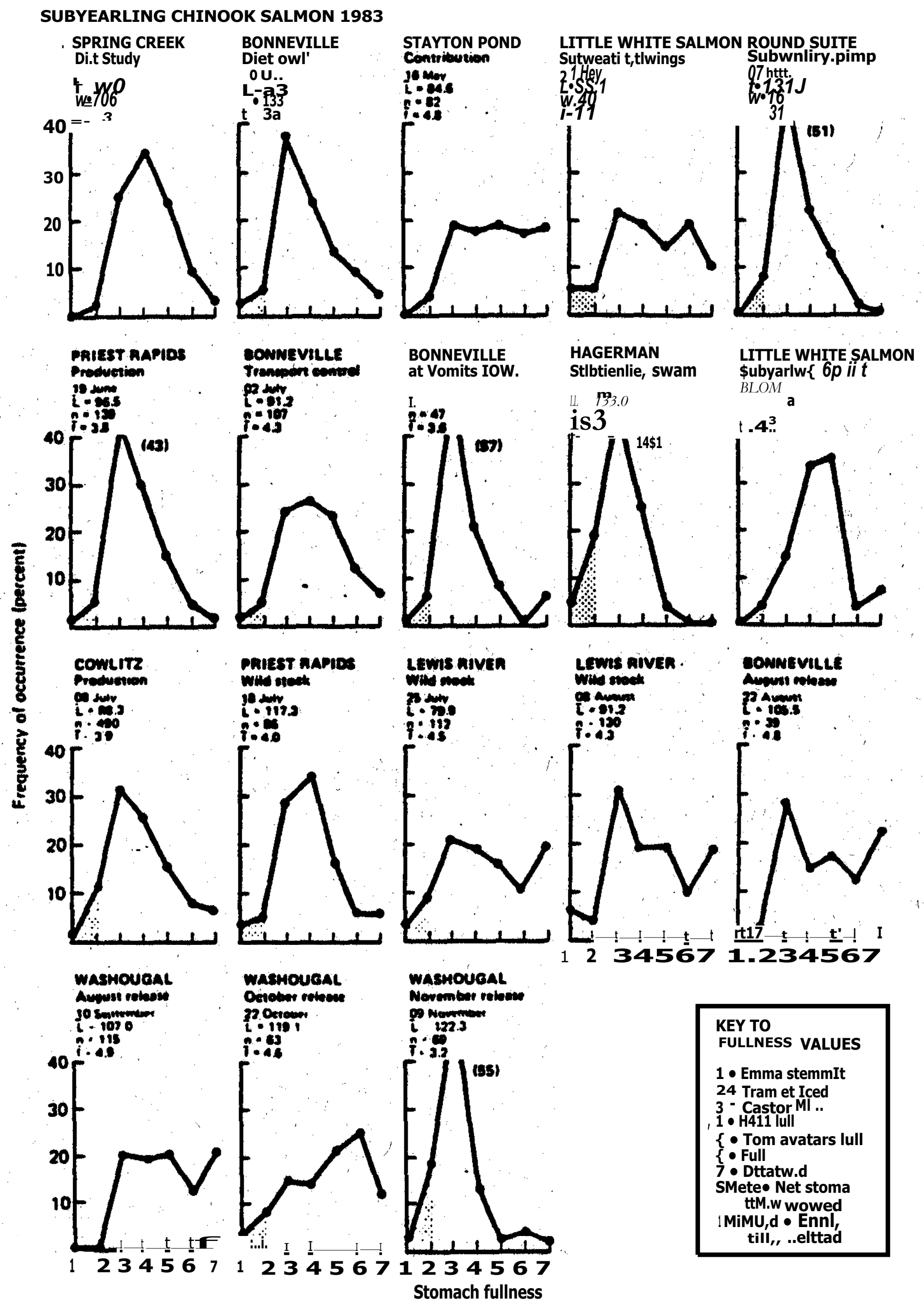

Figure 55.-Stomach fullness frequency curves for tag groups of subyearling chinook salmon captured at Jones Beach, 1983. Source, study descriptor, date of median fish recovery, mean length (mm) number observed, and mean stomach fullness value are included.

within the. time period of migration, in condition factor, •amounts of visible body fat, and fullness value indicated that the wild fish were better. utilizing the available food resources.

Other fish groups showed significant differences in mean fullness values. In .1982, Bonneville Hatchery diet study fish (tule stock) had a significantly higher mean. fullness value (4.2) than that for two tule stock production release groups (3.7..and,3.8,. Fig.. 54). In 1983, Bonneville Hatchery diet study fish `: had a significantly lower mean fullness value (3.8) than Spring Creek Hatchery diet. study fish (4.2) and the ` Stayton Pond fish. (Fig.. 55.). In 1982, Hagerman Hatchery fish had a. significantly lower mean fullness (3.7) than fish. from Lower Italama Hatchery (4.1).' In early July . 1983, fish groups from Hagerman, 'Bonneville .(transport and control. groups), Cowlitz, and Little White Salmon Hatcheries. had significant differences among mean stomach fullness values (range 3.1 to 4.4,.Table. 42). Differences of race and size affect this comparison,'i.e.,.the fish from Hagerman and.Little White Salmon Hatcheries were spring Chinook salmon and the others' were fall Chinook salmon; mean fork lengths at recovery ranged from 88 to 133 mm.

2. Yearling chinook salmon: Fish captured from March through April generally had low fullness values (Figs. 51 and 52). To interpret the feeding behavior during January to early May,, we divided the 1980'. to 1983 fullness data into two groups: fish released from hatcheries in the fall that overwintered in the river system (residual), and those released during March (Fig. 56). Residual fish fed consistently throughout recovery, and mean fullness values (3-day averages) showed insignificant (P<0.10) correlation to recovery dates (correlation coefficient, r - 0.37). The overall mean fullness value for residual fish was 4.2 (n - 149; date of median fish recovery - 2 April). Fish released in the spring did not feed consistently throughout the recovery period. and showed significant (P<0.001) positive correlation between mean fullness values (3-day averages) and dates of recovery (r = 0.93, non-linear power curve regression). Spring released fish had predominantly empty or trace full stomachs during March, with gradually increasing mean fullness thereafter; overall mean fullness was 2.8 (n - 376; date of median' fish recovery - 1 April). High proportions of non-feeding yearling chinook salmon were recovered from releases in March 1982 at Oxbow Hatchery (41%) and Bonneville [19] (iatchery in 1982 and 1983 (61 and 66%, respectively); Figure 57.,x. The proportion of non-feeding fish was highest for initial catches and decreased with time after release.

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[1] In 1983, a. second mark. group released from Bonneville, Hatchery on 23, March had 31% non-feeding fish; although. only 13 'were examined. and- there was no significant difference from the earlier group. . The two Bonneville releases were different stocks (tuleand bright, respectively). In 1982, thesetwo. stocks were released on' the same date (17 March) and had similar numbers of non-feeding fish (tule - 58%, bright 64%). Time of release in the. spring .may affect feeding rate for yearling chinook salmon..

Table 42.--Comparison of mean stomach fullness for different marked groups of subyearling chinook salmon captured at Jones Beach in early July 1981.

	Source_/ Descriptor				
	Magerman/ subyearling spring chinook	Bonneville/ Vernito Br. fall chinook'	Cowlitz/ fall chinook	Bonneville/ full chinook	Little White Sal, subyearling spring chinook
Dote	6 July	5 July	8 July	2 July	6 July
Mean length b/	133	114	88	91	111
Number sampled	27	47	490	107	42
Mean fullness	3.1	3.6	3.9	4.3	4,4
Significance E/					--

A/ Date of median fish recovery for individuals with fullness observations.
b/ Mean fork length imm) for intire tag group; 7 day overage about the date of median fish recovery.
/ Underlined fullness means have no significant difference IP>0.05).

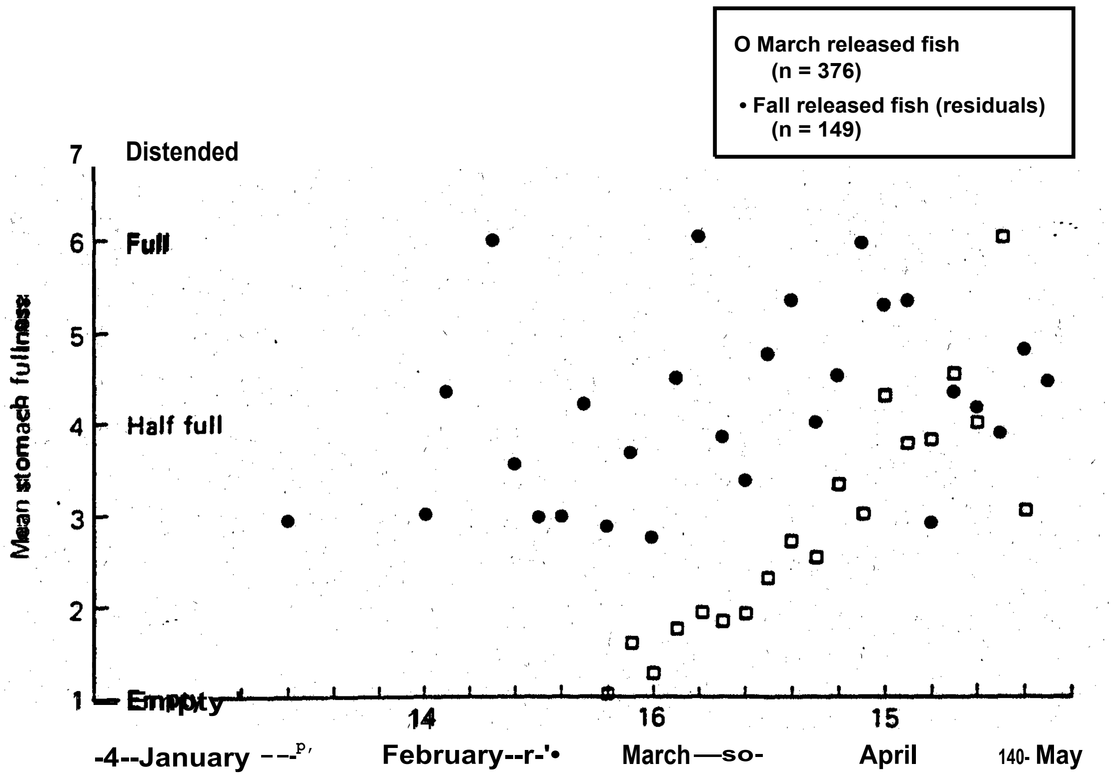

Figure 56.-Mean stomach fullness for yearling chinook salmon (residual and March released fish) captured at Jones Beach, 1980-1983, plotted by 3-day intervals.

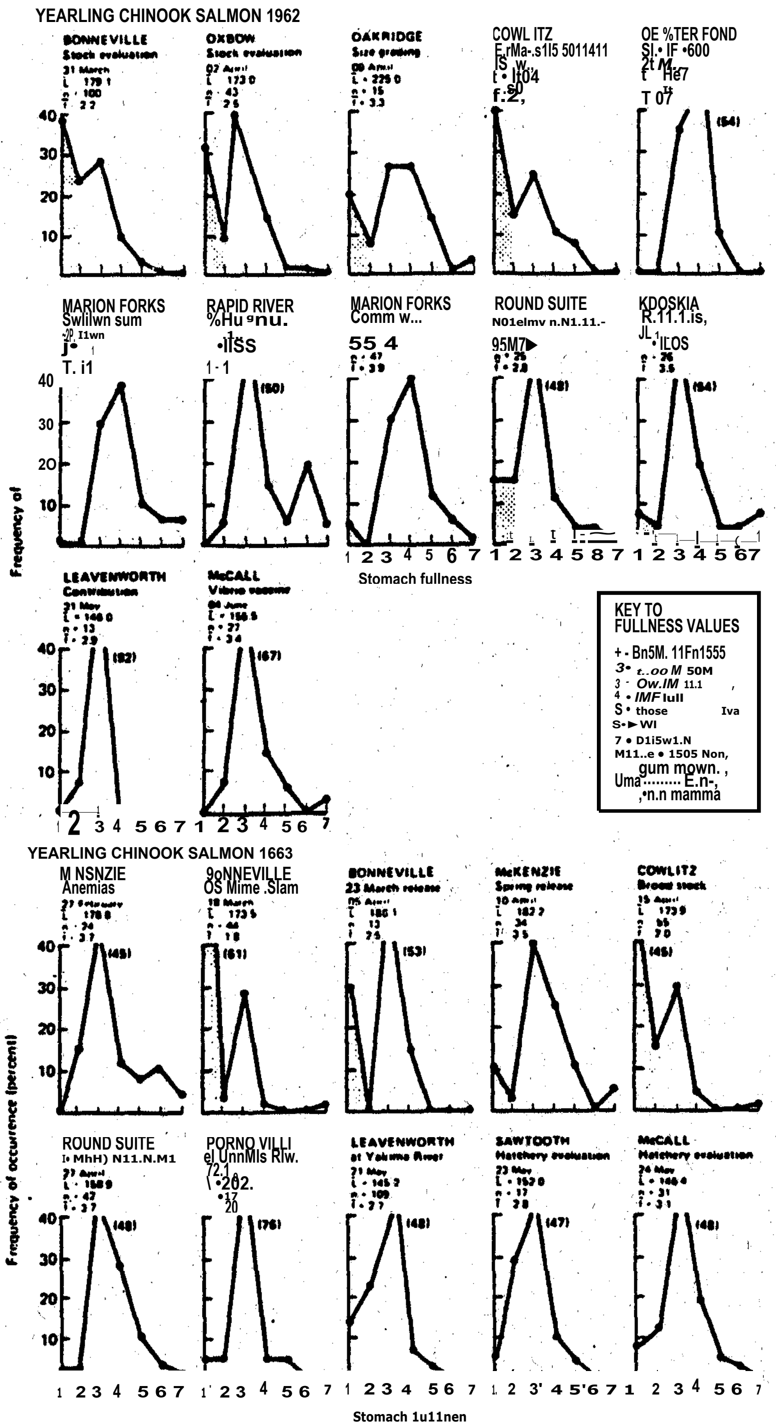

Figure 57.--Stomach fullness frequency curves for. tag groups of yearling chinook salmon captured at Jones Beach, 1982 and 1983. Source, study descriptor, date of median fish recovery, mean length (mm), number observed,. and mean. stomach fullness value are included.

Fish captured in May and June generally elicited higher mean fullness values than those collected in March and early April, but each year there was a decrease in mean fullness` during May (r 0.82, -0.69, -0.66, and -0.52, respectively, for 1980, 1981, 1982,' and 1983) (Figs. 51 and 52). This decreasing fullness trend seemed to occur within mark groups as well as for the aggregate of, all individuals. For example, Warm Springs Hatchery chinook salmon showed high food consumption in early May with progressively lower fullness through the month (Fig. 58).

Some fish groups passing Jones Beach in May and June showed significantly lower feeding rates than others passing during the same period (Fig. 57). , In 1982, the mean fullness of fish from. Round Butte Hatchery was significantly lower than that for fish from Marion Forks and Rapid River Hatcheries (2.8 versus 3.9, and 4.0, respectively). Mean fullness for Leavenworth Hatchery fish was significantly lower than for McCall Hatchery fish (2.9 versus 3.4). In 1983, mean fullness values of fish from Bonneville and Cowlitz Hatcheries were significantly lower than means for fish from McKenzie Hatchery (2.5 and 2.0 versus 3.5, respectively).

3. Coho salmon: Fullness values for coho salmon were lowest in 1983 (mean - 3.8) and highest in 1980 (mean 4.1) (Figs. 51 and 52). In 1980 and 1981, proportions of non-feeding coho salmon did not exceed 10%, except for fish from Willard Hatchery released shortly after the eruption of Mount St. Helens.

In 1982, all groups of coho salmon had less than 5% non-feeding fish, but some groups captured during the same date range had significantly different fullness means (Fig. 59) Fullness mean for fish from Lower Kalama Hatchery was significantly lower than that for Cowlitz Hatchery fish', and both were significantly lower than the mean for Sandy.Hatchery fish (3.3, 3.6, and 4.0, respectively). Fullness means for fish, from Eagle Creek and Washougal Hatcheries were significantly lower than the mean for Cascade Hatchery fish (3.9, 4.1, and 4.4, respectively).

In 1983, all groups of coho salmon had less than 10% non-feeding fish except those from Lower Kalama and .Cowlitz Hatcheries (14 and 15%, respectively); Figure 59. Although sample size was. small (n 29), the mean fullness value for fish from Lower Kalama Hatchery (3.7) was not significantly different than fish from Washougal (3.9) or Sandy Hatcheries (4.1); it was significantly lower than Bonneville Hatchery fish (4.7). Cowlitz Hatchery fish had a significantly lower mean fullness than fish from either Sandy or Eagle Creek Hatcheries (3.4 versus 4.1 and 3.8, respectively).

4. Steelhead: Fullness values were lowest in '1983 (mean - 2.6) and highest in 1982 (mean • 3.0; Figs. 51 and 52). In 1982, mark groups captured during similar time periods showed no significant differences'between fullness means (range 2.7-3.1; Fig. 60). In 1983, Hagerman Hatchery B stock had a significantly lower fullness mean than fish from Lyons Ferry and Dworshsk Hatcheries (2.1 versus 2.6 and 2.6), but 11 days later mean fullness for Hagerman A stock steelhead was not significantly different than that of a second group of Dworshak Hatchery fish (2.3 and 2.6, respectively). In 1982, Hagerman stock' A and B steelhead were captured during similar date periods; both had fullness means of 3.1.

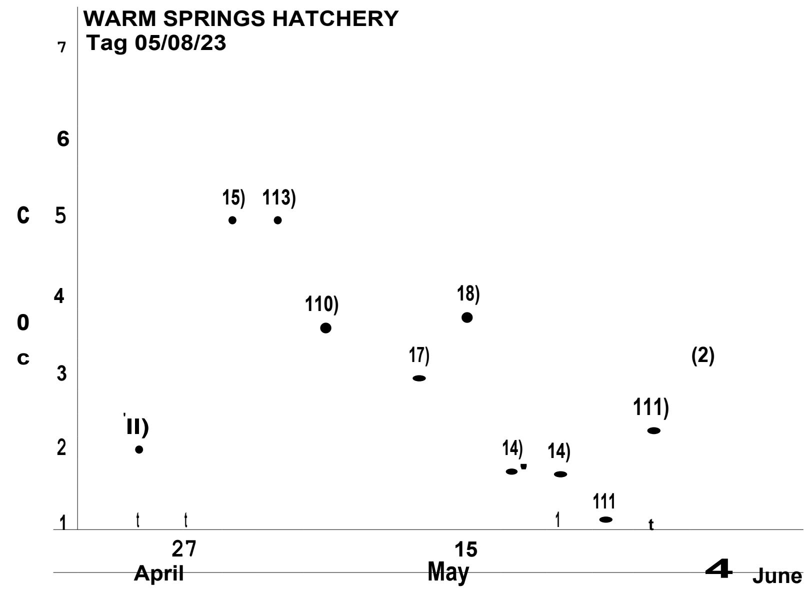

Figure 58.--Mean stomach fullness (3-day intervals) for yearling chinook salmon released at Warm Springs Hatchery and captured at Jones Beach, 1981. Sample number in parenthesis.

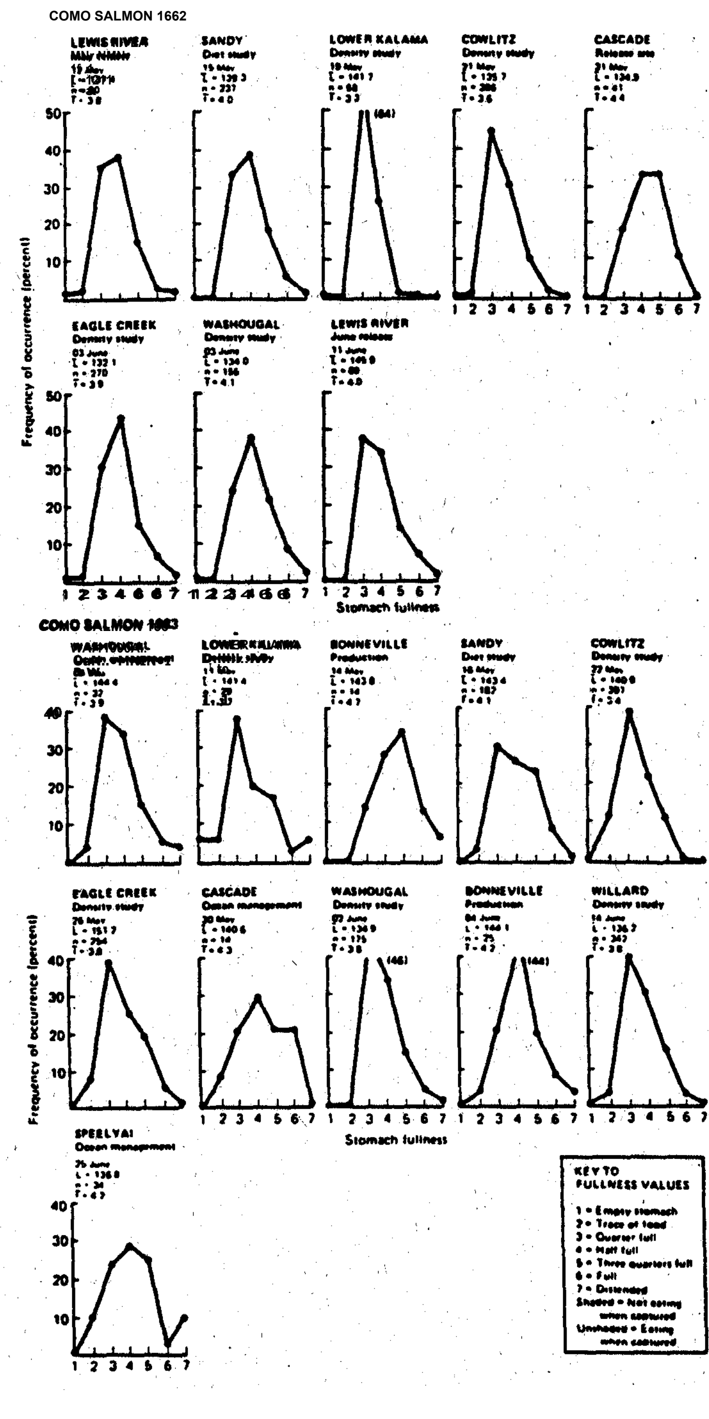

Figure 59.-Stomach fullness frequency curves for coho salmon captured at Jones Beach, ' 1982 and 1983. Source, study descriptor, date of median fish recovery, mean length (mm), number observed, and mean fullness value are included.

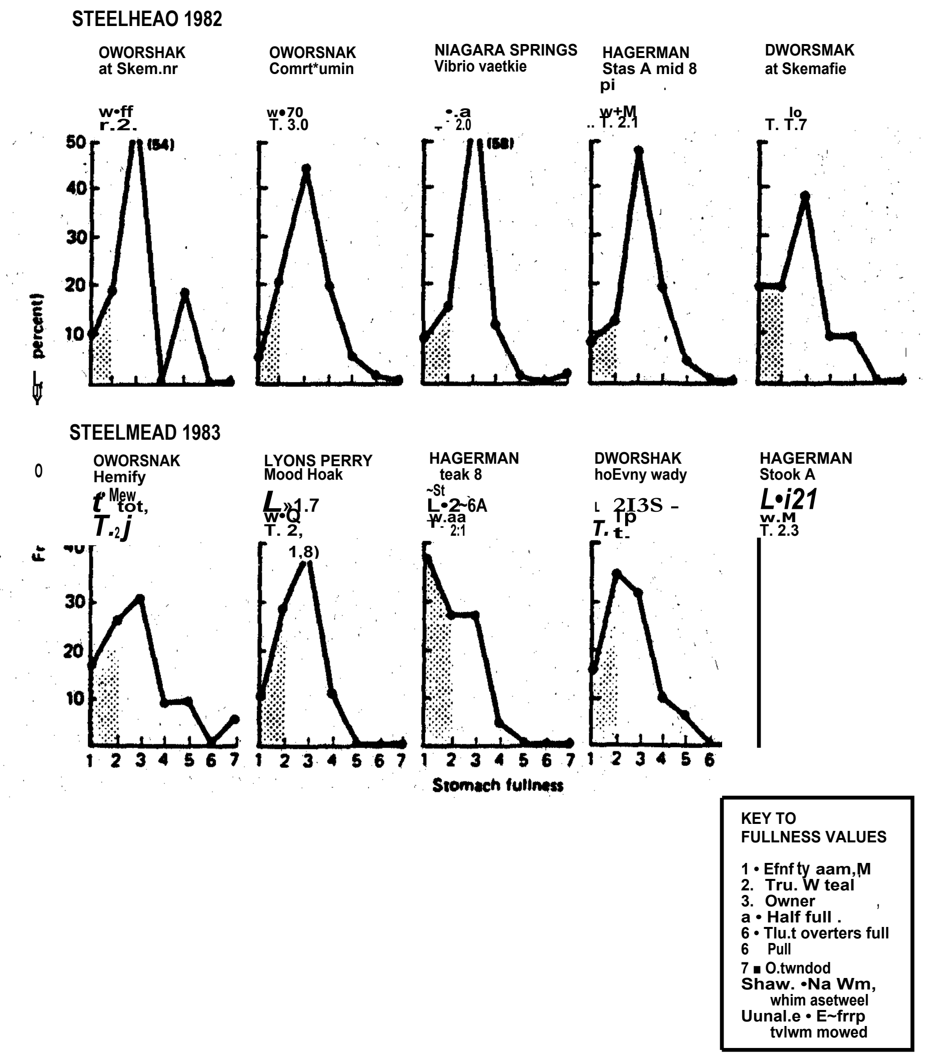

Figure W.—Stomach fullness frequency curves for steelhead' captured at Jones Beach, 1982 and 1983. Source, study descriptor,. date of median fish recovery, mean length (nun), number observed, and mean fullness value are included.

5. Interspecific Comparisons: During May, the time period of peak out-migration, mean stomach fullness of yearling chinook salmon. decreased coincidentally with increased migrants passing, Jones Beach. No decrease was observed for subyearling chinook salmon or the other salmonid species. To determine if the decline in stomach fullness' might show evidence'of density dependence, we correlateddaily mean stomach fullness of purse seine captured yearling chinook salmon to accumulated catch per set (ACPS) of all yearling salmonids captured in May and June 1980-1983. In all years there was inverse correlation (r -0.70, -0.61, -0.60, and -0.37 for 1980, 1981, 1982, and 1983). Fullness values for yearling chinook salmon declined during increasing CPS in early May and continued to'decline as CPS decreased in late May. Only in 1981 did fullness values increase in June, (Fig. 51); in 1980, few yearling fish were captured following the 18 May eruption of Mount St. Helens, and in 1982 and 1983 negative slopes for mean fullness values occurred during early, June for all yearling salmonids. In 1983, sufficient numbers of tagged coho salmon were captured during mid-June to July for analysis. These fish showed increased feeding during months when migration of all yearling fish was minimal.

6. Effects of Time and Tide: We examined fullness data collected during May and June, 1980-1983 for relationships to hour of' catch. There was high variability in the data and correlations were poor. To eliminate some of the variability, we selected for fish captured less than 2 'h'after sunrise (morning) and compared their mean stomach fullness to that of fish captured more than 6 h after sunrise (afternoon) (Table 43). Each year, coho and subyearling chinook salmon captured in the beach seine had higher mean fullness values in the afternoon than in-'the morning (7 out of 8 comparisons were significant, $P<0.05$).. Fish captured in the purse seine showed differences between morning and afternoon mean fullness values, in both directions and no trend was observed:

Little or no relationship was observed between fullness values and tide. Preliminary analyses comparing fullness value to time intervals from high or low slack tide were poorly correlated.

<u>Diet Composition and</u> overlap.---Stomach contents from a. sample of each species captured 6-19 May. 1980 were identified to examine interspecific. dietary overlap. overlap calculations were performed at the ordinal level of identification using biomass to' characterize the .diets. Unidentified insects and fish were omitted from the Analysis '(only one. fish was :consumed--by a subyearling chinook salmon; we felt it was anomalous data). A C 1. value of 0.6 is considered significant overlap,(Zaret and Rand 1971)..

The diet..of subyearling. chinook salmon was distinct from that of steelhead (C = 0.2) but had significant overlap with yearling chinook salmon (C = 0.6) and. coho salmon (C 0.8) (Table 44). Cladocera, was the most distinctive item in the diet of subyearling chinook .. salmon (7% IRI')'. Amphipoda and , Insecta (primarily Diptera), together with Cladocera accounted for over 90% of the IRI' (Fig..61).

At- the ordinal level. Of prey identification, yearling chinook salmon showed significant dietary overlap *with, coho* salmon (C = 0.6) and steelhead (C 0.6) (Table 44). All three species fed heavily on Amphipoda and Insecta

Table 43.--Comparison of morning and afternoon mean stomach fullness values for juvenile salmonids captured at Jones Beach during May and June 1980-1983.

Year	Species	location a/	Morning b/ n	Morning b/ mean fullness	Afternoon c/ n	Afternoon c/ mean fullness	t-value
1980	Coho salmon	Shore	47	2.9	19	3.9	2.3 d/
1981			18	3.5	23	4.1	1.5
1982			78	3.6	44	4.2	2.9 d/
1983			68	3.4	67	3.9	2.5 d/
1980		Mid river	138	4.4	30	4.2	0.7
1981			217	3.8	47	442	1.8
1982			403	3.9	46	3.9	-0.1
1983			529	3.7	164	3.8	1.2
1980	Yearling chinook salmon		63	3.9	5	3.2	-140--
1981			77	3.1	41	3.9	3.7 d/
1982			47	3.4	10	3.2	-0.9
1983			76	2.8	34	3.0	0.8
1980	Steelhead		96	2.7	15	3.7	2.3 d/
1981			86	2.9	41	3.8	4.1 d/
1982			50	3.0	27	3.2	0.7
1983			137	2.4	77	2.5	0.6
1980	Subyearling Chinook salmon	Shore	187	3.5	124	4.0	3.3 d/
1981			450	3.2	175	349	6.2 d/
1982			584	3.9	127	4.8	7.0 d/
1983			227	3.9	127	4.3	2.5 d/
1980		Mid river	41	5.1	23	4.1	-2.8.4
1981			136	3.8	28	3.9	0.5
1982			196	4.1	54	4.4	1.8
1983			100	3.9	44	4.1	0.8

a/ Shoreline sampling with a beach seiner mid-river sampling with a purse seine. Insufficient yearling chinook salmon and steelhead were captured in the beach seine for evaluation,

b/ Morning defined as less than 2 hours after sunrise.

c/ Afternoon defined as greater than 6 hours after sunrise.

d/ Differences in morning mean fullness significantly different than afternoon mean fullness (P ≤ 0,05).

Table 44.--Diet overlap of juvenile salmonids[J] captured at Jones Beach, 6-19 May 1980.

Fish species compared X	Y	Overlap
Subyr. chinook salmons/	Yr. chinook salmon	
	Coho salmon	0.8a~
	Steelhead	0,2
Yr..chinook salmon	Coho. salmon	0.6 !
..	Steelhead	0.6a/
Coho salmon	Steelhead	0.3

a/: Classifications of food categories to order with unidentified. insects and' items. Which constitute less than 1% of the total .biomass present omitted.
b/ Index of diet overlap from Morisita'(1959) as modified by Horn (1966), based upon. the proportional biomass ofdiet items present in two species.
c/ Biomass of: one fish. present in the stomach of a single subyearling chinook salmon omitted.
d/ An' overlap value of 0.6 or greater is. considered significant (Zaret and Rand 1971).

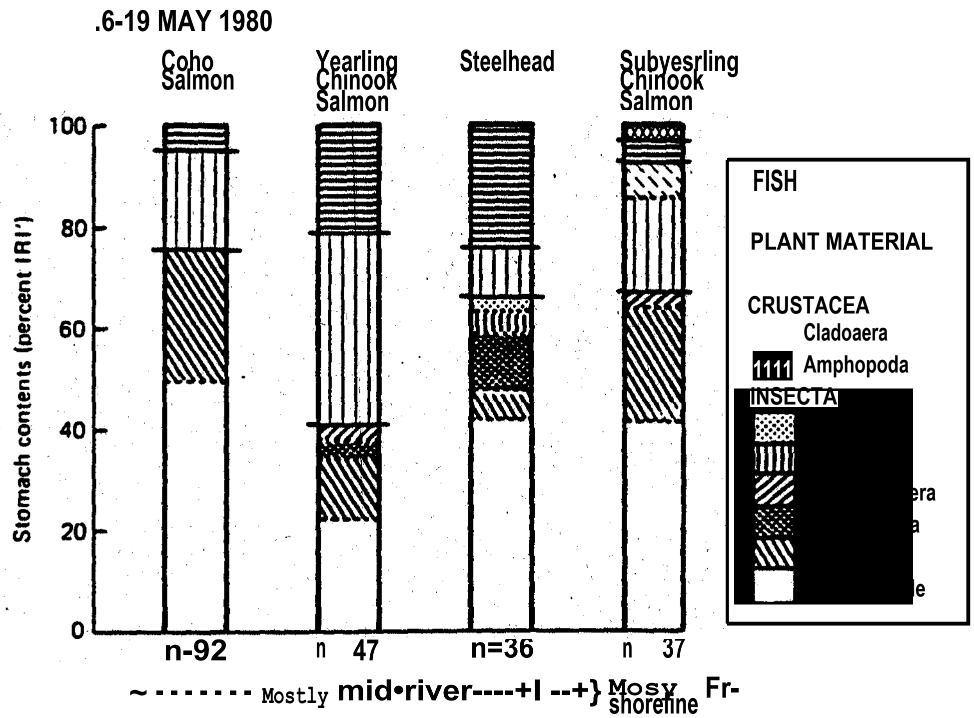

Figure 61.-Modified index of relative importance (IRI') for food items consumed by juvenile salmonids collected at Jones Beach, 6-19 May 1980.

(from 78 to 96% of the IRI'), with dipteran insects' predominant in coho and chinook salmon and .hymenopteran .insects dominating the diet. of .steelhead (Fig. 61). , Plant material: .accounted for more than 20% of the IRI.' for both yearling chinook salmon and steelhead.

Proximate Analysis.--Proximate analysis of stomach contents provided a cursory evaluation of food quality for the four salmonid species (Table 45). Compared to hatchery' diets, contents of migrants appeared low in protein (26-36%), high in carbohydrates (28-39%) and ash (13-24%), aR4,normal in fat (6-26%). The composition of Oregon Moist Pellet, OMP-2!a(, a standard hatchery diet, is: 52, 17, 13, and 192 protein, carbohydrate, ash, and fat, respectively (Westgate et al. .1983). The low protein percentage in' the stomach contents of migrant fish may have resulted from more rapid absorption of protein relative to ash and carbohydrates

Stomach Content Weight.--In 1982, the mean stomach content weights for subyearling and yearling chinook salmon, coho salmon, and steelhead collected throughout the May and June peak migration period were: 0.55, 0.16, 0.23, and 0.09% body weight (%BW), respectively (Table 46). The %BW of stomach contents decreased with increasing body size (Fig. 62) as previously observed for juvenile salmonids in culture situations (Buterbaugh and Willoughby 1967).

Statistical correlation of fullness value plus fork length or fish weight to weights of stomach contents was used to evaluate the consistency of the fullness data for 1982 (Table 47). Length produced slightly ,better correlation than body weight when, used as the second independent variable. Correlation was highest for subyearling chinook salmon (r- 0.78) and lowest for yearling chinook salmon (r - 0.70). By using fullness as an estimator of the actual contents weight (i.e., integer fullness values used to predict the continuously variable stomach content weight) about 50% of the observed variability' in the stomach content weight data was not explained with this model. There were. two main sources for the variation: (1) integer fullness values (previously discussed) and 12) estimating volume of food consumed by weighing. The first source of error is unavoidable because of the limitations inherent with visual indexes--even expanding the scale might not improve the resolution of the observations. The second source could be improved by using weights.. dried to constant weight (Congleton 1979). Blotted dry weights were used here to better allow for future prey identification.

Discussion

Caloric content of food ingested plus metabolic. activity. are the determinants of 'adequate nutrition. A thorough evaluation of nutritional

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20/ Reference to trade names does not.imply endorsement by the National Marine-Fisheries Service, NOAA.

Table 45.--Proximate analysis of stomach contents from juvenile salmonids captured at Jones Beach during May and June 1982.

Species	Wet weight (g)	Composition (% dry weight) a/				
		H_2O	Fat	Protein	Ash	Carbohydrate
Coho salmon b/	14.7	82.2	11.2.	31.5	23.0	34.3
Yr. chinook salmon	15.1	77.9	26.2	25.8	12.7	35.3
Steelhead	6.4	82.9	5.8	35.1	20.5	38.6
Subyr.chinook salmon	10.1	80.0	12.0	36.0	24.0	28.0

a/ Carbohydrate calculated by the difference.
b/ Eighty-four stomachs from May and June 1981 were lidded to the 1982 samples to obtain a minimum dry weight of 1.0g per sample.

Table 46.--Mean stomach content weight of juvenile salmonids captured at Jones Beach during May and June 1982.

Sample [a]	Subyearling chinook salmon: Sample (n)	Mean weight (g)	Mean stomach content weight (g)	Stomach content (% BW) [b]	Yearling chinook salmon: Sample (n)	Mean weight (g)	Mean stomach content weight (g)	Stomach content (% BW)
All fish	855	6.7	0.0371	0.55	96	39.1	0.0619	0.16
Fish selected by size [c]	244	5.1	0,0334	0.66	13	38.1	0.0571	0.15
	Coho salmon				**Steelhead**			
All fish	612	24.0	0.0562	0.23	108	109.0	0.0970	0.09
Fish selected by size	186	24,4	0.0573	0.23	14	101.2	0.1087	0.11

a/ Only data for fish with stomach fullness values >2 (feeding fish) were used.
b/ Stomach content weight as a percent of body weight.
c/ Size selection; ± 10% of the mean weight of fish captured except for subyearling chinook salmon for which 5g ± 10% was used for analysis to compare with fish from other areas.

Table 47.-Multi-linear relationships between stomach *content* weight, fullness value, and fork length or body weight for juvenile salmonids captured at Jones Beach during 1982.

MODEL --FORS LENGTH

$$\hat{Y} = B_0 + B_1X_1 + B_2X_2$$

Where: $\hat{Y}$ = Stomach content weight ($g^{1/3}$) a/

X_1 = Fullness 3-6 b/

X_2 = Fork length (mm)

Species	n	BO	B1	B2	Regression coefficient
Coho-salmon.----'	595	-0.04762	0.073123	0.0008154	0.74
Yr. chinook sal.	191	-0.11073	0.088765	0.0009689	0.70
Steelhead	100	-0.23261	0.105870	0.0011684	0.71
Subyr. chinook sal.	1314	-0.11986	0.057360	0.0020409	0.78

MODEL B--WEIGHT

$$\hat{Y} = B_0 + B_1X_1 + B_2X_2$$

Where: $\hat{Y}$ = Stomach content weight ($g^{1/3}$) a/

X_1 = fullness 3-6 b/

X_2 = fish weight (g)

Species	n	BO	B1	B2	Regression coefficient
Coho salmon	595	0.03373	0.073175	0.0012856	0.74
Yr. chinook sal.	191	0.00713	0.089054	0,0008066	0.70
Steelhead	100	0.05957	0.108370	0.0008304	0071
Subyr. chinook sal.	1314	0.02353	0.057047	0.0047928	0.76

a/ The cube root transformation of the stomach content weight was used to produce normally distributed' residual values of uniform variance.

b/ Fullness values 1, 2, and 7 omitted from the analysis because their relationship to stomach content weight is not linear.

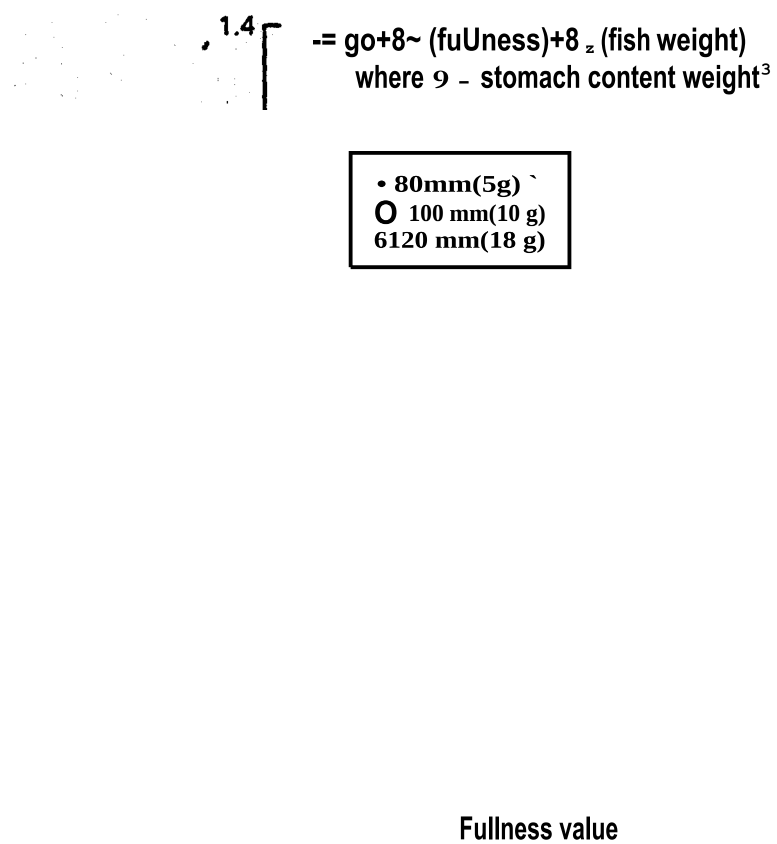

Figure 62. --Percent. body weight of stomach contents fox 5,.10, and 18.g subyearling chinook salmon aspredicted from a regression model with stomach fullness and fish weight as predictor variables from Table 47.

sufficiency for even ...a few. groups of migrants would be difficult and time. consuming. With substantially less effort,. evaluation of stomach fullness and content weights. provided a preliminary, evaluation of. feeding behavior and relative food .intake for thousands of .individuals representing many groups. Visual observation .of fullness takes about 1 minute per stomach compared with hours, in addition to the specialized equipment-, required for a comprehensive analysis.

There are compromises associated with using. estimates for fullness and stomach *content* weight to describe food consumption Comparisons between dissimilar sized. fish are affected by nonlinear variation of food requirements over' the size range of.juvenile' migrants (Patrick. 1974). Also, comparisons between similar. sized fish captured at different times are affected by differences in metabolic activity associated with water temperature' and differences of caloric intake from ..the prey items consumed. Therefore, statistical comparisons of fullness values were made only between mark groups passing'. Jones Beach .within narrow date. ranges. Significant differences in. fullness means were not always directly correlated .with fish size, 'but the mean lengths are presented for consideration (Figs.-54, 55, 57,'59, and 60).

Fish lose weight in' response to low nutritional intake.. *To* correctly identify fish'groups that have lost weight from malnutrition, feeding indices (%BW) were calculated using length' transformed to a corresponding body weight according to length/weight relationships observed for tagged fish at Jones Beach (Table 48)

<u>Compensation Mechanism for, Low Food</u>Availability.--Foraging. behavior of fish changes in response to food availability--Dill (1983)` termed this adaptive flexibility. As hunger increases, search for food increases and diet includes less preferred prey. Consequently,. a change in diet .or a change in migration rate, as well. as increased, numbers.. of empty stomachs might be indicators of low food availability... A diet change. for subyearling chinook salmon was observed at Jones Beach following ..the eruption of- Mount St. Helens. Sediment deposition reduced the supply of a preferred .food item, <u>Corophium</u> salmonis,.which resulted in a diet shift to insects and mysids.

<u>Food Consumption Compared with 'Juveniles in Other</u>Locations.--Stomach content weights (BW) of migrant chinook salmon captured at-Jones Beach were compared to those of juveniles in other geographical areas, rivers, and estuaries and indirectly to traditional feeding rates, at hatcheries.

1. Subyearling Chinook Salmon: Subyearling;chinook salmon, 77-82 mm fork length, captured at Jones Beach during May and June (about 5 g; Table 46), averaged about half full stomachs d stomach content weights averaged about 0.7 %BW (wet weights, Table 46)..t[1] Herrman (1971) found that stomach

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21/ During May and .June, the water temperatures at Jones Beach ranged between 10° and'19°C (mean 14°C). For this. evaluation,. non-feeding fish were considered atypical migrants and were notused,' therefore, providing a liberal estimated food. consumption.. for fish at Jones, Beach.

Table 48.--iencth/werght relationships of tagged juvenile salmonids captured at Jones beach during 1982 and 1983.

Species	n	Prediction Formula "	Correlation coefficient (r)
Coho salmon	3831	$\hat{wt}$ (1.24x10-5)(lth2. 94	0.96
		ith (51.42)(wt $^{0.313}$)	
Yearling	893	wt = (3.05)(10 $^{-6}$)(1th $^{3'22}$)	0.98.
chinook salmon		$\hat{1th}$ (52.98) (wt $^{0.300}$	
Steel head	1462,	wt (1.37x10^{-5})(lth2 $^{'91}$)	0.98
		1th (49.90)(wt $^{0.332}$)	
Subyearling	7215	wt = (6.79x10 $^{-6}$)(1th $^{3.08}$)	0.99
chinook salmon		1th = (47.47)(wt $^{0'320}$)	

= weight of fish (g)

ltn fork length of fish (me)

A. = predicted value

content weights averaged 1.2 %BW (wet weights) for similar sized chinook salmon; captured in the. Chehalis River estuary, Washington. Healey (1980) reported that stomach content weights ranged from 0.1 %BW in May (during peak abundance) to 5 %BW in June for chinook salmon in the Nanaimo River estuary, British Columbia (wet weights in 1975, dry weights in 1976 and 1977). Becker (1973) found that dry stomach content weights averaged 0.4% dry food to wet body weight for 5-g chinook salmon collected in the Hanford reach of the Columbia River (RKm 591 to 629). Converting these percentages to represent XBW (dry weight), assuming preserved fish were 20% dry matter (Healey 1978), the average stomach content weight of Becker's fish was about 2 %BW.

These comparisons generally indicate that subyearling chinook salmon captured at Jones Beach had low food consumption. However, both of the aforementioned estuary studies characterize subyearling chinook salmon residing in the estuary (Healey calculated growth of fish in June to be 5.8 XBW/day).. Likewise, fish examined by Becker in the Columbia River were residents of the sampling area. Subyearling chinook salmon captured at Jones Beach were actively migrating (average 16 to 18 km/day, Dawley at al. 1984) and such activity and physiological state (we assume that most are smolts) may affect foraging behavior. Loftus and Lenart (1977) observed heavy feeding by subyearl ing chinook salmon during downstream migration' in the the Salcha River, Alaska. Over 99% of juvenile chinook salmon smolts (mean length 73 mm) had fed prior to capture, and most stomachs were full and distended. Fish were sampled 1,544 km upstream from the ocean, and those smelts may not be comparable to smolts collected only 75 km from the ocean at Jones Beach.

2.. Yearling Chinook Salmon: Stomach content weights .for .yearling chinook salmon were available from. two upstream sites in the Columbia River: the reservoir of'l pum. Dam (RKm 707) and the reservoir of John Day Dam (RKm 395) (Rondorf.—). The mean. weight of fish captured at RKm 707 was 22.8 g and stomach contents averaged 0 .6 'XBW,: whereas at RKm 395, fish .were smaller, mean weight of 16.0 .g-and stomach. contents averaged 0.8 %BW (dry stomach content converted to wet weight, samples collected at 0900 h during May). At Jones Beach'during May-and June, : stomach. content weights for similar sized fish were less: 0.2 XBW (n = 27,.weight range 20.0 - 26.0 g)'and 0.6 %BW (n - 9, weight range 12.0 - 18.5 g).

3. Coho salmon and Steelhead: No data were. found regarding food consumption of yearling coho salmon or steelhead in rivers or estuaries.

Food Consumption at Hatcheries.--Bardach et al. (1972) reported that salmon reared Yn hatcheries at 10°-15°C require .daily rations of about 1 XBW/day for body maintenance, and upwards to.7 %BW/day for growth (weight of

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22/. D. Rondorf, U.S. Fish .and Wildlife Service, National Fisheries Research Center, Willard Station,: Star Rt., Cook, WA 98605, pers. common.'

food, about 20% water; and wet weight of fish). Fairgrave[3] found .that juvenile coho salmon (10-20 g fish) fed various hatchery diets at 0.6 %BW/day or less, exhibited negative, zero, or little growth.

Daily and morning hours rations were estimated for migrant fish captured at Jones Beach in May and June to ,compare with rations at hatcheries (Table 49). Diel observations of food consumption by juvenile salmonids were not made, so we assumed that available daily feeding.curves in 1ublished and unpublished literature (Johnson and Johnson 1981; Rondorf,_._ Table 49) properly represented diurnal feeding behavior of migrants captured at Jones Beach. The proportion of the total daily meal present in the gut in mid-morning (0800 to 0900 h) observed in those studies was about 22%. Assuming that proportion for average sized migrant fish at Jones. Beach (Table 46), the total daily ration for each species was about 3.0, 0.7, 1.0, and 0.6 %BW/day, respectively for subyearling and yearling chinook salmon, coho salmon, and steelhead (wet weight of food). If these, estimated daily rations are converted to 202 water for comparison to hatchery diets (0.03, 0.06, 0.13, and 0.05 %BW/day, respectively), all are. substantially below the body maintenance requirements for hatchery feeds. -

Interspecific Interaction.--Species interaction possibly caused lower feeding rates for yearling Chinook. salmon in May, when all 'salmonid: species were present in the Columbia River in large numbers.' Stein at al. (1972) observed that chinook salmon are less competitive than coho salmon, which impacts quantity and quality of food ingested. Interaction with steelhead elevated stress among yearling Chinook salmon (Park et Al. 1983, 1984), which may also affect their feeding success. Subyearling Chinook salmon are more shore oriented than the yearling fish, thus may not be affected' by the increased numbers of yearling. migrants. The observed .decline in food consumption .for all. yearling fish. during early June immediately following the peak migration period suggests one ormore of the following: (1) the food resources were cropped by large numbers of migrant fish, (2) .the food resources available to the migrants were reduced by increased water volume during June,. or (3) yearling fish 'passing 4t the later' portion of the migration. period were poor foragers.

Conclusions

1. Percentages of non-feeding fish within populations observed at Jones Beach were generally lower than 20, 10, and 30% for chinook and coho salmon and steelhead, respectively.

2. Relatively low mean fullness end high incidences of empty stomachs in particular fish groups were correlated with the following: close roximity of

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~[3]B. Fairgrave, Oregon Department Fish and Wildlife, 17330 S.E. Evelyn St., Clackamas, OR;' pers. commun.

Table 49.-Published and unpublished data assessing daily and morning hours .food consumption by juvenile salmonids.

River	Species	Age	Total daily[a] meal (mg)	Observations at 0800 or 0900 h: stomach content (mg)	Observations at 0800 or 0900 h: Portion of daily meal (%)
Orwell Brook[b] New York State	Coho salmon	0	10.6	1.83	17.3
Orwell Brook[b] New York State	Steelhead	0	7.8	1.40	17.9
Columbia River[c] at RKm 395	Chinook salmon	1	158.2	31.1	1947
Columbia River[c] at RKm 707	Chinook salmon	1	69.4	23.9	34.4
				Average	22.3

a/ Daily meal amount of food consumed per day.
b/ Johnson and Johnson (1981).
c/ D. Rondorf, U.S. Fish and Wildlife Service, National Fisheries Research Center, Willard Station, Star Rt., Cook, WA 98605, pers. commun.

release to recovery site and/or short migration ,period prior to recovery, early .March release of yearling chinook salmon, high turbidity from the .eruption of Mount St..Helens, and disease incidence prior to release at the hatchery.. Some: stocks of fish with high,.. percentages of 'non-feeding individuals could not be correlated with'knownphysical or biological factors likely tohave affected feeding.

3. Relatively high mean fullness. values were documented for Stayton. Pond groups that were cultured. in earthen ponds.

4. The 'turbid water resulting from the eruption of Mount St. Helens temporarily decreased ,food consumption `by. several stocks of subyearling chinook salmon and coho salmon.

Si The eruption of Mount St. Helens is not . expected to have long .term effects on the food resources of subyearling chinook salmon. Their decreased consumption of amphipods and increased consumption of insects, mysids,..and cladocerans "appears to be a temporary change. Partial restoration of amphipod consumption was observed in 1982, and continued improvement of..benthic substrateshould'allow complete recovery to pre-eruption levels.

6. Jones Beach appears to be a geographical area of dietary transition for subyearling chinook salmon. Other researchers found that fish captured upstream consumed primarily insects, and fish captured downstream consumed primarily amphipods, whereas fish we"captured at Jones Beach consumed both.

7. The decline in food consumption of yearling chinook salmon during the peak outmigration (May) may have been related to interspecific interaction and slow recovery of the food resources available. Significant dietary overlaps were indicated between the other salmonids. Decreased consumption was not apparent for subyearling chinook and coho salmon and steelhead.

8. Food items most important to juvenile salmonids near Jones Beach were insects including Diptera, Hymenoptera, Coleoptera, Ephemeroptera, and Trichoptera; and crustaceans including Amphipoda and Cladocera.

9. Stomach content weights from subyearling and yearling chinook salmon captured at Jones Beach` were less than similar sized fish examined at other estuarine and riverine locations Results of proximate analyses of stomach contents for fish captured at Jones Beach indicated that the food eaten was not of sufficient quality to compensate for low consumption rates.

10. Visual assessment of stomach fullness is a fast and economical method for examining the food consumption of large numbers of fish.

Visceral Fat Content of Subyearling. Chinook Salmon Captured at Jones Beach

Introduction

The quantity of 'fat within the visceral cavity surrounding the pyloric caeca, stomach, ,intestine, and spleen of juvenile salmonids was used by Myers .(1980) to differentiate between hatchery ' and wild fish in the Yaquina River estuary.- In Myers' study,' none of 18 wild coho or 87 wild chinook salmon had fat visible in the visceral cavity; whereas. many of the hatchery fish had internal organs completely obscured by fat..

We examined tagged subyearling chinook salmon captured at Jones Beach to determine if differences ,in visceral fat could be. used. to differentiate, between, wild and hatchery' fish in the Columbia -River. If , clear-cut differences were apparent for tagged hatchery fish, then the ratio of wild. to hatchery juveniles could. be estimated for unmarked fish.

In 1983, comparisons. of visceral fat between wild and hatchery stocks .of subyearling chinook salmon were possible..Timing at Jones Beach of. wild fish from the Lewis River (96,444 tagged fish, mentioned earlier--Table 16) was coincidental with .tagged fish from several hatcheries ' including the Cowlitz.. Comparison with Cowlitz stock was particularly appropriate. because the. Lewis and Cowlitz Rivers enter the lower Columbia River at'RKm 140 and RKa 109, respectively, and. the distance of migration was similar for both stocks.

Methods

Generally, fish used for visceral fat observations were those selected for stomach fullness observations; the selection was based on holding time restrictions necessary for fullness observation and time available for additional processing.

The body cavities of selected fish were opened longitudinally, and the body organs were observed for surrounding fat. Observations were quantified numerically: 1 • no visible fat; 2 some fat present; and 3 . extensive quantities of fat present.

Individual fish were weighed to ± 0.005 g (W) and measured to ± 0.5 mm fork length (L); condition factor (K) was calculated for each ,individual according to the formula K . W/L^3.

Results

From June through August 1983, a .total of 1,748 tagged subyearling chinook salmon were examined for quantities of visceral fat (1,522 . hatchery fish and 226 wild fish). Some individuals within all marked groups examined had visceral fat. Twenty eight percent of the hatchery fish examined had no, observable visceral fat, ' 38% had some fate, and 34% had extensive fa t

(Table 50). Included in the hatchery group were 481 fish released from the Cowlitz Hatchery (31% no fat,'. 36% some fat, ,and 33% extensive. fat).. There were 226 wild fish from the Lewis River examined -(47% no fat, 44% some fat, and 9% extensive fat).

There was- a strong decrease through time for. the proportion -of' Cowlitz Hatchery fish having visceral fat and anincrease through time. for. the Lewis River wild fish (correlation coefficient, r-,-0.9 and 0.6, respectively) (Fig. 63). The positive slope 'for the, relationship' of visceral fat' to date of capture for the wild fish may be related to decreased competition for food during late July and August; large, numbers of hatchery.. fish were migrating through the estuary in June;. in -comparison,.'few fish were passing Jones Beach in late July and August. More food-may be available to. later migrants which resulted in increased visceral fat of Lewis` River wild fish..

Condition factors of fish from Cowlitz Hatchery were nearly constant through the date range of recovery; overall mean 10.4x10 (Fig. 64). Conditio9 factors for Lewis River wild fish were higher (overall mean 10.7x10 °) and showed strong positive correlation with date of capture (r = 0.8). By early August the condition factor of the wild fish reached 11.0×10^{6}.

Stomach fullness of the wild fish was consistently greater than that of Cowlitz Hatchery fish and. of other hatchery fish passing during theperiod..

While' examining wild subyearling chinook from the.Lewis .Rivet, we observed a .high incidence of nematodes in, the visceral cavity (primarily in the air bladder). During the time period. when we consistently recorded the . incidence (1 July - 8 September 1983), 64%. of the fish, observed contained nematodes. These fish `appeared outwardly. .healthy and showed no significant difference in relative stomach fullness from those of- the same' tag groups without nematodes (P>0.4).

Conclusions

1. Observations of visceral fat content for subyearling chinook salmon captured in the Columbia River at Jones Beach are not useful f or separating Lewis River wild stock from hatchery fish because' a substantial portion of wild fish (53%) contained fat and 28% of the hatchery fish observed contained no fat.

2. _Differences in natural food resources available to wild chinook salmon may exist between the Lewis and' Yaquina Rivers which could explain the observed difference in the percentage of individuals containing visceral fat (53 and 0%, respectively).

Table 50.--Visceral fat• observations from subyearling chinook salmon captured At Jones Beach, June through August 1983.

	Fish observed						
	No fat		Some fat		Extensive fat		Total
			no.		no.	2	no.
Total hatchery fish	423	28,	574	38	525	34	1,522
Cowlitz Hatchery fish	147	31	175	36	159	33	481
Lewis River wild fish	106	47	99	44	21		226.

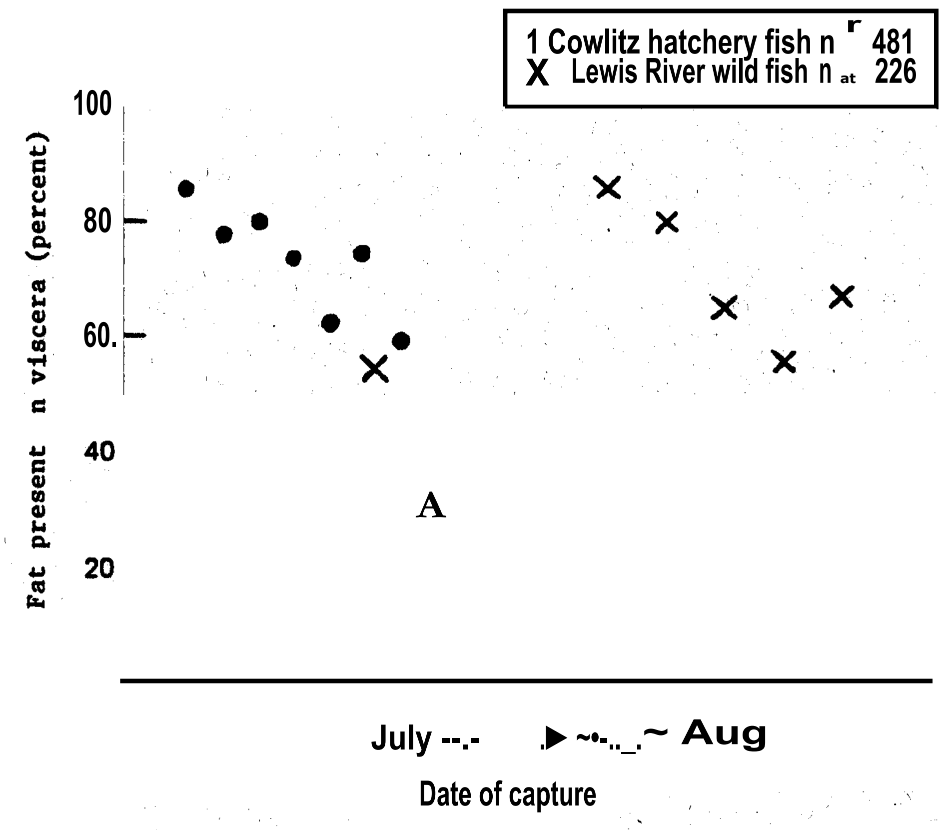

Figure 63.--Temporal plot of the proportion of subyearling chinook salmon of the Lewis'River wild and the Cowlitz Hatchery stocks containing fat,in the. visceral cavity, from marked Individuals.. captured at Jones Beach.

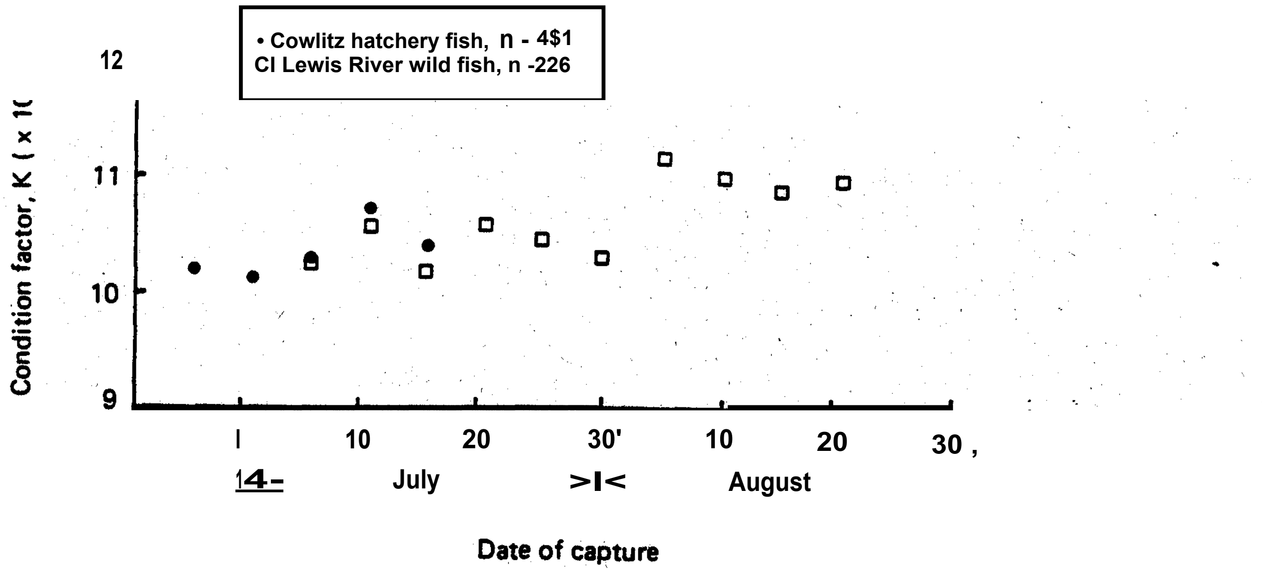

Figure 64.--Condition factor for Cowlitz Hatchery and Lewis River wild :subyearling Chinook salmon. by 5-day intervals (intervals with less than nine fish measured were. omitted),.

3. Cowlitz Hatchery fish rapidly lost visceral fat following release from the hatchery, whereas wild Lewis River fish gained visceral fat during the period of capture at Jones Beach.

4... Wild 'fish from Lewis River generally had More food. in their stomachs than hatchery fish.

Catches of Non-Salmonids

Introduction

Capturing fish of non-targeted ' species is inherent in sampling juvenile. salmonid populations. Migrating and resident species were captured at all times of the year and. inlarge numbers. The objective of this part of the report is to document catches of these fish.

Results

Non-salmonids comprised nearly 40% of the total catch at Jones Beach (Dawley et al. 1985a). Adult and juvenile threespine stickleback, Gas terros teus aculeatus, and peamouth, Mylocheilus caurinus, were' captured in large numbers year-round. Large catches of juven American, shad, Alosa sapidissima, were obtained during their migration period (April through November). Two separate size groups were recovered each year. Large individuals were generally captured between April and August with a peak in May when they averaged about 105 mm fork length. More numerous. smaller individuals were captured from July to December; peak catches occurred during the fall (undefined because of limited sampling in the fall) at an average fork length of about '70 mm. Eastern banded killifish,' Fundulus diaphanus, were captured in the beach seine 'in 1971, 1981, and 1983 Le gerwood et al. 1985); the Columbia River is not described as part of the normal geographical range for this species (Scott and.Cros,sman 1973).

In 1980, there was a significant increase in beach seine catches, of several predator and-scavenger fish species at Jones Beach, beginning with the heavy turbidity created by the eruption of Mount St. Helens. Catches of northern squawfish, Ptychocheilus oregonensis; prickly sculpin, Coottus aspen; peamouth; and suckers, Ca tos torous sp., in late May and June were more than double those of previous years (Fig. 65). These fish were adults, not juveniles. It is possible that the increase in the catch resulted from fish being forced out of the Toutle and Cowlitz Rivers by high .water temperature and turbidity.

Population changes of northern squawfish at Jones Bosch were of particular interest'due to their role as a predator in other areas (Ricker 1941; Jeppson and Plaits 1959; Thompson 1959; Thompson and Tufts' 1967, Steigenberger and Larkin 1974; Uremovich et al. 1980;- Bentley and Dawley 1981). We observed an increase of squawfish during the sampling period. Catches escalated from none in 1966 to 1,754 in.1981. The trend of population increase was accelerated in 1980, as previously discussed. Stomach contents from a subsample of squawfish captured in 1983 were examined to determine the

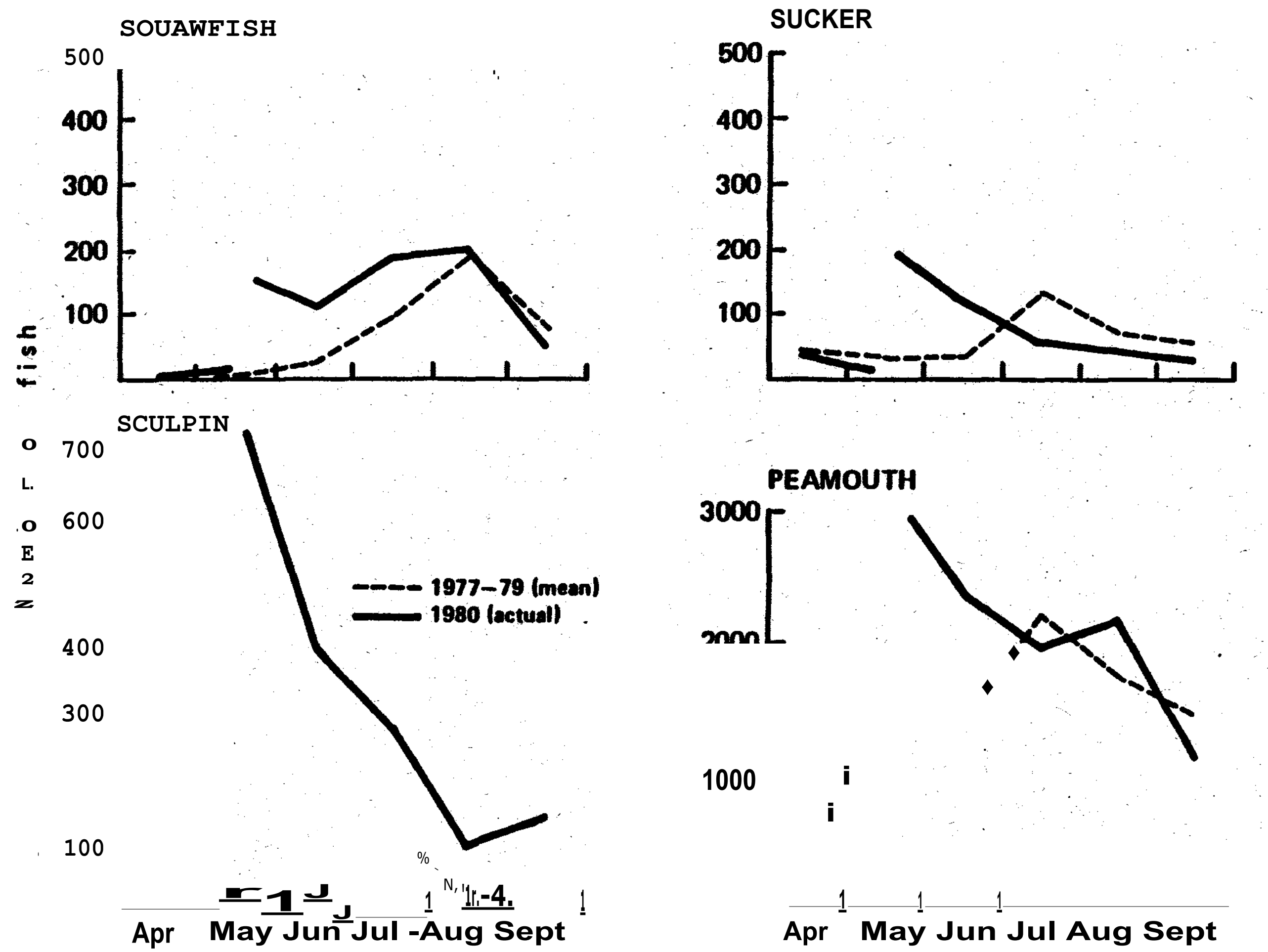

Figure 6 . --Monthly beach seine catches of predator and scavenger species at Jones Beach for 1977-1979 (3-year means), compared to 1980. The month of May 1980 is divided into catches before and after arrival of highly turbid water.

extent of predation on juvenile salmonids. Ninty-five percent of the 197 squawfish examined contained food items, primarily crustaceans, insects, and fish. None of the squawfish examined had consumed salmonids. For details of the squawfish population change and stomach content analyses refer to Kim et al. (1985).

SUMMARY AND CONCLUSIONS

1. Generally, subyearling chinook salmon concentrate in shallow near-shore areas of the estuary, and when they are in deep water areas they are found within 3 m of the surface. However, large fish (< 50/lb) and those that migrate long distances (>250 km) before entering the estuary do not concentrate in near-shore areas.

2. Yearling salmon and steelhead concentrate in mid-river areas except early in the year (March, April, and early May), presumably prior to smol tif.ica tion.

3. Most movement of juvenile salmonids through the estuary occurs during daylight hours. Tidal conditions and direction of flow do not appear to substantially influence diel movement patterns. Generally, diel movement patterns appear consistent between years, and sampling 7 h/day in the morning provides samples which are representative of the overall migrant population.

4. Timing of the juvenile salmonid migrations into'-the estuary-"is primarily dependent on dates of release from hatcheries and river flow. Generally, high river flows cause faster. migration through the. river. In some instances., fall released fish groups' overwintered upstream from Jones-Beach and migrated in the spring; size of fish and stock differences appear to have influenced the migration timing.

5. Movement rates of. marked groups of subyearling chinook salmon and coho .salmon increase with size at release and. distance of migration... From 1966 to 1972, larger individuals of marked 'groupsmigrated at a faster rate than smaller fish; however, within . groups observed from.1977 to 1983, the larger individuals did _not necessarily move at a faster. rate. This change of migration behavior may have resulted from a general increase in site of fish at release, and, for coho salmon specifically, later dates of release. We speculate both. factors increased the proportion of smolted .dish among the smaller individuals'. of most groups and resulted in more uniform migration rates.

6. Movement rates through the estuary and into the ocean are similar to rates from release site to .the estuary, indicating that the use of' the Columbia River estuary by juvenile salmonids originating upstream from Jones Beach is rather limited compared to documented use of other estuaries..

7.- Increased river flow causes decreased catch rates of all species, which decreases precision of'comparisons between time periods. An adjustment factor was computed to standardize catch percentages of groups recovered at different flow conditions.

8. Total numbers of subyearling chinook salmon, yearling chinook salmon, coho salmon, or steelhead sampled in the estuary do not relate to numbers of returning adults because 'overall survival' rates are different between stocks. However, estuarine catch data are useful for within stock examination of survival differences among treatments. Generally, estuarine samples which show statistically significant differences among groups, show similar

differences in adult recoveries. However, many, groups which showed differences in returns of'adults did not show differences in juvenile sampling data. Trends of survival differences between treatment and' control groups were attainable from estuarine sampling in evaluations of size at release; release date; release site; and' from particular studies with density, nutrition, and fish stocks.

9.. Minimum-size thresholds for migration and survival of Columbia River coho and wild fall chinook salmon and Willamette steelhead were supported with Jones Beach data.

10. Baseline data for catch rates for marked groups can be used for identifying groups which have substantially'decreased survival during river migration.

11. Food consumption of migrants examined at Jones Beach appears. to be substantially less, than in other reaches of 'the ' river ' and in other river systems. Interspecific interaction or competition for food may be decreasing the overall 'food consumption 'rates , for yearling ''. chinook salmon..:--. Adverse environmental conditions from the eruption of Mount 'St.. Helens. caused decreased feeding, alteration of available food resources, and decreased survival of juvenile migrants.. Cultural practices., poor health, and ' release timing also affect food consumption of migrants. Although insufficient-data are ` available for evaluation",'.... we ' suspect that decreased '. feeding rate may impact survival to adulthood.

12. Absence of fat `within the. viscera of migrants captured at Jones Beach was not usable as an indicator for wild subyearling chinook .salmon.

13.. Resident populations of sq uawf ish have increased dramatically At Jones Beach during the period of sampling, however,, there are no 'signs of their predation on salmonids.

14. Researchers and culturists made extensive use of the estuarine sampling 'data to evaluate migration timing and relative success of marked groups. Additionally, marked fish from specific groups were utilized to: compare various physiological changes which occurred during migration, to evaluate transmission of disease between stocks originating from different tributary streams that mingled during migration, and to evaluate changes of sex ratio within populations of coho salmon following migration. We conclude that observation of marked fish groups at the terminus of freshwater migration is important to salmonid enhancement activities.

ACKNOWLEDGMENTS

The success of this evaluation of estuarine .catch . . data depended upon the cooperation and assistance from. personnel of state and federal fishery agencies. Of primary importance in the study ,of subyearling chinook salmon survival were personnel of the U.S..,Fish and Wildlife Service (USFWS) Elmo Barney and staff, Jack Bodel and his staff; personnel of the Oregon Department of Fish and Wildlife (ODFW).Ken Johnson, Art Oakley, Ed Weiss, Brunell Boho, Vern Knowles, and Ray Sheldon and his staff; personnel of the Washington Department of Fisheries (WDF) Dick Noble, Harry Senn, Bob Haggan, Bill Hopley, Dick Johnson and his staff, and Carl Ross and his staff. Mark release information and adult recovery data Were, expedited for our needs; we relied heavily on assistance from Steve Leek and Steve Olhausen of USFWS; Dennis is sac, Harold Hansen, Eugene Smith,, Jeff Zakel, Jean Legasse, and Lynn Roberts of ODFW, Dick O'Conner, Gary Sherman, Bob Foster, Guy -Norman, and Rich. Schneider of WDF; and `Rodney Duke of the Idaho Deparmentof Fish and.Game. Our thanks to these individuals for. helping produce these. data and observations.

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APPENDIX A

Uses of,Estuarine Catch Data and Biological Samples, or Observations Collected for Related Research

A

INTRODUCTION

Upon request biological observations were made and tissue samples collected for other research programs. Tissues and internal organ observations were only made from fish sacrificed for tag identification. The objective of this section of the report is to provide examples showing how data obtained at Jones Beach are being used by managers and other researchers.

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APPENDIX B

Miscellaneous Tables Relating to Migration of Juvenile Salmonids

Appendix Table B1.--Number and percent recovery of juveniles at Jones Beach and adults from mark groups which were identified as replicates or.near replicates. and used to empirically define sampling variability.

Appendix Table B2.--Mean stomach fullness and standard deviation for juvenile salmonids captured in purse and beach seines.. at Jones Beach by 3-'day intervals, 1980.

Appendix Table B3.--Mean stomach fullness and standard deviation for juvenile salmonids captured in purse and 'beach seines at' Jones Beach by 3-day intervals, 1981.

Appendix Table B4.--Mean stomach fullness and standard deviation for juvenile salmonids captured in'purseand beach. seines at Jones Beach by 3-day intervals,. 1982.

Appendix Table B5.--Mean stomach fullness and standard deviation for juvenile salmonids, captured in purse and. beach seines at Jones Beach by 3-day intervals, 1983.

Appendix Table B6.--Status of juvenile salmonid stomachs collected at Jones Beach (RKm 75), 1979-1983.

Appendix Table B7.--Source, date of median recovery, and tag codes for fish groups used in graphic comparison of stomach fullness (Figures 44, 45, 46, 47, and 48). Subyearling and yearling chinook salmon, coho salmon, and steelhead groups captured at Jones Beach in 1982 and 1983.

Appendix Table B8.--Taxonomic classifications and codes for food items found in juvenile salmonids from the lower Columbia River and near-shore marine waters.

Appendix Table B1.--Number and percent recovery of juveniles at Jones Beach and adults from mark groups, which were identified as, replicates or near replicates and used to empirically define sampling variability.

REPLICATE GROUPS 1983

""RaFR"n1""- (Loc Br Rot) (Ag/D1/D2)	Rglease IInforwitign Site (source) b/	Number	Date (da/so/yr)	Juvenile catch at Jon s (no.)	ch c/ (W	Adult Rec ▶ tEi Ino.)	std/ (2)
			SgbXeorlio cch;1nook sQUon				
07/27/27	Bonn, Hat.	50,000	04/Nay/83	82	0,164		
07/27/28		50,800		90	'0.177		
07/27/29		52,600		85	0,162		
07/27/30		47,400		86	0,181		
05/11/42	Spring Cr. Hat.	49,700	28/Apr/83	65	0,131		
05/11/43		51,300		71	0,138		
05/11/44		51,700		82	.00159		
05/11/45		52,100		89	0,171		
RD U 3	Bonn. Dom	51,400	02-03/Nny/83	89	0,173		
RD U 1	(Sp. Cr. Not.)	53,200		100	0,188		
LD U 3		53,900		107	0,198		
LD U 1		52,800		107	0,203		
07/23/28	Wi11om. River	28,900	26/Apr-19/Nay/83	17	0,059		
07/28/30	(Stayton Pd.)	24000		24	0,100		
07/28/31		26,000			0,074		
07/28/32		26,200		15	0,051		
07/28/33		24,800		36	0,150		
07/28/34		26,800		16			
			Yearling chino~ksalmi				
07/23/63	Bonn. Hat.	45,900	01/Nov/82	123	0.268e/		
07/25/46		51,600		123	0.230/		
07/25/48		50,700		107	0.211e/		
07/25/45		48,600		107	0.220e/		
63/24/50	Cowlitz Hat.	8,300	01/Sep/82	1	0.012e/		
63/26103		51,200		15	0.029e/		
63/25/05	"	73,000	04/Apr/83	18	0,025		
63/25/06		77,500		26	0,034		
			Coho salmon				
63/26/13	Cowlitz Hat.	10,900	03/Nay/83	19	0,174		
63/26/14		10,400		11	0,106	-	-
63/26/15		10,400		26	0,250	-	-
63/26/16		10,700		16	0,150	-	-
63/26/17		10,000		12	0,120		
63/26/18		10,000		8	0,080		
63/26/19		10,200		8	0,078		
63/26/20		10,100		19	0,188		
63/26/21		10,300		16	0,155	-	-
63/26/22		10,500		21	0,200	-	-
63/26/23		10,600		24	0,226	-	-
63/26/24		10,200		11	0,108	-	-
63/26/25		10,300		14	0,136	-	-
63/26/26		10,600		7	0,066		
63/26/27		10,400		15	0,144		

Appendix Table BI.--continued.

			Colic so1mon				
63/26/28	Cowlitz Hot.	10,200	03/Mor/83	19	0,186		
63/26/29		10,300		16	0,155		
63/26/30		10,400		17	0,163		
63/26/31		10,200		17	0,167		
63/26/32		10,600		17.	0,160		
63/26/33	'	10,500		21	0,200		
63/26/34		10,100		22	0,218		
63/26/35		10,600		11	00104,		
63/26/36		10,400,		16	0,154		
63/26/37		10,500		10	0,095 ,		
63/26/38	,	10,500	'	17	0,162		
63/26/39		10,100		16	0,158		
63/26/40		10,200		15.	0,147		
63/26/41		10,000		13	0,130		
63/26/42		10,700		19	0,178		
05/11/33	Engle Cr. Hot.	60,500	04/Mor/83	78	0,129		
05/11/34		62,800		76	0,121		
05/11135		40,900		45	0,110		
05/11/36		39,300		65	0,165	-	-
05/11/37		20,900		32	0,153	-	-
05/11/38		20,300		36	0,177	-	-
07/27/31	Sandy Hot.	54,700	29/Apr/83	32	0,059		
07/27/36		54,900		46	0,084		
07/27/32	. .		.	34	0,062		
07/27/35		54,60		33	0,060		
07/27/33		54,100	.	36	*0,066*		
07/27/34		54,700		37	0.068.		
63/26/51	Woshougol Hot.	8,000	.27/Hoy/83	7	0,087		
63/26/52		7,900		3	0,038		
63/26/53		8,000		4	0,050		
63/26/54		8,000					
63/26/55		7,900		8	0,101		
63/26/57		9,700		7	0,072	-	-
63/26/58		9,400				-	-
63/26/59		.9,800		4	0,041		
63/26/60		.9,700		7	.00072		
63/26/61		9,900		5	0,050		
63/26/62		9,900		5	0.050.		
63/26/63		9,900		10'	0,101		
63/27/01		9,700		3	0,031		
63/27/02		10,000		. 7	0,070	-	-
63/27/03		10,100		7	0,069	-	-
63/27/04		10,400		7	0,067	-	-
63/27/05		10,100		10	0,099	-	-
63/27/06		10,600		5	0,047	-	-
63/27/07		10,100		3	0,030	-	-
63/27/08		10,400		3	0,029	-	-
63/27/09		10,300		9'	0,087	-	-
63/27/10		10,400		8	0,077	-	-
63/27/11		10,400		5	0,048	-	-
63/27/12		10,500		7	0,067	-	-
63/27/13		10,000		7	0,070	-	-
63/27/14		10,900		8	0,073	-	-
63/27/15		10,300		8	0,078	-	-
63/27/16		10,300		3	0,029.		
63/27/17		10x600		12	0,113		

Appendix Table B1.--continued.

			Coho skkron		
05/09/28	Willard Hat.	22,600	07/Jun/83	22	0.097
05/09/29		22,200		20	0.090
05/09/30		21,900		18	0.082
05/09/31		22,500		14.	0.062
05/09/42		23,300		21	0.090.
05/09/43		22.800		17	0.075
05/09/32.		23,300		16	0.069
05/09/33		20,800		16	0.077
05/09/38		22,200		19	0.085
05/09/39		21,900		,23	0.105
05/09/40		20,500		17	0.083.
05/09/41 '		23,000		32	0.139-
05/09/34		23,700		19	0.080.
05/09/35		22,100		13	0.059
05/09/36		22,700		23	0.101
05/09/37		22,200.		15	0.067.
05/09/44		23,200		23	0.099
05/09/45.		23,300		18	0.077
			Stg jjegd_ .		
63/28/391 RAS1	Lyons Ferry Hot.	33,000	09-13/Hny/83	96	0.291
63/28/401 RA S2		32,000		78	0.244
RD KE 2	Wh.R Falls/Rnd.Butte	1,000	01/Jun/83	1	0.100
RD KE 3		1,000	06/Jun/83	1	0.100

Appendix Table B1.—continued.

REPLICATE GROUPS 1982

'Rork q7' (Loc Br 9ot) (Ag/D1/D2)	Releuse_Infornation _ Site (source) b/	Nudber	Date (da/.o/ir)	Juvenile catch at Jones Cno:1	.Beoch c/ ;13T '	Adult R o (no.T	es d/
		mrling_chinook sa					
05/10/58 05/10/59	Abernathy SCDC	9 0, 29 00	20/Apr-01/Jun/82	93 34	`0.103 0.114	7	0.008 0.007
07/24/14 07/24/15	Bonn. Hat,	51,600 52,400	04/Jun/82	34 50	0,066 0.	0	0.000
07/24/16 07/24/17		52,500 54,100		45 46	0.086 0.085	0' 0	0.000 00000.
LD T 1 RD T 1	Bonn. Dai Hat. (Bonn. Hat.)	51,800 54,400		221 199	0.427 0.366	-	-
LD T 2 RD T 2		52,900 49,800		215 159 .	0.406 0.319		
05/04/35 05/04/36	Lit,Ub.Snl.Hat.	101,300 98,400	02-03/Jun/82	121 .146,	0.119 0.148	0 0	0.000 0.000
'07/23/30 07/24/11	Oxbow Hot.	52,300 52,500	04-25/Jun/82	45 46	0.086 0.088	0 0	0.000 0.000
05/08/51 05/10/57	Spring Cr. }into	46,700 102,300	08-13/Apr/82	48' 105	0.103 0.103	.8 10	0.017 0.010
05/10/53 05/10/54	Spring Cr. Hat,	43,100 48,500	15/Apr/82	68 ' 71	0.157 46	3 12	 0025
05/10/55 05/10/56		41,200 48,200		71 64	0.172 0.133	8 7	0.019 0.014
		Ne rding chnoa. Inon					
63/23/09 63/23/10	Cowlitz Hat.	23,900 23,200	01/Apr/82	16 6	0.067 0.026	18 30	0.075 0.129
63/23/11 63/21/34		24,300 24,000		10 9	0.045 0.038	11 20	0.045 0.083
07/25/25 07/25/26 07/25/27	N. Santini R. (Marion Fks Hat.)	50,600 50,600 49,500	17/Mar/82	12 13 26	0.024 0.026 0.053	0 0 0	0.000 0.000 0.000
07/25/28 07/25/29 07/25/30		50,000 49,400 49,200	18-22/Mar/82	14 22 20	0.028 0.044 0.041	1 0 2	0.002 0.000 0.004
10/24/121 RD SU 4	S.FK. Salmon R. (McColl Hat.)	40,700 ,	08-10/Apr/82	16	0.039	f/	
10/24/131 RD SU 2		40,500		25	0.062	f/	
		9 Slsgn					
07/24/29 07/24/33	Cascade Hot.	27,700 28,200	25/Mor/82	25 30	0.090 0.106	111 121	0.401 0.429
63/24/20 63/24/21 63/24/22 63/24/23 63/24/24	Cowlitz Hat.	9,700 800 10,300 10,200 10,100	03/Mar/82	18 15 25 18 19	0.184 0.154 0.240 0.175 0.188	89 77 93 85 103	0.908 0.778 0.894 0.825 1.020
63/24/25 • 63/24/26 63/24/27 63/24/28 63/24/29		10,500 .10,400 10,400 10,500 10,400.		13 15 15 18 11	0.124 0.143 0.144 0.171 0.106	145 110 114 106 116	10381 1.048 1.096 1.010 1.115

Appendix Table B1.--continued.'

Coho saleon

63/24/30	Cowlitz Hat.	10,500	03/HoY/82	17	0.160	97 •	0.915
63/24/31		10,500		13	0.123.	102.	0.962,
63/24/32		10,100		16	0.157	92	0.902
63/24/33		10,400		17	0.163	100'	0.962;
63/24/34		10,400		18	0.171	83	0.790
63/24/35		10,300		18	' 0.175	98'	-0.951
63/24/36		10,300		20	0.194	122	1.184
63/24/37.		10,100		17	0.168	101	1.000
63/24/38		10,200		20	00196	119	1.167
63/24/39		10,300		17	00165	115	1.117
63/24/40		10,500		24	0.226	138	1.302
63/24/41		10,600		16	0.150	133	1.243
63/24/42		10,600 ,		17	0.159	133	1.243
63/24/43		10,400		22	0.210.	.145	1.381
63/24/44		10,700		22	04206	122	1.140
63/24/45		10,200		16	0.155 '	140	1.359
63/24/46		10;300		21	0.202	136	1.308
63/24/47		10,500		24	0.226	122	1.151
63/24/48		10,200,		.15	0.146	113	1.097
63/24/49		10,000		19	0188	105	1.040
05/10/35	Eagle Cr. Hot.	20,000	06/Mor/82	29	0.145	159	0.795
05/10/36		19,100		42	0.220.	119	0.623
05/10/37		42,600		68	0.160,	250	0.587.
05/10/38		42,400		77	0.182	257	0.606
05/10/39		64200	''	114	0.167	387	0.567
05/10/40		66,600		115	0.173	379	0.569
07/25/49	Sandy Hat.	23,900	30/Apr/82	31	0.129	361	1.504
07/25/57		28,100		43	0.153	398	1.416.
07/25/50	',	26,400		50	0.189	396	1.500
07/25/58		27,800		36	0.129'	378	1.355
07/25/54		27,600		46	0.167	345	1.250
07/25/51		27,200		34	0.125	372	1.363'
07/25/55		28,200		33	0.117	411	1.452
07/25/53		25,900		25	0.096	315	1.212
07/25/56		27,600		43	0.156	336	1.217
07/25/52		26,800		36	0.134	407	1.513
63/25/13	Washougal Hot.	10,100	25/Har/82	9	0.088	42	0.412
63/25/14		9,800		9	0.091	33	0.333
.63/25/15		10,200		14	0.136	29	0.282
63/25/16		9,900		6	0.061	35	0.354
63/25/17		.9,800		6	0.061	44	0.449
63/25/18		10,100		6	0.059	38	0.376
63/25/19		10,100		8	0.079	39 '	0.386
63/25/20		10,000		4'	0.040	37	0.366
'63/25/21		10,200		4	0.039	43	0.422
63/25/22		10,200		12	0.117.	37	0.359
63/25/23	'	10,100		7	0.069	59	0.578
63/25/24		10,000		4	0.040	38	0.376
63/25/25		10,100		5	0.050-	66	0.653
63/25/26		10,100		'7	0.069	30	0.294
63/25/27		10·000		9	0.089	51	0.505

Appendix Table B1.--continued'.

			Coho Bolton				
63/25/28	Hoshougol Hot.	10,100	25/Mor/82	9	04089,	61	0.604
63/25/29		10,100		12	0.118	42	0.412
6 /3		10,100		10	0,099	60	0.594
63/25/31		10,000		4	0.040'	47	0.470
63/25/32		9,900		3	0.030.	58	0.586
63/25/33		9,600		8		26	406
63/25/34		9,600			0,094		0
63/25/35		9,600		' 5	0.052	38 40	0.412
63/25/36				7	0.073	30	0.313
63/25/37		4,600		11	0.113	35	0.361
63/25/38		8,000		8	0.100	22	0.275
63/25/39		7,900		e	0,101	47	
63/25/40		8,100				30	0.370
63/25/41		8,100		2 4	0.025 0.049	'37	0.457
63/25/42		7,900		7	0.088	31	0.388
			Steelhead				
10/24/04	P.ahsieeroi R.	40,100	09/Apri82	56	0.139	160	0.398
10/24/50	(Niagara Spr.Hot.l	40,500		47	0.116	144	0.356

Appendix Table B1.--continued.

REPLICATE GROUPS 1981

ro7" (Loc 1060 (Aq/D1/D2)	Release Information Site (source) b/	Huger	Date (da/.o/yr)	Juvenile catch at Jones Beach c/ tno.3~`T1T		Adult Rec~.eti (no:T	d/ T
			5stb a ,lingchinoak 91eon				
05/07/44	Abernathy SCDC	22,300	15-26/Apr/81	11	0.049	87	0.389
05/07/45		74,100		48	0.065	260	0.351
07/23/41	Bonn, Hat.	50,800	12/May/81	45	0.089	37	0.073.
07/23/42		51,600		45	0.087	24	0.047
07/23/43		53,200		59	0.111	30	0.056
07/23/44		51,800		55	0.106	59	0.114
07/23/45		51,000		41	0.080	10	0.020
07/23/46		50,800		58	0.114	32	0.063
05/07/47	Lit.Uh.Sal.Hat.	183,400	04-05/Jun/81	117	0.064	12	0.007
05/08/49		52,400		43	0.082	1	0.002
05/08,'0		13,300		4	0.030	1	0.007
05/07/43	Rock Creek	25,700	21-22/Apr/81	10	0.039	50	0.194
05/07/46	(Spring Cr. Nat.)	150 ,500		56	0.037	311	0.207
05/07/40	Spring Cr. Hot.	104,600	25/Mar/81	63	0.060	42	0.040
05/07/48		28,800		12	0.042	8	0.028
05/07/50		13,700•		9	0.065	1	0.007
05/07/51		15,300		8	0.052	6	0.039
05/07/41		76,700	15/Apr/81	78	0.102	54	0.070
05/07/49		30,900		35	0.113	25	0.081
			Y Wrllnoch'no sgpon				
10/22/21	Leah R.	50,000	08/Apr/81	7	0414	10	0.020.
10/22/22	(Hayden Pd.)	51 ,000		7	0.014	4	0.008
10/05/19	Kooskio Hat.	17,900	07/Apr/81	2	0.011	0	0.000
10/22/19		37,700			o.008	2	0.005
10/22/20		38,600	08/Apr/81	4	0.010	1	0.003
07/22/47	N. Unbar R.	49,900	05/Nov/80	4	0,008	8	0.016
07/22/48	(Marion Fks. Hot.)	49,900	06-07/Nov/80	5	0.010	11	0.022
07/22/51		47,100	16-23/Mar/81	7	0.015	22	0.047,
07/22/50		49,600	17-20/Mar/81	7	0.014	20	0.040
07/22/49		50'200	18-20/Har/81	10	0.020	24	0.048
07/22/53		42 , 200	16-24/Mer/81	10	0.024	27	0.064
07/22/52		39,600	23-24/Nor/81	10	0.025	34	0.086
07/22/18	Mckenzie8Leaburg	32,300	05/Nov/81	i	0.003	23	0.071
07/22/21	(McKenzie Hot.)	37,900		4	0.011	17.	0.045
10/22/36	Rapid R. Hat.	49,000	12/Apr/81	3	0.007	f/	
10/22/37		44,200		7	0.016.	2	0.005
10/22/38		51,900		10	0.019	1	0.002
			ohoo sg n				
07/22/55	Sandy, Rat.	27,600	01/May/81	21	0.076	.363	1▸313.
07/22/57		28,900		16	0.055	387	1.337
07/22/56		27,300		20	0.073	371	1.358
07/22/5h		28 ,000		12	0.043	364	1.298
07/22/59		29,800		34	0.114	535	1.792
07/22/62		27,700		25	0.090	501	1.803
07/22/60		28,100		17	0.061.	442	1.573.
07/22/63		29,600		18	0.061	485	1.636

Appendix Table B1.--continued..

			Coho solson				
07/22/61	**Sandy** Har.	29,700.	01/May/81	20	0.067	451	1,515
07/23/01		28,800		22	0.076	454	1.571
07/21/27	Tanner Creek	24,900	06/0ar/81	24	0,098	510	.2.047
07/21/30	(Cascade Hat.)	26,600		'28 -	0.105,	488.	1,828
07/21/28		27,900	08/Jun/81:	21.	0,075	1017	3.644
07/21/31.		26,000		25	0.096'	752	2.883
07/21/29		27,700	06/Jul/81	13	0.047	811	2.925.
07/21/32		28,900		19	0.066	644	2.225
RA IT 1	Rock Island	5,000	24/May/81	2	0.041		
RA IY 2	(Turtle Rock Pd)	4,900	25/May/81	I.	0.021.		
LA IY 1		5,000	27/Mar/81	2 .	0.040..		
LA IY 2		4,900	28/110/81 ,	1	0.021;		
LA **IN** 2		1,000	01/Jun/81	1	0.101		
LA IN 4		1,000		1	0.101		
63/21/50	Washougal Hat.	51,700	30/Apr/81	45	0.087	366	0.707
63/22/02		51,900		46	0.089	226.	0.435
			Steelh.ml				
LA P 2	Clarkston	1,700	01/Mar/81	3	0.175		
LA S 1	(to. Granite DAM)	2,200		3	0.137		
LA P 3		5,500	05-09/May/81	10	0.181		
LA S .2		6,,800		13	0.191		

Appendix Table B1.--continued.

REPLICATE GROUPS 1980

Release Information				Juvenile catch at Jones Beacch.~~/		Adult Rem veerigs d/	
(Loc Br Riot) (Ag/D1/D2)	Site (source) b/	Number	Date (da/ao/yr)	tno:I`	CZT~	(noa	(t)
			SugvearlinQ chinook 1				
07/21/33	Bonn, Hat. .	50,400	27/Mar/80	12	0.024	17	0.034
07/21/34		49,900		14	0.028	24	0.048
07/21/35		48,000		24	0.050	10	0.021
07/21/36		49,400		26	0.053	21	0.043
07/21/62	Masonic Lt.	50,100	27-28/Nar/80	21	.0.042	21,	0.042
07/21/63	(Oxbow Hat.)	53,000		20	0.038	32	0.060
05/06/48	DS Bonn. Dai	99,500	19/Nor/80	40	0.040	1091'	1.096
05/06/49	(Spring Cr. Hat.)	99,700		31	0.031	1021	1.024
			ing rhinQok'saloon				
10/21/25	Leehi R.	40,100	01-03/Apr/80	2	0.005	18	0.045
10/21/26	(Hayden Cr. Pd.)	41,100	03-04/Apr/80	4	0.010	11	0.027
LD IL 2	Methow R.BMo.	15,000	05/Hey/00	5	0.034		
RD A 2	(Leavenworth Hat.)	13,800		2	0.015		
LD F 1	·	16,400	10/May/80	6	, 0.037		
RDF1		15,200		2	0.014		
LD IY 1		15,200	13/May/80	7	0.046		
RDIY1		13,300		1	0.008		
LA PI 2	Icicle Creek	32,900	27/Mar/80	6	0.019		
LA PI "4	(Leovenworht Hat.)	33,000	01/Moy/80	4	0.013		
LAPI1		32,700	24/Apr/80	4	0.013		
LDIL3	Pr. Rapid	15,200	20/Mar/80	5	0.033		
RD IL 3	(Leavenworth Hat.)	14,700		4	0.028		
LD F 2	·	16▶ 200	22/May/80	3	0.019		
RD F 2		15,400		13	0.084.		
'LD IY 2		15,200	27/Mar/80	16	.0.105		
RD IY 2		13,200		7	0.053		
LA PP 11	Wh. Bluffs	32,600	24/Apr/80	13	0.040		
LAS11	(Leavenworth Hat.)	35,400		16	0.046		
LDIL1	Richland	15,900	22/May/80	4	0.026		
RDIL1	(Leavenworth Hat.)	13,600		6.	0.044		
LD F 3		16,200	26/Mar/80	6	0.037		
RD F 3		15,800		8	0.051		
LD IY 3		15,400	29/Mar/80	10	0.065		
RDIY3		13,900			0.044		
RA 9 1	Dalton Pt.	32,400	24/Apr/80	14	0.044		
RA IK 1	(Leavenworth Hat.)	32,900		22	0.068		
	·	32,700	27/Apr/80 ,	15	0.047		
RA IK 2		32,800		29	0.090		
RA IK 3 f		32,600	01/Mar/80	34	0.101		
/02		32,600		34	0.101		
39 RA		32,400			0.084		
07/20/43	Dexter	31,300	05/Nov/79	5	0.016	34`	0.109
07/20/45	(OaKridge Hat.)	30,800		6	0.019	41	0.133
07/20/42	▪	304700	10-11/Nar/80	20	0.065	294	0.957
07/20/44		30,700	10/Mar/B0	25	0.081	265	0.862

Appendix Table B1.continued.

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07/19/49	Deschutes R.	28,100	14/Apr/80	15	0.053	0	0400
07/19/50	(Rnd. Butte Hat.)	29,900		8			4.007
07/19/51		29,100	14-15/Apr/80		0.024	5	0.017
07/20/18	DS Villas. Falls	34,700	05-06/Nov/79	3	0.009	5	0.014
07/20/19	(S. Santion Hat.)	.35,000		4	0.011	6	00017,
07/20/20	Foster	33,000				10	
07/20/21	(S. Santias Hat.)	34,800			0.003	28	0.080

Soho saloon

07/20/31	Sandy Hat.	25,100	01/May/80	16	0.064	216	0.858
07/20/33		25,100		15	0.060	152	1.604
07/20/32		25,500		16	0.063	259	1.014
07/20/34		25,200		17	0.067	276	1.095
07/20/35		25,700		12	0.046.	264	1.019
07/20/36		24,400		20	0.082	285	1.163
07/20/37		26,000		13	O.OSO	377	1.448
07/20/38		26,400		20	0.076	298	1.126
LD 52 1	Rocky Reach Res.	24,100	13/Nay/80	7	0.029		
RD 52 1	(Turtle R. Pd.)	24,100		5	0.021		
LD 52 2	Rocky Reach Tail	25,400		10	0.040		
RD 52 2	(Turtle R. Pd.)	22,400		5	0.023		
LD IX 2	Rocky Reach Res.	27,100	16/Nay/80	5	0.019		
RD IX 2	(Turtle R. Pd.)	24,800		2	0.009		
LD IH 2		24,900	19/Nay/80	8	0.033		
RD IH 2		27,200		3	0.012		
LD IH 3	Rocky Reach Tail	27,900		4	0.015		
RD IH 3	(Turtle R. Pd.)	25,400		6	0.024		
63/20/39	Washougal Hat.	99,600	08/Noy/80	82	0.082	683	0.686
63/20/40		98,600		68	0.069	686	0.696
63/20/37		97,200	09/Jun/80	53	0.054	2393	2▶462
63/20/38		97,800		65	0.066	2267	2.318
63/19/54		106,700	07/Jul/80	126	0▶118	4556	4.270
63/19/55		106,900.		118	0.110	4430	4.144
05/03/59	Lit. Wh. Sal. R.	42,300	23/Nay/80	12	0.028	137	0.323
05/06/54	(Willard Hot.)	51,500		6	0.012	158	0.307
05/06/60	DS Bonn. Doe	33,700	24/Noy/80	3	0.009	74	0.219
05/06/50	(Willard Hat.)	47,900	Na	8	0.017	119	0.248
05/06/55		51,400		,18	0.035	123	0.239

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RD X3 1	Pahsiseroi R.	5,400	0 /Feb-27/Apr/80	1	0.019		
LA MI	(Dworshok Hat.)	5,000	2~-27/Apr/80	1	0,020		
RD IU 2	Lehi R.	10,500	Apr/80	2	0.019		
LA SU 4	(Dworshak Hat.)	10,100	2 /Apt/80	2	0.020'		
LA X3 3	Duorshok Hat.	10,100	27/Apr/80	2	0.020		
RA DT 3		9,900		'2	0.021		
10/21/56	Pohsiseroi	49,900	06·16/Apr/80	'26	4,052	241	0.483
10/21/57	(Niogra Sp. Hat.)	50,300	07-17/Apr/80	31	0.062	207	0.411
LD Y 1	Wells D. Res.	13,400	01%Noy/80	1	0.008		
RD Y 1	(Wells Spa. Ch.)	13,000		1	"0.008		

Appendix Table B1:--continued.

			Steel of		
LD Y 3	Wells D. Tail.	13,000		2	0.016
RD Y 3	(Wells Spw. Ch.)	12,200		1	0.009
LD K 3	Wells D. Res.	14,300	03/May/80	1	0.007
RK K 3	(Wells Spw. Ch.)	•13,600		1	0.008
LD K 2	Wells D. Tail..	13,100		2	0.016
RD K 2	(Wells Spw. Ch.)	13,800		1	0.008
LD IJ 3	Wells D. Res.	13,100	05/May/80	1	0.008
RD IJ 3	(Wells Spw. Ch.)	11,200		1	0.009

Appendix Table B1.-continued.

REPLICATE GROUPS 1979

(Lot Br ,tot) (Ag/D1/D2)	Release Information Site (source) b/	Nusber	Date (do/ao/yr)	Juvenile catch at Jones Beach c/ tno:I	CXT"	Adult Recoveries d/ (no:T	cTT"
		§ibmgarlina ch kook sake					
LD IC 1	John Day D.	20,000	06/Jun/79	29	0.146		
LD IC 2	(Spring Cr. Hat.)	20,400		21	0.103		
LD IC 3		190800		20	0,101		
LD IF 1	'	19,600	05/Jun/79	19	0.097		
LDIF2		20,100 .		6	0.030		
LD IF 3		20,200		15	0.074		
LD IK 1		19,500		17	0.087		
LD IK 2		19,500		10	0.052		
LD IK 3		19,500-		19	0.098		
LDPI1	.	21,200	06/Jun/79.	17	0.081		
LD PI 2		20,200		24	0.119		
LD PI 3		19,600		22	0.113		
RD IC 1		24,800		26	0.106		
RD IC 2		20,000		19	0.095		
RD IC 3		20,200		21	0.105		
RD PI 1		20,100	.	30	0.150		
RD PI 2		20,300		23	0.114 `.		
RD PI 3		20,100		21	0.105		
RD IF 1		20,100	05/Jun/79	16	.0..080		
RD IF 2		20,100		18	0,090		
RD IF 3		19,700		23	0.117		
RD IK 1		21,500		30	0.140		
RD IK 2		.. 200700		33	0.160		
RD IK 3		19,000		28	0.148		
03/55/01	Big Wh. Pd.	28,500	26/Jun/79	25	0.080	1	0,004
03/56/01	(Spring Cr. Hat.)	34,700		17	0.049	2	0.006
03/57/01		36,300		11	0.030	0	0.000
05/04/34	Spring Cr. Hat.	95,500	20/Apr/79	196	0,206	f/	
05/04/44		135,500		281	0.208		
		Y 101IO chi PI-sleon					
07/16/26'	All Creek	.51,500	08-09/Nov/78	9	0.017e/	23	0.045
07/19/17	(Bonn. Hat.)	48,200		10	0.021	20	0.041.
07/19/18.		51,100		8	0.016-	27.	.0.053
63/18/17	Cowlitz Sal, Hat.	24,000	23/Apr/79	35	0.146	833	3.471
63/18/18		.24,300		34	0.140	636	2.617
10/04/15	Rapid R.	127,000	15/Mar-15/Apr/79	30	0,024	115	0.091
10/04/24	(Dworshok Hat.)	122,000		48	0.039	107	0.088
07/17/47	Eagle Creek Hat.	46,200	01/Har/79	39	0.084	29	0.063
07/17/48		48,200		50	0.104	51	04106
LD IH 1	Vantage Bridge	49,800	11/Hoy/79	85	0.172		
RD IZ 4	(Leavenworth Hat..)	55,900	-	94	0.168		
LD II 1		62,600	12/Moy/79	95	0.152		
RK II 2		50,000		94	0.189		
RD IH 1	Wanapue D.	38,400	13/May/79	92	0,240		
RD II .1	(Leavenworth Hat.)	49,000	-	101	0.208		
LD II 2		52,400	14/May/79	83	0.159		
RK IZ 3		62,500		100	0.160		

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Appendix Table Bl.--continued.

			Yarling Chinook sgt				
07/17/25	N. Santini,	49,600	03-05/Apr/79	32	0.064	17	0.034
07/17/26	(Marion Fks. Hat.)	49,600		21	0.042	18	0.036
07/17/29		44,900		37	0.082	22	0.049
07/19/26	S. Satin Hat.	31,500	07/Nov/78	4	0.0138/	64	0.203
07/19/27		32,700		1	0.003	43	04131
07/19/29	DS Villas. Falls	32,600		6	0.018/	68	0.208
07/19/30	(S. Santior Hot.)	32,800		12	0,0368/	114	0.341
05/03/52	Willard Hat.	35,500	01/Nov/78	5	0.014e/	0	0.000
05/03/53		35,700		1	0.003'	1	0.003
05/03/54		36,900		1	0.003	1	0.003
05/03/49	tit. Wh. Hot.	31,100	19/Apr/79	20	0,064	20	0.064
05/03/50	(Willard Hat.)	31,200		12	0.038	24	.0.077
05/03/51		32,900		10	0.030	30	0,091
			Coho scion				
07/19/08	Tanner Creek	27,900	07/May/79	18	0.064	144	0.515
07/19/11	(Cascade Het.)	26,900		18	0.067	169	0.627
07/19/07		27,100	07/Jun/79	37	0.136	299	1.101
07/19/10		25,900		32	0.123	344	1.327
07/19/09		24,500	06/Jul/79	50	0.203	192	0.781
07/19/12		25,100		56	0.223	248	0.986
63/19/11	Toutle Hat..	42,400	07/Mar/79	46	0.108	482	1.137
63/19/12		34,600.		40	06115	476	1.372
63/19/28		39,700	06/Jul/79	109	0.274	400	1.008
63/19/29		41,100		96	0.233	436	1.061
63/19/23	Washougal Hat.	74,300	07/May/79	81	0.109'	1022	1.374
63/19/24		80,600		87	0.108	1333	1.654
.63/19/27		81,000	06/Jul/79.	197	0.243	1078	1.331
63/19/34		82,000		191	0.233	980	1.195
			Stelhecd				
LA AN 11 WHLBYW	Icicle Creek (Chelan Hat.)	23,900	26/Apr/79	22	0.092	108	0.451
LA AN 21 WHLPPX		19,100		14	0.073	'76	0.396
LA AN 31 WHLBLG		24,100		19	0.079	92	0.381
RAY 1 1 WHLBWH	DS Bonn. Dan (Chelan Hat.)	23,300	28/Apr/79	38	0.163	92	0.394
RA 2 D		24,300		21	0.086	97	0.399
RAT 4	DS Bonn. Dan.	20,700	17/May/79	90	0.434		
RA Y 4	(Tucannon Hot.)	22,000		68	0.308		
LD P 1	Wells Darn	10,000	04/Mor/79	2	0.021		
LD P 3	(Wells Spow, Ch.)	10,000		1	0.010		
RDP1		10,000		4	0.041		
RD P3		9,600		2	0.021		

Appendix Table B1.--continued.

REPLICATE GROUPS 1978

(Loc Br lot) (Ag/D1/D2)	Release Infornotion: Site (source) b/	Number	Dote (da/eo/yr)	Juvenile catch at Jones Beach c/ cno:3¯	`:CxT¯	Adult Recoveries d/ (no.r--¯	TIT"'
			Subre rling Chinook snue4D				
05/03/43	Lit. Wh. Hat.	49,500	25/May/78	96	.00194	5.	0.010
05/03/44		51,300		107	0.209	3	0.006
05/03/45		52,100		127,	0.243	1	0.002
05/03/46		49,800	·	114	0.229	5	0.010
05/03/47		49,400		'99	0.200	4	0.008
05/03/48		49,500		121	0.244	1	0.002
05/03/55		39,300	12/Jul/78	15	0.038	15	0.038
05/03/56		40,100		18	0.045-	11	0.027
05/03/57		39,100		28	0.071	1,7	0.043
05/03/42	·	50,500	24/May/78 `	106	0.210	3	0.006
05/61/01		480400		117	0.242	8	0.017
05/63/01		520200.		105	0.201	6,	0.011
05/03/39	Spring Creek Hat.	49,900	18/Aug/78	6	.012	172	0.345
05/03/40		520000			012	231	0.444
05/03/41		50,500		6		182	0.360
05/60/01		98,100	18/Apr/78	153	.157	e/'	
05/62/01		92,300		175	.191		
07/17/08	Upstr. Wilke, Falls	50,900	31/May/78	44	0.086	43	0.084
07/17/10	(Stoyton Pd.)	51,100	01/Jun/78	52	0.102	56	0.109
			sstlio ChinookSalmon				
63/16/12	Cowlitz Hat.	28,200	08/Mar/78	34	00122	1100	3.901
63/16/13		27,700		27	0.097	'1245	4.495
63/17/09		89,400		124	0.139	2836	3.172
63/17/10		87,900		109	0.125	2790	3.174
63/17/11		580200		77	0.132	2161 ·	3,713
63/17/12		56,900		85	0.149	2218	3.898
63/17/17		71,300		70	0.098	2181	3.059
63/17/18		69,400		64	0.092	2240	3.228
63/16/01	Klickitat Hat.	144,800	31/Mar/78	73	0.051		
63/16/02		146,300		76	0.053	f/	
WHRDLB RAL1	DS Bonn. Dai '	37,000	09/May/78	22	0.059		
WHRDPK RAL2	(Kooskia Hot.),	36,900		22'	0.060	4	0.010
WHRDYW RAL3		35,400		20	0,056	1	0.008
WHRDXY RAL4		37100		15	0.040		0.000
09/16/61	N. Santiam R.	48,600	13-14/8er/78	17	0,035	17	0.035
09/16/62	(Marion Fits. Hot,)	45,900		22	0.048	18	0.039
09/16/63		50,200		17	0.034	18	0.036
09/17/01		49,100	'	28	0.058	e/'	
09/17/02		49,600		22	0.046	e/	
09/17/03		50,000		22	0.044	e/	
07/16/11	Rnd. Butte Hot,	46,400	31/May/78	33	0.072	f/	
07/16/12		46,200		34	0.074	f/.	
09/16/27	S. Santion Hat.	28,700	07/Nov/77	2	0.007	158	0.550
09/16/29		28,700		1	0.003	164	0.571
09/16/30	DS Willem. Falls	25,900	08/Nov/77	4	0.015	. 72	0.277
09/16/31	(S. Sontiao Hat.)	29,000		3	0.010	95	0.327

Appendix Table B1.--continued.

			atium chiniozK salon				
09/16/23	DS Wi11am. Falls	26,900	13-14/Mae/78	30	0.111	355,	1.319
09/16/24	(S. Sadism Hat.)	24,600		25	0.102	288	1.170•
			CAP.:MUM				
LA ID 1	John Day Ios	31,400	09/May/78	33	0.105		
LA ID 2	(Carson Hat.)	31,500		37	0.119		
LA ID 3		32,300		22	0.069		
RA ID 1		33,000	22/May/78	28	0.085		
RA ID 2		33,000		17	0.053		
RA ID 3		33,000		12	0.037		
LD IJ 1	DS Bonn. Dom	31,500	18/Mor/78	13	0.042		
LD IJ 2	(Carson Hat.)	33,100		17	0.053		
LD IJ 3		32,300		27	0.085		

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Appendix Table B1.--continued.

REPLICATE GROUPS 1977

Mark a/ (Loc Br lot) (Ag/DI/D2)	Release Information Site (source) b/	Number	Dote (da/'o/yr)	Juvenile catch at Jones tree.)	Beach c/ tz)	Adult.; Recoveries d/ (nor-`--TIT"	
			S1lbL? lingChinooksalmi				
09/16/12	Upstr. Willa'. Falls	44,600	,02-04/Apr/77	106	0.238	16	0.036
09/16/13	(Au.sville Pd.)	43,100		103	0.239	19	0.044
09/16/06	DS Willa'. Falls	92,000		238	0.259	26	0.028
09/16/11	(Auasvilli Pd.)	46,400		143	0.308	17	0.037
09/16/07		43,500		123	0.282	17	0.039
05/44/01	Spring Creek Hat.	96,700	08/Apr/77	216	0,223	f/	
05/45/01		95,800		207	0.216	1/	
05/49/01&RD U 1		75,800		215	0.284	7/	
			Lejrlino dilatable				
13/09/11	Cowlitz Hat.	88,000	'08/Mar/77	44	0.050	904	1.027
13/09/12		88,600		36	0.041	1104	1.246
13/09/14		61,700		31	0.050	1078	1.747
13/11/04		61,600		24,	0.039	1052	1.708
13/13/01		28,700		12	0.042	612	2.132
13/13/04		27,900		12	0.043	717	2.570
09/16/02	Rnd. Butte Hat.	29,400	02/May/77	2	0.007	0	0.000
09/16/01		31,700		2	0.006	2	0.006
			oho sahon				
06/05/14	Sandy Hat.	24,800	27/Apr/77		0.032	421	1.691
06/06/01		25,800		7	0.027	341	1.321
06/05/15	Sandy Hat.	24,400	27/Apr/77	8	0.033 '	418	1.708
06/06/03		22,800		6	0.026	339	1.483
06/06/02		20,100		6	0.030	382	1.897
06/06/04		23,400		10	0.043	459	1.960
LA X3 1;	Pasco	16,600	01/May/77	3	0.019		
RA X3 1.	(Turtle Rock Pd.)	16,600		1	0.007		
05/20/04	Willard Hat.	88,300	02-04/May/77	20	0.023	R/	
05/21/04		93,800		21	0.024	e/	
			1teelh 9g				
10/13/07	.DS Bonn. Do'	17,000	21/May/77		0.024	10	0.059
10/13/09	(Dworshok Hat.)	17,300			0.017	20	0.116
10/13/11	Cleo,rwater R.	57,200	20-21/Apr/77	7	0.017	52	0.124
10/13/13	(Dworshak Hat.)	31,100		5	0.016	38	0.122
10/02/36	Pahsimeroi R.	55,400	05-10/Apr/77		0.004	9.	0.016
10/02/35	(Hiogro Sp. Hat.)	59,300			0.008	9	0.015

'a/ Percent of total release calculated from observed recovery.. No data (-).means either adults have yet to return. were not collected. or were not obtained from fishery agencies prior to analysis. Comparisons between groups released at different tins, may be erroneous because of differences in ocean' distribution. unequal fishing effort, or sampling effort.

More complete release information is available in Davley et al. 19t5b and from the releasing agency Figure 1. Abbreviations: bonm onneville. Cr-Creek. D=Dam, DS- Downstream. PkePork. watsbstchery, LitvLlttls, Lt Light. Lo.Lower, N•North. Pd'.Pond, Pr Priest. R.River, Ree-Reservoir.. Rad-Round,. S-South. Sal•Salmon, Spr-Spring, Stry Stream,..SCDC«Salmon Culture Developmental Center, Tail-tailrace, and wh s,hite.

c/ Actual catch and percent of number released for beach seine and purse seine combined.

d/ Observed recoveries from ocean and river fisheries plus escapement; preliminary data.

e/ includes fall catch as well as spring catch.

f/ Not used for adult recovery comparison due to probable survival difference in seawater due to treatment.

Appendix Table B2.--Mean stomach fullness and standard deviation for juvenile salmonids captured in purse and beach seines at Jones Beach by 3-day intervals, 1980.

1980	2'&L2t.AtL-L.			~~i4G0..$S1^_			Purse $ Beach		
	n	Mean	SD	n	Mean	SD	A	Mepn	SD
COHO SALMON									
MAY 5-MAY. 7	1	3.0	0.00	8	4.9	1.13	9	4.7	1.22
MAY. 8-MAY 10	11	4.1	1.58	7	4.6	1.40	18	4.3	1.49
MAY 11-MAY 13	27	4.3	1.30	4	4.5	1.91	31	4.3	1.35
MAY 14-MAY 16	66	5.1	1.00	16'	5.0'	1.10'	82	5.1	1.01
MAY 17-MAY 19	79	4.0	1.12	33	4.1	1.11	112	4.1	1.11
.MAY 20-MAY 22	13	3.3	1.27	0	0.0	0.00	13	3.5	1.27
MAY 23-MAY 25	12	3.6	1.31	24	1.8	1.51	36	2.4	1.68
MAY 26-MAY. 28.	20	4.3	1.34	11	3.3	1.19	31	349	1.36
MAY 29-MAY 31	6	4.3	1.37	11	2.6	1.21	17	3.2	1.48
JUN 1-JUN 3	9	4.4	1.13	1	2.0	0.00	10	4.2.	1.32
JUN 4=JUN 6	8	3.8	1.28	2	4.5	0.71	10	3.9	1.20
JUN 7-JUN 9	2	5.0	1.41	0	0.0	0.00	2	5.0	1.41
JUN 10-JUN 12	1	4.0	0.00'	0	0.0	0.00	1	4.0	0.00
JUN 13-JUN 15	48	4.3	1.45	6	4.5	1.52	54	4.3	1.45
JUN 16-JUN 18	39	3.8	1.20	23	3.7	1.21	62	3.8	1.20
JUN 19-JUN 21	2	5.5	0.71	1	3.0	0.00	3	4.7	1.53.
JUN 22-JUN 24	0	0.0	0.00	0,	0.0	0.00	0	0.0	0.00
JUN 25-JUN 27	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN 28-JUN 30	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
'JUL 'I-JUL 3	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 4-JUL 6	0	0.0	0.00	0	0.0	0.00	0	.0.0	0.00
JUL 7-JUL 9	0	0.0	0.00	0	0.0	0.00	0	OO	0.00
JUL 10-JUL 12	74	4.5	0.89	11	4.8	0.75	85	4.5	0.88
JUL 13-JUL 15	0	0.0	0.00	3	3.7	1.53	3	3.7	1.53
JUL 16-JUL 18	0	0.0	0.00	2	5.5	0.71	2	5.5	0.71
JUL 19-JUL 21	0	0.0	0.00,	0	0.0	0.00	0	O.O	0.00
JUL 22-JUL 24	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 25-JUL 27	1	3.0	0.00	0	0.0	0.00	1	3.0	0.00
JUL 28-JUL 30	0	0.0	0.00		0.0	0.00	0	0:.0	0.00
YEARLING CHINOOK SALMON									
MAR 9-MAR 11	0	0.0	0.00	5	2.8	0.84	5	2.8	0.84
MAR 12-MAR 14	0	0.0	0.00	5	3.6	1.52	5	3.6	1.52
MAR 15-MAR 17	1	1.0	0.00	3	1.7	1.15	4.	1.-3	.1.00
MAR 18-MAR 20	2	1.0	0.00	39	2.5	1.35	41	2.4	1.55
MAR 21-MAR 23	0	0.0	0.00	10	2.7	1.89	10	2.7	1.89
MAR 24-MAR 26	3	2.0	1.00	31	2.5	1.57	34'	2.5	1.52
MAR 27-MAR 29	1	2.0	0.00	25	2.6	1.58	26	2.6	1.55
MAR 30-APR 1	2	2.5	0.71	20	3.0	2.14	22	2.9	2.04
APR 2-APR 4	9	3.4	1.67	19	3.4	1.54	28	3.4	1.55
APR 5-APR 7	8	3.6	1.06	5	3.4	1.14	13	3.3	1.05
APR 8-APR 10	21	3.8	1.83	31	3.4	1.33	52	3.6	1.55
APR 11-APR 13	9	3.4	0.73	6	3.3	1.03	15	3.4	0.83
APR 14-APR 16	44	4.3	1.56	20	4.1	1.28	64,	4.2	1.47
APR 17-APR 19	28	4.2	1.25	3	2.0	1.73	31	4.0	1.43.
APR 20-APR 22	18	4.3	1.27	8	3.6	1.19	26	4.1	1.26
APR 23-APR 25	17	4.9	2.03	8	4.1	1.89	25	4.6	1.98
APR 26-APR 28	8	5.0	1.20	2	4.5	0.71	10	4.9	1.10
APR 29-MAY 1	19	5.0	1.15	5	3.0	1.41	24	4.6	1.44
MAT 2-MAY 4	11	5.5	0.69	0	0.0	0.00	11	5.5	0.69
MAY 5-MAY 7	63	3.8	1.40	31	3.8	1.19	94	3.8	1.33
MAY B-MAY 10	38	4.4	1.41	29	3.9	1.29	67	4.2	1.37
MAT 11-MAT 13	6.	4.3	1.21	1	4.0	0.00.	7	4.3,	1.11
MAT 14-MAT 16	3	4.3	0.58	0	0.0	0.00	3	4.3	0.58
MAT 17-MAY 19	9	3.6	1.33	1	1.0	0.00	10	3.3	1.49
MAY 20-MAY 22	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
MAT 23-MAY 23	4	2.0	0.00	0	0.0	0.00	4	2.0	0.00
MAY 26-MAY 28	0	0.0	0.00	0	0.0	0.00	'0	0.0	0.00
MAY 29-MAT 31	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN 1-JUN 3	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN 4-JUN 6	1	1.0	0.00	1	2.0	0.00	'2	1.5	0.71
JUN 7-JUN 9	1	4.0	0.00	0	0.0	0.00	1	4.0	0.00
JUN 10-JUN 12	3	1.0	0.00	0	0.0	0.00	3	1.0	0.00
JUN 13-JUN 15	0	0.0	0.00	0	0.0	0.00	0	040	0.00
JUN 16-JUN 18	1	4.0	0.00	0	0.0	0.00	1	4.0	0.00
JUN 19-JUN 21	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00

Appendix Table B2.--continued.

1900	t*s21-flka1_ n	Ms..	Sn	..lf9sb..iiiat_ n	M•4n	20	Pu►•• 1 pooch --stun Ni		—fi—
				ITEELNEAO					
APR 20-APR 22	1	7.0	0.00	0	0.0	0.00	1	7.0	0.00
AMI 23-AMR 25	1	5.0	0.00	**0**	0.0	0.00	1	5.0	0.00
-APR 24-APR **20**	1	5.0	0.00	0,	0.0	0.00	1	5.0	0+00
AMR 21-MAY 1.	40	3.5	1.49	'0	0.0	0.00	40	3.5	1.19
MAY 2-AAY 4	23	2.5	.1.54	' 0	0.0	0.00	23	**2.0**	1:54
MAY 5-MAY 7	111	2.4	1.32	4.	1.5	'0.04.	117	**2.4**	.1.31
MAY 0-MAY **10**	53	**3.0**	1.07	2	2.0	1.41	35	**3.0**	1.09
MAY II-NAY.13	25	3.5	1.19	' 0	0.0	0.00	25	3.5	1.19
MAY 14-MAY 14	32	3.8	1.40	0	0.0	0.00	32	**3.0**	'1.40
MAY 17-MAY 19	0	2.1	1.13	0	0.0	0.00	**0**	2.1	1.13
MAY 20-MAY 22	2	4.0.	0.00	0	0.0	.0000	2	4.0	0.00
MAY **23-MAY'25**	17	**2.4**	1.41	0	0.0	0.00	17.	2.4	1.41
MAY 24-MAY:.20.	1	4.0	**0.00**	0	0.0.	0.00	1	4.0	0.00
MAY 29-MAY 31	2	2.0	0.00	0	0.0	0.00	'2	2.0	0.00
JUN 1-JUN 3	2	1+5	0.71	0	0.0	0.00	2	1.5	0.71
JUN **4-JUN..** 4	1	7.0.	0.00	0	0.0	0.00	1	**7.0**	0.00
JUN 7-JUN' 9	0	0.0	0.00	0	0.0	0.00'	0	0.0	0.00
JUN10-JUN:12	A	**2.0**	1.50	0	0.0.	0.00	4	**2.0**	1.50
JUN 13-JUN 15	0'	0.0	0.00	0	CO	**0.00**	0	0.0.	**0.00**
JUN 14-JUN 10	2	2.5	0.71	0,	0.0	0.00	2.	2.5	0.71
JUN 19-JUN 21	1	2.0	0.00	0'	0.0	0.00	1	2.0	0.00
JUN 22-JUN 24	0	0.0	0.00	0	**0.0**	0.00	0	0.0	0.00
JUN-25-JUN 27	2	3.0	1.41	0	.0.0	**0.00**	' 2	3.0	1.41
JUN 20-JUN 30	0	0.0	.0.00	. 0	0.0	0.00	0	0.0	0.00.
				IUSYEARI.IWG CHINOOK SALMON					
MAR 12-MAR 14	.0	0.0	0.00	2	4.0	1.41	2	4.0	1.41
MAR 15-NAR 17.	0	O.OO	.OO'.	4	4.0	1.55 .	·4	4.0	1.55
MAR 1O.MA1 20	0	0.0	0.00	21	4.3	1.24	21	4.3	1.24
MAR 21-MAR 23	0	0.0	0+00	7	4.7	0.74	7	4.7	0.74
MAR 24-NAR 24	0	0.0	0.00	10	4.0	1.51	14	4.0	1.51
MAR 27•MAR 2'	0	0.0	0.00	0	0.0	0.00	. 0	0.0	.0.00
MAR 30-AMR 1	0	0.0	0.00	4	4.3	1.24	4	4.3	1.24
APR 2-APO. **4**	'**0**	**0.0**	0.00	**4**	4.3	2.22	4.	4.3	.2.22
APR 5-APR **7**	0	0.0	0.00	..**I**	7.0	0.00	·1	7.0.	0.00
AMI O-APR 10	**4**	3.0.	1.43	· 7	2.1	1.07	11	2.5	1.29
APR 11•APR 13	0	0.0	0.00	4	3.0	1.41	4,	3.0	1.41
APR 14-APR 16	6	4.3	1.37	4	4.5	1.05	12	4.4	1.14
APR 17-APR 19	3	5.3	**0.50**	12	4.2	1.03	15	4.4	1.04
APR 20-APR 22	0	0.0	0.00	24	3.3	1.29	24	3.3	1.29
APR 23-APR 25	0	0.0	0.00	-32	3.3	1.47.	32	3.3	1.47
APR 24-APR **20**	0	0.0	0.00	2	4.5	2.12	2	4.5	2.12
APR.25-MAY 1	0	0.0	0.00	23	4.7	**1.30**	23	4.7	1.30
NAY 2-RAY **4**	0	0.0 '	0₀00	12	4.4	1.40	12	4.4	**1.45**
MAY 5-NAY 7	2	4.0	0.00	25•	4.5	1.24	27	404	1.20
RAY MMAY 10	2	4.0	2003	10	4.4	0.92	20.	4.4	1.10
'11AY 11 IS AY 13	31	5.3	1.14	11	5.4	1.34	42	5.4	1.21
NAY 14-MAY 14	15	5.1	1.30	20	3.0	1.94	35	4.4	1.52
NAY 17-NAY, 19	4	5.0	0.02	27	3.4	1.42	31	3.4,	1.44
MAY 20rNAY 12	26	2.7	1.52	1.	?.0	0.00	27	2.4	1.50
NAY 23-INKY 25	24	3.5	1.24	16	**2.0**	1.11	42	3.2	1.22
NAY 24-MAY 25	**2**	3.5	0.71	11	3.4	1.12	13	3.4	1.04
NAY 29-MAY 31	1'	1.0	0.00	21	2.7	1.71	22	2.4	1.71.
JON 1-JUN 3	9	5.4	-1.13	57	3.4	1.31	44	3.9	1.47
JUN 4-JUN 4	'3	4.0-	1.00	01	**3.0**	1.30	04	**3.0**	1.37
JUN 7-JUN 9	12	5.1	1.31	50	3.5	1.34	62	**3.0**	1.47
JUN 10-JUN 12	**0**	4.0	1.20	73	4.1	1.39	51	4.1	1.37
JUN 13-JUN 15	2	3.5	3.54	37	4.0	1.30	31	4.0	1.47
JUN 14-JUN 15.	12	3.2	1.27	44	3.2	1.13	74	3.2	1.14
JUN 19-JUN 21	7	5.4	1.51	41	3.5	1.45	40	**3.0**	1.40
JUN 22-JUN **24**	5	1.4	1.34	10	4.0	1.90	23	4.7	1.76
JUN 25-JUM 27	2	4.0	1.41	27	3.3	1.54	29	3.3	1.54
JUN **20-JUN** 30	•	4.5	0.94	22	3.4	1.24	24	**3.0**	1.21
JUL 1-JIM. 3	7	4.4	1.13	74	3.1	1.40	**03**	3.9	1.39
JUL 4-JIM. 4	3	3.7	1.53	35	3.1	1.41	**30**	.3.1	1.59
JUL 7-JUL	14	3.9	1.12	.71	3.7	1.72	**07**	3.5	1.42
JUL 10-JIM. 12	**4**	4.0	0.02	47	**3.0**	1.25	71	**3.0**	1.23
JUL 13-JUL 15	13'	4.0	1.40	**40**	3.9	1.10	53	4.1	1.37
JUL 14-JUL 10	**i**	4.1	1.55	. 39	4.0	1+35	47	4.0	1.34
JUL19-JUL 21	1	**7.0**	0.00	20	4.0	1.43	21	4.1	1.55
JUL 22-JUL 24	11	4.5	1.01	5E	**2.1**	1.34	49.	3.0	1.54
JUL25-JUL. 27	3	3.0	1.00	10	3.1	1.37	21	3.1	1.30
JUL20-JUL 30	4	4.5	0.04	41	3.4	1.27	47	3.5	1.27
JUL 31-AUO 2	10	**5.1**	1.52	**30**	4.7	1.40	40	4.0	1.42
AUG 3-AIO 3	4	4.5	0.50	44	3.4	1.73	**40**	3.5	1.70
, AUG 4+AU0 5	2	5.5 ,	0.71	50'	3.0	1.46	40	3.1	1.51
AUG 9-AUO 11	4.	**3.1**	1.71	23	3.1	1.53	27	3.2	1.55.
AUG 12-A00 34	3	4.3	1.53	40	4.1	1.37	43	4.1	1.34
AUO 15-AU0 17	3	4.3	1.53	22	4.4	1.14	25	4.4	1.14
AUG 1S-A10 20	9	4.3	1.73	40	3.4	1.44	57	3.$.	1.49
AUG 21.AUO 23	0	0.0	0.00	40.	2.1	1.34	40	2.1	1.34
AUG 24-AJO 24	0	0.0	0.00'	40	3.2	1.49	40	3.2	1.49
AUG 27-AU0 29	0	0.0	0.00	53	3.•	1.77	53	3.9	1.77
AUG 30-RP 1	0	0.0	0.00	0	0+0	0.00	0	0.0	0.00
SEP 2-03P 4	2	4.0	0.00	23	2.5 •'	1.59	25	**2.0**	1.50
SEP 5•KP 7	**0**	**0.0**	0.00	**10**	2.7.	2.00	10	2.7	2.00
SEP **0-SEP** 10	0	0.0	0.00	10	2.5	0.97	10	2.5	0.17
SEP 11-SEP 13	**0**	0.0	0.00	12	3.2	1.34	12	3.2	1.34.
SEP 14-5P 14	**0**	**0.0**	**0.00**	12	3.3	1.23	12	3.3	1.23
SEP 17-SEP 19	0	0.0	•0.00'	5	3.4	1.14	.5	3.4	1.14
SEP **20-SEP** 22	**0**	**0.0**	0.00	**0**	**0.0**	**0.00**	**0**	**0.0**	**MOO**
SEP 23-SEP , 25	**0**	**0.0**	**0.00**	**0**	**0.0**	0.00	**0**	**0.0**	**0.00**

Appendix Table B3.--Mean stomach fullness and standard deviation for juvenile .salmonids captured in purse and beach seines at Jones Beach by 3-day intervals, 1981.

1981	t% CIE-$11tt-.			1tst k5LOt.			Purse i Beach		
		.Mean	SD'	n	Mean	SD	n	Mean	SD
COHO SALMON									
APR 29-MAY 1		4.0	0.00	2	4.5	0.71	3	4.3	0.58
MAY 2-MAY 4	6	4.3	0.52	3	.4.7	1.53	9	4.4	0.88
MAY 5-MAY 7	40	4.4	1.08	10	4.2	1.92	50	4.4'	1.05
MAY 8-MAY 10	'3	2.7	0.58	21	4.0	1.34	24	3.8	1.34
MAY 11-MAY 13	86	3.3	0.97	27.	3.1	0.92	113	3.3	0.96
MAY 14-MAY 16	63	4.3	1.07	4	3.5	1.73	67	4.2	1.11
MAY 17-MAY 19	61	4.1	1.24	3	4.7	1.15	64	4.2	1.24
MAY 20-MAY 22	100	3.4	0.94	1	2.0	•0.00	101	3.4	0.95
MAY 23-MAY 25	35	4.1	1.42	.1	4.0	0.00	-36	4.1	1.40
MAY 26-MAY 28	'43	4.1	1.18	0	0.0	0.00	43	4.1	.1.18
MAY 29-MAY 31	25	4.0	0.84	6.	3.8	0.75	31.	3.9	0.81
JUM 1-JUN 3	37	4.6	0.92	10	4.4	1.07.	.47	4.6	0.95
JUN 4-JUN 6	14	:3.6	1.02	1	6.0	0.00	13	3.7	1.16
JUN 7-JUN 9	3	4.0	1.00	2	4.3	0.71	5	4.2	0.84...
JUN 10-JUN 12	19	3.9	0.99	22	3.6	1.00	41	3.8	.0.99
JUN 13-JUN 15	2	5.0	0.00	1	4.0	0.00	3	4.7	0.58
JUN 16-JUN 18	0	0.0	0.00	.1	2.0	0.00'	1	2.0	.0.00
JUN 19-JUN 21	1	3.0	0.00	.0	0.0.	0.00	1	5..0	0.00
JUN 22-JUN 24	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00..
JUN 25-JUN 27	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN 28-JUN 30	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
'JUL 1-JUL 3	0	0.0	0.00	0	0.0	0.00	0,	0.0	0.00
JUL 4-JUL 6	.0	0.0	0.00	0	0.0	0.00`	0	0.0	0.00
JUL 7-JUL 9	.14	4.4	1.08	3	3.0	1.00	17	4.1,	1.17
JUL 10-JUL 12	12	3.8	0.75	1	4.0.	0.00-	13	3.8	0.73
JUL 13-JUL 15	2	5.5	0.71	0	0.0	0.00	2	5.5	0.71
JUL 16-JUL 18	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
YEARLING CHINOOK SALMON									
MAR 18-MAR: 20	0	0.0	0.00	1	3.0	0.00	1	5.0	0.00
MAR 21-MAR 23	0	0.0	0.00	0	0.0	0.00	0	0.0.	0.00
MAR 24-MAR 26	0	0.0	0.00	1	4.0	0.00	1	4.0	0.00
MAR 27-MAR 29	0	0.0	0.00	1	1.0	0.00	1	1.0	0.00
MAR 30-APR 1	5	4.0	1.22	2	1.5	0.71	7	3.3	1.60
APR. 2-APR 4	5'	3.2	2.28'	0'	0.0	0.00	5	3.2	2.28
APR' 5-APR 7	6	5.0	1.41	0	0.0	0.00	6	5.0	1.41
APR' B-APR 10	2	4.5	0.71	1	5.0	0.00	3	4.7	0.5&.
APR 11-APR 13	6	6.2	0.98	.1	4.0	0.00	7	5.9	1.21
APR 14+APR 16	31	4.5'	1.36	1	3.0	0.00	32.	4.4	1.36
APR 17-APR 19	11	440	1.00	0	0.0	0.00	11	4.0	1.00
APR 20-APR 22	17	3.5	1.12	3..	4.0	1.73	20	3.6	1.19
APR 23-APR 2S	14	3.4	1.09	2	4.5	2.12.	16	3.6	1.21
APR 26-APR-"28	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
APR 29-MAY 1	31	4.5	0.99	0	0.0	0.00	31	4.5	0.99
MAY- 2-MAY 4.	34	4.5	1.11	2	4.0	1.41	36	4.4	1.11
MAY 5-MAY 7	22	3.7	1.17'	0	0.0	0.00	22	3.7	1.17
MAY B-MAY 10	0'	0.0	0.00	1	3.0	0.00	1	3.0	0.00'
.MAY **11-MAY** 13	16	3.3	0.86	0.•	0.0	0.00	16	3.3'	0.86
MAY 14-MAY 16	17	3.8	1.25	0	0.0	0.00	17	3.8	1.25
MAY 17-NAY 19	9	2.3	0.71	0	0.0	0.00	9,	2.3	0'.71
MAY 20-MAY 22	9	2.6	1.13	0	0.0	0.00	9	2.6	1.13
MAY 23-MAY 25	13	2.4	1.19	0	0.0	0.00	13	2.4	1.19
MAY.26-MAY 28	24	2.8	1.29	0,	0.0	0.00	24	2.8	1.29
MAY 29-MAY. 31	18.	3.5	0.86	0	0.0	0.00	18	3.5	0.86
JUN 1-JUN 3	4	4.0	1.15	1	4.0	0.00	5	4.0	1.00
JUN 4-JUN 6	8	3.0	0.53	2	2.0	1.41	10	2.8.	0.79
JUN 7-JUN 9	1	3.0	0.00	0	0.0	0.00	1	3.0	0.00
JUN 10.-JUN 12	1	2.0	0.00	1	3.0	0.00	2	2.5	0.71
JUN 13-JUN 15	2	5.5	0.71	1	1.0	0.00	3	4.0	2.65
JUN 16-JUN 18	2	4.5	2.12	0	0.0	0.00	2	4.5	2.12
JUN I9-JUN 21	0.	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN 22-JUN 24	2	3.5	2.12	0	0.0	0.00	2	3.5	2.12
JUN 25-JUN 27	0	0.0	0.00	0	0.0	0.00	0	0.0	•0.00
JUN 28-JUN 30	0	0.0	0.00	0	0.0	0400	0	0.0	0.00
JUL 1-JUL 3	0.	0.0	0.00	0	0.0	;0.00.	0	0.0	0.00
JUL- 4-JUL 6	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 7-JUL 9	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 10-JUL 12	2	3.0	0.00	0	0.0	0.00	2'	3.0'	0.00
JUL 13-JUL 15	.0	0.0	0.00	0	0.0	0.00	'0	0.0	0.00

Appendix Table 83.--continued.

1101	2Mz.uJtlas_ n	Moen	SO	J213LiI6EE_ A	NAA	SD	PYP44 I 544cM n	Mean	1D
STELLNEAO									
APO 29-MAY 1	2	5.0	0.00	0	0.0	0.00	2_	5.0	0.00
MAY 2-MAY 4'	'S	3.3	1.16	0	0.0	0.00	0	3.3	1.16
MAY 5-MAY 7	5	3.4	0.55	0	0.0	0.00	5	3.4	0.53
MAY ...MAT 10	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
MAY 11-MAY 13	111	2.7	1.06'	0	0.0	0.00	111	.2.7	1.06.
.MAY 14-MAY 16	14	2.4	1.20	0	0.0	0.00	14	2.6	1.20
MAY 17-MAY 19	27	2.1	1:04	0	0.0	0.00	27	2.9	1.04
MAY 20-MAY 22	15	2.9	1.25	0	0.0	0.00	15	2.0.	3.20
MAY 23-NAY 25	14.	2.7	1.07	0	0.0	0.00	14	2.7	1.07
MAY 26-NAY 25	10	3.0	0.94	0	'0.0	0.00	10	3.0	0.94
NAY 29-MAY 31	52	3.9	1.10	1	5.0	0.00	53	3.9	1.10,
.JUN 1-JUN 3	1	3.0	0.00	1	3.0	0.00	2	3.0	0.00
JUN 4•JUN 6	14	3.6	1.43-	0	0.0	0.00	14	3.6	1.45
JUN 7-JUN 9	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN10-JUN 12	0	0.0.	0.00	0	0.0	0.00	0	0.0	0.00
JUN 13-JUN 15	2	5.0	2.53	0	0.0	0.00	2	5.0	2.03
JUN 14-JUN 10.	1	6.0	0.00	0	0.0	0.00	1	6.0	0.00
JUN 19-JUN 21	2	2.5	0.71	0	0.0	0.00	2	2:S	0.71
JUN 22-JUN' 24.	2	2.0	0.00	0'	0.0	,0.00	2	2.0	0.00
JUN 25-JUN 27	1	3.0	0.00.	..0	.0.0	0.00	1	3.0	0.00
JUN 25-JUN 30	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
OUOYEMLINO CMINOOR.SALMON									
MM IS-MM 20		04	0.00	1	3.0	0.00	1	3.0	0.00
'MAR 21-MAR 23	0	010	0.00	0	0.0	0.00	0	0.0	0.00
MAR 24.MAR 26	0	0.0	0.00	0	0.0	0:00	0	0.0	0.00
MM. 27.MAR. 29	0	0.0	0.00	0	0.0 -	0.00	0	0.0	0.00
	0.	0.0	0.00	1	'3.0	0.00	1	3.0	0.00
M 4	1	4.0	0.00	13	3.2	1.64	14	3.3	1.50
APA 5-APM 7	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
AMR 5-APE 10	0	0.0	0.00	0.	0.0	0.00	0	0.0.	0.00
APE.11•APR 13	0	0.0	0.00	2	6.0	1.41	2	6:0	1.41
AMR 14MIM 16	1	4.0	0.00	0	0.0	0.00	1	4.0	0.00
AM 17.APE 17	0	0.0	0.00.	5	2:2	0.43	5	2.2	.0.45
APE 20-APE 22	6	4.7	1.37	5	4.2	1.79'	11	4.5	1.51
APR 23-APR 25	1'	3.0	0.00	10	4.3,	1.16	11	4.2	1:17
APR 26-APR 25	0	0.0	0.00	16	3.3	1.01	16	3.3	1.01
APE 29-MAY 1	9	34'	1.27	125	3.5	0.96	134	3.4	0.95
MAY 2-MAY 4	4	4.2	0.75	40	3.9	1.31	46	4.0	1 45
MAY 5-MAY' 7	7	4.1	1.07	9	3.9	1.34	14	4.0	1.21
MAY S-MAY 10	0	0.0	0.00	51	3.1	1.10	51	3.1	1 40
MAY.11-MAY 13	20	3.1	1.02	01	3.2	0.04	101	3.2	0.00
MAY 14-MAY 16.	19.	4.4	1.43	34	3.2	1.59	55	3.4	1.64
MAY 17-NAY.19	55	3.7	1.22	92	3.6	1.13	147	3.7	1.16
MAY 20-MAY 22	32	3.9	1.06	131	3.6	1.04	143	$.6	1.05
MAT 23-MAY 25	0	3.4	1.30	42	4.1	1.54.	50	.4.0	1.00
MAY 26-MAY 25	30	3.7	1.36	45	3.1	1.20	104	3.3	1.20
MAT 29-MAY 31	15	3.0	1.01	40	3.4	1.00.	04	3.6	...1.06
JUN 1-JUN 3	23	4 0 7	1.10		3.7	0.10	95	4.0	1.10
.JUN 4-JUN. 6	19	4.2	1.27	70	3.0	0.92	97	3.9	1:01
JUN 7-JUN	12	3.5	0.03	52	3.9	1.12	94.	3.9	1.09
JUN.10-JUN 12	27	3.0	1.00	100	3.4	0.94	135	3.3	0.90
JUN 13-JIM' 15	15	4.3	1.10	30	3.4	1.10	53	3.6	1.16
JUN 16-JUN 10	14	4.4	1.20	30	3.5	0.95	52	3.0	1.12
JUN 19-JUN 21	12	3.0.	0.97	66	4.0	1.26	70	4.0	1.22
JUN 22-JUN 24	5	4.2	1.30	34	3.4	1.20	59	'3.4	1.22
JUN 25-JUN 27	5	2.6	0.59	27	4.0	1.30	32	3.5	1.34
JUN 25-JUN 30	4	3.3	0.50	110	2.9	1.31.	114	3.0	1.20
JUL 1-JUL 3	19	3.0	047	404	2.4	049	423	2.4	0.05
.JUL 4-JIR. 6	5	2.0	1.30	129	2.3	0.03	134	2.5	0.94_
JUL 7-JUL 9	14	3.A	1.22	202	2.9	1.11	216	2.9	1.13
JUL 10-JUL 12	4	4.5	1.73	53	3.3	1.05	57	3.4	1.13
JUL 13-JUL 15	4.	4.0	1.41	44	4.4	1.53	40	4.4	1.51
JUL 16-JUL 10	1	4.0	0.00	24	2.5	0.93	25	2.6	0.96
JUL 19-JUL 21	2	2.5	0.71	22	3.5	1.34'	24	3.4	1.31
JUL 22-JUL 24	0	0.0	0.00	45	2.0	1.30	40	2.0	1.30
JUL 25-JUL 27'	0	0.0	0.00	7	2.9	0.90	7	2.9	0.90
JUL 20-JUL 30	3	4.7	1.15	27	3.2	1.30	30	3.3	1.35
JUL 31 MUG 2	9	3.2	0.44	6	2.0	1.53	15	3.1	1.16
AUG 3-AU0 5	13	4.3	0.55	27	3.6	1.15	40	3.9	1.10
AYO 4MU0 5	4	6.0	2.00	13	4.4	1.94	17	4.0	1.90
AUG 'MUG 11	27	4.2	1.50	5	3.0	1.45	32	4.2	1.40'
AUG 12MU0 14	10	3.5	0-05	9	3.2	0.97	19	3.4	0.90
AUG 15-AUG 17	0	0.0	0.00	3	2.7.	1.53	3	2.7	1.53
AUG 15-AU0 20	0	0.0	0.00	7	4.4	1.90	7	4.4	1.90
AUG 21-AUS	0	0.0	0.00	1	3.0	0.00	1	3.0	0.00
AUG 24-AUO 26	0	0.0	0.00	4.	2.3	0.94'		2.3	0.96
AUG 27MUG 29	0	0.0	0.00	0	0.0	0.00	0	0.0.	0.00
AUG 30-SEP 1	0	0.0	0.00	1	3.0	0.00	1	3.0	0.00
SEP 2-SEP 4	0	010	0.00	2	5.0	2.03	2	5.0	2.03
Sn 5-5EP 7	.0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
SEP 5-SEP.10	3"	6.0	1.00.	2	3.5	2.12	5	5.0	1.07
SEP 11-SIP 13.	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
SEP 14-SEP 16	0	0.0	0.00	0	4.0	4.00	0	0.0	0.00
SIP 17-SEP 19	0	0.0	0.00	0	0.0	0.00	0'	0.0	0.00
SIP 20-SEP 22	0	0.00.00		0	0.0	0.00	0	0.0	0.00
SO 23-SEP 25	0	0.0	0.00'	5	3.0	1.30	5	3.5	1.30
SEP 26-SEP 25	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
SEP 20-OCT 1	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00

Appendix Table B4.--:Mean stomach fullness and standard deviation for juvenile salmonids captured in purse and beach seines at Jones Beach by 3-day intervals, 1982.

				..Ara :j_=_,			Purse i leach		
1982	n	Mean	SD	n	Mean	SD	n	Moon	SD
				'COHO SALMON					
APR 29-MAY 1	1	7.0	0.00.	0.	0.0	0.00	1	7.0	0.00
MAY 2-MAY 4	1	7.0	0.00.	0	0.0	0.00	1	7.0	0.00
MAY 5-MAY 7	5	3.6	0.89	37	3.1	0.81	42	3.2	0.82
MAT 8--MAY 10	13	3.6	1.1!1	92	3.7	0.97	405	3.7	1.00
MAY 11-MAY 13	35	3.8.	0.99	85	3.7	.0.78	120.	3.7	0.84
MAT 14-MAY 16	77	3.7	0.94	33	4.1	1.23	110	3.8	1.04
MAY 17-MAY 19	83	3.9	1001	20	3.9	1.21	103	3.9	1.04
MAY 20-MAT 22	60	3.9	1.09	17	4.2	1.19	77	4.0	1.11
MAT 23•MAY 23	1	4.0	1.07	14	3.9	0.95	75	3.9'	1.04
MAY 26-MAY 28	102	4.0	0.97	9	3.9	1.45	14.	4.0	1.01
MAY 29-MAY 31	60	4.5	1.21	35	4.3	1.43	'93.	4.4	1.29.
JUN 1-JUN 3	108	3.9	0081	21	3.9	0.83	129	3.9	0.81
JUN 4-JUN 6	95	3.9	0.87	2	5.0	0.00	97	3.9	0.97-
JUN 7-JUN 9	60	4.0	1.07	0	'0.0,	.0.00	60	4.0	1.07
JUN 10-JUN 12	79	3.7	1.00	1	5.0	0.00	80	3.8	1.00
JUN 13-JUN' 15	45	"3.4	00.77	3	4.3.	1053	48	3.4.	0.85
JUN 16-JUN 18	34	3.8	0.82	1	4.0'	0.00	35	3.0	0.01-
JUN 19-JUN 21	27	3.5	1.09	1	4.'0	0.00	28	3.5	1.07•
-JUN 22-JUN 24	2	3.0	'0.00	2	4.0	2.83	4	3.3	1.73
JUN 25-JUN 27	1	3.0	0.00	0	0.0	0.00	1	3.0	0.00
JUN 28-JUN 30	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 1-JUL 3.	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 4-JUL 6	0.	0.0	0.00	0	0.0	0.00	0.	0.0	0.00
JUL 7-JUL 9	1	4.0	0.00	0	0.0	0.00	1	4.0	0.00
JUL 10-JUL 12	1	340	0.00	0	0.0	0.00	1	3.0	0.00
				YEARLING CHINOOK SALMON					
MAR 6-MAR 8	0	0.0	0.00	1	3.0	0.00	1	3.0	0.00
MAR 9-MAR 11	0	0.0	0.00	0	0.0	0.00.	0	0.0	0.00
MAR 12-MAR 14	0	0.0	0.00	1	3.0	0.00	1	3.0	0.00
MAR. 15-MAR 17	0	0.0	0.00	3	3.3	0.58	3	3.3	0.58
MAR 18-MAR. 20	0	0..0.	0.00'	1	3.0	0.00	1	3.0	0.00
MAR 2:-MAR 23	0	0.0	0.00	11	1.7	0.65	11	1.7	0.65 '
MAR 24-MAR 26	0	0.0 '	0.00	49	1.9	1.24	49.	1.9	1.24
MAR 27-MAR'29	5	3.0	1.58	13	1.7	0.75	18	2.1	1.16
MAR 30-APR 1	3	2.7	2.08	19	2.1	1.03	22	2.1	1.17
APR 2-APR 4	0	0.0	0.00	23	2.5	.1.78	23	2.5	1.78
APR 5-APR 7	3	3.3	3.21	21	2.2	1.18	24	2.4	1.30
APR 8-APR 10	3	4.3	2.31	21	2.8	1.26	-24	3.0'	1.46
APR 11-APR 13	'0	0.0	0.00	25	2.4	1.19	25	2.4	1.19
APR 14-APR 16	1	4.0	0.00	10	3.8	2.10.	11	3.8	1.99
APR 17-APR 19	4	3.0	1.15	3	3.8	'0.84.	9	4.3	1.12
APR 20-APR 22	7	4.9	3.21.	13	4.5	1.23	20	4.6	1.27
APR 23-APR 25'	4.	3.8	0.96	2	3.5	0.71	6	3.7	0.82
APR. 26-APR 28	14	3.8	1.32	8	3.6	1.83:	22	3.8	1.38.
APR 29-MAY 1	38	4.1	1.35	5	4.6	1434	43	4.1	1.35
NAY 2-MAY 4	19	3.8.	1.42'	3	3.0	.1.00	22	3.7	'1.39
MAY 5-MAY 7	19	3.6	0.69	2	'3.0	0.00	21	3.5	0.68
MAY 8-MAY 10	12	3.8	0.62	5	.3.2	1.30	17	''3.6	0.87
MAY 11-MAY 13	21	3.3	0.48'	1	3.0	0.00	22	3.3	0.48
MAY 14-MAY 16	9	3.2	0.97	1	5.0	0.00	10	3.4	1.07
MAY 17-MAY 19	8	3.9	1.46	1.	3.0	0.00	9	3.8	'1.39
MAY 20-MAY 22	3	3.0	0.00	3	4.3	2.31	6	3.7	1.63
MAY 23-MAY 25	3	3.3	:0.58	0.	0.0	0.00	3.	3.3	0.58
MAY 26rMAY 28	6	3.2	0.90	1	3.0	0.00	7	3.1	0.90
MAY 29-MAY 31	3	3.7	0.58.	1	2.0	0.00	:4	3.3	0.96
JUN 1-JUN 3	7	3.1	0.38	2	2.5	0.71..	9	3..0	.0.50
JUN ,4-JUN 6	7	3.0	0.00	3	1.7	1.13	10	2.6	.0.84
JUN 7-JUN 9	3	3.0	0.00	0	000	'0.00	3	3.0	0.00
JUN 10-JUN 12	3	3.0	0.00	0	0.0	0.00	3	3.0	0.00
JUN 13-JUN 15	10	2.9	0.32	0	-0.0	0.00	10	2.9	0.32
JUN 16-JUN 18	2	2.0	1.41	0	0.0	0.00	2	2.0	1.41
JUN 19-JUN 21	4	3.0	0.82	"0	00·0	0.00	.4	3.0	0.82
JUN 22-JUN 24	0	0.0	0.00	0.	0.0	0.00.	0	0.0	0.00
JUN 25-JUN 27	0	0.0	0.00	0	0.0.	0.00	0	0.0.	0.00
JUN 28-JUN 30	0	0.0	0.00	0	0.0	0.00	0	0.0 .	0.00

Appendix Table B4.--continued.

1982	-ES238 n	,Ao!_ Mean	SD	_$1450.1miax- n	Mean	SD	Purse : 8eucn --BRADS-- -.n	Mean	SD
STEELHEAD									
APR. 23-APR 25	2	1.5	0.71	0	0.0	0.00	2.	1.5	0.71
APR 26-APR 28	0	0.0	0.00	2	2.0	0.00	2	2.0	0.00
APR 29-MAY 1	1	3.0	0.00	0	0.0,	0.00	1	3.0	0.00
MAY 2-MAY 4,	1	2.0	0.00	0	.0.0	0.00	1	2.0	0.00
MAY 5-MAY 7	7.	3.7	0.95	1	3.0	0.00	8	3.6	0.92
MAY 8-MAY 10	5	2.6.	0.55	0	0.0	0.00	5	2.6	0.55
MAY 11-MAY 13	16	3.2	0.66	1	3.0	0.00	17	342	0.64
MAY 14-MAY 16	19	2.4'	0.96	0	0.0	0.00	19	2.4	0.96
MAY 17-MAY 19	36	3.1	0.97	0	0.0	0.00	36	3.1	0.97
MAY 20-MAY 22	30	2.9	-1.04	0	0.0	0.00	30	2.9	1004
MAY 23-MAY 25	13	3.4	0.87	0	0.0	0.00	13	3.4	0.87:
MAY 26-MAY 28	20	3.2	0.81`.	0	0.0.	0.00	20	3.2	0.81
MAY 29-MAY 31	26	3.3	0.68,	0.	0.0	0.00	26	343	0.68
JUN 1-JUN 3	18	2.9	0.96	0	0.0.	0.00	18	2.9	0.96
JUN 4-JUN '6	30.	3.1	1.06	1	1.0;	0.00	31	3.0	1.11
JUN 7-JUN 9	12	2.6	0.67	0	0.0	.0.00	12	2.6	0067
JUN 10-JUN 12	14	209	0.62	0	0.0	0.00	14	2.9	0.62
JUN 13-JUN 15	15	3.5	1.81	0	0.0	0.00	15	3.5	1081
JUN 16-JUN 18	3	3.3	2.31	0	0.0	0.00	3	3.3	.2031
JUN 19-JUN 21	3	3.7	2.52	0	0.0	0.00	3	3.7	2452
JUN 22-JUN 24	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN 25-JUN 27	1	2.0	0.00	0	0.0	0.00.	1	2.0	0.00
JUN 28-JUN 30	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00.
JUL 1-JUL 3	0	0.0	0.00	0	0.0	0.00	0	O.O	0.00
JUL 4-JUL 6	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 7-JUL 9	0	0.0	0.00	0'	0.0	0.00	0	0.0	0.00
JUL 10-JUL 12.	0	0.0	0.00	0	0.0	0.00	0	040	0.00
JUL 13-JUL 15	1	3.0	0'.00	0	0.0	0.00	1	3.0	0.00
JUL 16-JUL 18	0	0.0.	0.00	0	0.0	0.00	0	0.0	0.00

ZT•Z	S•Z	Z	ZT'Z·	1•Z	Z·	00·0	0·0	0	St 330-CT 330
ZS•Z	2'4	Y	It1	t'Y	C	00·0	0•t	t	Z1 330-01 .330
44.0	Pt	•.	44'0	t•C-	•	00·0	0·0	0	4 034-L .330
•0·0.	t•Z	C	SS•.0	t•C	c	o0·o	0·0	0	• 330-•. 330
owl	►•t	CT	WO'	S'C	TT	'00·0	0•Z	t	t 030-T 330
6f•1.	vs	6	10'	4•Z	•	00·0	0't	I	Ot AON-•Z AOM
S►•t	6't	4	4P'I	1'V	f	21'1	t•t	t	CZ AON-SC AOM
OPT	$'C	it	SPT	VT	OI	t►•t	0•t	Z	►Z AON-ZZ AON
Sr'	•'t	TZ	Li't	••C	1Z	00·0	0·0	0	II AON-4T AOM
Tf'T	CC	SZ	tf•T	et.	0Z	00·0	0'0	0	•t AON-St ACM
CZ't	C•C·	i;	LZ•T	Z•C	·►	'WO	t•►	►	ST AON-tT AON
LOT	PC	•f'.	60'1	1•t	ff	00·0	we	t	CT..AOM•OT AOM
TWO	f•L	Cf	14.0	,f'Z	Zf	00·0	o•t	T	4 AON-L AON
tT'I	O't	COT	YPT	O't	4Ct	00·1	T't	YZ	P AON-f- AOM
SC•Z	0'2.	S	02·0	L'S	C	►W►	0•►	Z	C AON-t AOM
00·0	0'O	0	00·0	0·0	0··	00·0	0'O	0·	tt 130-61 130
...o0.00	0	0	00·0	0·0	0	00·0	0·0	0-	SZ 130-9Z 130
00.0.	0'0"	0	00·0	0·0.	0	00·0	0·0	0	SZ 130-CZ 130
00·0	0·0	0·	00'0	0·0	0	o0•0	0·o	`0	CZ130-OZ 130
00·0	0.0	0·	00·0	0·0	0	00·0	-0•o...	0	61 130·41.130
00·0	0·0	0·	00·0	0·0	0	00·0	0·0	0	'fT 130-rt 130
00·0	O.0	0	00'O	O'0	0	'00-0	0·0	0	Ct 130-IT 100
00·0	0·0	0.	00·0.	0·0	0	00·0	0·0	0	Ot 130·o 130
00'O	0·0	0	.110·0	0'0	0.	00·0	0·0	0	1 130·1 130.
00·0	0·0	0	00·0	0·0.	0	00·0	0·0	0	r, 130·4 130
'00'0.0	0.0	0.	00·0	0·0	0·	00·0	0·0	0	1 130-6Z 43•
00·0	OO	0	00·0	0.0	0	00·0	0·0	0	•Z d34-fC d3$
00•o	0·4	I	00'0	0'0	t	00·0	0'0	0	SZ 430·11 d3$
O0 0	0•Z	I	o0'0	O'Z	t	00·0	0·0	0	CZ d35-Oi d39
00·0	Oto	0	00·0	0·0	0	00·0	0'0	0	•!. d3S-41 d$s,
60·0•f•►		S	6••0	f•Y	S	00'0	0·0	0	fi 43$',T 43$
•S'0	c•►	t	00·0	O'r	Z	00·0	wt	T	CI 030-11 all
C••I	q•Y	ca	O••t	1·0	CI	00·0	O't	T	01 430·0 d3•
tt't	S••	Y	CL•t	S•►	Y	00.0	0·0	0	L d3•-S' d3•
00·0	0·0	Z	00·0	0•S	Z	00·0	0'0	0	1. 435·1 43S
EZ'Z	••t	Y	iso	L'L	C	00·0	0•t	t	1 13•-Ot OnV
CPC	S•s	Z	CT'S	S'S	Z'	00•0	0'0	0	4Z ofV-LC Onv
•t•t	••S	Ct	O'1	I'S	01	04·0	t•f	C	OC ono-•C 01W
•S0	t'S	C	ISO	C•O	C	00·0	0·o	0	CC Onv-TZ CAM
01.1'	►••	)C..	'Pt	`S•P	ZC	00'0	0.t	Z	0Z 01W-•I 01W
4••0.	t•C	LZ	t4·0	Pt	SZ	-twe	0'C	Z	Lt OnV-CT 01W
01-L	PY	6C.	OZ•T	0••	It	CI•Z	S•S	Z	►T 01W-Z1 OnV
SWI	0•►	L•	►Z•I	PO	Si	00'T	6't	6	IT ono-6 Ono
clot	f•►	6T	T►•1	St►	S1	OS•T	..C'S	Y	0' DAMS Omr
.04 0	••C	Z►	kO	►'C	0►	00·0	0•C	Z	C -OnY-t OnV
LZ•I	L•t	tt	►0•t	••C'	•	•0'Z	L•t	C	Z OnM.tt Inr
wit	6•t	TS	I►•T	6't	L►	Z••0	0•►	Y	Ot Inr-SC lilt
ft•I	0•►	CO	•t•T	t•►	o►	•C C	0•C	cT	IZ 11W-SZ 11M'
Lf•r	r v	1Z	►L$	t'►	►Z	00·0	0•r.	Z	►L lilt-ZZ Int
:art	Y•►	$0	CS•t	t•►	CO	0•0	•••	0	1Z" InNOi 'YM'
MT	S'►	fL	61'1	►•►	ZL	I►•I	0'9	v··	et Int-ft lil'
•T•1	Z•r	001	01·1	t•►	14	60•1	L•S	•	11 tilt-tt lilt
OZ•T	Z•►	►It	•Z•T	t•►	InT	06·0	••C	CZ	ZI lil'-Ot lilt
VZ•T	t•►	SCT	Vt·'	►•►	101,	14'0	rip	•Z	6: lilt-4 lllr
Pt·'	Z'►	S►	41'T	P►	0C	tO't	••►	4	0 W It-•
06·0	0•►	Ztt	040	O'►	•S	N•0	0•►	JL	C lilt-t lilt
•6·0	L•t	ZLt	•0 1	6'#	Si	two	•'t	►4	Ot Nnr-K' WAr
6Z•I	0•r	K	►►•t	t•►	VS	,0P0	••t	02'	LC Nnr-SZ lilt
LT•t	t•►	fS	CZ•1	t•►	LZ	•O•T	Z•r	6Z	rZ Mnr-CC MIN'
Zt•T	0•►	SIT	11·1	0•►.	►f	S►•I	;•Y	TS	1Z Nnr-41 M1M'
CZ•T	P•	.Z,1	LZ•1	0•►	ITT	►Pt	t•►	of	•t tilt-•t Nnr'
ZZ•t	O•r	►ZZ	YZ•t	T•►	Mt	ZT•t.	L.t	4f	St NOr-ti lilt
tt'1	►••	61Z	14·1.	►'•	061	04·0	Z•►	CZ'	Z1 Mnr-OI MAr
►4·0	O'►	CZL	Z4•0	t•v	1ST	Iwo	eft	ZL	6 Nnr-4 MAt
COT	S't	LOI	ow'	►•t	►ZT	00•1	4 C	tC	NAt-• Nnr.
,60·1.	►•C	*It	40·1	••t	44	oP t	rt	OZ	C Nnr-T NAt
Z0·1	T••	•t	06·0	c•►	TI	Ot•1	0•t	S	IC AVM-6Z AVM
01·1	Y•►	SZ	ti•T	L•►	•T	•6·0	f•t	L	•Z AVM-•Z' AVM
Ot•T	0•►	Tf	CZ'T	0•►	C►	•••0	rt	•T	SZ AWN-CZ.AVN
Ye•T'	t•S	st	OS•T	►•S	CI	t1•0,	S•Y	Z	CC AVM-OZ AVM
·ors	L•►	Oi-	TV'T	4't	LC"	'PVT		•	6I AVN-LI AWN
sr•T	4•►	CO	S►•t	•••	cc	wt	1'S	01	VT AVN-VI AVM
IV!	S•►	44	LS'T	t•►	f►	►C•I	Z'S	CI	CI AVM-Ti AVM
1Z't	VP	OS	tr'	C••	04	00·0	0'O	0	OT AVM-, AVN
CZ•T	C•f	f•	CZ't	t•►	IS	WI	S•Y	Y	L AVM-f. AVN
MT	6•4	£4	tI'T	4•t	06	•0•o	t•►	C	0. AVN-Z AVM
TT•T	L•t	Sit	It·;	f•C	Z*T	ere	c·v·	t	T AVN-CC MdV
eV·'		sot	VC'S	et	101	we	C·!	C	•C VdV••C MdV
►0·1	4•t	IS	1S•t	6'C	OS	00·0	0•►	1	LZ"M4v-CZ MdV
SC'S	I•Y	L•	SZ•t	0•►	90	00·0	wt	i	ZZ MaV-OZ M4V
LZ•T	►•t	•t'	21'T	PC	•t	00·0	0·0	0	41 VdV-tI MdW
cot·'	Z.•	s	oP t	vv	'S	·00·0	0·0	0	ft Mdv-►1 Ndv
ZZ•T	0•►	t	ZZ•t	0•Y	S·.	00·0	0·0	0	CI 111Y-It MaY
02•0	t•C	t	•S'0	C•C	t	00·0	0·0	0..	Ot MdW'•. MdV
00·0	0•c'	t	00.0	o•C	T	00·0	0·0·	0	L MdY S WV
10'1	►•C..	Ot	to•T	►•C	Ot	00·0	0·0.	0	• Pal-C WIV
Z4'T	L•C	It	set	et	ZI	'00•0	coo	0	1 o44-OC MVM
Z►•t	rt	6	set	pc	4	00·0	0·0	0	42 MVM•LZ WM

MOMIVS 710OMIM3 ONIIMV3A0n0

CS- SINK_W OT es 000w V Os vW Y 1.61

Va••• • "d. '•5af0s'QS60r –

Appendix *Table* B5.--Mean stomach tuliness and standard ***deviation tor*** juvenile salmonids captured in purse and beach seines ***at*** Jones Beach by 3-day intervals 1983.

	.tMtee ceae2-.			Jeeub.lt4oe..-			Puree 1 004c1 --.'foaa.-$5		
1923	A	mess	80	0	Me•A	e0	A	sRMIR.	t0
FOND SALMON									
APR 23-AMR 23	0	0.0	0.00	1	4.0	0.00	1	4.0	0.00
APR 26-APR 28	2	5.0	0.00	1	3.0.0.00		2	4.0	1.41
APR 21-MAY 1	4	4.3	1.50	3	4.7	2.00	7	4.4	1.62
MAY 2-MAY 4	2	5.0	1.41	2	3.0	0.00	4	4.0	1.41
RAY 5-MAY 7	3I	3.3	1.27	33	3.6	1.17	04	3.5'	1.22
0AY O-MAY 10	34	3.0	1.26	24	4.0	1.2•	58	3.•	1.26
MAY 1$-MAY 13	50	4.4	1.22	20	4.1	1.32	70	4.5	1.26
MAY 14-MAY 10	100	3.7	1.12	12	3.7	1.44	112	3.7	1.15
MAY 17-MAY 1•	111	3.8	1.06	57	3.6	1.12	176	3.7	1.00
MAY 20-MAY 22	0s	3.6	1.12	17	3.4	1.17	102	3.6	1.12
MAY 23-MAY 25	71	4.3	1427	2	1.5	0.71	81	4.2	1.32
MAY 24-MAY 20	01	4.3	1.0•	2	. 3.5	0.71	93	4.3	1.00
MAY 21-MAY 31	116	3.1	1.02	11	4.0	1.41	127	3.•	1.06
JUN i-JUN 3	·176	3.5	1.03	22	3.0	0.64	110		0.92
JUN 4-JUN·	60	3.3	0.•3	0	3.3	0.46	08	3.3	0.01
JUN 7•JUM •	23	3.1	0.70	4	2.5	0.58	27	3.0	0.70
JUN 10-JUN 12	54	3.4	0.08	1	5.0	0.00	'55		0,•1
JUN 13-JUN 15	231	3.7	1.02	20	3.0	1.41	251	3.?	1.05
JUN 16-JUN 18	44	3.8	0.06	I7	3.0	1.24	03	3.5	0.92
JUN..11-JUN21	15	3.5	o	3	4.3'	1.53	' 10	3.7	0.17
.JUN 22-JUN 24	36	3.7	40	14	4.4	1.28	30	4.0	1.31
JUN 25-JUN 27	5'	3.0	0.04	2	5.0	2.83	7	4.1	1.46
JUN 21-JUN 30	.8	4.0	1.07	0	0.0	0.00	e,	4.0	1.07
JUL 1-JUL 3	0	0.0	0.00	0	0.•	0.00	0'	o.•	0.00
JUL,. 4-JUL 4	•	4.2	1.72	0	0.0	0.00	4	4.2	1.72
JUL 7-JUL. •	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
1EAR1.1N0 CHINOOK SALMON									
JAN 24-JAN 28	0	0.0	0.00	0	3.0	0.00.	4	3.0	0.00
JAN 21-JAN 31 .	0	0.0	0.00	0	0.0	0.00	0,	0.0	0.00
PEP 1-Fee 3	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
FLe 4-Fte 4	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
icO 7-FEe 0	0	0.0	0.00	1	3.0	0.00	1	3.0	0.00
r[1 10-FEe 12	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
FEe 13-FEe 15	0	0.0	0.00	2	2.5	0.71	2		0.71
Ftt 14-IEe 10	0	0.0	0.00	3	4.3	143	3	4:3	1.53
FED 19420 21	0	0.0	0.00	0	0.0	0.00	. 0	0.0	0.00
FED 224Ee 24	0	0.0'	0.00	2	4.•	1.41	2	4.0	1.41
FEe 254Ee 27	0	0.0	0.00	5	3.4	1.34	5	3.4	1034
FED 2$-MAR 2	0	0.0	0.00	3	4.0	1.73	3	4.0	1.73
MAR 3-MAR S	0	0.0	0.00	2	3.0	0.00	2	3.0	0.00
MAR 4-MAR e	0	0.0	0.00	3	403	1.53	3	4.7	1.53
MAR 1NUIR 11	1	1.0	0.•0	0	3.4	1.41	•	3.1	1.54
MAR 12-MAR $4	0	0.0	0.00	11	1.0	1.17	11	1.8.	1.17
MAR 15-MAR 17	0	0.0	0.00	10	1.3	0.77	18	1.3	0.77
MAR 18-MAR 20	2	1.0;	0.00	5	2.6	2.41	7.		2.27
MAR 21-MAR	1	5.0'	0.00	12	2.4	1.56	13	2.4	1.66
MAR 24-MAR 24	0	0.0	0.00	3	2.7	0.50	3	2.7	0.50
'MAR 274IAR 21	1	4.0	0.00	5	2.6	1.14	6	2.8	1.17
MAR 30-APR	1	7.0	0.00	8	3.0	1.85	•	3.4	2.11
APR 2-APR 4 '	I	4.0	0.00	2	2.0	1.41	3	2.7	1.53
APR 5-APR 7	•	3.1	1.•0.	74	2.3	1.54	33	2.7	1.78
APR S-APR 10	0	0.0	0.00	13	1.7	1.03	13	1.7	1.03
APR 11-APR 13	1	4.0	0.00	4	3.0	1.26	7	3.1	1.21
APR 14-AIR 14	4	2.0	0.•4	2	1.0	0.00	6'	2.2	1.17
APR 17•0P0· 1t	6	4.5	1.05	5	3.8	2.51	11	4.2	1.03
APR 20-APR 22 '	16'	3.4	0.42	2	2.5	0.71	10	3.5	0.71
AMY 23-APR 25	•	3.3	0471	0	0.0	0.00	1	3.3	0.71
APR 2•-APR 20	11	3.3	1.01	1	5.0	0.00	12.	3.4	1.00
APR 21-MAY 1	12	3.1	0.•0	1	3.0	0.00	13	3.1	0.84
MAY 2-MAY 4	10	3.5	0.71	2	,3.5	0.71	12	3.5	0.67
MAY 5-MAY 7	10	2.7	1.04 '	0	0.0	0.00,	10	2.7	. 1.04
MAY 8-MAY 10 ,	7	2.7	1.25	0	0.0	0.00'	7	2.7	1.25
MAY 11-MAY 13	20	3.5	1.43	0	0.0	. 0.00	20	3.5	1.43'
MAY 14-MAY 14	22	3.1	1.06	1	5.0	0.00	23	3.2	1.11
NAY I7-MAY I4	33	2.5	1.25	0	0.0	0.00	33	2.5	1.23
MAY 20-MAY 22	20	2.•	0.85	1	2.0	0.00	21	2.7	0.05
MAY 23-MAY 25	31	2.9	1.10'	1	2.0	0.00	32	2.0	1.17
NAY 24-MAY 28	4	2.5'	0.04	0	0.0	0.00	4	2.5	0.04
MAY 29-MAY 31	21	2.7	0.11	0	0.0	0.00	21	2.7	0.•1
JUN 1-JUN 3	1	4.1	0.70	0	0.0	0.00	•	3.1	0.70
JUN *4-.NMI* -	0	2.1	1.13	0	0.0	0.00	0	2.1	143
JUN 7-JUN 9	3	3.0.	0.00	0	0.0	0.00	3	3.0	0.00'
JUN *0-JUN 12	1	3.0	0.00	0	0.0	0.00		3.0	0.00
JUN 13-JUN 1s	2	3.5	0.71	0	0.0	0.00	2	3.5	0.71
JUN 1•-JUN 18	2	3.0	0.00.	0	0.0	0.00	2	3.0	0.00
JUN 11-JUN 21'	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN 22-JUN 24	0	0.0	0.00	0	0.0	0.00'	0	0o	0.00
JUN 25-JUN 27 . -	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUN20-JUN 30	•	0.0.	0.00	0	0,.0	0.00	0	0.0	0.00
JUL 1-JUR. 3	•	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 4-JRN. 6	2	2.5	0.71	0	0.0	0.00	2	2.5	0.71
JUL 7-.RML 1	0	0.0	0.00	0	0.0	0.00.	0	0.0	0.00
JUL 10-JUL 12	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00

Appendix Table B5.--continued.

1983	?sr2LJSiDB, n	neon	SD	.JSSsb_Ssist_ n	Mean	SD	'Purse 1 Bioch n	Mean	SD
				STEELHEAD					
APR 29-MAY 1	1	4.0	0.00	1	3.0	0.00	2	3.5	0.71
MAY 2-MAY 4	2	2.0	1.41	0	0.0	0.00	2	2.0	1.41
MAY 5-MAY 7	2	1.5	0.71	1	7.0	0.00	3	3.3	3.21
MAY 8-MAY 10	6	2.7	0.52	0	0.0	0.00	6	2.7	0.52
MAY 11-MAY 13	22	2.6	0.95	0	0.0	0.00	22	2.6	0.95
MAY 14-MAY 16	30	2.8	1.81	0	0.0	0.00	30	2.8	1.81
MAY 17-MAY 19	43	2.5	1.30	0	0.0	0.00	43	2.5	1.30
MAY 20-MAY 22	12	2.7	0.98	0	0.0	0.00	12	2.7	0.98
MAY 23-MAY 25	30	3.0	1.43	2	2.0	0.00	32	2.9	1.40
MAY 26-MAY 28	29	3.4	1.53	0	0.0	0.00	29	3.4	1.53
MAY 29-MAY 31	93	2.8	0.94	0	0.0	0.00	93	2.6	0.94
JUN 1-JUN 3	79	2.5	1.14	0	0.0	0.00	79	2.5	1.14
JUN 4-JUN 6	20	2.5	1.05	0	0.0	0.00	20	2.5	1.05
JUN 7-JUN 9	63	2.0	1.01	0	0.0	0.00	63	2.0	1.01
JUN 10-JUN 12	24	2.7	0.82	0	0.0	0.00	24	2.7	0.82
JUN 13-JUN 15	45	2.5	1.20	0	0.0	0.00	45	2.5	1.20
JUN 16-JUN 18	16	2.4	0.89	0	0.0	0.00	16	2.4	0.89
JUN 19-JUN 21	11	2.2	0.75	0	0.0	0.00	11	2.2	0.75
JUN 22-JUN 24	3	2.3	0.58	0	0.0	0.00	3	2.3	0.58
JUN 25-JUN 27	1	1.0	0.00	0	0.0	0.00	1	1.0	0.00
JUN 28-JUN 30	3	4.0	0.00	0	0.0	0.00	3	4.0	0.00
JUL 1-JUL 3	1	2.0	0.00	0	0.0	0.00	1	2.0	0.00
JUL 4-JUL 6	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 7-JUL 9	1	2.0	0.00	0	0.0	0.00	1	2.0	0.00
JUL 10-JUL 12	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 13-JUL 15	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
JUL 16-JUL 18	1	2.0	0.00	0	0.0	0.00		2.0	0.00
JUL 19-JUL 21	0	-0.0	0.00	0	0.0	0.00		0.0	0.00

Appendix Table B5.--continued.

1953	.Earls-Jlios--			-liasb.JsLDz--			Pura.: 9.sch		
	e	Neon	$D	ro	NNn	SD	n.	nnnn	~n-
				SU•YEARLINO CNINOOK SALMON					
MAR 24-MAR 26	0	0.0	0.00	1	7.0	0.00	•1	7.0	0.00
MAR 27-MAR 21	0	0.0	.0.00	0	0.0	0.00	0	'0.0	0.00
MAR 30-APR 1	0	040	0.00	0	0.0'	0.00,	0	0.0	0.00
APR 2-APR 4	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
APR 5-APR 7	0,	0.0	0.00	0	0.0	0.00	0	0.0	0..00
APR S-APR 10	0'	0.0	0.00	0	0.0	0.00	0	0.0	0.00
APR 11-APR 13	0	0.0	0.00	0'	0.0	0.00	0	0.0	0.00
APR 14-APR 16	0	0.0	0.00'	0	0.0	0.00	0	0.0	0.00
APR 17-APR 19	0	0.0	0.00.	0	0.0	0.00	0	0.0	0.00
APR 20-APR 22	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
APR 23-APR 25	0	0.0	0.00	0	'0.0	0.00	0	0.0.	0.00
APR 26-APR 28	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
APR 29-MAY 1	0	0.0	0.00	1	3.0	0.00	1	3.0	0.00
MAY 2-MAY 4	24	3.9	0.96	106	4.3	1.11	130	4.2	1.01
MAY 5-NAY 7	14	3.5	1.02	74	3.9	1.15	••	3.8	1.13
MAY S-MAY 10	12	3.0	1.11	01	3.7	1.04	93	3.7	1.04
MAY 11-NAY 13	9	5.7	1.12	34	5.0	1.55	43	5.2	1.4•
MAY 14-MAY 16	S	'5.9	0.19	22	3.0	0.19	30	5.2	1.04
MAY 17-MAY 19	1	6.0	0.00	34	4.0	1.42	37	4.•	1.61.
MAY 20-MAY 22	2.	4.0	4.24	26	2.1	1.60•	2$	3.1	1.74.
MAY 23-MAY 25	0	0.0	0.00	6	6.0	1.26	6	6.0	1.26
NAY 26-MAY 2•	0	0.0	.0.00.	-. 4	4.5	1.21	4	4.5	1.21
MAY 29-MAY 31,	14	3.9'	1.14.	1	3.0	0.00	15	3.9	1.13
JUN 1-JUN 3	•	'4.3	0.89	1.	4.0	0,00..	9	4.2	0.83
JUN 4-JUN 6	1	4.3	'1.26	1	5.0	0.00	3	4.4	1.14
JUN 7-JUN 9	15.	3.1	0.64.	2	445	3.54'	17	3.3 .	1.16,
JUN 10-JUN 12	33	3.7	0.85	1	5.0	0.00	34	3.7	0.86
JUN 13-JUN 15	51	3.4	0.85	3	2.7	0.58	62	3.6	0.86
JUN 16-JUN 18	21	3.9	1.41	17	4.0	1.46	46	4.0	1.41
JUN 19-JUN 21		3.8	1430	1	4.2	1.48	1•	4.0	1.37
JUN 22-JUN 24	5	4.2	1.71	16	34	1.52	21	3.9	1.55
JUN 25-JUN 27	12	4.1	1.00 .	,69	3.5	1.13	81	3.6	1.27
JUN 2•-JUN 30	23	4.1	1.35	85:	4.1	1.18	10.	4.1	1.21
JUL 1-JUL 3	11	3.1'	0.54	54'	4.3	1.46	65	4.2	1.35
JUL' 4-JUL 6	44	4.0	1.30	81	3.1	1.21	123	3.9	1.24
JUL 7-JUL 7	55	4.2	1.30.	55	3.8	1.33	110	4.0	1.33
JUL 10-JUL 12	13	4.6	1.89	61	4.6	1.49	•2	4.6	1.55
JUL 13-JUL 15	14	4.9'	1.64	87	,3.4	1.50.	101.	3.6	1.60
JUL 16-JUL 18	22	3.3	1.25	43	3.9	1.47	67	3.7	1.42..
JUL 19-JUL 21	40	3.3	0.97	35	4.3	1.75	93	3.7	1.39
JUL 22-JUL 24	15	4.2	1.37	5	'5.6	1.34	20	4.6	.1 0 47
JUL'25-JUL 27	5	5.4	1.52	30	4'.6.	1.11	35	4.7	1.75
JUL 2S-JUL 30	4	4.5	1.73	12	3.5	1.03	16	4.0	1.21
JUL 31-AUG 2	2	6.0	0.00	3	5.0	2.45	5	3.4	1.95
AUG 3-AUG 5	1	3.0	0.00	24	4.3	1.91	25	4.3	1.97
AUG 6-AUO •	4	5.5	1.73	4	5.5	1.29	0	5.5	1,41
AUG 9-AUG 11	2	5.0	1.41	27	4.3	1.71.	29	.4.4	1.68..
AUG 12-AUG 14	4	5.5	1.73	13	6.6	0.45	17	6.4	1.06
AUG 15•AUG 17	9	4.7	1.32	22	4.1	1.60	31	4.3	.1453
AUG 1•-AUG 20	0	0.0	0.00	•	4.0	1440	8	4.0	.1.60
AUG 21-AUG 23	1	3.0	0.00	7	2.7	0.76	8	2.•=	'0.71
-AUG 24-AUG 26	0	0.0	0.00	•	4.0	1.07	0	4.0	1.07
AUG 27-AUG 29	0	0.0	0.00	4	3.0	0.00	1	3.0	0.00
AUO 30-SEP 1	0	0.0	0.00	6	S.•	1.40 -	6	5.5.	1.60
SEP 2-SEP . 4	0	0.0	0000	1	3.0	0.00	1	3.0	0.00
SEP 5-SEP, 7	11	4.9	0.70	40	5.1	1.34	51	5.1	1.24.
SEP S-SEP 10	5	5.4	1.67	36,	4.3	1.34	41	4.4	1.41
SCP 11-SEP 13	1	7.0	0.00	9	5.2	1.72	10	5.4.	1.71
SEP 14-SEP 16	0	0.0	0.00	29'	3.0	1.72	29	5.0	1.72
SEP 17-SEP 19	0	0.0	0.00	4	4.0	1.15.	4	4.0	1.15
SEP 20-SEP 22	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
SEP 23-SEP 25	0	0.0	0.00	2	3.5	0.71	2	3.5	0.71
SEP 26-SEP 28	0	0.0	0.00	0	0.0	0.00	0.	0.0	0.00
SEP 29-OCT 1	0	0.0	0.00	0	0.0	.0.00 .	0	0.0	0.00
OCT 2-OCT 4	0	0.0	0.00	0	0.0	0..00	0	0.0	0400
OCT 5-OCT 7	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
OCT' 6-OCT 10	0	0.0	0.00	0	0.0	0.00	0	0.0.	0.00
OCT 11-OCT 13	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00
OCT 14-OCT 16	0	0.0	0.00	1	2.0	0.00	1	2.0	.0000
OCT 17 00T 11	27	5.1	0.16	10	401	2.02	37	4.8	1.37
OCT 20-OCT 22	0	0.0	0.00	•	6.1	0.64	S	6.1	0.64
OCT 23-OCT 25-	3	4.3	0.55	12	3.7	2.19.	15	3.•	1.97
OCT 26-OCT 20	0.	0.0	0.00	'2.	.505.	2.12	2	5.5	2.12
OCT 29-OCT 31	0	0.0	0.00	1	2.0	0.00	-1	2.0	0.00
NOV 1-NOV 3	2	3.5	2012	3	3.3	2.52	3	3.4	2.07
NOV .'-NOV 6	7	3.0	1.15	14	3.1	'1.69	'21	3.0	1.50..
NOV 7-NOV 9	0	0.0	0.00	57	3.2	1.11	57	3.2	1.11
NOV 10-NOV 12	0	0.0	0.00	- 17	3.1	0.11.	17	3.1	0.19
NOV 13-NOV 15	0	0.0	0.00	9	2.1	0.33	9	2.1	0.33
NOV .16-NOV 18	0	0.0	0.00	3	2.3	0.50	3,.	.3.3	0.58
NOV 19•NOV 21	4	2.3	0.50	1	4.0	0.00	5	2.6	0.89
NOV 22-NOV 24	0	0.0	0.00	'2	4.5	2.12'	2	4.5	2.12
NOV 25-NOV 27	0	0.0.	0.00	0	0.0	0,.00	0	0.0	0.00

Appendix Table B6.--Status of juvenile salmonid stomachs collected' at Jones Beach (RKm 75), 1979-1983.

Year: -Mt-- 1112._ -1121-_ ,,122Z-- _1221 -12Z!_ 4222-- _1221__ -1222-- -122L.,

ngtes n²/ ~3/ P P— ~-_._P----~_.._P C.._~~~_~ ► G P~&~P~~—~

	Subyearling Chinook saloon										Yeorlinq chinook salmon									
01 Jon - 13 Jan	0	0	0	0	0	0.	0	0	0	0	.0	0	0	0.	0,	0	0	0	0	0
14 Jon- 27 Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
28 Jon 10 Feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11 Feb 24 Feb	0	0	0	0	0	0.	0	0	0	0	0	.0.	0	0	0	0	0	0	6	0
25 Feb - 10 Mar	0	0	0	0.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	19	.0
11 Mnr 24 "Mor	0	0	50	0°	1	0	0	0	0	0	8	0	30	0	1	0	43.	0	20,	0
25 Mor 07 Apr	22	17	16	9	6	5	32	13	1	0	29	22	129	19	14	0	85	0	34'	0
08 Apr 21 Apr	22	15	68	10	11	7	82	26	0	0	32	27	174.	50	46	0	63	0	31	0
22 Apr 05 'May	25	19	86	25	103	38	4145/20		27	0	26	22	114	44..	590/0		1120/0		43	0
06-May 19 May	13	11	153	37	162	18	247s/20		50	0	10	10	119	47 .	190/0		660/0		12	0
20 May 02 Jun	15	13	168	18	185	20	160g/20		16	0	10	10	4	0	120/0		250/0		'38.	0
03 Jun 16 Jun	8	11	309	15	187	20	882s/20		44	0	11	9	7	0	40/0		280/0		3	0
17 Jun 30 Jun	16	15	167	18	106	21	358g/20		95	0	4	3	0	0	20/0		30/0		0	0
01 Jul 14 Jul	6	0	315	25	26	0	302	0	61	0	1	0	0,	0	0	0	0	0	1	0
15 Jul 28 Jul	3	0	216	18	0	b	147	0	50	0.	0	0	0	0	0	0'	0	0	0-	0
29 Jul 11 Aug	3	0	229	15	14	0	82	0	43	0	0	0	0	0	0	0	0:	0	0	0
12 Aug 25 'Aug	4	0	204	14	1	0	46	0	45	0'	0	0	0	0	0	0	0	0	0	0
26 Aug 08 Sep	'o	0	98	2	0	0	18	0	28	0	-.0	0	0	0	0	0	0	0	0	0
09 Sep 22 Sep	0	0	29	0	3	0	13	0	13	0	0	0	0	0		0	0	0	0	0
23 Sep 06 Oct	0	0	0	0	0	0	1	0	2	0	0	0	0.	0	0	0	0	70	0	0
07 Oct 20 Oct	0.	0	.0	0	0	0	0	0	17	0	0	0	0	o	0	0.	0	'0	0	0
21 Oct 03 Nov	0	O^	0	0	0	0	4	0	17	0	0	0	0	0	0	0	0	0	0	0
04 Nov 17 Nov	0	0	0	0	0	0	103	0	24	0	0	.0	0	0	0	0	0	0	0	0
18 Nov 01 Dec	0	0	0	0	0	0	30	0	2	0	0	0'	0	0	0	0•	0	0	0	0
02 Dec 15 Dec	0	0	0	0	0	0	7	0,	0	0	0	0	0	0	0	0	0	0	0	0
16 Dec 31 Dec	0	0	0'	0	0	0	0	0	.0	0	0	0	'0	0	0	0	0	0	0	0.
Total4:		101		206		129		139		0		103		.160		0		0		0
Totals:	143		2108		805		2928		535		131		577		157		426		212	

	Coho salmon										Steelhead									
01 Jnn - 13 Jan	0	-	0	0'	0	0	0	0.	0	0	0	0	0	0.	0.	O-,	0	0	.44	0
14. Jon - 27 Jon	0	0	- 0.	0	0	0	'0	0	0	0'	0	0	0	0	0	0	0	0	0	0
28 Jan - 10 Feb	'0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0'	0	.0	0
11 Feb - 24 Feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0'	0	0	0	0	0
25 Feb 10 Mar'	.0	0	.0.	0	0	0	0	0.	0	0	0	0	0	O	0	0	0.	0'	0	0
11 Mar 24 Mar	0	0.	0	0	0	0	0	0	0.	0	0	0	0	0	0	0	-0	0	0	0
25 Mar - 07 Apr	0	0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	.0	0	0	0
08 Apr - 21 Apr	0	0	0	0	0.	0	0	0	'0	0	0	0	1	0	0	0	0	0	0	0'
22 Apr 05 May	3	0	3	0	30	0	13s/	0	21	0	12	9	161	39	.8	.0	10s/0		3	0
.06 May - 19 hoy	13	10	260	92	155	0	463s/	0	55	0	30	10	136	36	37	0	72g/0		26	0
20 May - 02 Jun	12	10	107	14	118'	.0	424s/	0	64	0:	13	11'	24	7	24	0	95g/0		46	0
03 Jun -.16 Jun	18	17	124.	20	41	0	329g/	0	52	0	12	10	7	0	8	0	62s/0		31	0
17 Jun - 30 Jun	10	10	8	3	1	0	40s/	0	27	0	1	1	3	0	0.	0	5g/0		4	0
01 Jul - 14 Jul	8	0	86	0	2.	0	2	0	2	0.	1	0	0	0	0	0	1.	0	0	0
.15Jul-28 Jul	3	0	3	0	.0	0	0	0	0	0	0	0	0	0	0	.0	0	0	0	0
29 Jul - 11 Aug	0	0	0	0.	0	0	0.	0	0	0.	0	0	0.	0	0	0	0	0	0	0
12 Aug - Aug	0	0.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Auq - 08 Sep	0	0	0	0	0	0	0	0	0	0'	0	0	0	0	0	0	0	0	0	0
09 Sep - 22 Sep-	0	0	'0	0	0	.0	0	0	0	0.	0	0	0'	0	0.	0	0	0	0	0
23 Sep - 06 Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07 Oct 20.. Oct	0	0	0	0	'0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 Oct - 03 Nov.	0	0	0	0	0	0	0	0	0	0	'0	0	0	0'.	0	0	0	0	0	0
04. Nov - 17 Nov	0	0	0	0	'0	0.	0	0	-0	0	0	0	0	0	0	0	0	0	0	0
18 Nov - 01 Dec	0	0	0	0	0	0	0	0	0	0`	0	0	'0	0.	..0	0	0	0	0	0
02 Doc - 15 Oic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.	0	0'	0
16 Dec - 31 Dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	67	47	591	.129	347	0	1271	0	221	0	49	41	332	82	77	-0	245	0	110	0

J/. P ■ Number stomachs preserved. Some stomachs may be missing frets the collection due **to** storage problems.
ti C • Number of stomachs with contents identified as of December 1984.
/ Approximately 25Z used for proximate analyses.
A/ Approximately 50Z used for proximate analyses.

Appendix Table B7.--Source, date of median recovery, and tag codes for, fish groups used in graphic comparison of stomach fullness (Figures 54, 55, 57, 59, and 60). Subyearling and yearling chinook salmon, coho salmon, andsteelhead groups captured at Jones Beach in 1982 and 1983.

Soure	Uate of median fish	CWT
	Subyearling chinook salmon	
Spring Creek IA/	19 April 82	05/10/50
	26 April 82	05/10/53-56
	27 April 82	05/10/51
Bonneville b/	01 May 82	07/24/07
Spring Creek	08 May .82	05/08/51,10/57
Bonneville	10 May 82	07/26/63
Stayton Pond b/	18 May 82	07/26/62
Spring Creek	24 May 82	05/10/52
Abernathy g/	30 May 82	05/10/58,59
Bonneville	04 June 82	07/24/08
	06 June 82	07/24/25
I	10 June 82	07/24/14-17
Little White Salmon 2/	11 June 82	05/04/35,36
Klickitat c/	13 June 82	63/21/57
Bonneville	15 June 82	07/24/24
Stayton Pond	19 June 82	07/26/62
Oxbow t/	22'June 82	07/23/30,24/11
Hagerman a/	27 June 82	05/10/22,23
Lower Kolame c/	28 June 82	63/24/63
Priest Rapids c/	29 June 82	63/22/52,24/56
Kalamu Falls c/	09 July 82	63/24/60
Washougal c/	18 July 82.	63/24/61
Cowlitz c/	20 July 82	63/20/32,24/62
Bonneville	13 August 82	07/24/26
	10 November 82	07/25/48
	11 November 82	07/25/45
	11 November 82	07/23/63
	11 November 82	07/25/46
Spring Creek	04 May 83	05/11/42-45
Bonneville	10 hay 83	07/27/27-30
Stayton Pond	16 May 83	07/23/28,28/30-34
Little White Salmon,	21 May 83	05/11/41
Round Butte b/	07 June 83	07/28/36
Priest Rapids	17 June 83	63/26/].1
Bonneville	02 July 83	07/28/27
	05 July 33	07/28/26
Little White Salmon	06 July 83	0S/11/39
Hagerman	06 July 83	10/25/15
Cowlitz	08 July 83	63/25/03
Priest Rapids	18 July 83	63/26/12

Appendix Table B7.--continued.

Source	Late of median fish	CWT
Lewis River c/	25 July 83	63/27/38
	08 August 83	63/27/37
Bonneville	22 August 83	07/28/28
Washougal	10 September 83	63/22/59
	22 October 83	63/22/39
	09 November 83	63/22/38
	Yearling chinooK salmon	
Bonneville	31 March 82	07/21/40,43
Oxbow	02 April 82	07/21/37
Oakridgde b/	09 April 82	07/24/19,25/13.
Cowlitz	16 April 82	63/21/34,23/09-11
Dexter Pond b/	25 April 82	07/24/20,22
Marion Forks b/	29 April 82	07/25/28-30
Rapid River d/	04 May 82	10/24/14-15
Marion. Forks	05 May 82	07/25/25-27.
Round Butte	06 May 82	07/24/48,50
Kooskia d/	15 May 82	05/05/30,06/59
Leavenworth a/	31 May 82	.05/10/61
McCall /	04 June 82	10/24/12-13
McKenzie b/	27 Feburary 83	07/25/21,27/19,21
Bonneville	18 March 83	07/27/01
	05 April 83	07/25/47
McKenzie	10 April 83	'07/25/22,27/18,20,24
Cowlitz	15 April 83	63/25/05-06,26/09
Round Butte	27 April 83	07/27/14,16-1.7
Bonneville	12 May 83	07/27/41"
Leavenworth	21 May 83	05/13/38-39
Sawtooth d/	23 May 83	10/24/0.8,25/35
McCall -	24 May 83	10/24/58
	Cohn salmon	
Lewis River	12 May 82	63/23/04
Sandy b/	15 May 82.	07/25/49-58
Lower Kaloma	19 May 82	63/23/03
Cowlitz	21 May-82	63/24/20-49
Cascade b/.	31 May 82	07/24/29,33
Eagle Creek b/	03 June 82	05/10/35-40
Washougal	03 June 82	63/25/13-42
Lewis River	11 June 82	63/23/05
Washougal	,06 May 83	63/26/45
Lower Kalama	11 May 83	.63/26/05
Bonneville	14 May 83	07/26/06
Sandy	16 May 83	07/27[31-36
Cowlitz	22 May 83	63/26/13-42
Eagle Creek	26 May 83.	05/11/33-38

Appendix Table B7.--continued.

Source	Uate of median fish	CWT
Cascade	30 May 83	07/27/47
Washougal	02 June 83	63/26'/61-63,27/01-17
Bonneville	04 June 83	07/26/07
Willard 2/	14 June 83	05/09/28-45
Speelyai c/	25 June 83	63/27/35
	Steelhead	
Iiworshok a/	01 May 82	23/06/07-08,16/05
	22-May82	05/10/24-27,23/16/02,04
Niagara Springs si/	27 May. 82	10/24/04,50
Hagerman	01 June' 82	05/10/20-21
Dworshok	04 June 82	23/16/01,03
	17 May 83	23/16/16,19,38
Lyons Ferry e/	26 May. 83	63/28/38-40
Hagerman	30 may 83	10/24/60
Dworshok	04 June 83	'05/13/49-52,23/16/20
Hagerman	10 June `83	05/13/33-34

a/ United States Fish and Wildlife Service.
b/ Oregon Department of Fish and Wildlife.
c/ Washington Department of Fisheries.
d/ Idaho Department of Fish and Game.
e/ Washington heportment of Game.

Appendix Table B8.--Taxonomic classifications and codes for food items found in juvenile salmonids from the lower Columbia River and near-shore marine waters

_tux_Item	NOAC-Code	Fret Item	NODC Code
Iaiatomaceoe.	070301	becapodo	6175
Chlorophyto	08	U. caridea	6179
Protozoa	34	Crongonidoe	617922
H. hydroids	3702	C. franciscorum	6179220107
Turbellaria	3901	Astocidae	6181
higeneo	3935	Galotheidoe	•618310
Nemertea	43	Concridae	618803
Nematoda	47	C. mogister	6188030104
Annelida	50	C. oregonensis	6188030106.
Polychneto	5001		
Oligochoeto	5004	Insecto I	•62
Naididae	500903	Apterygoto	6201
Hirudinea	5012	Proturo	6202
Gastropoda	51	Thysanura	6204
Bivolvio	55	Dipluro	6206
Corbiculidoe	551545	Collembolo	6208
Arochnida	59	Pterygota	6213
Araneae	5911	Ephemeroptera	6215'
Acarina	5922	Ephemeridae	621501
Hydracarino	5930	Hexogeniu	62150101
Halocaridoe	593001'	Boetidae	621602
Crustacea	61	Prosopistoeatoidea	6219
Cladocera	6108	Odonata	6223
Ostracoda	6110	O. anisoptero	6224
Copepoda'	6117	O. zygoptera	6229
C. culanoida_.	6118	Orthoptera	6231
E. offinis	*6118200201*	Isopters	6246
C. harpncticoida	6119	Dermaptero	6248,
C. cyclopoido	6120	Plecoptera	6251
C. caligoida	6123	Psocoptero	6256
Ci.rriped10	6130'	Anoplura	6267
Mysidaceo	6151	Thysonoptera	6269
Mysidacen mysido	6153	Hemiptera	6271
Neomysis.mercedis	6153011505	H. hydrocorizae	6272
Isopoda	6158	Corixidoe	627201
I. valvifera	6162	Homoptera	6282
Amphipodo	6168	Cicadellidoe	628403
A. gammoridea	6169	Psylloidea	6289
Corophiidoe	6.16915	Aphidoidea	6291:
C. salmonis	6169150209		
C. spinicorne	6169150215	Insecta II	63
Gammaridae	616921	Coleoptero	6302
A. subcurinatus	6169210101	hytiscidoe	630506
A. confervicolus	6169210109	Staphylinoidea	6310
Caprellidoe	6171	Curculionoidea	6325

Appendix Table B8.--continued.

P:n	NODC Code
Insecta III	64
Neuroptera	6405
Trichoptera	6418
Hydropsychidae	641804
Lepidoptera	6420
Insecta IV	65
Diptera	6501
Tipuloidea	6503
Tipulidae	650301
Psychodoidea	6504
Culicoidea	6505
Culicidae	650503
Chaoborus	65050301
Heleidae	650504
Dixidae	650505
Simuliidae	650506
Chironomidae	650508
Symbiocladius	65050821
Pentanura	65050834
D. brac,hycera	6515
Muscoidea	6540
Hymenoptera	6550
Scolioidea	6573
Apoidea	6576
222222222222	
Diplopoda	68
Bryozoa	78
Lamprey	860301
Gnathostomata	87
O. teleostei	8735
E. mordax	8747020101
O. tshawytscha	8755010206
A. hexopterus	8845010101
Aves	91
Inorganic matter	95
Unidentified organism	96
Unidentified Egg	97
Plant material	98
Digested Material	99

ig1btg1;PHI STA2E-_-- b/

Blank-no information
0-indeterminable
1-egg
2-nauplius
3-zoea
4-megalops
5-veliger
6-larva
7-juvenile (juv.)
8-adult
9-larvae, .juv., and adults
10-juv. and adults
11-larvae and .juv.
12-maturity unknown
13-polyp
14-cypris
15-copepodid
16-pupa
17-nymph

S OMAEH,.ONIENT-bIGESTION glblg b/

0-no information
1-all contents unidentifiable
2-traces of prey organisms identifiable
3-less than 50% identifiable
4-50% - 75% identifiable
5-75% - 100% identifiable
6-all contents identifiable

EBgl_ITEME b/

Blank-no information	
0-whole organism	9-bones
1-parts (misc.)	10-head
2-siphons	11-eye
3-inorganic parts	12-jaws
4-legs	13-tail
5-setae	14-seeds
6-chelae	15-leaves
7-zooecio	16-wings
8-sc9les	17_antennae_

g/ National Oceanographic Data Center, 2001 Wisconsin Ave., N.W.; taxonomic codes, 2nd edition, 1978. Each two digits of code represents a descrete taxon. Each code may contain up to five taxonomic levels, with a provision for two additional digits to represent subspecies or a variety in some taxonomic group. The code system enables an animal to be classified to any systematic aggregation of data.

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