

# SECOND EXPERIMENT IN TAGGING SALMON IN THE ALASKA PENINSULA FISHERIES RESERVATION, SUMMER OF 1923



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## INTRODUCTION

During the summer of 1923 the writers, assisted by W. P. Studdert, carried out an extensive program of salmon tagging in the district south of the westernmost portion of the Alaska Peninsula, between the Shumagin Islands and Isanotski Strait (commonly known as False Pass). Approximately 10,000 numbered aluminum tags were attached to adult red salmon within this district, and the recaptures of such as were again taken in the ordinary prosecution of the commercial fisheries were reliably reported, as to both place and time, through the cordial cooperation of all the salmon-packing concerns in western Alaska. The program of 1923 was planned as a continuation of a similar experiment on a smaller scale which had been undertaken the previous year and has been reported on by the senior author.<sup>1</sup>

<sup>1</sup> Gilbert, Charles H.: Experiment in tagging adult red salmon, Alaska Peninsula Fisheries Reservation, summer of 1922, Bulletin, U. S. Bureau of Fisheries, Vol. XXXIX, 1923-1924 (1924), pp. 39-50.

The principal results obtained in 1922 may be summarized as follows:

1. An extensive migration of mature red salmon occurs past the shores of the Shumagin Islands and westward along the Pacific coast of the Alaska Peninsula as far as False or Isanotski Pass. This migration forms the subject of an important fishery centering at Unga Island, King Cove, Ikatan, and False Pass. In these districts in 1922 were captured 3,311,911 red salmon, which produced 225,888 cases of the packed product, each case consisting of 48 one-pound cans.

2. The enormous body of fish from which this highly important commercial supply was drawn consisted of individuals fresh from their feeding grounds and still feeding. This is an unusual condition in the red-salmon fisheries, which for the most part are prosecuted near river mouths, where the fish already have begun their fast—a fast that remains unbroken to the end, when they will have fulfilled their mission and have perished on the spawning grounds. The Alaska Peninsula fisheries, which formed the subject of our investigations, are peculiar in the respect that they deal largely with salmon in the midst of their migration in the sea, far from the spawning streams toward which they are directing their course. Shortly before their capture we may assume they were associated with the hosts of immature salmon, from which one, two, and three years later would be drawn the spawning runs of those seasons; but before they were taken they had separated themselves from their younger brethren and in dense formation had started along well-defined migration routes to their final destination.

3. Of the Shumagin migrants a very limited number pursued an easterly rather than a westerly course, a few being recaptured as far to the eastward as Cook Inlet. The total number taking the eastward route was so inconsiderable, however, as to convince us that no appreciable draft would be made on the salmon supply of the Chignik, Karluk, and Cook Inlet fisheries, however intense might be the fishing in the Shumagin district.

4. Of the remainder of the Shumagin fish comparatively few belonged to local races and entered one or the other of the small red-salmon streams of Unga and Popof Islands. The vast majority throughout the fishing season formed a definite westward migration. This imposing body of fish impinged on the mainland shore, notably in Morzhovoi and Ikatan Bays, and a large and important element, in common with other Morzhovoi and Ikatan fish, traversed Isanotski Strait (False Pass) and became distributed to all that unequaled group of red-salmon streams that empty along the Bering Sea shores of the Alaska Peninsula and in Bristol Bay. The fact that this wide distribution existed, constituted perhaps the most important discovery of the season of 1922.

5. The salmon tagged in the neighboring bays of Ikatan and Morzhovoi in 1922 gave no evidence of any movement to the eastward. They passed freely back and forth from one of these bays to the other, and often lingered for two or three weeks in the locality where marked. A limited number belonged to local streams, but many traversed False Pass and were reported from all the red-salmon streams in Bristol Bay and along the peninsula.

Thus far we have the results of 1922. They were obtained during a year when the Bristol Bay red-salmon run was exceptionally heavy and might be considered likely to invade territory that would be left unoccupied in years of less



abundance. It seemed advisable to test this by a second experiment, which might enable us to ascertain whether the extensive banks south of the peninsula served constantly as feeding grounds for Bering Sea salmon, or whether their presence on these banks in 1922 was an exceptional occurrence. It will be noted in the present report that the second experiment completely verified the results of 1922, although the season of 1923 was marked by a red-salmon run of very different character.

The methods employed in 1923 did not differ from those in use the previous year. Photographs are presented showing the character of the aluminum tags, the tongs that served to attach them to the upper portion of the base of the salmon's tail, and the method of work. The salmon were secured from three different traps on Unga Island, from four in Morzhovoi Bay, and from three in Ikatan Bay and one in East Anchor Cove. Practically all of this material was furnished by the Pacific American Fisheries, from whom we received, in addition, all possible assistance and sympathetic cooperation. We wish also to acknowledge gratefully numerous courtesies extended us at the P. E. Harris plant in False Pass.

In the prosecution of our work there was used a small seine skiff, in which we entered the spiller of the trap. The spiller was then sufficiently lifted to pen the salmon along its outer walls, where they were caught up with a dip net, tagged, and released. Four men ordinarily were employed in this process and, under favorable conditions of wind and weather, could tag and release 300 salmon in one hour. On two different occasions 1,000 fish were tagged in the course of a single day's work. Unga Island (Squaw Harbor), Morzhovoi Bay, and Ikatan cover a span about 125 miles in length, and it was desired in each of these localities to tag salmon near the beginning, the middle, and the end of the short run, which lasts only about six weeks. This program was carried out with fair success, although not infrequently our work was interrupted by the high winds for which this region is noted; but the results secured by this division of the season and the different behavior of the later fish of the season, compared with those running during the earlier and middle portions of the run, amply justified this feature of the plan.

An interesting problem which early presented itself was the extent to which the homing habit of salmon controls their movements during migration. Salmon were found associated in the same trap on Unga Island which were shown to scatter to more than 20 different streams, ranging from Cook Inlet on the south to Goodnews Bay, the Kuskokwim, and the mouth of the Yukon in the far north. The vital question which arises with regard to these is whether each of them is returning to the stream in which it had its origin—its home stream—or to what extent we may find among them strays, scattering aimlessly in search of a spawning stream. If the homing instinct prevails, we are compelled to accept at the other end of the salmon's life an extremely wide dispersal of the young to feeding grounds hundreds of miles distant from the mouths of the streams in which they were reared; and at the close of their period of growth and development, at the beginning of the season in which their eggs and milt will ripen, we must figure them leaving the feeding grounds and independently retracing the hundreds of miles which may separate each of them from its natal stream.

No landmarks have been suggested that seem in any way adequate to guide these fish in their prolonged journey through an apparently trackless sea. The

physical and chemical conditions of their immediate environment assuredly were identical for all the salmon tagged and released at a given time from a single trap. In quick succession the numbered tags are attached to the struggling fish, fresh-dipped from the trap corral. Rapidly they are restored to freedom, tossed over the trap web into the clear waters, through which their aluminum tags shine bright. For a brief while they linger outside the trap to recover from their enforced sojourn in the upper air. A dozen or more of them can usually be seen while the marking is in progress, lazily fanning their gills and recuperating their strength. But they soon disappear, and when next they come to the attention of men, bearing their tags, after the lapse of a few days or a few weeks, it is found that some have journeyed east, some north, and some west, and some have passed into Bering Sea through an obscure channel, which the navigator locates with the aid of all his instruments.

What is it that guides them in these journeys? From the same starting point, at the same moment of time, they pursue divergent paths to their destinations hundreds of miles away. How can we conceive that any elements of the common environment in which they lie immersed can so react as mechanically to lead different individuals in opposite directions? It is easy to demonstrate that they pursue their course in no haphazard fashion. Time schedules can be constructed on the basis of our recaptures, to which they conform with remarkable fidelity. We can not escape the conviction that they pass along the ocean ways with directness and speed.

That salmon possess a "homing instinct"—whatever that term may connote—that they do, in fact, wherever they may have wandered, find their way back to their native streams, has in recent years found wide acceptance. It comes as a necessary inference from facts established by a study of separate colonies of spawning fish. As each colony is stamped by certain distinctive physical characteristics, it appears impossible to account for this fact except upon the assumption that we are dealing with isolated, self-perpetuating groups with the constant habit of home-coming at maturity. This does not signify that no individuals every stray beyond the boundaries of their own groups and enter streams other than those in which they were bred. We have never succeeded in recognizing such strays even in strongly marked colonies, in which it would seem an alien should be immediately detected; but admitting the existence of strays, the inference is unavoidable that they are present in very small proportion, too small to prevent, in each colony, the formation and the maintenance of racial peculiarities.

Whatever inferences concerning migrations in the sea we have felt warranted in making heretofore, based on a study of spawning colonies, we have never until now been in a position to take up the problem from the other end and to trace the operation of the homing instinct in the case of salmon about to leave their feeding grounds in the sea and to disperse widely from a common center. While there are good *a priori* reasons for believing that this dispersal is along lines that lead to their home streams, the present tagging experiments have given us our first opportunity to verify this assumption—an opportunity too unique and too valuable to be neglected. This became apparent at the close of the 1922 experiment, when the tagged individuals, to our surprise, were reported from so very extended a geographic range. It was then too late to obtain samples of their scales, so the problem could not then be taken up, for our only available means of testing the return of salmon to the streams of their nativity is through a microscopic examination of their scales and

the discovery in them of sufficiently well-marked racial peculiarities to locate the migrants in the colony to which they belong.

It was in the hope of accomplishing this in some measure that, in the 1923 experiment, we made a prominent feature of collecting a full set of scales of all the salmon that were tagged. At the time each tag was attached a sample of the scales was removed and was immediately transferred to a specially prepared blank book, which was ruled in five spaces to the page, each space bearing a serial number identical with that of the tag. The material, then, includes the scales of some 10,000 red salmon, so arranged that there can be singled out for critical study those belonging to any individual recaptured at the stream it was preparing to enter, the racial affinities of which it was desired to ascertain. Other results, which we were justified in anticipating, include the following:

1. Some estimate of the intensity of the commercial fishing, based on the proportionate number of tagged fish that are recaptured. Such an estimate will of necessity be a minimum. The percentage of the run actually captured will be greater than our estimate, for some of the tags unquestionably become detached and are lost although the fish are recaptured, some tags are taken by fishermen, and others are not reported; but as a minimum record the figures still have value.

2. We may anticipate valuable information concerning the routes traversed, the association of races in a common wave of migration, and their segregation on approaching the streams for which they are bound. Still more interesting will be evidence that certain races take a distinct route from that followed by others that traverse the same general region. The existence of distinct ocean lanes for colonies still far from home opens wide grounds for speculation.

3. The rates of travel of salmon bound in different directions and the rates of those bound in the same direction in different portions of the run. It might be anticipated that the rate of travel would bear a definite relation to the exigencies of the case, causing laggards in leaving the feeding grounds to accelerate their pace in comparison with the migrants of the early part of the season.

## METHOD OF TAGGING

The tags used are of a common commercial type intended originally for tagging sheep and cattle. Each consists of a flat strip of aluminum about 3 inches long, on one side of which is stamped a serial number and the initials "U. S. B. F." Close to one end a hole is cut, and the other end is flattened and sharpened into a sort of prong. The tag is then bent, as illustrated by the open tag held in the tongs in Figure 2. The photograph also shows the character of the tongs by which the tags are attached. A spring within the handles of the tongs keeps them wide open except when closed by the hand of the operator. This tool is so made that the tag snaps into place and is held by the elasticity of the tag itself, which is opened slightly wider than the tongs when fully extended. As the tongs are closed, the prong or sharpened end of the tag passes through the hole on the other end and is crimped back securely against the body of the tag. This is well illustrated by the views of the closed tag (fig. 2).

The tags were attached to the upper lobe of the caudal fin of the salmon. An attempt was made, and nearly always successfully, to insert the prong through the skin which extends back over the bases of the rays of the caudal fin. This is illus-

trated in Figure 3, taken from the report by the senior author on the results of the tagging operations of 1922.<sup>2</sup> The tags were almost invariably so firmly attached that it was necessary to cut the tail in order to remove them. It seems very improbable, therefore, that any considerable number were lost from the fish while they were free. Some were torn from the fish as they were brailled from traps into scows or cannery tenders, as was evidenced by occasional tags found loose on the scows or in the holds of the tenders. A very small proportion, however, was found in this manner, and the possible loss of tags as a result must be considered as negligible. A slight wearing of the tissue of the fish is sometimes caused by the tag, but no examples have come to our attention where this appeared to be serious. It can be noticed in Figure 3.

As mentioned above, the tagging was done exclusively in traps. It was found impracticable to tag at the time the traps were lifted by the fishing crews from the canneries on account of the fact that these fishing crews were nearly always anxious to complete their work as soon as possible and return with the fish, whereas the tagging operations usually consumed several hours. In ordinary practice, therefore, we found it necessary to lift the traps ourselves, an operation which was not always easy with the limited aid at our disposal. We usually had but two assistants. In this connection we wish to acknowledge the efficient aid of W. P. Studdert, who assisted in the tagging both in 1922 and 1923. His practical knowledge of boats and fishing gear and his willing and energetic activities along many practical lines made his assistance invaluable.

A small seine skiff was made use of in manipulating the traps and in doing the actual tagging. (See fig. 4.) With the top line lowered the skiff was introduced into the spiller of the trap, which was then "lifted" in the usual manner until a sufficient number of fish were collected in the pocket formed by the outer wall of the spiller. Then the bottom line was lifted above the surface of the water and was fastened to the gunwale of the skiff. The top line was then dropped, pulled in, and fastened to the gunwale near the bow of the skiff in order to facilitate the release of the tagged fish. With this arrangement the pocket formed by the side wall of the spiller remained open toward the stern of the skiff, so that the fish were easily reached by the man assigned to dip them up. A section about 4 feet long was roughly partitioned off in the stern to prevent the fish when dipped into the skiff from getting forward where the tagging was being done.

To aid in holding the fish for tagging, a number of small boxes were made, approximately 4 by 7 by 18 inches. One end was left open and the box lashed with heavy seine twine. This lashing formed a sort of handle and also strengthened the box. The fish were placed head first in these boxes. In this position only the tail and the caudal peduncle of fish of average size extended beyond the box. The peduncle was grasped by the operator holding the fish for marking, and the box so restricted the movements of the fish that holding was a comparatively easy matter.

The tags, tongs, books in which the scale samples were preserved, and a small knife used in scraping scales from the fish were arranged conveniently on one of the thwarts near the bow of the skiff. The tags were arranged on sticks in serial order and, as mentioned above, the spaces in the scale books were serially numbered to correspond with the tags. The scale samples were taken from the caudal peduncle,

<sup>2</sup>See footnote, p. 27.

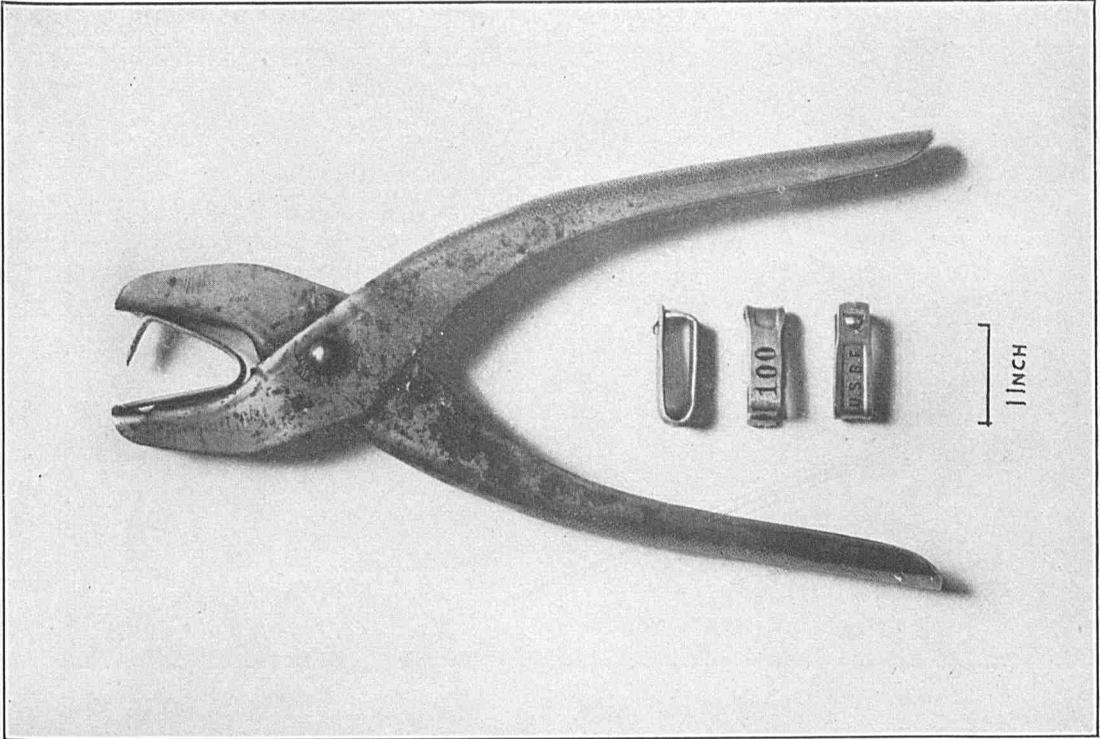


FIG. 2.—Tags and tongs

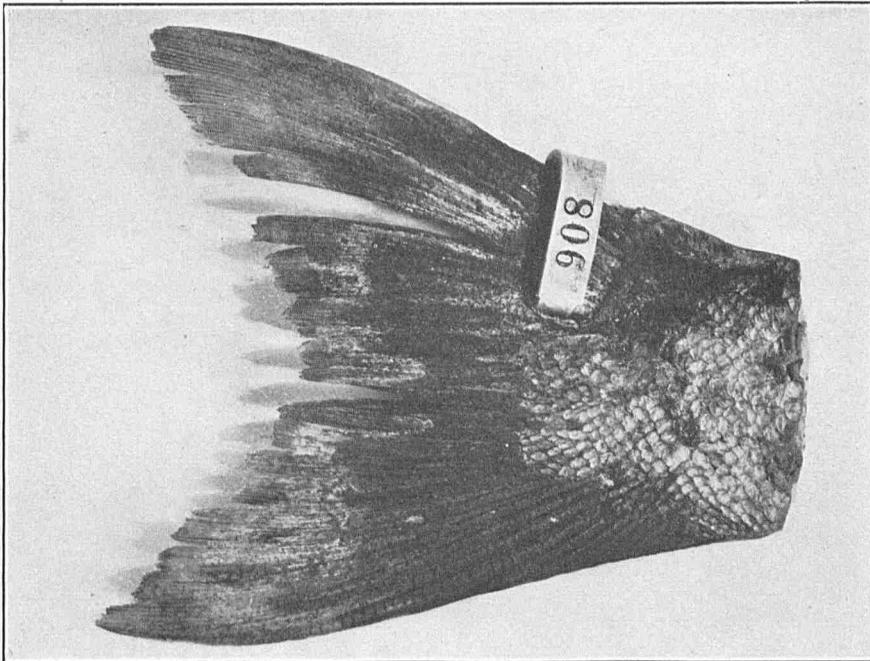


FIG. 3.—Tag No. 908, attached at East Anchor Cove, Ikatan Peninsula, June 15, 1922, and retaken July 4 at Squaw Creek, Kvichak River, Bristol Bay, distant, by direct course about 350 miles from place of marking

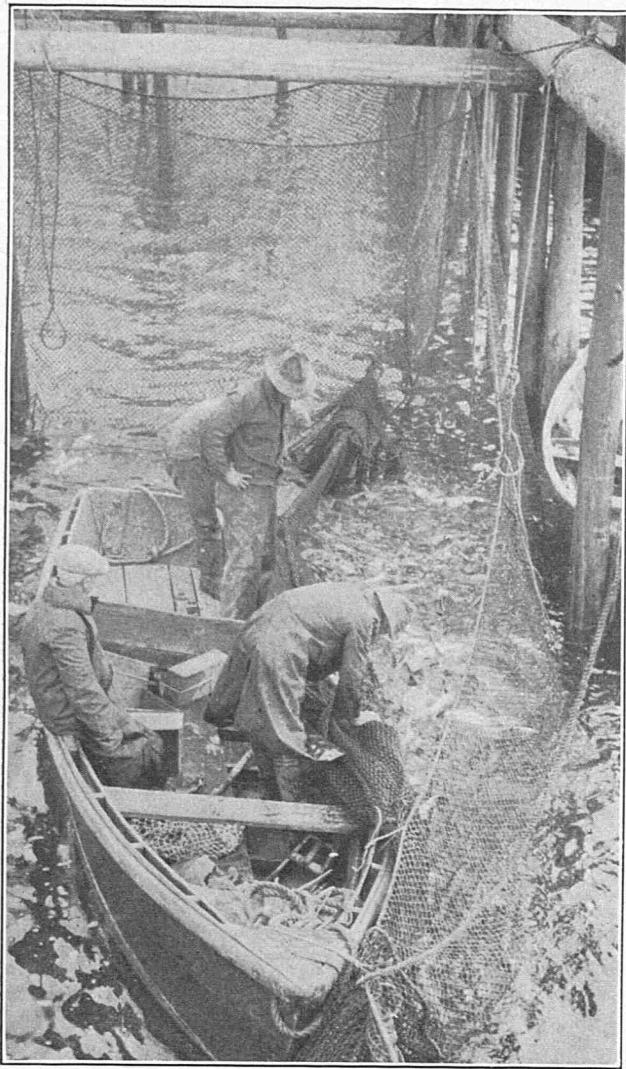


FIG. 4.—Preparing to tag. The skiff is in position, with the bottom line of the spiller over the gunwale of the boat and the top line pulled down and also fastened to the gunwale. The fish are in a pocket of the webbing by the wall of the spiller



FIG. 5.—Placing the fish in the holding boxes

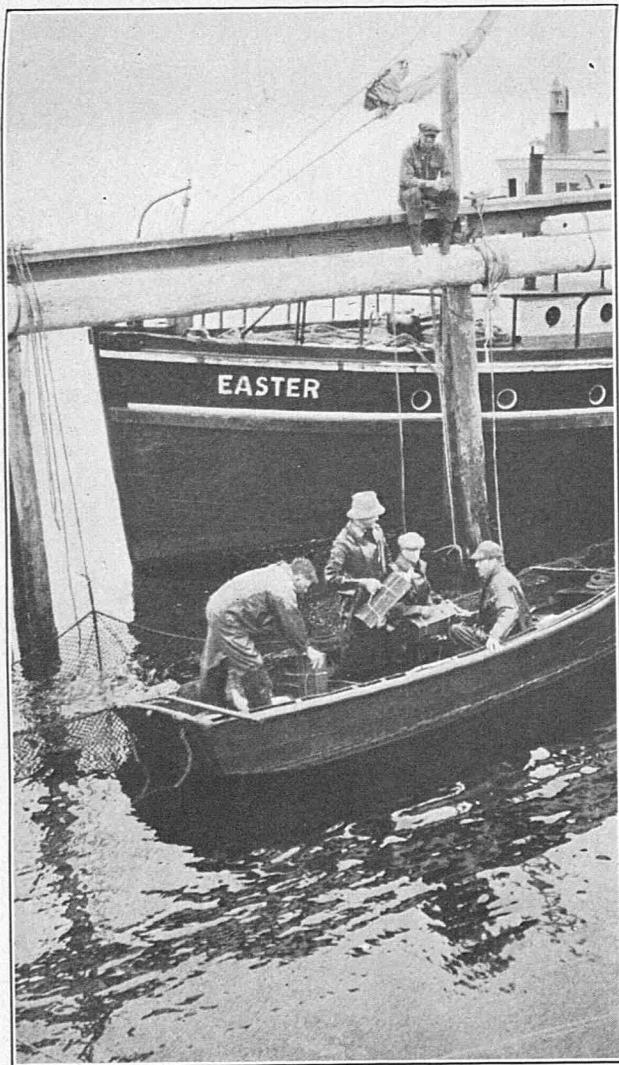


FIG. 6.—Tagging. This illustrates the usual placement of the personnel. The man in the stern of the skiff dips the fish out of the pocket of the trap and places them in the holding boxes. The man next helps to place the fish in the boxes and passes them on to the next man, who holds the fish for tagging. The man at the extreme right of the photograph attaches the tags, takes scales, and keeps the record



FIG. 7.—Another view, showing the tagging procedure. The tools, book for scale samples, and tags (arranged on a stick) are to be seen on the thwart just forward of the men who are doing the tagging



FIG. 8.—Here the tag is just being attached. Immediately after this has been done the man holding the fish turns slightly and allows the fish to slide out of the box into the water outside the webbing of the trap

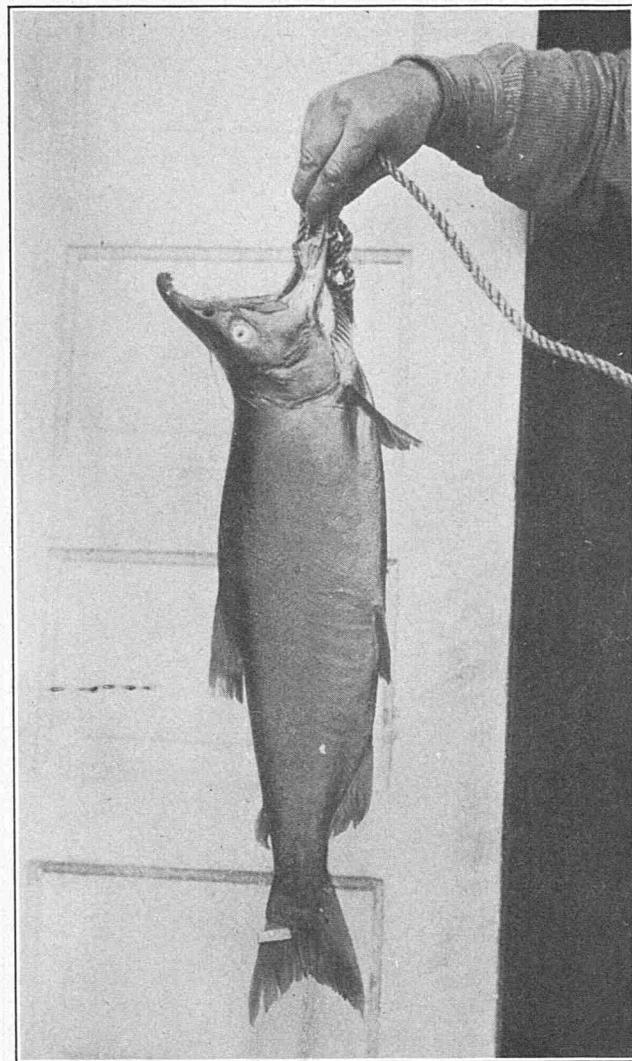


FIG. 9.—Fish bearing tag No. 4588, released from Kelly Rock trap, Unga Island, June 7, 1923, and retaken on the spawning beds in Morzhovoi Lake, August 5. The appearance of the tag when attached is well shown

usually just below the adipose fin, and were placed in the books opposite the serial number corresponding to the tag.

The procedure in tagging was as follows: An assistant, provided with a long-handled dip net, was stationed in the stern of the skiff and dipped up several fish, usually from two to five, and deposited them in the stern section mentioned above. This same assistant then placed the fish as rapidly as possible in the holding boxes, which were next taken by another assistant, who passed them forward to one of the operators seated on the outer side of the skiff, who held the fish while the second operator attached the tag and took the sample of scales. Then the first operator released the fish and returned the box to where it could be conveniently reached by the assistant who placed the fish in the boxes. By the time this was done another fish was usually ready for tagging. Figures 4 to 9 illustrate the process.

Only a few seconds were required for tagging each fish. Even when several fish were dipped up at once it was seldom that any one of them was out of water for more than a minute. With good weather and smooth water from 250 to 300 fish were tagged in an hour. When released, the fish seldom showed any distress and usually disappeared within a very short time, apparently uninjured. There may have been some slight mortality due to the handling they received, but we have no evidence that such was the case.

## RETURNS

The following list gives the numbers of the tags attached at various times and places during 1923 and also indicates the species of salmon used. Out of the 10,000 fish tagged only about 800 were other species than red salmon.

TABLE 1.—List of tags attached, 1923

Lot number	Serial number	Number of fish	Species	Locality	Date
1	4001-4122	1 120	Red	Unga Island, Kelly Rock trap	June 2, 3, and 5.
2	4123-4700	575	do	do	June 7.
3	4701-5500	799	do	Ikatan Bay, P. A. F. No. 7	June 18.
4	5501-6300	800	do	Morzhovoi Bay, P. A. F. No. 8	June 20.
5	6301-6800	499	do	Unga Island, Kelly Rock trap	June 23
6	6801-7300	490	do	do	June 26.
7	7301-7438	137	do	Unga Island, Coal Harbor trap	June 27.
8	7439-8300	1 850	do	Unga Island, Big Valley trap	Do.
9	8301-8396	592	do	Morzhovoi Bay, P. A. F. No. 8	June 30.
10	8397-9300	403	do	Morzhovoi Bay, P. A. F. No. 5	Do.
11	9301-10000	3 699	do	Ikatan Bay, P. A. F. No. 2	July 1.
12	10001-10300	300	do	Ikatan Bay, P. A. F. No. 11	July 2.
13	10301-10466	110	do	Unga Island, Coal Harbor trap	July 4.
14	10467-11500	55 633 190 199 10	Dog Red Dog Humpback Silver	Unga Island, Big Valley trap	July 6.
15	11501-11926	436	Red	Morzhovoi Bay, P. A. F. No. 3	July 8.
16	11937-12048	110	do	Morzhovoi Bay, P. A. F. No. 5	Do.
17	12047-12178	131	do	Ikatan Bay, P. A. F. No. 13	July 10.
18	12179-12510	1 326	King Red	Ikatan Bay, P. E. H. No. 5	Do.
19	12511-13000	1 447	King Red	Ikatan Bay, P. A. F. No. 2	July 11.
20	13001-13453	39 6 279	Dog Silver Red	Morzhovoi Bay, P. A. F. No. 5	July 13.
21	13454-13800	171 3	Dog Silver	do	July 18.
22	13801-14000	2 170 172 3 198 2	Red Dog Silver Red Dog	Morzhovoi Bay, P. A. F. Nos. 3, 8, and 2	July 20.

<sup>1</sup> This and other similar discrepancies are due to the loss or breaking of some of the tags.

<sup>2</sup> One previously tagged was taken and released and is included here.

<sup>3</sup> Three previously tagged were taken and released and are included here.

In Tables 2 to 29 are given in detail the results obtained from each tagging experiment listed above. The actual date of recapture (or, more properly, the date on which the recapture was reported) is given for each locality, and at the bottom of each column is given the total number reported from each locality, the percentage of the total number tagged taken in that locality, and the average time that elapsed between the time of tagging and the reported recapture. Careful consideration has been given to the relative advantages of calculating the percentage returned from each locality on the basis of the number tagged in each experiment and on the basis of the total number returned from each experiment. If these percentages are based on the number returned, it is implied that the fish tagged and, in fact, all the fish found with them at the time of tagging were distributed only to the localities from which tags were reported and in the percentages given. This does not give consideration to the possibility that fish may have gone to localities where no fishing is conducted and from which no returns could be expected. Furthermore, the percentage of fish taken in a given locality may be profoundly affected by extreme variations in the percentage taken in another locality if these percentages are based on the number of fish returned. By basing these calculations on the number tagged these difficulties will be avoided and the results of the separate experiments are strictly comparable. Accordingly, this has been done.

In determining the average time en route the median has been selected as the measure of central tendency best describing the average time required by the fish in passing from point to point. The median seems best for the purpose, since it gives less weight to extreme measures than does the mean, yet is not subject to the instability of either the empirical or the theoretical modes. The median seems especially appropriate for use in handling such data as we have to work with in this paper, in which a few of the frequency distributions are extremely skewed (those provided by the returns from points close to the place where the tags were attached), while others are approximately normal. The returns from some localities are numerous and from others we have only a few.

The interpretation of the median as used for this purpose is very simple. It may be given thus: At the expiration of the median time as given in the tables one-half of the total number of returns reported from that particular point had been taken.

TABLE 2.—Returns from 120 red salmon tagged June 2, 3, and 5, 1923, at Kelly Rock trap, Unga Island. Recaptures, 13 (10.8 per cent)

Date	Locality of recapture				
	Unga Island	Ikatan-False Pass	Egegik	Naknek	Kvichak
June 8.....	1	1	-----	-----	-----
June 11*.....	-----	2	-----	-----	-----
June 14*.....	-----	1	-----	-----	-----
June 16*.....	-----	1	-----	-----	-----
June 17.....	-----	1	-----	-----	-----
June 22*.....	-----	-----	1	-----	-----
June 25*.....	-----	-----	-----	-----	3
June 29*.....	-----	-----	1	-----	-----
July 25*.....	-----	-----	-----	1	-----
Total.....	1	6	2	1	3
Percentage returned.....	0.8	5.0	1.7	0.8	2.5
Median time in days.....	3	8.5	21.5	52	23

NOTE.—In this and subsequent tables the asterisk is employed to indicate a break in the continuity of the table. It indicates that one or more dates have been omitted from the table just preceding the date thus marked. No returns were recorded on these omitted dates.

TABLE 3.—Returns from 575 red salmon tagged June 7, 1923, at Kelly Rock trap, Unga Island. Recaptures, 105 (18.3 per cent)

Date	Locality of recapture												
	Unga Island	Morzhovoi Bay	Morzhovoi Lake	Ikatan-False Pass	Nelson's Lagoon	Bear and Sandy Rivers	Egegik	Naknek	Kvichak	Nushagak Egu-shik	Kuskokwim River	Chignik	Afognak
June 8	1												
June 11*				21									
June 12				12									
June 14*		13		5									
June 15		6		2									
June 16		3		4									
June 17				1									
June 18		2		1									
June 19		2											
June 22*											1	1	
June 26*								2	1				
June 27									1				
June 28									3				
June 29					1		2		1	1			
June 30		1							1	2			
July 1													1
July 2				1									
July 4*								1					
July 5								3	1				
July 6													
July 8*					1								
July 9						1							
July 18*									1				
July 22*										1			
July 25*								1					
August 5*			1										
August 8*	1												
No date									1				
Total	2	27	1	47	2	1	2	7	9	4	1	1	1
Percentage returned	0.3	4.7	0.2	8.2	0.3	0.2	0.3	1.2	1.6	0.7	0.2	0.2	0.2
Median time in days	(1)	7.58	59	4.7	26.5	32	22	28.8	<sup>2</sup> 21.1	23	15	15	24

\* Indicates a break in the continuity of the table.

<sup>1</sup> The two returns are at such extremes that an average has no significance.<sup>2</sup> Calculated from the 8 for which dates are given.

TABLE 4.—Returns from 799 red salmon tagged June 18, 1923, at Ikatan Bay, Pacific American Fisheries trap No. 7. Recaptures, 217 (27 per cent)

Date	Locality of recapture										
	Ikatan-False Pass	Morzhovoi Bay	Swanson's Lagoon	Bear and Sandy Rivers	Ugashik	Egegik	Little Becharoff Lake	Naknek	Kvichak	Nushagak	Kuskokwim River (Bethel)
June 18	6										
June 19	45										
June 20	22	11									
June 21	9	17									
June 22	15										
June 23	11										
June 24	17										
June 25	1	4									
June 26	4										
June 27	2	1									
June 28	1										
June 29	1	1		1							
June 30				1							
July 2*	2		1			1					
July 3		1		2							
July 4	2			1				1	1		
July 5				3							
July 6									1		
July 7						1		2	1		
July 8										1	

\* Indicates a break in the continuity of the table.

TABLE 4.—Returns from 799 red salmon tagged June 18, 1923, at Ikaton Bay, Pacific American Fisheries trap No. 7. Recaptures, 217 (27 per cent).—Continued

Date	Locality of recapture										
	Ikatan-False Pass	Morzhoval Bay	Swan-son's Lagoon	Bear and Sandy Rivers	Uga-shik	Egegik	Little Becharoff Lake	Nak-nek	Kvi-chak	Nusha-gak	Kusko-kwim River (Bethel)
July 9.....						1		1	1	2	
July 11 *.....				1				1			
July 12.....								2	4		
July 13.....								2		1	
July 14.....											
July 15.....									2		
July 16.....								1	1		
July 17.....											
July 20 *.....								1	1		
July 23 *.....								1			
July 24.....								1			
Aug. 11 *.....							1				1
No date.....									1		1
Total.....	138	35	1	9	1	2	1	12	13	4	1
Percentage returned.....	17.3	4.4	0.1	1.1	0.1	0.2	0.1	1.5	1.6	0.5	0.1
Median time in days.....	2.32	2.88	14	16	14	20	54	25	24	21	?

\* Indicates a break in the continuity of the table.  
 † Recorded as taken June 22. As this is most improbable, the record has been placed with those for which no date was given.  
 ‡ Calculated from the 12 for which dates were available.

TABLE 5.—Returns from 800 red salmon tagged June 20, 1923, at Morzhovoi Bay, Pacific American Fisheries trap No. 8. Recaptures, 187 (23.4 per cent)

Date	Locality of recapture												
	Morzhoval Bay	Ikatan-False Pass	Nel-son's Lagoon	Bear and Sandy Rivers	Bear Lake	Uga-shik	Egegik	Little Becharoff Lake	Nak-nek	Kvi-chak	Nusha-gak	Cold Bay	No locality
June 21.....	2	1											
June 22.....		5											
June 23.....		5											
June 24.....		34											
June 25.....	11	4											
June 26.....		15											
June 27.....	9	8											
June 28.....		4											
June 29.....	2	4											
June 30.....		1											
July 2*.....		1											
July 3.....		3	1										
July 4.....		2		1									
July 5.....									1	1			
July 6.....											2		
July 7.....	1			1		1			1	1			
July 8.....	1		1	1			1		2	3			
July 9.....		1	1	2					1	1			
July 10.....							2			1		1	
July 12*.....							1			3			
July 13.....		1					1			1			
July 14.....							1		1	1			
July 15.....							1		1	1			
July 16.....			1				1		1	1			
July 17.....								4					
July 18.....									2	1			
July 20*.....		1							1	1			
July 21.....									1				
July 23*.....									2				
July 24.....										1			
July 25.....									6	3			
July 26.....										1			
Aug. 22*.....								1					
No date.....						1							1
Total.....	26	91	3	5	1	1	8	1	26	21	2	1	1
Percentage returned.....	3.2	11.4	0.4	0.6	0.1	0.1	1.0	0.1	3.2	2.6	0.2	0.1	0.1
Median time in days.....	6	4.62	18	18		17	21	63	27.25	23	10	20	

\* Indicates a break in the continuity of the table.

TABLE 6.—Returns from 499 red salmon tagged June 23, 1923, at Kelly Rock trap, Unga Island. Recaptures, 213 (42.6 per cent)

Date	Locality of recapture											
	Unga Island	Pavlof and Volcano Bays	Morzhovoi Bay	Ikatan-False Pass	Nelson's Lagoon	Uga-shik	Egegik	Nak-nek	Kvi-chak	Iliama Lake	Nushagak	Chignik
June 26.....	6											
June 27.....	4		13	6								
June 28.....	1		15	20								
June 29.....	2		23	27								
June 30.....			11	3								
July 1.....	1			7								
July 2.....				7								
July 3.....	1		3	7								
July 4.....		1		2								
July 6*.....				1								
July 8*.....				1							1	
July 10*.....					1		1		1			
July 11.....									1		3	
July 12.....								6	2			
July 13.....	1											
July 14.....							1	2	1		2	
July 15.....								1				
July 16.....								4	1		1	
July 17.....												1
July 18.....												
July 19.....											1	
July 20.....									1	1		
July 21.....									1			
July 22.....	1						1					
July 25*.....	1							1	2			
July 26.....	1											
July 31*.....								1	1	1	1	
No date.....												
Total.....	21	1	65	81	1	1	4	14	12	2	10	1
Percentage returned.....	4.2	0.2	13	16.2	0.2	0.2	0.8	2.8	2.4	0.4	2	0.2
Median time, in days.....	5	11	5.67	6.06	18	21	21	21	21	27	20.75	25

\* Indicates a break in the continuity of the table.  
 † Reported as taken in July.

‡ From the one complete record.  
 § Taken 100 miles up the river.

TABLE 7.—Returns from 499 red salmon tagged June 26, 1923, at Kelly Rock trap, Unga Island. Recaptures, 110 (22 per cent)<sup>1</sup>

Date	Locality of recapture												
	Unga Island	Pavlof and Volcano Bays	Thin Point	Morzhovoi Bay	Ikatan-False Pass	Nelson's Lagoon	Bear and Sandy Rivers	Uga-shik	Egegik	Nak-nek	Kvi-chak	Nushagak Egu-shik	Chignik
June 29.....	1			1	4								
June 30.....				1	1								
July 1.....				1	1								
July 2.....				2	11								
July 3.....					8								
July 4.....					3								
July 5.....					1								
July 6.....					2								
July 7.....					1								
July 8.....					1						1		
July 9.....							1						
July 10.....							1						
July 11.....						1	2						
July 12.....					1		1		1			1	
July 13.....											1	1	

<sup>1</sup> In addition to those tabulated, one tag was taken in Good News Bay in August and another on July 10 in the Togliak River.

TABLE 7.—Returns from 499 red salmon tagged June 26, 1923, at Kelly Rock trap, Unga Island. Recaptures, 110 (22 per cent)—Continued

Date	Locality of recapture												
	Unga Island	Pavlof and Volcano Bays	Thin Point	Morzhovoi Bay	Ikatan-False Pass	Nelson's Lagoon	Bear and Sandy Rivers	Uga-shik	Egegik	Nak-nek	Kvi-chak	Nushagak Egu-shik	Chig-nik
July 14						1				1	1	1	
July 15		1								2	4	3	
July 16										7	2	1	
July 17										3	2	2	
July 18										1	2	3	
July 19											2		
July 20										1	3		
July 21											1	1	
July 22												2	
July 23										2	1		
July 24								1				1	
July 25										1			
July 29*				1							1		
Aug. 10*													1
No date											2		
Total	1	1	2	3	34	2	5	1	1	18	23	16	1
Percentage returned	0.2	0.2	0.4	0.6	6.8	0.4	1	0.2	0.2	3.6	4.6	3.2	0.2
Median time, in days	3	19	7	4	6.5	16.5	14.75	28	16	20.36	21.25	21	45

\* Indicates a break in the continuity of the table.

‡ Calculated from the 21 complete records.

TABLE 8.—Returns from 137 red salmon tagged June 27, 1923, Unga Island, Coal Harbor trap. Recaptures, 53 (38.7 per cent)

Date	Locality of recapture												
	Unga Island	Thin Point	Morzhovoi Bay	Ikatan-False Pass	Bear and Sandy Rivers	Uga-shik	Nak-nek	Kvi-chak	Nushagak	Good News Bay	Orzinski	Cook Inlet Kamishak	
July 1	1							1				1	
July 2	1			5									
July 3	1			8									
July 4		1		6									
July 5				1									
July 6	1			1									
July 7			1	1									
July 8													
July 9	2									1			
July 10													
July 11	1				1								
July 13*				1								1	
July 14									1				
July 15							1	2	1				
July 17*								1					
July 18	1							1					
July 21*				1									
July 22									2				
July 23							1						
July 24							1						
July 25								1					
Total	7	1	2	24	1	1	3	6	4	1	1	1	
Percentage returned	5.1	0.7	1.5	17.5	0.7	0.7	2.2	4.4	2.9	0.7	0.7	0.7	
Median time, in days	11.75	7	10.5	6.37	14	20	26	20	21.5	13	4	16	

\* Indicates a break in the continuity of the table.

† Doubtless an error. Not included in calculating the median time.

‡ In addition one tag was taken in Lake Clark during July.

TABLE 9.—Returns from 859 red salmon tagged June 27, 1923, at Big Valley trap, Unga Island. Recaptures, 277 (32.2 per cent)

Date	Locality of recapture													
	Unga Island	Pavlof and Volcano Bays	Thin Point	Morzhovoi Bay	Ikatan-False Pass	Nelson's Lagoon	Bear and Sandy Rivers	Egegik	Naknek	Kvichak	Nushagak	Chignik	Karluk	Cook Inlet
June 27	2													
July 2*	1				20									
July 3	2		2	1	23									
July 4					40									
July 5			1		7									
July 6			1		32									
July 7					5									
July 8		1			8					1				
July 9	1				3		2							
July 11*					2		2							
July 12							2			1				
July 13										1				
July 14	2				3	2				2				1
July 15		1			1			2	1	6			1	
July 16							1		16	4	1			
July 17							2	4	12	2	1	1		
July 18									3	3	1			
July 19									1		3			
July 20									1	1		1		
July 21								2	1	2	1			
July 22									1					
July 24*										1				
July 25									3	2				
Aug. 14												1		
No date										4				
Total	8	2	4	12	144	2	9	8	46	29	8	3	1	1
Percentage returned	0.9	0.2	0.5	1.4	16.8	0.2	1.0	0.9	5.4	3.4	0.9	0.3	0.1	0.1
Median time in days	5.75	14.5	7	10.12	7.22	16	14.75	20	19	19.12	21.5	23	18	17

\*Indicates a break in the continuity of the table.

TABLE 10.—Returns from 592 red salmon tagged June 30, 1923, at Morzhovoi Bay, Pacific American Fisheries trap No. 8. Recaptures, 250 (42.2 per cent)

Date	Locality of recapture										
	Morzhovoi Bay	Ikatan-False Pass	Bear and Sandy Rivers	Bear Lake	Ugashik	Egegik	Naknek	Kvichak	Nushagak	Thin Point	Cold Bay
July 2		92									
July 3	5	43									1
July 4		27									
July 5		1									
July 6		13								1	
July 7	1	6									
July 8		3									
July 9		1								1	
July 12*			1					1			
July 15*		2					1	2			
July 16	1		3				10	3			
July 17							8				
July 18							1	2	1		
July 19							1	1			
July 20						1					
July 21						1		1			
July 22							1		2		
July 25*							2	1			
July 30*						1					
July 31				1	1						
No date				1			4	1			
Total	7	188	4	1	1	3	28	12	3	2	1
Percentage returned	1.2	31.8	0.7	0.2	0.2	0.5	4.7	2.0	0.5	0.3	0.2
Median time in days	3.2	2.54	15.8		31	21	16.62	16.17	21.75	7.5	3

\* Indicates a break in the continuity of the table.

TABLE 11.—Returns from 403 red salmon tagged June 30, 1923, at Morzhovoi Bay, Pacific American Fisheries trap No. 5. Recaptures, 228 (56.5 per cent)

Date	Locality of recapture										
	Morzhovoi Bay	Ikatan-Falso Pass	Nelson's Lagoon	Bear and Sandy Rivers	Egegik	Naknek	Kvichak	Nushagak	Thin Point	Cold Bay	Pavlof Bay
July 2.....		100									
July 3.....	7	42							5	1	
July 4.....		23					1		3		
July 5.....		1									
July 6.....		7							1		
July 7.....		2									
July 8.....		3		1							
July 9.....		1		1					2		
July 10.....										1	
July 11.....			1							4	
July 12.....				1							
July 13.....									1		
July 15*.....						1	2				
July 16.....				1		4	1				
July 17.....						1	1				
July 18.....					1			1			
July 19.....										1	1
July 21*.....						1					
July 24*.....						1					
Aug. 7*.....										1	
No date.....							1				
Total.....	7	179	1	4	1	8	6	1	12	8	1
Percentage returned.....	1.7	44.4	0.2	1.0	0.2	2.0	1.5	0.2	3.0	2.0	0.2
Median time in days.....	3	2.39	11	10.5	18	16.25	15.5	18	3.83	11	19

\* Indicates a break in the continuity of the table. † Doubtless an error. Not included in calculating the median time.

TABLE 12.—Returns from 699 red salmon tagged July 1, 1923, at Ikatan Bay, Pacific American Fisheries trap No. 2. Recaptures, 308 (44 per cent)

Date	Locality of recapture									
	Ikatan-Falso Pass	Morzhovoi Bay	Nelson's Lagoon	Bear and Sandy Rivers	Egegik	Naknek	Kvichak	Nushagak	Thin Point	Belkofski Village
July 2.....	99									
July 3.....	57	10								
July 4.....	38									
July 5.....	4									
July 6.....	14									
July 7.....	11	7							1	
July 8.....	4	5	1							
July 9.....	3								1	
July 13*.....	2	1	1							
July 14.....				1						
July 15.....						3	2	2		
July 16.....			1	1		2	1	2		
July 17.....					1		1	1		
July 18.....							1	1		
July 19.....						6	2	1		
July 20.....						3	3	1		
July 21.....						2				
July 22.....				1				4		
July 23.....						1				
July 24.....	1									1
No date.....					1		2			
Total.....	233	23	3	3	2	17	12	12	2	1
Percentage returned.....	33.4	3.3	0.4	0.4	0.3	2.4	1.7	1.7	0.3	0.1
Median time in days.....	1.8	5.7	12	12	16	18.08	17.5	17.5	7	23

\* Indicates a break in the continuity of the table.

† Calculated from those with definite data only.

TABLE 13.—Returns from 300 red salmon tagged July 2, 1923, at Ikaton Bay, Pacific American Fisheries trap No. 11. Recaptures, 220 (73.3 per cent)

Date	Locality of recapture					
	Ikatan-False Pass	Morzhoval Bay	Bear and Sandy Rivers	Egegik	Naknek	Kvichak
July 2.....	36					
July 3.....	98					
July 4.....	41					
July 5.....	5					
July 6.....	20					
July 7.....	4	2				
July 8.....	2	1				
July 9.....	4					
July 11*.....			1			
July 12.....	1					
July 14*.....						1
July 16*.....					2	
July 18*.....		1		1		
July 20*.....					1	1
Total.....	209	4	1	1	3	2
Percentage returned.....	69.6	1.3	0.3	0.3	1.0	0.7
Median time in days.....	1.21	5.5	9	16	14.25	15

\*Indicates a break in the continuity of the table.

TABLE 14.—Returns from 110 red salmon tagged July 4, 1923, Unga Island, Coal Harbor trap. Recaptures, 43 (39.1 per cent)

Date	Locality of recapture								
	Unga Island	Thin Point	Morzhoval Bay	Ikatan-False Pass	Nelson's lagoon	Bear and Sandy Rivers	Naknek	Kvichak	Nushagak
July 7.....	1		1						
July 8.....	8								
July 9.....				1					
July 10.....				1					
July 12*.....				1					
July 13.....	1			3					
July 14.....	2							1	
July 15.....				1					
July 16.....					1				
July 17.....		1							
July 18.....	1							2	
July 20*.....								2	1
July 21.....						1	4		
July 22.....							1		
July 23.....							1		
July 24.....								3	
July 25.....							1	1	
July 29*.....	1								
No date.....							1		
Total.....	14	1	1	7	1	1	8	9	1
Percentage returned.....	12.7	0.9	0.9	6.4	0.9	0.9	7.3	8.2	0.9
Median time in days.....	4.25	13	3	8.66	12	17	17.37	16.25	16

\* Indicates a break in the continuity of the table.

† Omitting one with incomplete data.

TABLE 15.—Returns from 55 dog salmon tagged July 4, 1923, Unga Island, Coal Harbor trap. Recaptures, 19 (34.6 per cent)

Date	Locality of recapture								
	Unga Island	Pavlof and Volcano Bays	Morzho-voi Bay	Ikatan-False Pass	Naknek	Kvichak	Nushagak	Togiak River	Pankara River, Karagin, Kamchatka
July 7	1								
July 8		1							
July 9	1								
July 15*		2							
July 16				1					
July 18*		2							
July 19		1					1		
July 20						1	1		
July 21					1				
July 22							1		
July 27*		1	1						
July 30*							1		
Aug. 18*									1
Aug. 20*								1	
Total	2	7	1	1	1	1	4	1	1
Percentage returned	3.6	12.7	1.8	1.8	1.8	1.8	7.3	1.8	1.8
Median time in days	4	13.75	23	12	17	16	17	47	45

\* Indicates a break in the continuity of the table.

TABLE 16.—Returns from 633 red salmon tagged July 6, 1923, Unga Island, Big Valley trap. Recaptures, 172 (27.2 per cent)

Date	Locality of recapture																
	Unga Island	Pavlof and Volcano Bays	Cold Bay	Thin Point	Morzho-voi Bay	Ikatan-False Pass	Bea and Sandy Rivers	Ugashik	Egegik	Naknek	Kvichak	Nushagak	Togiak River	Orizanski	Chignik	Altak	Cook Inlet
July 7	7																
July 8	4																
July 9	3					2											
July 10	4					3											
July 11	5	1		3		4											
July 12	1																
July 13	3			1		16											
July 14	2	1		1		1					2						
July 15	2	2				2											
July 16					9	3					1						1
July 17				1		3				1					3		
July 18	1	1			1	3	1				1				1		
July 19				1				2		1							
July 20	3					2	2		2		1	5					
July 21									1	7	5	5	2				
July 22	1							1	1	4	1				1		
July 23										1	3	1					
July 24										1	1						
July 25	1							2		8	1				1		
July 26											1						
Aug. 1*	1																1
Aug. 3*																	1
Aug. 20*													1				
No date										1	3						
Total	36	3	2	7	10	39	3	5	4	24	25	4	1	1	5	2	1
Percentage returned	5.7	0.5	0.3	1.1	1.6	6.2	0.5	0.8	0.6	3.8	4.0	0.6	0.2	0.2	0.8	0.3	0.2
Median time in days	4.5	9.26	6.5	7.0	10.05	7.15	14.25	16.0	14.0	16.12	14.9	16.0	45	16.0	11.33	17.5	28.0

\* Indicates a break in the continuity of the table. † Specimens with incomplete data omitted in making these calculations.

TABLE 17.—Returns from 190 dog salmon tagged July 6, 1923, Unga Island, Big Valley trap. Recaptures, 45 (23.7 per cent)

Date	Locality of recapture						
	Unga Island	Pavlof and Volcano Bays	Thin Point	Morzhovoi Bay	Ikatan-False Pass	Nushagak	Yukon
July 7.....	1						
July 8.....	2						
July 9.....	2						
July 10.....	2						
July 12*.....		2					
July 13.....					2		
July 15*.....		3					
July 16.....				1			
July 18*.....		12					
July 19.....		2					
July 21*.....		2					
July 23*.....		1	1	2			
July 25*.....		1					
July 27*.....		3					
July 29*.....				1			
July 31*.....		1					
Aug. 1.....			1				
Aug. 3*.....			1				
Aug. 8*.....						1	
No date.....							1
Total.....	7	27	3	4	2	1	1
Percentage returned.....	3.7	14.2	1.6	2.1	1.1	0.5	0.5
Median time in days.....	8.75	12.20	26.0	17.0	7.0	33.0	(?)

\* Indicates a break in the continuity of the table.

TABLE 18.—Returns from 199 humpback salmon tagged July 6, 1923, Unga Island, Big Valley trap. Recaptures, 26 (13 per cent)

Date	Locality of recapture					
	Unga Island	Pavlof and Volcano Bays	Belkofski Bay	Thin Point	Morzhovoi Bay	Ikatan-False Pass
July 7.....	9					
July 8.....	7					
July 9.....	1					
July 10.....						1
July 11.....				1		
July 13*.....						1
July 15*.....		2				
July 17*.....			1			
July 18.....					1	
July 23*.....					1	
July 31*.....				1		
Total.....	17	2	1	2	2	2
Percentage returned.....	8.5	1.0	0.5	1.0	1.0	1.0
Median time in days.....	1.44	9	11	15	14.5	8.5

\* Indicates a break in the continuity of the table.

TABLE 19.—Returns from 436 red salmon tagged July 8, 1923, Morzhovoi Bay, Pacific American Fisheries trap No. 3. Recaptures, 110 (25.2 per cent)<sup>1</sup>

Date	Locality of recapture									
	Morzhovoi Bay	Morzhovoi Lake	Ikatan-False Pass	Uga-shik	Egegik	Naknek	Kvichak	Thin Point	Cold Bay	Pavlof and Volcano Bays
July 8						1				
July 9			6							
July 10			6					1		
July 11			5							
July 12			1							
July 13			3					1		
July 14									1	
July 15			1		1	1				
July 16	3		4			1				
July 17			3							
July 18	5									
July 19						1		1		
July 20			2		2		1			
July 21				1	3	2	3		1	1
July 22			1	1	2	2	2			
July 23					1	6	1		2	
July 24							2			
July 25						7	1			
July 26			1							
July 30 *							1			
July 31			1							
Aug. 8 *	1									
Aug. 11 *										1
No date		12					2			
Total	9	12	34	2	9	21	13	3	4	2
Percentage returned	2.1	2.7	7.8	0.5	2.1	4.8	3.0	0.7	0.9	0.5
Median time in days	9.8		3.5	13.5	13	15	14.25	5	14	23.5

\* Indicates a break in the continuity of the table.

<sup>1</sup> In addition to those tabulated one tag was reported taken in Bear Lake.<sup>2</sup> Obviously an error, not included in calculating time en route.<sup>3</sup> Returns for which no date is given were not included.

TABLE 20.—Returns from 110 red salmon tagged July 8, 1923, at Morzhovoi Bay, Pacific American Fisheries trap No. 5. Recaptures, 52 (47.3 per cent)

Date	Locality of recapture								
	Morzhovoi Bay	Ikatan-False Pass	Bear and Sandy Rivers	Naknek	Kvichak	Nushagak	Thin Point	Cold Bay	Pavlof Bay
July 9		1					3		
July 10		2					7		
July 11		1					5	6	
July 13 *		1					4		
July 14							1	1	
July 16 *	1								
July 17							1	1	
July 18	3								1
July 19									1
July 21 *				1	1		2	1	
July 22			1	1	1	1			
July 23				1				1	
July 24							1		
Total	4	5	1	3	2	1	24	10	2
Percentage returned	3.6	4.5	0.9	2.7	1.8	0.9	21.8	9.1	1.8
Median time in days	9.8	2.25	14	14	13.5	14	2.9	3.33	10.5

\* Indicates a break in the continuity of the table.

TABLE 21.—Returns from 131 red salmon tagged July 10, 1923, Ikaton Bay, Pacific American Fisheries trap No. 13. Recaptures, 51 (39 per cent)

Date	Locality of recapture						
	Ikatan-False Pass	Morzho-voi Bay	Morzho-voi Lake	Naknek	Kvichak	Nushagak	Thin Point
July 10.....	6						
July 11.....	10						
July 12.....	1						
July 13.....	11						
July 15 *.....	3				1		
July 16.....	2	2					
July 17.....							1
July 18.....	1	1					
July 20 *.....							1
July 21.....						1	
July 22.....					1		
July 23.....				2			
July 24.....					1		
July 26 *.....	1			1			
No date.....			4	1			
Total.....	35	3	4	3	3	1	2
Percentage returned.....	26.7	2.3	3.0	2.3	2.3	0.8	1.5
Median time in days.....	2.54	6.25	(over 50)	1.13	12	11	8.5

\* Indicates a break in the continuity of the table. † Omitting one without date of capture.

TABLE 22.—Returns from 326 red salmon tagged July 10, 1923, Ikaton Bay, P. E. Harris trap No. 5. Recaptures, 110 (33.7 per cent)

Date	Locality of recapture								
	Ikatan-False Pass	Morzho-voi Bay	Morzho-voi Lake	Bear and Sandy Rivers	Egegik	Naknek	Kvichak	Nushagak	Belkofski vil-lage
July 11.....	3								
July 12.....	3								
July 13.....	30								
July 14.....						1			
July 15.....	4								
July 16.....		4				1			
July 17.....						1			
July 18.....				1			2		
July 19.....				3					
July 20.....				1	1		5		
July 21.....					3	5	4	1	
July 22.....				1		5	3		
July 23.....						6	1		
July 24.....						4	4	1	
July 25.....						5	4		
July 30 *.....					1				
Aug. 4 *.....									1
No date.....			1						
Total.....	40	4	1	6	5	23	23	2	1
Percentage returned.....	12.3	1.2	0.3	1.8	1.5	8.6	7.1	0.6	0.3
Median time in days.....	2.96	6	(over 50)	9.16	11.0	12.66	11.66	12.5	25

\* Indicates a break in the continuity of the table.

TABLE 23.—Returns from 447 red salmon tagged July 11, 1923, Ikatán Bay, Pacific American Fisheries trap No. 2. Recaptures, 299 (66.9 per cent)

Date	Locality of recapture									
	Ikatan-False Pass	Morzho-voi Bay	Morzho-voi Lake	Bear and Sandy Rivers	Ugashik	Egegik	Naknek	Kvichak	Nushagak	Cold Bay
July 11	12									
July 12	24									
July 13	197	1								
July 15*	11							1		
July 16	14	6								
July 17	2						2			
July 18	2	1					1			
July 19	1									
July 20	1			1						
July 21	1						2	1		1
July 22					1		2	1		
July 23	1						1		1	
July 24							2	2	1	
July 25						1	2			
No date			2				1			
Total	265	8	2	1	1	1	13	5	2	1
Percentage returned	69.3	1.8	0.4	0.2	0.2	0.2	2.9	1.1	0.4	0.2
Median time in days	1.99	5		9	11		11.0	11.0	12.5	10.0

\* Indicates a break in the continuity of the table.

† Omitting one without date of capture.

TABLE 24.—Returns from 36 dog salmon tagged July 11, 1923, Ikatán Bay, Pacific American Fisheries trap No. 2. Recaptures, 18 (50 per cent)

Date	Locality of recapture			Date	Locality of recapture		
	Ikatan-False Pass	Morzho-voi Bay	Volcano Bay		Ikatan-False Pass	Morzho-voi Bay	Volcano Bay
July 11	1			July 23*			1
July 13*	9			July 25*		1	
July 16*	1	1					
July 17	1						
July 18	1			Total	14	2	2
July 19			1	Percentage returned	38.9	5.5	5.5
July 20	1			Median time in days	2.16	9.5	10.0

\* Indicates a break in the continuity of the table.

TABLE 25.—Returns from 279 red salmon tagged July 13, 1923, Morzhovoi Bay, Pacific American Fisheries trap No. 5. Recaptures, 135 (48.4 per cent)

Date	Locality of recapture							
	Morzho- voi Bay	Morzho- voi Lake	Ikatan- False Pass	Little Becharoff Lake	Nusha- gak	Thin Point	Cold Bay	Pavlof Bay
July 13.....			1					
July 14.....			5					
July 15.....			4					
July 16.....	25		4					
July 17.....			1			9	3	
July 18.....	9		3			4		1
July 19.....			2			5	5	6
July 20.....			1			2		
July 21.....						1	4	
July 22.....			1					
July 23.....	3					1	4	
July 24.....			1			5		
July 25.....	8				1	1	1	
July 27 *.....								1
Aug. 1 *.....						1		
Aug. 4 *.....				1				
Aug. 6 *.....	1							
Aug. 18 *.....							1	
No date.....		9						
Total.....	46	9	23	1	1	29	18	8
Percentage returned.....	16.5	3.2	8.2	0.4	0.4	10.4	6.5	2.9
Median time in days.....	3.42		2.87	22	12	5.83	7.75	6.0

\* Indicates a break in the continuity of the table.

TABLE 26.—Returns from 171 dog salmon tagged July 13, 1923, Morzhovoi Bay, Pacific American Fisheries trap No. 5. Recaptures, 62 (36.2 per cent)

Date	Locality of recapture				
	Morzho- voi Bay	Ikatan- False Pass	Thin Point	Belkofski Bay	Pavlof and Volcano Bays
July 16.....	10				
July 17.....		1			
July 18.....	7	1			4
July 19.....		1			1
July 23 *.....	7		1	1	2
July 25 *.....	14				1
July 26.....		1			
July 27.....	2				1
July 28.....			1		
July 29.....					2
July 31 *.....					1
Aug. 4 *.....					2
Aug. 16 *.....					1
Total.....	40	4	2	1	15
Percentage returned.....	23.4	2.3	1.2	0.6	8.8
Median time in days.....	9.93	5.5	12.5	10.0	12.0

\* Indicates a break in the continuity of the table.

TABLE 27.—Returns from 170 red salmon tagged July 18, 1923, Morzhovoi Bay, Pacific American Fisheries trap No. 5. Recaptures, 80 (47 per cent)<sup>1</sup>

Date	Locality of recapture						
	Morzhovoi Bay	Morzhovoi Lake	Ikatan-False Pass	Thin Point	Cold Bay	Belkofski Bay	Pavlof Bay
July 20.....			1				
July 21.....				1			
July 23*.....	3		1	6	7	1	
July 24.....			1	9			
July 25.....	8			7	5		1
July 26.....			3	2			
July 27.....	4		1				
July 28.....				1	2		
July 29.....	1						
July 31*.....			1	3			1
Aug. 1.....				1			
Aug. 3*.....				1			
Aug. 6*.....	1						
Aug. 7.....			1				
Aug. 9*.....				1			
No date.....		4					
Total.....	17	4	9	32	14	1	2
Percentage returned.....	10.0	2.4	5.3	18.8	8.2	0.6	1.2
Median time in days.....	7.18		8.0	6.5	6.0	5.0	10.0

\* Indicates a break in the continuity of the table.  
<sup>1</sup> In addition to those tabulated, one tag was taken in Bear Lake.

TABLE 28.—Returns from 172 dog salmon tagged July 18, 1923, Morzhovoi Bay, Pacific American Fisheries trap No. 5. Recaptures, 63 (36.6 per cent)

Date	Locality of recapture				Date	Locality of recapture			
	Morzhovoi Bay	Ikatan-False Pass	Thin Point	Pavlof and Volcano Bays		Morzhovoi Bay	Ikatan-False Pass	Thin Point	Pavlof and Volcano Bays
July 20.....	2	1			Aug. 1.....			1	
July 21.....				1	Aug. 3*.....			1	
July 22.....		1			Aug. 4.....			1	
July 23.....	12				Aug. 8*.....	1			
July 24.....		5			Aug. 16*.....				1
July 25.....	20			2					
July 26.....		1	1						
July 27.....	2			3					
July 28.....			1						
July 29.....	1			2					
July 30.....		1							
July 31.....				2					
					Total.....	38	9	5	11
					Percentage returned.....	22.1	5.2	2.9	6.4
					Median time, in days.....	6.75	6	14	9.33

\* Indicates a break in the continuity of the table.

TABLE 29.—Returns from 198 red salmon tagged July 20, 1923, Morzhovoi Bay, Pacific American Fisheries traps Nos. 8, 3, and 2. Recaptures, 63 (31.8 per cent)

Date	Locality of recapture							
	Morzhovoi Bay	Morzhovoi Lake	Ikatan-False Pass	Bear Lake	Naknek	Thin Point	Cold Bay	Volcano Bay
July 23	6		1		1		1	
July 24			8					
July 25	5					4	2	
July 26			3			2		
July 27	5		1					1
July 28			1			1		
July 29	3							
July 31*						1		
Aug. 1						1		
Aug. 3*					1			
Aug. 4								1
Aug. 6*								
Aug. 8*	2		2				1	
Aug. 9						1		
Aug. 16*	1							
No date		4		3				
Tagged in No. 3	10	3	4			2	3	
Tagged in No. 8	9		11		2		1	1
Tagged in No. 2	3	1	1			3		1
Total	22	4	16	3	2	10	4	2
Percentage returned	11.1	2	8.1	1.5	1	5	2	1
Median time, in days	6	(Over 50)	4.37		8.5	6	5	11

\* Indicates a break in the continuity of the table.

## RED SALMON

### ROUTES TRAVELED

In order to simplify the interpretation of the data given in Tables 2 to 29, other tables have been prepared combining the data obtained from the various experiments begun in each main locality. Thus, the results obtained from each experiment begun in the Kelly Rock and Big Valley traps on Unga Island are presented in Table 30 (p. 30). This table gives the percentage recaptured in each locality from which recaptures were reported, the time, in days, between tagging and recapture, and in the last two columns the total number of recaptures reported from each locality and the percentage of the total number tagged taken in each locality. The same has been done for the experiments begun in the Coal Harbor trap on Unga Island (Table 31, p. 52), Ikatan Bay (Table 32, p. 53), 3 traps (Pacific American Fisheries traps Nos. 8, 3 and 2) on the western and northern shores of Morzhovoi Bay (Table 34, p. 56), and from one trap (Pacific American Fisheries trap No. 5) located on the eastern shore of Morzhovoi Bay (Table 35, p. 57.) This particular grouping of experiments was made as a result of a careful inspection of the data, which showed that the results from these various localities were distinct enough to justify their separation, and that the results from the experiments that have been thrown together were similar enough to justify such treatment.

The localities from which recaptures were reported have been arranged in each of these tables as nearly as possible in the order of their proximity to the point

where the tagging was done. As the fish traveled in various directions, it was impossible to follow strictly such an arrangement. We have, therefore, arranged the localities, first in the order presented as the fish were going to Bristol Bay (where the great majority were apparently bound), and then we have given the localities to the eastward of the place of tagging. In Table 30, therefore, the localities appear in order of proximity to Unga Island, following along the south shore of the Alaska Peninsula, then along the northern shore of the Peninsula to Bristol Bay, and northward from Bristol Bay as far as the Kuskokwim. Following this, other localities where tags were taken are given in the order of their proximity to Unga Island, going in an easterly direction as far as Cook Inlet.

KELLY ROCK AND BIG VALLEY TRAPS, UNGA ISLAND

The returns from the various experiments begun at this place are given in Table 30. The two traps are those where tagging was done during the season of 1922, and, with minor variations, the results were the same.

TABLE 30.—Returns of red salmon from each tagging at Kelly Rock and Big Valley traps, Unga Island. Percentage taken in each locality and median time en route in days

[Number of fish tagged, 3,185]

Locality of recapture	Approximate distance (standard miles)	June 2, 3, and 5—120 tagged, 13 returned		June 7—575 tagged, 105 returned		June 23—499 tagged, 213 returned		June 26—499 tagged, 110 returned	
		Per cent returned	Time in days	Per cent returned	Time in days	Per cent returned	Time in days	Per cent returned	Time in days
Unga Island		0.8	3	0.3	(1)	4.2	5	0.2	3
Pavlof Bay <sup>1</sup>	65					.2	11	.2	19
Cold Bay	110								
Thin Point	105							.4	7
Morzhovoi Bay	120			4.7	8	13	6	.6	4
Morzhovoi Lake	125			.2	59				
Ikatan Bay	120	5	8	8.2	5	16.2	6	6.8	6
Nelson's Lagoon	255			.3	26	.2	18	.4	16
Bear River	295			.2	32			1	15
Ugashik	430					.2	21	.2	28
Egegik	455	1.7	21	.3	22	.8	21	.2	16
Naknek	480	.8	52	1.2	29	2.8	21	3.6	20
Kvichak	480	2.5	23	1.6	21	2.4	21	4.6	21
Iliamna Lake	610					.4	27		
Nushagak	465			.7	23	2	21	3.2	21
Good News Bay	415							.2	
Togiak	415							.2	14
Kuskokwim	560			.2	15				
Orzinski Bay	40								
Chignik	150			.2	15	.2	25	.2	45
Karluk	290								
Alitak	290								
Afognak	430			.2	24				
Cook Inlet	480								
Total		10.8		18.3		42.6		22	

<sup>1</sup> See Table 3.

<sup>2</sup> Including also Volcano Bay.

TABLE 30.—Returns of red salmon from each tagging at Kelly Rock and Big Valley trap, Ungo Island. Percentage taken in each locality and median time en route in days—Continued

Locality of recapture	June 27—859 tagged, 277 returned		July 6—633 tagged, 172 returned		Total number returned	Percent- age re- turned	Average time in days <sup>1</sup>
	Per cent returned	Time in days	Per cent returned	Time in days			
Unga Island.....	0.0	6	5.7	4	69	2.17	5.1
Pavlof Bay <sup>4</sup> .....	.2	14	.5	9	7	.22	12.4
Cold Bay.....			.3	6	2	.06	6.5
Thin Point.....	.5	7	1.1	7	13	.41	7
Morzhovoi Bay.....	1.4	10	1.6	10	117	3.68	6.9
Morzhovoi Lake.....					1	.03	59
Ikatan Bay.....	16.8	7	6.2	7	351	11.03	6.6
Nelson's Lagoon.....	.2	16			7	.22	19.4
Bear River.....	1	15	.5	14	18	.56	15.6
Ugashik.....			.8	16	7	.22	
Egegik.....	.9	20	.6	14	21	.66	
Naknek.....	5.4	19	3.8	16	110	3.45	
Kvichak.....	3.4	19	4	15	101	3.17	
Iliamna Lake.....					2	.06	
Nushagak.....	.9	21	.6	16	42	1.32	
Good News Bay.....					1	.03	
Togiak.....			.2	45	2	.06	29.5
Kuskokwim.....					1	.03	15
Orzinski Bay.....			.2	16	1	.03	16
Chignik.....	.3	23	.8	11	11	.34	19.1
Karluk.....	.1	18			1	.03	18
Alitak.....			.3	17	2	.06	17.5
Afognak.....					1	.03	24
Cook Inlet.....	.1	17	.2	28	2	.06	22.5
Total.....	32.2		27.2		890	27.93	

<sup>3</sup> For reasons given in the text the average time is not given for Bristol Bay points.

<sup>4</sup> Including also Volcano Bay.

The general movement of the body of fish found in the region of the Shumagin Islands is westward to Ikatan and Morzhovoi Bays, thence into Bering Sea—undoubtedly through False Pass (Isanotski Strait)—northeasterly along the shores of the Alaska Peninsula and to Bristol Bay. A little over 2 per cent of the fish were taken again in the same traps from which they were liberated, but these, of course, throw no light on the migrations. It should be noted, however, that the percentage of fish recaptured in the immediate vicinity of the place of liberation was considerably higher in these experiments than in those of 1922. In 1922 only 1 fish out of 861 tagged in these same two traps was retaken in these traps, while in 1923, 69 were taken out of a total of a little over 3,000 tagged. The difference is considerable, but no explanation of it can be offered. In 1922 no fish were taken on local fishing grounds around the Shumagin Islands, but in 1923 a number were taken in Red Cove, a small bay on the south shore of Popof Island, where some beach seining is conducted. Evidently the fish are inclined to linger somewhat among the channels of the Shumagin group, but not to the extent that they remain in the region of Ikatan and Morzhovoi Bays.

The fish taken along the main route of migration (Morzhovoi Bay, Ikatan Bay, and Bear River) and in the Bristol Bay region from Ugashik to Nushagak form over 24 per cent of those tagged. Only 18 fish (less than six-tenths of 1 per cent) went to the eastward, and most of these—that is, 11 fish—were taken at Chignik. A few were taken in local spawning streams between the Shumagin Islands and Bristol Bay. These included Pavlof Bay, Cold Bay, Thin Point, Morzhovoi Lake, and Nelson's Lagoon. A total of less than 1 per cent was returned from these

streams. It is very apparent, therefore, that the fish found about the Shumagin Islands are very largely Bristol Bay residents.

With one exception no very striking differences are to be observed in the percentage of the returns from different experiments taken in any given locality. This exception is the case of returns from Morzhovoi Bay. Relatively large percentages of the fish tagged on June 7 and June 23 were taken in Morzhovoi Bay—4.7 per cent and 13 per cent, respectively. After this last date apparently fewer fish visited Morzhovoi Bay on their migration to Bristol Bay. A similar difference is not noticeable in the case of Ikatan Bay, which is practically at the entrance to False Pass. It seems reasonable to conclude, therefore, that during the latter part of the season the fish go more directly from the region of the Shumagin Islands to Isanotski Strait and through this to Bristol Bay. Additional evidence of this will be presented in the section dealing with the rate of travel.

#### COAL HARBOR TRAP, UNGA ISLAND

On account of the position of the Coal Harbor trap in Unga Strait, on the north shore of Unga Island, it has been of interest to compare the results of tagging at this point with those obtained from the tagging at the Kelly Rock and Big Valley traps, which are located on the eastern shore of Unga Island near the extreme southern part of Popof Strait. Only two experiments were undertaken at the Coal Harbor trap, mainly because of the fact that this trap, which was new, did not prove successful and took but a few salmon at any time during the season. The results of these two experiments are given in Table 31.

TABLE 31.—Returns of red salmon from each tagging at Coal Harbor trap, Unga Island. Percentage taken in each locality and median time en route in days

[Number of fish tagged, 247]

Locality of recapture	Approximate distance (standard miles)	June 27—137 tagged, 53 returned		July 4—110 tagged, 43 returned		Total number returned	Percentage returned	Average time, in days <sup>1</sup>
		Per cent	Time in days	Per cent	Time in days			
Unga Island.....		5.1	12	12.7	4	21	8.50	6.7
Thin Point.....	105	.7	7	.9	13	2	.81	10.5
Morzhovoi Bay.....	120	1.5	10	.9	3	3	1.21	8
Ikatan Bay.....	120	17.5	6	6.4	9	31	12.55	6.9
Nelson's Lagoon.....	255			.9	12	1	.40	12
Bear River.....	295	.7	14	.9	17	2	.81	15.5
Ugashik.....	430	2.7	20			1	.40	
Naknek.....	480	2.2	26	7.3	17	11	4.45	
Kvichak.....	480	4.4	20	8.2	16	15	6.07	
Lake Clark.....	650					1	.40	
Nushagak.....	465	2.9	21	.9	16	5	2.02	
Good news Bay.....	415	.7	13			1	.40	13
Orzinski Bay.....	40	.7	4			1	.40	4
Cook Inlet.....	480	.7	16			1	.40	16
Total.....		38.7		39.1		96	38.86	

<sup>1</sup> See footnote 3 in Table 30.

A comparison with Table 30 shows that there was practically no difference in the returns obtained from these experiments and those begun at Kelly Rock and Big Valley. A somewhat larger percentage of the fish liberated from the Coal Harbor trap was taken in the vicinity of Unga Island—mainly in the other two traps

and in Red Cove. Evidently the fish in Unga Strait traversed Popof Strait to the southward in considerable numbers. No evidence was obtained to show that the reverse was true and that the fish found in the region of Kelly Rock and Big Valley passed northward through Popof Strait. It seems probable, therefore, that the majority of the salmon that escape the traps in the region of Kelly Rock skirt the south shore of Unga Island on their way to Morzhovoi and Ikatan Bays and False Pass.

## IKATAN BAY

The data obtained from the various experiments in Ikatan Bay are given in Table 32.

TABLE 32.—Returns of red salmon from each tagging in Ikatan Bay. Percentage taken in each locality and median time en route, in days

[Number of fish tagged, 2,702]

Locality of recapture	Approximate distance (standard miles)	June 18—799 tagged, 217 returned		July 1—699 tagged, 308 returned		July 2—300 tagged, 220 returned		July 10—P. A. F. No. 13, 131 tagged, 51 returned	
		Per cent	Time in days	Per cent	Time in days	Per cent	Time in days	Per cent	Time in days
Ikatan Bay.....		17.3	2	33.4	2	69.6	1	26.7	3
Morzhovoi Bay.....	20	4.4	3	3.3	6	1.3	5	2.3	6
Morzhovoi Lake.....	30							3.0	60+
Swanson's Lagoon.....	25	.1	14						
Nelson's Lagoon.....	130			.4	12				
Bear River.....	170	1.1	16	.4	12	.3	9		
Ugashik.....	300	.1	14						
Egegik.....	330	.2	20	.3	16	.3	16		
Little Becharoff Lake.....	400	.1	54						
Naknek.....	350	1.5	25	2.4	18	1.0	14	2.3	13
Kvichak.....	350	1.6	24	1.7	17	.7	15	2.3	12
Nushagak.....	340	.5	21	1.7	17			.8	11
Kuskokwim (Bethel).....	430	.1	?						
Thin Point.....	30			.3	7			1.5	8
Cold Bay.....	50								
Belkofski Village.....	50			.1	23				
Total.....		27.0		44.0		73.5		38.9	

Locality of recapture	July 10—P. E. H. No. 5, 326 tagged, 110 returned		July 11—P. A. F. No. 2, 447 tagged, 299 returned		Total number returned	Percentage returned	Average time, in days <sup>1</sup>
	Per cent	Time in days	Per cent	Time in days			
Ikatan Bay.....	12.3	3	59.3	2	920	34.05	1.9
Morzhovoi Bay.....	1.2	6	1.8	5	77	2.85	4.4
Morzhovoi Lake.....	.3	50+	.4	50+	7	.26	50.0
Swanson's Lagoon.....					1	.04	14.0
Nelson's Lagoon.....					3	.11	12.0
Bear River.....	1.8	9	.2	9	20	.74	12.6
Ugashik.....			.2	11	2	.07	
Egegik.....	1.5	11	.2	?	11	.41	
Little Becharoff Lake.....					1	.04	
Naknek.....	8.6	18	2.9	11	76	2.81	
Kvichak.....	7.1	12	1.1	11	58	2.14	
Nushagak.....	.6	12	.4	12	21	.78	
Kuskokwim (Bethel).....					1	.04	7.7
Thin Point.....					4	.15	10.0
Cold Bay.....			.2	10	1	.04	
Belkofski Village.....	.3	25			2	.07	24.0
Total.....	33.7		66.7		1,205	44.60	

<sup>1</sup>See footnote 3 to Table 30.

In full accord with the results obtained in 1922, these experiments show that a very high percentage of the returns were taken in Ikatan Bay where the fish had been liberated, and that, next to Ikatan Bay, the greatest number of tagged fish was reported from Morzhovoi Bay. In the report on the experiments of 1922 the senior author stated that "Recaptures from all the tagging experiments, without exception, indicate that the salmon tarry in this vicinity for a considerable period, often from two to three weeks, passing back and forth from Ikatan to Morzhovoi Bays and repeatedly running the gauntlet of all the traps."

It is interesting to compare the results obtained in the tagging done at the P. E. Harris trap No. 5 on July 10 with the results obtained in the five experiments for which fish were taken from traps operated by the Pacific American Fisheries. This experiment was made at the suggestion of Superintendent Nicholls of the P. E. Harris Co. The trap (P. E. Harris No. 5) is located very near the southern entrance to False Pass—in fact, is as near to the entrance as the extremely strong tidal currents will permit. In this location it is natural to suppose that the fish taken were approaching the entrance of the strait with the intention of passing through. Favorable currents would be expected to facilitate their passage through, and the tagging was therefore done on the beginning of the flood tide which sweeps up through the pass and is only met by the flood tide from the Bering Sea side well toward the northern entrance.

Although there is no appreciable difference in the time required for the fish tagged in this experiment to reach Bristol Bay (see Table 32, p. 53), there is a very significant difference in the percentage of fish that ultimately reached Bristol Bay when compared with the results of other experiments started in Ikatan Bay. It is apparent that a much larger percentage of the fish tagged in the P. E. Harris trap No. 5 escaped the traps of Ikatan Bay and proceeded through False Pass and on to Bristol Bay. The percentages are as follows:

TABLE 33.—*Fish tagged in Ikatan Bay, recaptured there and in Bristol Bay*

Point where tagged	Number tagged	Ikatan Bay		Bristol Bay	
		Number	Percentage	Number	Percentage
Other traps in Ikatan Bay.....	2,376	880	37	111	4.7
P. E. Harris trap No. 5.....	326	40	12.3	58	17.8

It is instructive to compare the results of this experiment with those obtained from the tagging done in the Pacific American Fisheries trap No. 13 on the same date and in the Pacific American Fisheries trap No. 2 the next day (July 11). These two Pacific American Fisheries traps are located some distance from the southern entrance to the pass. The two experiments were started so nearly simultaneously with the one in P. E. Harris trap No. 5 that they might reasonably have been expected to yield approximately the same results. However, the percentage of fish returned from Ikatan and Morzhovoi Bays is approximately twice as great in the case of the experiments started in the Pacific American Fisheries traps, while

the returns from Bristol Bay are only about one-fourth as great. The evidence clearly indicates that this trap (P. E. Harris No. 5) catches a large percentage of fish that have successfully evaded the fishing gear located in Ikatan and Morzhovoi Bays and which are just ready to enter False Pass on their way to Bristol Bay.

It is interesting to note that all of the fish reported from the local spawning grounds in Morzhovoi Lake and which were tagged in Ikatan Bay were tagged on July 10 and 11.

One of the fish tagged in Ikatan Bay was taken in Swanson's Lagoon on the north shore of Unimak Island, a short distance west of the northern entrance to False Pass. There was no established fishery in Swanson's Lagoon, so that no real opportunity was offered for collecting tags at this point. The one returned was secured by Mr. Wingard, of the Bureau of Fisheries, at the time of a brief inspection of the spawning grounds in this locality. It may be that a considerable percentage of the fish that enter Swanson's Lagoon for spawning feed in the north Pacific Ocean and pass through Isanotski Strait just as do the fish bound for Bristol Bay.

Three tags were reported from Nelson's Lagoon on the northern shore of the Alaska Peninsula and approximately 100 miles eastward from False Pass. Twenty were taken in the region of Bear and Sandy Rivers, about 20 miles east of Port Moller. Only a very few fish were taken at points to the eastward of Ikatan and Morzhovoi Bays along the southern shore of the peninsula. Of these, four were taken at Thin Point, one in Cold Bay,<sup>3</sup> and two were reported from Belkofski village and were probably taken in nets near that point. This again fully agrees with the results obtained in 1922.

#### MORZHOVOI BAY, PACIFIC AMERICAN FISHERIES TRAPS NOS. 8, 3, AND 2

During 1923 four traps were operated in Morzhovoi Bay, all under the control of the Pacific American Fisheries. Three of these—Nos. 8, 3, and 2—were located along the western and northern shores of the bay and one—No. 5—on the eastern shore. The results obtained from the various experiments in No. 5 were so different from the results obtained from the experiments conducted at the other traps that they have been tabulated separately. The results from the experiments in traps Nos. 8, 3, and 2 are given in Table 34.

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<sup>3</sup> The following data were received as the paper was in press, too late to insert in the tables and text: Seven tags taken at Cold Bay, recorded under date of Aug. 1, 1923. Two were attached in Ikatan Bay, July 10; one in Morzhovoi Bay, trap No. 5, July 13; two at the same place, July 18; and two at the traps on the western shore of Morzhovoi Bay, July 20. Since these data would not materially change the conclusions reached, no attempt has been made to accomplish the revisions necessary to include them. (W. H. R.)

TABLE 34.—Returns of red salmon from each tagging in Morzhovoi Bay, Pacific American Fisheries traps Nos. 8, 3, and 2. Percentage taken in each locality and median time en route in days

[Number of fish tagged, 2,026]

Locality of recapture	Approximate distance (standard miles)	June 20—800 tagged, 187 returned		June 30—592 tagged, 250 returned		July 8—436 tagged, 110 returned		July 20—198 tagged, 63 returned		Total number returned	Percentage returned	Average time in days <sup>1</sup>
		Per cent	Time in days	Per cent	Time in days	Per cent	Time in days	Per cent	Time in days			
Morzhovoi Bay.....	-----	3.2	6	1.2	3	2.1	10	11.1	6	64	3.26	6.2
Morzhovoi Lake.....	5	-----	-----	-----	-----	2.7	50+	2	40+	16	.79	50 (?)
Ikatan Bay.....	20	11.4	5	31.8	3	7.8	3	8.1	4	329	16.24	3.3
Nelson's Lagoon.....	150	.4	18	-----	-----	-----	-----	-----	-----	3	.14	18
Bear River.....	190	.6	18	.7	16	-----	-----	-----	-----	9	.44	17
Bear Lake.....	210	.1	-----	.2	-----	-----	-----	1.5	-----	6	.30	-----
Ugashik.....	320	.1	17	.2	31	.5	13	-----	-----	4	.20	-----
Egegik.....	350	1	21	.5	21	2.1	13	-----	-----	20	.99	-----
Little Becharoff Lake.....	420	.1	63	-----	-----	-----	-----	-----	-----	1	.05	-----
Naknek.....	370	3.2	27	4.7	17	4.8	15	1	8	77	3.80	-----
Kvichak.....	370	2.6	23	2	16	3	14	-----	-----	46	2.27	-----
Nushagak.....	360	.2	16	.5	22	.7	-----	-----	-----	5	.25	-----
Thin Point.....	25	-----	-----	.3	7	5	5	5	6	15	.74	6
Cold Bay.....	40	.1	20	.2	3	.9	14	2	5	10	.49	9.9
Pavlov Bay.....	90	-----	-----	-----	-----	.5	23	1	11	4	.20	17.2
Total.....	-----	23	-----	42.3	-----	25.1	-----	31.7	-----	609	30.16	-----

<sup>1</sup> See footnote 3 to Table 30.<sup>2</sup> One other tag was returned but with no data.

In general, there is no great difference between the results obtained here and those obtained from the experiments in Ikatan Bay. Similar high percentages of recapture were reported from Morzhovoi Bay, Ikatan Bay, and Bristol Bay. More fish were reported from Ikatan Bay than from any other locality (16 per cent), although it might have been expected that, since the fish were tagged in Morzhovoi Bay, more returns would have been reported from that locality. On the contrary, but 3 per cent were from Morzhovoi Bay, as compared with the 16 per cent taken in Ikatan Bay. A somewhat higher percentage of return was reported from local spawning grounds and from points to the eastward of Morzhovoi Bay than was the case with the experiments in Ikatan Bay—nearly 1.43 per cent, as compared with less than 0.26 per cent.<sup>4</sup> This fact will be more readily understood, however, in connection with the discussion of the returns from trap No. 5.

## MORZHOVOI BAY, PACIFIC AMERICAN FISHERIES TRAP NO. 5

A striking difference is observed in the results (presented in Table 35) obtained from the experiments conducted at this point. These are remarkable in that a comparatively small percentage of return was reported from Bristol Bay, while nearly 17 per cent came from local fishing grounds to the eastward of Morzhovoi Bay. In none of the other experiments begun in Ikatan and Morzhovoi Bays was more than a relatively insignificant percentage of the returns reported from these local fisheries, while considerably higher percentages were in all cases reported from Bristol Bay. This difference is not due to differences in the time of tagging, since other experiments, begun at approximately the same dates but in other traps in Morzhovoi and Ikatan Bays, show the usual high percentage of returns from Bristol Bay and few returns from points to the eastward. It is quite apparent that the

<sup>4</sup> See footnote 3, page 55.

fish running on the eastern side of Morzhovoi Bay represent races seldom found in the other districts. Some admixture is apparent, since a few fish from trap No. 5 went to Bristol Bay and a few from other traps went eastward, but the proportions are so distinctly different that there can be no question as to the essentially different character of the two streams of migrants.

TABLE 35.—Returns of red salmon from each tagging in Morzhovoi Bay, Pacific American Fisheries trap No. 5. Percentage taken in each locality and median time en route in days

[Number of fish tagged, 962]

Locality of recapture	Approximate distance (standard miles)	June 30— 403 tagged, 228 returned		July 8— 110 tagged, 52 returned		July 13— 279 tagged, 135 returned		July 18— 170 tagged, 79 returned		Total number returned	Per-centage returned	Average time in days <sup>1</sup>
		Per cent	Time in days	Per cent	Time in days	Per cent	Time in days	Per cent	Time in days			
Morzhovoi Bay.....	5	1.7	3	3.6	10	16.5	3	10	7	74	7.69	4.6
Morzhovoi Lake.....	5					3.2	50+	2.4	40+	13	1.35	50(?)
Ikatan Bay.....	25	44.4	2	4.5	2	8.2	3	5.3	8	216	22.44	2.7
Nelson's Lagoon.....	150	.2	11							1	.10	11
Bear River.....	190	1	10	.9	14					5	.52	11.2
Bear Lake.....	210							.6		1	.10	
Egegik.....	350	.2	18							1	.10	
Little Becharoff Lake.....	420					.4	22			1	.10	
Naknok.....	370	2	16	2.7	14					11	1.14	
Kvichak.....	370	1.5	15	1.8	13					8	.83	
Nushagak.....	360	.2	18	1.9	14	.4	12			3	.31	
Thin Point.....	25	3	4	21.8	3	10.4	6	18.8	6	97	10.09	5.1
Cold Bay.....	40	2	11	9.1	3	6.5	8	8.2	6	50	5.20	6.9
Belkofski Bay.....	50							.6	5	1	.10	5
Pavlof Bay.....	90	.2	19	1.8	10	2.9	6	1.2	10	13	1.35	8.3
Total.....		56.4		47.1		48.5		47.1		495	51.42	

<sup>1</sup> See footnote 3 to Table 30.

Inspection of the tables also shows that the local fish constituted a much larger percentage of the fish tagged toward the end of the season. Very few fish taken locally were tagged during June, but they form a conspicuous item in the returns from experiments started during July. In the case of 37 individuals taken in Morzhovoi Lake, but one was tagged during June (June 7 at Kelly Rock trap). Twelve of those recovered in Morzhovoi Lake were tagged in Morzhovoi Bay on July 8, 5 at Ikatan on July 10, 2 at Ikatan on July 11, 9 in Morzhovoi Bay on July 13, 4 on the 18th, and 4 on the 20th. It is quite apparent that this run of fish, which spawns in Morzhovoi Lake, appears in the vicinity of Ikatan and Morzhovoi Bays late in the season after the Bristol Bay run has passed on. It is not possible to state whether these local fish actually come into these bays later in the season or whether they are there along with the others but form such a small element in the total population that the chance of tagging many of them is slight. It is possible that the influx into the coastal waters of the tremendous shoals of salmon bound for Bristol Bay may either obscure the lesser runs or may tend to keep them out and away from the coast where the fishing gear is operated. It is also possible that the fish bound for local streams do not normally seek the shore as early as those bound for the more distant spawning areas. Whatever the ultimate explanation may be, it is certain that the local fish do not constitute a conspicuous percentage of the fish taken in this region until well along in July.

In the first experiment, started June 30, over 44 per cent of the fish tagged were taken in Ikatan Bay. This is correlated with a correspondingly low percentage of returns from points to the eastward (5.2 per cent). With this exception, comparatively few of the fish tagged here were reported taken in Ikatan Bay. This is additional evidence that of the fish found in Morzhovoi Bay those that are destined to enter local streams, both in Morzhovoi Bay and to the eastward, are found along the eastern shore of the bay and mainly during the latter part of the season.

#### RATE OF TRAVEL

In making an analysis of the rate of travel it has become apparent that certain facts affect the reliability of the returns from Bristol Bay. These will therefore be discussed after the returns from other localities have been examined. The data will be found in Tables 30 to 35.

It is obvious that the rates of travel, as determined from the elapsed time between tagging and the reported recapture, will be only a minimum rate. In the first place, the assumption that the fish travel in the most direct line is not reasonable. Then, too, there will necessarily be some delay between the time that the fish is first taken in the trap and the time that it is found and the recapture reported. Traps are seldom lifted more than once a day (frequently a much longer interval elapses), and since the fish may enter the trap at any time during the 24 hours or more between one lift and the next, it follows that the elapsed time between liberation and reported recapture will be, on the average, at least 12 hours longer than was actually required by the fish to make the journey. It is certain, therefore, that the actual rate of travel of these fish is somewhat higher than our figures show, but just how much higher it is impossible to say.

#### FROM THE SHUMAGIN ISLANDS

The important migration from Unga Island to Ikatan and Morzhovoi Bays, composed, as we have seen, largely of fish bound to Bristol Bay, requires approximately 7 days. After each tagging at Unga Island fish were reported from Ikatan and Morzhovoi Bays, or both, within 4 or 5 days, occasionally in 3 days, and were reported thereafter for about 2 weeks. Tagged fish were taken in the greatest numbers within 5 or 6 days after the tagging, the numbers diminishing gradually until only an occasional tag was reported later than 2 weeks after the experiment was begun.

An inspection of some of the more typical tables will show clearly the extremely skewed type of frequency distribution given by these data. Not infrequently there were more recaptures reported on the first or second day than on any subsequent date. (See returns from Ikatan in Tables 3 and 6.) No conspicuous difference is noticeable in the time required for the fish to go from Unga Island to Ikatan or to Morzhovoi Bay, nor is there any indication that the rate of travel varies in any regular manner during the season. The weighted means of the median times found in the tables are, from Unga Island to Ikatan Bay, 6.6 days, and to Morzhovoi Bay, 6.9 days. The distances are approximately equal—about 120 miles—so that if we assume that the fish traveled by the shortest and most direct route their rate of travel was not less than about 18 miles per day.

The rate of travel to other near-by spawning grounds along the southern shore of the peninsula is considerably slower. From Unga Island to Pavlof Bay required an average of 12.4 days; to Thin Point, 7.4 days; to Cold Bay, 6.5 days (2 individuals); to Orzinski, 10 days (2 individuals); and all of these places are much nearer Unga Island than are either Ikatan or Morzhovoi Bay. The inference is that the fish bound for the local spawning grounds are traveling more leisurely or less directly, perhaps ranging more widely on their way, than are the fish bound for Bristol Bay.

The fish tagged in the Shumagin Islands, and which went to the eastward as far as Chignik, Kodiak, and Afognak Islands and Cook Inlet, required still more time in which to make the journey. All of the tags reported from these localities were attached in the Shumagins. The average time to Chignik was about 19 days. This is about the same distance from Unga Island as Ikatan Bay—125 miles—yet the elapsed time is nearly three times as great. The rate of travel is correspondingly diminished and amounts to only about 6.5 miles per day—assuming, again, a uniform rate of speed by the shortest and most direct route. It is interesting to note that the fish that went to Cook Inlet (a distance of 450 miles, approximately the same as to Bristol Bay) traveled at a much faster rate, arriving at their destination about the same time as did the fish taken at Chignik. As will be shown later, the fish going to Bristol Bay travel at about the same rate as those that went to Cook Inlet, and they had just about the same distance to go. In these cases the rate of travel was approximately 20 miles per day. Evidently the fish having the longest distance to go travel at a faster rate.

Twenty tags attached at Unga Island were taken near the Bear and Sandy Rivers, some 15 miles east of Port Moller, on the northern shore of the peninsula, and distant from Unga about 280 miles. The fish required a little less than 16 days to go this distance—a rate of about 18 miles per day. Eight tags were taken in Nelson's Lagoon, where there are local spawning grounds, once of considerable importance but now seriously depleted. The average time required was 18.5 days. The distance is approximately 250 miles, hence the rate was 13.5 miles per day. Again, it is apparent that the fish bound for the more distant spawning grounds of Bering Sea travel more rapidly than do those going to near-by regions along the southern shore of the peninsula.

#### FROM IKATAN BAY

More of the tags attached in Ikatan Bay were taken in that same locality than anywhere else (34 per cent). From Bristol Bay 6.25 per cent were reported (to be discussed below), 2.8 per cent from Morzhovoi Bay, and 1.4 per cent from local spawning grounds on both the northern and the southern shores of the peninsula. The average time required to make the journey from Ikatan Bay to Morzhovoi Bay was 4.4 days, indicating a very slow rate of travel, as the distance is only some 20 miles. One tag was recovered in Swanson's Lagoon, on the northern shore of Unimak Island, 14 days after tagging; 3 were taken in Nelson's Lagoon, 125 miles distant, after an average time of 12 days; and 20 were taken near Bear and Sandy Rivers after an average time of 12.6 days. This last locality is about 160

miles from Ikatan Bay. The rate of travel to Nelson's Lagoon was about 10 miles per day and to Bear River about 13 miles per day.

So few fish tagged at Ikatan were taken at points to the eastward along the southern shore of the peninsula that the data can not be considered at all conclusive. The indications are, however, that from 8 to 10 days are required for the journey from Ikatan Bay to Thin Point or Cold Bay, either of which is about 30 miles distant.

#### FROM MORZHOVOI BAY

The most abundant returns from the experiments begun in Morzhovoi Bay were from Ikatan Bay, where many of the fish tagged in Morzhovoi Bay are evidently bound on their way to Bristol Bay through False Pass. Ikatan Bay is only some 20 miles distant, and the average time required to make the trip is close to 3 days.

A few tags attached in Morzhovoi Bay were taken at Nelson's Lagoon and Bear River. Those fish tagged from the traps on the western and northern shores of the bay required an average of 17 or 18 days to make the trip, but those tagged in trap No. 5, on the eastern shore, required only about 11 days. This last figure is approximately the same as for the fish tagged in Ikatan Bay. Although the general impression gained from these figures is that the fish tagged in Morzhovoi Bay require a somewhat longer time to go to Nelson's Lagoon and Bear River than did those tagged in Ikatan Bay, the data are too few to warrant definite conclusions.

It was pointed out above that there is a distinct migration from Morzhovoi Bay to local spawning grounds to the eastward along the southern shore of the peninsula and especially to Thin Point and Cold Bay. The fish tagged in trap No. 5 particularly entered into this migration. The distance to Thin Point is only about 20 miles, but the time required was 6 days from the traps on the west side of the bay and 5.1 days from trap No. 5. This indicates a rate of travel of only about 4 miles per day. To Cold Bay required, from the traps on the west side of the bay, an average of approximately 10 days and from trap No. 5 nearly 7 days. The distance to the point in Cold Bay where most of the fishing is conducted is approximately 40 miles. The rate of travel was therefore about the same as to Thin Point. This illustrates again the fact noted above, that the rate of travel to near-by spawning grounds is distinctly slower than to those more distant.

The extent to which the fish linger about the place where they have been liberated is indicated by the average length of time elapsing between the time of liberation and the time of recapture in the same locality. In the case of the fish tagged at Unga Island in the Kelly Rock and Big Valley traps this was 5.1 days. Fish tagged in the Coal Harbor trap lingered about the Shumagin Islands for an average of 6.7 days. Those tagged in the traps on the western and northern shores of Morzhovoi Bay remained in that bay for an average of 6.2 days, and those from the trap on the eastern shore for 4.6 days. The average time between liberation and recapture in Ikatan Bay was about 2 days. It appears probable that the shorter delay in Ikatan Bay is associated with the nearness of False Pass, through which the fish pass in large numbers to the spawning grounds of Bering Sea.

## TO BRISTOL BAY

The preceding discussion of the rate of travel has not included those fish that went to Bristol Bay. As noted above, consideration of this migration has been reserved for separate treatment, since the results are seriously affected by the closing of the season in Bristol Bay on July 25. Early in the season the average time required is about 20 days; later it is about 10 days; but this fact alone is not conclusive evidence that the fish are actually traveling faster, since the slower fish from the later experiments are eliminated from the records by the closing of the season in Bristol Bay. The result is that the average time required later in the season is certain to be less, even though the fish were not traveling faster. It has been possible, however, by other methods, to show that there is actually an acceleration of the rate of travel toward the latter part of the season. Tables 36, 37, and 38 show the time required for the fish to go to Bristol Bay from, respectively, Unga Island, Morzhovoi Bay, and Ikatan Bay. The results from various experiments are given in separate columns, and it is easily seen that the upper parts of the distributions were cut off by the closing of the season on July 25. The heavy line at the lower end of the columns indicates this date. Very few returns were reported after this date, and the few that were reported later than July 25 were probably tags that had been retained by fishermen and were not turned in previously.

In studying the comparative rate of travel during different parts of the season it has been necessary, in order to eliminate the error resulting from the closing of the fishing season on July 25, to consider only the first few fish to be reported in Bristol Bay from each tagging. In order that the number actually caught might not affect the results, the numbers which we have taken from each distribution have been based on the number tagged, not on the number retaken. Several methods of analysis were tried, but with practically identical results. The simplest and most obvious thing to do was to take the time required for the trip by the first arrival. In addition to this we took the time that elapsed before 1 per cent of the total number tagged were taken in Bristol Bay and the same for 2 per cent and 3 per cent; then we took the *average* time required before 1, 2, or 3 per cent of the total number tagged had reached Bristol Bay. We thus had 7 different series of data from each of 3 localities in which tagging was carried on, or 21 in all.

These data all told the same story, showing conclusively that the fish were actually traveling at a faster rate later in the season. Figures 10 to 12 present graphically the data on the time required by the first arrival and the time required for 2 per cent of those tagged to arrive. The time of first arrival is naturally the most variable, but is important, since it is subject to no possible error due to the closure of the season. The time required for 2 per cent of those tagged to arrive was selected from among the other series of data on account of the fact that it appeared to be the most stable. The curves shown on the graphs have been drawn in "by eye," as the character of the data did not seem to warrant more refined methods of curve fitting. The data on which these graphs are based are given in Table 39, which also shows the median time required for the journey from the various points of tagging to Bristol Bay and the rate of travel in miles per day.

Table 36. - Time to Bristol Bay from Unga Island

Number of days en route	Date and locality of tagging							
	June 2-5 Kelly Rock	June 7 Kelly Rock	June 23 Kelly Rock	June 26 Kelly Rock	June 27 Coal Harbor	June 27 Big Valley	July 4 Coal Harbor	July 6 Big Valley
1								
2								
3								
4					<sup>1</sup> 1			
5								
6								
7								
8								2
9								
10							1	1
11						1		1
12				1				1
13								3
14							2	8
15			1			1		14
16				2		1	3	7
17			1	2	1	6	4	5
18	1		2	3	4	11	1	2
19		3	4	9		21	1	12
20		1	8	10	2	19	3	<sup>2</sup> 2
21		3	7	7	1	7	2	
22	3	3	1	6		4		
23		3	1	2		2		
24			6	4		6		
25	1			2	2	1		
26			1	2	1			
27		1	1	3	1	2		
28		1	1	1	1	5		
29		3	1	2				
30								
31								
32			3					
33				<sup>2</sup> 1				
34								
35								
36								
37								
38					<u>C L O S E D</u>			
39					<u>S E A S O N</u>			
40								
41		1						
42								
43								
44								
45		1						
46								
47								
48		1						
49								
50								
51	1							

<sup>1</sup>Probably an error. Omitted in calculations<sup>2</sup>Probably taken earlier but not reported until after the close of the season

Table 37. - Time to Bristol Bay from Morzhovoi Bay

Number of days en route	Date and locality of tagging							
	June 20 No. 8	June 30 No. 8	June 30 No. 5	July 8 No. 3	July 8 No. 5	July 13 No. 5	July 18 No. 5	July 20 No. 8
0				<sup>1</sup> 1				
1								
2								
3								1
4			<sup>2</sup> 1					
5								
6								
7				2				
8				1				
9								
10								
11				1				
12		1		3		1		
13				9	2			
14				7	3			<sup>3</sup> 1
15	2	3	3	8	1			
16	2	13	5	2				
17	3	8	2	8				
18	6	4	2					
19	4	2						
20	4	1						
21		2	1					
22	4	3		<sup>3</sup> 1				
23	2							
24	3		1					
25	3	3						
26	2							
27	4							
28	3							
29								
30	2	<sup>3</sup> 1						
31	1	<sup>3</sup> 1						
32								
33	2							
34	1							
35	9							
36	1							

<sup>1</sup>Undoubtedly an error. Not considered in making calculations<sup>2</sup>Probably an error. Not considered in making calculations<sup>3</sup>Probably taken earlier but not reported until after the close of the season

Table 38. - Time to Bristol Bay from Ikatan Bay

Number of days en route	Date and locality of tagging					
	June 18 P.A.F.No.7	July 1 P.A.F.No.2	July 2 P.A.F.No.11	July 10 P.A.F.No.13	July 10 P.E.H.No.5	July 11 P.A.F.No.2
1						
2						
3						
4					1	1
5				1		
6					1	2
7					1	1
8					2	
9						
10					6	3
11				1	13	4
12			1	1	8	2
13				2	7	5
14	1	7	2	1	9	2
15		5			9	
16	2	3	1			
17		2				
18	1	9	2			
19	4	7				
20	1	2			1 <sup>1</sup>	
21	5	4				
22		1				
23	1					
24	4					
25	2					
26	3					
27	2					
28	1					
29	1					
30						
31						
32	1					
33						
34						
35	1					
36	1					
37						

<sup>1</sup> Probably taken earlier but not reported until after the close of the season

TABLE 39.—Time, in days, required to travel to Bristol Bay from various tagging stations

Locality and date	Elapsed time before—		Median time	Approximate rate of travel (miles per day) <sup>1</sup>	Locality and date	Elapsed time before—		Median time	Approximate rate of travel (miles per day) <sup>1</sup>
	First arrival	First 2 per cent arrived				First arrival	First 2 per cent arrived		
Unga Island:					Morzhovoi Bay—Contd.				
June 2 to 5.....	18	22	22.2	20.3	July 8 (trap No. 5)....	13	14	13.8	25.4
June 7.....	19	23	22.7	19.8	July 13.....	12			
June 23.....	15	20	20.9	21.5	July 18.....				
June 28.....	12	19	20.6	21.8	July 20.....	4			
June 27 (C. H.).....	17	18	20.2	22.3	Ikatan Bay:				
June 27 (B. V.).....	11	18	19.6	23	June 18.....	14	24	23.6	14
July 4.....	10	14	17.1	26.3	July 1.....	14	16	17.8	18.5
July 6.....	8	14	15.4	29.2	July 2.....	12	18	15	22
Morzhovoi Bay:					July 10 (P. A. F. trap No. 13).....	5	12	12.5	26.4
June 20.....	15	19	24.2	14.5	July 10 (P. E. H. trap No. 5).....	4	10	12.1	27.2
June 30 (trap No. 8)....	12	16	17	20.6	July 11.....	4	11	11.2	29.5
June 30 (trap No. 5)....	15	17	16.3	22.9					
July 8 (trap No. 3)....	7	13	14.2	24.6					

<sup>1</sup> Based on median time and considering the distance to Bristol Bay from Unga Island as 450 miles, from Morzhovoi Bay as 350 miles, and from Ikatan Bay as 330 miles.

NOTE.—When two experiments were started on the same date, the traps are indicated.

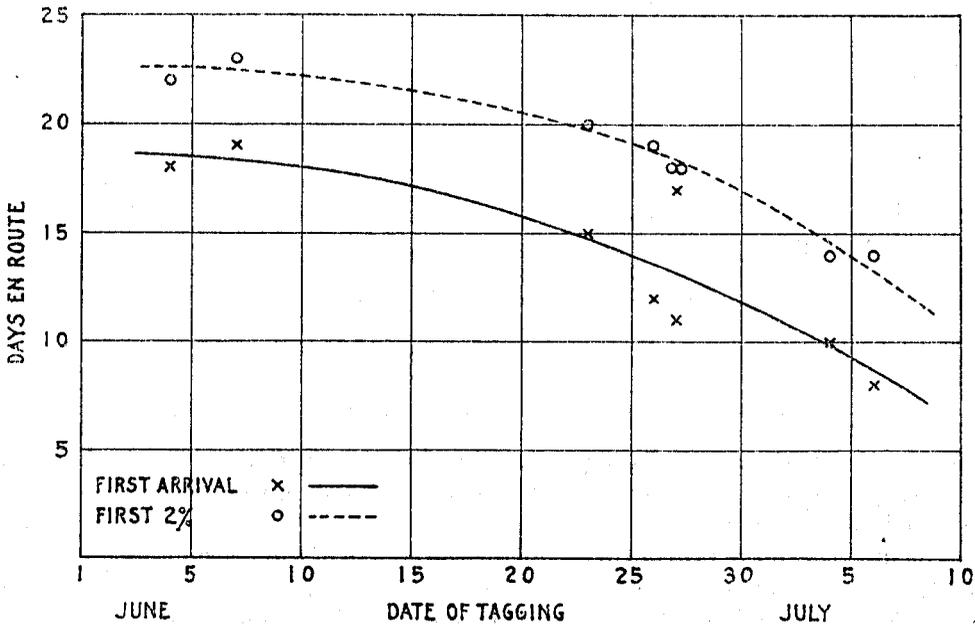


FIG. 10.—Showing time required for red salmon to travel from Unga Island to Bristol Bay

Having established the fact that the rate of travel increases markedly during the season, it remains to determine what the average rate of travel is at different times. The data given above in connection with the discussion of the comparative rate of travel does not, of course, give the average time required, since we have considered only a certain variable percentage of the total number retaken. In the case of at least the first few experiments it may be assumed that the returns from Bristol Bay were complete and were not affected by the closure of the season.

This is apparent from the distributions of the returns shown in Tables 36, 37, and 38. In most of the early distributions the frequencies gradually rise to a fairly well-defined maximum and then fall—a good indication that the distributions are approximately complete. If these distributions are then complete, we may fairly compare the median time required for the journey to Bristol Bay with the time required for 2 per cent of those tagged to reach Bristol Bay, and from this comparison can arrive at some conclusion as to the relative values of these two measures of the time required. From the data given in columns three and four of Table 39 it is very apparent that the values of these two measures are so nearly identical that for all practical purposes they may be so considered. The average difference of the times given in these two columns is exactly one day, the median time being the longer. It is furthermore apparent that even in the case of the later experi-

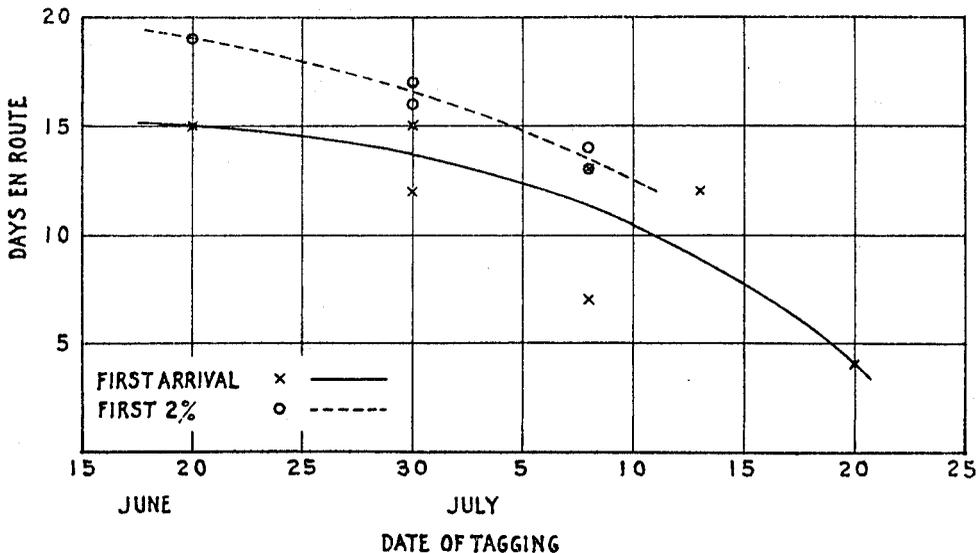


FIG. 11.—Showing time required for red salmon to travel from Morzhovoi Bay to Bristol Bay

ments the median is a satisfactory measure of the average time required to make the journey. The rates of travel shown in the last column of the table are therefore based on the median.

The increase in the rate of travel during the course of the season is very apparent from the figures given in the last column of Table 39. With but one exception the rate for each tagging is higher than for the preceding experiment. Early in the season the rate is approximately 20 miles per day, and toward the end of the season it rises to nearly 30 miles per day. Inspection of the table shows that for experiments begun on approximately the same dates the rate of travel is nearly the same in the case of Ikatan and Morzhovoi Bays, but that the rate is several miles a day faster in the case of the experiments begun in the region of Unga Island. This is, of course, in complete accord with the fact frequently noted before that the fish farthest from their spawning grounds travel at the fastest rates.

It has been of interest to compare the results obtained in these experiments with those of 1922. From the tables given in the report on the marking of 1922 by

the senior author we have determined the median time required for the journey to Bristol Bay from Ikatan and Unga Island. The data are as follows:

TABLE 40.—Median time required for tagged fish to travel from Ikatan and Unga Island to Bristol Bay in 1922

Locality and date of tagging	Median time to Bristol Bay	Number of tags returned
<b>Ikatan:</b>		
June 14.....	20	13
June 18.....	21	8
July 6.....	19	1
July 10.....	12	6
<b>Unga Island:</b>		
June 30.....	20	6
July 1.....	15	5

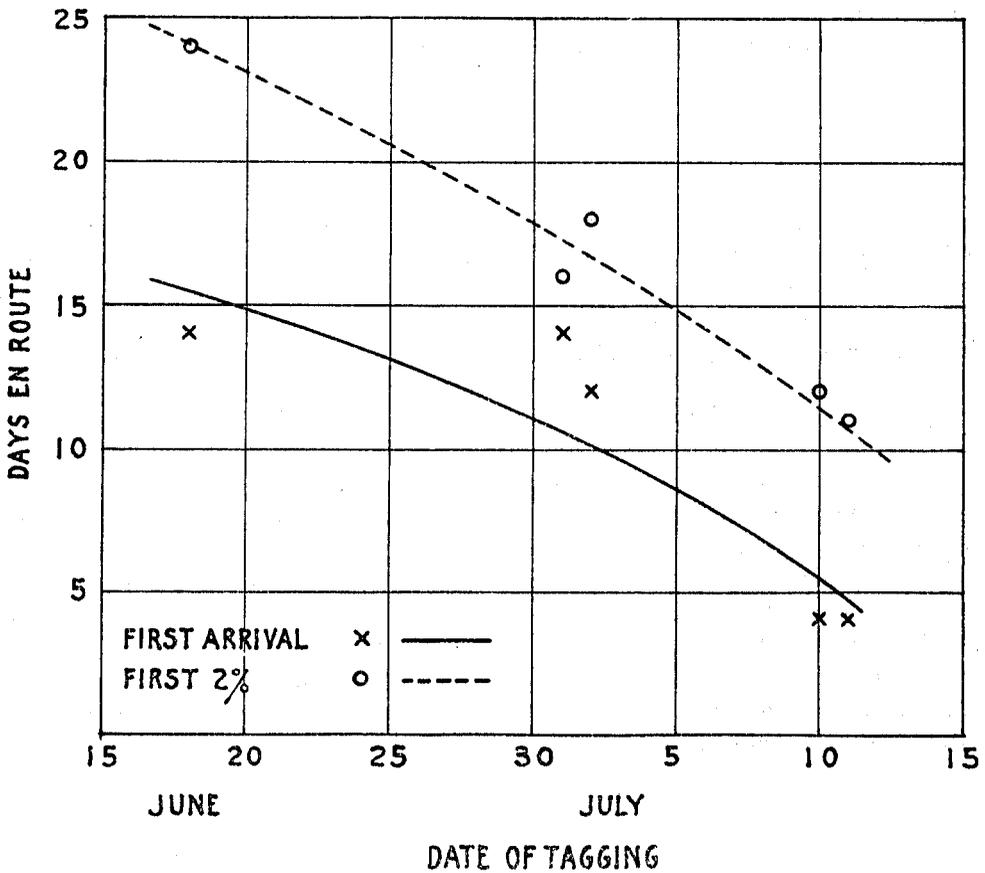


FIG. 12.—Showing time required for red salmon to travel from Ikatan Bay to Bristol Bay

The tagging of 1922 was on a much smaller scale than that of 1923, and as a consequence comparatively few returns were obtained from Bristol Bay. The total number was only 39, and the greatest number secured from the tagging of any one

day was 13. Under these circumstances it is to be expected that the variation in the median time required to make the trip would be much greater in 1922 than in 1923. In spite of this greater variability it is quite apparent that in general the results obtained in the two years are fairly similar. Experiments started on approximately the same dates in the two years gave results so similar as to leave no doubt that the conclusions drawn apply to the migration each year.

What determines the rate at which salmon travel in the ocean during their migration from the feeding grounds to the spawning grounds? It has been shown repeatedly that the rate of travel is distinctly more rapid in the case of those fish having a longer journey to make. The data on the migration to Bristol Bay has shown, further, that with the same distance to go the fish travel more rapidly with the approach of the spawning season. It seems possible to conclude, therefore, that the rate of travel is the resultant of two main forces—the relative maturity of the sex products and the distance from the spawning grounds. Other factors may possibly affect the rate of travel, but of these we know nothing at present, and it seems more than likely that the two mentioned are of primary importance.

#### PERCENTAGE OF RETURNS

The percentage of returns serves, although very imperfectly, as a measure of the intensity of fishing. If, out of 1,000 fish tagged and liberated in a given locality on a certain date, 500 are subsequently recaptured, it is fair to assume that approximately 50 per cent of the untagged fish found in that locality at that time were also taken. It must not be forgotten, however, that this is, at best, a minimum figure; that various factors are at work which keep the percentage of returns down and which, so far as we can see, will never raise it above the percentage captured of untagged fish with which they were associated at the time of liberation. These factors have been mentioned before and include the possible mortality of fish that have undergone the experience of being tagged, the retention of tags by fishermen and others as souvenirs, the loss of tags as a result of being detached between the time of tagging and recapture, and the failure on the part of the men engaged in handling the fish to notice the tags. In so far as our understanding of the intensity with which the important commercial runs of salmon are fished is concerned, these figures are also affected and reduced by the fact that some of the fish go to small streams in which no commercial fishery is maintained.

In spite of the fact that the figures can not be considered fully reliable as a measure of the intensity of fishing, certain very interesting facts are apparent from the data given in Table 41.

TABLE 41.—Percentage of returns from each experiment, red salmon only

Date and locality of tagging	Number tagged	Number returned from Bristol Bay	Number returned from other places	Total number returned	Percentage returned from Bristol Bay	Percentage returned from other places	Total percentage returned	Percentage of tagged salmon, not taken elsewhere, which were taken in Bristol Bay
Kelly Rock, June 2 to 5.....	120	6	7	13	5.0	5.8	10.8	5.3
Kelly Rock, June 7.....	575	22	83	105	3.8	14.5	18.3	4.5
Ikatan, June 18.....	799	33	184	217	4.1	23.1	27.2	5.4
Morzhovoi, June 20.....	800	59	128	187	7.4	16.0	23.4	8.8
Kelly Rock, June 23.....	499	43	170	213	8.6	34.0	42.6	13.1
Kelly Rock, June 26.....	499	59	51	110	11.8	10.2	22.0	13.2
Coal Harbor, June 27.....	137	14	39	53	10.2	28.5	38.7	14.3
Big Valley, June 27.....	859	91	186	277	10.6	21.6	32.2	13.3
Morzhovoi, June 30.....	592	47	203	250	7.9	34.3	42.2	12.1
Morzhovoi, trap No. 5, June 30.....	403	16	212	228	4.0	52.5	56.5	8.4
Ikatan, July 1.....	699	43	265	308	6.2	37.8	44.0	9.9
Ikatan, July 2.....	300	6	214	220	2.0	71.3	73.3	7.0
Coal Harbor, July 4.....	110	18	25	43	16.4	22.7	39.1	21.2
Big Valley, July 6.....	633	62	110	172	9.8	17.4	27.2	11.8
Morzhovoi Bay, July 8.....	436	45	65	110	10.3	14.9	25.2	12.1
Morzhovoi Bay, trap No. 5, July 8.....	110	6	46	52	5.4	41.9	47.3	9.4
Ikatan Bay, July 10.....	131	7	44	51	5.3	33.7	39.0	8.0
Ikatan Bay, P. E. Harris trap No. 5, July 10.....	326	58	52	110	17.8	15.9	33.7	21.1
Ikatan Bay, July 11.....	447	22	277	299	4.9	62.0	66.9	13.0
Morzhovoi, trap No. 5, July 13.....	279	2	133	135	0.7	47.7	48.4	1.4
Morzhovoi, trap No. 5, July 18.....	170	-----	80	80	-----	47.0	47.0	-----
Morzhovoi, July 20.....	198	2	61	63	1.0	30.8	31.8	1.5
Total.....	9,122	661	2,635	3,296	7.25	28.88	36.13	10.2

From the figures given in this table it is evident that the drain on the body of fish found during the fishing season in the region under discussion is so considerable that any further exploitation would be decidedly dangerous. Of the total number tagged 36.13 per cent were later recaptured and recorded. It has been mentioned above that this figure is a minimum; the actual drain on the salmon schools is therefore in excess of this figure. In other localities it has been found desirable to restrict the catch of fish to 50 per cent of the total run, and it is evident that the drain on the salmon resources of this region is so close to this figure that for practical purposes it may be considered equivalent. It is impossible to say whether these fish represent a unit of the Bristol Bay run, segregated more or less sharply from the remainder, or whether they represent merely a portion of an entirely mixed lot of fish that find their feeding grounds, in part at least, in the north Pacific Ocean. If they do represent a unit it is obvious that the fishery is being prosecuted with an intensity approximating that which obtains in the case of the fisheries at Karluk and Chignik, where a 50 per cent escapement is required.

Certain apparently significant differences appear in the percentages of returns obtained from the experiments started in the Shumagin Islands and in the region of Ikatan and Morzhovoi Bays. An especially good comparison can be made between the returns from 1,994 red salmon tagged at Unga Island June 23 to 27 and an exactly equal number tagged in Ikatan and Morzhovoi Bays June 30 to July 2. This tagging was all done during the height of the season, and there is no reason to think that the data obtained are not strictly comparable. It is very suggestive, therefore, that the experiments begun at Unga Island show a distinctly lower percentage of

recapture at other places than Bristol Bay and a distinctly higher percentage of returns from Bristol Bay even when, as shown in the last column of Table 41, the percentage is figured on the number remaining after the fish taken in other places than Bristol Bay are taken out. This was a necessary procedure since the returns from Bristol Bay are seriously affected by the capture of fish in other localities, especially close to the point where the tagging was done. Both of these facts point to the same conclusion, namely, that not all of the fish bound for Bristol Bay and found in the region of the Shumagin Islands during the height of the fishing season pass close to the shores in Ikatan and Morzhovoi Bays on their migration. There is plenty of reason to believe that a considerable proportion of the fish found south of the Alaska Peninsula do traverse these waters, but it seems probable, at least, that not all of them do so. It is possible that the fish enter Bering Sea through some one of the passages farther to the westward, or they may pass through the center of Ikatan Bay on their way to False Pass and thus avoid the traps. If some of the fish tagged in the Shumagin Islands went directly through Ikatan Bay and False Pass, or through some one of the western channels, it would account for the differences noted in the returns from these experiments and those begun in Ikatan and Morzhovoi Bays. No such migration through the western channels has ever been reported, however.

While it is felt that the figures given in Table 41 give a fairly acceptable minimum measure of the total intensity with which the schools of the Ikatan-Shumagin Island district are fished, and are, furthermore, sufficiently accurate for comparative purposes, it is not thought that the percentages taken in Bristol Bay give a reliable measure of the intensity of fishing at that point. All of the factors that tend to reduce the percentage of returns will continue to operate throughout the season, and will therefore be more effective in reducing the returns from Bristol Bay than from points nearer the place of tagging. The tagged fish actually reported from Bristol Bay form 7.25 per cent of the total number tagged. However, this figure is obviously affected by the fact that a large number of fish, undoubtedly bound for Bristol Bay, were taken in the Ikatan-Shumagin Island district, where they were tagged. If we take from the total number tagged those which were recaptured in other localities than Bristol Bay and calculate the percentage of the remainder which were taken in Bristol Bay, the result is very close to 10 per cent. It seems practically certain, however, that more than 10 per cent of the total run to Bristol Bay are taken by the fishery. The results are, of course, affected materially by the closing of the season in Bristol Bay on July 25, but it is not likely that this accounts in any great measure for the small number of returns. It is possible that this low percentage taken in Bristol Bay indicates that races bound for small local streams form a more important item in the Ikatan-Shumagin Island schools than is supposed.

The tagging experiments in 1922 and 1923 have agreed in demonstrating that the red-salmon colonies of the Chignik and Karluk Rivers, of Olga Bay, and Cook Inlet do not extend their range in any numbers as far to the westward as the Shumagin Islands and are therefore not at all involved in the fisheries of Morzhovoi and Ikatan Bays. No salmon tagged in either of these bays in 1922 or 1923 were captured even as far eastward as the Shumagin Islands. Only among those tagged

at Unga Island were eastern representatives found, and these in such limited numbers as possessed no practical significance. In 1923 there were tagged at Unga Island 3,432 red salmon. Only 20 of this number, as shown in Tables 30 and 31, were captured east of Unga, 11 being taken at Chignik, 1 at Karluk, 2 at Alitak, and 2 in Cook Inlet.

On the basis of the 1923 experiments, we are justified in repeating that no appreciable draft will be made on the salmon supply of the Chignik and Karluk Rivers and Cook Inlet by fisheries located in the Shumagin Islands and in Morzhovoi and Ikatan Bays. The red-salmon fisheries of these localities are recruited largely from the streams that enter Bristol Bay, and they should be subjected to whatever restrictions are elsewhere found necessary to protect the Bristol Bay runs.

### OTHER SPECIES

Although attention was focused on a study of the migration of the red salmon, 624 dog and 199 humpback salmon were also tagged. A very few silver salmon were included, as well as two king salmon. Neither of the kings was reported and but four of the silvers. Two of these were tagged in Ikatan Bay on July 11 and were recovered in the same place on the 13th. Two were tagged in Morzhovoi Bay on July 18, one of which was recovered in Ikatan Bay on the 24th and the other at Chignik on August 15. Data on the number of silver salmon tagged will be found in the list given on page 33. Since only 22 individuals in all were tagged, it is obvious that no reliable conclusions can be drawn.

*Humpback salmon.*—On July 6 there were tagged 199 humpback salmon from the Big Valley trap on Unga Island. The results of this experiment are given in Table 18. None of these fish were taken elsewhere than in the traps near where they were released and in the local fisheries along the southern shore of the peninsula. Although the number tagged is small, it seems probable that the humpbacks are very largely, if not exclusively, of local origin. It is well known that many of the small streams of this region support large runs of humpbacks, so that these results are not at all surprising. The returns amount to 13 per cent of the number tagged, and of this 8.5 per cent were taken on Unga Island. It would not appear from this that the fishery for humpback salmon was particularly intensive during 1923, but the intensity of the fishing for this species varies greatly from year to year, depending to a considerable extent upon the success of the red-salmon fishery. It is not safe to conclude, therefore, that the humpback runs can withstand any great increase in the present intensity of fishing.

*Dog salmon.*—Six hundred and twenty-four dog salmon were tagged in five different experiments. The returns are tabulated in detail in Tables 15, 17, 24, 26, and 28, and the more essential data are collected in Table 42. In addition to those tabulated, two individuals were tagged in Morzhovoi Bay on July 20 and both were subsequently taken—one in Morzhovoi Bay on the 29th and the other in Ikatan Bay on the 24th.

TABLE 42.—Returns from dog salmon. Percentage of total returns taken in each locality and median time en route, in days

Locality of recapture	Coal Harbor trap, Unga Island, July 4—55 tagged, 19 returned		Big Valley trap, Unga Island, July 6—190 tagged, 45 returned		Pacific American Fisheries trap No. 2, Ikatan Bay, July 11—36 tagged, 18 returned		Pacific American Fisheries trap No. 5, Morzhovoi Bay, July 13—171 tagged, 62 returned		Pacific American Fisheries trap No. 5, Morzhovoi Bay, July 18—172 tagged, 63 returned		Total number returned
	Per cent	Time in days	Per cent	Time in days	Per cent	Time in days	Per cent	Time in days	Per cent	Time in days	
Unga Island.....	3.6	4	3.7	9							9
Pavlof Bay.....	12.7	14	14.2	12	5.5	10	8.8	12	6.4	9	62
Thin Point.....			1.6	26			1.2	12	2.9	14	10
Morzhovoi Bay.....	1.8	23	2.1	17	5.5	9	23.4	10	22.1	7	85
Ikatan.....	1.8	12	1.1	7	38.9	2	2.3	5	5.2	6	30
Naknek.....	1.8	17									1
Kvichak.....	1.8	16									1
Nushagak.....	7.3	17	.5	33							5
Togiak.....	1.8	47									1
Yukon.....			.5								1
Kamchatka.....	1.8	45									1
Belkofski Bay.....							.6	10			1
Total.....	34.6		23.7		50.0		36.2		36.0		207

In general, it is apparent that the dog salmon are distributed from the Ikatan-Shumagin Island district over much the same territory as are the red salmon. Tags were reported from various points along the southern shore of the peninsula, from Bristol Bay, and from rivers to the north of Bristol Bay. It is interesting to note that this wide distribution only obtains in the case of the fish tagged near Unga Island; those tagged in Ikatan and Morzhovoi Bays were only taken locally. It may be that this is the result of a segregation of races—that the dog salmon bound for more distant streams do not enter Ikatan and Morzhovoi Bays—or it may be due to the fact that the Unga Island experiments were begun somewhat earlier in the season. It has been shown in the case of the red salmon that a much larger percentage of the fish found in Ikatan and Morzhovoi Bays late in the season are bound for local streams than is true during the height of the season. On account of the comparatively small number of dog salmon tagged the data are not sufficient to warrant definite conclusions on this point. Although, in so far as the general distribution is concerned, the dog salmon found in this district go to many of the same streams to which the red salmon found with them go, the percentage going to the more distant streams is apparently much lower, a much higher percentage being taken in local fisheries along the southern shore of the peninsula. Here again, however, the data are not sufficient to warrant final conclusions.

A unique and very interesting record is that of a fish tagged in the Coal Harbor trap on Unga Island and taken in the Pankara River, Kamchatka. The data were forwarded to the bureau by the director of the Far Eastern Fishery Board, Vladivostok. Regarding the recovery of this tag he states:

On August of this year, in the river Pankara in the district of Karagin, on the eastern shores of the peninsula of Kamchatka, a fish with the mark "U. S. B. F. No. 10358" was caught. The local residents did not pay any attention to this mark, and the fish was cleaned and salted, and in this form it was discovered by the agents of the Far Eastern Fishery Board at Vladivostok.

This fish, as far as we can judge in its salted state, was of the family *Oncorhynchus keta*, in all probability a male. The length of the fish is 59 centimeters, and it was in the spawning stage, as it was in "wedding dress" (changed color) and had grown teeth.

The record is important in that it indicates the possibility of a mingling, on the feeding grounds, of salmon from both the Asiatic and American shores of the north Pacific.

The data indicate that there are certain differences in the rate of travel of dog salmon when compared with red salmon. A comparison of the results of the experiment with dog salmon begun at Unga Island, July 6, with the results obtained with red salmon tagged the same day, shows that the two species required almost the same time to make the trip to Bristol Bay—about 16 days. In the case of the fish taken in local fishing areas along the southern shore of the peninsula, however, the dog salmon took a noticeably longer time, especially for the migration to Ikatan and Morzhovoi Bays. This may possibly be explained on the ground that most of the red salmon taken locally were actually bound for Bristol Bay and were therefore traveling more rapidly.

### HOMING INSTINCT IN TAGGED RED SALMON

Sufficient evidence had been obtained previous to this tagging experiment to demonstrate the practical unanimity with which salmon return to their native stream at spawning time. The most direct evidence has been derived from numerous marking experiments performed on fingerling salmon before they had left fresh water. The recapture of these, when they have returned to spawn on reaching maturity, has been invariably in the stream in which the marking experiment was conducted. Such cases number many hundreds and comprise a body of evidence in itself conclusive.

A less direct but equally important line of evidence is found in the fact that the salmon of different streams often possess obvious distinguishing characteristics, which mark them off as distinct races. The individuals of one race may be much smaller than those of another even when they are of the same age, or they may be longer and more slender; one may be consistently darker in coloration even when in the ocean, or the flesh may be redder and have more oil. Such differences could have arisen only by virtue of such a high degree of isolation and continuous in-breeding as would permit and foster divergence.

Among the other differences which thus arise are distinctive growth habits, which may register themselves in the structure of the scales and can be recognized when these are subjected to microscopic examination. These growth habits include amount and rapidity of growth both in stream and sea, the length of residence in fresh water, the final age at maturity, and many others.

As our experiments have shown, red salmon that were schooling in the vicinity of the Shumagin Islands and in Morzhovoi and Ikatan Bays preparatory to their spawning migration found their way when tagged to a large number of different rivers, some of which were located along the southern shores of the Alaska Peninsula, others along its northern shores in Bering Sea. That the majority of them were bound for Bristol Bay was but a corollary from the fact that Bristol Bay produces by far the most extensive red-salmon runs of these northern waters.

Tagged salmon were captured with the spawning runs of the Ugashik, Egegik, Naknek, Kvichak, and Nushagak Rivers, comprising all the red-salmon streams of Bristol Bay, and they were taken in sufficient numbers to warrant an inquiry as to



In the 71 Nushagak recaptures 58 per cent had, in their early history, left their native lake and descended to the sea when 1 year old and 42 per cent when 2 years old. Among the 228 Kvichak recaptures only 4 per cent belonged to the one-year-in-lake type, 84 per cent to the two-years-in-lake type, while 12 per cent had remained three years in the lake before migrating. The Nushagak is thus sharply distinguished from the Kvichak, and it is equally well marked off in the above respect from all the other streams in Bristol Bay. Examination of the table indicates that none of the other Bristol Bay streams showed any considerable number of tagged fish recaptured which belonged to the one-year-in-lake type. It is a growth habit for the young red salmon in all these other streams to remain at least two years in fresh water. The Ugashik recaptures contained only 8 per cent of the one-year-in-lake group, the Egegik 1 per cent, the Naknek 6 per cent, and the Kvichak 4 per cent. When it is considered that the fishes that were recaptured in these different streams had been tagged at the same places south of the Alaska Peninsula and on the same dates in a series throughout the fishing season, their final segregation to the different streams on any basis, such as their early history as fingerlings, can have but one significance. In certain of the streams this has been verified by a study of the fingerlings themselves on their way to sea. They agree with the scales of the adult fish that return to the same streams, and all lines of inquiry point to the same inevitable conclusion.

Three localities given in Table 43—Morzhovoi Lake, Thin Point, and Cold Bay—are located on the south side of the peninsula near its western extremity. The tagged sockeyes recaptured in these localities differed from all the Bristol Bay groups in the almost total absence of the two-years-in-lake type. Even the Nushagak, it will be recalled, had 42 per cent of this class; but Morzhovoi Lake, among 38 specimens, had but 1 per cent; Thin Point, with 130 specimens, had but 14 per cent; and Cold Bay, with 61 individuals, but 3 per cent. Yet Pavlof and Volcano Bays, also on the southern side of the peninsula a little farther to the east, had 39 per cent of the two-years-in-lake type.

On the basis of the limited evidence available to us, therefore, we are brought to the conclusion that red salmon captured in any trap in the Shumagin Islands, in Morzhovoi Bay, or in Ikatan Bay on any day during the fishing season contained an assemblage of individuals that had originated in diverse streams, some of which were far distant from the point of capture and others nearer at hand, and that when liberated these salmon proceeded each to the stream of its origin. The theory widely entertained by those engaged in the commercial fisheries—that the salmon constituting the runs to Bristol Bay form an undifferentiated lot and pass into one or the other stream in accordance with the direction of the wind or other external circumstance—is thus seen to be wholly without foundation. There is nothing difficult or abstruse in this problem. The facts speak for themselves to anyone who will take the trouble to examine the evidence. It can not be too soon realized by those interested in the continuance of our salmon industry that each stream is an independent unit, that its salmon runs are maintained if sufficient numbers are reserved for seed and are destroyed if this is not done. The Ugashik, the Egegik, the Nushagak, the Naknek and the Kvichak—each depends for its maintenance as an important salmon stream on the fish that are permitted to spawn within its own watershed.