RESEARCH BRIEFS

FISH COMMISSION OF OREGON
307 State Office Building
PORTLAND, OREGON

Volume Nine—Number One

MAY 1963

FOREWORD

These short reports are intended to inform the public, fishing industry, sportsmen, and fisheries scientists of research conducted by the Fish Commission. Reports will be published from time to time as studies are sufficiently complete. Most of the reports provide biological evidence upon which measures are based to enhance and conserve the fishery resource. Research Briefs are free and may be obtained upon request from the editor.

TABLE OF CONTENTS

History of the Oregon Trawl Fishery, 1884-1961[1]

GEORGE Y. HARRY, JR.[2]
and
ALFRED R. MORGAN

INTRODUCTION

Despite many previous attempts, a trawl fishery did not become firmly established in Oregon until about the beginning of World War II. The difficulty of obtaining profitable markets, which often restricts the present fishery, afflicted the pioneers in this industry.

Before the development of otter-trawl gear, the European beam trawl was used in Oregon waters for trawl fishing. An otter trawl is a bag-shaped net pulled on or near the ocean floor. The mouth of the net is held open by the force of the current against the otter boards or doors attached to each wing of the net. In contrast, the mouth of a beam trawl is held open by a rigid frame, and no otter doors are necessary; however, because of its rigidity the beam trawl is more difficult to handle on a fishing vessel. Various improvements have been made in otter-trawl gear and fishing vessels since the fishery's inception.

This report will record the progress of the Oregon otter-trawl fishery from its beginning to the present time. Some of the information is based on published reports, but much of it comes from interviews with fishermen. Scofield (1948) reports extensively on the trawl fishery of California and Alverson (1959) gives a brief account of the otter-trawl fishery along the Pacific Coast which applies in general to the Oregon fishery.

Figure 1 shows the areas and ports utilized by the Oregon trawl fleet.

EARLY RECORDS

The earliest known attempt at trawling in Oregon was in 1884 and 1885 by the 36-ton schooner *Carrie B. Lake* which successfully fished a beam trawl just outside the Columbia River mouth (Pacific Fisherman, March 1914). On January 3, 1886 the vessel and crew of three were lost. Later the steamer *Dolphen* made 40 trips between April and October 1887, but proved a failure. Late in 1888 the Yaquina Deep-Sea Fishing Company of Yaquina Bay, Oregon, purchased the steam schooner *George H. Chance* and fished Heceta Bank. The venture was not successful because of the lack of markets.

The earliest reference to otter-trawl gear along the Pacific Coast is found in the Pacific Fisherman of June 1903, announcing plans to fish for halibut with this gear off Queen Charlotte Islands, British Columbia. In May 1905 this magazine, "in answer to numerous inquiries", carried an article on the operation of otter-trawl gear. It was not until 1905 that the

---

[1] In part from a thesis submitted by George Y. Harry, Jr. to the Graduate School of the University of Washington in partial fulfillment of the requirements for a Ph.D. degree, 1956.

[2] Formerly with the Oregon Fish Commission; now Laboratory Director, Bureau of Commercial Fisheries, Auke Bay, Alaska.

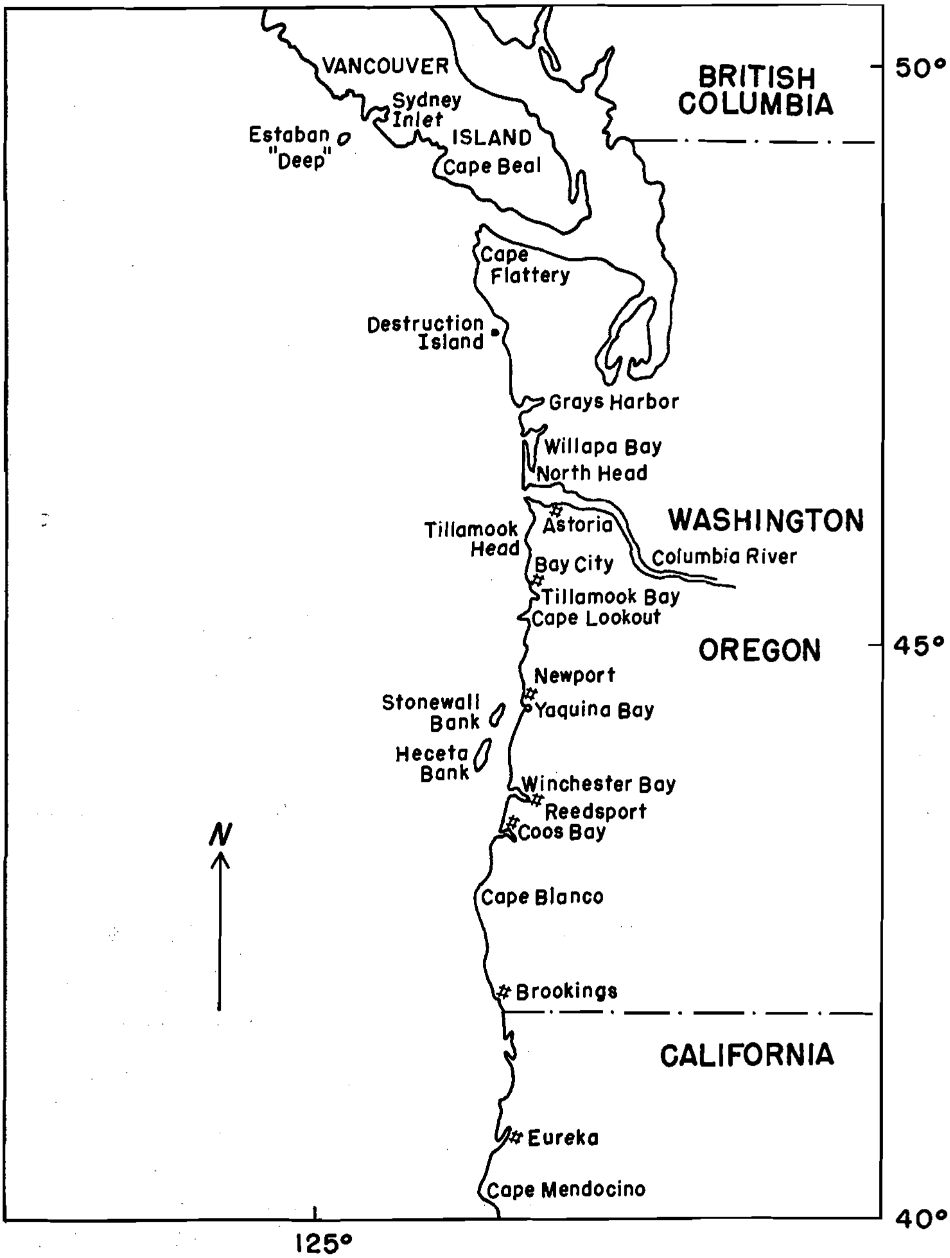

FIGURE 1. GEOGRAPHICAL AREAS AND PORTS UTILIZED BY OREGON TRAWLERS.

otter trawl was introduced into New England waters by the *Spray*, a few years after it appeared on the Pacific Coast (Scofield, 1948).

The Pacific Fisherman of August 1906 noted that Richard Obee was in Seattle for the purpose of introducing the Patent Beamless Trawl. Evidently this gear was not accepted by Seattle fishermen because in 1908

Captain Obee joined with F. P. Kendall and F. Barnes of Portland to introduce the otter-trawl net in Oregon waters (Pacific Fisherman, June 1908). A description of this gear and its operations was given in the September 1908 issue of this magazine.

On June 2, 1908, the 50-horsepower trawler *Evie* made its initial voyage under Captain Obee. A catch of 3,000 pounds of mixed ocean fish—lingcod, blackcod, halibut, flounders, groupers, and refuse fish—resulted from 1½ hours of fishing an area about 10 miles north of the Columbia River Lightship. A ready market was reported for the catch (Pacific Fisherman, July 1908). Captain Obee, however, was not satisfied with the *Evie's* performance. He believed that a heavier, more powerful engine of 100 to 120 horsepower was needed for propelling the boat and working the winch, which must be able to withstand the strain of lifting a heavy net aboard towed by 300 fathoms of ⅝-inch rope. He noted that off Great Britain 88,000 pounds of herring were netted by shortening the towing warps, putting engines to full speed, and taking "flying dashes" at schools of fish. Even in 1908 fishermen were thinking about the modern mid-water trawl. Captain Obee planned to charter a more powerful boat at Astoria with the hope of catching salmon. His last recorded activity was in 1909, when he became associated with The Oregon Deep-Sea Fishing Company which fished a gasoline schooner off the Oregon coast. This operation was unsuccessful.

The next recorded attempt to establish a trawl fishery in Oregon waters was in 1912, when the Oregon Coast Fishing Company opened a plant at Bay City. Their fishing vessel *Vida* encountered a heavy storm on her first trip and suffered extensive damage. This venture was then abandoned, although a fairly good catch was made (Pacific Fisherman, March 1914).

An interesting prophecy was made in the Pacific Fisherman for October 1914, regarding the catches the federal research vessel *Albatross* made with a beam trawl off Yaquina Bay. About 250 sand dabs were taken and it was predicted that "ultimately this will be one of the most profitable species taken from these banks as the demand for them from San Francisco is very heavy at present, and the same will be true elsewhere on the Pacific Coast when their excellent eating qualities have become better known". Unfortunately, these fish were scorned for human consumption in Oregon until recently and their only market was food for mink.

Early in May 1915 another attempt was made to establish a trawl fishery operating from Bay City (Pacific Fisherman, July 1915). The Union Fish Company chartered the steam tug *George R. Vosburg* (66 net tons) and outfitted her with a beam trawl. On the first trip about 4,000 pounds of sole and rockfish and a few small halibut were taken. However, the market was poor and the vessel was transferred to Astoria. A crew member of the Vosburg, the late Jess Hayes, who lived in Bay City, Oregon, provided some additional information regarding these trips. He said that the vessel used otter-trawl gear rather than a beam trawl as stated in Pacific Fisherman. It was 105 feet long, had a crew of 5, was equipped with a winch on each side, and used cable tow lines. About a dozen trips were made between Newport and Astoria within the 60-fathom curve in the month or two before the venture was abandoned because of market problems. About 800 pounds of fish were taken the first trip and sold at $.10 a pound, which was a very good price and even exceeds what recent trawlers have received for their product. However, the receiving plant was able to handle only a ton of fish and when 8 tons were landed the price dropped to $.02 a pound. Mr. Hayes also told of a beam-trawl operation carried out by Captain Dodge with the Elmore Cannery steamer *Harrison* between Astoria and Tillamook Bay around 1900 or possibly earlier. Captain Dodge caught mostly crabs with a 24-foot beam trawl.

In September 1919, the torpedo boat *Ace* was remodeled and equipped for ottter trawling in Puget Sound and off the coasts of Oregon and Washington (Pacific Fisherman, September 1919). This vessel discontinued operations in May 1920 because of lack of markets (Pacific Fisherman, May 1920). During the early spring of 1920 the trawler *Ituna* was chartered by the Reedsport Fish Company, Reedsport, Oregon. No fish were landed, however, because the vessel went down near San Francisco while underway to Oregon waters. Considerable experimental trawling (probably with paranzella gear) was done off southern Oregon in 1933 (Pacific Fisherman Yearbook, 1934) undoubtedly from vessels sent into Oregon waters from California. In 1934, Clyde Chase, head of the Coastal Fisheries at Reedsport, employed the 75-foot trawler *E. A. Smith* to bring in bottomfish (Pacific Fisherman, September 1934).

The recent phase of the Oregon trawl fishery began in mid-April 1937, when the San Francisco paranzella trawlers *International No. 2* and *International No. 6*, owned by the San Francisco International Fish Company, started dragging out of the Columbia River. E. E. Horgan was in charge of plant operations located in the Northwestern Ice and Cold Storage Company building at Astoria. On the first trip 7,000 pounds were taken, mostly petrale sole, which were dressed headless and shipped to San Francisco. These vessels made 46 one-day trips and caught a total of 509,000 pounds, of which 296,000 pounds were petrale sole. The venture was then abandoned (Pacific Fisherman, August 1937).

The following account of a trip by paranzella vessels is given in a letter from Vernon Brock, then a biologist with the Oregon Fish Commission:

> "To the best of my recollection, the catch was rather better per unit haul at Astoria than at San Francisco. Three hours was the usual length of drag at San Francisco whereas an hour and a half would suffice to fill the net at Astoria. The catch was either sorted into boxes and placed in a hold or sorted into bins on deck. The catch was measured in terms of the numbers of boxes taken, a box weighing 140 pounds. A big catch would be 100 to 110 boxes. The catch taken on the trip in April 1937 consisted of pointed nose sole, petrale, starry flounder, 60 boxes of these, two species of rock cod, a few crabs, mostly females of the common commercial species, skate, dogfish, and shark which were discarded, a couple of halibut, chicken

size, big blenny eel, a few small tom cod and an octopus with about a 10 foot spread."

In the spring of 1937 the Roy Chase Fish Company opened a plant at Reedsport to fillet the catch of the 60-foot trawler *Waseca,* a converted purse seiner. Captain Sam Scott reported in conversation that this was the first otter-trawl vessel to fish regularly off the Oregon coast. Scott conceived his plan after watching draggers in Puget Sound, where the industry had become well established. The *Waseca,* purchased at Gig Harbor, Washington, fished out of Reedsport during the summer of 1937. In 1952 this boat, still owned by Scott but operated by his son, was sunk in a collision with the dragger *Pearl Harbor* off Newport. Except for his own vessel, the first otter trawler Captain Scott observed in Oregon was the *Queen* which Earl McCarty brought down from Puget Sound in 1937 to fish for the Roy Chase Fish Company.

In conversation, Les McMillan stated that in 1937 he operated the *Verona* and delivered trawl-caught bottomfish to a Coos Bay plant. In December 1938 other landings were made at Coos Bay; the *Albacore* (Ernie McCoy, captain) and the *Rogue* (Harry Hallmark, captain) caught rockfish, dogfish, and occasionally substantial quantities of sea scallops (Pacific Fisherman, January 1939).

In 1938 the otter trawlers *Verona,* operated by Les McMillan, *Harold J.,* by Earl McCarty, and *Sarah E.,* by Jack McMillan, began fishing in Oregon waters. In 1939 the three vessels attempted to establish markets in various ports from Astoria to Coos Bay, although competition from California firms was intense. During this year, Bill White fished with the *Warren H.* and Sam Scott with the *Waseca* for the Yaquina Bay Fish Company, owned by William Penter.

During 1940, landings, primarily petrale sole, were made at Newport by the otter trawlers *Trio, Foster, Rio Janeiro,* and *New Zealand.*

There are no reports of trawl landings at Astoria from 1937, when the paranzella operations took place, until the summer of 1939. At that time Captain George Moskovita brought the *New Zealand* from Puget Sound to fish for crabs. Since the light Puget Sound crab pots were not satisfactory for use off the Columbia River, Captain Moskovita turned to trawling. During the summer of 1939 no market could be found except for mink food. Day trips were made without ice and fresh fish sold for 1¾ cents a pound. Towing lines made of rope were hauled in with the capstan and coiled on deck. Depths of 15 to 50 fathoms were fished off North Head and near the Columbia River Lightship. In the fall of 1939, the New England Fish Company became interested in this operation, and fish brought in by the *New Zealand* were accepted for filleting. No ice was used, landings were made at night, and the crew did the unloading.

From these early and sometimes unfortunate attempts to start a trawl fishery in Oregon, a thriving fishery resulted during World War II which has continued to the present time with large fluctuations in production.

DEVELOPMENT OF GEAR

As seen from the early records, different types of gear (beam trawls, otter trawls, and paranzella nets) were used in the trawl fishery. Captain Sam Scott reports that the gear he first used in 1939 for otter trawling with the 60-foot, 45-horsepower *Waseca* consisted of a small Western-type net. The webbing often came from salmon nets. Scofield (1948, p. 38) describes a Western (box-type) trawl. The towlines used by Captain Scott were 1¼-inch rope, 200 fathoms long. The vessel had no drums but a capstan on each side and the line was coiled on deck. After a year or so of trawling with this gear, Captain Scott installed drums and cables.

Edwin Niska, a biologist with the Oregon Fish Commission stationed at Astoria, gave the following description of a typical otter-trawl net in use in 1942 (unpublished notes):

> "Two mesh sizes are used in the otter-trawl nets: 3½-inch No. 96 cotton in the cod-end and in the intermediate; 4¼-inch No. 27 cotton in the body and the wings. The cod-end is 65 meshes long, the intermediate is 25, and both are 100 meshes around. The body of the net is 100 meshes long, 65 meshes deep at the wings, and tapers to a size comparable with the 25 intermediate. The bottom of the opening is 75 meshes across, sometimes cut to form a 'V', and it is hung to a lead line which has approximately 100 pounds of lead. The top of the opening is about 60 meshes longer than the bottom, but it is only 65 meshes across. The wings are 100 meshes long and taper on the top side from 65 meshes at the opening to 40 meshes at the ends which are connected to the shear boards with 20 fathoms of line. Shear boards are of 2-inch wood, 3 feet by 6 feet, and are reinforced with iron straps and shoes so that the total weight is about 450 pounds each. Half-inch steel cable wound on drums on the deck is fastened to the shear boards."

Before 1942 cod-ends were single and made of 96 cotton thread. Rope hog-ring cod-ends were introduced in 1942 by Ralph Horne on the *Grace H.* In 1943, most vessels used rope cod-ends, and instead of the meshes being tied with knots, metal hog rings were used as clamps. This type of cod-end then declined in popularity, but hog rings are still used in making chafing gear. In 1947, the use of double-wall cod-ends came into common practice. The cod-ends were doubled by folding over the last 20 to 25 meshes to make a double bag. This type continued to be popular until 1959, when synthetic fibers began to replace other materials in trawl nets. Many trawl fishermen began using single-wall cod-ends with large mesh and polypropylene rope chafing gear to protect and strengthen the cod-end. Some double-wall cod-ends and a few cotton nets are still in use and in a few instances, hemp nets have been observed.

The early nets were laced down the side and when loads were too heavy to lift to the deck, the net was unlaced and the catch brailed aboard. Rope splitting straps were introduced in 1939, but did not prove successful. In 1942 cable splitting straps were successfully adopted and in 1943 came into general use. A further improvement was made in 1960-61 when splitting straps of synthetic materials replaced cables. Figure 2 shows one split being dumped on the deck of the *Eagle* in 1961.

A balloon-type trawl net was introduced in 1942 for rockfish and became standard in 1945. This type of net opens high, or at least, because of additional floats, fishes farther from the ocean floor. Rockfish do not live as close to the bottom as flounders, and hence it is advantageous to have a net that has a higher opening to capture fish swimming above the bottom.

FIGURE 2. ONE OF FIVE SPLITS OF A TOW MADE BY THE *EAGLE* ON A TRIP IN 1961.

In 1954, Puusti and Company of Astoria introduced trawl nets of the type shown in Figure 3. This is a typical Eastern-type net; with some modifications by the fishermen, this basic net is still used in 1961. The head line and cable foot line are 66 and 97 feet, respectively. The throat is 400 meshes around, hence the name "400 Eastern". The body is made of thread with 27 strands (if cotton), and the intermediate and cod-end sections 120-strand thread. The latter two sections are 100 and 80 meshes around, respectively. Scofield (1948) gives a detailed description of the Eastern-type net. A few Western trawls have also been used, probably because they are somewhat easier to make and less expensive. In 1955, when regulations required an increase in trawl mesh sizes, nets of approximately 350 meshes around the throat replaced the 400-mesh nets, but the size of the net remained about the same.

CLASSIFICATION OF OREGON TRAWL BOATS

Captains from 69 otter trawl vessels who fished in Oregon were interviewed to document the history of gear and vessel improvements. The information obtained is summarized in Table 1. Vessels have been divided into 4 groups according to the time they started trawling: group 1 began trawling prior to 1942; group 2 in 1942-43; group 3 in 1944-45; and group 4 after 1945. The average lengths of vessels increased gradually from 57 feet for group 1 to 68 feet for group 4. The fish-holding capacity rose from an average of 26 tons in group 1 vessels to 42 tons in group 4.

Many boats operating in the Oregon trawl fishery in 1961 were constructed before World War II and originally were not designed for trawling. The oldest vessel in the trawl fleet is the *Tom and Al* built in 1900 but only recently equipped for trawling. The *Jennie F. Decker*, a former halibut sailing schooner, was built in 1901, entered the trawl fisheries in 1939, and has been fishing to the present time. The upper photogragh in Figure 4 shows the *Jennie F. Decker* in 1901 in full sail and the lower as she is today.①

Of the vessels for which information is available, 19 were built during the prosperous 1920's, and 6 in the depression years of the 1930's. The otter-trawl fleet expanded rapidly in the 1940's; 32 vessels were built during that period, the majority before 1946. Only 5 vessels were constructed in the 1946-49 period, and none after 1949. Most of the boats built in the 1940's were designed for otter trawling, but the earlier vessels were converted from another type of fishing, mainly salmon purse seining and halibut long lining. Nearly all boats outfitted for trawling in the 1950's were schooners formerly used for halibut long lining, as tenders, or for hauling freight. Figure 5 shows various types of vessels which operated in the Oregon trawl fishery in 1961. Figure 6 is a closeup of the wheelhouse, drums for cable, and the drum for the anchor line on the *Eagle*, a converted halibut schooner now fishing out of Astoria.

Gradually, as fishing gear became heavier and more complex, and fish-

① Upper photograph taken by Welster and Stevens, Seattle, and loaned by the International Pacific Halibut Commission. Lower photograph furnished by Trygve Johansen, present owner of the *Jennie F. Decker*.

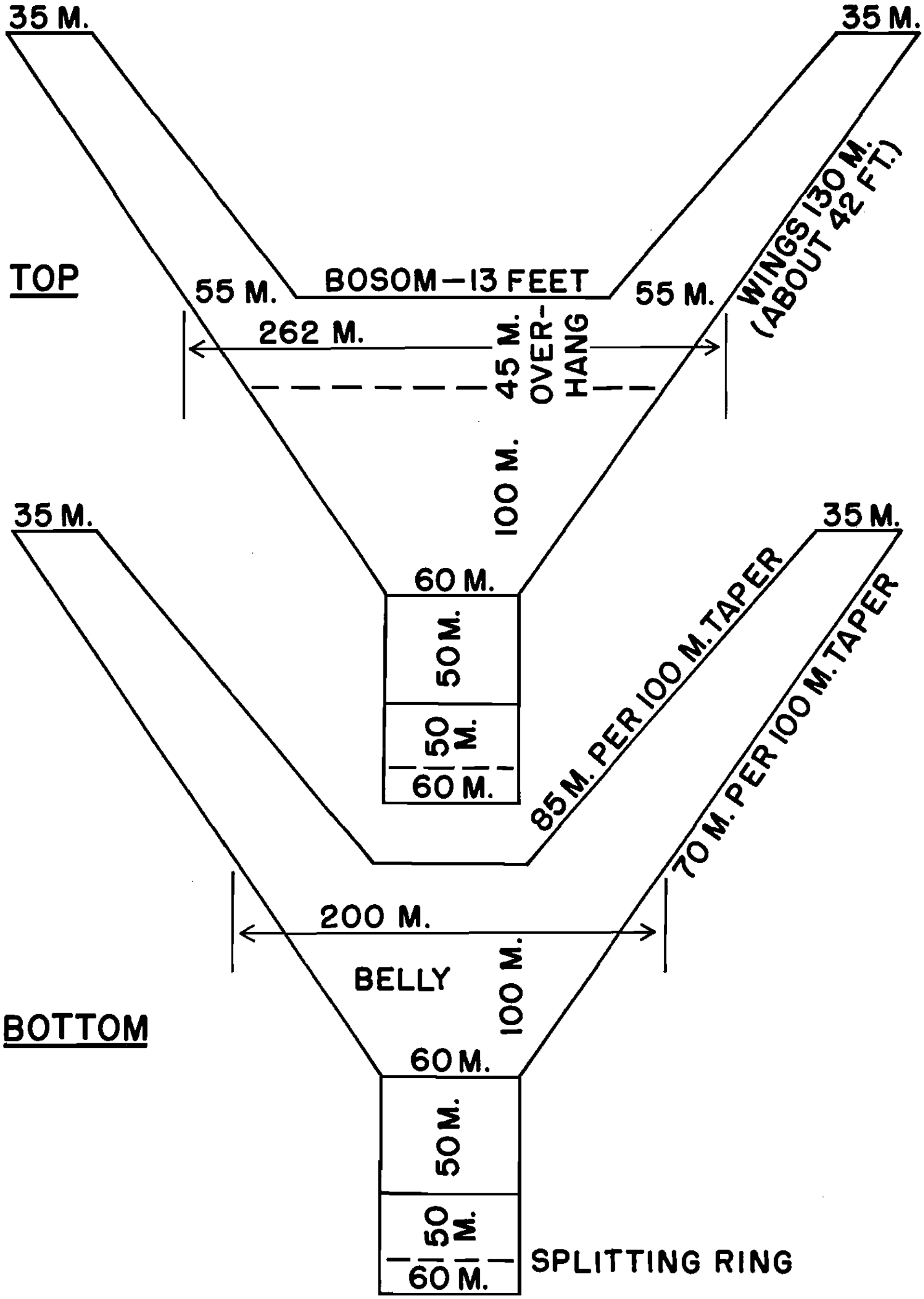

FIGURE 3. DIAGRAM SHOWING TOP AND BOTTOM SECTIONS OF A COMMON TYPE OF OTTER-TRAWL NET (THE 400 EASTERN PUUSTI NET MADE OF COTTON) USED BY OREGON FISHERMEN. (THE LETTER M. IS AN ABBREVIATION FOR MESHES.)

TABLE 1. **FREQUENCIES OF LENGTH, FISH CAPACITY, AND HORSEPOWER OF 69 OREGON OTTER TRAWLERS WHICH OPERATED DURING SELECTED PERIODS, 1939-61.**

Length (Feet)	*Number of Vessels*			
	Group 1	*Group 2*	*Group 3*	*Group 4*
41-45	1	0	0	0
46-50	2	0	1	2
51-55	3	2	3	2
56-60	6	4	3	4
61-65	2	2	4	5
66-70	0	2	3	3
71-75	1	0	3	4
76-80	0	0	0	2
81-85	0	0	1	3
Over 85	0	0	0	1
Total	15	10	18	26
Fish-Holding Capacity (Tons)				
11-15	2	0	0	0
16-20	6	3	1	3
21-25	4	1	3	2
26-30	2	1	3	3
31-35	0	1	3	2
36-40	0	1	2	0
41-45	0	0	0	4
46-50	0	2	1	2
51-55	0	0	2	0
56-60	0	1	2	7
61-65	0	0	0	1
66-70	0	0	0	1
71-75	1	0	0	0
Over 75	0	0	1	1
Total	15	10	18	26

	Group 1		*Group 2*		*Group 3*		*Group 4*	
Horsepower	*Original*	*1961*	*Original*	*1961*	*Original*	*1961*	*Original*	*1961*
26- 50	4	0	0	0	1	0	0	0
51- 75	3	2	3	1	6	0	2	0
76-100	4	1	4	0	3	0	3	1
101-125	1	1	3	6	1	2	6	3
126-150	3	5	0	0	4	7	7	4
151-175	0	3	0	2	1	3	3	3
176-200	0	0	0	0	0	1	0	4
201-225	0	0	0	1	0	2	0	4
226-250	0	2	0	0	2	3	2	2
251-275	0	0	0	0	0	0	1	1
276-300	0	0	0	0	0	0	0	2
Over 300	0	1	0	0	0	0	2	2
Total	15	15	10	10	18	18	26	26

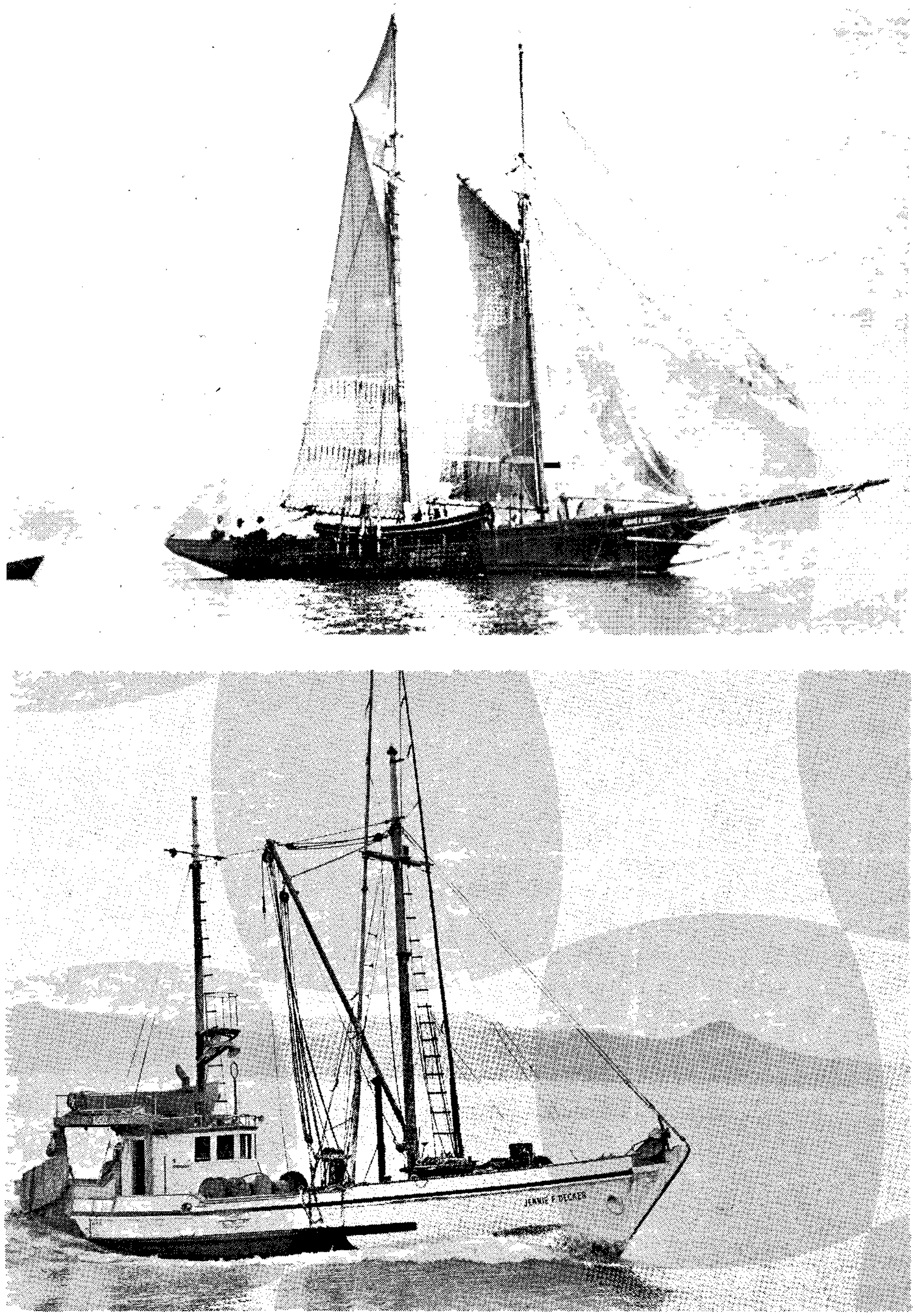

FIGURE 4. THE *JENNIE F. DECKER* UNDER FULL SAIL AND AFTER BEING CONVERTED TO TRAWLING.

ing operations extended into deeper waters, more powerful engines were installed. Group 1 vessels had engines with 84 average horsepower, but group 4 averaged 203 hp. As fishing extended into deeper waters, the length of cable on the drums increased from an average of 300 fathoms for group 1 boats to 475 fathoms for group 4. Otter boards (commonly called doors) also became heavier as nets became larger and fishing extended into deeper waters. Each otter board on group 1 vessels weighed an average of 468 pounds, while those in group 4 averaged 786 pounds.

DEVELOPMENT OF INSTRUMENTS AND GEAR

One of the most important developments in auxiliary gear was the fathometer, which enables trawlers to know at all times the depth of the water and permits them to stay in any desired depth. As shown in Table 2, many boats installed fathometers between 1942 and 1949. Radio direction finders were introduced in 1939 or 1940; by 1945 practically all vessels used them. Radios for communicating with one another and with the shore were first employed around 1941 and most of the fleet had them by 1949.

TABLE 2. **INSTRUMENTS AND GEAR INSTALLED ON 69 OREGON OTTER TRAWLERS DURING THE PERIOD 1939-61.**

	Instrument							*Gear*			
Period Installed	*Radio*	*Fathometer*	*Direction Finder*	*Iron Mike*	*Loran*	*Fish Finder*	*Radar*	*Dandyline Gear*	*Stabilizers*	*Reel*	*Brine Tanks*
	(Number of Vessels)										
1939-42	6	4	6	4	0	0	0	2	0	0	0
1942-45	19	22	24	13	0	0	0	8	0	0	0
1946-49	19	16	4	15	8	0	0	27	1	0	0
1950-53	7	6	4	7	30	0	0	7	18	0	0
1954-57	5	5	1	6	6	7	0	3	5	2	2
1958-61	2	5	0	1	3	13	6	2	1	16	2

The "iron mike", an automatic pilot that keeps a vessel on a set course and allows the man at the wheel to work or relax, was installed mainly in the 1942-49 period.

A major improvement was the introduction of loran by the *Dare II* and *Ruth Ellen* in the fall of 1949. This instrument came into common use in 1950-53. It is a navigational device, usually used in conjunction with a fathometer, that enables the captain to know his location on the fishing grounds within a radius of a few hundred yards in any weather.

Another instrument that has come into common use by the trawlers is the fishfinder. Early instruments were simply recording fathometers, but improved models with much greater sensitivity were installed on many boats, mostly in the 1958-61 period. They are valuable in locating concentrations of Pacific Ocean perch, other rockfish, and any fish found above the ocean floor. In the 1958-61 period several boat owners installed radar, but this instrument has not been generally adopted.

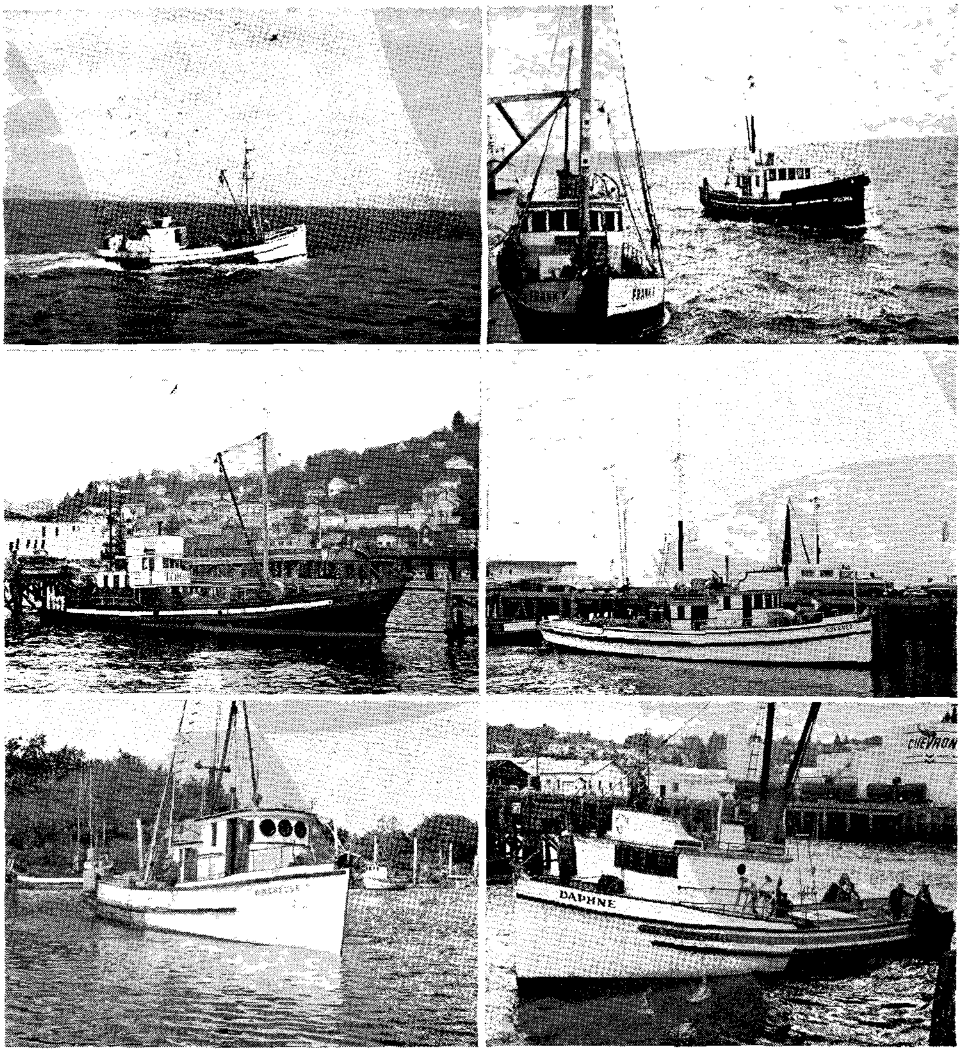

FIGURE 5. SEVERAL TYPES OF TRAWLING VESSELS THAT OPERATED OUT OF ASTORIA IN 1961.

Notable improvements have been made in handling the trawl gear. The use of splitting straps to bring heavy tows on board has been mentioned. Some Oregon trawlers were equipped with dandy-line gear, with which the otter boards can be stopped off and ground cables wound in on the drums, before 1942. Les McMillan stated in conversation that dandy-line gear and "G" hooks to release the doors were introduced by Captain Ralph Mason of the *Foster*. Most trawlers adopted these devices in the years 1946-49.

A recent innovation in handling the cumbersome trawl net is the reel (Figure 7), a large powered drum mounted on the stern, used to reel in the net until the intermediate section is reached. The cod-end is then

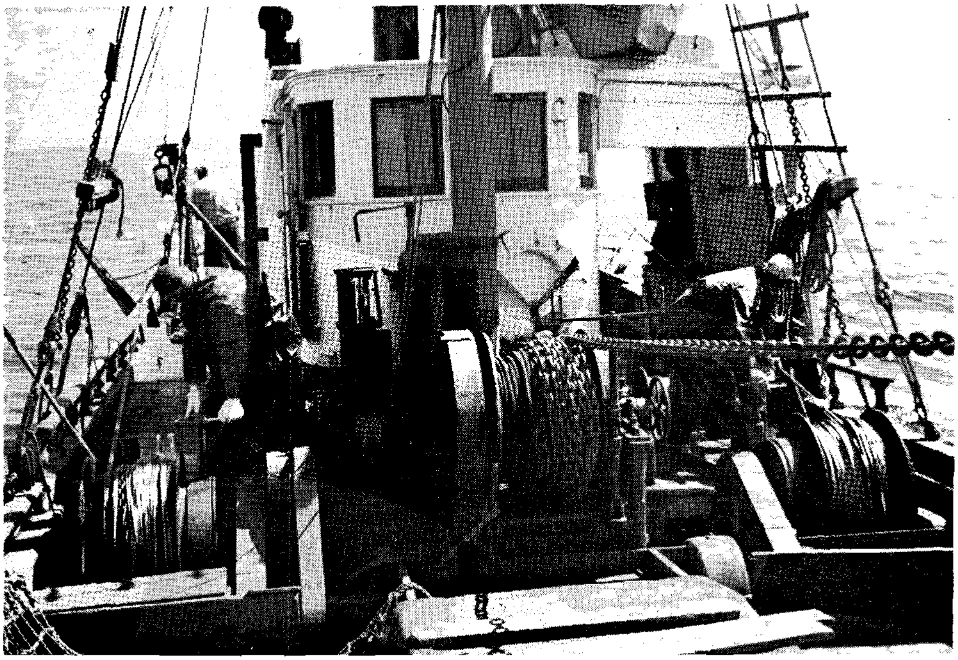

FIGURE 6. WHEELHOUSE, DRUMS FOR CABLE, AND DRUM FOR ANCHOR LINE ON THE *EAGLE*, A CONVERTED HALIBUT SCHOONER. CABLES ARE BEING WOUND ON THE DRUMS.

brought on board, in the conventional manner as shown in Figure 8, by means of winches or capstan and boom. The advantage in using the reel is that the wings and body of the net need not be shackled and lifted in the air (as shown in Figure 9) with the heavy metal floats whipping about the crewmens' heads. In heavy seas it is difficult, and often dangerous, to carry the net back to the stern so that it can be laid out for another tow. By 1961 about a fourth of the Oregon trawlers were using reels.

In the 1950-53 period, stabilizers, hung over each side of the vessel to reduce the roll at sea, were installed on many boats.

In recent years a few trawl boats have used chilled sea water stored in tanks for refrigeration instead of crushed ice. Paul Autio installed such tanks in his boats the *Marie H.* and *Western* in 1956 and 1957; Captain George Moskovita in the *New Hope* in 1959; and Captain Mel Wick in the *Columbia* in 1960. The tanks give satisfactory service and fish held in brine have excellent appearance. When boats are unloaded, the fish may be brailed from the hold (Figure 10) instead of pewed or shoveled. Brine tanks for holding bottom fish were also installed at the Astoria Seafood Company plant operated by James F. Kindred in 1958.

FISHING AREAS

In the early days of trawl fishing, boats stayed close to the ports of Newport and Astoria in relatively shallow waters—between 20 and 50

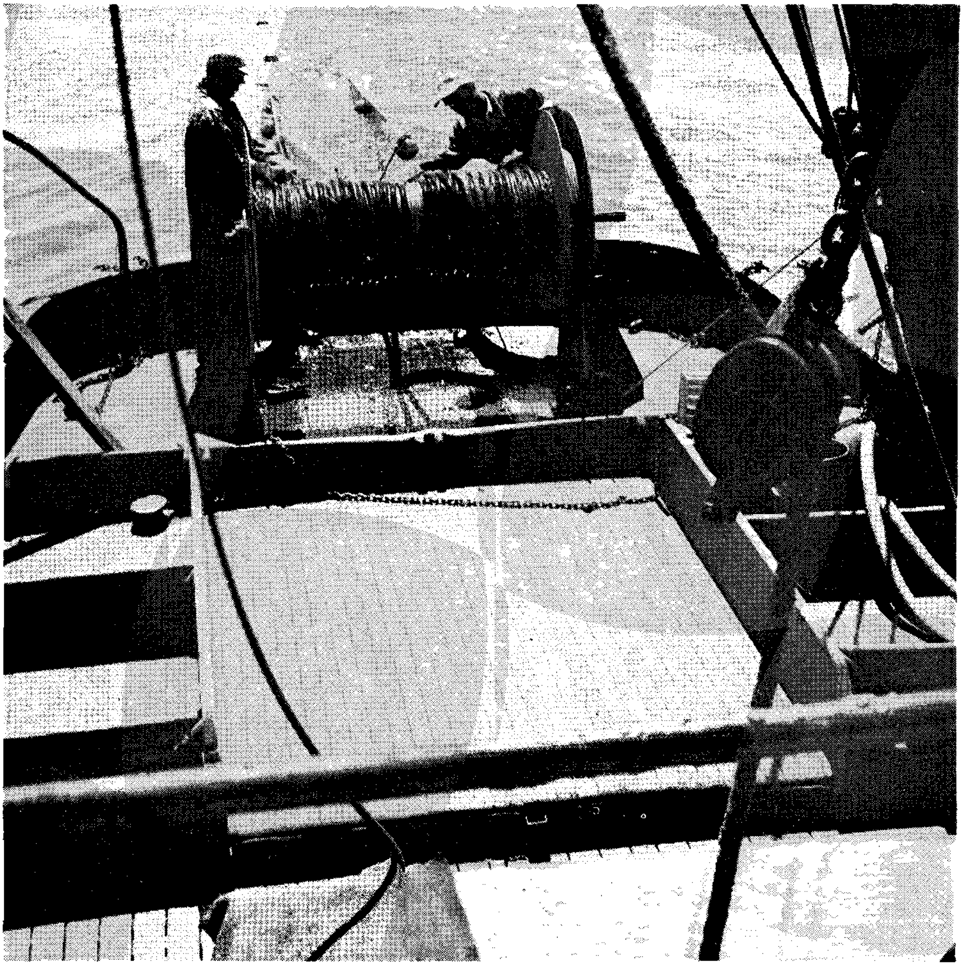

FIGURE 7. REEL ON THE STERN OF THE *MARIAN F.* SHOWING THE CABLES BEING WOUND IN, WITH THE NET IN THE WATER IN THE BACKGROUND.

fathoms. The principal fishing area off Newport was between Stonewall Bank, just south of Newport, and Depoe Bay, 20 miles north. Gradually the boats worked into deeper waters. In 1949, depths of 100 fathoms were commonly fished, and in 1952 Pacific Ocean perch were usually sought in 100 to 200 fathoms. Recently, Newport trawlers have extended their range from Coos Bay in the south to Cape Lookout in the north. They share the grounds with trawlers out of Astoria, Winchester Bay, Coos Bay, and at times Eureka and Puget Sound.

Astoria trawlers also extended their range both north and south and into deeper waters. During World War II Astoria boats usually fished between Tillamook Head, 20 miles south of the Columbia River, and Willapa Bay, 25 miles north of the Columbia. Other areas fished by the Astoria fleet included Cape Lookout, 38 miles south, and Destruction Island, 60 miles north. In 1945 and 1946 several Astoria vessels, including

FIGURE 8. SHOWING THE COD-END HOISTED AND SPILLED AFTER THE REMAINDER OF THE NET HAD BEEN WOUND ON THE REEL ON BOARD THE *MARIAN F.*

FIGURE 9. THE ANTERIOR PART OF THE NET HOISTED IN THE CONVENTIONAL MANNER ON BOARD THE *BETTY*.

FIGURE 10. BOTTOMFISH BEING BRAILED FROM THE BRINE TANKS OF THE *WESTERN* WHILE UNLOADING AT THE ASTORIA SEAFOODS COMPANY.

the *Metekla, St. Patrick, Sitka, Marian F.,* and *Kinchel'oe,* made trips of 10 days to 2 weeks on the dogfish grounds off Sydney Inlet, Vancouver Island, Canada. Some boats went as far north as Ketchikan, Alaska. These trips usually occurred in April or May, and after making a catch of dogfish for their livers, the boats completed the trip with a load of petrale sole. In recent years Astoria trawlers have ranged as far north as Cape Flattery, Washington (135 miles), with occasional trips to Esteban (225 miles), and south to Coos Bay (170 miles).

By 1953, several trawlers began fishing experimentally for Dover sole and Pacific Ocean perch off the Columbia River in depths to 300 fathoms, usually in late winter in an effort to locate Dover sole before they migrated inshore in the spring. In 1954, concentrations of Dover sole were located in 180-280 fathoms off Willapa Bay, and an extensive winter fishery resulted. The grounds between the Columbia River and Cape Flattery are shared by boats out of Astoria and Puget Sound.

LENGTH OF TRIPS AND DRAGS

In 1939 and 1940, Newport trawlers made one-day trips, usually only two drags of about 1 to 1½ hours each, and took 20,000 pounds of petrale sole (all that could then be marketed). Gradually trips became longer, and by the mid-1940's most vessels fished for 2 or 3 days each trip. Before 1942, the length of trips out of Astoria was limited by the capacity of plants to freeze fillets for shipping. With the installation of better plant equipment, the vessels commonly fished 3 to 5 days. Length of trip changed little from 1942 to 1961. Markets have dictated trip limits much of the time, and many boats deliver at regular intervals.

In general, duration of drags has increased from 1 hour to 2, 3, or even 4 hours in recent years. Drags of 1½ hours were common as late as 1950.

PRODUCTION

The center of the otter-trawl fishery shifted from Newport to Astoria in 1940, when 20 vessels landed an estimated 2 million pounds of dogfish shark at $150 a ton (round weight of fish but price was based on the livers) and 700,000 pounds of food fish. Petrale sole then sold for $.01-.03 a pound compared to $.09 in 1961. Bottomfish were filleted at the Paragon Fish Company and New England Fish Company. When war broke out in 1941, the otter-trawl fishery rapidly expanded in Oregon. Almost all species caught found a ready market. Near the height of the fishery in 1945, 73 vessels delivered about 26 million pounds of bottomfish to Oregon ports.

After the war, markets rapidly dwindled, and by 1948 catches were severely restricted. In 1949, the otter-trawl fishery suffered another serious blow when synthetic vitamin A and foreign imports of fish livers made fishing for dogfish shark unprofitable. In 1953, 44 vessels landed 10 million pounds of fish for human consumption and 5 million pounds for animal food, the lowest production since inception of the fishery prior to World

War II. Only Astoria received bottomfish for filleting (filleting and fillet fish refer to landings for human consumption) in any quantity, while 3 vessels fished at Newport, principally for mink food. Many otter-trawl vessels were converted to fishing for salmon, albacore, crabs, and, beginning in 1957, shrimp. Some boats alternate seasonally among these fisheries, depending on abundance, market demand, and price.

During World War II otter trawlers also operated out of Coos Bay, Depoe Bay, and Tillamook Bay, but by 1953 only occasional mink-food landings were made at Coos Bay and no landings at the other ports. In 1955 a trawl fishery for mink food was established out of Winchester Bay and some fillet fish were also processed. By 1955 the volume of mink food landed at Newport had increased considerably and some fillet fish were being marketed. Since 1957, the amount of bottomfish landed at Newport has increased, with landings made at the Yaquina Bay Fish Company, Oregon Fur Producers Association, and, since 1959, the New England Fish Company. Although no fillet fish were processed in Coos Bay (except for small local demand) during the years 1953-58, 1 to 6 trawlers landed bottomfish for transshipment to California processors located primarily in Eureka. In 1959 the Astoria Seafoods Company purchased the Charles Feller plant in Coos Bay and began processing bottomfish as the Coos Bay Seafood Company.

Annual Oregon trawl landings for 1941-60 are shown in Figure 11. Fillet fish landings as calculated by Jones (1958) and Jones and Harry (1961) are given separately for the years after 1945. Prior to 1945, dogfish for reduction and other species for animal food comprised an undetermined portion of the total landings. While landings had recovered by 1956 from the decline of the early 1950's, much of the production came from increased landings of whole fish for animal food. Fish landed for the fillet market did not approach the volume of the 1940's until 1960.

Plants which received bottomfish in the Astoria area in 1961 were San Juan Fish Company, Astoria Seafood Company, Sebastian-Stuart Fish Company, Oregon Fur Producers Association, and Bio-Products, Inc.

SUMMARY

Early records show that between 1884 and World War II several attempts were made to start a trawl fishery, but it did not flourish until the war created a demand for bottomfish. Since the war, the Oregon fishery has been maintained at various levels of production.

Many gear improvements have been introduced: otter trawls replaced beam trawls; drums with wire rope replaced capstans and manila rope; splitting straps replaced the brailing method of bringing fish aboard; dandy-line gear was introduced to free the doors while the net was being recovered; synthetic materials were substituted for cotton and other natural fibers in webbing; and reels were added to aid in handling the nets.

The average size of fishing vessels has increased and larger engines, heavier otter doors, and drums with greater cable capacity have been installed.

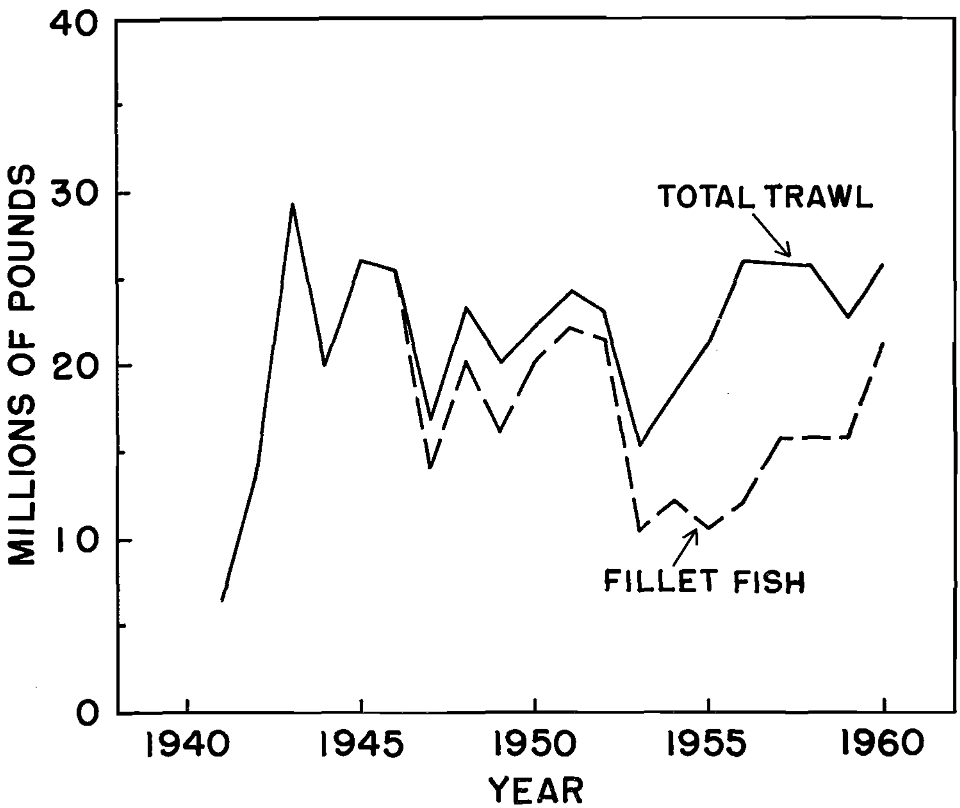

FIGURE 11. ANNUAL OREGON OTTER-TRAWL LANDINGS, 1941-60, WITH FILLET FISH LANDINGS SHOWN SEPARATELY AFTER 1945.

More instrumentation has been added to aid the trawl fisherman—radios, fathometers, radio direction finders, iron mikes, loran, radar, and fishfinders have been utilized to make the trawlers more efficient. Some boats have abandoned ice for refrigeration in favor of chilled sea water in tanks.

Trawlers have tended to move farther from their home ports although fishing trips are still only about 3 to 5 days. The time per tow has increased in recent years to 3 or 4 hours on some grounds. Fish landings have fluctuated in response to market conditions. The peak trawl fishery in number of boats and pounds landed occurred during World War II, followed by a severe decline in landings in the early 1950's and slow recovery in the late 1950's.

ACKNOWLEDGMENT

Thanks are due to many fishermen who patiently answered questions to provide information for this report. Boat captains were interviewed by Austin R. Magill and Robert B. Herrmann to bring boat histories up to date. Robert B. Herrmann supplied all the photographs except Figure 4.

LITERATURE CITED

Alverson, D. L.

1959. Trends in trawling methods and gear on the west coast of the United States, p. 317-320. *In* Modern fishing gear of the world, Fishing News (Books) Ltd., London.

Jones, W. G.

1958. The mink food fishery of Oregon in 1953 and 1954. M. S. Thesis. Oregon State Univ., Corvallis.

Jones, W. G., and G. Y. Harry, Jr.

1961. The Oregon trawl fishery for mink food—1948-1957. Oreg. Fish Comm. Res. Briefs 8(1):14-30.

Pacific Fisherman.

1903. June 1(5):7.

1905. May 3(5):7-8.

1906. August 5(8):29.

1908. June 6(6):18.
July 6(7):11.
September 6(9):17.

1909. March 7(3):19.

1914. March 12(3):18.
October 12(10):12.

1915. July 13(7):28.

1919. September 17(9):26.

1920. May 18(5):52.

1934. September 32(9):39.
Yearbook: 181.

1937. May 35(5):62.
August 35(9):64.

1939. January 37(1):42.

Scofield, W. L.

1948. Trawling gear in California. Calif. Dept. Fish and Game, Fish Bull. 72: 1-60.

An Attempt To Mark Juvenile Silver Salmon by Feeding Selected Metallic Compounds

THOMAS B. McKEE
and
WALLACE F. HUBLOU

INTRODUCTION

Marking juvenile salmon by the excision of fins as a means of identifying returning adults has been practiced for many years. There is evidence however that fin removal may affect the ability of fish to survive, as well as alter normal patterns of behavior (Foerster, 1936; Shetter, 1950; and Parker, Black, and Larkin, 1961).

Alternate methods to fin clipping are needed in studies evaluating hatchery contribution. The feeding of metallic compounds which can be detected later may offer such a method.

An experiment was conducted with silver salmon (*Oncorhynchus kisutch*) at the Oregon Fish Commission Sandy River Hatchery to determine if certain metallic compounds were toxic and if they would be deposited in the scales and other bony structures to provide means for later identification.

METHODS AND MATERIALS

The experiment, conducted in 6-foot circular tanks utilizing the hatchery water supply, was initiated April 12, 1954 and was terminated February 16, 1955 after a 44-week study period. The test animals were fingerling silver salmon of the 1953 brood averaging 454 fish per pound.

Initially 3 lots of 500 fish each were activated and on July 8 a fourth lot numbering 361 fish was added. Each lot received the same basic diet composed of equal parts beef liver, hog liver, and salmon viscera plus 2% salt and a particular metallic salt as an additive mixed thoroughly in the diet just before feeding. There was no control diet. The salts used were bismuth subcarbonate, cobaltous carbonate, manganous sulfate monohydrate, and strontium carbonate. The dietary level of each salt (Table 1) was set at the beginning of the experiment; this quantity remained constant throughout the study. All lots were fed a set percentage of their body weight per day. Although this percentage varied throughout the experiment it remained the same for all lots.

The fish were weighed periodically and the food intake adjusted to the gain in weight. Food was offered 2 to 3 times daily 6 days a week until September, at which time feeding frequency was changed to 1 to 2 times daily 5 days a week for the remainder of the experiment.

At the end of the experiment 20 fish from each lot were preserved in 5% formalin and shipped to Laucks Testing Laboratories in Seatle, Washington, for spectographic analyses of scales and whole fish ash. As a comparison, scale samples and whole fish ash of juvenile silvers which had not been fed metallic salts and scale samples from adult chinook salmon (*O. tshawytscha*) were also analyzed.

RESULTS

The results of the experimental studies are summarized in Table 1. Manganous sulfate monohydrate fed at the level of 1.0 gram per day was toxic and the lot fed this additive was discontinued after 6 days with a 4% mortality. The lot was fed a rehabilitation diet for one month and then returned to a diet containing manganese at 0.5 gram per day, suffering 12.7% mortality over a 164-day period. Manganese was found to be present in the scales and ash of the fish fed this material, but was also present in all samples from the other lots not fed manganese.

Strontium carbonate at 0.5 gram per day was found to be non-toxic, 4.8% mortality after 136 days of feeding, but was present in the samples of all lots whether included in the diet or not.

Cobaltous carbonate at 1.0 gram per day was very toxic and feeding of this material was discontinued after 7 days with a fish mortality of 23.8%. Cobalt was not detected in any of the scales or ash samples analyzed.

Bismuth subcarbonate at 1.0 gram per day was non-toxic—4.6% mortality in 188 days of feeding. It was found to be present only where included in the diet.

Bacterial kidney disease (*Corynebacterium* sp.) was encountered during the course of the experiment. The incidence was mild and appeared to affect all lots similarly. No therapy was instituted.

All lots of fish ate well, but bismuth subcarbonate appeared to cause constipation. Average fish size at termination of the experiment varied from 33 to 36 per pound between lots.

TABLE 1. **SUMMARY OF METALLIC COMPOUND FEEDING TESTS.**

Tested Metallic Ion	*Amount Fed per Day (Grams)*	*Number Days Fed*	*Total Metallic Salts (Grams)*	*Total Lot Mortality (Per Cent)*	*Spectographic Results*① *Scales*		*Whole Fish Ash*	
Bismuth (Bi)	1.0	188	188	4.6	Bi,Mn,Sr Co	+ —	Bi,Mn,Sr Co	+ —
Cobalt (Co)②	1.0	7	7	23.8	No Test		Mn,Sr Bi, Co	+ —
Manganese (Mn)③	1.0	6	6	4.0	Mn,Sr	+	Mn,Sr	+
Manganese (Mn)	0.5	164	82	12.7	Bi, Co	—	Bi, Co	—
Strontium (Sr)④	0.5	136	68	4.8	Mn,Sr Bi, Co	+ —	Mn,Sr Bi, Co	+ —
——————⑤	......	......	......	......	Mn,Sr Bi, Co	+ —	Mn,Sr Bi, Co	+ —
——————⑥	......	......	......	......	Mn,Sr Bi, Co	+ —	No Test	

① + indicates element present in detectable quantities.
— indicates element not present in detectable quantities.

② Discontinued after 7 days; although this diet was fed only 7 days, mortalities continued for one month thereafter.

③ Fed 6 days and temporarily discontinued because of increased mortality; put back on this diet at a reduced metallic salt intake after one month's respite; mortalities decreased to zero prior to resuming experiment.

④ Diet started on July 8 with 361 fish.

⑤ Fish taken from stock tanks at U. S. Fish and Wildlife Service, Montlake Laboratory, Seattle. No metallic salts were added to the food.

⑥ Scales of adult chinook salmon taken in the Alaska fishery in the summer of 1954.

CONCLUSIONS

Manganese and strontium commonly occur in fish and are, for this reason, unsuitable for marking purposes.

Cobalt was toxic to silver salmon at the 1.0 gram per day level. It was not found in the ash or scale samples, but was probably not fed long enough to be absorbed in detectable quantities.

Bismuth offers promise as a method of marking fish as it was non-toxic and readily deposited in scales and bony tissue when included in the diet.

These preliminary studies point up the need for further experiments using bismuth compounds to determine how long the element remains identifiable in scales and bones. Methods of introducing bismuth in the fish other than by diet should be explored.

ACKNOWLEDGMENTS

Thanks are due to Kenneth H. Mosher, U. S. Fish and Wildlife Service, for suggesting the study, arranging for the chemical analyses, and reviewing the manuscript.

LITERATURE CITED

Foerster, R. E.

1936. The return from the sea of sockeye salmon (*Oncorhynchus nerka*) with special reference to percentage survival, sex proportions and progress of migration. J. Biol. Bd. Can. 3 (1): 26-41.

Parker, R. R., E. C. Black, and P. A. Larkin.

1961. Some aspects of fish marking mortality. North Atlantic Fish Marking Symposium, Woods Hole, Mass., May 1961. Intern. Comm. for the NW Atlantic Fisheries Contr. 19:10.

Shetter, D. S.

1950. The effect of fin removal on fingerling lake trout (*Cristivomer namaycush*). Trans. Amer. Fish. Soc. 80:260-277.

An Operculum Marking Experiment on Juvenile Chinook Salmon

EARL F. PULFORD
and
LAWRENCE M. WOODALL

INTRODUCTION

Biologists working with Pacific salmon are continually searching for better methods of marking fish for later identification. In 1959, staff members of the Oregon Fish Commission observed a Japanese poster depicting a salmon marked with a clipped operculum. Subsequent correspondence brought to their attention a Japanese report (Sano and Kobayashi, 1953) based on a study in which the operculum and adipose fin of pink salmon (*Oncorhynchus gorbuscha*) were clipped as a method of marking. This report illustrated the manner of marking and marked adults recovered. Igarachi (personal communication, 1959) described the instrument used in the Japanese experiments.

It was decided in the winter of 1959-60 to conduct an experiment at the Oregon Fish Commission Clackamas Research Laboratory in which the technique of marking by removing a portion of the operculum would be applied to fall chinook salmon (*O. tshawytscha*) at two different stages of development. Fall chinook are usually liberated from the hatcheries as fingerlings, after about 90 days of rearing, but are sometimes released as unfed fry. Because of their very small size, the unfed fry are particularly difficult to fin clip, and it was hoped that the operculum clip would provide a suitable alternative which would also be less detrimental to the fish. This study was designed to measure differential effects upon mortality and growth of marking fingerlings and unfed fry.

Two earlier attempts at marking the opercula of chinook salmon were reported by Hyland (1915) and Rich and Holmes (1929). Hyland mentioned that chinook salmon were marked at Bonneville Hatchery on the Columbia River in 1912 by having "v"-shaped notches cut into their opercula. The number of salmon marked by this method was not given. In 1914, when the salmon would have been three years old, chinook with deformed opercula were observed at the hatchery. The number was not reported, although pictures of 12 possibly marked opercula were presented. No further evaluation of this marking was found.

The paper by Rich and Holmes discussed the marking of 4,000 1914-brood yearling chinook of Willamette stock at Bonneville Hatchery by removing the adipose fin and cutting a "u"-shaped clip from the right gill cover. Because it was suspected that the clip on the operculum might not prove satisfactory, some specimens were held in a tank at the hatchery for several months and the process of regeneration noted. After approximately four months the clipped sections were regenerated almost completely. Only one adult fish was recovered that unquestionably showed the mark used in this experiment.

PROCEDURE

Two wooden troughs were divided by longitudinal partitions to provide four parallel compartments of equal size. A flow of approximately 2.5 gallons per minute of water from a natural spring was introduced into each compartment. Temperature range of the water during the experiment was 53-57° F.

The marking instrument was a pair of sharp-pointed, stainless steel surgical iris scissors (Figure 1). One blade was inserted under the operculum to achieve as large a clip as possible (Figure 2).

The 400 salmon used in the study were recently hatched fall chinook from the Sandy River Hatchery. Upon arrival as unfed fry on February 16, 1960, the salmon were assigned by a random numbers table to the four compartments until there were 100 in each. On February 18, following a day of acclimation, the lot of 100 unfed fry randomly selected for treatment was anesthetized with M.S. 222 (tricaine methanesulfonate) and every second fish was marked by having its left operculum clipped. The compartment of fry randomly selected for replication received the same treatment. The salmon in the remaining two compartments were not handled at that time. After completion of marking in the two compartments, the test fish in all four compartments received their first feeding. On May 11, after having been reared for 82 days, the 200 fingerlings that received no handling were removed from the remaining two compartments and treated in the same manner as the unfed fry—anesthetized, handled, and every second fish marked.

The principal phase of the experiment terminated on June 10, 1960 after the salmon had been reared for 112 days, but a group of 30 marked and 34 unmarked fingerlings was held to check on regeneration at a later date.

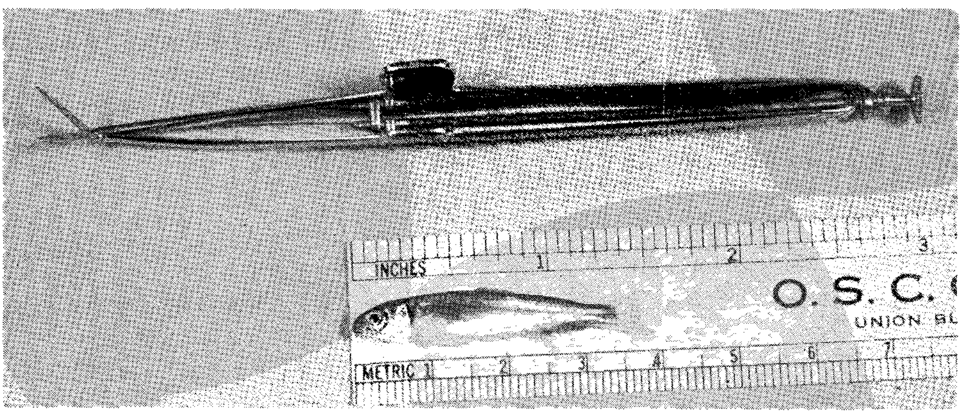

FIGURE 1. THE SURGICAL IRIS SCISSORS USED AS THE MARKING INSTRUMENT AND AN UNFED FRY WITH CLIPPED OPERCULUM.

RESULTS

Mortality Analysis

The compartments in which the test fish lived were examined daily for mortalities. Although only 10 mortalities occurred during the experiment

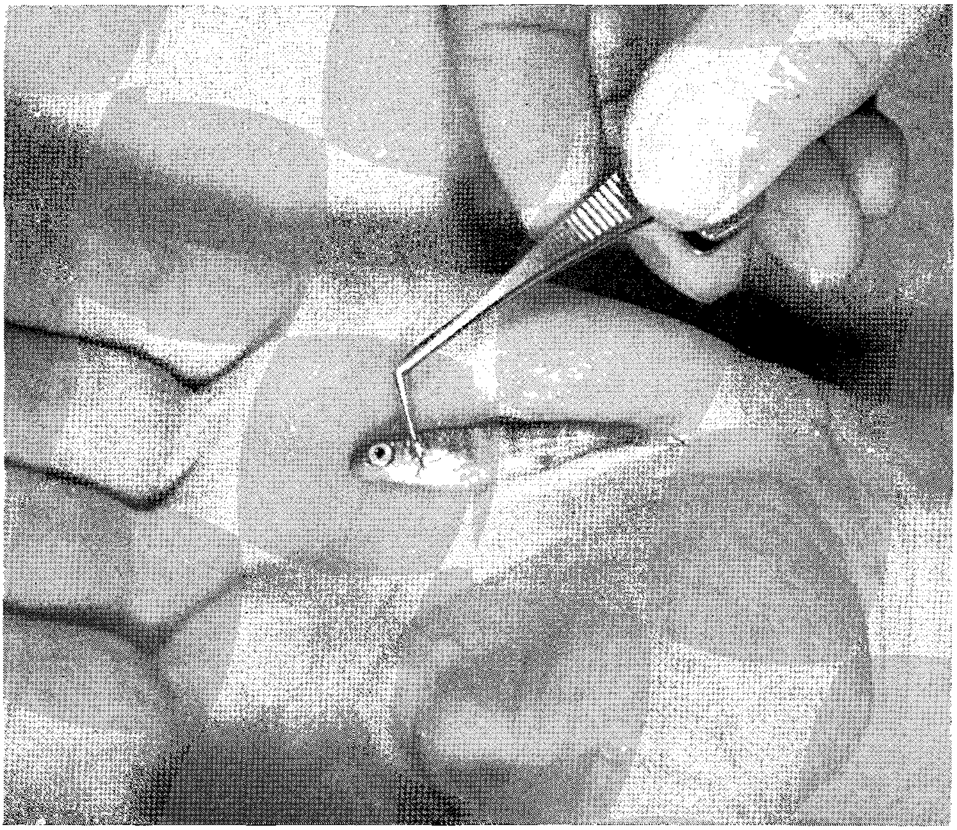

FIGURE 2. THE MARKING OPERATION ON AN ANESTHETIZED CHINOOK SALMON FRY.

(Table 1), the question of statistically significant differences in mortality among treatments was considered. A square root transformation was first applied to the mortality data and the transformed data were then analyzed by analysis of variance. The results are presented in Table 2. The tests of significance were performed at the 5% level. No significant differences could be detected in mortalities in the following 3 comparisons:

(1) Fry classification versus fingerling classification.

(2) Marked fry versus unmarked fry.

(3) Marked fingerlings versus unmarked fingerlings.

TABLE 1. **MORTALITY, BY TREATMENT AND REPLICATION, OVER THE DURATION OF THE STUDY.**

	Treatment				
	Fry		*Fingerlings*		
Replication	*Marked*	*Unmarked*	*Marked*	*Unmarked*	*Total*
1	0	2	0	3	5
2	2	2	0	1	5
Total	2	4	0	4	10

TABLE 2. **ANALYSIS OF VARIANCE OF TRANSFORMED MORTALITY DATA.**

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Fry vs. Fingerling	0.2852	1	0.2852	0.90
Marked Fry vs. Unmarked Fry	0.5000	1	0.5000	1.58
Marked Fingerling vs. Unmarked Fingerling	1.8661	1	1.8661	5.89
Error	1.2680	4	0.3170	
Total	3.9193	7		

$F_{.05} = 7.71$ with 1 and 4 d.f.

Growth Analysis

The experiment design called for measuring differential growth in weight and length among the lots receiving the various treatments. The fish were very small at the start (mean individual weight 0.3 gram) and uniform in size. It was decided to use the length and weight values obtained at the conclusion of the experiment for analysis of growth differences.

The observed weight and length values (Tables 3 and 4) were treated by analysis of variance. Results of the analysis are presented in Tables 5 and 6. As before, the tests of hypothesis were performed at the 5% significance level. No significant differences could be demonstrated for the weight and length data resulting from the different treatments.

Regeneration

After 112 days, regeneration of the clipped opercula of the fry had occurred to such an extent that it was impossible to distinguish many salmon which had been marked as unfed fry from those not marked. From a group of 50 marked and 48 unmarked fish, an observer obtained the erroneous ratio of 39 marked to 59 unmarked fish. The same group was then anesthetized and three observers made independent judgments as to whether each fish had been marked. Of the 98 fish in the group, observers agreed upon 66 and disagreed upon 32. Even during post-mortem examination, when it was possible to remove the opercula and examine them closely, determination as to whether an individual had been marked sometimes proved difficult.

Fingerlings marked 29 days prior to termination of the experiments were still easily distinguished when the experiment concluded. However, 2 months later it was impossible to distinguish many marked fingerlings from the unmarked. Figure 3 shows two fish which had been marked as fry with regenerated opercula and a fingerling whose clipped operculum is still readily distinguishable.

TABLE 3. **MEAN WEIGHT IN GRAMS, BY TREATMENT AND REPLICATION, AT THE CONCLUSION OF THE EXPERIMENT.**

	Treatment				
	Fry		*Fingerlings*		
Replication	*Marked*	*Unmarked*	*Marked*	*Unmarked*	*Total*
1	4.0	3.8	3.7	3.5	15.0
2	3.5	3.6	3.1	3.9	14.1
Total	7.5	7.4	6.8	7.4	29.1

TABLE 4. **MEAN LENGTH IN MILLIMETERS, BY TREATMENT AND REPLICATION, AT THE CONCLUSION OF THE EXPERIMENT.**

	Treatment				
	Fry		Fingerlings		
Replication	*Marked*	*Unmarked*	*Marked*	*Unmarked*	*Total*
1	73.4	71.2	72.7	70.5	287.8
2	70.8	70.3	68.3	73.3	282.7
Total	144.2	141.5	141.0	143.8	570.5

TABLE 5. **ANALYSIS OF VARIANCE OF WEIGHT DATA.**

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Fry vs. Fingerling	0.0613	1	0.0613	0.61
Marked Fry vs. Unmarked Fry	0.0025	1	0.0025	0.02
Marked Fingerling vs. Unmarked Fingerling	0.0900	1	0.0900	0.89
Error	0.4050	4	0.1012	
Total	0.5588	7		

$F_{.05} = 7.71$ with 1 and 4 d.f.

TABLE 6. **ANALYSIS OF VARIANCE OF LENGTH DATA.**

Source of Variation	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Fry vs. Fingerling	0.1013	1	0.1013	0.02
Marked Fry vs. Unmarked Fry	1.8225	1	1.8225	0.42
Marked Fingerling vs. Unmarked Fingerling	1.9600	1	1.9600	0.45
Error	17.3850	4	4.3462	
Total	21.2688	7		

$F_{.05} = 7.71$ with 1 and 4 d.f.

From these observations, it was concluded that clipping the operculum as described does not result in a satisfactory mark for fall chinook salmon studies lasting as long as four months. However, the technique may have some merit in short-term experiments, particularly since no difference was found in mortality and growth between the marked and unmarked fish.

SUMMARY

In searching for methods of marking juvenile salmonids, a study to determine the practicality of marking by removal of a portion of the operculum was conducted.

No statistically significant differences in mortality were determined among marked and unmarked groups of salmon. No significant differences between the marked and unmarked salmon in growth, based on length and weight measurements, were obtained.

Within 112 days, the clipped opercula regenerated in the fry group to a point where differentiation between marked and unmarked chinook by

FIGURE 3. PRESERVED SPECIMENS OF FISH MARKED AS UNFED FRY (TOP AND CENTER) AND FINGERLINGS SHOWING REGENERATION OF THE CLIPPED OPERCULA AT THE END OF THE EXPERIMENT.

direct observation became inaccurate. The same was true when members of the group marked as fingerlings were held for 82 days after marking. It appears, therefore, that clipping the operculum in fish of this size does not produce a suitable mark for use in chinook salmon studies lasting as long as four months. However, the technique may have some use in short-term experiments.

ACKNOWLEDGMENTS

The authors acknowledge the assistance of the following Oregon Fish Commission personnel: Thomas B. McKee and John W. Westgate assisted in the experiment throughout its duration; Mrs. Winona Richey clipped the opercula; and Irving W. Jones took the photographs. Thanks are due Dr. Igarachi who kindly supplied a copy of the Japanese report and a pair of surgical scissors.

LITERATURE CITED

Hyland, H. W.

1915. Observations on the scales of the chinook salmon (*Oncorhynchus tshawytscha*) with particular reference to the variations which may affect the determination of age. M. S. Thesis, Oregon Agricultural College, 52 p.

Rich, W. H., and H. B. Holmes.

1929. Experiments in marking young chinook salmon on the Columbia River, 1916 to 1927. Bull. U. S. Bur. Fisheries 44:214-264.

Sano, S., and T. Kobayashi.

1953. On the returning of pink salmon (*Oncorhynchus gorbuscha,* Walbaum) in Yurappu River. (In Japanese, English summary); Sci. Rep. of the Hokkaido Fish Hatchery 8(1): 1-9.

Length-Weight Relationship of Artificially Propagated Juvenile Silver Salmon

DAVID A. LEITH

and

ELLIS J. WYATT[1]

INTRODUCTION

Most studies of length-weight relationships of Pacific salmon pertain to fish found in the ocean or on their spawning migrations. A few investigators have recorded length and weight data for juvenile Pacific salmon, but the information has not been reported in a uniform manner that would facilitate comparison (Dombroski, 1952 and 1954; Foerster, 1954; Krogius and Krokhin, 1958; and Nelson, 1959). Others have reported length-weight curves, but did not discuss the mathematical relationships (Foerster, 1929; Foerster and Ricker, 1953; Mihara, 1959). Salo and Bayliff (1958) presented perhaps the most complete discussion of length-weight relationships in a report on both wild and hatchery-reared silver salmon fingerlings (*Oncorhynchus kisutch*) at Minter Creek, Washington.

Data on length-weight relationships of juvenile Pacific salmon can be useful in attempts to evaluate the condition of fish in various environments. Therefore it is desirable to have comprehensive relationships available for as many species as possible. This paper deals with the length-weight relationship of juvenile silver salmon reared at Oregon Fish Commission hatcheries.

MATERIALS AND METHODS

Length and weight measurements were obtained from 1958- and 1959-brood silver salmon fingerlings during periodic examinations of fish health.

All lengths were fork lengths, i.e., from tip of snout to fork of tail, measured to the nearest millimeter. Weights were recorded to the nearest 0.1 gram with a 2,610-gram-capacity, triple-beam balance.

The length-weight relationship was calculated using the formula $\log W = \log c + n \log L$, where W = weight in grams and L = fork length in millimeters. The constants c and n were determined by the least squares method (Clark, 1928).

RESULTS

Lengths and weights were obtained from 2,246 silver salmon fingerlings 46 to 140 mm long and weighing from 1.0 to 37.0 gm. The number of fish weighed and measured per month is presented in Table 1 and the number examined per hatchery in Table 2. Relatively few samples were collected during February, March, and April because the yearlings are generally

---

[1] Formerly biologist, Oregon Fish Commission; now a staff member, Department of Biology, Central Oregon College, Bend, Oregon.

liberated during that period. The sample from Coos Hatchery was relatively small because this station was not visited on a routine basis.

The length-weight relationship was calculated to be $W = 0.00001251 L^{2.98581}$, and is represented by the curve in Figure 1. The observed and calculated mean weights used in preparation of the curve are compared in Table 3.

DISCUSSION

Salo and Bayliff (1958) calculated length-weight relationships for large and small hatchery-reared silver salmon fingerlings both before and after liberation. The constants for their "before liberation" equations and the values obtained in this study are compared in Table 4.

The comparison shows that the relationship calculated for the hatchery-reared fish in Oregon is quite similar to the formulae determined by Salo and Bayliff. The slight differences between the three equations may be due to the separate analysis of large and small fish at Minter Creek, variations in amount of food the fish contained, and the fact that Salo and Bayliff made their observations immediately prior to liberation and not throughout the rearing period.

TABLE 1. **NUMBERS OF ARTIFICIALLY PROPAGATED SILVER SALMON FINGERLINGS SAMPLED BY MONTH.**

Brood Year	Month												Total
	May	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	
1958	0	102	225	168	208	165	0	185	82	0	12	55	1,202
1959	175	229	131	168	90	32	87	60	72	0	0	0	1,044
Total	175	331	356	336	298	197	87	245	154	0	12	55	2,246

TABLE 2. **NUMBERS OF ARTIFICIALLY PROPAGATED SILVER SALMON FINGERLINGS SAMPLED BY HATCHERY.**

Brood Year	Hatchery											Total
	Alsea	*Big Creek*	*Bonneville*	*Cascade*	*Coos*	*Klaskanine*	*Nehalem*	*Oxbow*	*Sandy*	*Siletz*	*Trask*	
1958	166	167	104	103	34	138	60	106	148	80	96	1,202
1959	99	95	134	112	29	85	133	92	83	87	95	1,044
Total	265	262	238	215	63	223	193	198	231	167	191	2,246

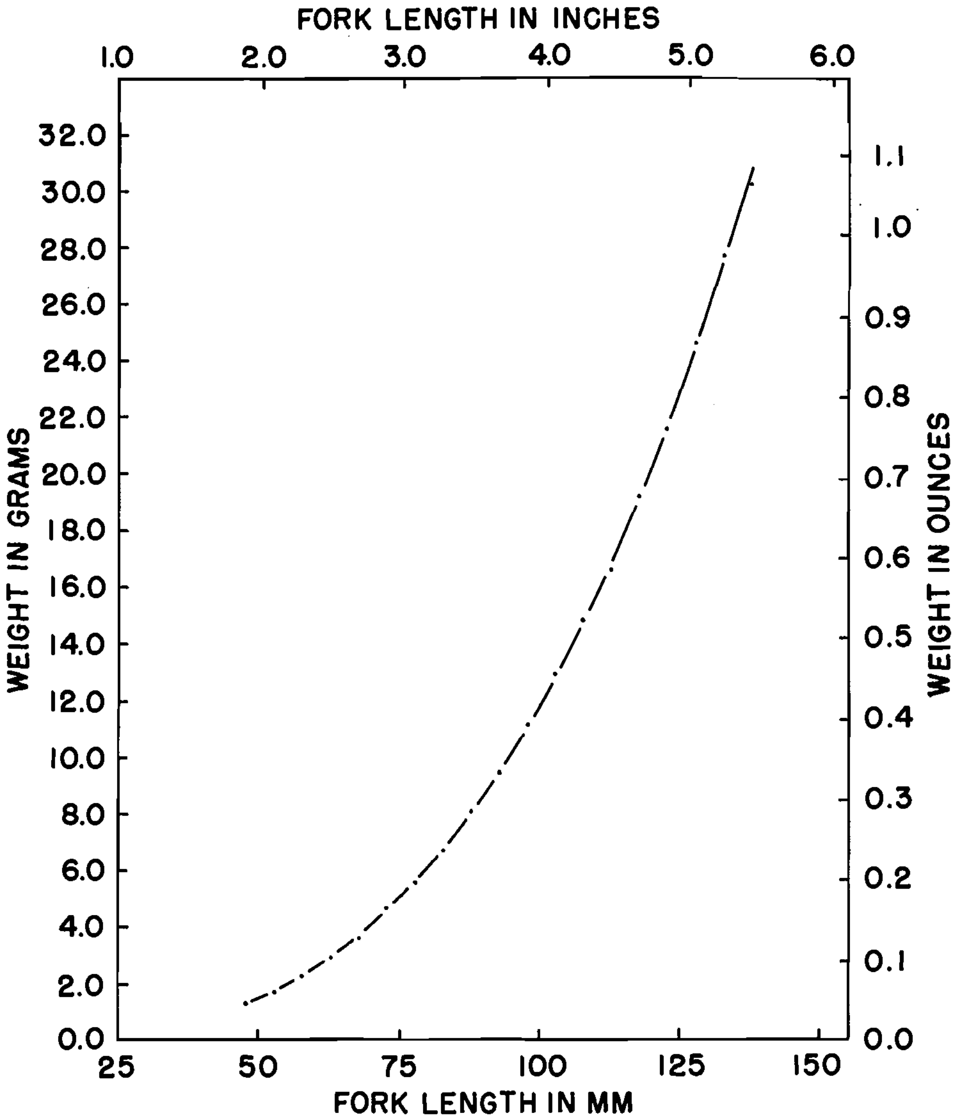

FIGURE 1. LENGTH-WEIGHT RELATIONSHIP OF HATCHERY-REARED SILVER SALMON FINGERLINGS. (POINTS ARE OBSERVED VALUES.)

TABLE 3. **OBSERVED AND CALCULATED MEAN WEIGHTS OF ARTIFICIALLY PROPAGATED SILVER SALMON FINGERLINGS.**

Fork Length (millimeters)		*Mean Weight (grams)*	
Interval	*Midpoint*	*Observed*	*Calculated*
46- 50	48	1.33	1.31
51- 55	53	1.72	1.76
56- 60	58	2.33	2.30
61- 65	63	2.89	2.95
66- 70	68	3.61	3.70
71- 75	73	4.72	4.58
76- 80	78	5.62	5.58
81- 85	83	6.68	6.72
86- 90	88	8.07	8.00
91- 95	93	9.52	9.44
96-100	98	11.12	11.03
101-105	103	12.88	12.80
106-110	108	14.82	14.75
111-115	113	16.63	16.88
116-120	118	19.22	19.21
121-125	123	21.59	21.74
126-130	128	24.59	24.49
131-135	133	27.65	27.46
136-140	138	30.19	30.66

TABLE 4. **VALUES OF LOG C AND N IN LENGTH-WEIGHT EQUATIONS FOR ARTIFICIALLY PROPAGATED SILVER SALMON FINGERLINGS AT MINTER CREEK, WASHINGTON, AND OREGON FISH COMMISSION HATCHERIES.**

Source	*Log c*	*n*
Oregon Fish Commission		
Before liberation	–4.90274	2.98581
Minter Creek		
Before liberation		
Large fish	–4.91002	2.98080
Small fish	–4.86877	2.98550

SUMMARY

The length-weight relationship for juvenile silver salmon reared at Oregon Fish Commission hatcheries was computed by the least squares method. A total of 2,246 fish was weighed and measured throughout the rearing periods of the 1958 and 1959 broods. The fish ranged from 46 to 140 millimeters in fork length and from 1.0 to 37.0 grams in weight. The length-weight relationship was determined to be $W = 0.00001251\ L^{2.98581}$ where W = weight in grams and L = fork length in millimeters.

ACKNOWLEDGMENTS

We are indebted to Sigurd J. Westrheim and Earl F. Pulford of the Oregon Fish Commission for their advice concerning analysis of the data and preparation of this paper, and to members of the Hatchery Biology Section and Fish Culture Division for collecting the data.

LITERATURE CITED

Clark, F. N.

1928. The weight-length relationship of the California sardine (*Sardina caerulea*) at San Pedro. Calif. Dept. Fish and Game, Fish Bull. 12, 59 p.

Dombroski, E.

1952. Sockeye smolts from Babine Lake in 1951. Fish. Res. Bd. Can., Prog. Rep. Pac. 91: 21-26.

Dombroski, E.

1954. The sizes of Babine Lake sockeye salmon smolt emigrants, 1950-1953. Fish. Res. Bd. Can., Prog. Rep. Pac. 99: 30-34.

Foerster, R. E.

1929. An investigation of the life history and propagation of the sockeye salmon (*Oncorhynchus nerka*) at Cultus Lake, British Columbia. III. The down-stream migration of the young in 1926 and 1927. Contr. Can. Biol. Fish. N. S. 5 (3): 55-83.

Foerster, R. E.

1954. On the relation of adult sockeye salmon (*Oncorhynchus nerka*) returns to known smolt seaward migrations. J. Fish. Res. Bd. Can. 11 (4): 339-350.

Foerster, R. E., and W. E. Ricker.

1953. The coho salmon of Cultus Lake and Sweltzer Creek. J. Fish. Res. Bd. Can. 10 (6): 293-319.

Krogius, F. V., and E. M. Krokhin.

1958. Results of a study of the biology of sockeye salmon. The conditions of the stocks and the fluctuations in numbers in Kamchatka waters. Fish. Res. Bd. Can. Transl. Series 176: 21 p.

Mihara, T.

1959. An ecological study on the salmon fry, *Oncorhynchus keta,* in the coastal waters of Hokkaido. Fish. Res. Bd. Can. Transl. Series 226: 13 p.

Nelson, P. R.

1959. Effects of fertilizing Bare Lake, Alaska, on growth and production of red salmon (*O. nerka*). U. S. Fish and Wildlife Serv. Fish. Bull. 159: 59-86.

Salo, E. O., and W. H. Bayliff.

1958. Artificial and natural production of silver salmon, *Oncorhynchus kisutch,* at Minter Creek, Washington. Wash. Dept. Fish., Res. Bull. 4: 76 p.

Summer Steelhead Tagging Experiments at McNary Dam in 1955 and 1956

WAYNE A. BURCK
and
IRVING W. JONES

INTRODUCTION

Summer-run steelhead trout (*Salmo gairdneri*) enter the Columbia River from June to October and spawn in the spring of the following year, mostly in tributaries above Bonneville Dam. They are harvested in the lower Columbia River by sport and commercial fishermen during the summer months, and in the upper Columbia and its tributaries by sport anglers of Oregon, Washington, and Idaho during the fall, winter, and spring months.

In December 1954, during unwatering operations necessary for ladder maintenance, numbers of summer steelhead were found in the Oregon shore fishway at McNary Dam. Because summer steelhead were known to "winter over" in portions of the main Snake and Columbia rivers, and because few fish had been counted out of the fishway in the days preceding the unwatering, it was assumed that these fish had taken up temporary winter residence in the fishway. Since little biological data on summer steelhead were available from areas above the commercial fishery, a tagging experiment was undertaken to provide information concerning the distribution, sex and size composition, migration rates, and movements of steelhead temporarily residing in the McNary fishways. During January 1955 tagging was carried out in the Washington shore fishway and in April 1955 and February 1956 in the Oregon shore fishway.

METHODS

On January 17, 1955, the downstream entrance to the Washington shore fishway of McNary Dam was stop-logged to a height of about 6 feet above tailwater. Although normal transportation flow continued, the 6-foot fall prevented fish from entering the fishway. On January 20, 1955, the upstream entrance was stop-logged, thus cutting off the transportation flow through the fishway and allowing the lower, sloping portion to drain. The receding water was followed down the fishway by the maintenance crew and the fish present were chased through the orifices in each weir to tailwater. The upper portion of the fishway, divided into sections by 3-foot-high sills supporting tilting weirs, could not drain resulting in pools, 30 feet square and 3 feet deep, in which some steelhead were trapped. In general, the same procedures were followed in the unwatering of the Oregon shore fishway. The tagging was done on January 21 and 22 and April 6 and 7, 1955 and February 28 and 29, 1956.

Steelhead were removed from the pools with seines and dipnets, transferred to canvas-covered tagging cradles, measured to the nearest ½ inch (fork length), and tagged with Petersen disc tags fastened at the origin of the dorsal fin with a nickel pin bent in a single knot. Sex determinations were not made during January 1955, but in April 1955 and February 1956 sex was determined from external characteristics. A portable direct-current fish shocker was used to capture stragglers in April 1955. After being tagged, the fish were transferred to wet burlap bags, lifted to the top of the training wall, and dropped about 12 feet into the forebay of McNary Dam. In January 1955, whenever two fish were captured simultaneously, one was released untagged to speed up the operation. Half of the tagged fish were released back into the fishway pools during the April 1955 tagging.

RESULTS

A total of 1,786 steelhead was tagged, of which 297 (16.6%) were recovered, principally in the tributary streams by anglers, dam traps, and research fyke nets. Several tagged fish were recovered more than once, making a total of 333 recoveries. Table 1 summarizes the numbers tagged and recovered.

TABLE 1. **SUMMARY OF RESULTS, 1955-56 McNARY DAM STEELHEAD TAGGING PROGRAM.**

Tagging Period	*Number Tagged*	*Number Recovered*	*Per Cent Recovered*	*Multiple Recoveries*	*Total Recoveries*
Jan. 1955	464	119	25.6	4	123
Apr. 1955	570	66	11.6	12	78
Feb. 1956	752	112	14.9	20	132
Total	1,786	297	16.6	36	333

Distribution of Recoveries and Recovery Gear

The distribution of tag recoveries is summarized in Table 2 by tagging period. Figure 1 is a map of the Columbia River watershed showing the tributaries where tagged steelhead were recovered.

Recoveries downstream from the tagging site came from as far as Astoria, Oregon (–275 miles). Recoveries in the lower Columbia River were made during May or later of the same year, suggesting that these fish were migrating back to the ocean after having spawned. A few fish were recovered from the Umatilla River, a tributary of the Columbia 3 miles below McNary Dam.

Upstream recoveries were reported from as far as the Wenatchee River (+200 miles), a tributary of the upper Columbia, and the Weiser River (+450 miles), a tributary of the Snake. Large numbers of fish from each tagging period were recovered in the Clearwater River. Recoveries from the January and February tagging periods were more widely distributed in the upper Columbia and upper Snake tributaries than those from the April tagging period. However, April-tagged fish may have been present in the upper areas but not recovered, due to a short period of availability and a normal decrease in angling effort during that time of the year.

TABLE 2. **NUMBER OF RECOVERIES BY RECOVERY AREA AND TAGGING PERIOD.**

Tagging Period	*Number of Recoveries*	*Recovery Area*														
		Columbia R. below McNary Dam	*Umatilla R.*	*Columbia R. above McNary Dam*	*Walla Walla R.*	*Touchet R.*	*Yakima R.*	*Wenatchee R.*	*Snake R., Main Stem*	*Tucannon R.*	*Clearwater R.*	*Asotin Cr.*	*Grande Ronde R.*	*Wenaha R.*	*Salmon R.*	*Weiser R.*
Jan. 1955	123	13	2	1	15	0	2	1	27	2	43	2	2	0	8	5
Apr. 1955	78	4	4	1	3	0	0	0	12	1	49	4	0	0	0	0
Feb. 1956	132	13	2	1	7	3	1	0	55	4	24	20	0	2	0	0
Total	333	30	8	3	25	3	3	1	94	7	116	26	2	2	8	5

Table 3 presents a summary of recoveries by gear. Time of tagging had an effect on the relative importance of the principal recovery gears. Angling accounted for over 40% of the recoveries from the January tagging period, but only 9% from the April period. Conversely, fixed gear (dam traps and experimental fyke nets) accounted for less than 50% of the recoveries from the January tagging period and almost 80% from the April period. Comparable figures for the February 1956 tagging period are intermediate.

TABLE 3. **NUMBER OF RECOVERIES BY GEAR AND TAGGING PERIOD.**

Tagging Period	*Recovery Gear*					
	Angling	*Dam Traps*	*Fyke Nets*①	*Gill Nets*	*Misc.*	*Total*
Jan. 1955	53	43	14	2	11	123
Apr. 1955	7	51	10	3	7	78
Feb. 1956	17	44	54	13②	4	132
Total	77	138	78	18	22	333

① The Oregon Fish Commission was operating two batteries of fyke nets in the main Snake River at the time tagging took place. The lower battery was approximately 155 miles and the upper battery 185 miles upstream from McNary Dam (Thompson *et al.*, 1958).

② Includes 9 recoveries by experimental gill nets in the vicinity of McNary Dam.

Sex Composition

External characteristics were examined in April 1955 and February 1956 to determine sex. Internal determination of sex was included with tag recovery data for 46 of the February-tagged steelhead, and only 3 had been incorrectly sexed by the tagging crew. Sex composition by tagging period is summarized in Table 4.

Size Composition

In summarizing, length data were grouped to the nearest lower whole inch. Lengths shown for recovered fish are those recorded at the time of tagging. The size compositions of tagged and recovered steelhead are shown in Figure 2. The fish have been divided into two size groups to

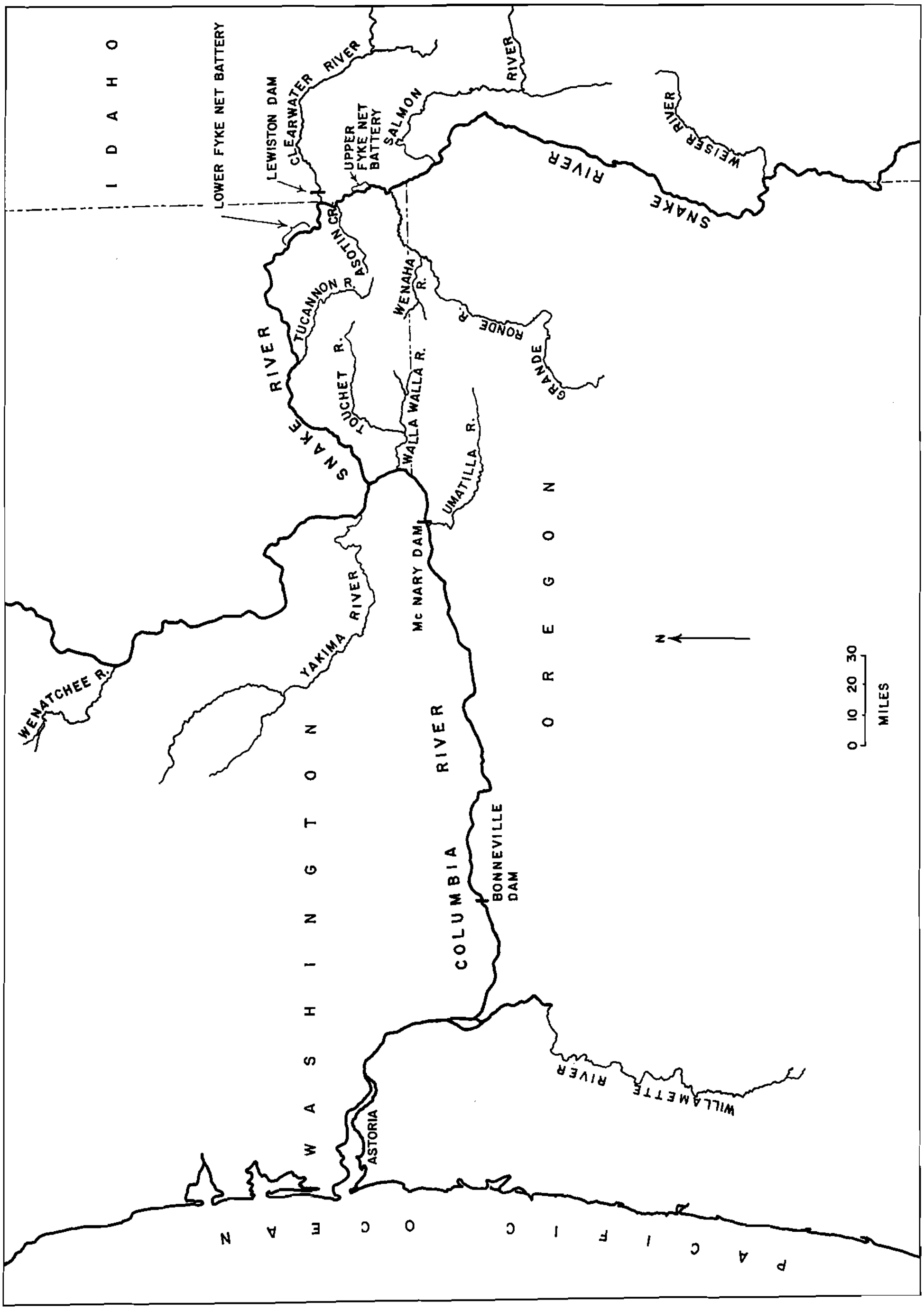

FIGURE 1. MAP OF THE COLUMBIA RIVER WATERSHED SHOWING TRIBUTARIES WHERE RECOVERIES WERE MADE.

facilitate comparison. This was done by referring to the length-frequency curves and arbitrarily separating at the trough between modes. Thus, small steelhead are 25 inches and shorter and the large fish 26 inches and longer. Comparisons of size groups are shown in Table 5. The proportion of small and large fish tagged varied among the tagging periods; however, the proportion of large fish recovered was greater than that tagged in each tagging period. This may be explained by the large number of recoveries at Lewiston Dam on the Clearwater River (Table 2) where the run includes a high proportion of large fish. Figure 3 shows the size composition of tagged and untagged fish passing over Lewiston Dam. These data were taken at the dam traps and can be considered non-selective as to size of fish because all fish passing the dam were captured and measured.

TABLE 4. **SEX COMPOSITION BY TAGGING PERIOD.**

Tagging Period	*Males*		*Females*	
	Number	*Per Cent*	*Number*	*Per Cent*
Apr. 1955	167	33	341	67
Feb. 1956	357	48	387	52

TABLE 5. **COMPARISON OF THE PERCENTAGE OF SMALL AND LARGE STEELHEAD TAGGED AND RECOVERED, BY TAGGING PERIOD.**

Tagging Period	*Small*		*Large*	
	Tagged	*Recovered*	*Tagged*	*Recovered*
Jan. 1955	43	39	57	61
Apr. 1955	58	33	42	67
Feb. 1956	78	68	22	32

Migration Rates and Movements

Tags recovered at Lewiston Dam on the Clearwater River, 176 miles from McNary Dam, provided the only adequate source of data for computing migration rates, depicted in Table 6 by tagging period.

The January 1955 tagging was carried out during a period of very light migratory activity compared to the April tagging. Although there was a difference of 75 days between the two tagging periods in 1955, 75% of the combined number of tags recovered at Lewiston Dam appeared in the dam trap between April 15 and May 5 (21 days). This intermingling of January and April tags at Lewiston Dam is shown in the lower portion of Figure 4. The daily counts of all steelhead passing the dam in the period April 1 to May 31, 1955 are shown in the upper portion of Figure 4. Comparison of the two portions shows that the fluctuation in counts of tagged steelhead corresponded to counts of all steelhead.

TABLE 6. **COMPARISON OF MIGRATION RATES BY TAGGING PERIOD FOR STEELHEAD RECOVERED AT LEWISTON DAM ON THE CLEARWATER RIVER.**

Tagging Period	*Numbers of Fish*	*Days Out*①	*Miles Per Day*①
Jan. 1955	30	86.9	2.0
Apr. 1955	34	23.3	7.6
Feb. 1956	17	73.1	2.4

① Geometric mean.

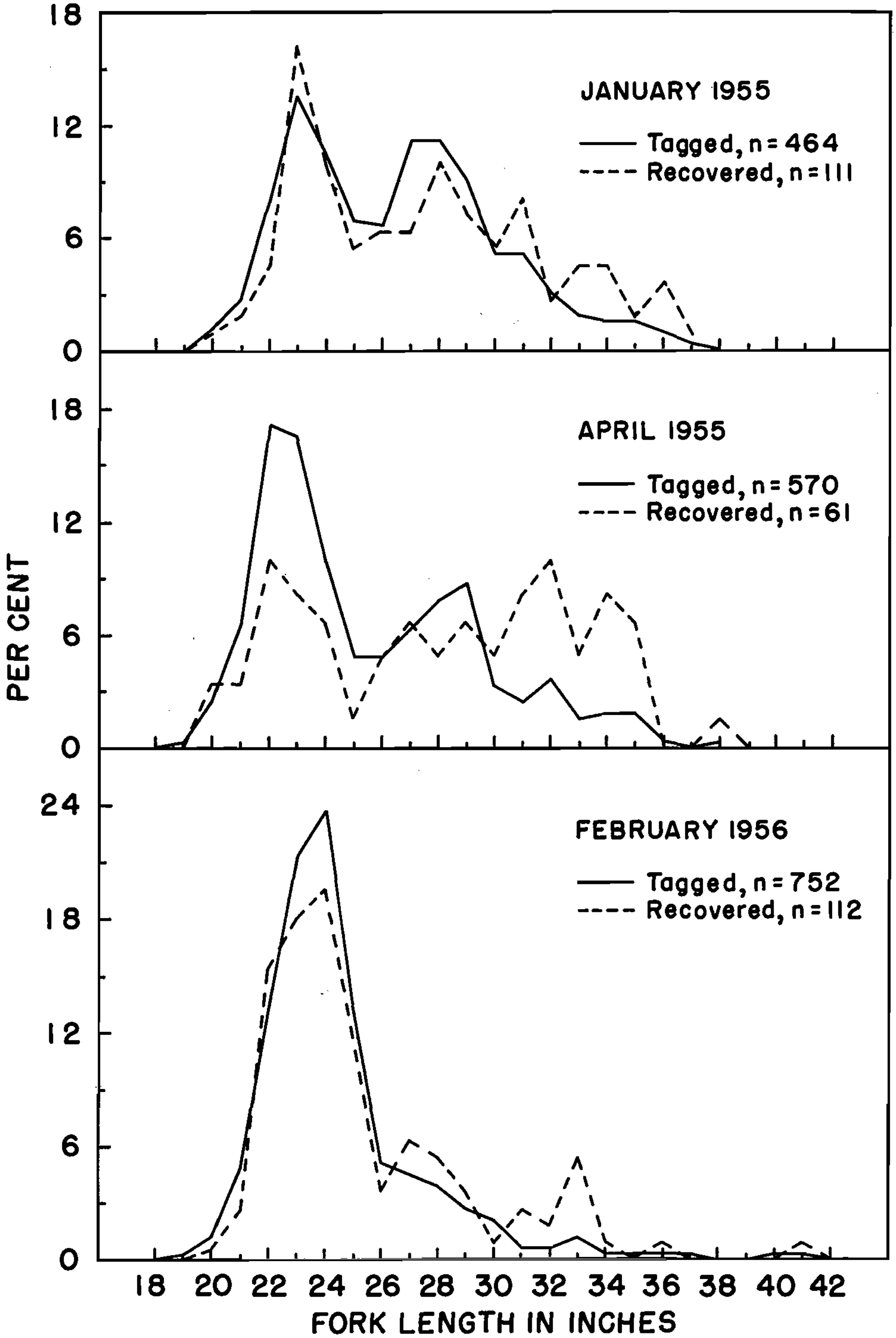

FIGURE 2. SIZE COMPOSITION OF TAGGED AND RECOVERED STEELHEAD BY TAGGING PERIOD.

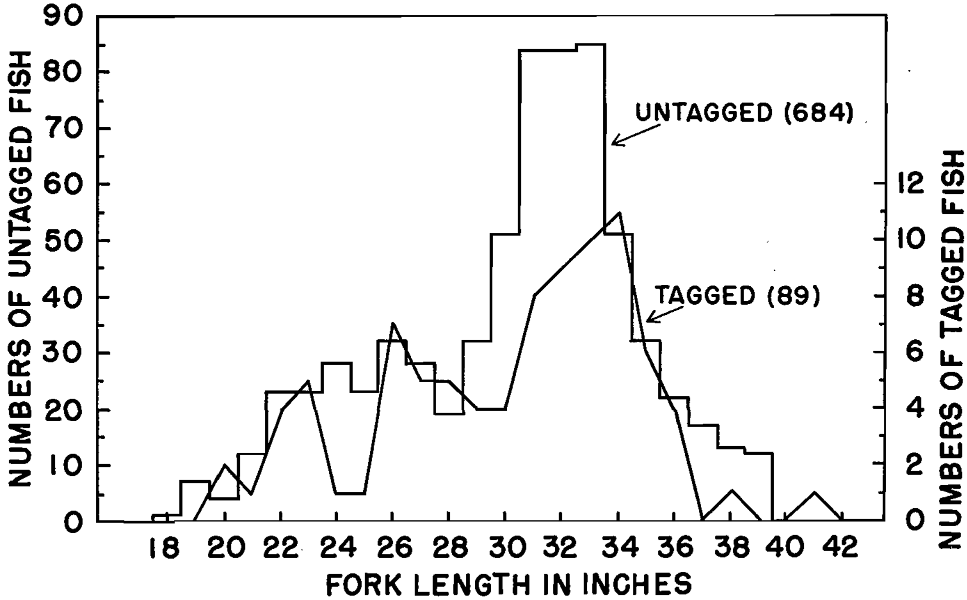

FIGURE 3. SIZE COMPOSITION OF TAGGED AND UNTAGGED STEELHEAD PASSING LEWISTON DAM ON THE CLEARWATER RIVER, MARCH-JUNE 1955. (COURTESY OF THE IDAHO DEPARTMENT OF FISH AND GAME.)

Half of the April-tagged steelhead were released back into the Oregon shore fishway of McNary Dam. Twenty-three forebay-released fish required an average of 22.5 days (7.8 miles per day) and 11 ladder-released fish 25.1 days (7.0 miles per day) to make the journey to Lewiston Dam. Timing of the tagged and untagged steelhead passing through the Oregon shore fishway was compared by recording the daily number of fish crossing the counting weir. Fluctuations in counts of tagged steelhead corresponded with the counts of untagged fish (Figure 5).

SUMMARY

A tagging program was undertaken to provide information about summer-run steelhead trout residing in the McNary Dam fishways during the winter months. The tagging was accomplished in January and April 1955 and February 1956.

A total of 1,786 steelhead was tagged, of which 297 (16.6%) were recovered.

Recoveries of January- and February-tagged steelhead were more widely distributed in tributaries of the upper Columbia and Snake rivers than recoveries of April-tagged steelhead. The largest numbers of tagged fish were recovered in the Clearwater River (116) with smaller numbers from Asotin Creek (26), Walla Walla River (25), Salmon River (8), Umatilla River (8), Tucannon River (7), Weiser River (5), Touchet River (3), Yakima River (3), and 1 or 2 tags each from the Wenatchee, Grande Ronde, and Wenaha rivers. The relative numbers recovered in the various tribu-

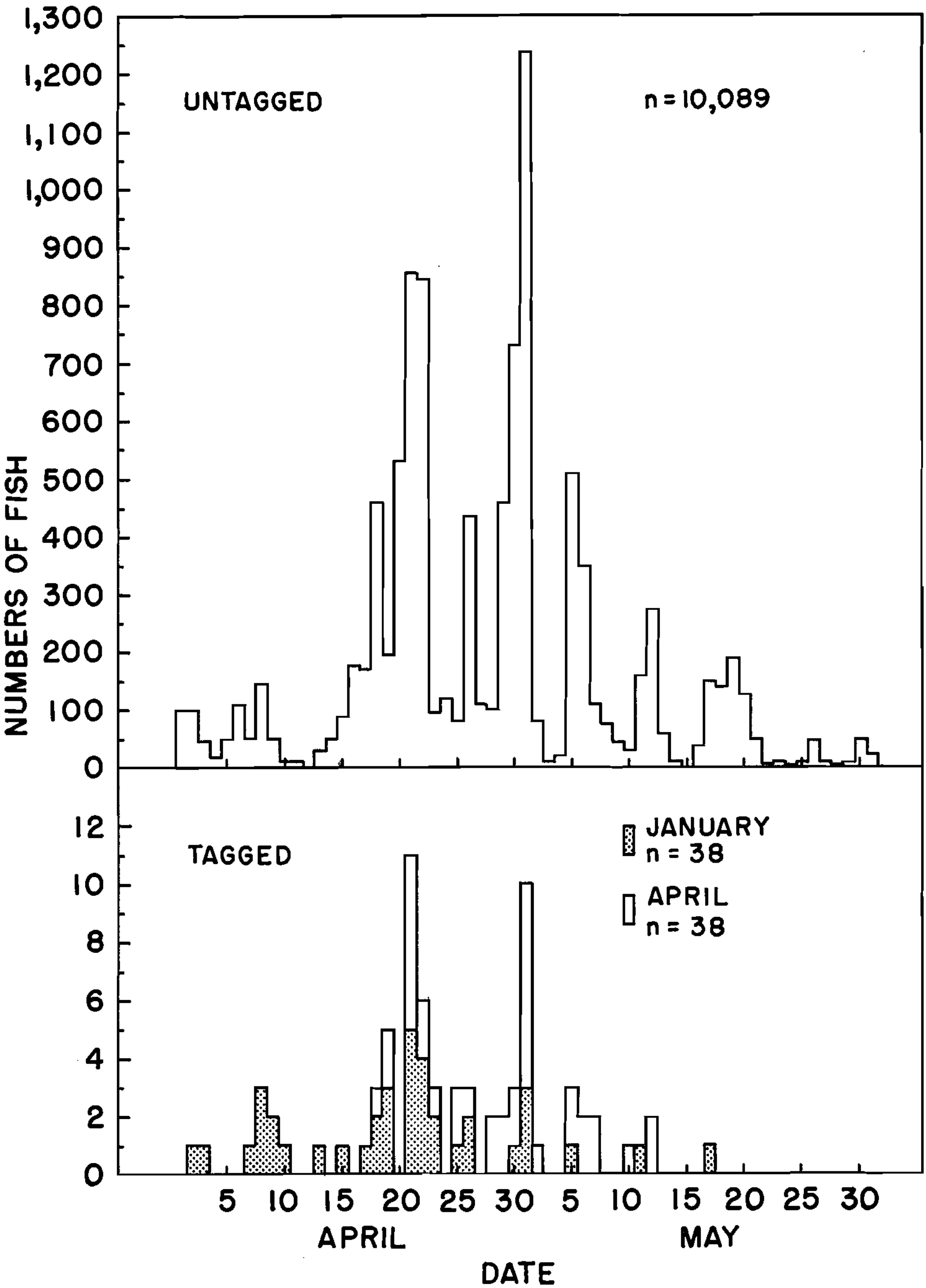

FIGURE 4. COMPARISON OF THE DAILY COUNT OF TAGGED AND UNTAGGED STEELHEAD PASSING LEWISTON DAM, APRIL 1-MAY 31, 1955.

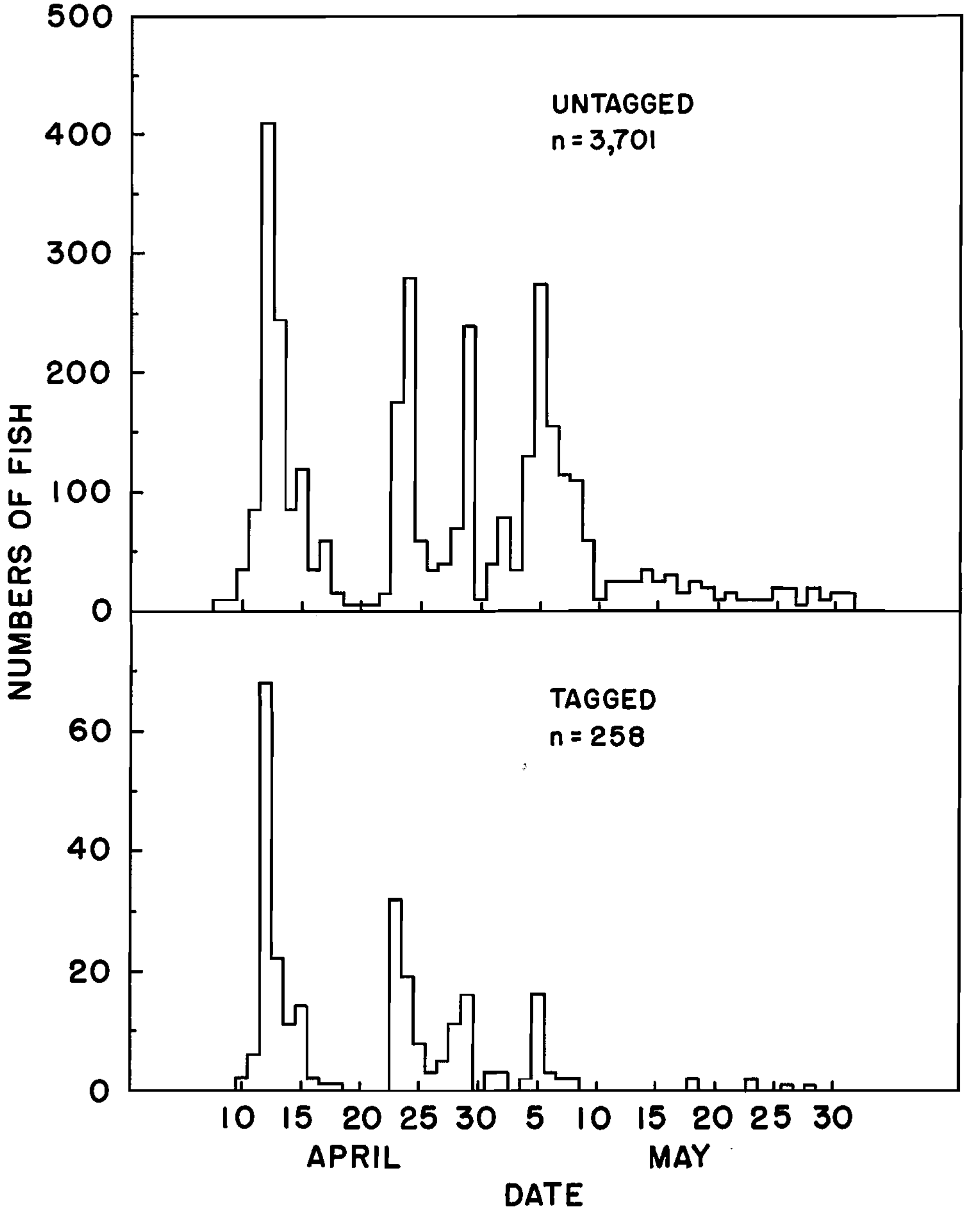

FIGURE 5. COMPARISON OF THE DAILY COUNT OF TAGGED AND UNTAGGED STEELHEAD PASSING THE OREGON SHORE FISHWAY AT McNARY DAM, APRIL 8-MAY 31, 1955.

taries do not necessarily reflect the tributaries' importance as steelhead streams due to the varying recovery intensities.

Angling accounted for over 40% of the recoveries from the January tagging period but only 9% from the April tagging period. Dam traps and research fyke nets accounted for less than 50% of the recoveries from the January tagging but almost 80% from the April tagging.

Males were estimated to comprise 33% and 48% of the fish tagged during the April 1955 and February 1956 tagging periods, respectively.

The proportion of small and large fish tagged varied with the tagging period. However, the proportion of large fish (26 inches and longer) recovered was greater than the proportion tagged for each period. The Clearwater River has a run of predominantly "large" steelhead.

The earlier tagged fish migrated at a slower rate (2.0-2.4 miles per day) than the later tagged fish (7.6 miles per day). Although 75 days separated the two tagging periods in 1955, 75% of the combined recoveries at Lewiston Dam on the Clearwater River appeared during a 21-day period. Fluctuations in the counts of tagged steelhead corresponded with fluctuations in the counts of untagged steelhead at both McNary and Lewiston dams.

ACKNOWLEDGMENTS

The tagging program was carried out under the direction of Harry L. Rietze, then in charge of Columbia River Investigations for the Oregon Fish Commission. Melvin D. Collins, Joseph M. Cicrich, Charles P. Selden, Robert T. Gunsolus, and Monte R. Richards assisted with the tagging and data compilation.

LITERATURE CITED

Thompson, R. N., J. B. Haas, L. M. Woodall, and E. K. Holmberg.

1958. Results of a tagging program to enumerate the numbers and to determine the seasonal occurrence of anadromous fish in the Snake River and its tributaries. Oreg. Fish Comm. proc. rept. Final report to the U. S. Army Corps of Engineers, Contract DA-35-026-eng-20609, 202 p.

Eighth Progress Report on Salmon Diet Experiments[1]

THOMAS B. McKEE
JAMES W. WOOD[2]
Oregon Fish Commission
and
RUSSELL O. SINNHUBER[3]
DUNCAN K. LAW
T. C. YU[3]
Oregon Agricultural Experiment Station
Seafoods Laboratory, Astoria, Oregon

INTRODUCTION

The Oregon Fish Commission and Seafoods Laboratory of Oregon State University are continuing to test potential components which may be used in practical production diets for Pacific salmon. In previous studies, workers of these groups have evaluated various livers and dry meals as potential sources of protein.

Skim-milk powder and cottonseed-oil meal are used in trout rations but little work has been reported on their use in salmon diets. Titcomb *et al.* (1929) reported that linseed meal was fatal to brook trout (*Salvelinus fontinalus*) after four weeks. Sinnhuber *et al.* (1961) found soybean meal to be an unsatisfactory diet component for chinook salmon (*Oncorhynchus tshawytscha*) and silver salmon (*O. kisutch*).

The present study tested vitamin B_{12}, Rita-liver (a commercially prepared dried liver product), and albacore tuna (*Thunnus alalunga*) liver as additives to the Oregon test diet (Sinnhuber *et al.*, 1961). In addition, linseed-oil meal, dried skim milk, and cottonseed-oil meal were evaluated as replacements for portions of the Oregon test diet.

PROCEDURES

The experiment was conducted at the Oregon Fish Commission Willamette River Hatchery for 22 weeks from May 7 to October 13, 1954. The stock used was 1953-brood Willamette River spring chinook salmon averaging 0.48 grams in weight (945 fish per pound). The fish were randomly divided into lots of 700 each and stocked in eight 6-foot circular tanks. The lots were moved systematically every two weeks to reduce experimental error. Salmon Creek was used as the water supply; the flow was approximately two gallons per minute in each tank.

Eight diets were fed to single lots of fish (Table 1). A meat-fish diet (McKee *et al.*, 1952) was used as the maximum control and the Oregon test diet was used as the minimum control. All diets were compounded to give the same moisture content and proximate analysis as the maximum control. The dry components were stored in friction-top cans and the

[1] Technical Paper No. 1656, Oregon Agricultural Experiment Station.

[2] Present Address: Washington State Department of Fisheries, Seattle, Washington.

[3] Present Address: Department of Food Science and Technology, Oregon State University, Corvallis, Oregon.

meat and fish products were kept frozen until used. During the first part of the study, while the fish were very small, the food was passed through a garlic press. Later a modified Alemite gun was used to extrude worm-like particles. The bind of the food was partially destroyed by this process and was restored by heating the "worms" momentarily with an infrared lamp to remelt the gelatin binder. The worms were then allowed to cool, cut in short lengths, and fed by hand. The meat-fish control diet was spread on the water with a spoon.

The amount of food fed daily was computed on a dry weight basis equal to a percentage of the lot weight (McKee *et al.*, 1951). The daily allotment varied from 0.75 to 5.00% of the lot weight during the course of the experiment. All lots were fed six days per week.

The fish were weighed biweekly and the daily food allotment adjusted according to the new lot weight. After the lots were weighed, samples of fish were examined for gill color. Dark red gills were considered excellent, red—good, pink—anemic, and white—very anemic. Mortalities were removed and recorded daily. The fish were counted at the end of the experiment to check on possible unaccounted loss.

TABLE 1. **DIET DESCRIPTIONS AND OBSERVATIONAL RESULTS.**

Diet Number	*Composition*	*Dry Wt. Food Conv. Factor*	*Per Cent Mortality*	*Gill Color*	*Remarks*
1	Maximum control: equal parts beef liver, pork liver, and salmon viscera plus 2% salt.	1.08	1	Red	Very good growth. Good appetite.
2–0	Minimum control: Oregon test diet.	1.22	17	Pink-Red	Poor growth. Fair appetite.
2–1	Oregon test diet plus additional B_{12}.①	1.20	21	Pink-Red	Poor growth. Fair appetite.
2–2	Oregon test diet 90%, Rita-liver 10%.②	1.04	12	White-Red	Fair growth. Good appetite.
2–3	Oregon test diet 90%, fresh-frozen albacore tuna liver 10%.	1.03	2	Red-Dark Red	Very good growth. Good appetite.
13	Oregon test diet modified by replacing 36.2 parts with linseed-oil meal (solvent extracted, 39% protein).③	1.73	36	White-Red	Very poor growth. Poor appetite.
14	Oregon test diet modified by replacing 33.9 parts with dried skim milk.③	1.27	22	Pink-Red	Poor growth. Fair appetite.
15	Oregon test diet modified by replacing 41.2 parts with cottonseed-oil meal (solvent extracted, 41% protein).③	1.68	25	Pink-Red	Very poor growth. Poor appetite.

① Vitamin B_{12} added to bring total content to the equivalent of the maximum control diet.
② Rita-liver is a commercially prepared product composed of dried animal and codfish livers.
③ The ingredient to be tested replaced regular components to maintain standardized chemical composition of the Oregon test diet.

RESULTS

Lot growth and weekly average water temperatures are shown in Figure 1. Dry weight food conversion factors, per cent mortality, gill color, and remarks on growth and appetite are given in Table 1.

Early in July a heavy infestation of *Octomitis* was found in mortalities from all lots. In an attempt to control this protozoan, all lots were fed carbarsone at a level of 0.2% of the daily food. The drug was fed from July 1 to 7 and from August 4 to 11. The treatment was not effective in eliminating *Octomitis*.

CONCLUSIONS

Three ingredients were evaluated as additives to the Oregon test diet: (1) additional vitamin B_{12}—did not noticeably affect fish growth or gill color but mortality increased somewhat over that of fish fed the test diet; (2) Rita-liver—produced slightly better growth and less mortality than the test diet but seemed to have an adverse effect on gill color; and (3) albacore tuna liver—greatly improved growth, substantially lowered mortality, and improved gill color.

Solvent-extracted linseed and cottonseed-oil meals, tested separately as replacements for portions of the Oregon test diet, produced very poor growth, increased mortality, and poorer gill color than the test diet. However, linseed meal was not found to be fatal for chinook salmon as has been reported for brook trout. Although both linseed and cottonseed meals produced poor growth results, they were observed to possess good binding qualities, especially linseed meal.

Dried skim milk, substituted for portions of the Oregon test diet, produced slightly less growth, increased mortality, and poorer gill color than the test diet.

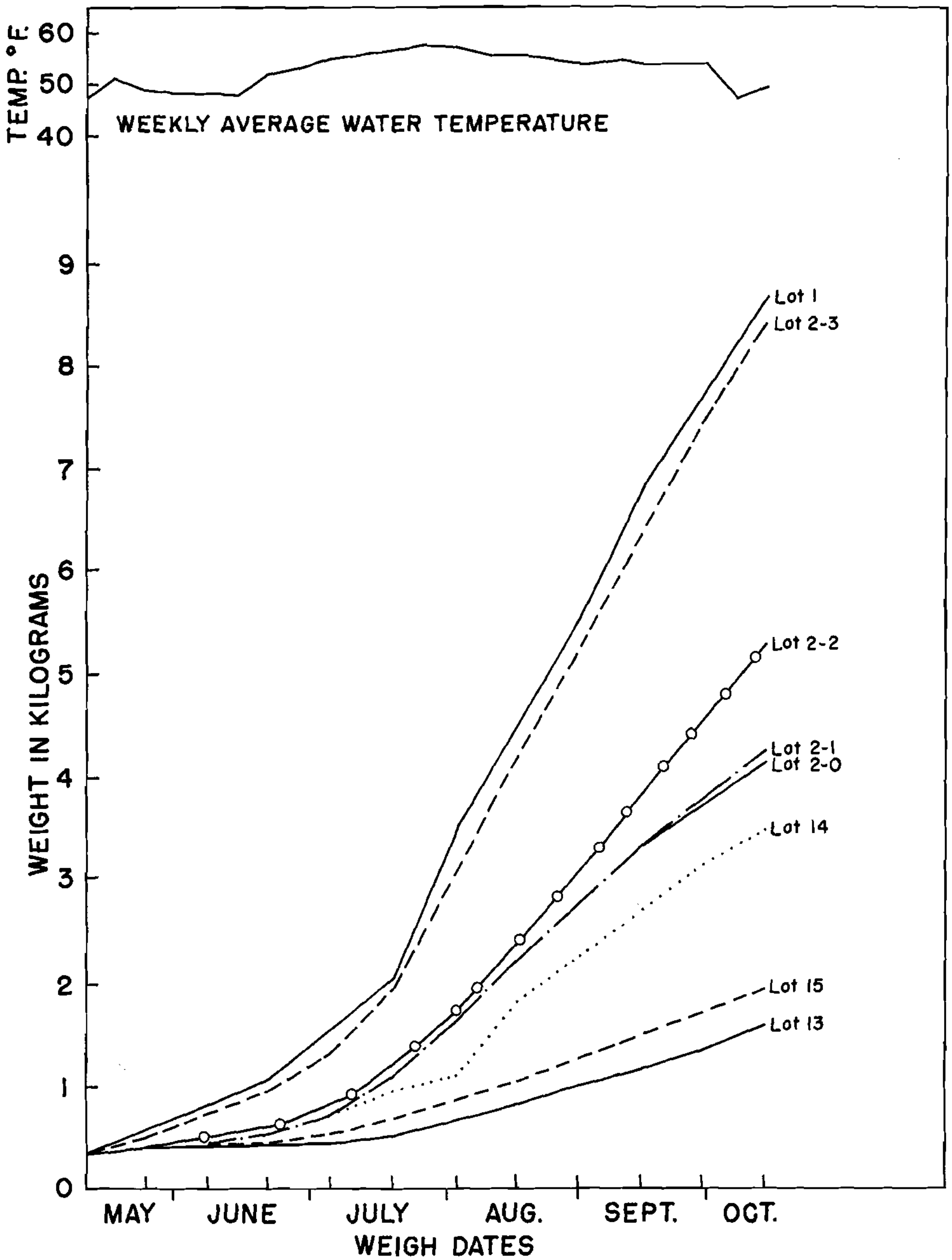

FIGURE 1. LOT GROWTH BY WEIGH DATE AND WEEKLY AVERAGE WATER TEMPERATURE, WILLAMETTE DIET EXPERIMENT, 1954.

LITERATURE CITED

McKee, T. B., R. O. Sinnhuber, and D. K. Law.

1951. Spring chinook salmon diet experiments at the Bonneville Hatchery. Oreg. Fish Comm. Res. Briefs 3 (2):22-31.

McKee, T. B., E. R. Jeffries, D. L. McKernan, R. O. Sinnhuber, and D. K. Law.

1952. Second progress report on spring chinook salmon diet experiments. Oreg. Fish Comm. Res. Briefs 4 (1):25-30.

Sinnhuber, R. O., D. K. Law, T. C. Yu, T. B. McKee, W. F. Hublou, and J. W. Wood.

1961. Sixth progress report on salmon diet experiments. Oreg. Fish Comm. Res. Briefs 8 (1):53-61.

Titcomb, J. W., E. W. Cobb, M. F. Crowell, and C. M. McCay.

1929. The relative value of plant and animal by-products as feed for brook trout and the basic nutritional requirements of brook trout in terms of proteins, carbohydrates, vitamins, inorganic elements, and roughage. Trans. Am. Fisheries Soc. 59:126-145.

Ninth Progress Report on Salmon Diet Experiments[1]

WALLACE F. HUBLOU
THOMAS B. McKEE
Oregon Fish Commission
and
DUNCAN K. LAW
RUSSELL O. SINNHUBER[2]
T. C. YU[2]
Oregon Agricultural Experiment Station
Seafoods Laboratory, Astoria, Oregon

INTRODUCTION

During the past several years over 30 food components have been tested as additives or replacements in the Oregon test diet (Sinnhuber *et al.,* 1961) in joint studies by the Oregon Fish Commission and Astoria Seafoods Laboratory. This diet is capable of producing minimum growth and maintaining satisfactory health in chinook (*Oncorhynchus tshawytscha*) and silver (*O. kisutch*) salmon fingerlings over a long period of time.

The present feeding experiment evaluated the growth response of silver salmon to the following groups of animal meals fed as replacements in the Oregon test diet: blood, dogfish (*Squalus acanthias*), Bellingham or butter sole (*Isopsetta isolepis*), yellowfin tuna (*Thunnus albacares*) viscera, and Pacific cod (*Gadus macrocephalus*). In addition, crab meal was deleted from the Oregon diet in one ration and replaced with shrimp meal in another. Also, the following ingredients were tested as additives to the test diet: herring (*Clupea harengus pallasi*) solubles, distillers solubles, wheat germ meal, and fresh-frozen beef lungs.

PROCEDURES

The experiment was conducted at the Oregon Fish Commission Sandy River Hatchery for 34 weeks from July 5, 1955 to February 28, 1956. Cedar Creek, the hatchery water supply, was supplied to thirteen 6-foot circular tanks. Each tank was stocked with 319 silver salmon of the 1954 brood averaging 1.82 grams (249 fish per pound) in weight.

Thirteen diets were fed to single lots of fish (Table 1). A meat-fish diet (McKee *et al.,* 1952) known to produce very good growth and excellent general health was used as a maximum control and the Oregon test diet served as the minimum control. The experimental diets were modifications of the test diet. All diets were compounded to give the same moisture content and proximate chemical analysis as the maximum control.

The fish were fed 3 to 4 times daily, 6 days per week, except when cold or muddy water hampered operations. Food was prepared by extrusion through a modified Alemite gun as described by McKee *et al.* (1962). Each

[1] Technical Paper No. 1657, Oregon Agricultural Experiment Station.

[2] Present Address: Department of Food Science and Technology, Oregon State University, Corvallis, Oregon.

lot received a daily allotment of food computed on a dry weight basis equal to a set percentage of the lot weight (McKee *et al.*, 1951).

The lots were weighed biweekly until November 8, 1955, again on December 6, and again at the end of the experiment. Past experience at the Sandy Hatchery indicated that little growth could be expected during the mid-winter months.

When the fish were weighed, gill-color checks were made on samples from each lot to determine the possible existence of anemia. At the end of the test, hemoglobin determinations were made with a Klett-Summerson photometric colorimeter using the oxyhemoglobin method with ammonium hydroxide.

RESULTS

Lot growth and weekly average water temperatures are shown in Figure 1. Dry weight food conversion factors, per cent mortality, and observational results are given in Table 1. Results of gill-color examination and hemoglobin determinations at the end of the experiment are found in Table 2.

TABLE 1. **DIET DESCRIPTIONS AND OBSERVATIONAL RESULTS.**

Diet Number	*Composition*	*Dry Wt. Food Conv. Factor*	*Per Cent Mortality*	*Remarks*
1	Maximum control: equal parts beef liver, hog liver, and salmon viscera plus 2% salt.	1.15	5.6	Lot growth good. Appetite very good.
2–0	Minimum control: Oregon test diet.	1.36	6.0	Lot growth poor. Appetite good.
2–4	Oregon test diet with crab meal deleted.	1.38	2.2	Lot growth poorest. Appetite good.
2–5	Oregon test diet with crab meal replaced by shrimp meal.	1.11	0.3	Lot growth good. Appetite good. Fish highly colored.
2–6	Oregon test diet 95%, herring solubles 5% (dry weight basis).	1.08	1.9	Lot growth good. Appetite fair.
2–7	Oregon test diet 95%, distillers solubles 5% (dry weight basis).	1.39	5.6	Lot growth poor. Appetite fair.
2–8	Oregon test diet 95%, wheat germ meal 5% (dry weight basis).	1.30	5.0	Lot growth fair. Appetite fair.
2–9	Oregon test diet 90%, fresh-frozen beef lungs 10% (wet weight basis).	1.17	2.5	Lot growth good. Appetite good.
4	Oregon test diet modified by replacing 19.5 parts casein with dogfish meal.①	1.06	2.5	Lot growth very good. Appetite very good.
5	Oregon test diet modified by replacing 22.4 parts casein with Bellingham sole meal.①	1.06	3.1	Lot growth very good. Appetite very good.

TABLE 1. **DIET DESCRIPTIONS AND OBSERVATIONAL RESULTS**—Continued.

Diet Number	*Composition*	*Dry Wt. Food Conv. Factor*	*Per Cent Mortality*	*Remarks*
6	Oregon test diet modified by replacing 20.9 parts casein with yellowfin tuna viscera meal.①	1.05	1.3	Lot growth very good. Appetite very good.
7	Oregon test diet modified by replacing 22.1 parts casein with Pacific cod meal.①	1.08	0.9	Lot growth very good. Appetite very good.
9	Oregon test diet modified by replacing 25.4 parts casein with commercial blood meal.	......	2.8②	Lot growth very poor. Appetite very poor at first, changing to very good. Diet discontinued after 6 weeks.

① Drum dried at the Astoria Seafoods Laboratory.
② To August 16, 1955.

TABLE 2. **TERMINAL GILL EXAMINATION AND PHOTOMETRIC COLORIMETER READINGS FOR HEMOGLOBIN, SANDY DIET EXPERIMENT, 1955-56.**

Lot Number	*Gill Examination① Color*					*Colorimeter Readings②*	
	No. 1	*No. 2*	*No. 3*	*No. 4*	*Average*	*Range*	*Average*
1	18	1	1	0	1.2	108–126	117
2–0	0	20	0	0	2.0	79–109	93
2–4	0	17	3	0	2.2	76–97	88
2–5	4	15	1	0	1.7	90–100	96
2–6	0	19	1	0	2.1	89–104	97
2–7	0	19	1	0	2.1	84–103	93
2–8	2	17	1	0	2.0	80–111	97
2–9	0	20	0	0	2.0	88–113	100
4	5	14	1	0	1.8	92–116	103
5	0	18	2	0	2.1	88–107	97
6	6	14	0	0	1.7	92–114	104
7	6	14	0	0	1.8	87–104	94
9	....	....	..	..	③	....	......

① 1—dark red gills (excellent); 2—red gills (good); 3—pink gills (anemic); 4—white gills (very anemic).
② Duplicate samples obtained from 5 fish in each lot.
③ Diet discontinued; fish not examined.

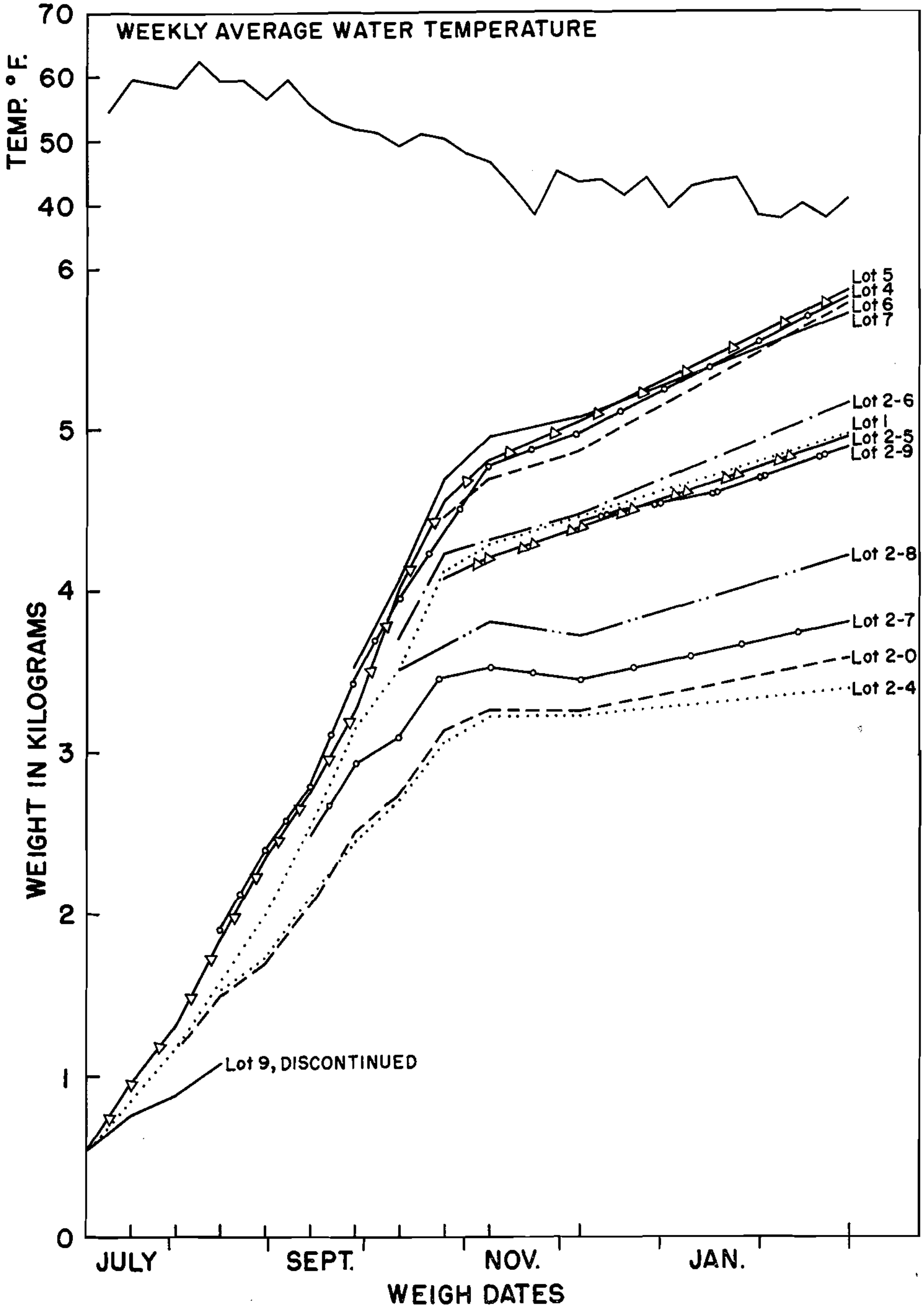

FIGURE 1. LOT GROWTH BY WEIGH DATE AND WEEKLY AVERAGE WATER TEMPERATURE, SANDY DIET EXPERIMENT, 1955-56.

The mortality rate was relatively low in all lots except diet 9 which was discontinued after 6 weeks. Most of the fish that died in the other lots had deformed spinal columns (scoliosis and/or lordosis). This condition, not apparent when the fish were counted at the start of the experiment, developed at an earlier age in some fish than others. The same malady was described by Law *et al.* (1961) in 1953-brood silver salmon from the Sandy River. The cause has not been determined.

Periodic gill-color checks have been made since the inception of the experimental diet studies. Gill color reflects to some degree the hemoglobin level of the blood; however, results can be clouded by varying light conditions, fish size, and the observer's color perception. At the end of the experiment hemoglobin determinations were made with a photometric colorimeter and readings were compared with the final gill-color examination (Table 2). The results show some degree of similarity: lot 1 had the best gill-color (1.2) and highest colorimeter reading (117), while lot 2-4 had the poorest gill-color (2.2) and lowest colorimeter reading (88).

CONCLUSIONS

The following drum-dried fish meals produced very good growth as partial casein replacements in the Oregon test diet: dogfish, Bellingham sole, yellowfin tuna viscera, and Pacific cod. Commercially prepared animal blood meal produced very poor growth when tested in the same manner and was discontinued after 6 weeks because of the debilitated condition of the fish.

Deletion of crab meal from the Oregon test diet resulted in a somewhat lessened growth response. Shrimp meal, substituted for crab meal, produced better growth than the control containing crab meal.

Other ingredients tested as additives to the Oregon test diet produced the following results: (1) herring solubles—good growth; (2) distillers solubles—fair growth (slightly better than the test diet); (3) wheat germ meal—fair growth; and (4) fresh-frozen beef lungs—good growth.

Mortality rate in the test lots was 6% or less, resulting mainly from a deformed condition present in fish in all lots.

Blood condition, as observed by gill-color and hemoglobin determinations, varied somewhat between lots but all diets produced satisfactory results.

LITERATURE CITED

Law, D. K., R. O. Sinnhuber, T. C. Yu, W. F. Hublou, and T. B. McKee.
1961. Seventh progress report on salmon diet experiments. Oreg. Fish Comm. Res. Briefs 8 (1):62-70.

McKee, T. B., R. O. Sinnhuber, and D. K. Law.
1951. Spring chinook salmon diet experiments at the Bonneville Hatchery. Oreg. Fish Comm. Res. Briefs 3 (2):22-31.

McKee, T. B., E. R. Jeffries, D. L. McKernan, R. O. Sinnhuber, and D. K. Law.
1952. Second progress report on spring chinook salmon diet experiments. Oreg. Fish Comm. Res. Briefs 4 (1):25-30.

McKee, T. B., J. W. Wood, R. O. Sinnhuber, D. K. Law, and T. C. Yu.
1962. Eighth progress report on salmon diet experiments. Oreg. Fish Comm. Res. Briefs 9 (1):52-56.

Sinnhuber, R. O., D. K. Law, T. C. Yu, T. B. McKee, W. F. Hublou, and J. W. Wood.
1961. Sixth progress report on salmon diet experiments. Oreg. Fish Comm. Res. Briefs 8 (1):53-61.

Occurrence of a Striped Bass in an Otter Trawl Catch

On November 5, 1961 the trawler *Mary R.*, operated by Harold Sizemore, captured a striped bass (*Roccus saxatilis*) while fishing at depths of 12 to 13 fathoms in the ocean off the north side of the Columbia River.

The striped bass, a male, measured 71 cm fork length and weighed 10.6 pounds. Scale examination to determine age revealed the presence of six annuli. No food was present in the stomach.

Although the catches by the trawlers at sea are made up of a variety of species, the capture of a striped bass is a rare occurrence. Mr. Sizemore also reported the capture of another specimen which he did not retain during the summer of the same year off the Columbia River. Striped bass are also uncommon in the Columbia River estuary as evidenced by the fact that they are rarely taken in the gill-net fishery.

Robert B. Herrmann
Oregon Fish Commission
Clackamas, Oregon

New Downstream Distribution Record for the Sand Roller, *Percopsis transmontana*, in the Columbia River

On July 22, 1961, a specimen of the sand roller was seined from Horseshoe Island Slough, 25 miles above the Columbia River mouth. This collection extends the distribution of this species downstream about 110 miles. The specimen measured 25 mm in length.

Past collections in the Columbia River drainage have been between Bonneville Dam and the Clearwater River, a tributary of the Snake River (Pratt and Whitt, 1952). In the Willamette River drainage, Dimick and Merryfield (1945) list 13 collections between Albany and Eugene. Also, the University of Michigan has one specimen from Rock Creek, a tributary of the Clackamas River.

Other species collected with the sand roller at Horseshoe Island Slough were: chinook salmon (*Oncorhynchus tshawytscha*); peamouth chub, (*Mylocheilus caurinus*); largescale sucker (*Catostomus macrocheilus*); white crappie (*Pomoxis annularis*); largemouth bass (*Micropterus salmoides*); prickly sculpin (*Cottus asper*); and threespine stickleback (*Gasterosteus aculeatus*). These species indicate the slough locality is an ecological niche similar to that found throughout the geographical range of the sand roller. Since the sand roller and other Percopsidae (trout-perches) are thought to be strictly freshwater fishes, and the slough is near waters of low salinity, physiological tests of the species salinity tolerance and a knowledge of salinity patterns in the lower river would be useful in predicting the limits of downstream distribution.

LITERATURE CITED

Dimick, R. E., and F. Merryfield.

1945. The fishes of the Willamette River system in relation to pollution. Oregon State Eng. Expt. Sta. Bull., Ser. 20, 58 p.

Pratt, V. S., and C. R. Whitt.

1952. First record of the percopsid fish *Columbia transmontana* from Idaho. Copeia 1952 (4):267-268.

Paul E. Reimers

Oregon Fish Commission
Astoria, Oregon
and
Oregon State University
Corvallis, Oregon

Occurrence of the California Flyingfish off Northern Oregon

The range of the California flyingfish (*Cypselurus californicus,* Cooper) has been given by Roedel (1953) as Point Conception, California, south to at least Cedros Island, Baja California, Mexico. Jordan, Evermann, and Clark (1930) list the range as Point Conception to Cape San Lucas, Baja California, while Cooper, when describing the species in 1864, stated that the northward limit was Santa Cruz. Hubbs and Kampa (1946) determined this to be the city of Santa Cruz, California, rather than the island, but felt that the range was not as far north.

The northerly range of this species was extended about 800 miles from the published range by the occurrence of an 18½-inch male found October 1, 1962 in a shallow tide pool about one-half mile south of Cannon Beach, Oregon (45° 53′ N. latitude) by Ray and Ernest Gilman of Rock Falls, Illinois. Although they were unfamiliar with the fishes of the Pacific Northwest, they felt that possibly this fish was uncommon so they captured it and notified the local newspaper, The Daily Astorian. The flyingfish was alive when caught and according to Mr. Gilman "unfolded its wings and flopped and quivered".

Two other reports of flyingfish off Oregon have been reported since this recovery at Cannon Beach. Rudy Lovvold, master of the fishing vessel *Sunrise* reported seeing a flyingfish in 1962 off Cape Blanco, Oregon, while fishing for albacore tuna (*Thunnus alalunga*). The second report was from H. Mowick, proprietor of a curio and driftwood store in Hammond, Oregon, who remembers picking up a flyingfish on the beach just south of the Columbia River some 15 years ago (ca. 1947).

Above average water temperatures were recorded off the Oregon coast during the summer and early fall months of 1962. Fishermen reported seeing and catching albacore tuna within a few miles of shore which is rather unusual. The water temperatures at the Seaside Aquarium, about 7 miles north of Cannon Beach, during the period of recovery were as follows:

Date	*Temperature*
Sept. 24, 1962	53.0° F.
25	55.9
26	55.8
27	56.6
28	......
29	56.1
30	56.6
Oct. 1	57.4
2	57.4
3	56.7
4	57.4

Miller (1952) mentions collecting spawning specimens of *Cypselurus* in water 62.6° to 64.5° F. along the southern California coast. Sea surface temperature isotherms issued by the U. S. Bureau of Commercial Fisheries for the last half of September and first half of October show the 60° F. isotherm within 100 miles of the northern Oregon coastline.

Identification of this specimen was made from the description by Hubbs and Kampa (1946). Meristic counts and measurements are as follows:

Fork length	387 mm
Total length	462 mm
Head length	72 mm
Snout length	20 mm
Orbit diameter	21 mm
Pectoral fin spread	552 mm
Pectoral rays	right—14 left—14
Pelvic rays	right—6 left—6
Dorsal rays	13
Anal rays	11
Scales in lateral line	58

The specimen is at the Oregon Fish Commission Research Laboratory, Astoria, Oregon.

LITERATURE CITED

Hubbs, C. L., and E. M. Kampa.

1946. The early stages (egg, prolarva and juvenile) and the classification of the California flyingfish. Copiea 1946 (4):188-218.

Jordan, D. S., B. W. Evermann, and H. W. Clark.

1930. Check list of the fishes and fishlike vertebrates of north and middle America north of the northern boundary of Venezuela and Columbia. U. S. Government Printing Office, Washington, 670 p.

Miller, D. J.

1952. Notes on the embryology and behavior of the flyingfishes (*Cypselurus*) off the coast of southern and Baja California. Calif. Fish and Game 38(4):549-555.

Roedel, P. M.

1953. Common ocean fishes of the California coast. Calif. Dept. Fish and Game, Fish Bull. 91, 184 p.

Austin R. Magill

Oregon Fish Commission
Astoria, Oregon

Possible Albino Adult Chinook Salmon Observed

An adult chinook salmon (*Oncorhynchus tshawytscha*) of unusual coloration was observed at Pelton Dam on the Deschutes River near Madras, Oregon, on May 18, 1961. The fish was pale, from near white to buckskin, with a few faint spots visible on the body. The fins appeared translucent. Eye color was not observed. Its length and weight were estimated at 26-28 inches and 6-8 pounds. The fish was examined from a distance of 2-3 feet in a trap at the lower end of the fish ladder and was allowed to pass upstream.

Albinism is not uncommon in juvenile salmon and several instances of this condition have been reported in adult trout. However, no documented record of an albino adult salmon was found in a literature search.

Laurie Leonards
Oregon Fish Commission
Clackamas, Oregon

Elwood Madden
Portland General Electric Co.
Madras, Oregon

Occurrence of a Sockeye Salmon Stray in an Oregon Coastal River

A mature female sockeye salmon (*Oncorhynchus nerka*) was captured in the Kilchis River, a tributary of Tillamook Bay, on September 15, 1961. This fish was digging a redd 5 miles above the head of tidewater just below the Little South Fork. Estimate flow of the Kilchis River was 30 c.f.s. and the water temperature was 58° F. at 11:10 a.m.

The following measurements and counts were obtained from the salmon: fork length, 24.3 inches; weight, 4.8 pounds; gill rakers on first arch, 32; scales in the lateral line, 131; anal rays, 14; and age, probably 4_2 (all scales were somewhat eroded so the fish may have been older).

No other sockeye salmon were seen in the vicinity of this female or in two miles of stream. This species normally spawns in tributaries to lakes and also on gravel shores of some lakes. No known sockeye run exists south of the Columbia River. The fish exhibited typical sockeye salmon breeding coloration—dull brick red on the dorsal surface above the lateral line and a green head.

Since straying and other forms of aberrant behavior have at times been associated with various diseases, John L. Fryer, staff fishery pathologist, examined the frozen specimen, but found no evidence of bacterial or other disease.

Arthur L. Oakley
Thomas E. Kruse
Oregon Fish Commission
Newport, Oregon