NOAA Technical Report NMFS SSRF-689

Ocean Distribution of Stocks of Pacific Salmon, *Oncorhynchus* spp., and Steelhead Trout, *Salmo gairdnerii*, as Shown By Tagging Experiments

Charts of Tag Recoveries by Canada, Japan, and the United States, 1956-69

ROBERT R. FRENCH, RICHARD G. BAKKALA, and DOYLE F. SUTHERLAND

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Ocean Distribution of Stocks of Pacific Salmon, *Oncorhynchus* spp., and Steelhead Trout, *Salmo gairdnerii*, as Shown by Tagging Experiments

Charts of Tag Recoveries by Canada, Japan, and the United States, 1956-69

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ABSTRACT

Extensive tagging experiments by member nations of the International North Pacific Fisheries Commission—Canada, Japan, and the United States—have been conducted in offshore waters of the North Pacific Ocean to investigate the ocean distribution of stocks of Pacific salmon, *Oncorhynchus* spp. This effort has resulted in the recovery of 15,215 tags including steelhead trout, *Salmo gairdnerii*, from inshore and high-seas areas. To provide a reference by which the offshore distribution of the various stocks can be readily seen as shown by tagging results through 1969, the tagging locations at sea are illustrated for each species and recovery area.

INTRODUCTION

The Canadian National Section of the International North Pacific Fisheries Commission (INFPC) provided a list (Aro, Thomson, and Giovando 1971a, 1971b)[3] of all tag recoveries of Pacific salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdnerii*, reported by the three member nations of the Commission—Canada, Japan, and the United States. This impressive listing of 15,215 tag recoveries includes basic biological data for each fish and lists recoveries by areas and subareas of the Asian and North American continents and also by oceanic areas of the North Pacific Ocean, Bering Sea, Okhotsk Sea, and Sea of Japan. The extremely valuable and useful listing has prompted us to prepare charts showing the tagging locations on the high seas of returns to the various inshore areas. The atlas will provide a reference by which the high-seas distribution (as shown by results from tagging up to 1969) of any of the several species and many stocks of Asian and North American salmon and steelhead trout can be quickly determined by examination of the appropriate figure.

Application of the tag and recovery method to the identification and distribution of salmon and steelhead trout stocks on the high seas has as its basis the strong tendency of the fish to return to their home stream to spawn. When a fish is caught in coastal or inland waters in an advanced state of sexual maturity, it is assumed to have originated from that area. The possibility of individual fish straying to other areas or being intercepted enroute to its home stream cannot be fully discounted. Such instances are believed to be few in number and probably have little effect on the general pattern of distribution revealed by the data.

The origins of Pacific salmon and steelhead trout tagged offshore and recovered offshore are not known. They are included as added information on the spatial distribution of each species on the high seas.

The oceanic distribution of the various stocks as revealed by the recovery of tagged fish is based solely on their location (within 1° lat. × 1° long.) at the time of tagging. Although their spatial movement prior to tagging and subsequent to tagging until time of recapture is not known, a general profile of the oceanic distribution of the major stocks may be constructed from the recovery data. For some stocks sufficient numbers of fish were recovered from tagging over broad areas to show progressive changes in population density from high to low abundance; reliable conclusions, however,

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[3]Aro, K. V., A. Thomson, and D. P. Giovando. 1971a. Recoveries of salmon tagged offshore in the North Pacific Ocean by Canada, Japan, and the United States, 1956 to 1969. Fish. Res. Board Can., Manuscr. Rep. No. 1147, 493 p.

Aro, K. V., A. Thomson, and D. P. Giovando. 1971b. Summaries of salmon tag recoveries in North Pacific coastal and high seas areas from salmon tagging in INPFC Statistical Areas in the North Pacific Ocean by Canada, Japan, and the United States, 1956 to 1969. Fish. Res. Board Can., Manuscr. Rep. No. 1148, 641 p.

regarding centers of population and distribution are dependent upon further analysis of tagging effort. Information on tagging effort is shown for those salmon species (sockeye, chum, pink, and coho) for which it was available. These tagging effort data are not directly applicable to the tag recovery information, however, since the available effort data cover a longer series of years (1956-71) than do the recoveries (1956-69). They do serve to illustrate the numbers tagged in relation to the number of recoveries from various areas. The numbers tagged in 1970-71 were a small proportion of the total numbers tagged from 1956 to 1969.

For many of the minor stocks the recoveries of tagged fish simply reveal their occurrence at certain locations in offshore waters. Because salmon tagging experiments were primarily performed in spring and summer months, conclusions inferred about their distribution apply to those periods.

The recovery area designations defined by Canadian scientists (Aro et al. 1971a, see footnote 3) are retained in this atlas. To reduce the number of figures to practical levels, certain recovery areas were grouped into a single area. The original tag recovery areas are listed in Table 1 and shown in Figures 1-4. Numbers of recoveries are summarized in Table 2.

For each species, those fish recovered in coastal areas in the same year in which they were tagged are presented first. These recoveries in Asia and North America were sexually maturing at the time and place of tagging; the tagging locations provide information on distribution and migration of the fish during their final spring and summer at sea.

Tagging returns presented second for each species are those made on the high seas in year of tagging. The maturity of sockeye, *O. nerka*; chum, *O. keta*; and chinook, *O. tshawytscha*, salmon recovered at sea is generally known except in instances where weight or stage of gonad development was not recorded. The fish of unknown maturity may, therefore, be destined to remain at sea another year or more or they may be on their inshore migration to spawn. Pink, *O. gorbuscha*, and coho, *O. kisutch*, salmon are generally all mature at capture since immature forms are too small to be taken in commercial fishing gear used on the high seas. High-seas recoveries come from the Japanese mothership and land-based salmon fisheries which operate in the North Pacific Ocean and Bering Sea west of long. 175°W; the mothership fleet also operated in the Okhotsk Sea prior to 1959, which accounts for the few recoveries there. The distribution of tag returns, therefore, is largely dependent upon the time-space distribution of the mothership fleet. The Japanese offshore fishing area has been divided into five tag recovery areas (Fig. 2), the Sea of Japan, Okhotsk Sea, Bering Sea, the western Pacific Ocean west of long. 165°E, and the North Pacific Ocean south of the central and western Aleutian Islands between long. 175°W and 165°E.

The third series of charts for each species shows the tag recoveries subsequent to year of tagging which represent fish that were immature when tagged. Survival of the smaller immature fish is less than that for maturing fish and hence recoveries are much fewer. The oceanic distribution of immatures is therefore not as well illustrated by tagging as that for maturing salmon. Tagging of immatures took place mainly in the summer although some were tagged in the spring. The location of fish at time of tagging, therefore, mainly represents waters they inhabit during the summer.

Finally, for species in which data are available, we have shown the high-seas recoveries in years subsequent to tagging. These fish were, of course, immature at tagging and may or may not have been mature at recovery.

In the sections which follow we show tag recoveries by species and by geographical area of recovery. A key to the species is provided on the margin to facilitate locating charts for a particular species.

Table 1.—Code numbers for the geographical areas from which tagged fish were recovered.[1]

Area number	Geographical area of tag recovery
Asia (see Fig. 1)	
01	Honshu Island
02	Hokkaido Island
03	Kurile Islands
04	Japan Sea coast of USSR, south of Reineke Island
05	Amur River
06	Sakhalin Island
07	Okhotsk Sea coast, Reineke Island to Cape Tolstoi
08	Shelekhova Bay, Cape Tolstoi to Cape Yuzhnyi
09	West Kamchatka, south of Cape Yuzhnyi
10	East Kamchatka, south of Cape Afrika
11	Kamchatka River
12	Karaginskii District, Cape Afrika to Cape Olyutorskii
13	Siberian coast, north of Cape Olyutorskii
14	Anadyr River
15	USSR - Unknown
18	Asian coast - Other
19	Asian coast - Unknown
High Seas (see Fig. 2)	
20	Sea of Japan
21	Okhotsk Sea
22	Bering Sea, west of long. 170°E
23	Bering Sea, long. 170°E-175°E
24	Bering Sea, long. 175°E-180°E
25	Bering Sea, 180°-175°W
26	Bering Sea, east of long. 175°W
27	North Pacific, south of lat. 48°N and west of long. 165°E
28	North Pacific, south of lat. 48°N, long. 165°E-175°W
29	North Pacific, north of lat. 48°N and west of long. 160°E
30	North Pacific, north of lat. 48°N, long. 160°E-165°E
31	North Pacific, north of lat. 48°N, long. 165°E-170°E
32	North Pacific, north of lat. 48°N, long. 170°E-175°E
33	North Pacific, north of lat. 48°N, long. 175°E-180°
34	North Pacific, north of lat. 48°N, long. 180°-175°W
35	North Pacific, long. 145°W-160°W
37	North Pacific, north of lat. 50°N and east of long. 145°W
38	North Pacific, south of lat. 50°N and east of long. 145°W
39	High Seas - Unknown
Alaska (see Figs. 3, 4)	
40	North of Cape Prince of Wales, Kotzebue Sound
41	Norton Sound Area, Cape Prince of Wales to Stuart Island
42	Yukon River
43	Yukon River to Kuskokwim River, Cape Romanzof to Cape Avinof
44	Kuskokwim River and Bay
45	Togiak vicinity, Cape Newenham to Cape Constantine
46	Nushagak vicinity
47	Naknek-Kvichak
48	Egegik
49	Ugashik
50	Ugashik to Unimak Pass, north side of Alaska Peninsula
51	Bristol Bay - Unknown, somewhere within areas 45-49
52	Aleutian Islands, west of Unimak Pass
53	South side of Alaska Peninsula, west of long. 159°W
54	South side of Alaska Peninsula, east of long. 159°W
55	Kodiak Island, Shelikof Strait side
56	Kodiak Island, Gulf of Alaska side
57	Cook Inlet, Cape Douglas to Gore Point
58	Southeast side Kenai Peninsula, Gore Point to Cape Fairfield
59	Prince William Sound, Cape Fairfield to Point Steele, Hinchinbrook Island
60	Copper River and Bering River
61	Yakutat District
62	Southeastern Alaska, Icy Strait District
63	Southeastern Alaska, Chatham District
64	Southeastern Alaska, Petersburg District
65	Southeastern Alaska, Prince of Wales District
66	Southeastern Alaska, Ketchikan District
67	Southeastern Alaska - Unknown
68	Alaska - Other
69	Alaska - Unknown
British Columbia (see Fig. 4)	
70	Queen Charlotte Islands
71	Nass River
72	Skeena River
73	Central British Columbia
74	Rivers Inlet and Smith Inlet
75	Queen Charlotte Strait and Johnstone Strait
76	Strait of Georgia
77	Fraser River and Strait of Juan de Fuca, Canadian waters
78	West coast of Vancouver Island
79	British Columbia - Other and Unknown
Washington, Oregon, Idaho, and California (see Figs. 3, 4)	
80	Strait of Juan de Fuca, United States waters
81	Salmon Bank
82	Skagit River
83	Puget Sound
84	Outer Washington coast, south of Cape Flattery
85	Columbia River, including entire Columbia River drainage
89	Washington State - Unknown
90	Oregon, excluding Columbia River drainage
91	California
Other areas	
98	North America coast - Unknown
99	Entirely unknown

[1]This area listing is taken from Aro et al. 1971a, 1971b (see text footnote 3).

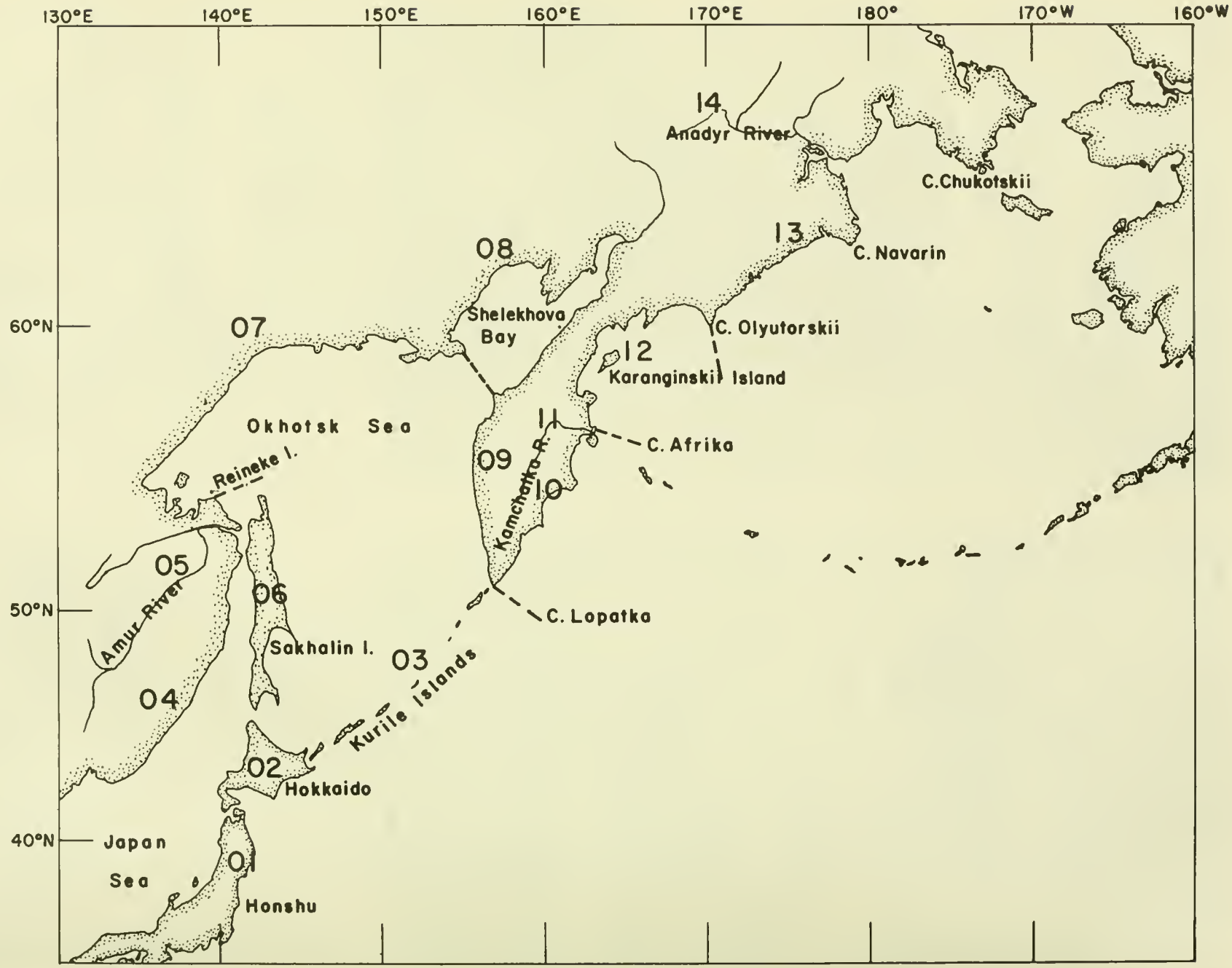

Figure 1.—Recovery areas in Asia.

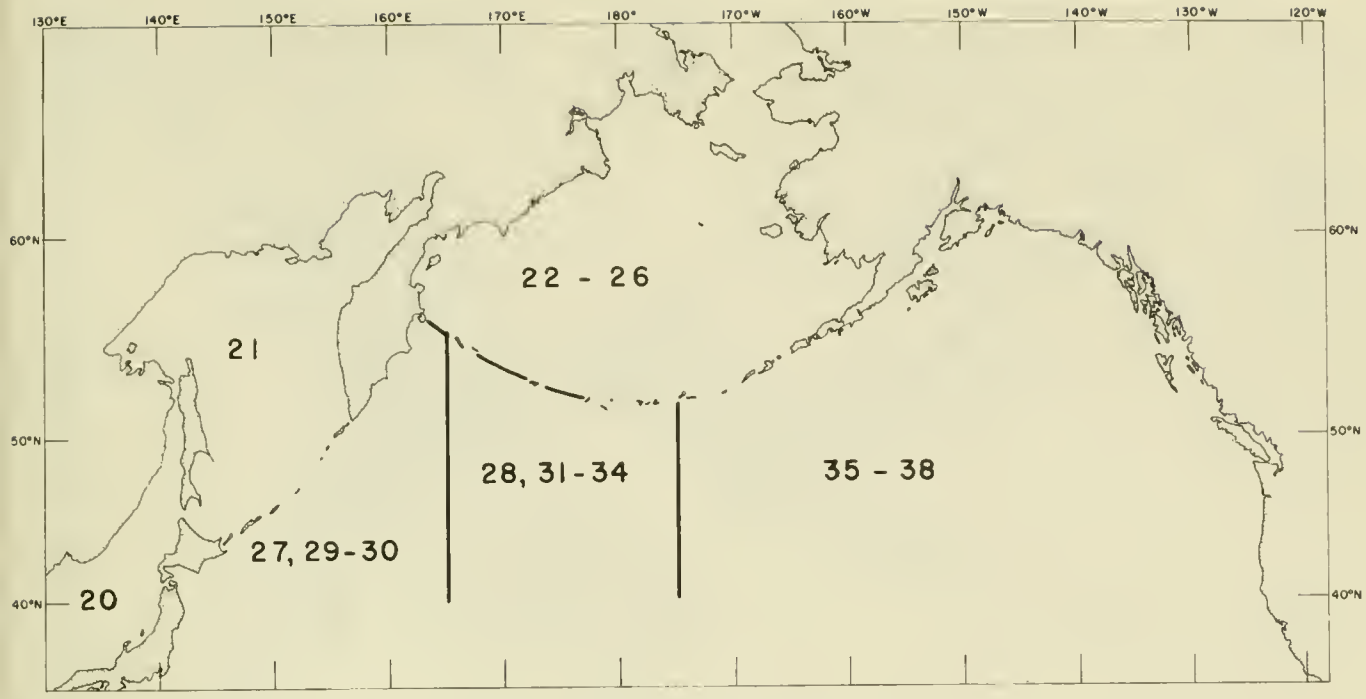

Figure 2.—Recovery areas on the high seas.

Table 2.—Recoveries during year of tagging and in subsequent years for Pacific salmon and steelhead trout tagged offshore in the North Pacific Ocean by Canada, Japan, and the United States, 1956-69 (from Aro et al. 1971a, see text footnote 3).

Recovery period and species	Canada	Japan	United States		Total
			FRI[1]	ADFG[2]	
Recoveries in tagging year					
Sockeye	2,203	853	2,730	29	5,815
Chum	374	750	884	16	2,024
Pink	1,214	1,420	2,128	463	5,225
Coho	245	83	373	95	796
Chinook	22	3	47	2	74
Steelhead	37		12		49
Total	4,095	3,109	6,174	605	13,983
Recoveries in years subsequent to tagging year					
Sockeye	32	77	379		488
Chum	20	91	349		460
Pink			54		54
Coho			178	1	179
Chinook	1	7	27		35
Steelhead	9		7		16
Total	62	175	994	1	1,232
Grand total	4,157	3,284	7,168	606	15,215

[1]Fisheries Research Institute, University of Washington.
[2]Alaska Department of Fish and Game.

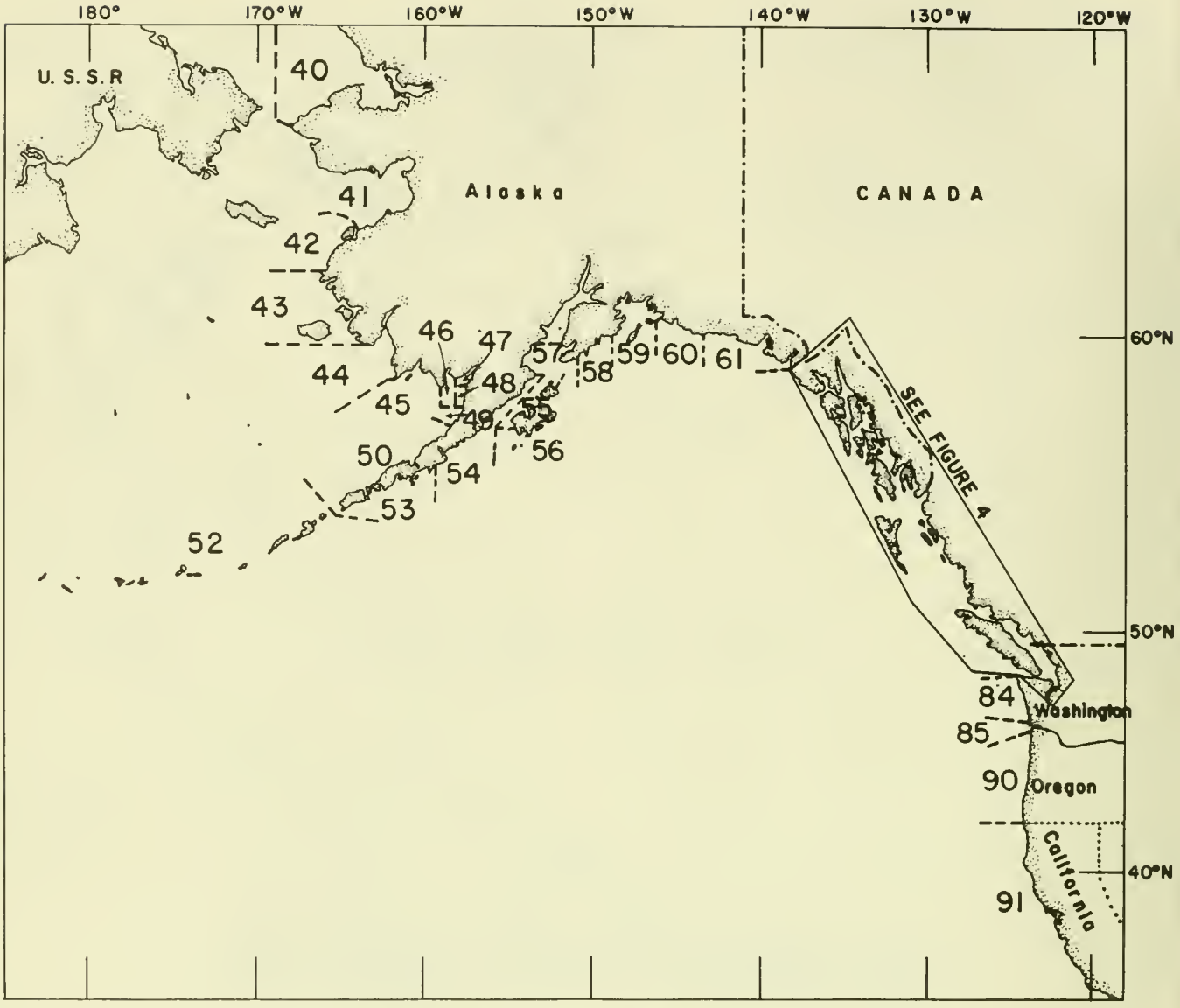

Figure 3.—Recovery areas in North America (inset enlarged in Fig. 4).

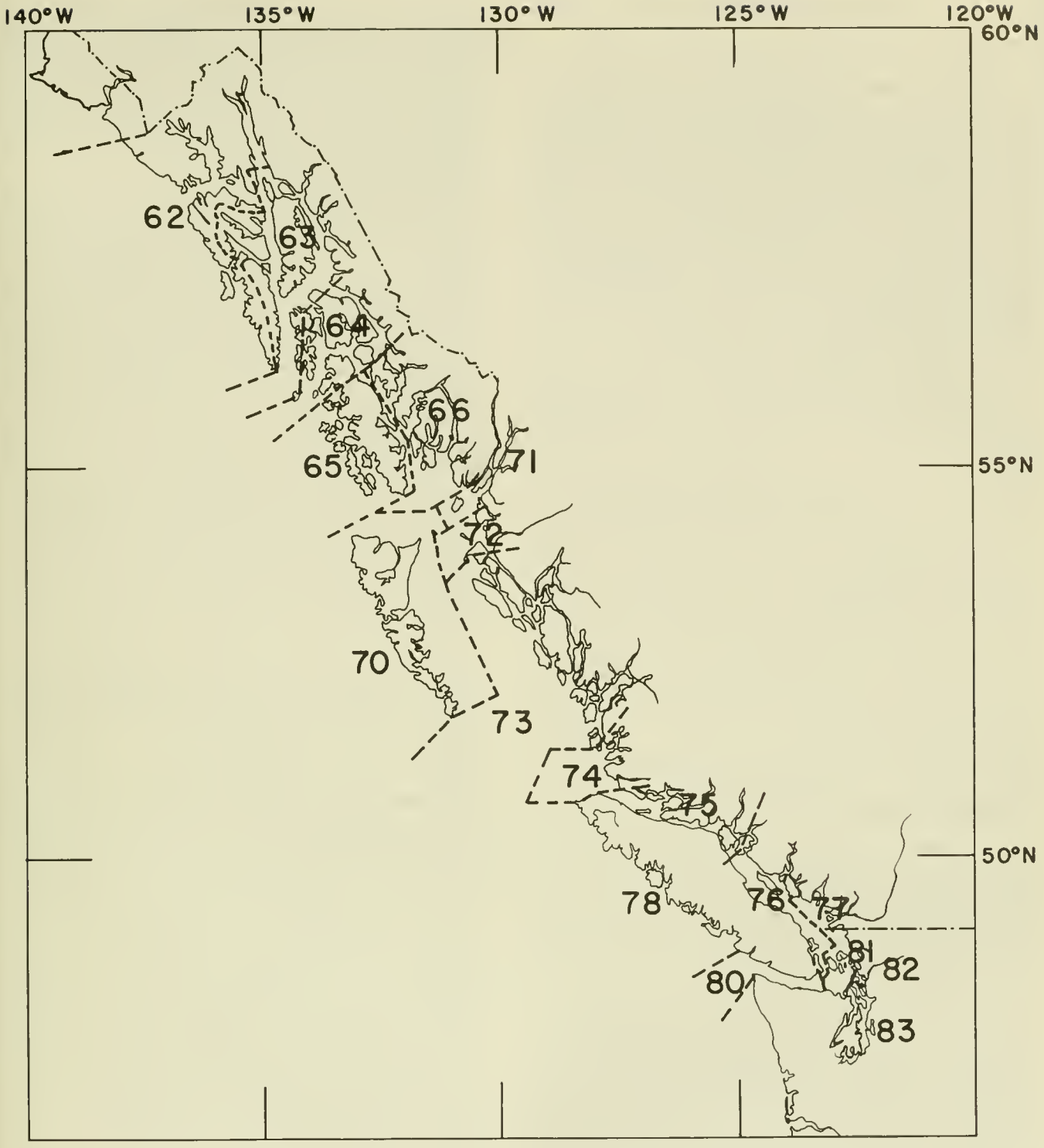

Figure 4.—Recovery areas in southeastern Alaska, British Columbia, and Puget Sound.

SOCKEYE SALMON

Figures 5-32

Sockeye salmon are found in Asia, principally in river systems of the Kamchatka Peninsula, and in North America in river systems from northern and western Alaska, south-eastward to the Columbia River in the State of Washington (Margolis et al. 1966). It is generally recognized that the total abundance of North American sockeye salmon is greater than that of Asian sockeye salmon (Kasahara 1961). It might be expected, therefore, that in tagging experiments made throughout the North Pacific Ocean and Bering Sea where sockeye salmon occur, most of the recoveries would be from North American streams.

Total coastal recoveries of sockeye salmon (Fig. 6) show that most of the releases were made in areas along the Aleutian Islands and in the northeastern Pacific Ocean. The recoveries reflect the main tagging effort which was concentrated along the Aleutian Islands by the United States (mainly work done by the Fisheries Research Institute, University of Washington) and in the northeastern Pacific by the United States and Canada (Fig. 5). The recoveries also illustrate rather well the distribution of sockeye salmon at sea. From south to north the tag returns show that sockeye salmon were distributed from near lat. 46°N in the North Pacific to near lat. 59°N in the Bering Sea. The east-west distribution extends from the North American coast to the Kamchatka Peninsula in the North Pacific; in the Bering Sea, recoveries were primarily from tagging areas in the southeastern part of the Bering Sea.

Coastal Recoveries in Year Tagged

Asian stocks (Figs. 7, 8).—The distribution of maturing sockeye salmon from Asian streams (Fig. 7) as reflected by the release locations and coastal recoveries is confined to waters west of long. 179°W in the northwestern Pacific Ocean. Southern limits of distribution were near lat. 46°N.

West and East Kamchatka.—The distribution of sockeye salmon returning to Kamchatka is illustrated in Figure 8. Stocks from the east and west coasts of Kamchatka (including three recoveries made in the area from the Okhotsk Sea coast and Shelekhova Bay) were from similar tagging areas of the ocean. This, as explained above for all Asian stocks, was the northwestern Pacific Ocean mainly west of long. 175°E. Included with the tagging locations of the east Kamchatka stocks are locations of four fish that were recovered along the Bering Sea coast from the Karaginskii District to the Anadyr River, which showed a similar distribution to the Kamchatkan stocks.

North American stocks (Figs. 9-20).—North American sockeye salmon stocks, on the basis of coastal tag recoveries, were widespread in the North Pacific (Fig. 9). Coastal recoveries came from tagging areas near lat. 46°N in the northeastern Pacific, as far west as the vicinity of long. 166°E in the northwestern Pacific and from near lat. 58°N in the central Bering Sea. The largest number of recoveries came from tagging areas off the Aleutian Islands and in the northeastern Pacific Ocean.

Western Alaska.—Recoveries in western Alaska are illustrated according to various salmon producing systems. The few Norton Sound and Kuskokwim River sockeye salmon recoveries generally came from tagging off the Aleutian Islands (Fig. 10). One fish came from the Gulf of Alaska. The distributions of tagged fish that were recovered in the important and major spawning systems of Bristol Bay (Togiak, Nushagak, Naknek-Kvichak, Egegik, and Ugashik rivers) are shown in Figures 10-14. In general each river system shows the same oceanic distribution with most recoveries coming from tagging areas along the Aleutian Islands and the northeastern Pacific Ocean. The westernmost tagged fish that was recovered in western Alaska was recovered in the Egegik area; this fish was tagged at long. 166°51′E-lat. 50°47′N. The easternmost tagged fish recovered in western Alaska were from the Nushagak area; these were tagged near long. 140°W.

Central Alaska.—Recoveries on the south side of the Alaska Peninsula east of long. 159°W, which includes the Chignik area (Fig. 15), came mainly from tagging in the Gulf of Alaska.

Kodiak Island recoveries (Fig. 15) came from a slightly broader area of the Gulf of Alaska and northeastern Pacific Ocean than those from the south side of the Alaska Peninsula. The southernmost tagging point producing a recovery in Kodiak Island was at lat. 46°N (at long. 159°30′W). Two recoveries on Kodiak Island were tagged as far west as the waters off the central Aleutian Islands, near long. 176°W.

Cook Inlet recoveries (Fig. 16) were from tagging primarily in the northeastern Pacific Ocean and Gulf of Alaska north of lat. 50°N and east of long. 156°W. Four recoveries were from tagging south of the eastern Aleutian Islands and Alaska Peninsula. Tag recoveries in Prince William Sound came primarily from releases in the Gulf of Alaska (Fig. 16). These fish showed a more restricted distribution at time of tagging compared to other central Alaskan stocks. The majority of returns were from releases north of lat. 55°N. One recovery did come from as far south as lat. 49°N (at long. 140°W). Recoveries in Copper and Bering rivers showed a slightly broader ocean distribution than the Prince William Sound fish (Fig. 16), but most also came from releases north of lat. 55°N. These fish were also distributed mainly in the northern Gulf of Alaska compared to Cook Inlet and Kodiak Island stocks which were distributed farther to the south.

Southeastern Alaska.—Recovery areas within southeastern Alaska, including the Yakutat area, have been combined in one chart (Fig. 17). Most recoveries came from tagging north of lat. 50°N and east of long. 155°W. A small group of recoveries was from the area between lat. 46°N and 49°N and between long. 153°W and 161°W. Three recoveries came from as far west as waters off the central Aleutian Islands near long. 175°W, indicating extensive migrations for some of these fish at least in some years.

British Columbia.—Recoveries in British Columbia from offshore tagging were shown according to the major sockeye salmon producing areas (Figs. 18-20). Nass River recoveries (Fig. 18) were virtually all from tagging in the Gulf of Alaska east of long. 155°W and north of lat. 52°N. A single recovery came from the central Aleutian Islands area, long. 176°42′W and lat. 49°47′N. Skeena River tag recoveries were from offshore areas similar to those of the Nass River with the exception that Skeena River fish extended somewhat farther south (Fig. 18). Central British Columbia recoveries (Fig. 19) came from high-seas areas somewhat farther south than those of the Nass and Skeena rivers but showed generally the same distribution. The distribution of fish from Rivers and Smith inlets (Fig. 19) was similar to that of recoveries in central British Columbia, and the center of tag abundance for these areas was south of Nass and Skeena river stocks. Additional recoveries came from tagging around Vancouver Island. A single recovery from tagging at approximately long. 165°W (at lat. 49°N) was the second westernmost point of tagging for a recovery in British Columbia.

Sockeye salmon from the Fraser River, including recoveries made in the Strait of Juan de Fuca and the Salmon Banks fishing area (U.S. waters in northern Puget Sound), are shown in Figure 20. The ocean distribution of these fish primarily was the central part of the northeastern Pacific, with most recoveries coming from tagging between lat. 47°N and 56°N and between long. 139°W and 155°W. The westernmost tagging point for Fraser River fish was near long. 164°W (at about lat. 49°N). Although the distribution of important British Columbia sockeye salmon stocks overlapped in the northeastern Pacific Ocean, the center of abundance of the various stocks from north-to-south in the ocean appeared to be related to the north-to-south geographical location of their spawning region.

Washington State.—A small number of sockeye salmon of the Columbia River (a relatively minor stock) were recovered from scattered tagging locations in the northeastern Pacific (Fig. 20). These fish extended north to approximately lat. 55°30′N (at long. 144°W) and westward to about long. 153°W (at lat. 49°N).

High-Seas Recoveries in Year Tagged

High-seas recoveries of tagged sockeye salmon in the year tagged (almost all by the Japanese mothership salmon fishing fleet) are shown grouped in large divisions of the ocean. Recoveries in the Okhotsk and Bering seas (Fig. 21) were primarily of salmon tagged off the central Aleutian Islands, although a few came from tagging locations in the Bering Sea and the northwestern Pacific Ocean. Recoveries in the western North Pacific (Fig. 22) were mainly of salmon tagged within the area or adjacent to it. One recovery was made of a fish tagged as far east as long. 159°W at lat. 48°30′N. Recoveries made in the central and western North Pacific (recovery areas 28, 31-34) and including four recoveries made east of long. 175°W (areas 35-38) were mainly from tagging locations in the central and western North Pacific (Fig. 23). Three fish recovered in this area came from the northeastern Pacific at long. 143°W (at lat. 50°N) and long. 144°W (at lat. 48°N).

Coastal Recoveries Subsequent to Year of Tagging

Recoveries of tagged sockeye salmon in coastal areas subsequent to year of tagging indicate beyond doubt that the fish were immature at time of tagging. Recoveries, therefore, provide some insight into the distribution of the salmon as immatures.

Asian stocks (Fig. 24).—Only three sockeye salmon recoveries were made in Asia subsequent to the year of tagging. Two fish recovered in the Kamchatka River were tagged south of Adak Island and south of Kiska Island (Fig. 24). Another fish, recovered in the Karaginskii District, was tagged near long. 164°E and lat. 49°N.

North American stocks (Figs. 25-29).—North American recoveries of tagged fish subsequent to the year of tagging were much more numerous than Asian recoveries and came from broad areas of the ocean (Fig. 25). The two main areas contributing to the recoveries were in the northeastern Pacific Ocean and off the Aleutian Islands.

Northern and western Alaska.—Most western Alaska recoveries of sockeye salmon tagged as immatures came from tagging near the central Aleutian Islands (Fig. 26). A few were from the northeastern Pacific Ocean in the general vicinity of lat. 50°N and long. 150°W, and some returns were from taggings in the Bering Sea. These recoveries illustrated that immature sockeye salmon from western Alaska inhabit broad areas of the ocean much the same as the maturing fish from this area.

Central Alaska.—The area south of the Alaska Peninsula and Kodiak Island (Fig. 27) produced

recoveries from tagging as far west as the central Aleutian Islands (south of Adak Island) and from the northeastern Pacific Ocean as far south as lat. 47°50'N (at long. 145°W). Recoveries in the areas of Cook Inlet, Prince William Sound, and Copper and Bering rivers subsequent to year of tagging (Fig. 27) were from tagging off the central Aleutian Islands (four recoveries) and from the central part of the northeastern Pacific (between long. 143°W and 157°W and between lat. 47°N and 52°N).

Southeastern Alaska.—Southeastern Alaska recoveries of fish tagged as immatures were from three widely scattered areas (Fig. 28). Three recoveries came from tagging in the central Aleutian Islands area, four recoveries from the northeastern Pacific Ocean, and two recoveries from near coastal areas.

British Columbia.—Tag recoveries in northern and central British Columbia subsequent to year of tagging came from the same three general areas as southeastern Alaska returns (Fig. 29). A number of fish were from releases in the northeastern Pacific, five fish came from tagging in the central Aleutian Islands area and five fish from the coastal areas of the northern Gulf of Alaska. The last named fish were tagged as juveniles (age .0) in August during their first summer at sea and indicated a northwestward movement of the juveniles during their first summer at sea as pointed out by Hartt et al. (1969).

With Fraser River recoveries (Fig. 29) we have added recoveries around Vancouver Island, the Strait of Juan de Fuca, and Puget Sound inasmuch as most of these fish were probably Fraser River stock which is by far the most important stock in this area. These recoveries came from tagging along the southeastern Alaska coast, from near Prince William Sound, from near Kodiak Island (all tagged as age .0 fish), and from the central part of the northeastern Pacific. The recovery location of the fish tagged as juveniles further indicates the long northwestward migration of the fish during their first summer at sea.

In general the distribution of various stocks of sockeye salmon from river systems entering the northeastern Pacific Ocean as immatures in the spring and summer was south of their distribution as maturing fish the following spring. The tagging locations illustrate the long migrations made by the stocks as immatures. Although maturing stocks from central Alaska and from southeastern Alaska and British Columbia were distributed primarily in the northeastern Pacific in the spring, recoveries of fish tagged in the central Aleutian Islands area as immatures indicated extreme westward migrations of some elements of the stocks some years.

High-Seas Recoveries Subsequent to Year of Tagging

High-seas tag recoveries of immature sockeye salmon were grouped by major ocean areas. Recoveries in the Bering Sea (areas 22 and 26) came primarily from tagging off the Aleutian Islands, mostly south of Adak Island; two fish were from tagging near the east Kamchatka coast. One fish was from a tagging experiment near long. 162°W and lat. 48°N (Fig. 30). Recoveries in the western North Pacific Ocean (areas 27, 29, and 30) (Fig. 31) were mainly from tagging around the western Aleutian Islands and off the eastern coast of the Kamchatka Peninsula; four recoveries were from tagging south of Adak Island. The recoveries in the central and western North Pacific (areas 28, 31-34), which produced the most recoveries, were again mainly from tagging off the Aleutian Islands chain with a few recoveries from the western Bering Sea and northwestern Pacific (Fig. 32). Three fish were recovered from tagging in the northeastern Pacific. A single tag recovery (not shown) was made on the high seas east of long. 175° W and lat. 50°32'N, which was tagged south of Adak Island.

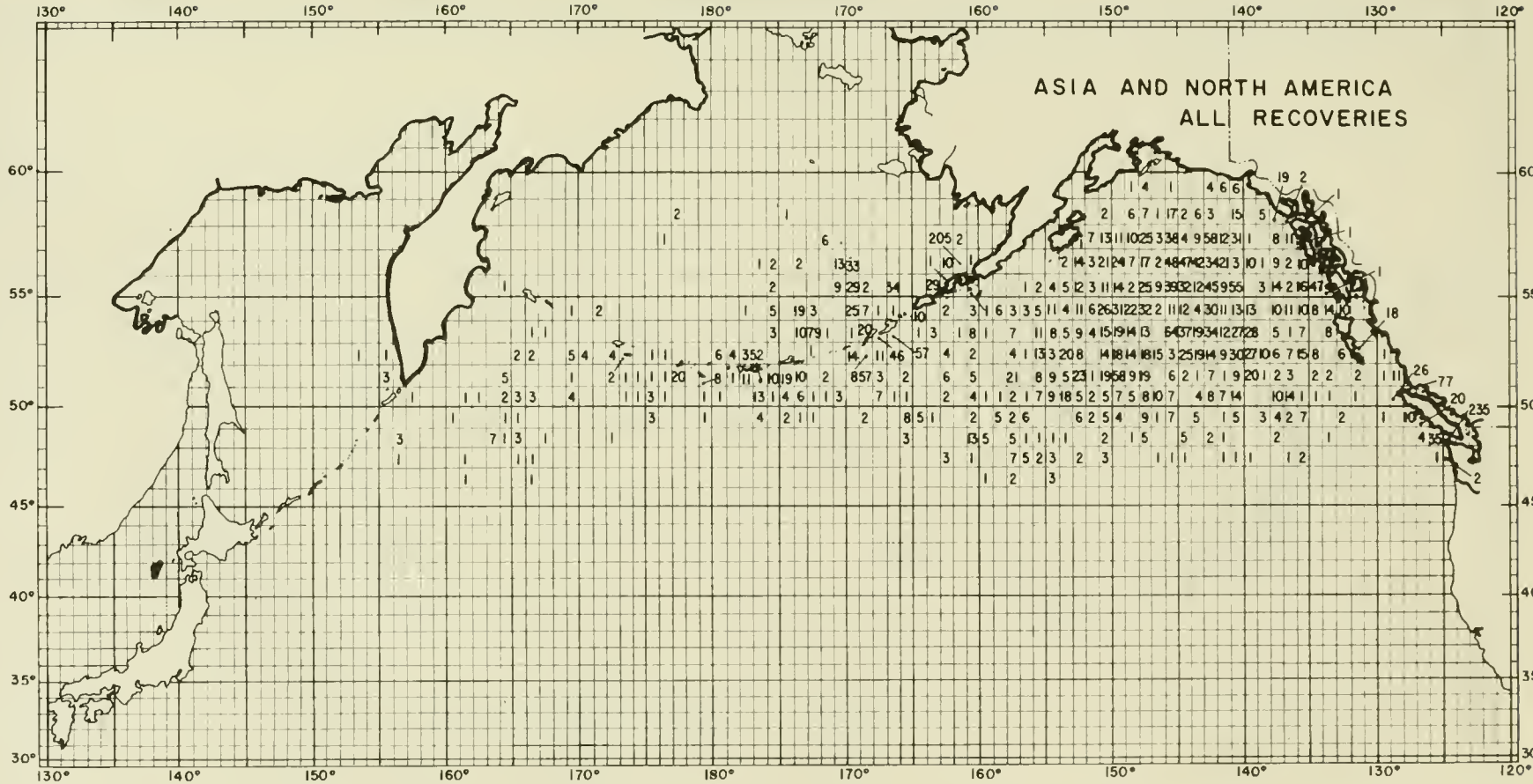

Figure 5.—Tagging locations of sockeye salmon recovered in Asia and North America.

Figure 6.—Number of immature and maturing sockeye salmon tagged by Canada, Japan, and the United States, 1956-71 (source of data: Allan Hartt, Fisheries Research Institute, University of Washington, Seattle, Wash.).

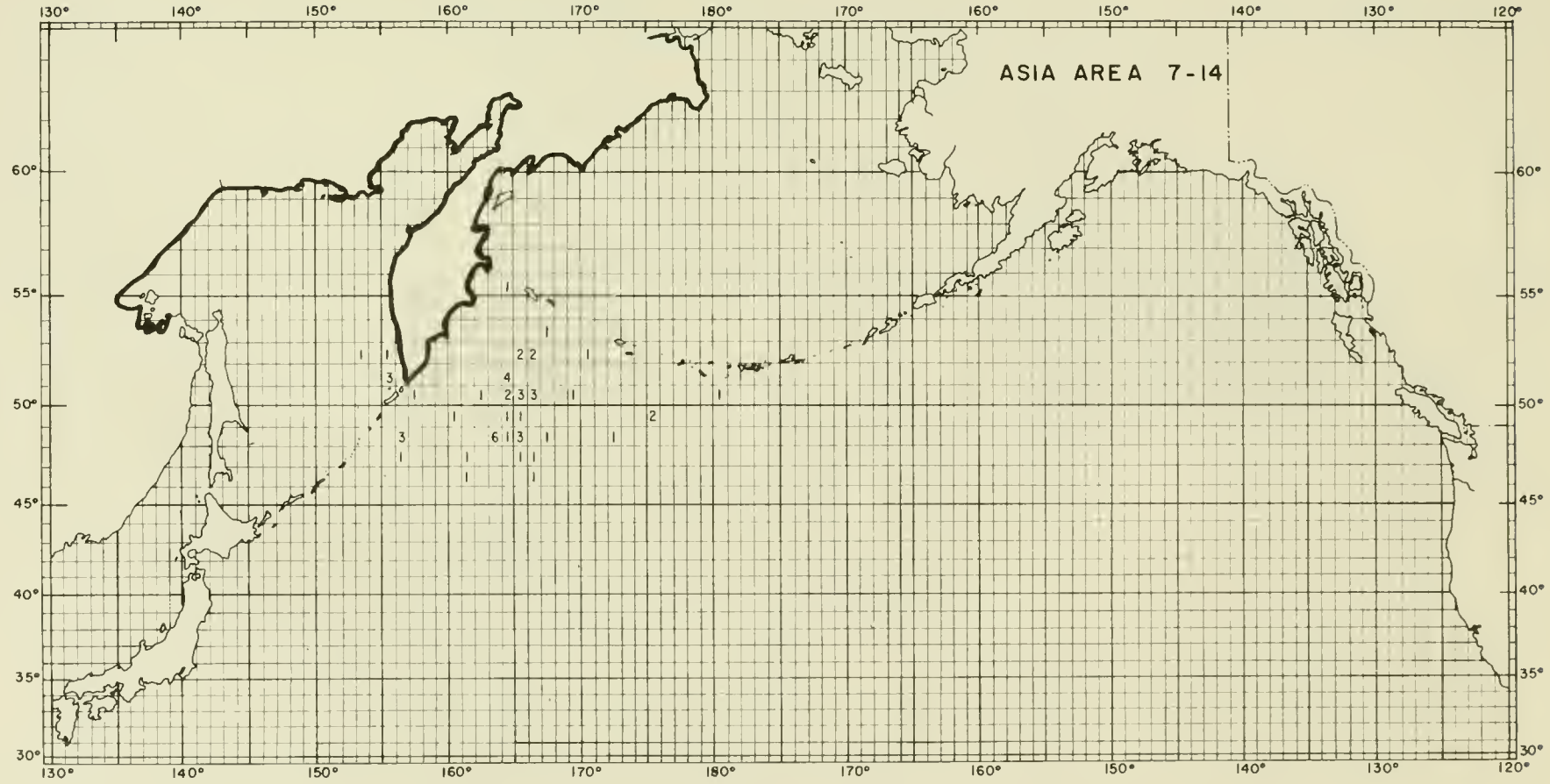

Figure 7.—Tagging locations of maturing sockeye salmon recovered in Asia.

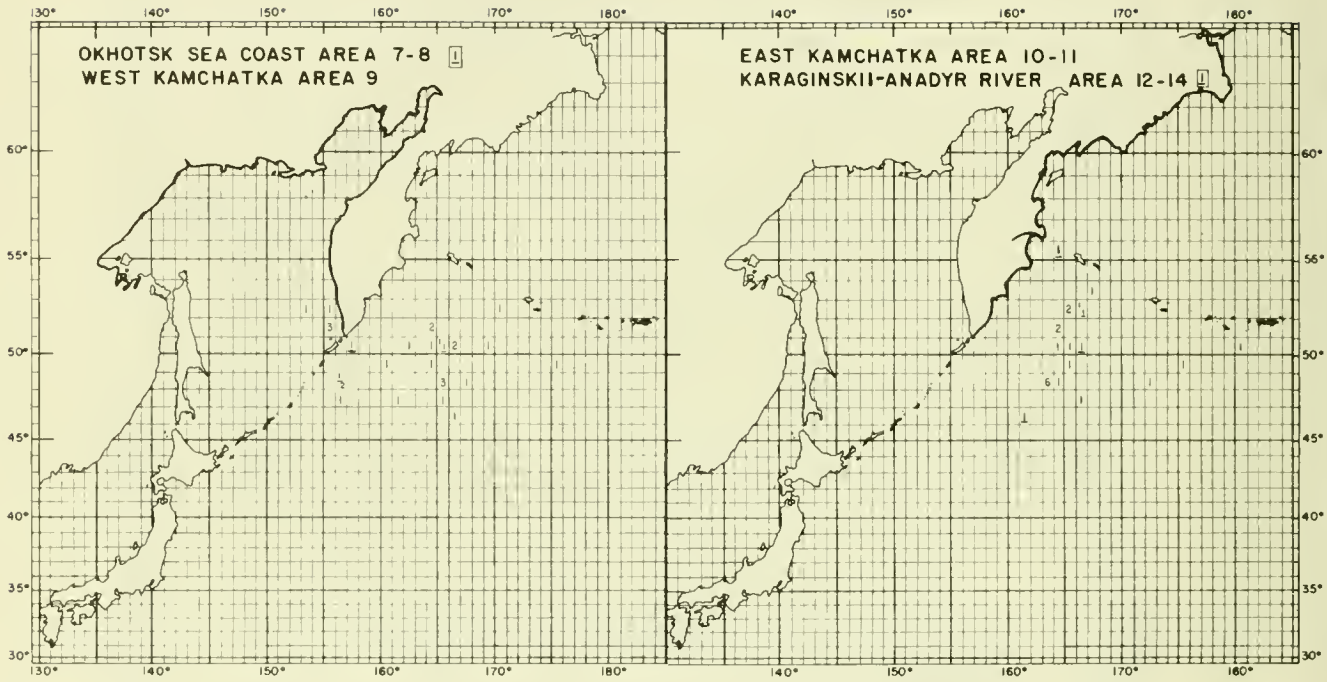

Figure 8.—Tagging locations of maturing sockeye salmon recovered in Asia—Okhotsk Sea coast, west Kamchatka, east Kamchatka, and Karaginskii-Anadyr River areas.

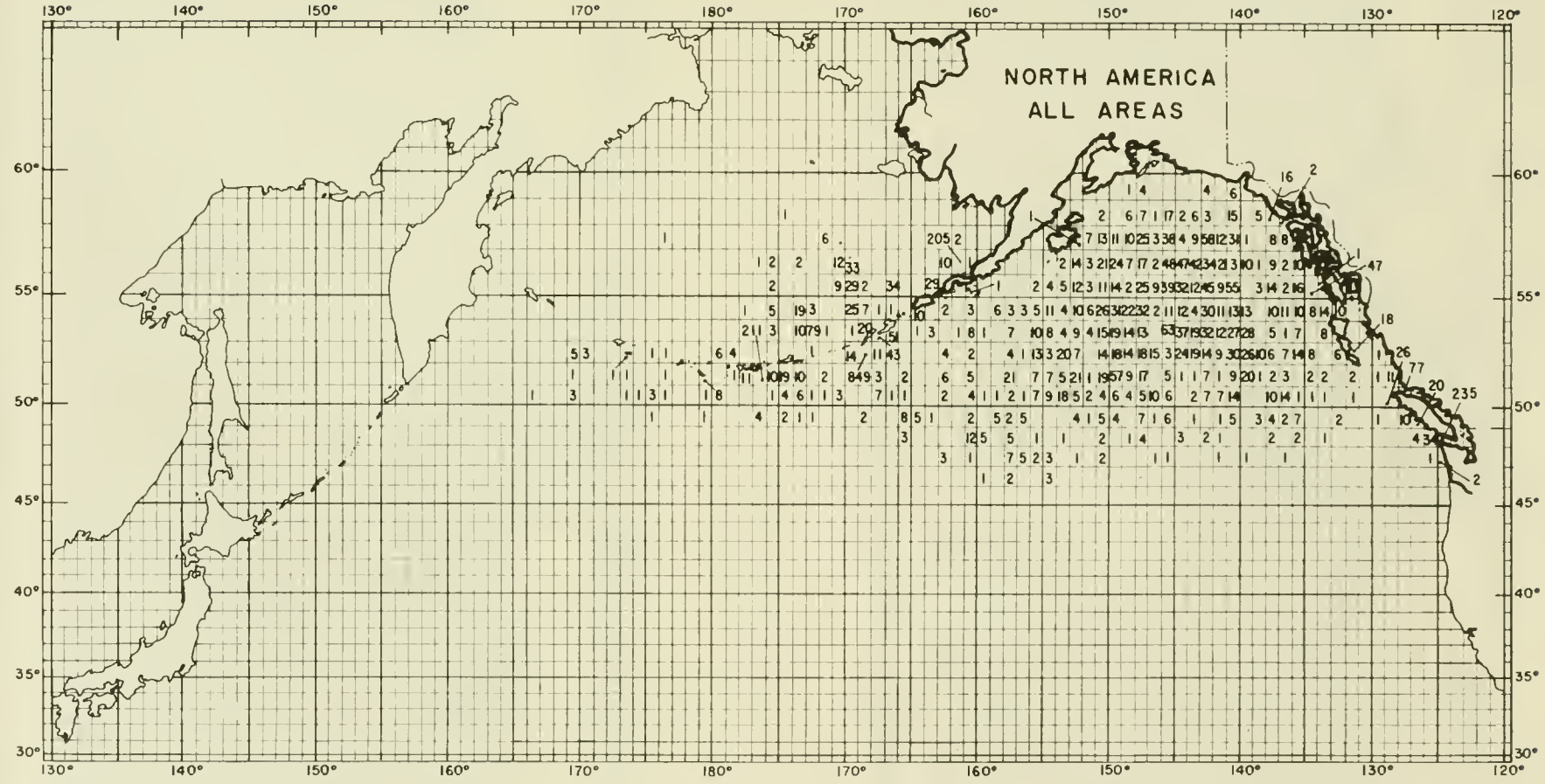

Figure 9.—Tagging locations of maturing sockeye salmon recovered in North America.

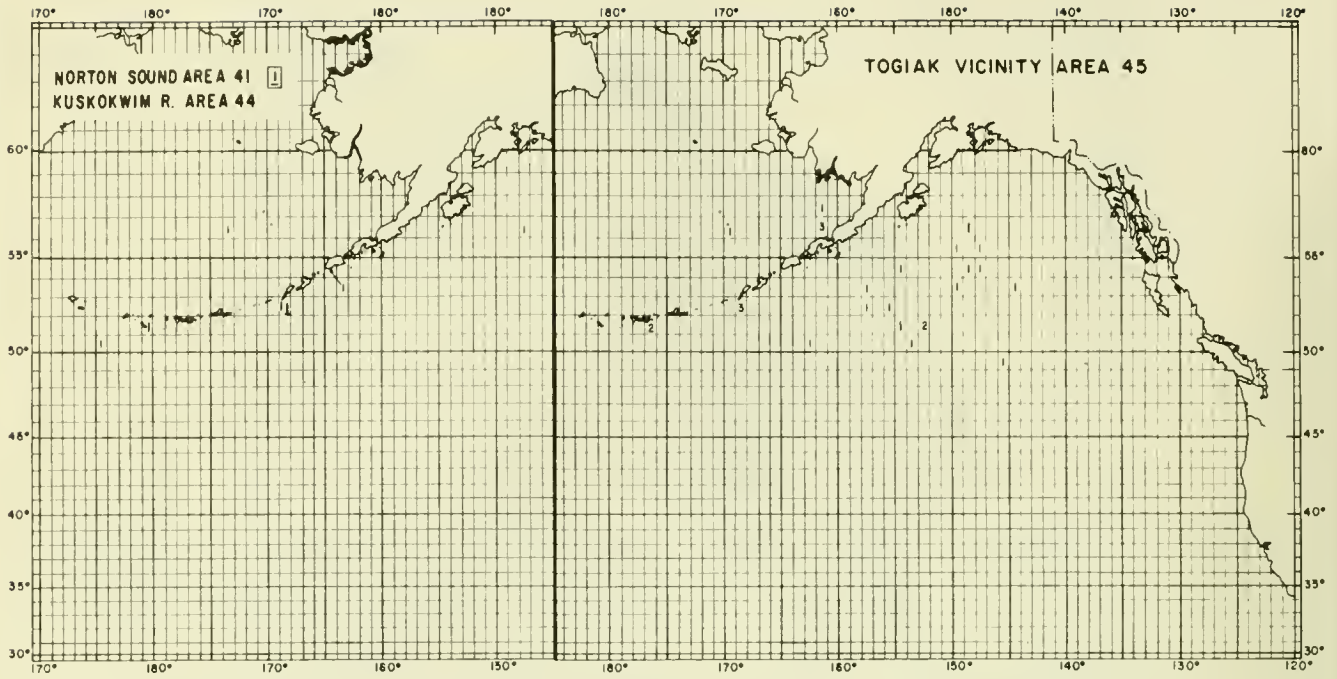

Figure 10.—Tagging locations of maturing sockeye salmon recovered in Norton Sound and Kuskokwim River and in Togiak vicinity.

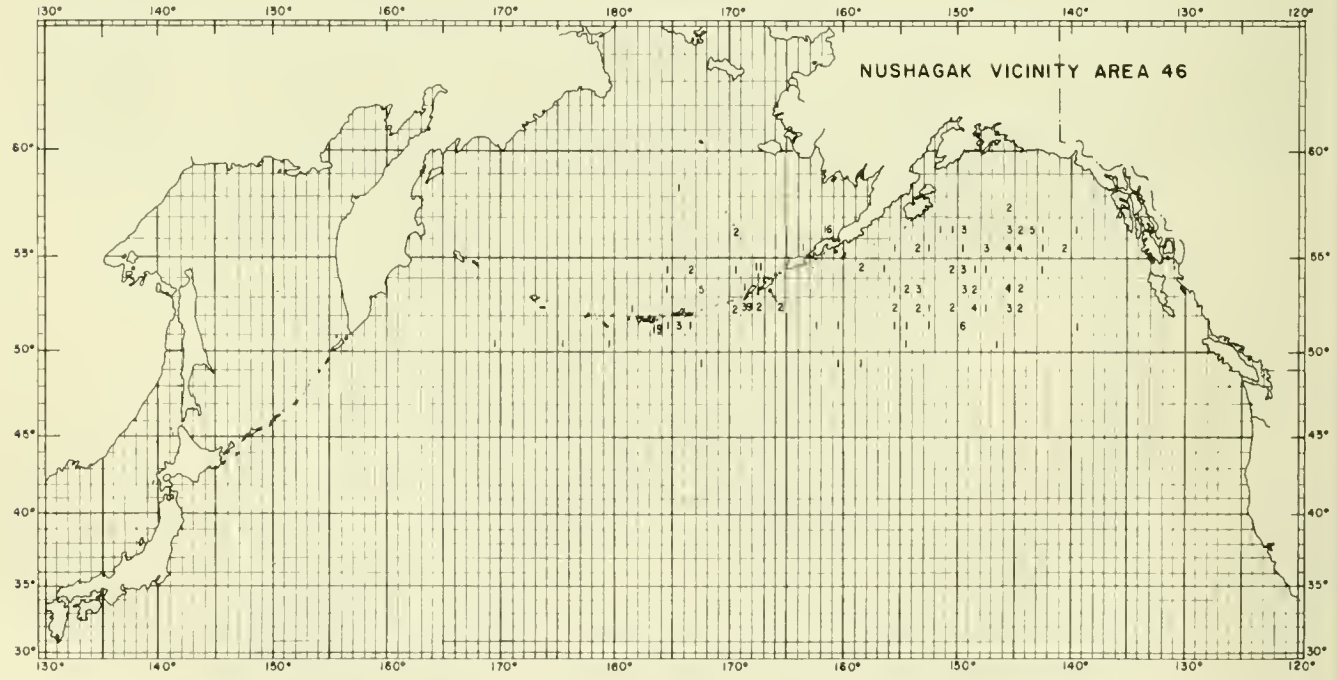

Figure 11.—Tagging locations of maturing sockeye salmon recovered in the Nushagak vicinity.

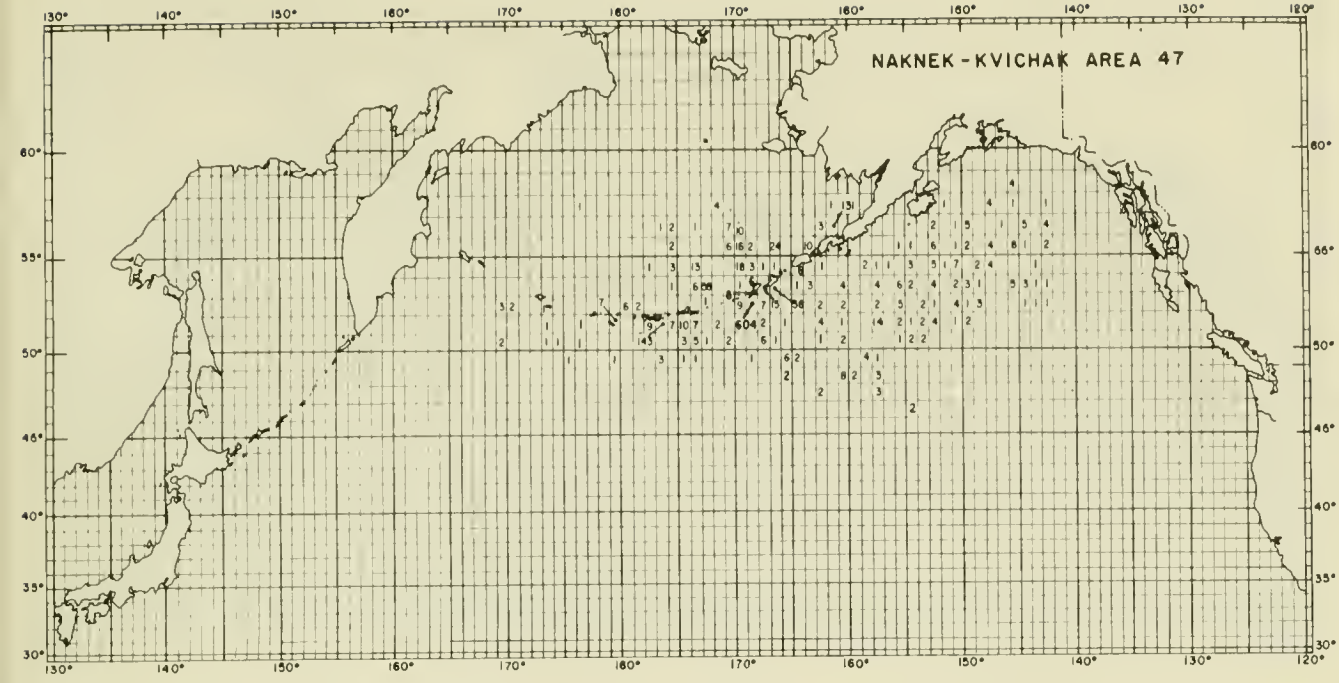

Figure 12.—Tagging locations of maturing sockeye salmon recovered in Naknek-Kvichak.

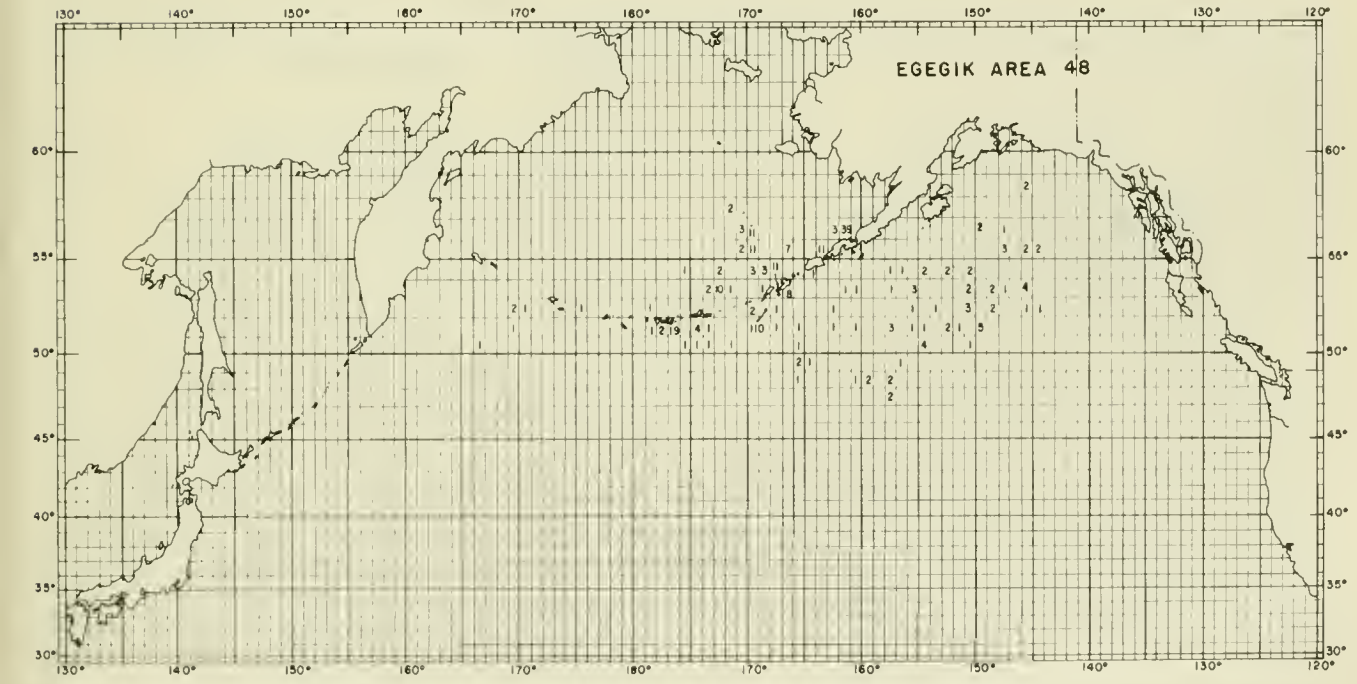

Figure 13.—Tagging locations of maturing sockeye salmon recovered in Egegik.

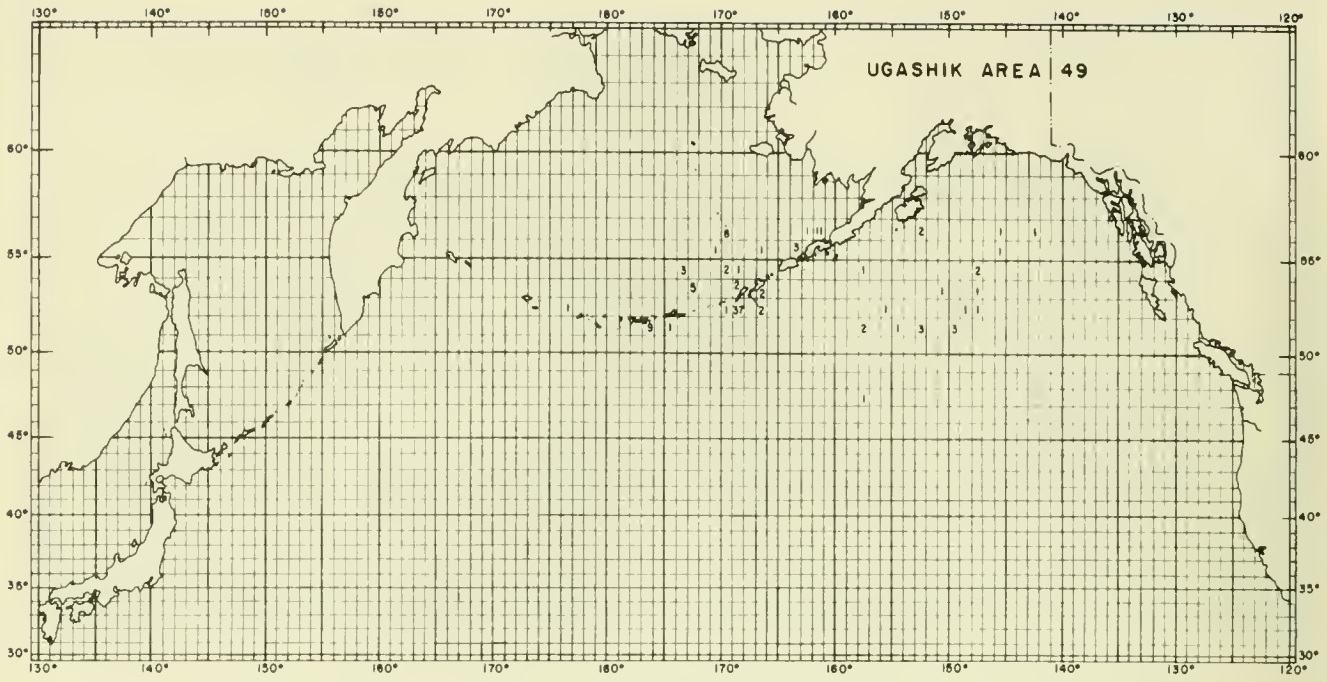

Figure 14.—Tagging locations of maturing sockeye salmon recovered in Ugashik.

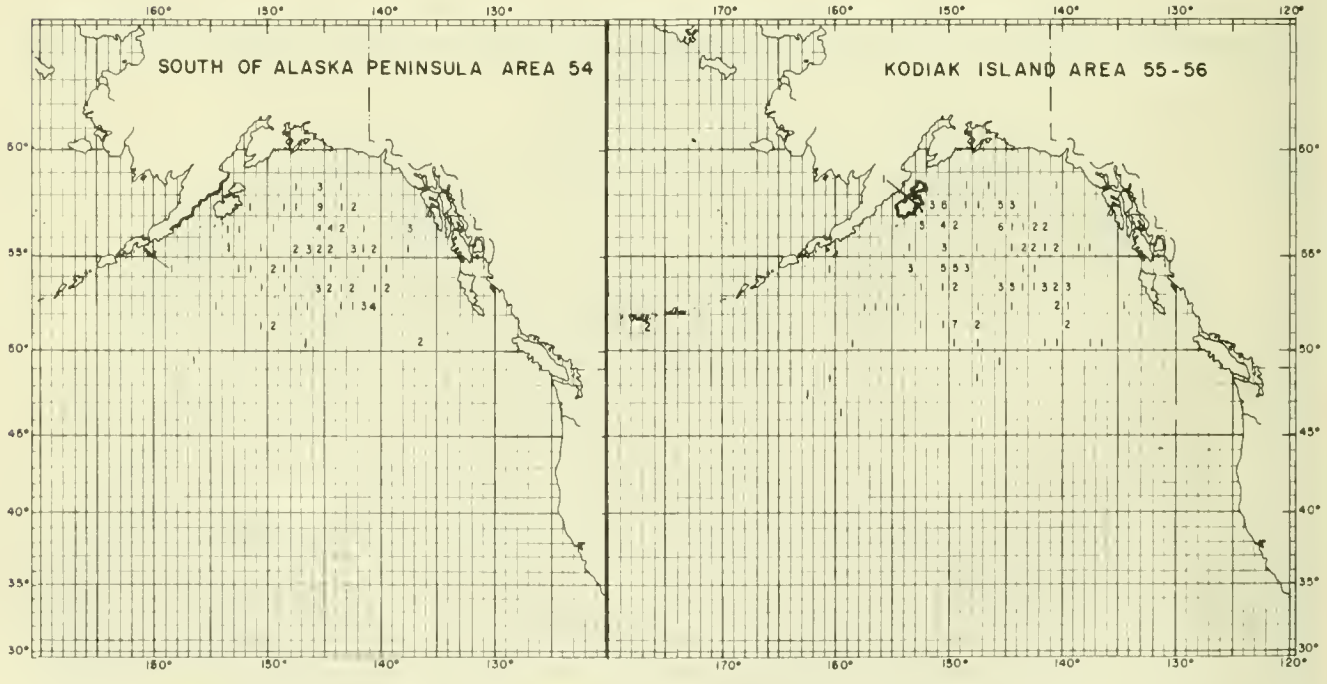

Figure 15.—Tagging locations of maturing sockeye salmon recovered from south of the Alaska Peninsula and Kodiak Island areas.

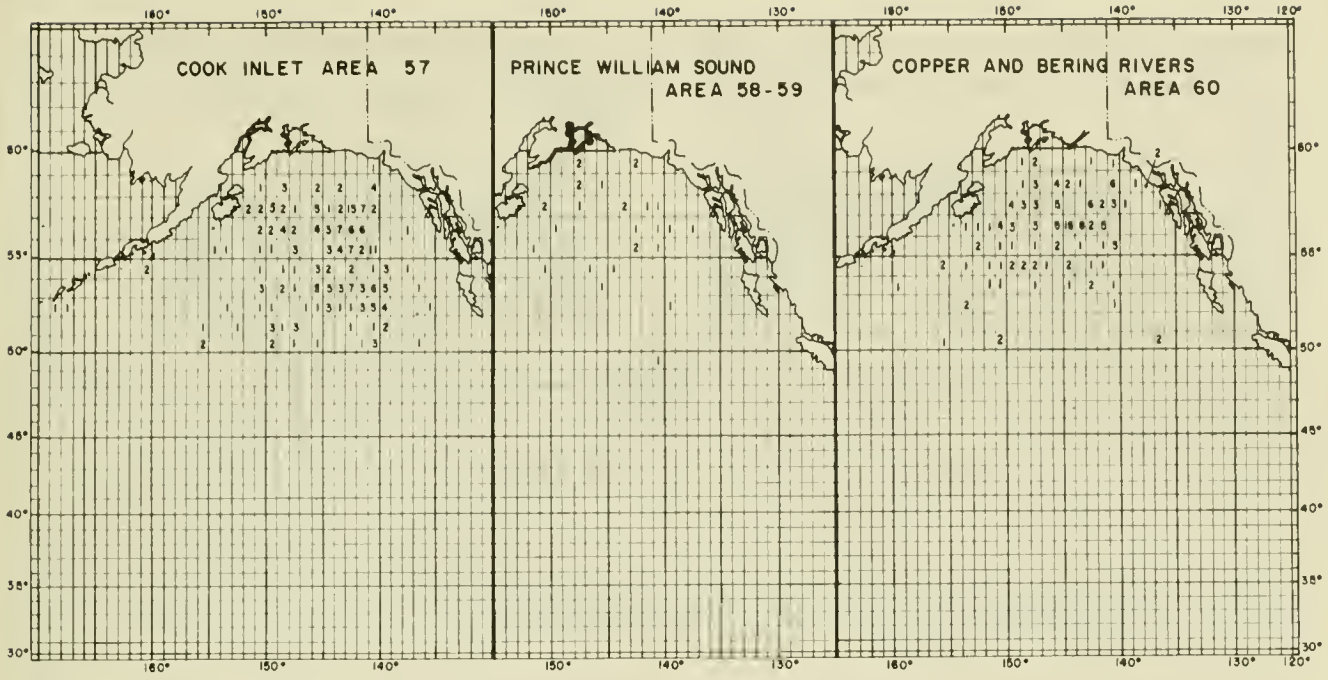

Figure 16.—Tagging locations of maturing sockeye salmon recovered in Cook Inlet, Prince William Sound, and Copper and Bering rivers areas.

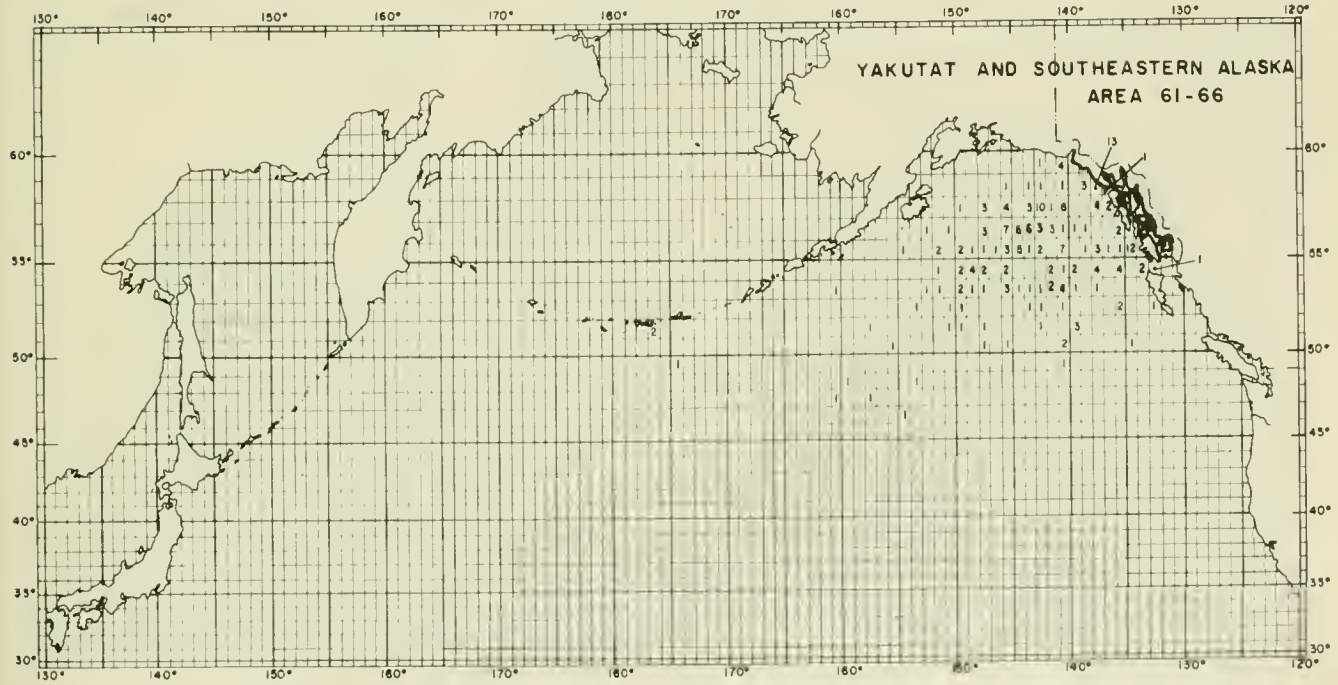

Figure 17.—Tagging locations of maturing sockeye salmon recovered from Yakutat to southeastern Alaska.

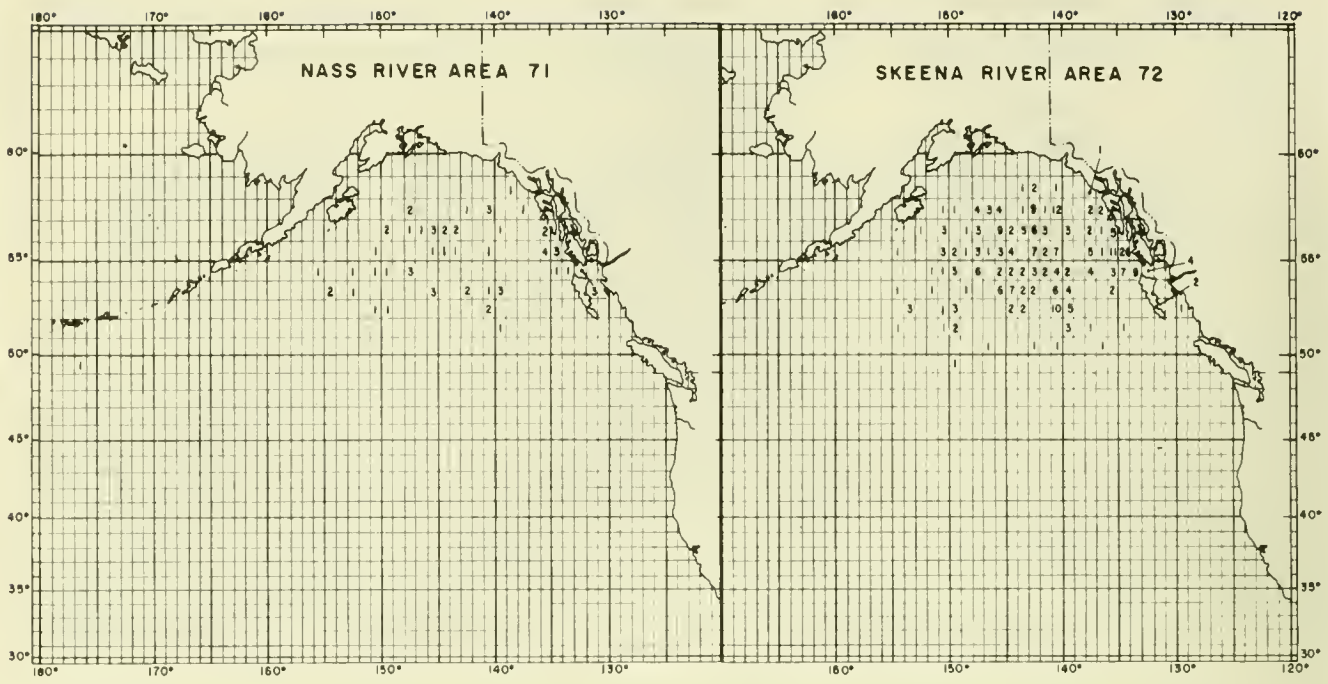

Figure 18.—Tagging locations of maturing sockeye salmon recovered in Nass and Skeena rivers.

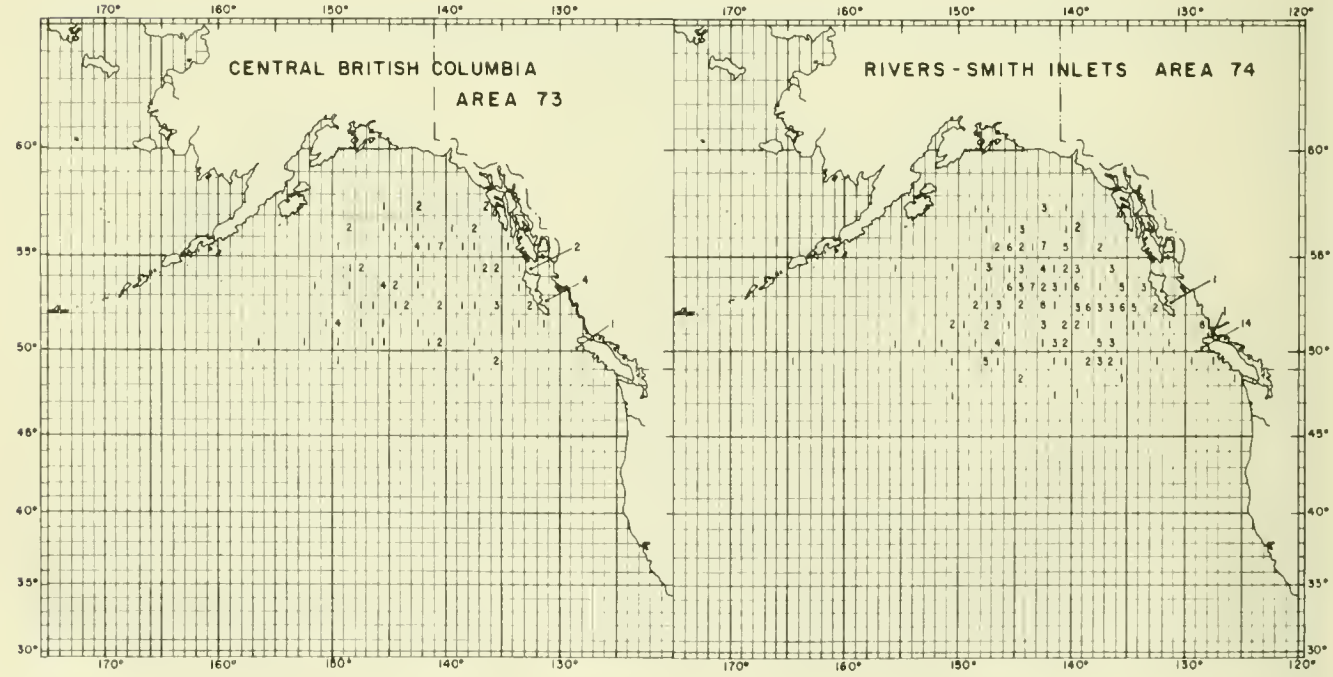

Figure 19.—Tagging locations of maturing sockeye salmon recovered in central British Columbia and River-Smith inlets.

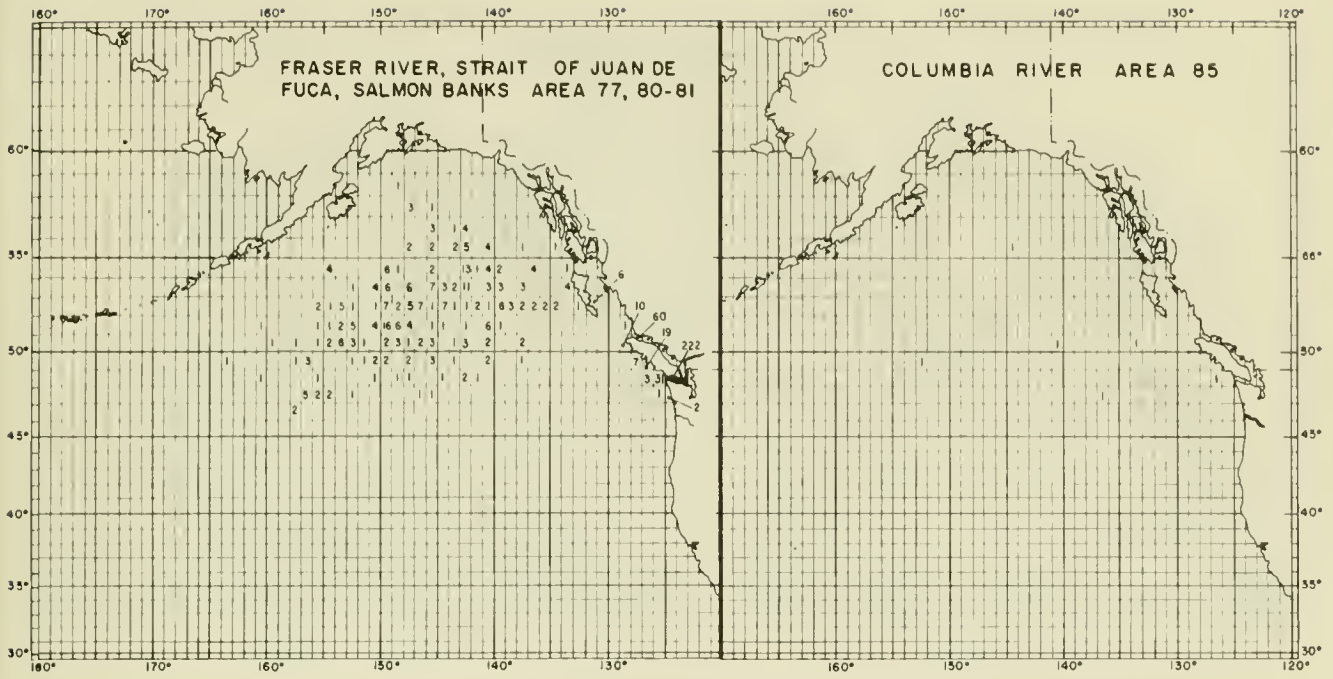

Figure 20.—Tagging locations of maturing sockeye salmon recovered in Fraser River, Strait of Juan de Fuca, and Salmon Banks and in the Columbia River.

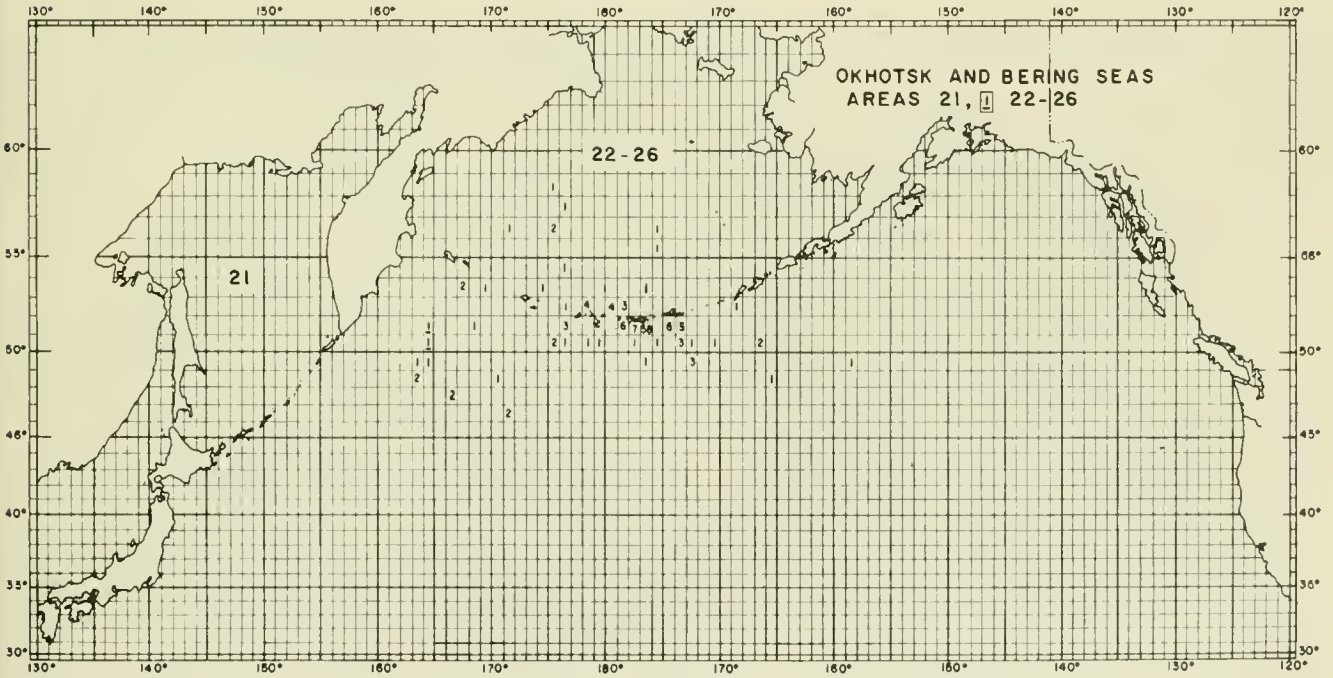

Figure 21.—Tagging locations of sockeye salmon (includes matures, immatures, and maturity unknown) recovered in the Okhotsk and Bering seas.

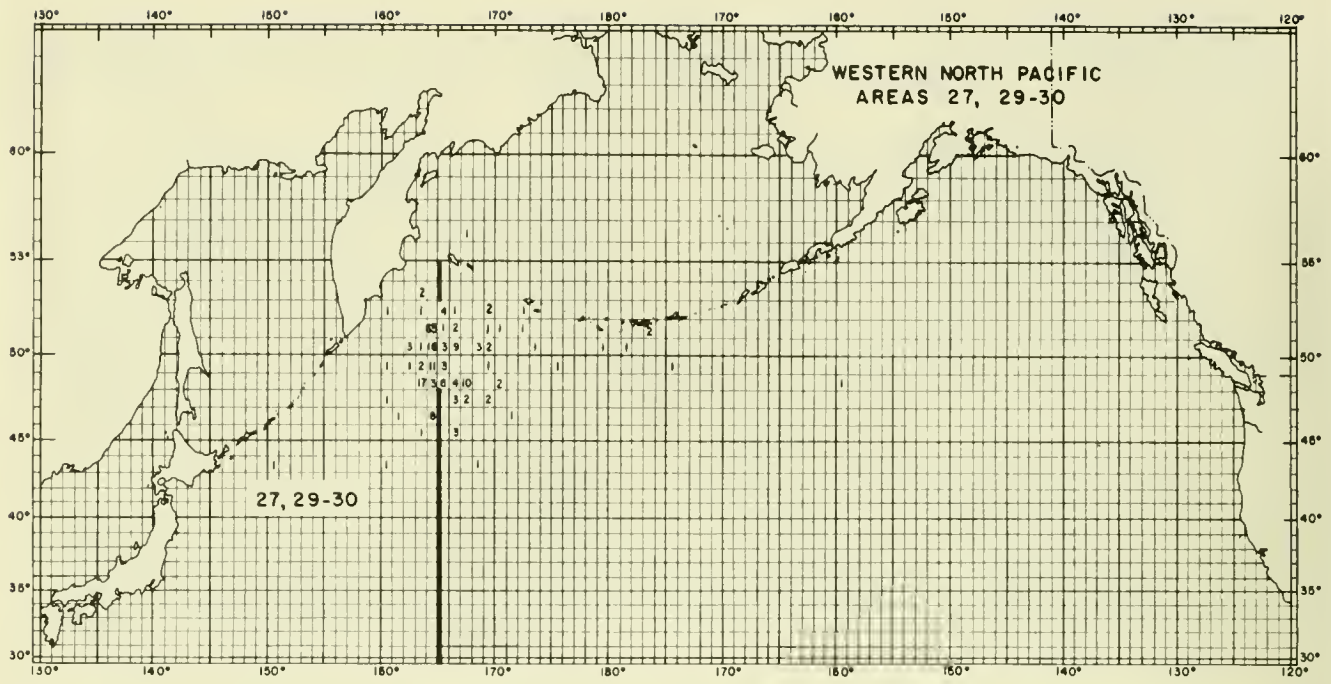

Figure 22.—Tagging locations of sockeye salmon (includes matures, immatures, and maturity unknown) recovered in the western North Pacific.

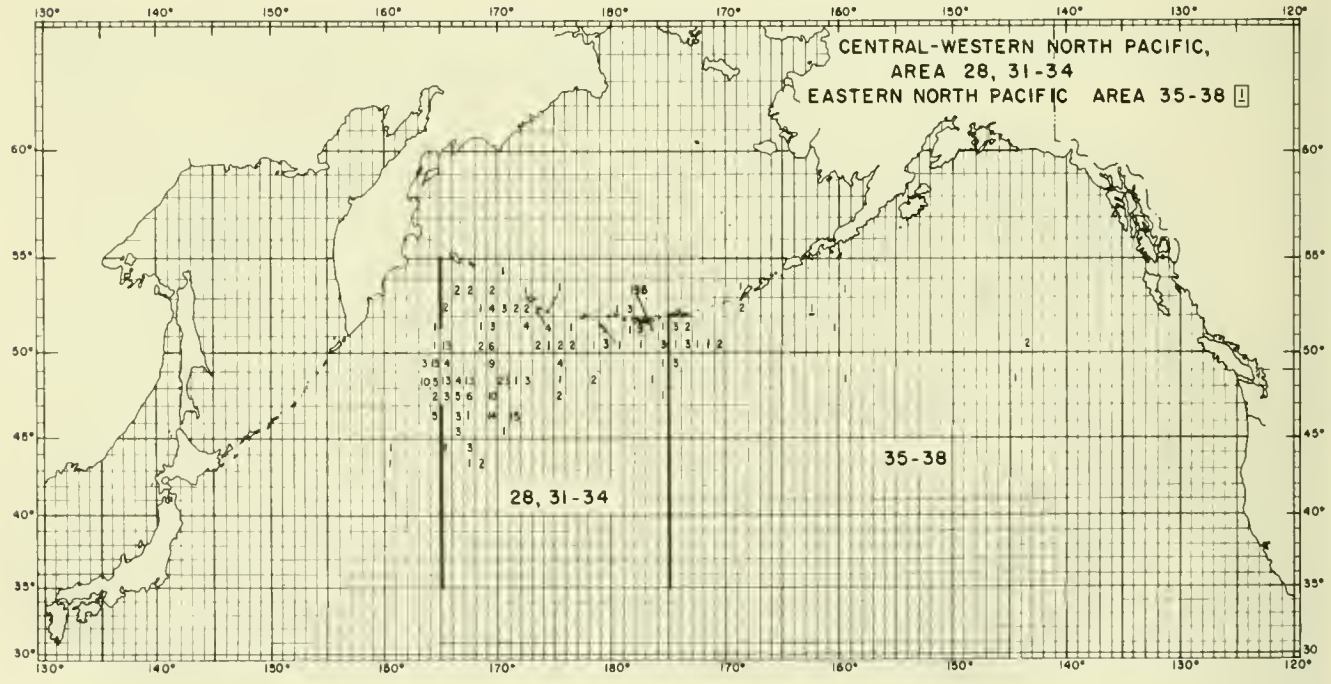

Figure 23.—Tagging locations of sockeye salmon (includes matures, immatures, and maturity unknown) recovered in the central-western North Pacific and eastern North Pacific.

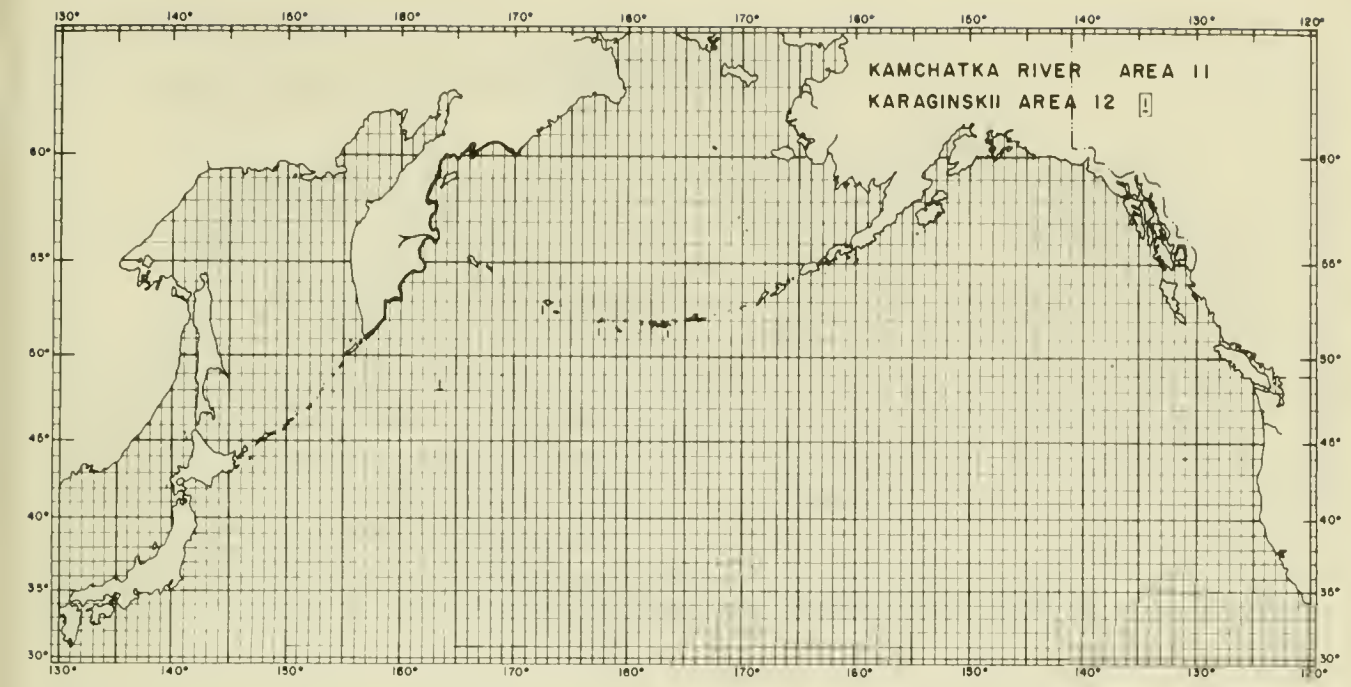

Figure 24.—Tagging locations of sockeye salmon recovered subsequent to year of tagging in Kamchatka River and Karaginskii.

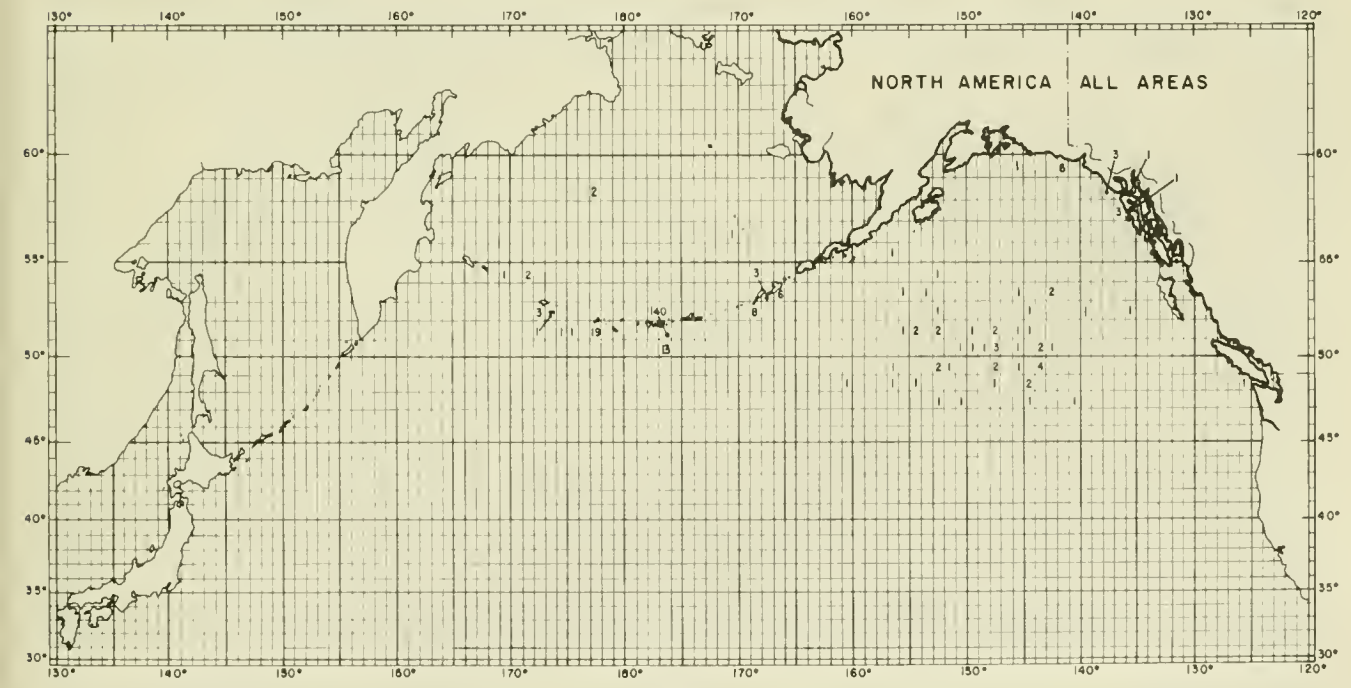

Figure 25.—Tagging locations of sockeye salmon recovered subsequent to year of tagging in North America.

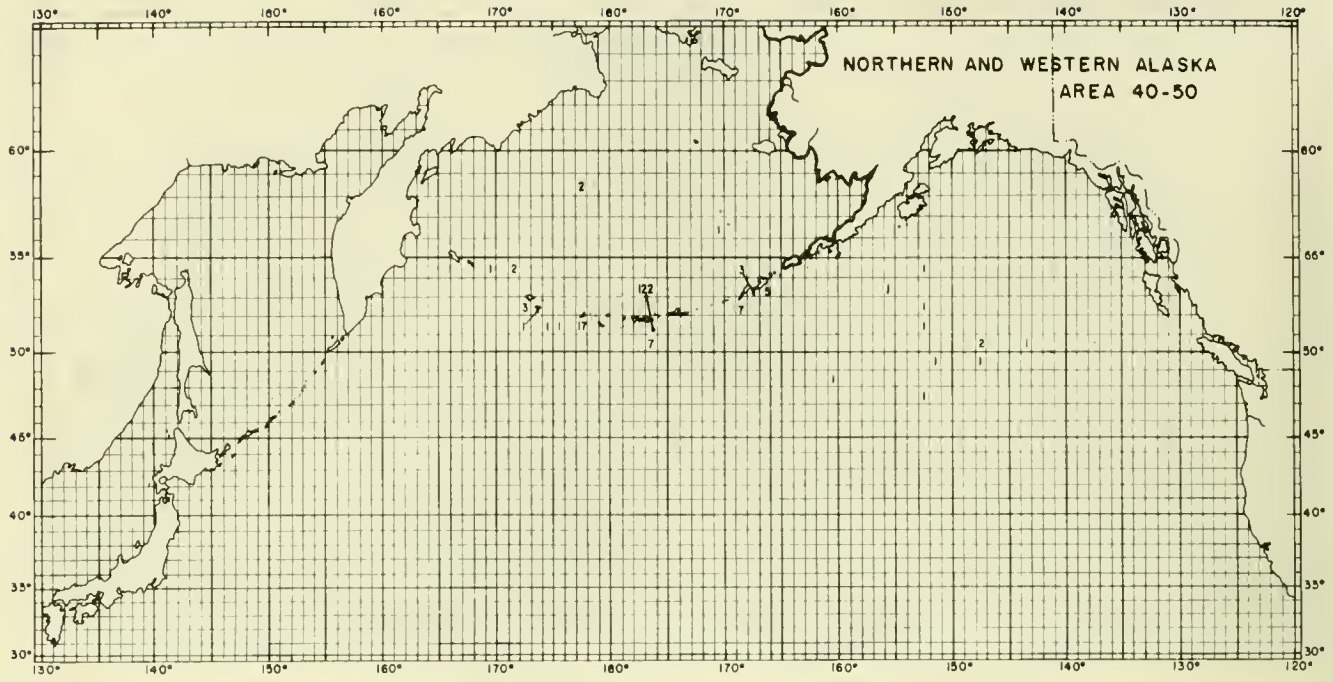

Figure 26.—Tagging locations of sockeye salmon recovered subsequent to year of tagging in northern and western Alaska.

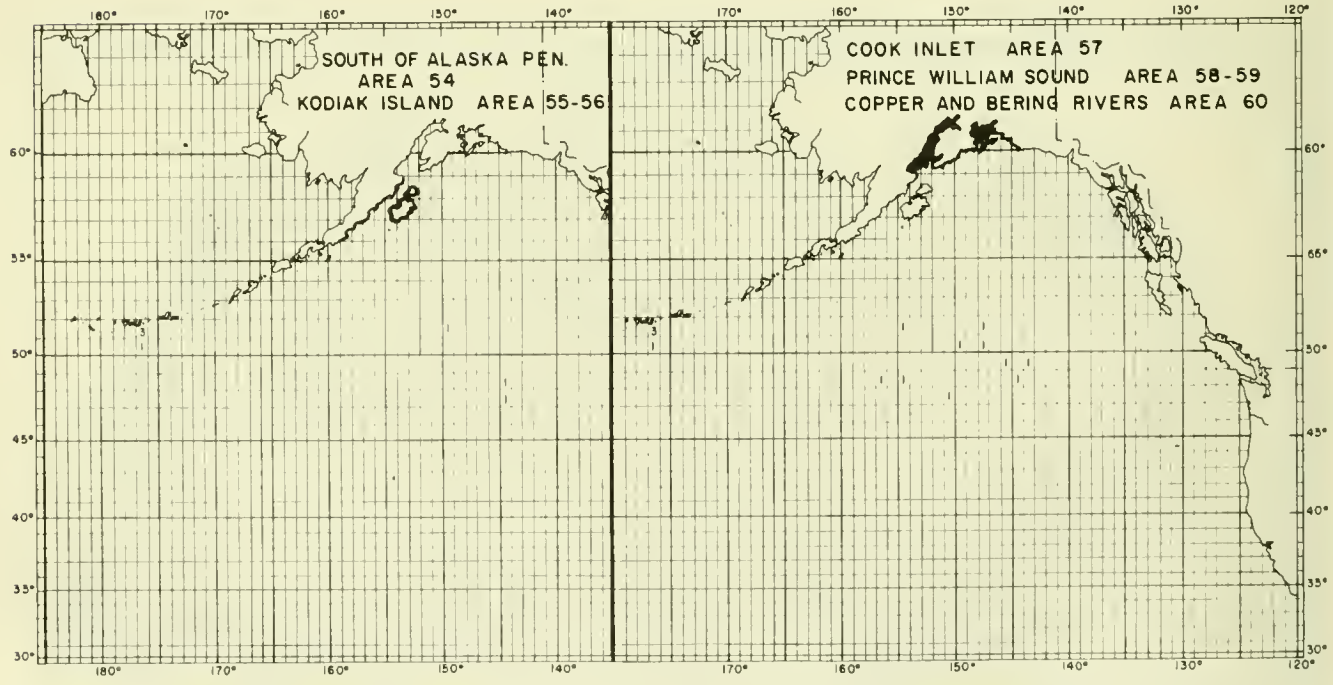

Figure 27.—Tagging locations of sockeye salmon recovered subsequent to year of tagging in south of Alaska Peninsula and Kodiak Island and in Cook Inlet, Prince William Sound, and Copper and Bering rivers areas.

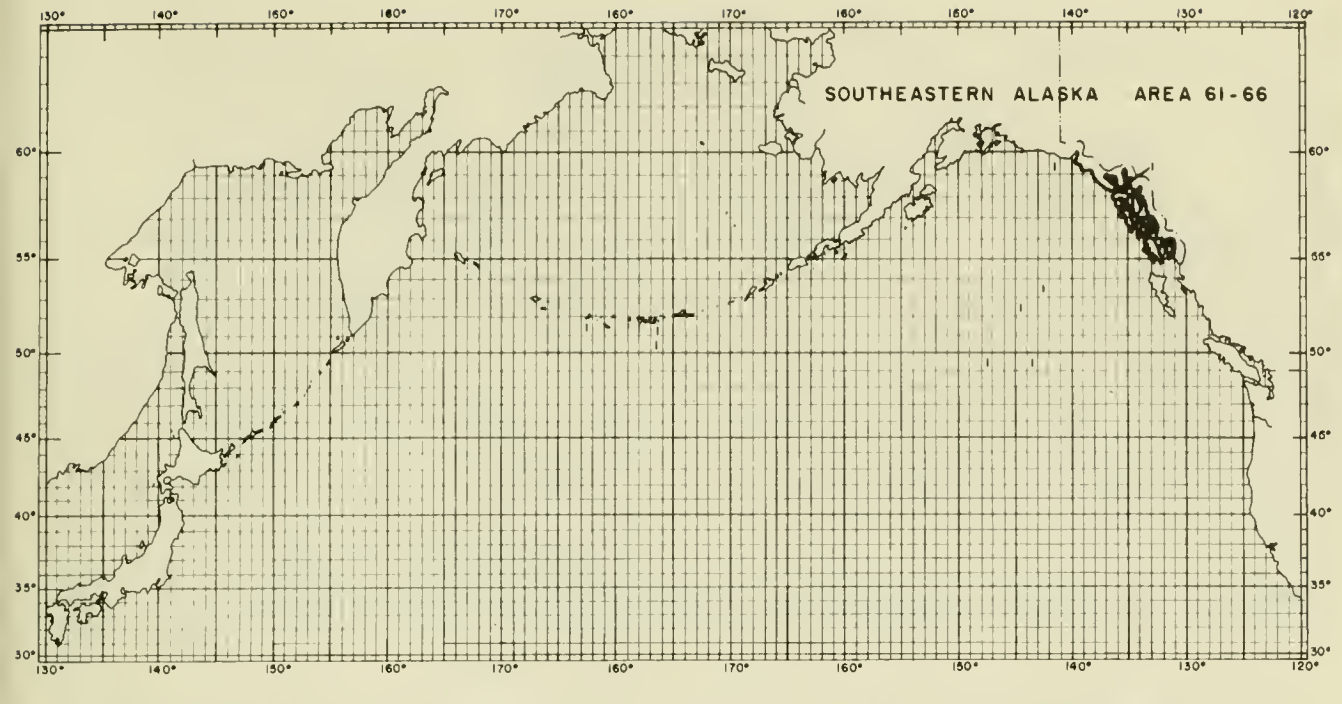

Figure 28.—Tagging locations of sockeye salmon recovered subsequent to year of tagging in southeastern Alaska.

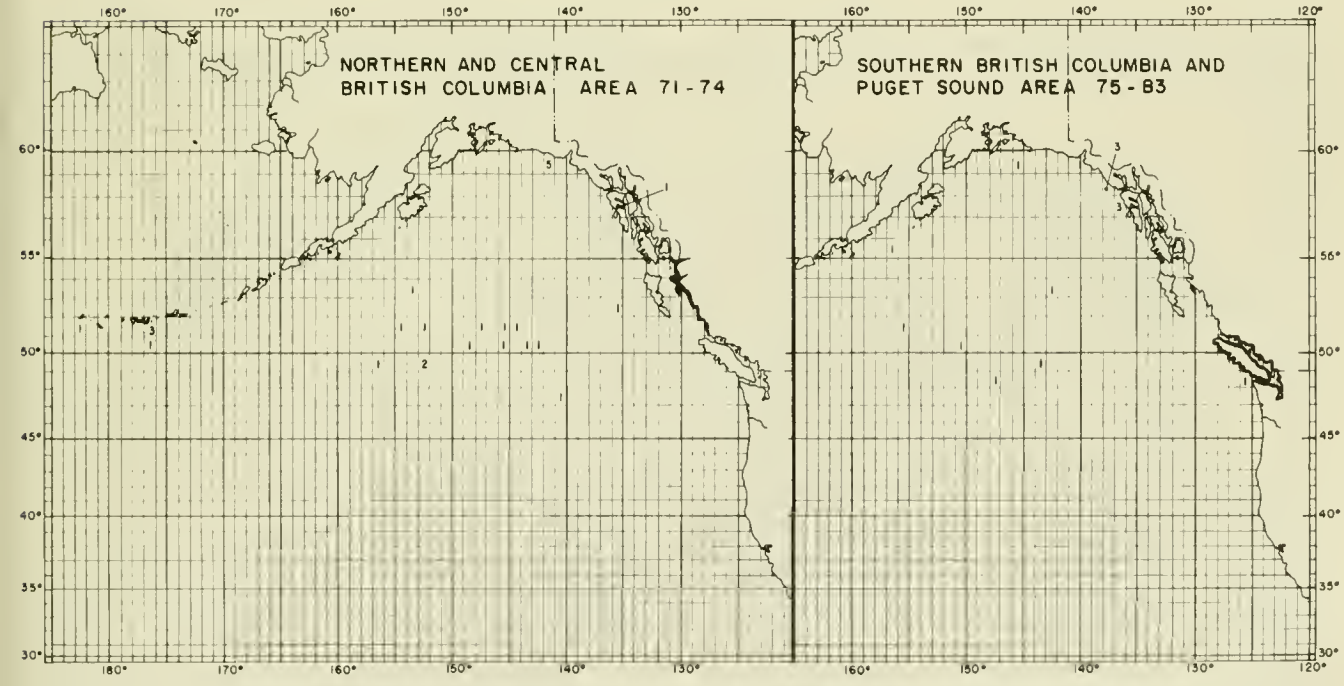

Figure 29.—Tagging locations of sockeye salmon recovered subsequent to year of tagging in northern and central British Columbia and in southern British Columbia and Puget Sound areas.

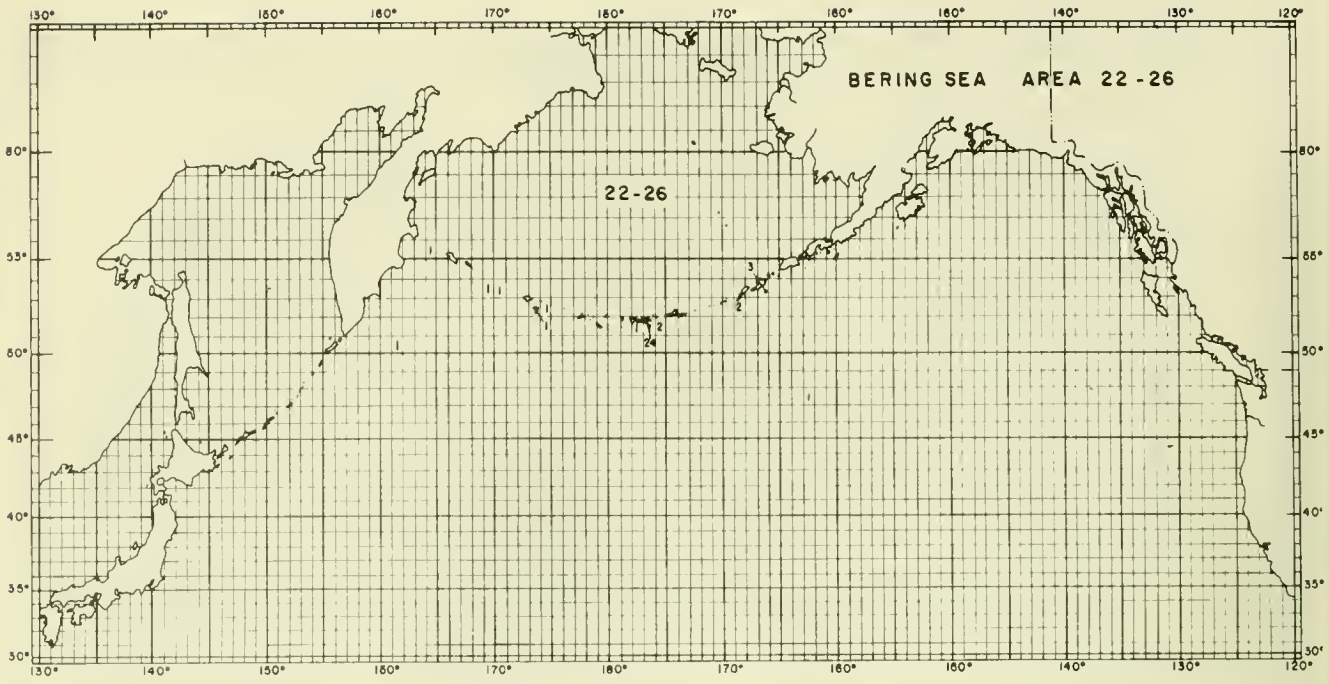

Figure 30.—Tagging locations of sockeye salmon recovered in the Bering Sea subsequent to year of tagging.

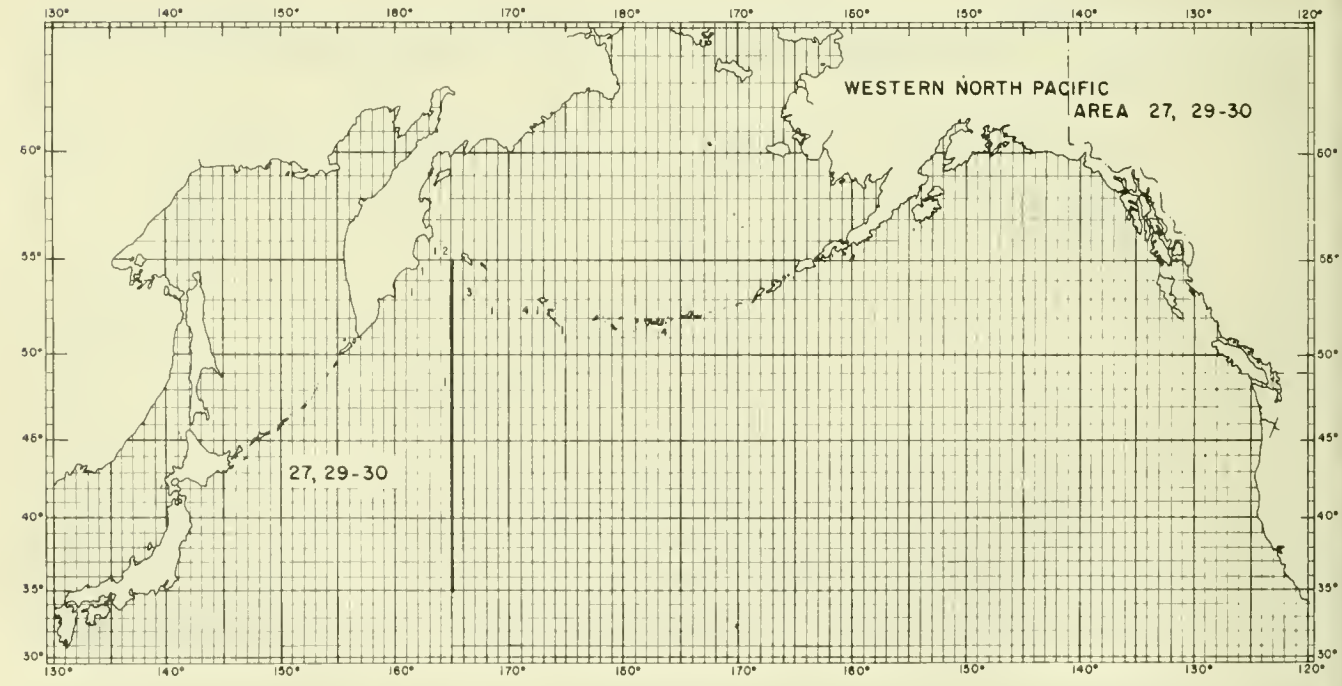

Figure 31.—Tagging locations of sockeye salmon recovered in the western North Pacific subsequent to year of tagging.

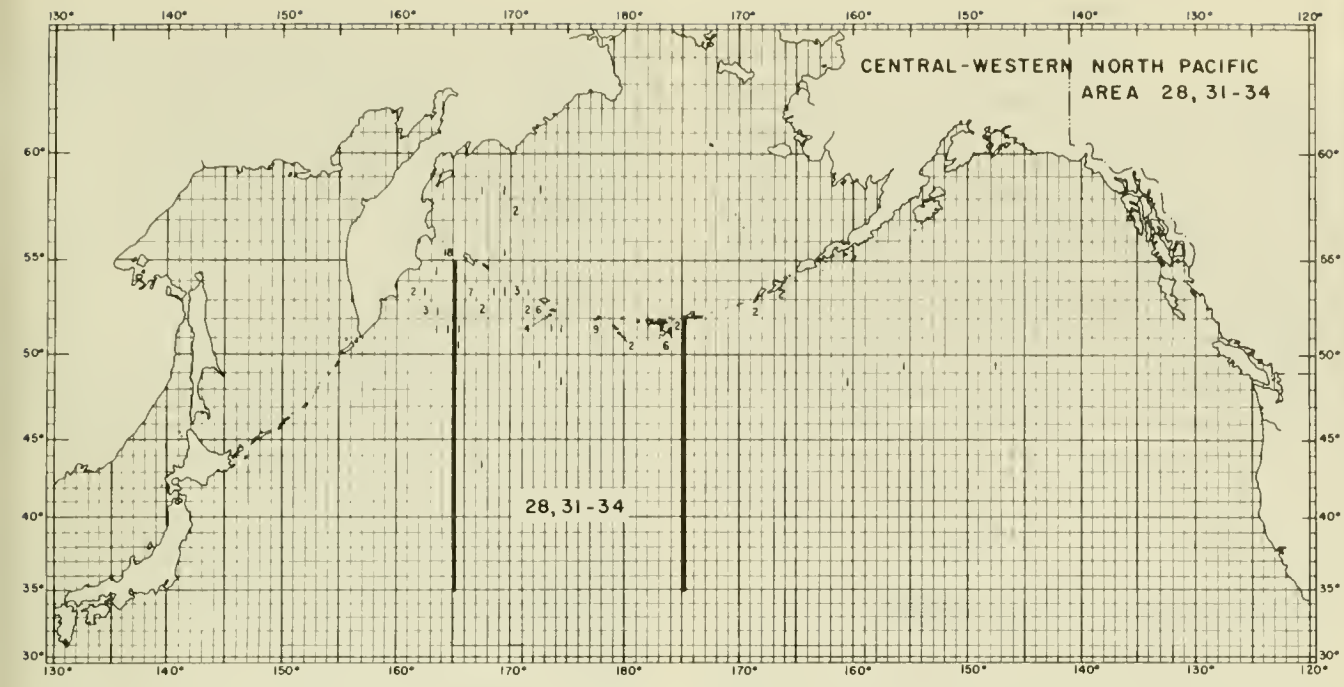

Figure 32.—Tagging locations of sockeye salmon recovered in the central-western North Pacific subsequent to year of tagging.

CHUM SALMON

Figures 33-70

The tagging effort for chum salmon and the tagging locations of chum salmon subsequently recovered in coastal areas are illustrated in Figures 33 and 34. The distribution of tagging locations and the inshore recovery areas were much broader than those for sockeye salmon and demonstrate the wide range of oceanic distribution and spawning areas for this species; spawning stocks of chum salmon are the most widely distributed of all the Pacific salmon. Although the tag recoveries illustrate the extensive distribution for chum salmon at sea, the limits of destribution are known to be even wider, extending to the Arctic Ocean in the north and in the south to about lat. 40°N in the western Pacific and lat. 44°N in the eastern Pacific Ocean and over much of the Okhotsk Sea and Sea of Japan (Shepard et al. 1968).

Coastal Recoveries in Year Tagged

Asian stocks (Figs. 35-46).—The distribution of maturing chum salmon from Asian streams (Fig. 35) extends over much of the total ocean range for chum salmon. This extensive ocean distribution parallels the abundance of Asian chum salmon relative to the more restricted distribution and lesser abundance of chum salmon in North America. Abundance of Asian stocks was about four times that of North American stocks for the period 1954-62, based on commercial catches of chum salmon (average catch of 36.7 million chum salmon in Asia and 9.2 million in North America [Shepard et al. 1968]). The only areas not occupied by Asian chum salmon appear to be waters near the coast of North America.

Some differences in distribution of stocks from various subareas of Asia will be evident in the following discussions.

Japan and Kurile Islands.—Catch statistics indicate that chum salmon produced in these areas form a rather small proportion of the total Asian production. Shepard et al. (1968) reported that for the period 1946-54 less than 15% of the Asian coastal catch came from the Japanese Islands, Sakhalin Island, and some smaller producing areas of the USSR. Of these islands largest numbers of chum salmon are produced in Hokkaido.

Tag recoveries show that at least some chum salmon from Honshu, Hokkaido, and the Kurile Islands migrate extensive distances to the east during their life at sea (Figs. 36-38). Each subarea was represented by recoveries from as far east as the northeastern Pacific, and fish tagged as far east as about long. 141°W were recovered in Hokkaido and the Kurile Islands. Most recoveries were from near the Aleutian Islands, the western Pacific Ocean, and the Bering Sea. By far, the greatest number of recoveries were from Hokkaido. As pointed out by Shepard et al. (1968), the number of recoveries in Hokkaido is far out of proportion to the commercial catch in Hokkaido relative to the number of tag recoveries in areas of much greater chum salmon production such as coastal areas of the Okhotsk Sea and Kamchatka. These authors attribute the large number of recoveries to an intense commercial fishery and close examination of the escapement in the artificial propagation program in Hokkaido.

Sakhalin Island, western and northern Okhotsk Sea coast.—This region accounts for the greatest proportion of Asian chum salmon, producing in excess of 50% of the total commercial catch in Asia for the period 1946-53 (Shepard et al. 1968). The important Amur River run, alone, produced approximately 30% of the total catch in this period.

The ocean distribution of chum salmon from this region varied to some degree by subarea. Amur River fish appeared to have the most limited distribution with returns restricted to the western North Pacific, well south of the Aleutian Islands (Fig. 39). Chum salmon from Shelekhova Bay were similarly distributed according to the tag returns, but two returns also came from near the Aleutian Islands (Fig. 41). Fish from the western and northern coast of the Okhotsk Sea were found in the same areas as the Amur River and Shelekhova Bay chum salmon but were also distributed farther east with a number of returns coming from off the western and central Aleutians (Fig. 41). Sakhalin Island chum salmon appeared to have the most extensive distribution of this group, with tag returns from as far east as long. 155°W and from the eastern Bering Sea (Fig. 40).

Kamchatka.—Kamchatka is also an important chum salmon producing area and contributed about a third of the Asian commercial catch for the period 1946-53 (Shepard et al. 1968). The tagging locations of inshore recoveries to Kamchatka demonstrate that the ocean distribution of these stocks is extensive (Figs. 42-44). Returns came from as far east as the central Gulf of Alaska and eastern and central Bering Sea but most were from waters along the Aleutian Islands. This relatively high proportion of tags from near the Aleutians may only reflect greater tagging efforts in these waters, however. Distribution from south to north was also extensive, ranging from near lat. 42°N in the Pacific Ocean to about lat. 59°N in the Bering Sea.

Karaginskii to Anadyr River.—Chum salmon from the northern coast of the USSR become widely distributed at sea like many of the other Asian stocks (Figs. 45, 46). Most of the returns came from the North Pacific Ocean between the central Aleutian Islands and central Gulf of Alaska. Unlike most other Asian chum salmon, they did not appear to inhabit waters south of the Aleutians in the western North

Pacific to a large degree; only one tag return was reported from there.

In summary, tag recoveries have demonstrated that Asian chum salmon occupy much of the North Pacific Ocean and Bering Sea in their last year at sea. The various Asian stocks can be roughly divided into four groups based on regions they occupied during the last spring and summer at sea. Those with the most extensive distribution, extending eastward to the Gulf of Alaska in the North Pacific Ocean and into some areas of the Bering Sea were from the Japanese Islands, the Kurile Islands, Sakhalin Island, and Kamchatka. A somewhat more restricted distribution, apparently limited mainly to the western Pacific Ocean but extending to waters off the central Aleutian Islands, was found for fish from the Okhotsk Sea coast. This did not apply to the Amur River chum salmon which had the most limited distribution of any Asian stock, being found only in the western Pacific. A fourth group from the Bering Sea coast of the USSR was widely distributed, extending from waters along the Aleutian Islands to the Gulf of Alaska but not into the western North Pacific Ocean to any degree—waters commonly inhabited by most other Asian chum salmon.

North American stocks (Figs. 47-58).—It is immediately apparent from a comparison of Figures 35 and 47 that North American chum salmon have a much more limited distribution at sea than Asian chum salmon. North American stocks are primarily limited to the northeastern Pacific Ocean and eastern Bering Sea. The differences in size of areas occupied by chum salmon from the two continents appeared related to the numbers of chum salmon produced by each continent—as previously discussed, the production in Asia was about four times that in North America.

Most chum salmon in North America are produced in many moderate and small streams and commercial catches have indicated that production is about equal in each of the coastal areas of central Alaska (Bristol Bay to Yakutat), of southeastern Alaska, and from British Columbia southward (Shepard et al. 1968). Production from northern Alaska (streams north of Bristol Bay) is not as well documented due to the lack of intensive fisheries in this region, but production is probably in excess of 1½ million fish annually.

Northern and western Alaska.—Tag returns indicate that the offshore distribution of maturing chum salmon are somewhat similar for the various river systems in western Alaska (Figs. 48-51). They primarily occupied waters of the eastern North Pacific Ocean, extending south to about lat. 45°N. Recoveries from south of the Aleutians, however, show that maturing fish extend westward to waters off the central Aleutian Islands. Yukon River returns were the most numerous, coming from broad areas of the eastern North Pacific and from wider areas of the Bering Sea than for other river systems. One return came from near the coast of Siberia.

Central Alaska.—Central Alaska chum salmon appear to have a much more limited distribution than those from western Alaska (Figs. 52, 53). Tagging locations of recoveries were restricted to east of long. 160°W in the eastern North Pacific Ocean, but from this longitude they were found eastward to near the coasts of southeastern Alaska and British Columbia. In spring and summer, when the tagging took place, almost all of the maturing chum salmon appeared to be north of lat. 50°N and the majority, particularly for some stocks, north of lat. 55°N. A few recoveries near British Columbia, however, came from south of this latitude.

Southeastern Alaska.—Maturing chum salmon from southeastern Alaska like those from central Alaska were found across the eastern North Pacific Ocean but the westward range of tag releases only extended to about long. 155°W for most fish (Figs. 54, 55). A single recovery from south of the central Aleutians, however, suggests that some proportion of southeastern Alaska chum salmon may at times migrate far to the west. Their north-south distribution was rather restricted with most recoveries coming from north of lat. 55°N with the exception of some fish near the coast which ranged as far south as about lat. 50°N.

British Columbia.—The maturing chum salmon from streams in British Columbia appeared to have a limited east-west distribution in their last spring and summer at sea (Figs. 56, 57). Except for Vancouver Island and Fraser River chum salmon, recoveries were largely from waters relatively close to the coasts of southeastern Alaska and British Columbia. The north-south distribution was wide, extending from off the north coast of the Gulf of Alaska southward to Vancouver Island.

The few recoveries from the Fraser River and Vancouver Island suggested that these stocks had a broader east-west distribution than northern British Columbia stocks, extending across the eastern North Pacific to about long. 155°W.

Washington and Oregon.—Recoveries were few in these States where production of chum salmon is low (Fig. 58). Most returns were from Puget Sound, and these probably represent in part chum salmon that were destined for the Fraser River in British Columbia. The tagging location of fish taken in Puget Sound was primarily in the northeastern Gulf of Alaska. One return, however, came from south of the eastern Aleutian Islands.

Only three tag recoveries were made along the coasts of Washington and Oregon (one each from coast of Washington, Columbia River, and coast of Oregon). These were all from the northern Gulf of

Alaska, north of lat. 55°N, suggesting that at least a portion of these runs are located well to the north in spring and summer prior to their inshore migration.

High-Seas Recoveries in Year Tagged

Okhotsk Sea and Bering Sea.—The few recoveries in the Okhotsk Sea were mainly from an area southeast of Kamchatka, but one was from near the eastern Aleutian Islands. Recoveries in the Bering Sea were from fish tagged over extensive areas of the ocean (Fig. 59). Most returns were from waters off the Aleutian Islands, an area of intensive tagging effort. Recoveries were also quite abundant from south of the Alaska Peninsula and from the western Bering Sea. Areas from which returns were notably lacking were the western North Pacific Ocean and the eastern Bering Sea. The pattern of tagging locations for these recoveries is similar to those of some Asian stocks of maturing fish shown earlier, and the Bering Sea recoveries may primarily represent fish intercepted on their migration to these same areas such as the Bering Sea coast of the USSR and Hokkaido.

Western North Pacific.—Recoveries by the mothership and land-based fisheries in the western North Pacific Ocean (Fig. 60) came from rather limited areas. Very few returns came from east of the central Aleutians or the Bering Sea, and most were concentrated from waters off the central Aleutians west to Hokkaido and the Kurile Islands. This distribution corresponds to the ocean distribution of maturing chum salmon originating from the western and northern coasts of the Okhotsk Sea.

Central and western North Pacific.—Recoveries in these waters largely came from within this area although some also came from as far east as the central Gulf of Alaska (Fig. 61). Recoveries from the Bering Sea and from the western North Pacific were almost nil.

Recoveries in Years Subsequent to Tagging

Asian recoveries (Figs. 62-65).—A distinctive feature of the recoveries in Asia was the recognizable similarities between the general distribution of stocks of immatures and the distribution of the same stocks of maturing fish. Immatures from the Islands of Japan and from land areas adjoining the Okhotsk Sea (Figs. 62-64) were found mainly off the Aleutian Islands but were also found in the western North Pacific Ocean and to a limited degree in the eastern North Pacific and Bering Sea, as were maturing chum salmon originating from these coastal areas. Immatures from eastern Kamchatka and the Bering Sea coast of the USSR were restricted to near the Aleutian Islands and the Bering Sea, a pattern of distribution resembling that of maturing chum salmon from this region (Fig. 65). Contrasting with the distribution of maturing fish from Asia was the lack of Asian immatures from as far east as the eastern North Pacific.

North American recoveries (Figs. 66, 67).—As in the case of Asian chum salmon, the distribution of stocks of immature chum salmon from the Bering Sea coast of Alaska paralleled in general the distribution of maturing fish from this area, being found throughout the eastern North Pacific Ocean and waters off the Aleutian Islands (Fig. 66). The immatures from the Pacific Ocean coast of Alaska, however, had a dissimilar distribution to that of maturing fish from this area, having a more westerly distribution extending mainly from south of Kodiak Island to the central Aleutian Islands (Figs. 66, 67). This conclusion is based on relatively few recoveries which may not truly reflect the actual distribution of immatures from this region. Only four recoveries have been made from the coasts of British Columbia and Washington; these came from the Gulf of Alaska north of lat. 55°N and off the coast of British Columbia (Fig. 67).

High-Seas Recoveries in Years Subsequent to Tagging

Immatures recovered in the Bering Sea by the Japanese mothership fishery a year or more after tagging came mainly from near the Aleutian Islands, with a few from the eastern North Pacific Ocean and Bering Sea (Fig. 68). One fish was recovered in the Sea of Japan from the Aleutain area. These locations were similar to the pattern of tagging locations for maturing fish that were also subsequently taken in the Bering Sea and may indicate that both maturity groups were of the same stocks.

The immatures recaptured offshore by the Japanese fisheries in the western North Pacific came from waters off the Aleutian Islands and from the western Pacific Ocean and western Bering Sea (Fig. 69). This distribution was similar to that of maturing fish recaptured at sea in the western Pacific.

Immatures captured a year or more after tagging in offshore waters south of the central and western Aleutian Islands came mainly from within this area or directly north of this area in the Bering Sea (Fig. 70). These tagging locations probably illustrate the ocean areas occupied by many Asian stocks of immatures during summer months. Two fish, not illustrated, were recovered in areas 35-36 (near long. 167°W and 150°W) which had been tagged the previous year south of Adak Island.

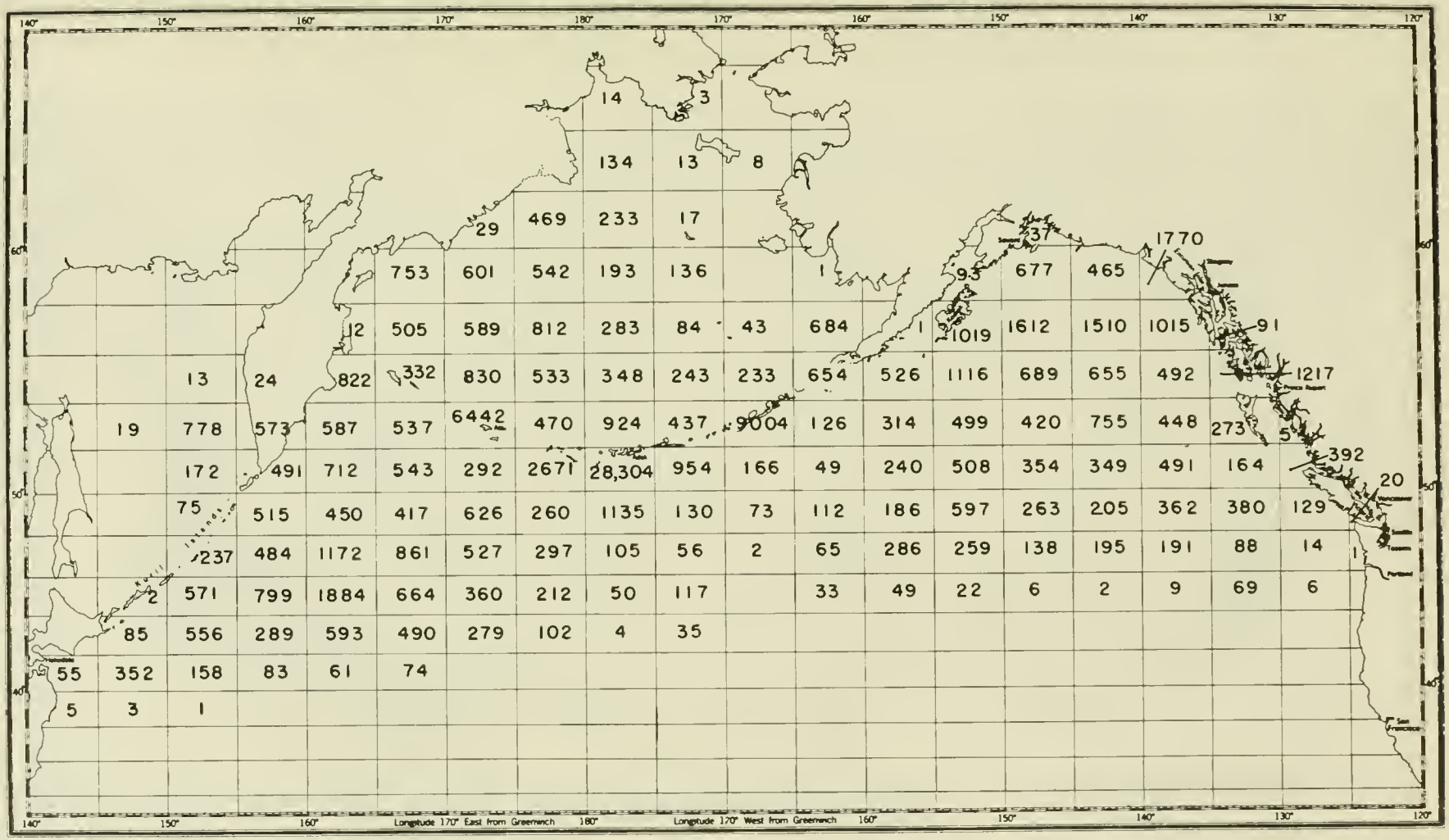

Figure 33.—Numbers of immature and maturing chum salmon tagged by Canada, Japan, and the United States, 1956-71 (source of data: Tamotsu Yonemori, Far Seas Fisheries Research Laboratory, Fisheries Agency of Japan, Shimizu, Japan).

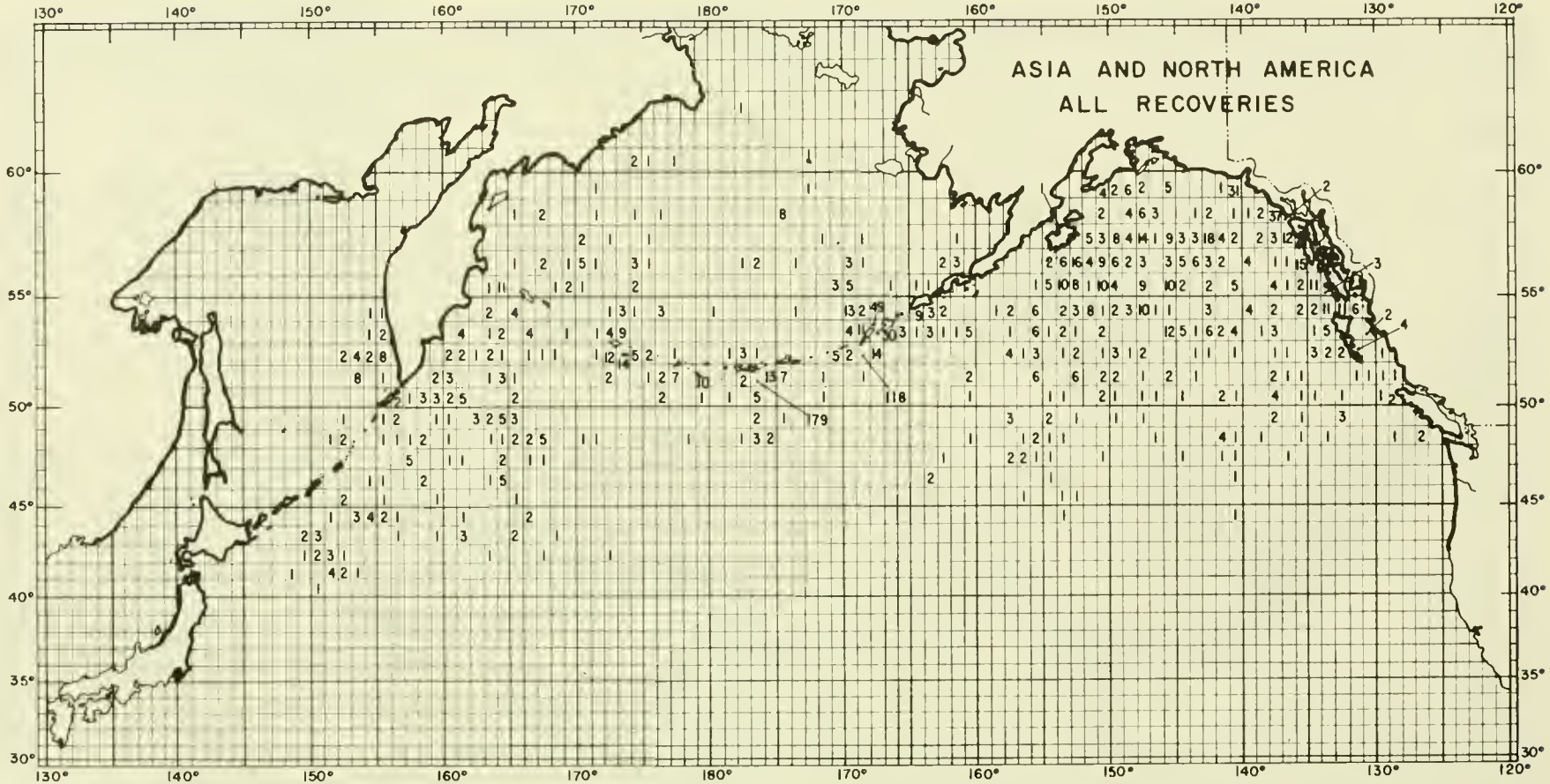

Figure 34.—Tagging locations of chum salmon recovered in Asia and North America.

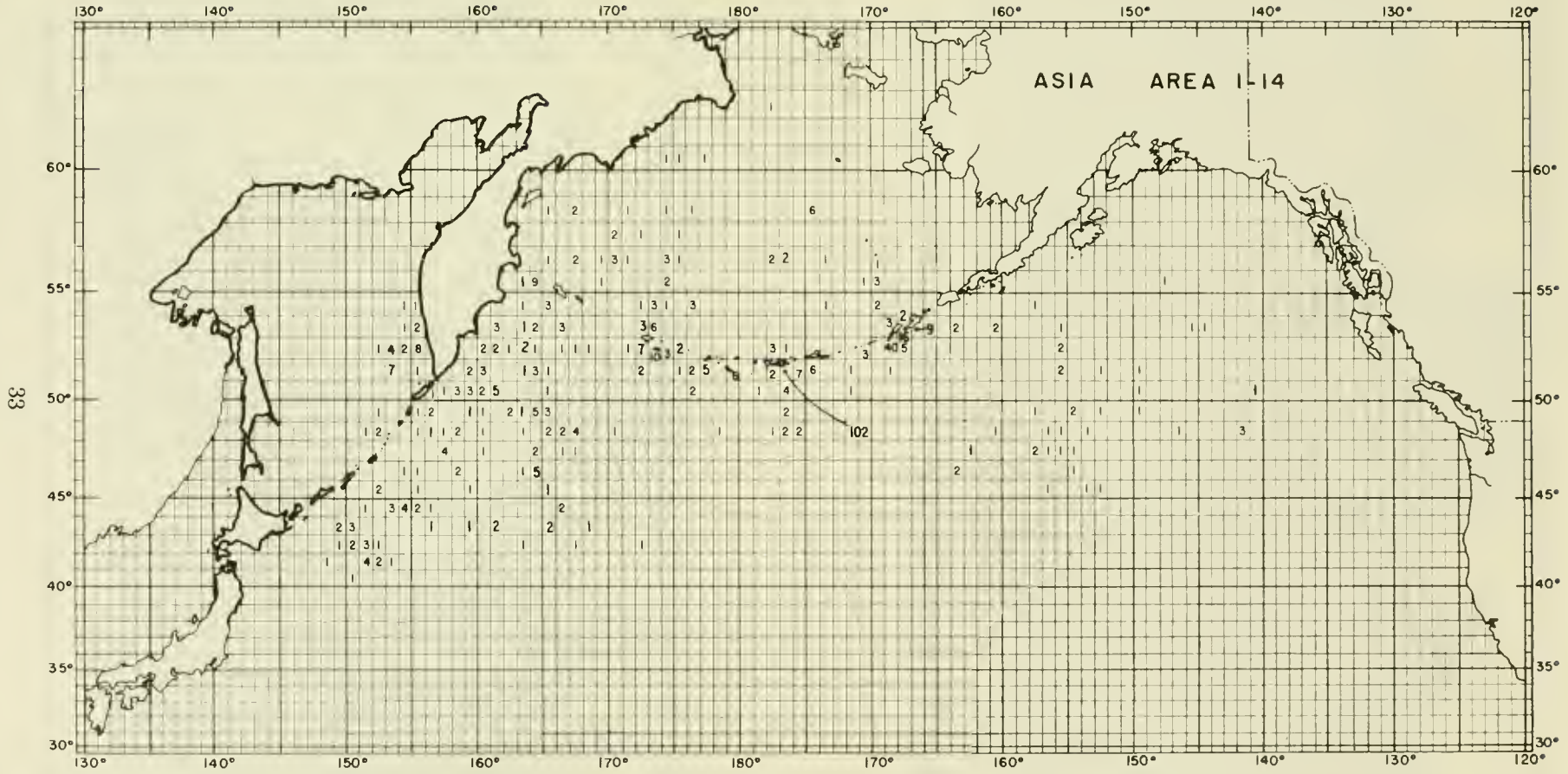

Figure 35.—Tagging locations of maturing chum salmon recovered in Asia.

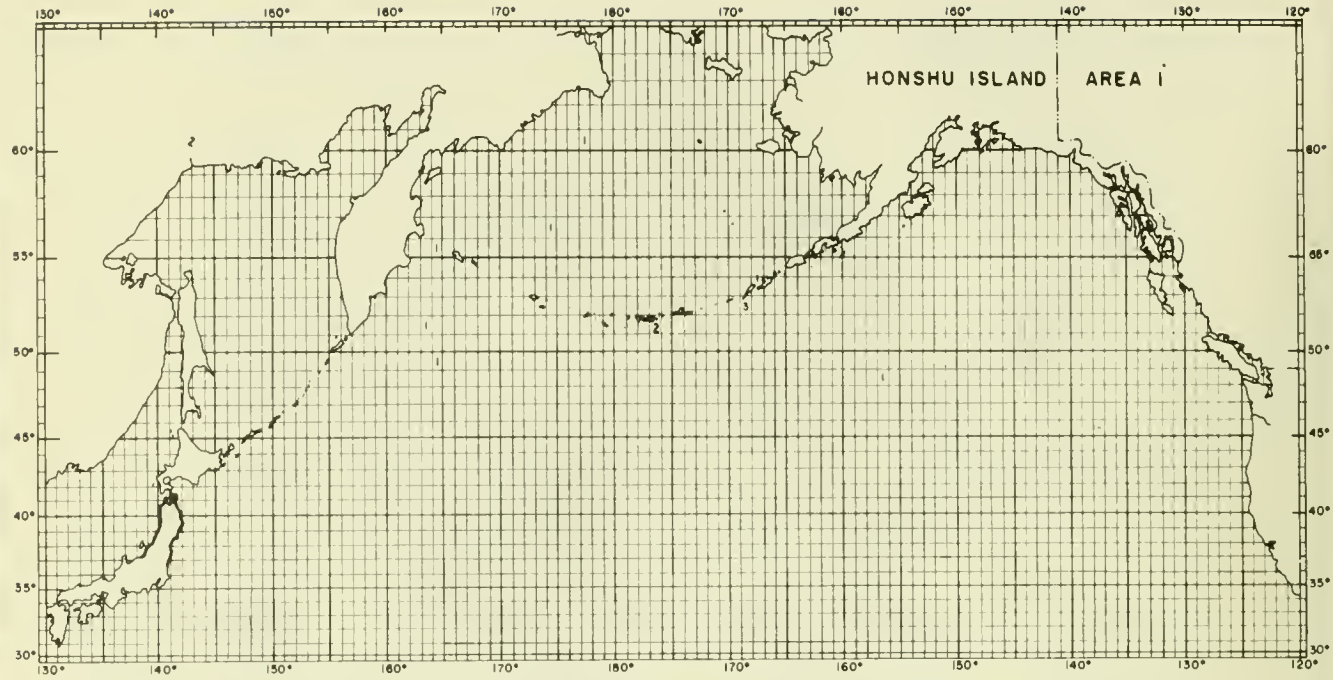

Figure 36.—Tagging locations of maturing chum salmon recovered on Honshu Island.

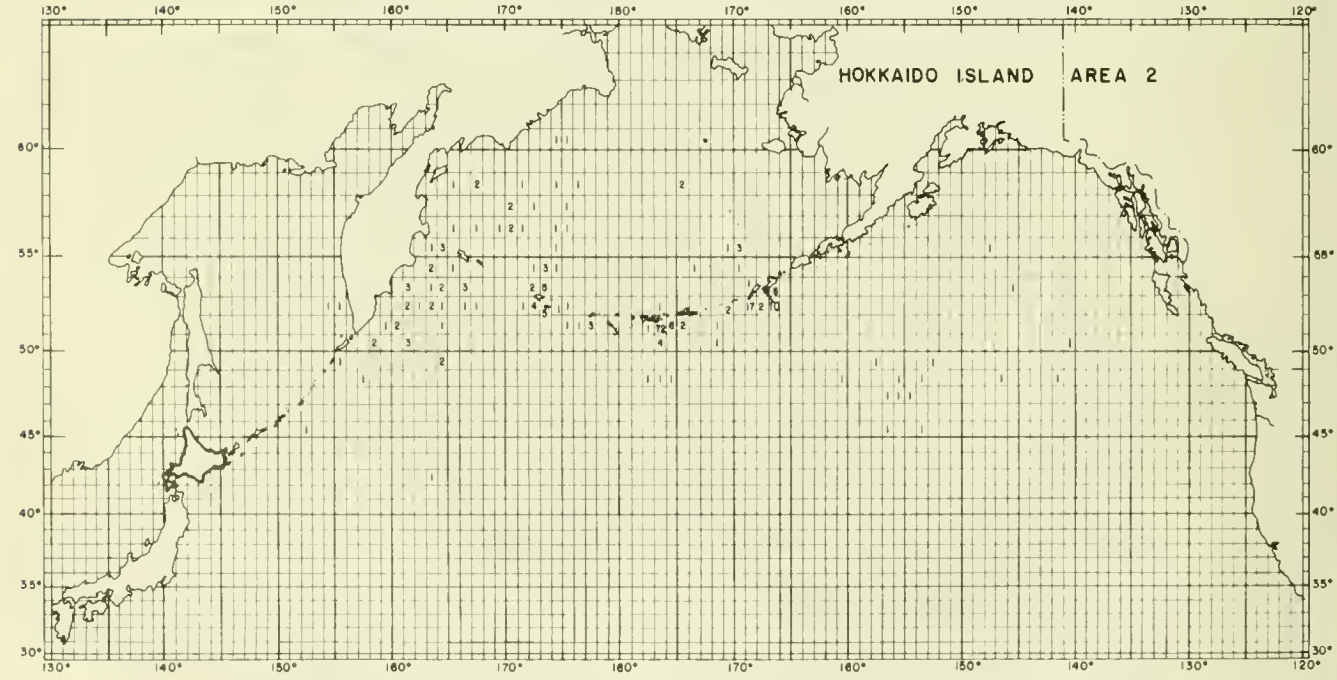

Figure 37.—Tagging locations of maturing chum salmon recovered on Hokkaido Island.

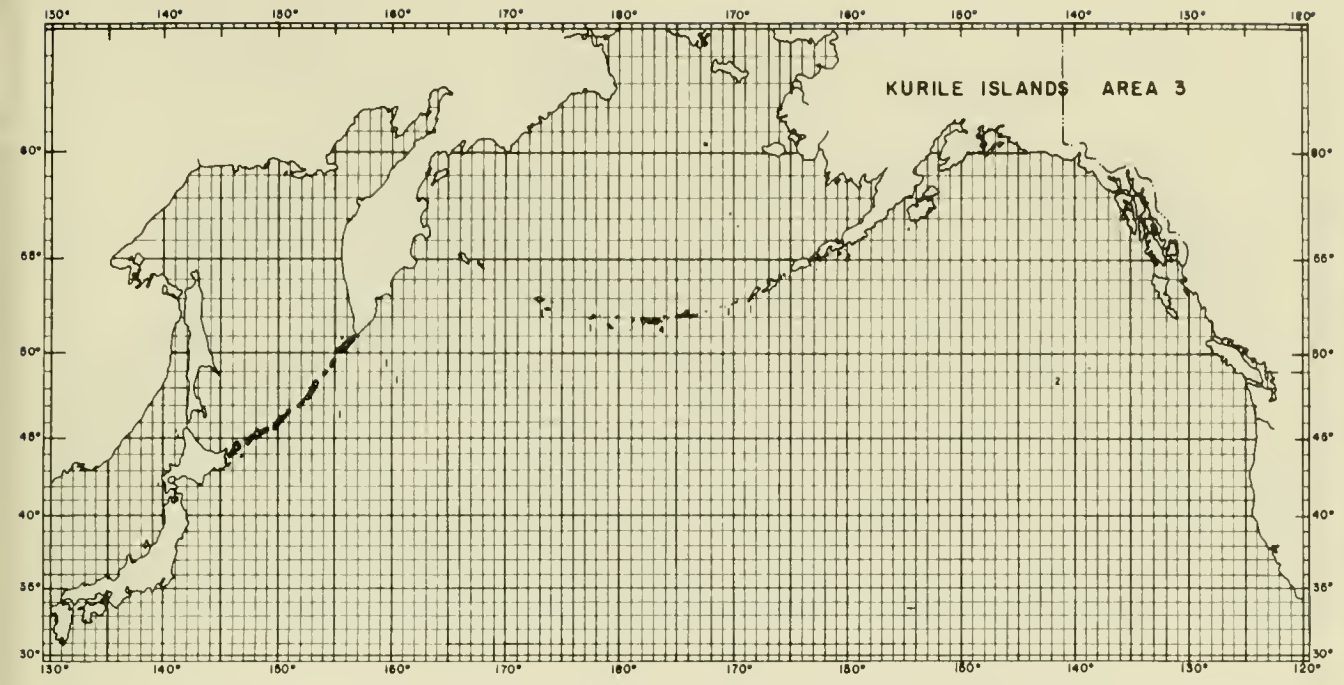

Figure 38.—Tagging locations of maturing chum salmon recovered on the Kurile Islands.

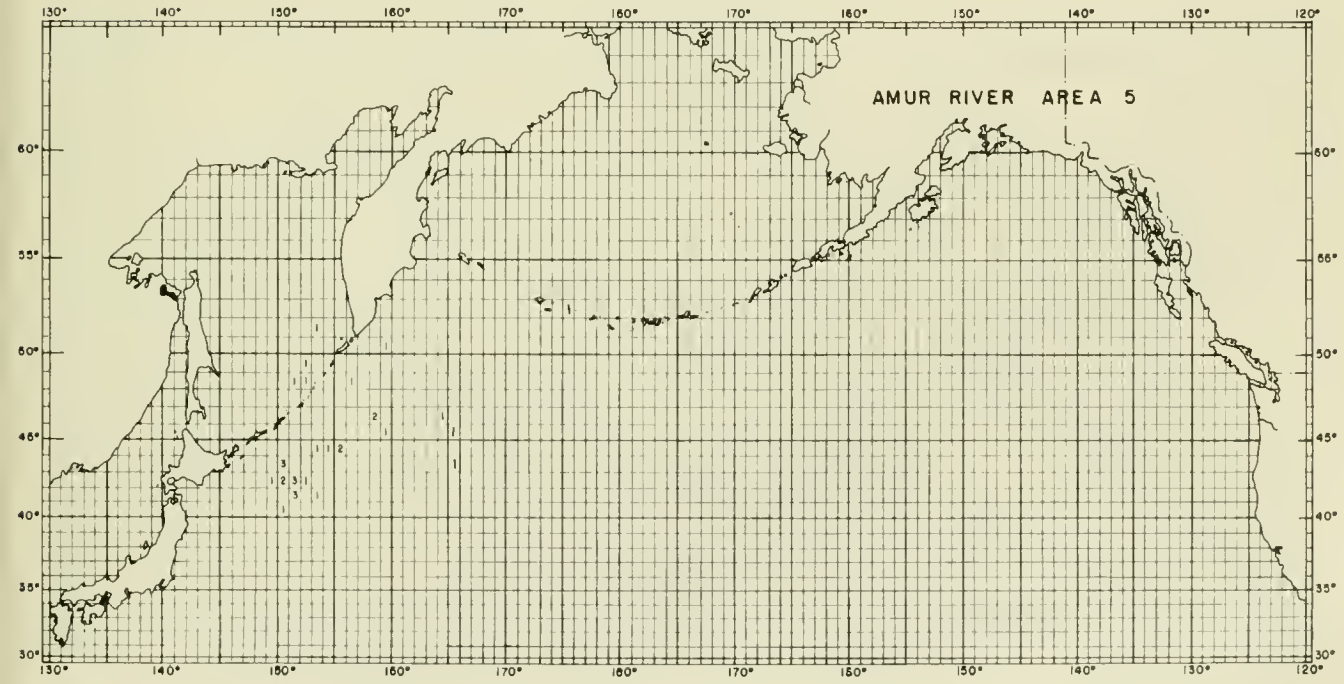

Figure 39.—Tagging locations of maturing chum salmon recovered in the Amur River.

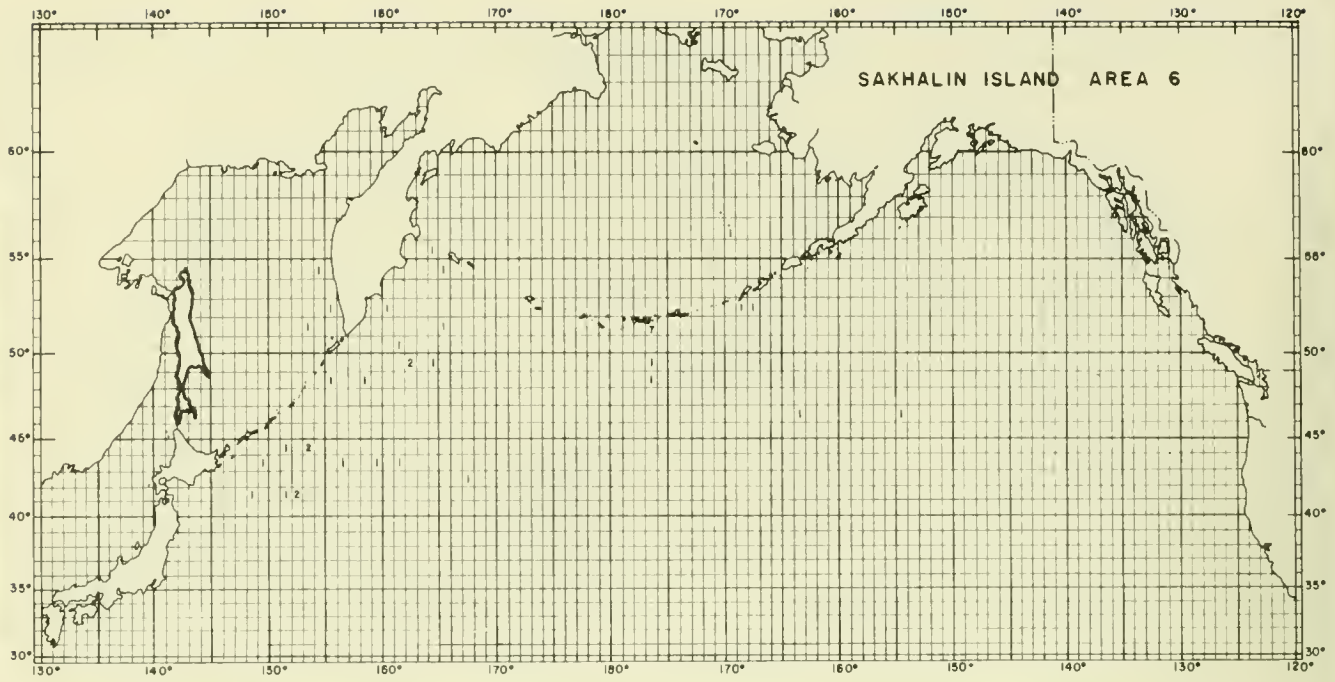

Figure 40.—Tagging locations of maturing chum salmon recovered on Sakhalin Island.

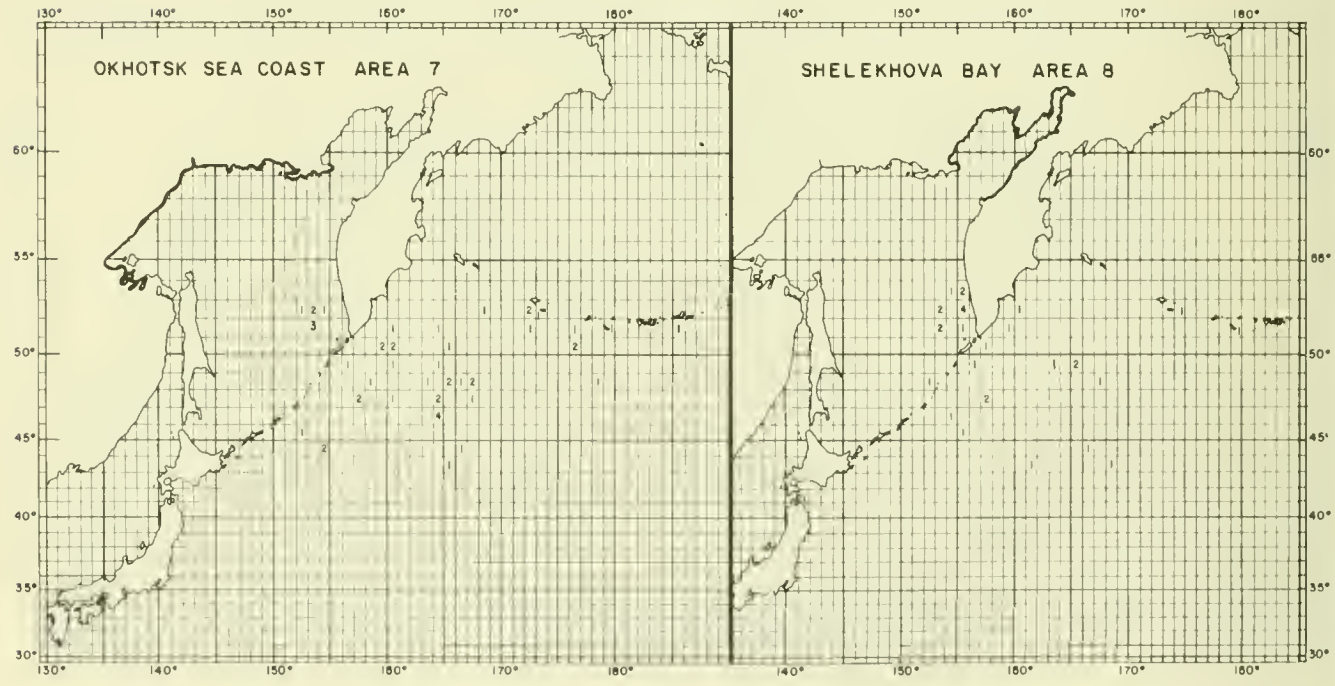

Figure 41.—Tagging locations of maturing chum salmon recovered in Okhotsk Sea coast and Shelekhova Bay areas.

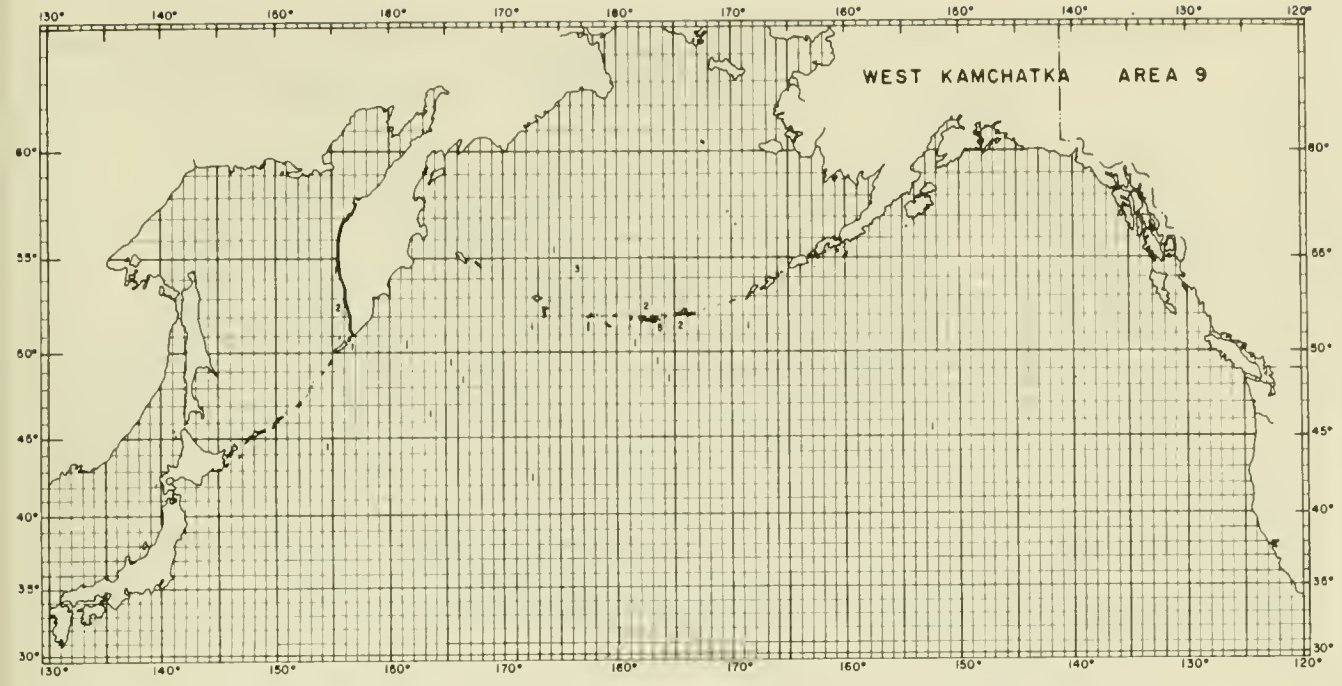

Figure 42.—Tagging locations of maturing chum salmon recovered in west Kamchatka.

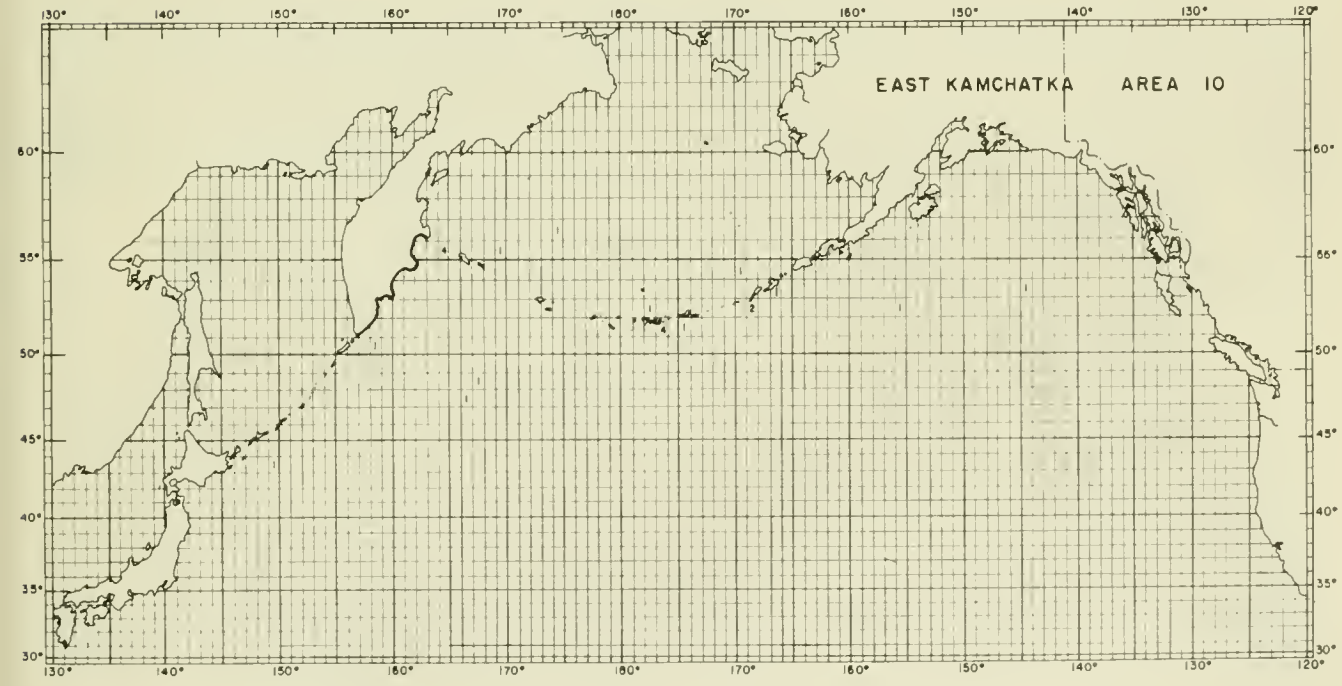

Figure 43.—Tagging locations of maturing chum salmon recovered in east Kamchatka.

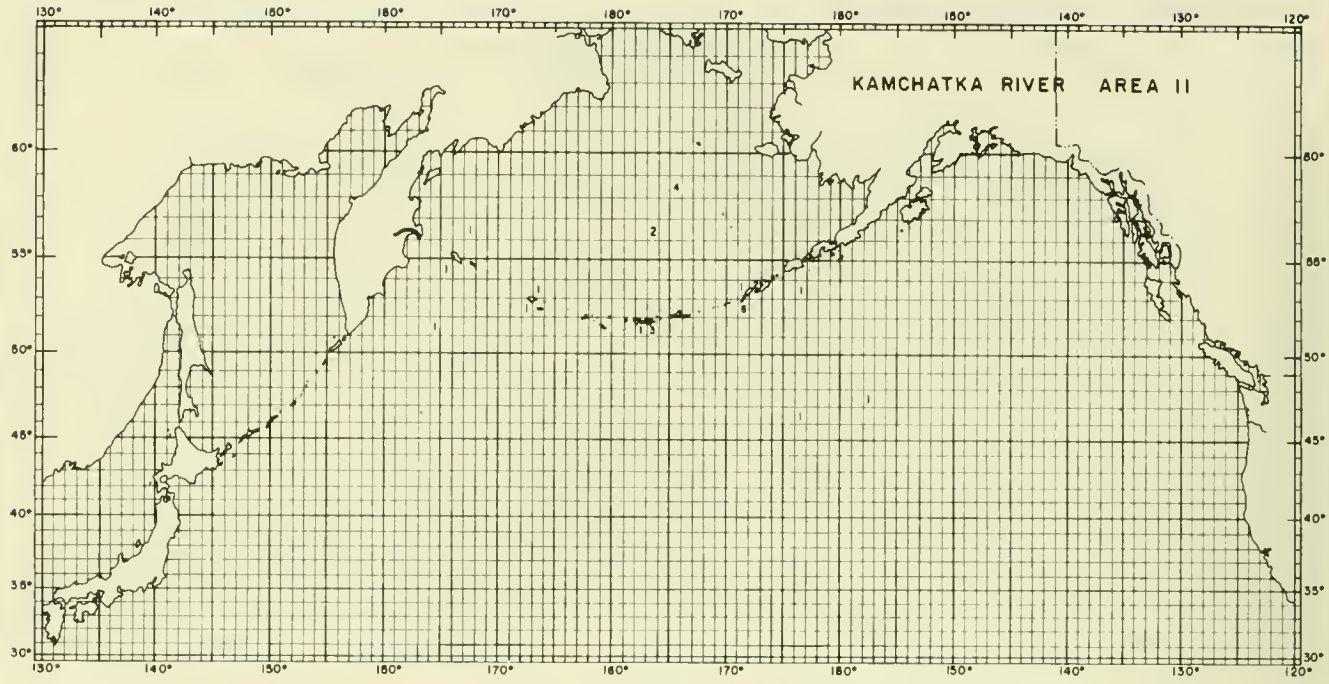

Figure 44.—Tagging locations of maturing chum salmon recovered in Kamchatka River.

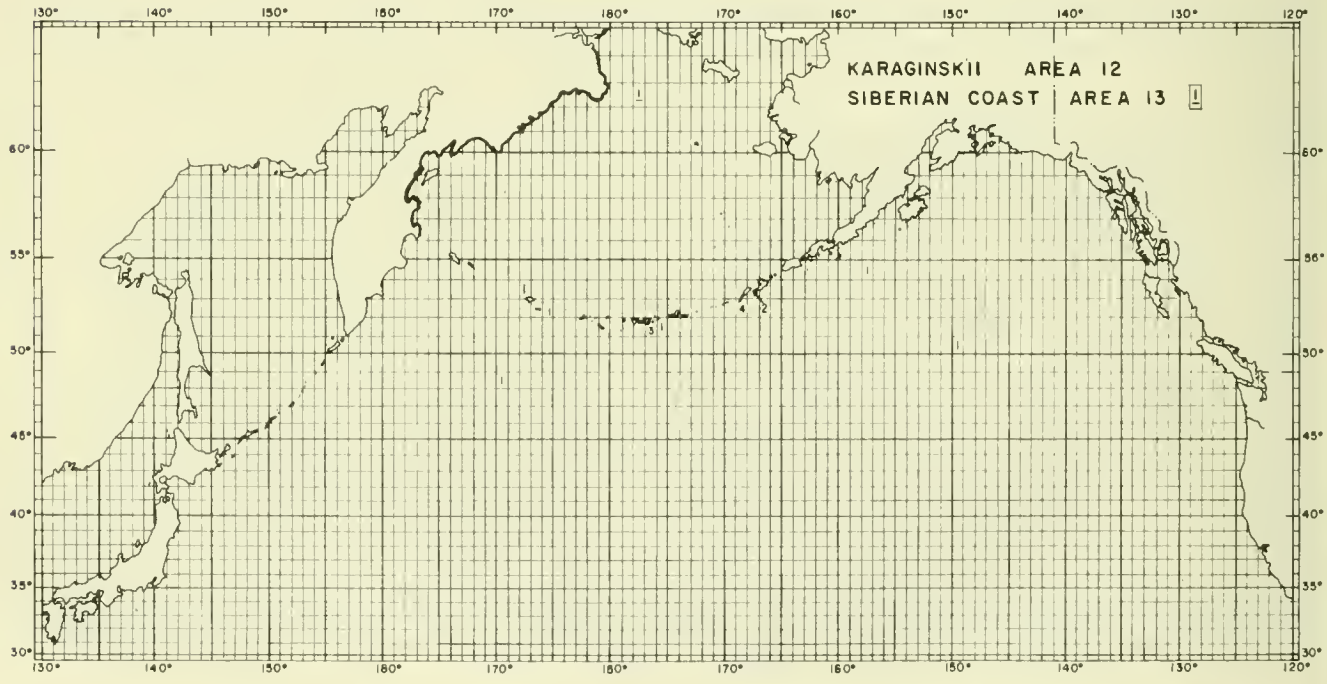

Figure 45.—Tagging locations of maturing chum salmon recovered in Karaginskii and Siberian coast areas.

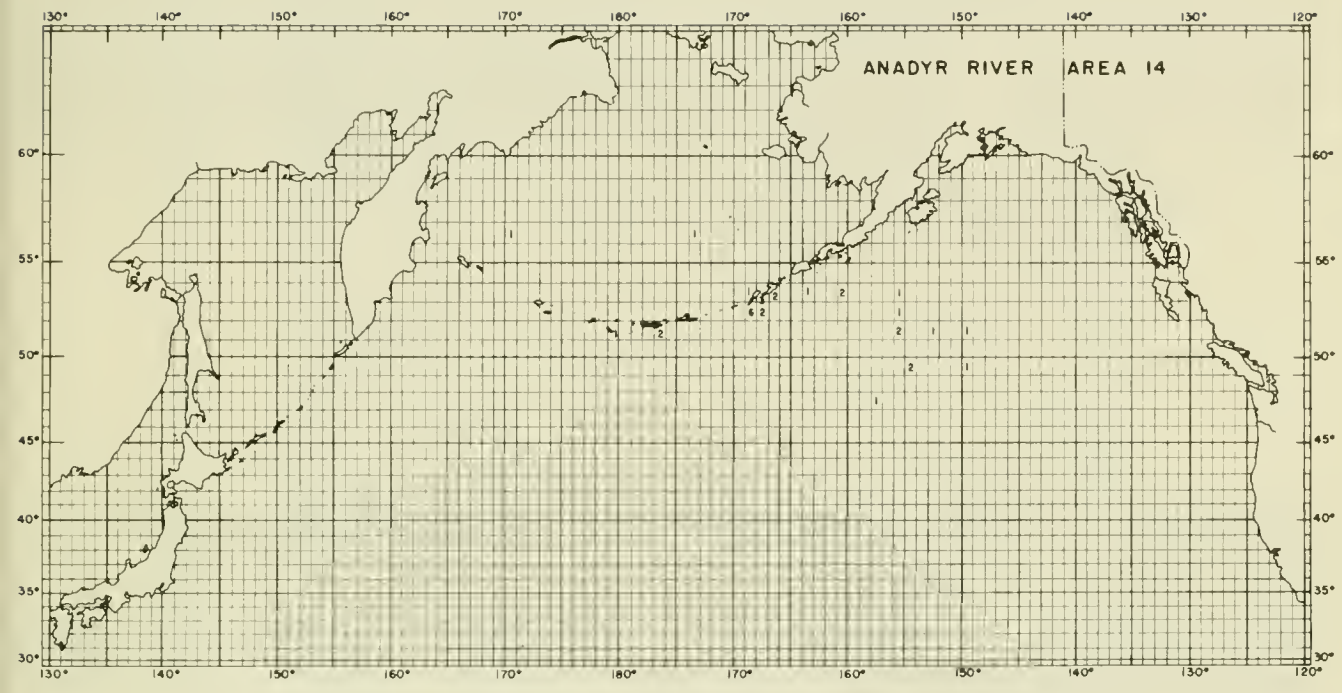

Figure 46.—Tagging locations of maturing chum salmon recovered in Anadyr River.

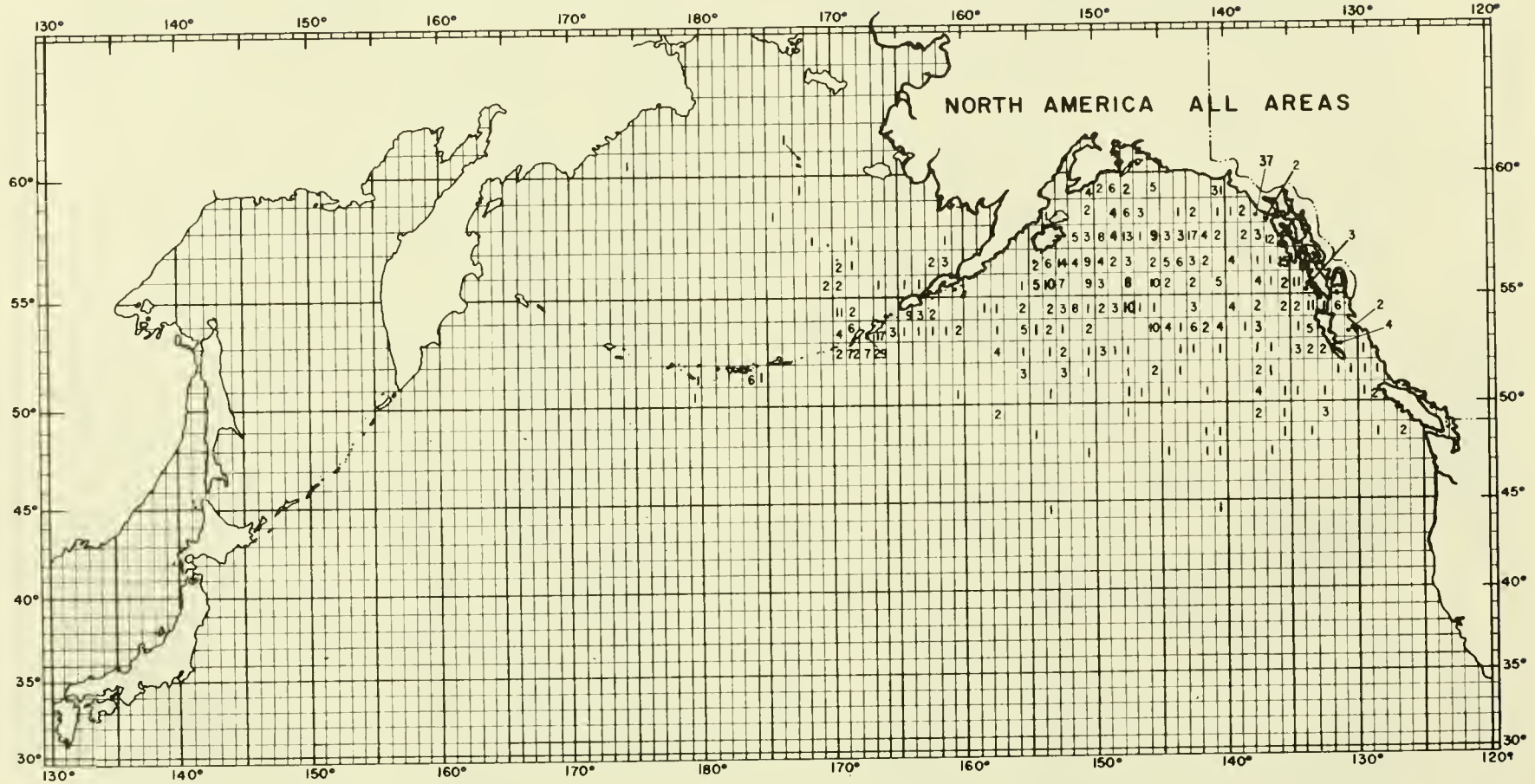

Figure 47.—Tagging locations of maturing chum salmon recovered in North America.

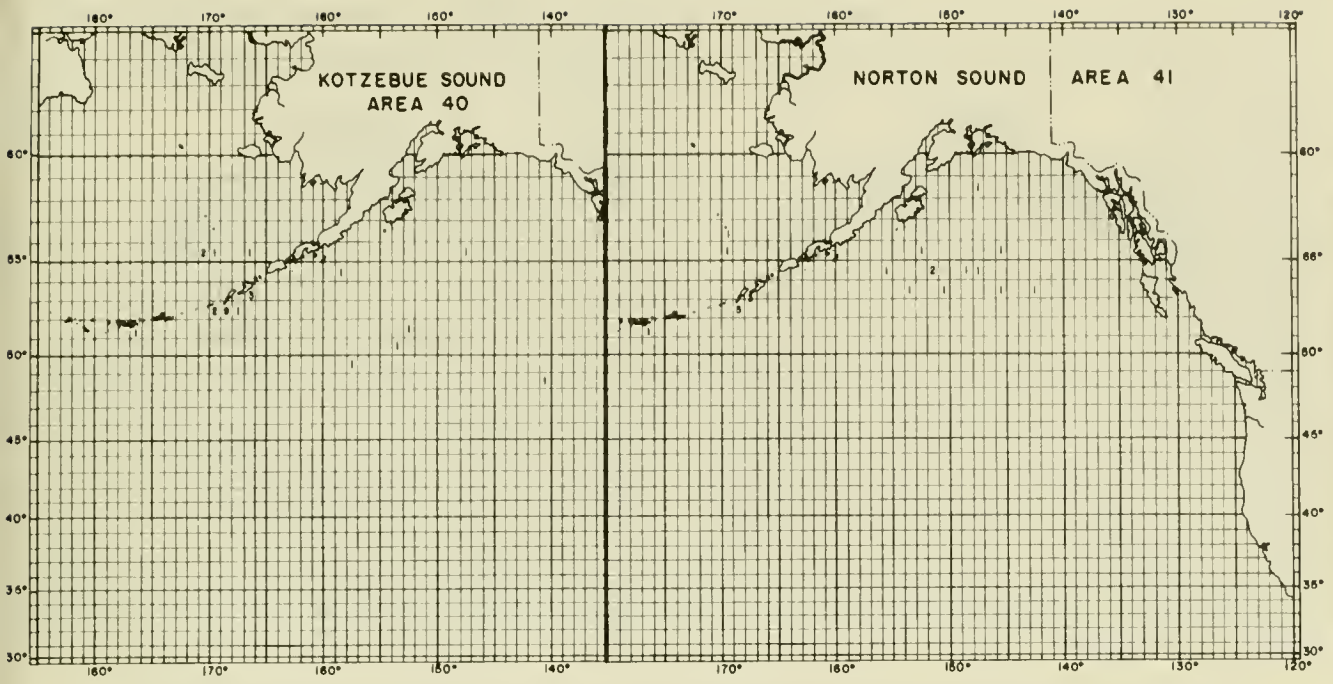

Figure 48.—Tagging locations of maturing chum salmon recovered in Kotzebue and Norton sounds.

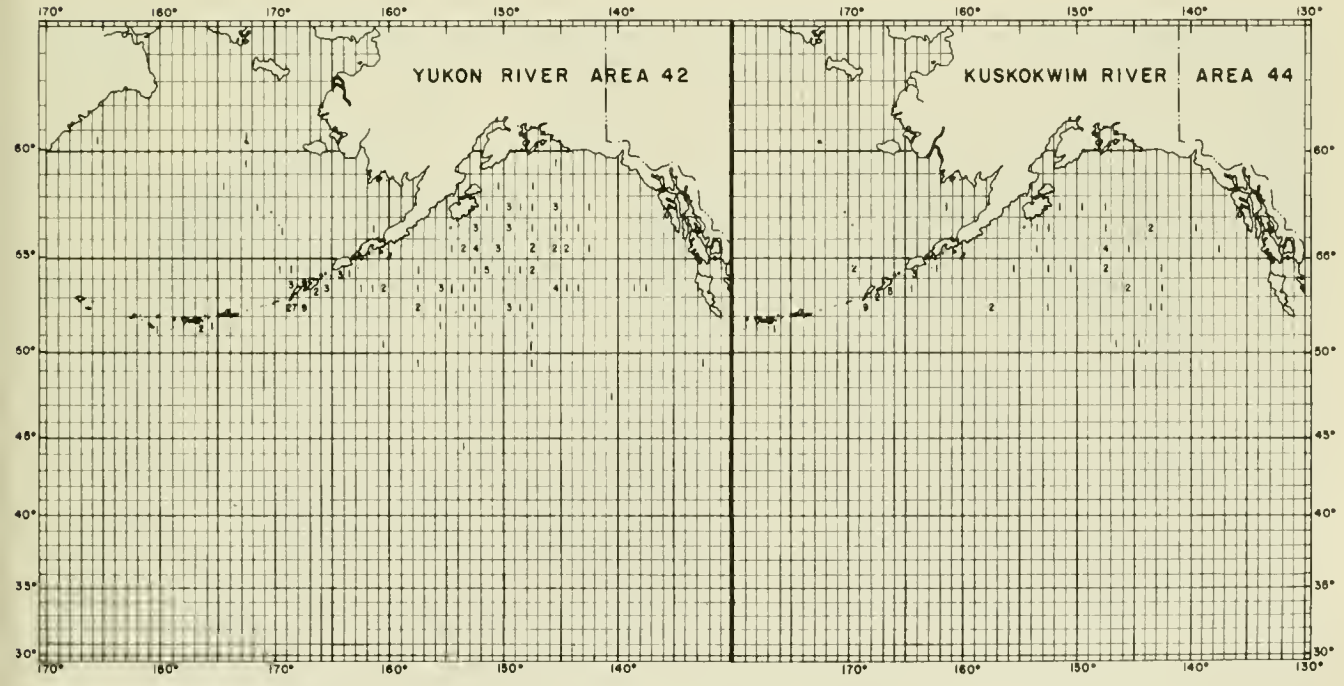

Figure 49.—Tagging locations of maturing chum salmon recovered in Yukon and Kuskokwim rivers.

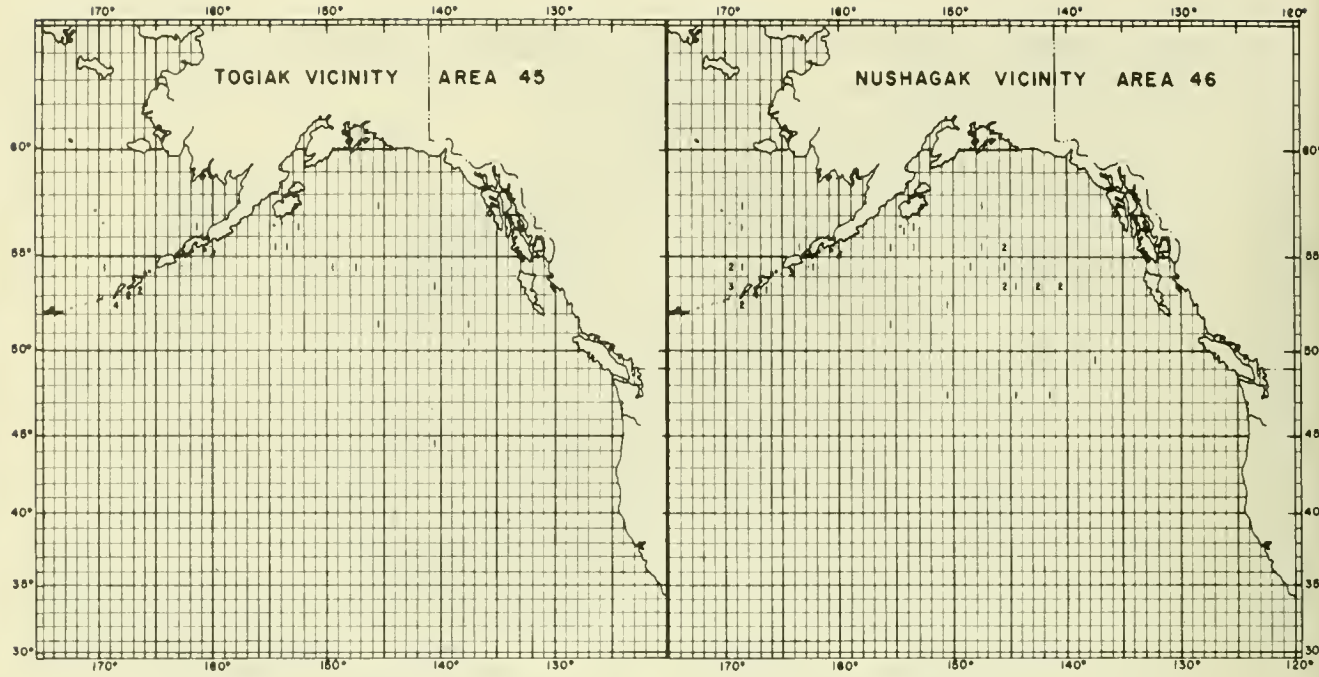

Figure 50.—Tagging locations of maturing chum salmon recovered in Togiak and Nushagak vicinities.

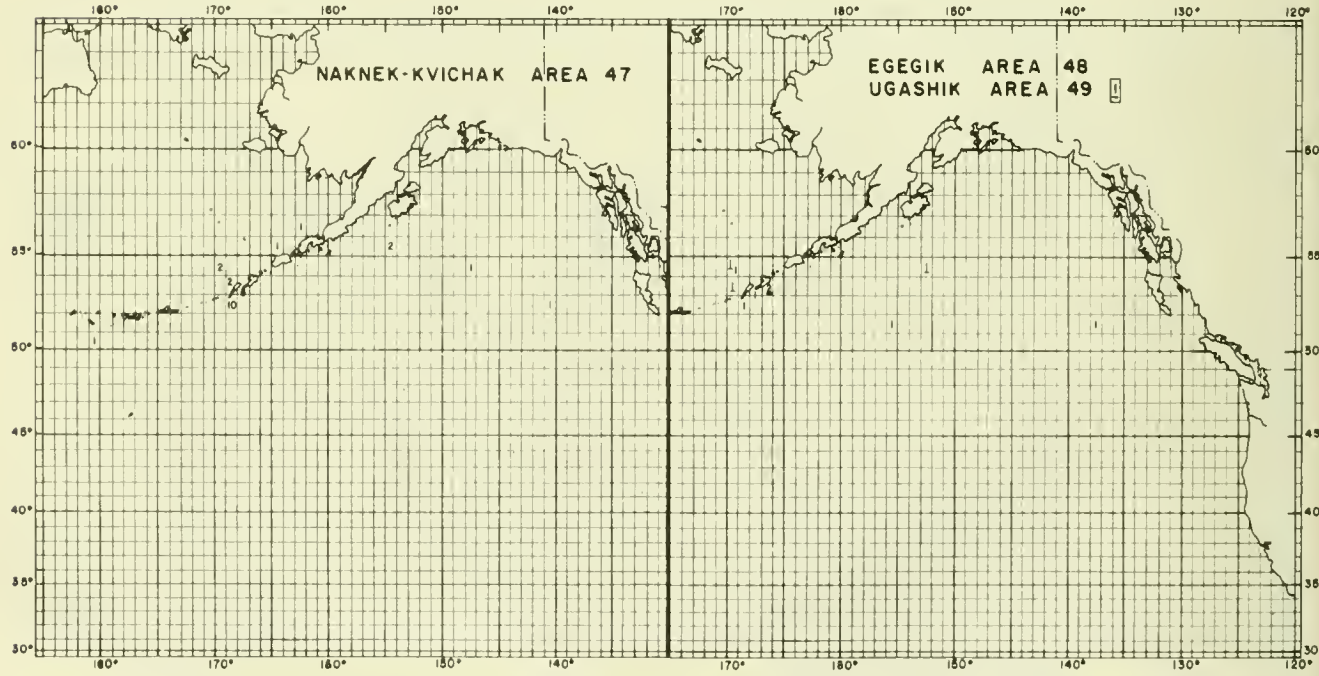

Figure 51.—Tagging locations of maturing chum salmon recovered in Naknek-Kvichak and in Egegik and Ugashik areas.

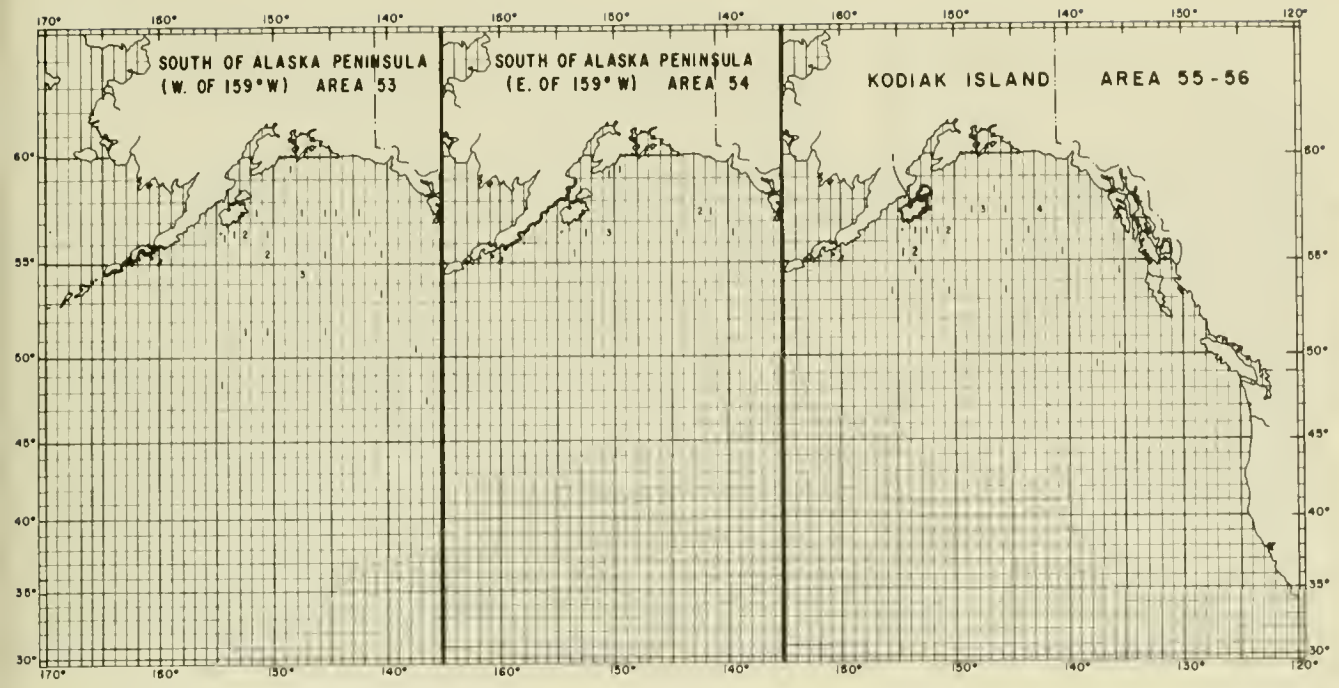

Figure 52.—Tagging locations of maturing chum salmon recovered south of the Alaskan Peninsula and in Kodiak Island.

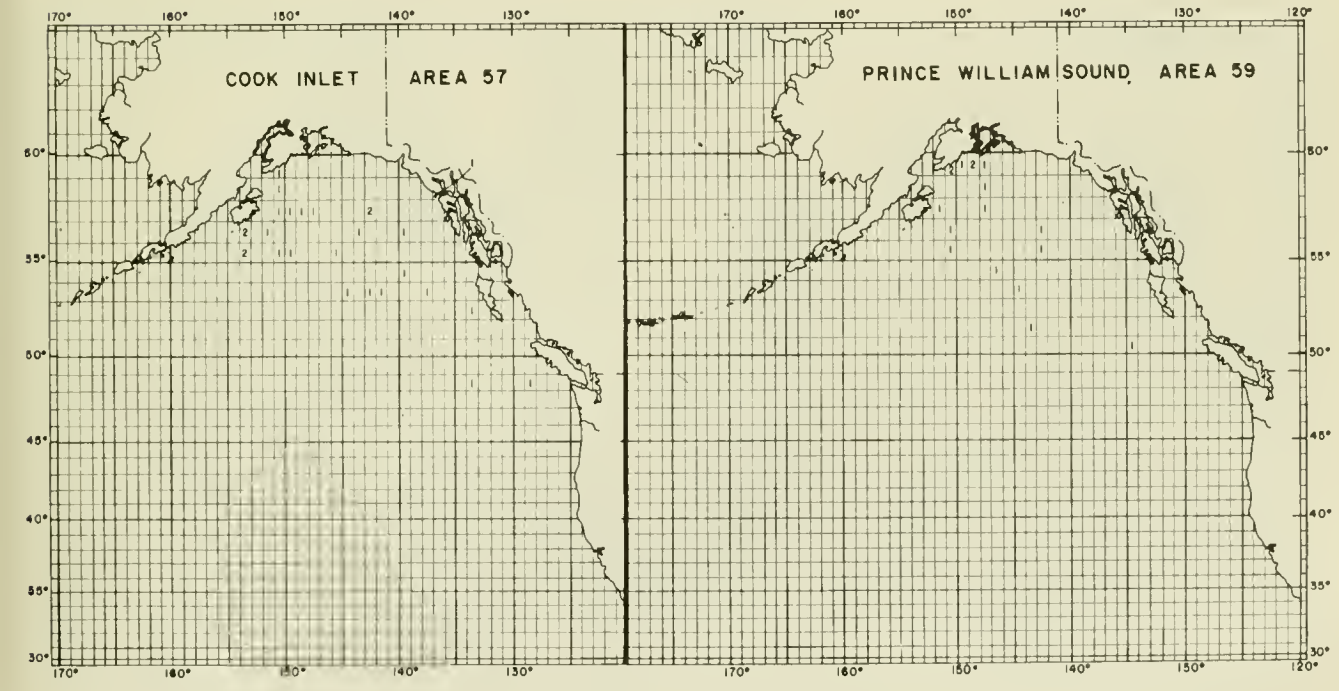

Figure 53.—Tagging locations of maturing chum salmon recovered in Cook Inlet and Prince William Sound.

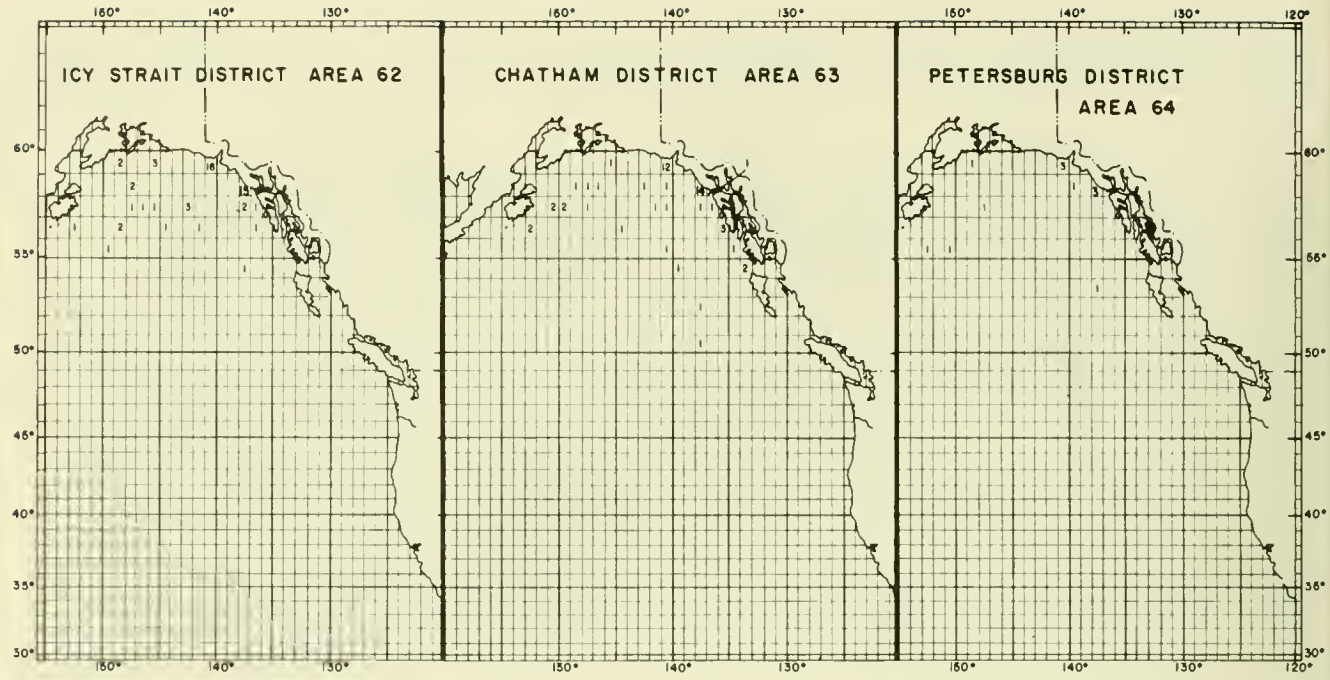

Figure 54.—Tagging locations of maturing chum salmon recovered in Icy Strait, Chatham, and Petersburg districts.

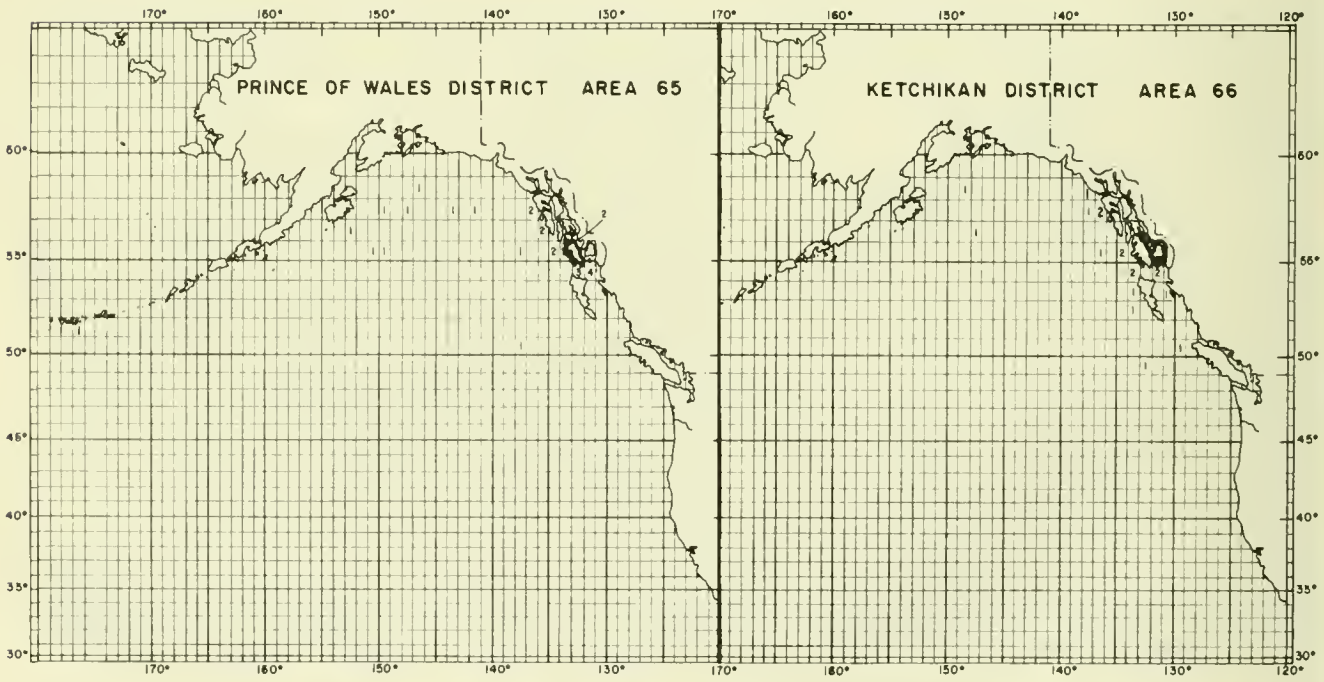

Figure 55.—Tagging locations of maturing chum salmon recovered in Prince of Wales and Ketchikan districts.

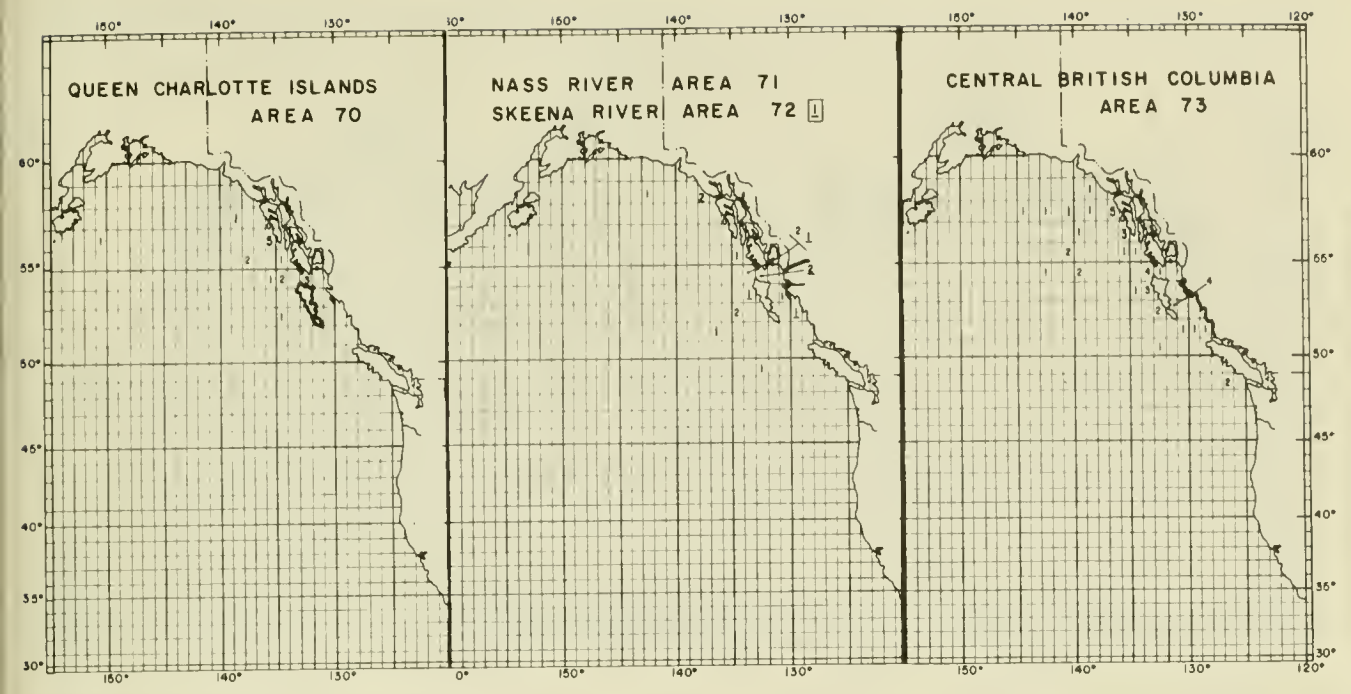

Figure 56.—Tagging locations of maturing chum salmon recovered in Queen Charlotte Islands, Nass and Skeena rivers, and central British Columbia areas.

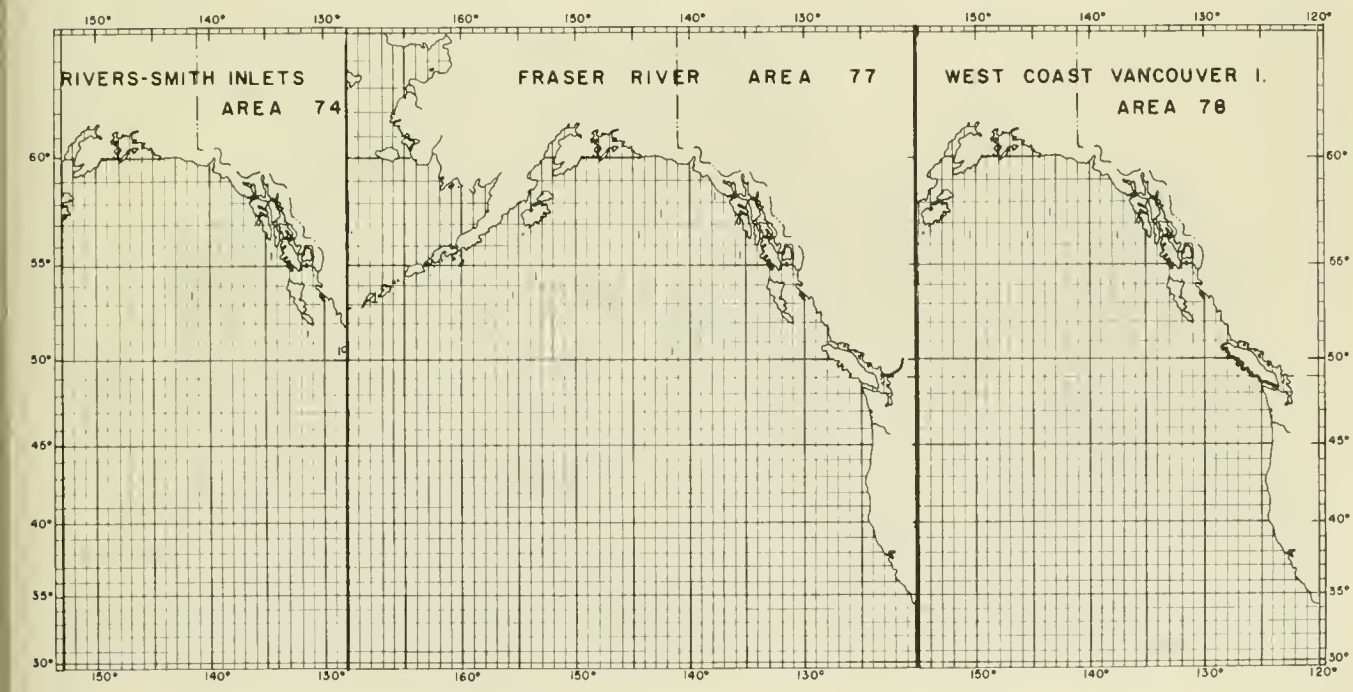

Figure 57.—Tagging locations of maturing chum salmon recovered in Rivers-Smith inlets, Fraser River, and west coast of Vancouver Island.

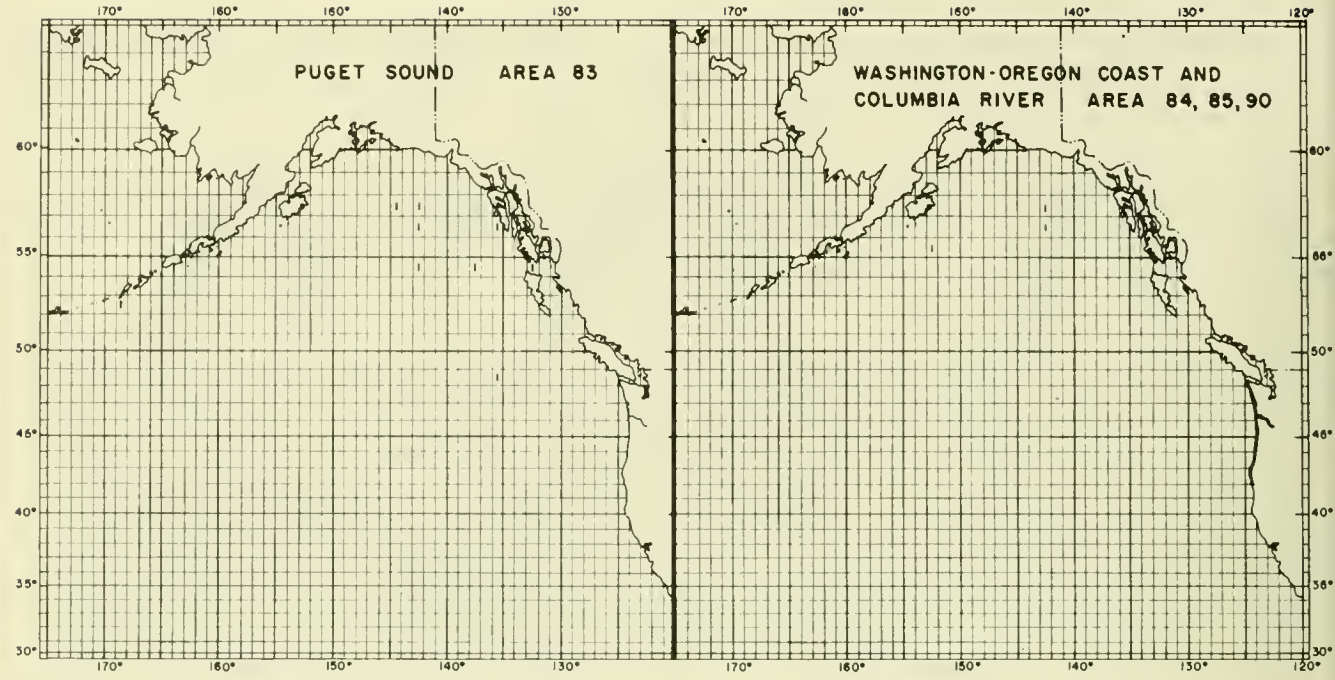

Figure 58.—Tagging locations of maturing chum salmon recovered in Puget Sound and on the Washington-Oregon coast and Columbia River.

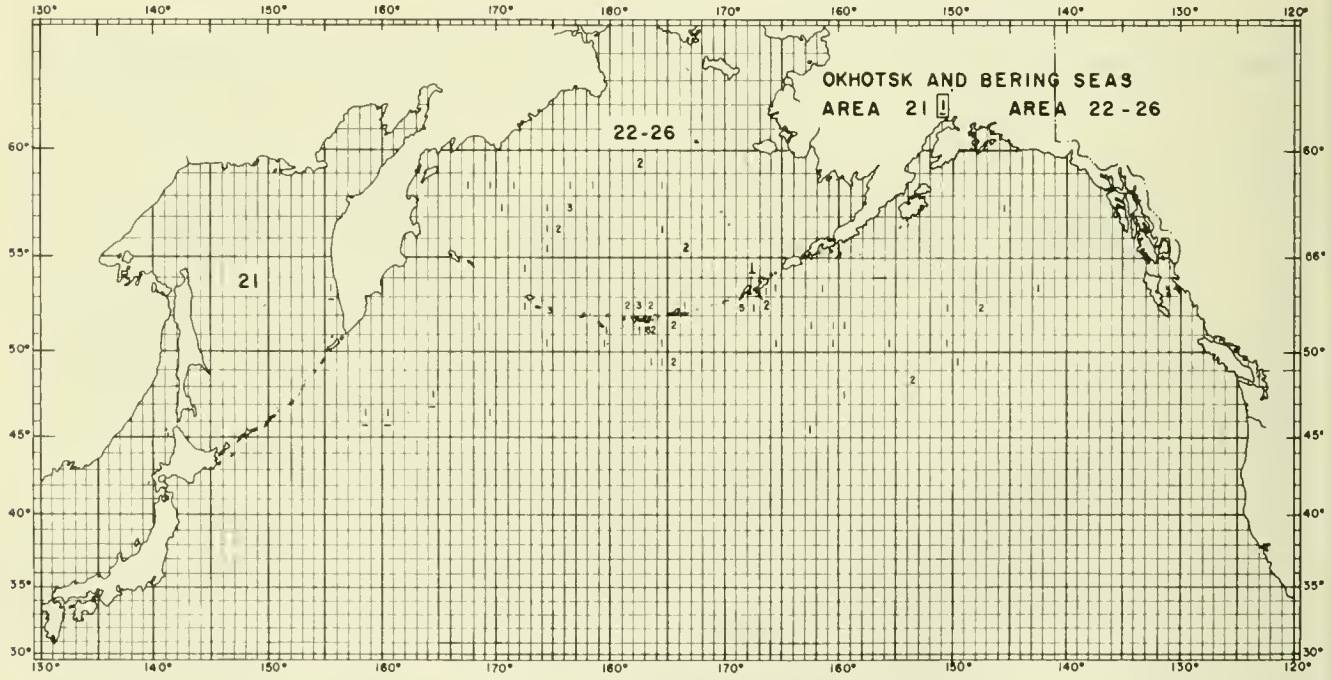

Figure 59.—Tagging locations of chum salmon (includes matures, immatures, and maturity unknown) recovered in the Okhotsk and Bering seas.

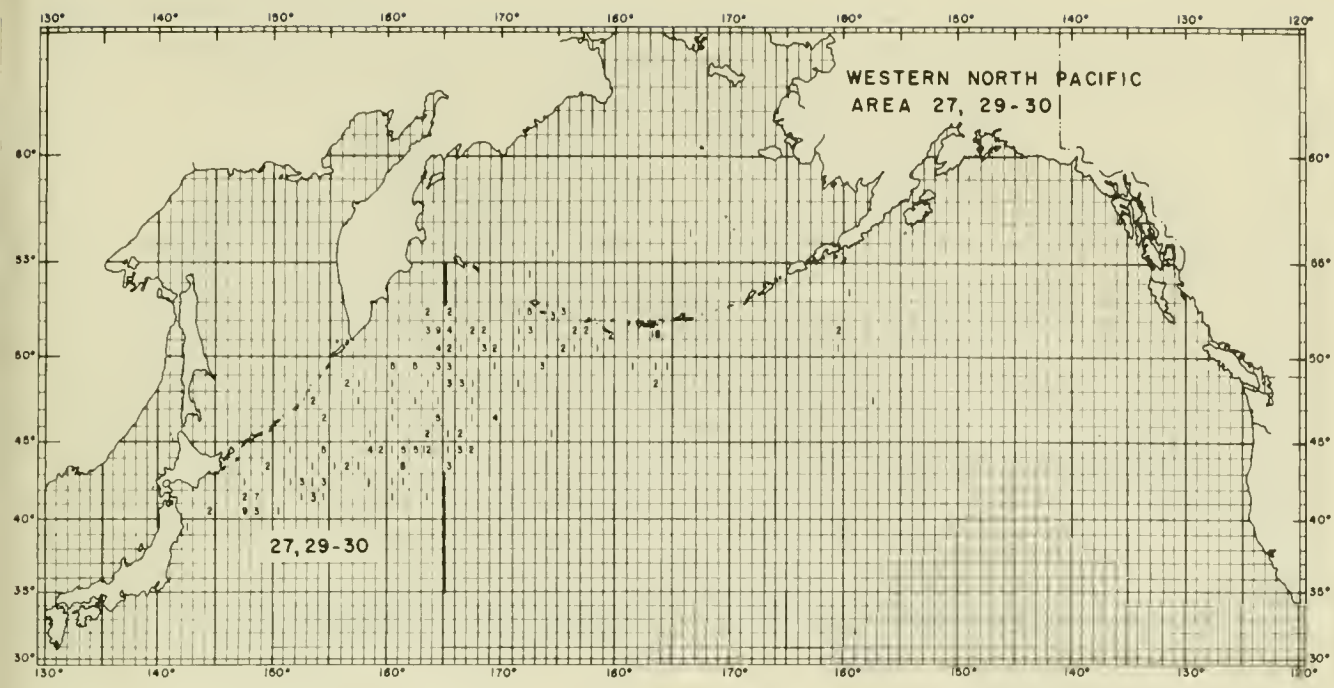

Figure 60.—Tagging locations of chum salmon (includes matures, immatures, and maturity unknown) recovered in the western North Pacific.

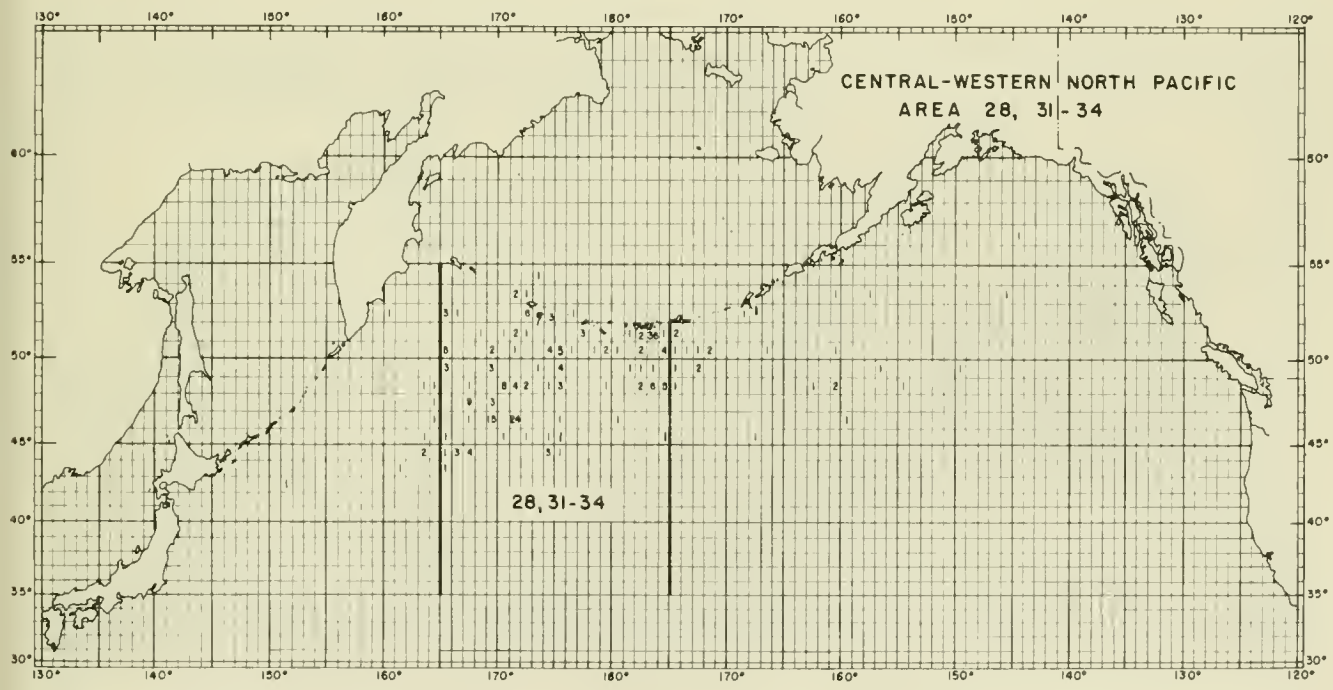

Figure 61.—Tagging locations of chum salmon (includes matures, immatures, and maturity unknown) recovered in the central-western North Pacific.

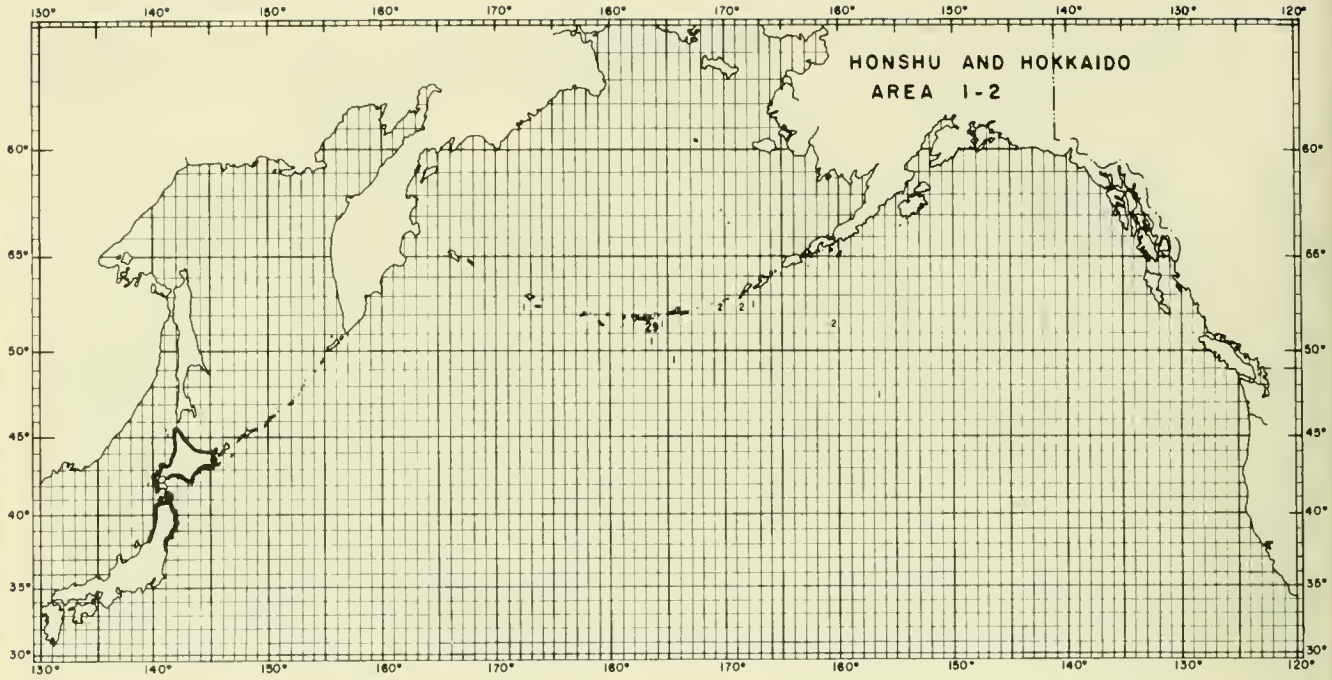

Figure 62.—Tagging locations of chum salmon recovered subsequent to year of tagging on Honshu and Hokkaido islands.

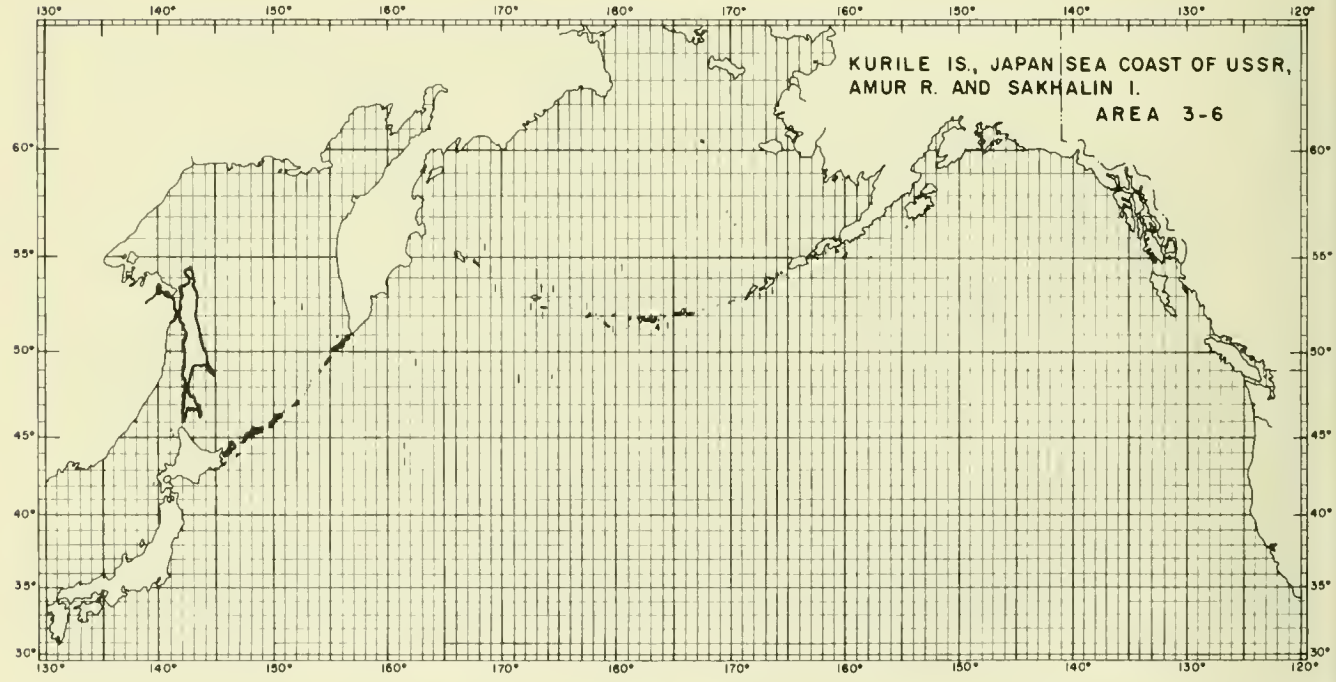

Figure 63.—Tagging locations of chum salmon recovered subsequent to year of tagging in the Kurile Islands, Japan Sea coast of USSR, Amur River, and Sakhalin Island areas.

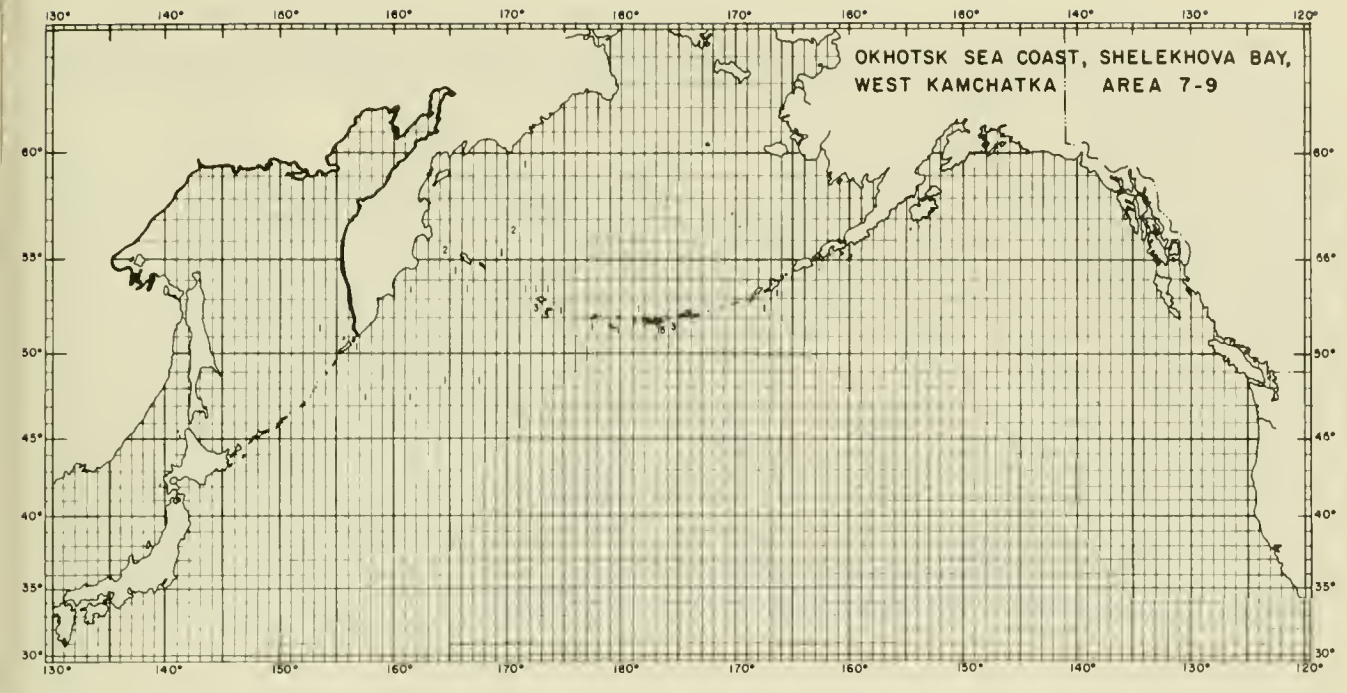

Figure 64.—Tagging locations of chum salmon recovered subsequent to year of tagging in the Okhotsk Sea coast, Shelekhova Bay, and west Kamchatka.

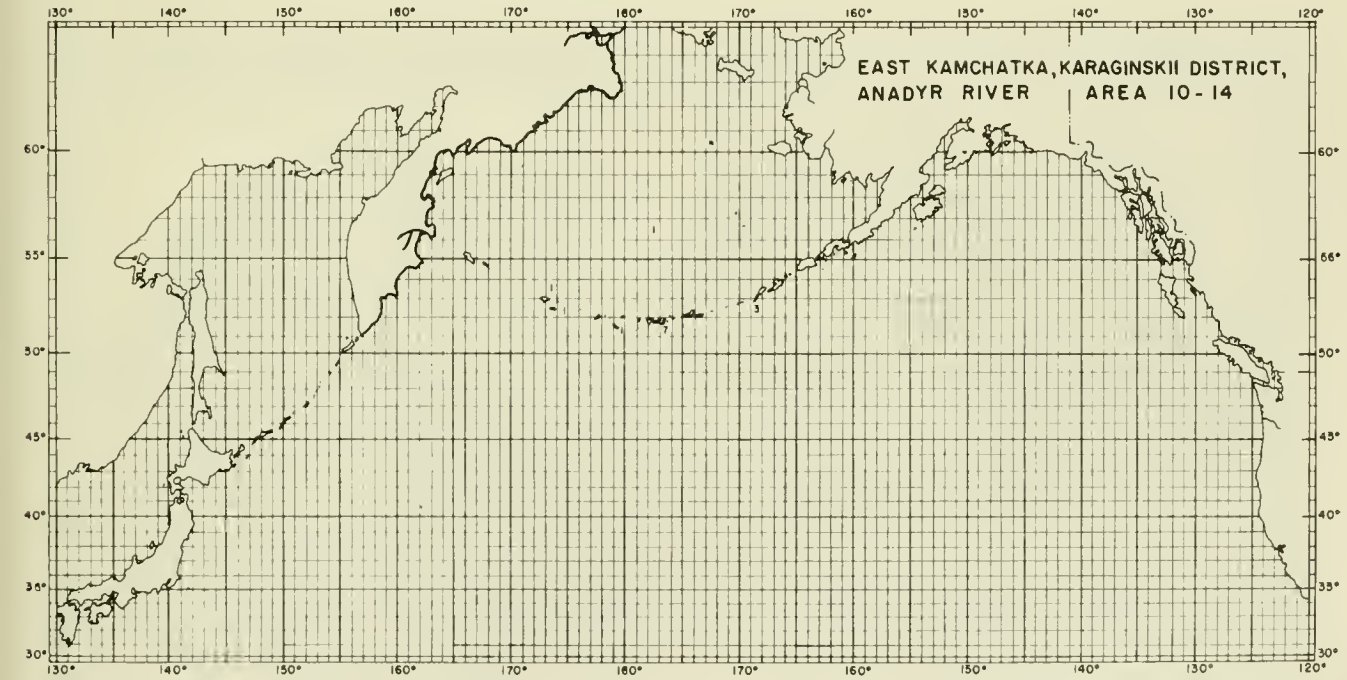

Figure 65.—Tagging locations of chum salmon recovered subsequent to year of tagging in east Kamchatka, Karaginskii district, and Anadyr River.

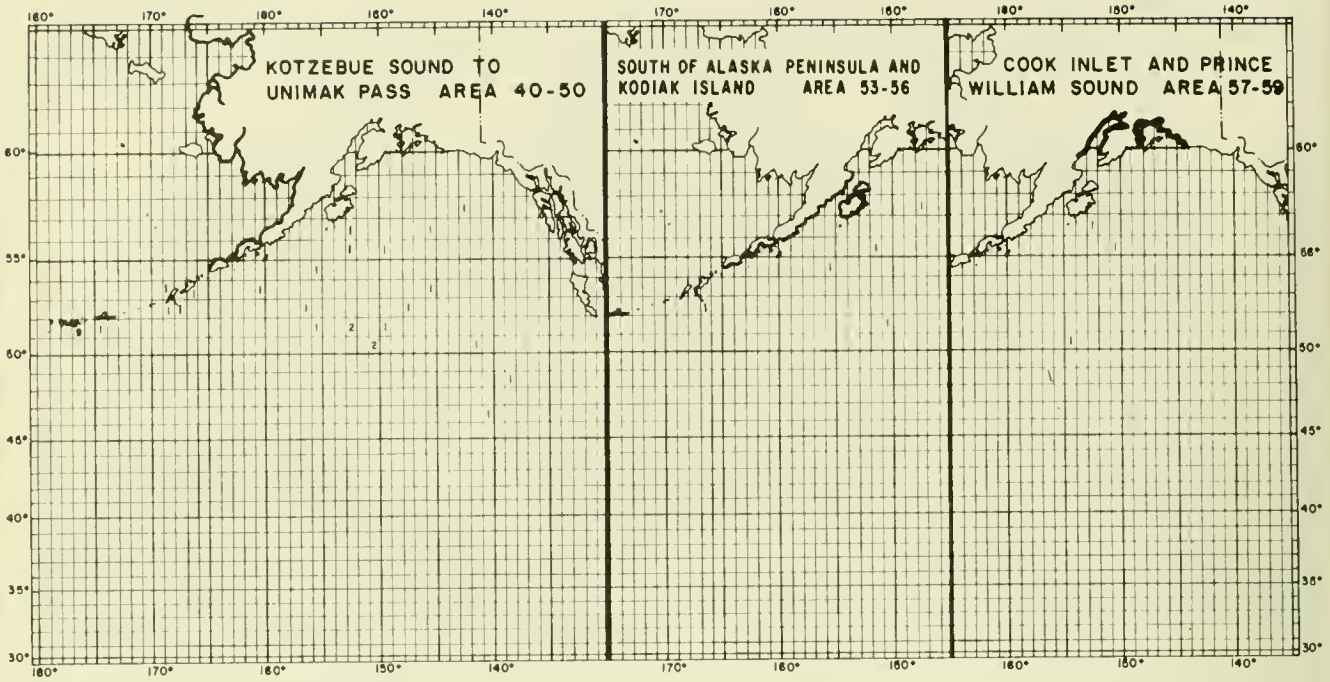

Figure 66.—Tagging locations of chum salmon recovered subsequent to year of tagging from Kotzebue Sound to Unimak Pass, south of Alaska Peninsula and Kodiak Island, and Cook Inlet and Prince William Sound areas.

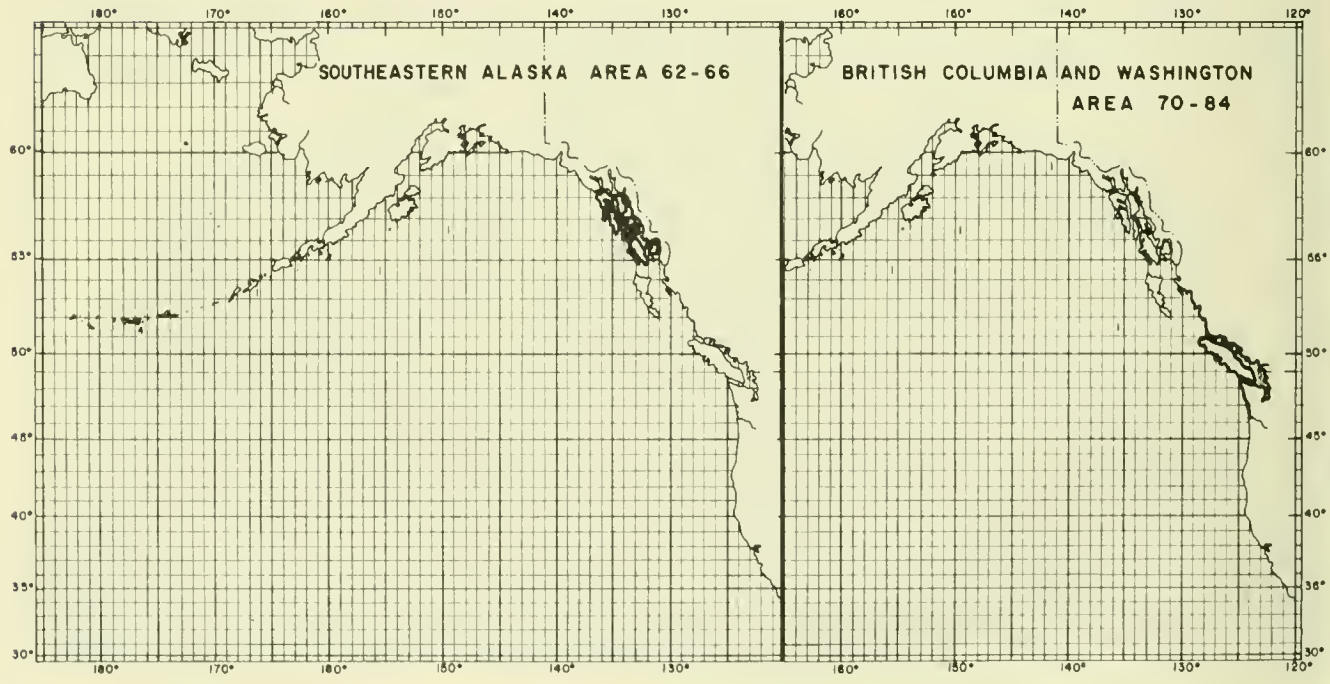

Figure 67.—Tagging locations of chum salmon recovered subsequent to year of tagging in southeastern Alaska and in British Columbia and Washington areas.

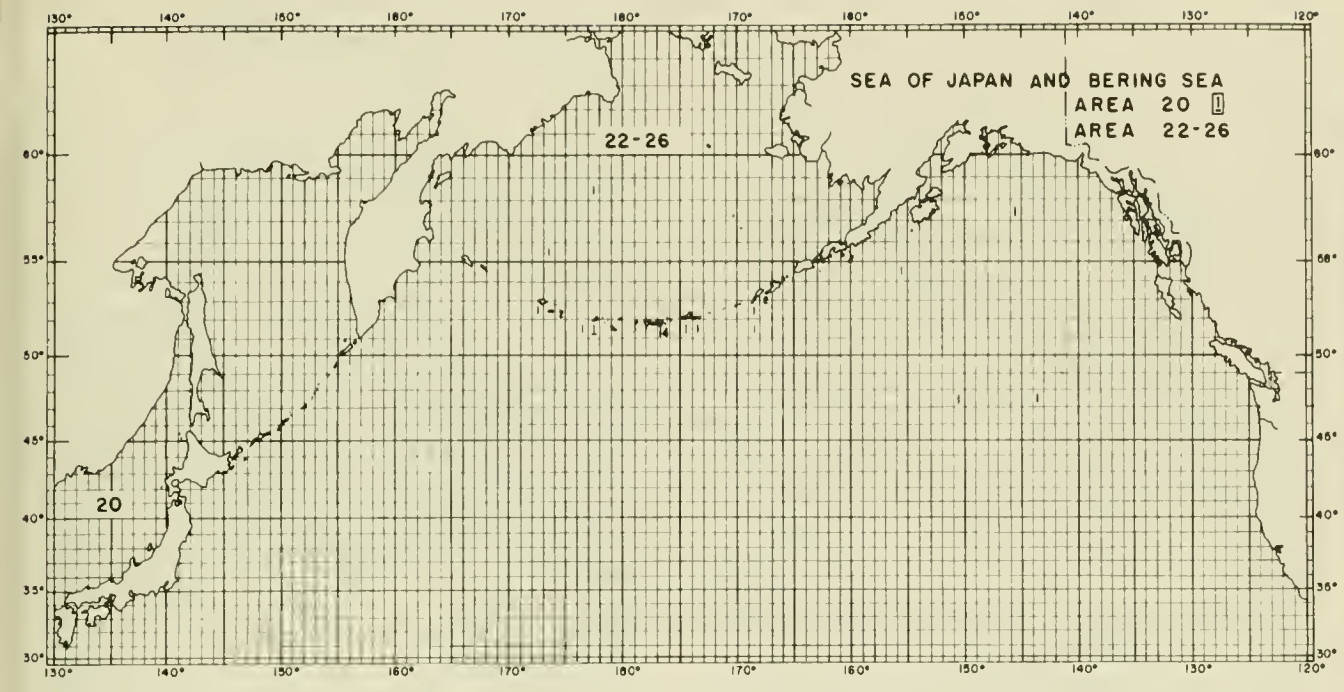

Figure 68.—Tagging locations of chum salmon recovered in the Sea of Japan and Bering Sea subsequent to year of tagging.

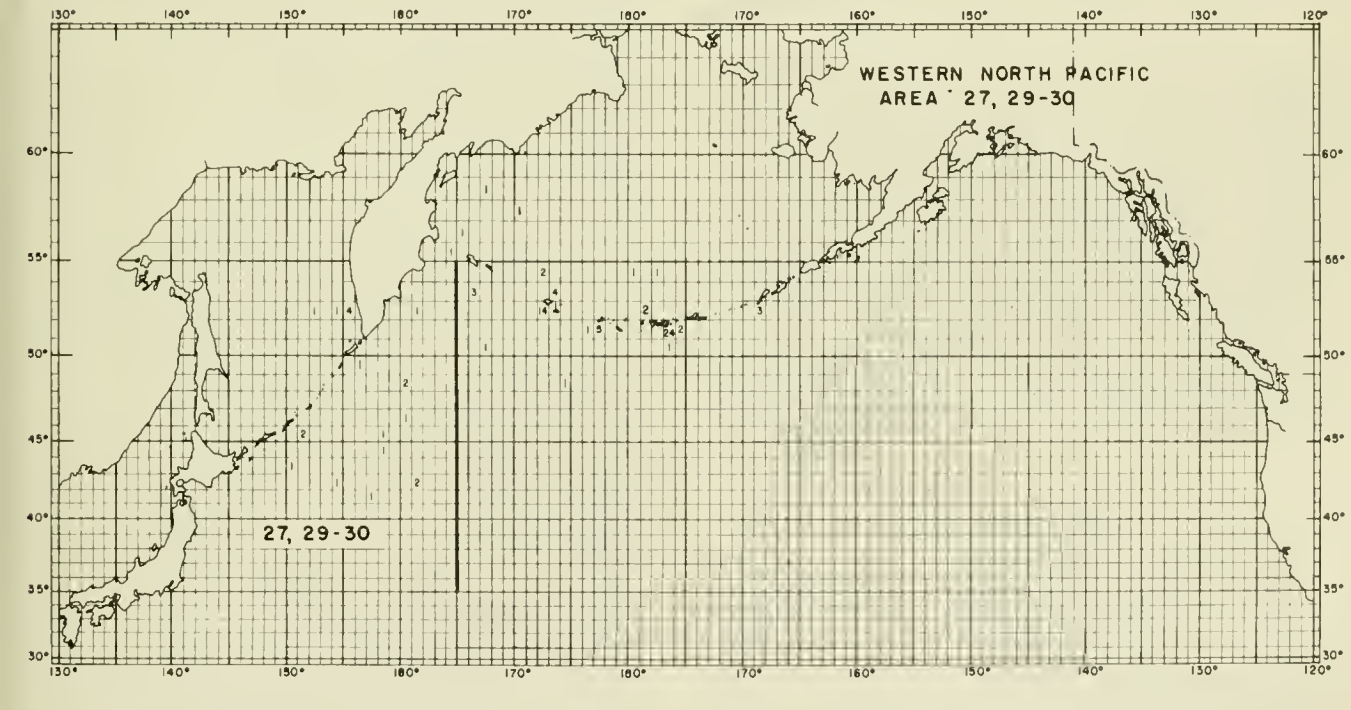

Figure 69.—Tagging locations of chum salmon recovered in the western North Pacific subsequent to year of tagging.

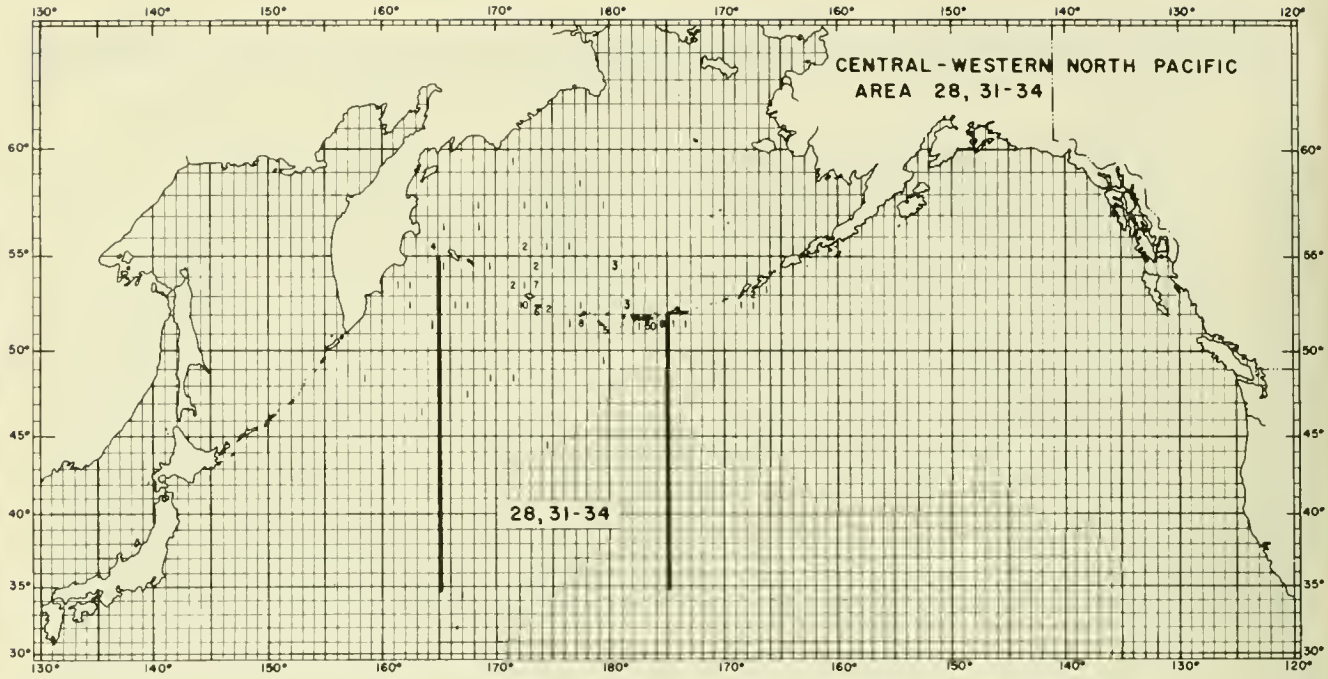

Figure 70.—Tagging locations of chum salmon recovered in the central-western North Pacific subsequent to year of tagging.

PINK SALMON

Figures 71-89

Pink salmon are the most numerous of Pacific salmon and provide a larger proportion of the total annual catch of Pacific salmon than any other single species. During the period from 1954 to 1961, pink salmon contributed about 40% of the weight and nearly 60% of the numbers of all salmon caught commercially in the North Pacific and adjacent seas and fresh water (Neave et al. 1967).

In Asia, pink salmon spawn in streams extending from North Korea and the Japanese Island of Hokkaido northward to the Yana and Lena rivers which flow into the Arctic Ocean. In North America, pink salmon have been noted from the Russian River in central California northward to central Alaska, westward to Attu Island, northward to northern Alaska, and eastward to the McKenzie River in Canada (Neave et al. 1967).

Abundance of pink salmon in Asia is substantially greater than in North America. During the years 1951-60 the average commercial catch of pink salmon in Asian waters (west of long. 175°W) was about 99.4 million fish; in North America the commercial catch averaged about 31.3 million fish or about one-third the Asian catch (Kasahara 1963).

Coastal Recoveries in Year of Tagging

Pink salmon invariably return to spawn after one winter at sea, and high-seas tagging was done primarily on the maturing individuals during their final few months at sea. During purse seine fishing with fine-meshed nets, the Fisheries Research Institute, University of Washington, captured and tagged juvenile pink salmon which returned the year after tagging. The total numbers of pink salmon tagged since 1956 are shown in Figure 71. Total inshore recoveries from Asia and North America (Fig. 72) show that most recoveries were from tagging areas in the northwestern Pacific Ocean, southeast of the Kurile Islands, off the Aleutian Islands, and in the northeastern Pacific. Of interest is the virtual absence of recoveries from south of lat. 50°N and between long. 165°E and 160°W although substantial numbers of fish were tagged in this area. Recoveries came from tagging locations as far south as near lat. 40°N in the western Pacific (near lat. 38°N in the Sea of Japan) and near lat. 43°N in the eastern Pacific. In the Bering Sea the northernmost point of tagging which resulted in an inshore recovery was near lat. 58°N (at long. 168°E). These tagging locations do not reflect the entire range of distribution of pink salmon which, as shown by Manzer et al. (1965), extended north of lat. 60°N in the Bering Sea in June and July and as far south as about lat. 40°N in the central North Pacific in May.

Asian stocks (Figs. 73-77).—Total Asian recoveries of pink salmon (Fig. 73) came primarily from tag releases in the northwestern Pacific Ocean and the central and western Aleutian Islands area. The easternmost point of tagging of an Asian coastal recovery was near long. 162°W at about lat. 47°N. There was a noticeable lack of recoveries from the general area south of the western Aleutian Islands to the Kamchatka Peninsula. Pink salmon are either not distributed abundantly in this area or tagging effort was inadequate in the area. An interesting feature of the distribution of Asian pink salmon was that although they are the most abundant of the salmon species, their ocean distribution appeared more limited than the less abundant Asian chum salmon or western Alaska sockeye salmon. This could be an actual feature of their distribution or the Asian pink salmon may not have been as available at the time and areas of the tagging experiments as the chum or sockeye salmon and their distribution not as fully depicted.

Honshu and Hokkaido islands to Okhotsk Sea.—Pink salmon recoveries in the northern Japan Islands, Kurile Islands, Sakhalin, and other streams emptying into the Okhotsk Sea all were from the same general release area in the northwestern Pacific Ocean; this was primarily the area southeast of the Kurile Islands (Figs. 74-76). The single recovery from Honshu Island, five fish from Hokkaido, and several from the Amur River, Japan Sea coast of USSR, and Sakhalin were from tagging locations in the Japan Sea. The easternmost location of a tagged pink salmon recovered in the Okhotsk Sea area (in Sakhalin) was near long. 177°E and lat. 50°N.

East Kamchatka to Siberian coast.—Recoveries of tagged pink salmon in Asia from east Kamchatka to the Siberian coast were from quite different tagging locations than the recoveries to other areas in Asia (Figs. 76, 77). They came mainly from tagging locations off the Aleutian Islands and in the Bering Sea. Two recoveries in east Kamchatka and one in the Karaginskii District, however, were from southeast of the Kurile Islands. The easternmost tagging location of a pink salmon recovered in Asia was near long. 162°W and lat. 47°N; this fish was recovered in the Karaginskii District. A few fish from this district were also tagged off the eastern Aleutian Islands to near long. 163°W.

North American stocks (Figs. 78-86).—North American coastal recoveries of pink salmon (Fig. 78) illustrate that the maturing fish were primarily distributed in the northeastern Pacific Ocean east of long. 155°W and in the Aleutian Islands area east of about long. 177°W. A comparison of Asian recoveries (Fig. 73) with the North American recoveries indicates the general separation of the two stocks of

maturing fish except in waters along the Aleutian Islands east of long. 177°W.

Inadequate tagging effort and lack of tag recoveries from the central North Pacific Ocean south of lat. 50°N obscures the distribution of Asian and North American pink salmon in this area of the ocean where they are known to occur in early spring. The preponderance of recoveries in North America compared to recoveries in Asia, despite the greater numerical abundance of Asian stocks, reflects the difference in tagging and recovery efforts of the two groups.

Northern and western Alaska.—Tagged pink salmon recovered in Norton Sound were from taggings off the Aleutian Islands as were three of the four recoveries made in the Yukon River (Fig. 79). One recovery in the Yukon River came from a release point near long. 137°W and lat. 47°N.

Recoveries in the Kuskokwim River and Nushagak vicinity (Fig. 80) were primarily from taggings near the Aleutian Islands and in the eastern Bering Sea. The range of Nushagak fish to the northeastern Pacific Ocean was shown by the recovery of a pink salmon that was tagged near long. 154°W and lat. 48°N. Pink salmon recovered in the Naknek-Kvichak District (Fig. 80) came from tagging areas similar to those that were recovered in the Nushagak area.

Recoveries in the Aleutian Islands (Fig. 81) were from taggings near the Aleutian Islands.

Northeast Pacific coastal areas.—Tag recoveries in coastal areas from the Alaska Peninsula to Puget Sound were all from tagging locations east of long. 169°W. Recoveries from the south side of the Alaska Peninsula (Fig. 81) were generally from the western part of the Gulf of Alaska and north of lat. 50°N; those recovered in Kodiak, Cook Inlet, and Prince William Sound were generally from tagging throughout the Gulf of Alaska to well south of lat. 50°N (Fig. 82). Pink salmon from the latter group of coastal areas were distributed similarly according to the recoveries although fish returning to Cook Inlet and Prince William Sound indicated a more southern distribution than Kodiak Island fish.

Pink salmon returning to coastal areas of southeastern Alaska and northern and central British Columbia were distributed in the eastern part of the North Pacific Ocean (Figs. 83-85). Little difference was indicated in ocean distribution of tagged pink salmon bound for individual areas.

Tagged pink salmon returning to southern British Columbia and Puget Sound (Fig. 86) indicated a more restricted ocean distribution than the fish returning to northern British Columbia and southeastern Alaska. Most fish were from tagging along the coastline.

High-Seas Recoveries in Year Tagged

Recoveries of maturing pink salmon in the high seas by location of tagging are illustrated in Figures 87 and 88. Primarily most recoveries were of fish tagged and released within or close to the area of recovery. The exception was the recoveries in the Okhotsk Sea which came mainly from tagging in the northwestern Pacific Ocean (Fig. 87). Recoveries of tagged pink salmon in the Bering Sea, in addition to being from releases in that area and from releases in waters along the Aleutian Islands, were from widely dispersed tagging points in the northeast Pacific and northwest Pacific Ocean (Fig. 87).

The major number of recoveries in the northwestern Pacific Ocean was from tagging experiments east of Hokkaido Island (Fig. 88). It is interesting that several recoveries were made in the central North Pacific Ocean (areas 28, 31-34) from tagging south of lat. 50°N, although only a single recovery was made inshore from this area.

Coastal Recoveries Subsequent to Year of Tagging

Figure 89 illustrates coastal recoveries of pink salmon tagged as juvenile fish in their first summer at sea. Because pink salmon mature in their second year, they are only available for tagging as immatures during their first summer at sea as age .0 juveniles. The recoveries illustrate the movement of juveniles after they leave the estuaries. Returns to Kodiak Island, and southeastern Alaska, suggest that the juveniles move westward. The returns to British Columbia and Washington indicate juveniles from these areas move northward along the coast. Movements of the juveniles have been described by Hartt, Smith, Dell, and Kilambi 1967; Hartt, Dell, and Smith 1969, 1970; Rothschild et al. 1971; and Sakagawa 1972.

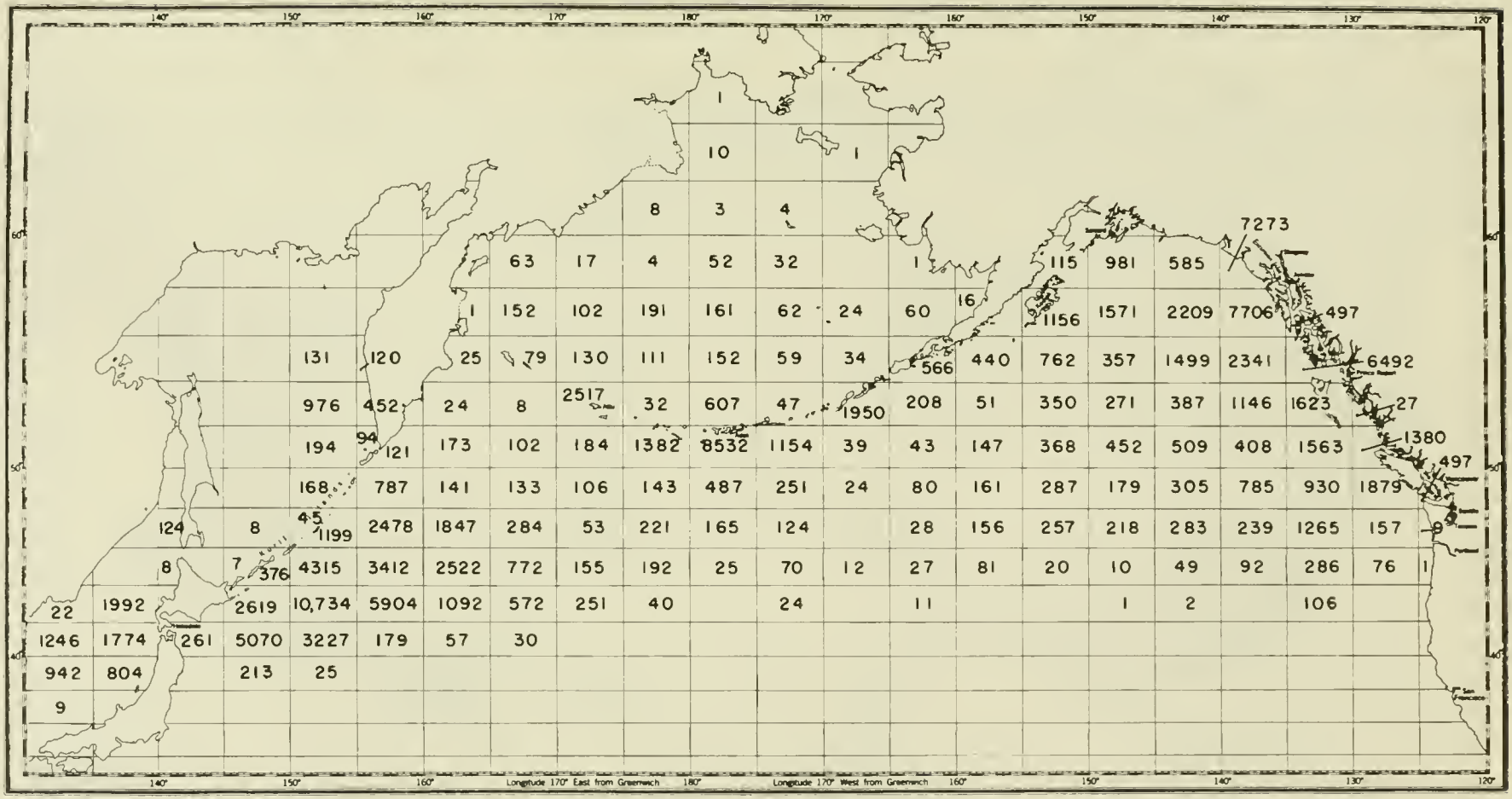

Figure 71.—Numbers of immature and maturing pink salmon tagged by Canada, Japan, and the United States, 1956-71 (source of data: Allan Hartt, Fisheries Research Institute, University of Washington, Seattle, Wash.).

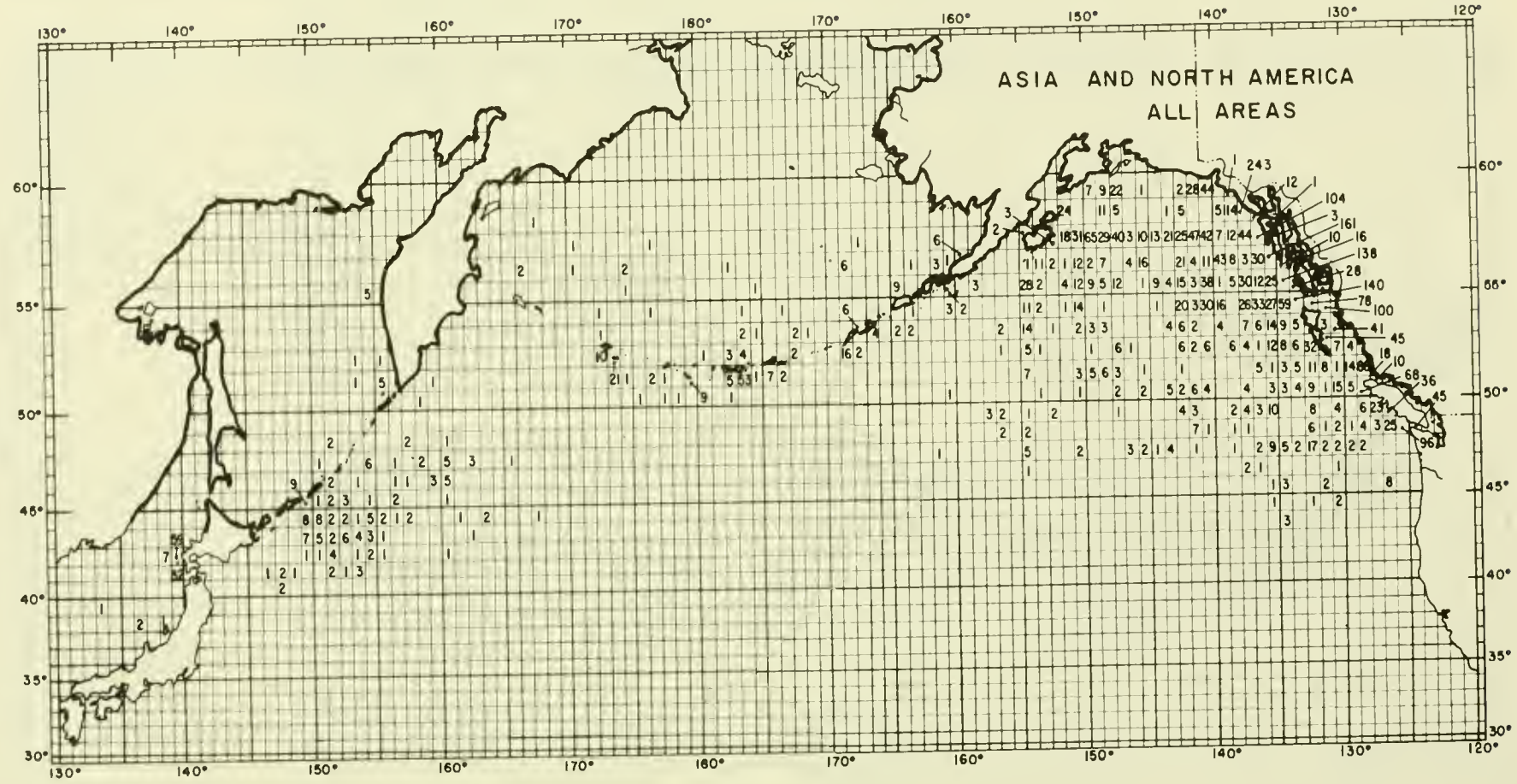

Figure 72.—Tagging locations of pink salmon recovered in Asia and North America.

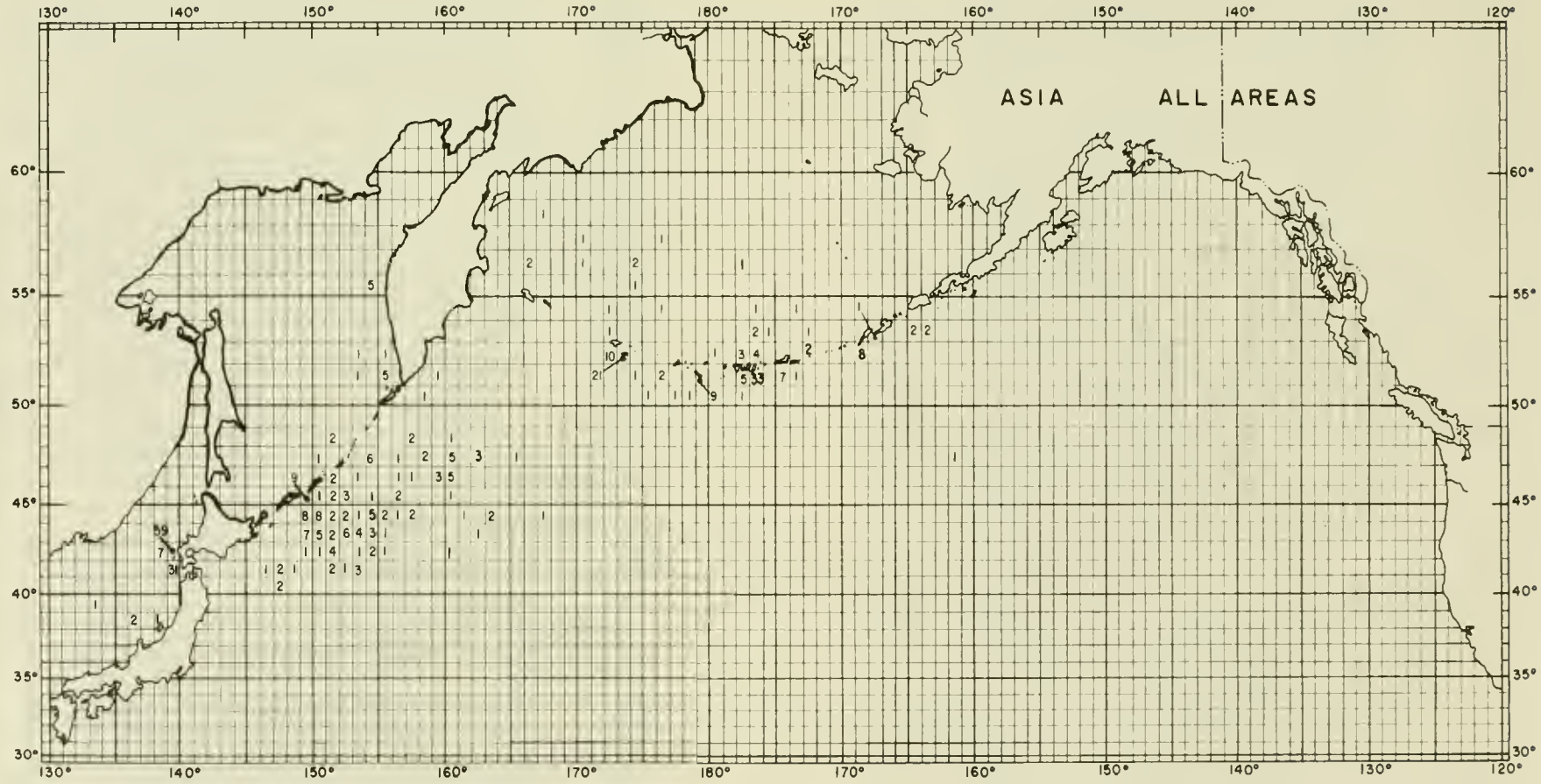

Figure 73.—Tagging locations of maturing pink salmon recovered in Asia.

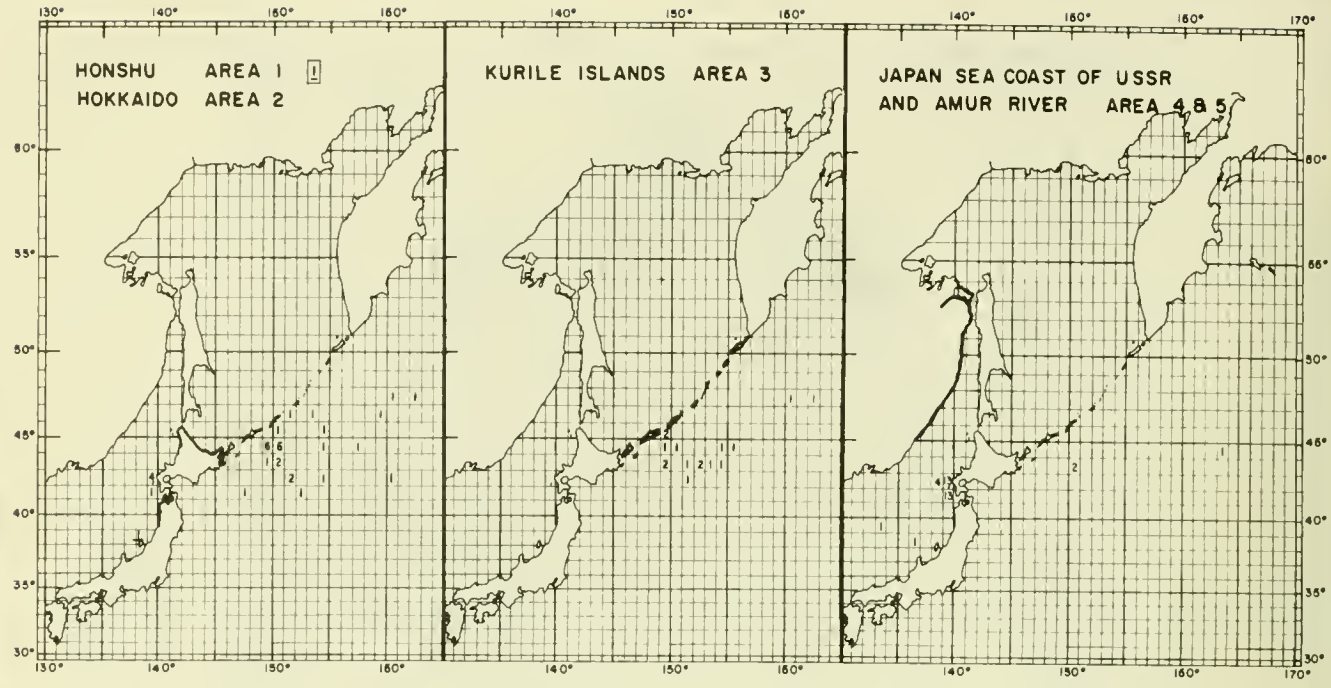

Figure 74.—Tagging locations of maturing pink salmon recovered in Honshu and Hokkaido islands, Kurile Islands, and Japan Sea coast of USSR and Amur River areas.

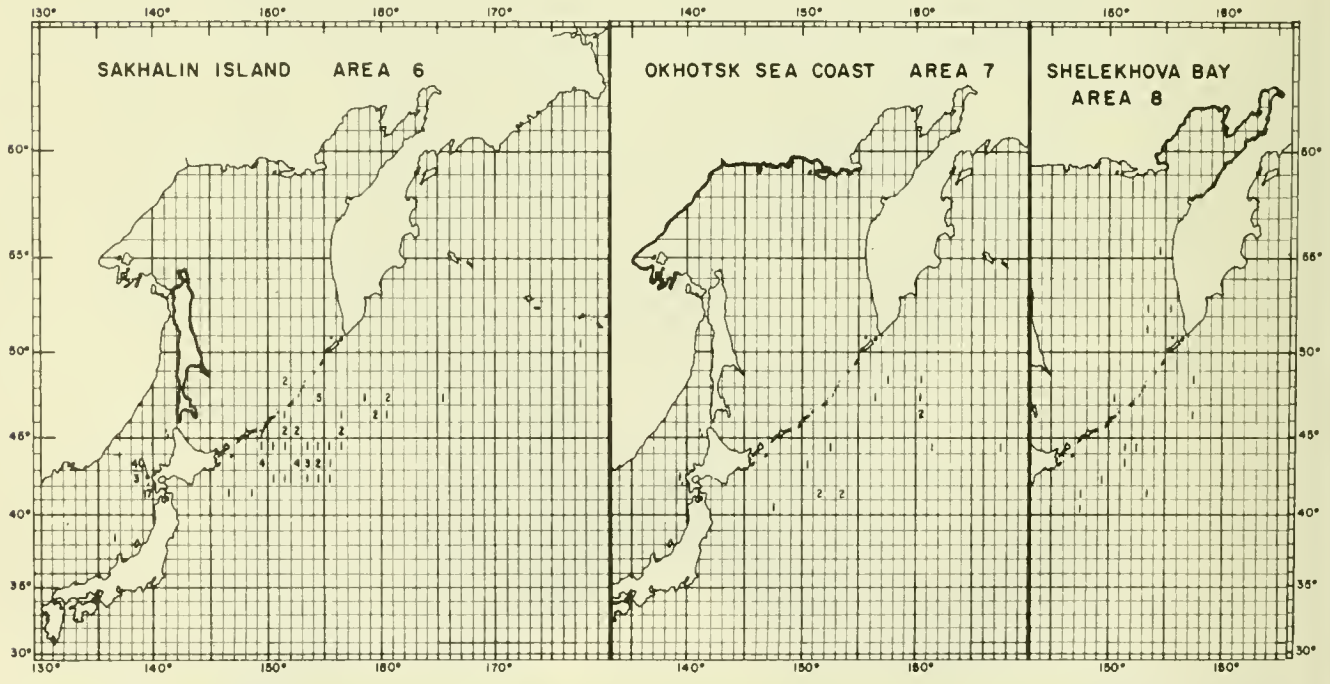

Figure 75.—Tagging locations of maturing pink salmon recovered in Sakhalin Island, Okhotsk Sea coast, and Shelekhova Bay areas.

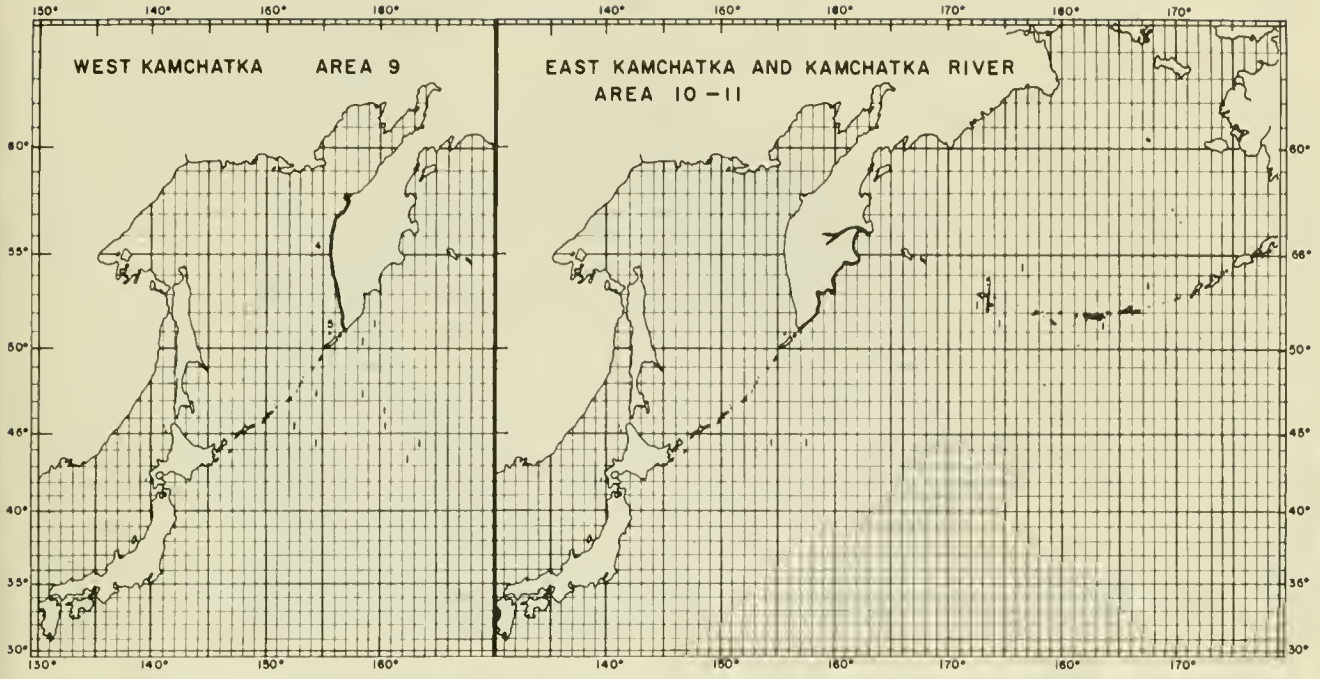

Figure 76.—Tagging locations of maturing pink salmon recovered in west Kamchatka and in east Kamchatka and Kamchatka River.

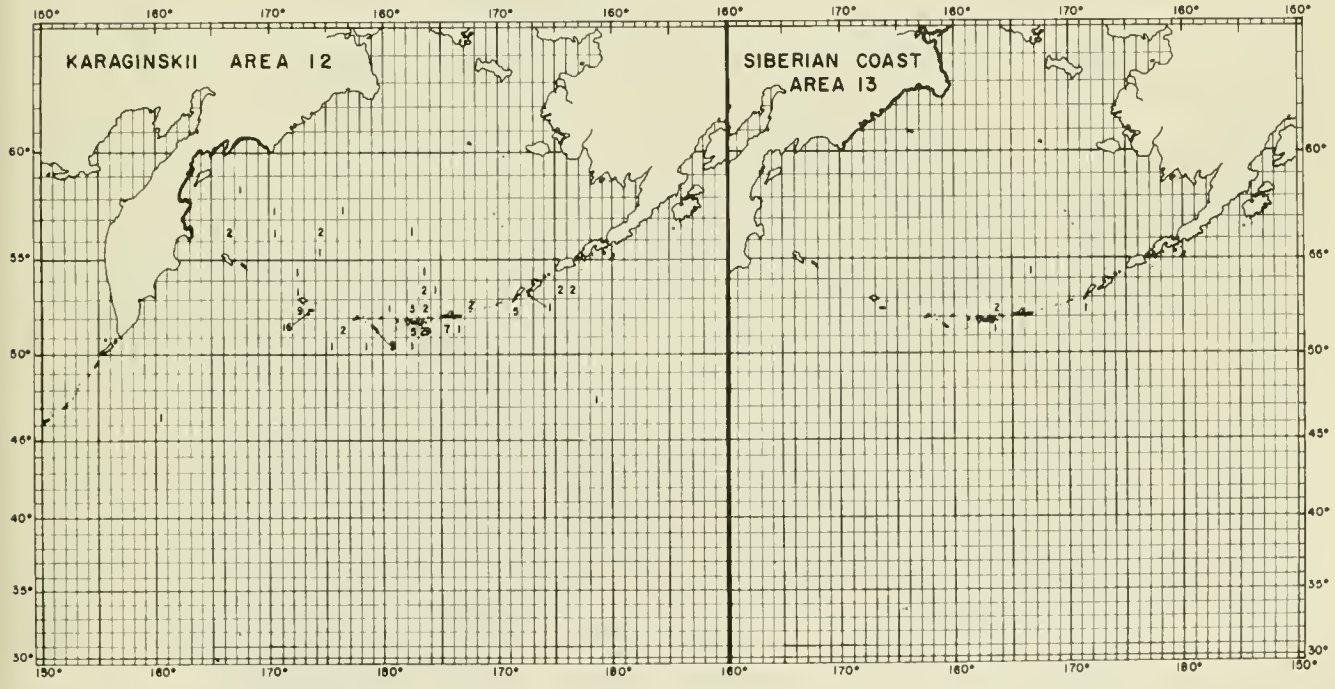

Figure 77.—Tagging locations of maturing pink salmon recovered in Karaginskii and on the Siberian coast areas.

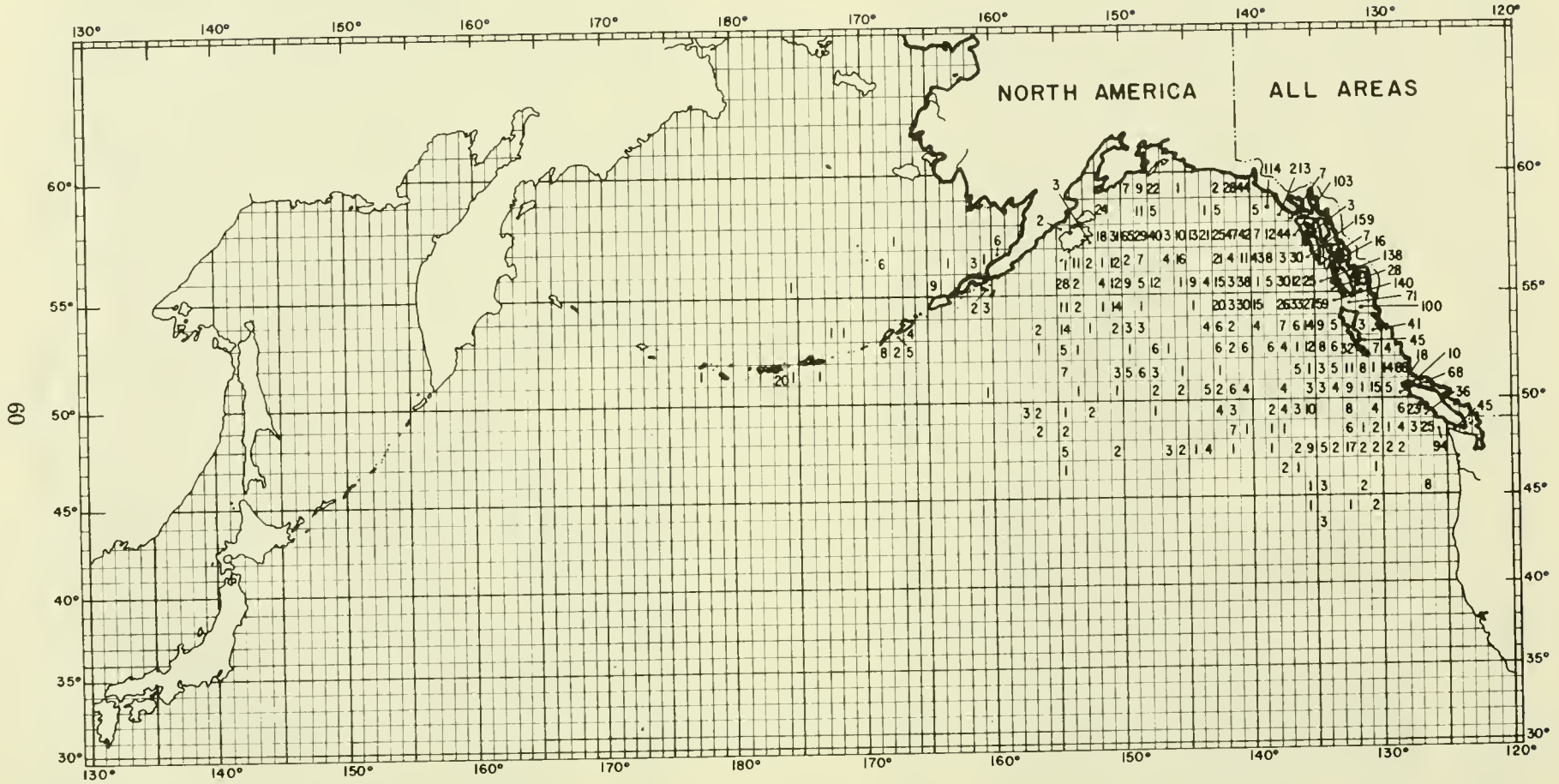

Figure 78.—Tagging locations of maturing pink salmon recovered in North America.

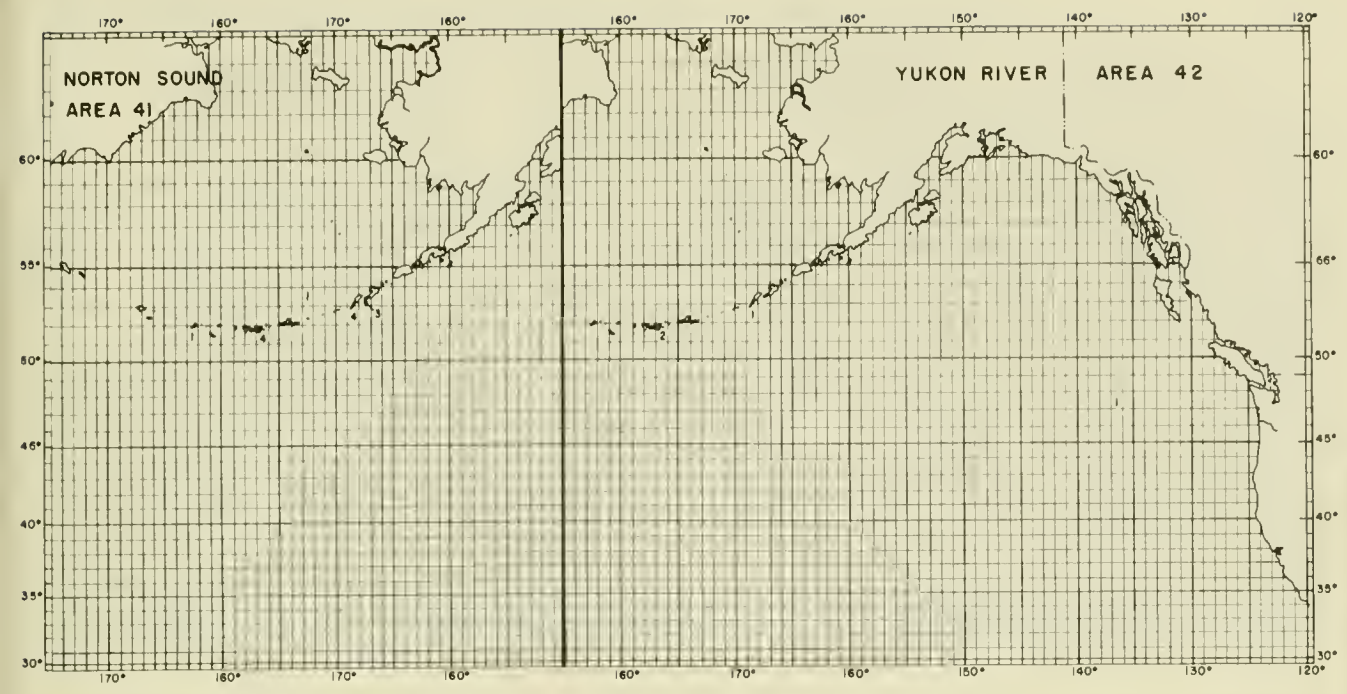

Figure 79.—Tagging locations of maturing pink salmon recovered in Norton Sound and Yukon River.

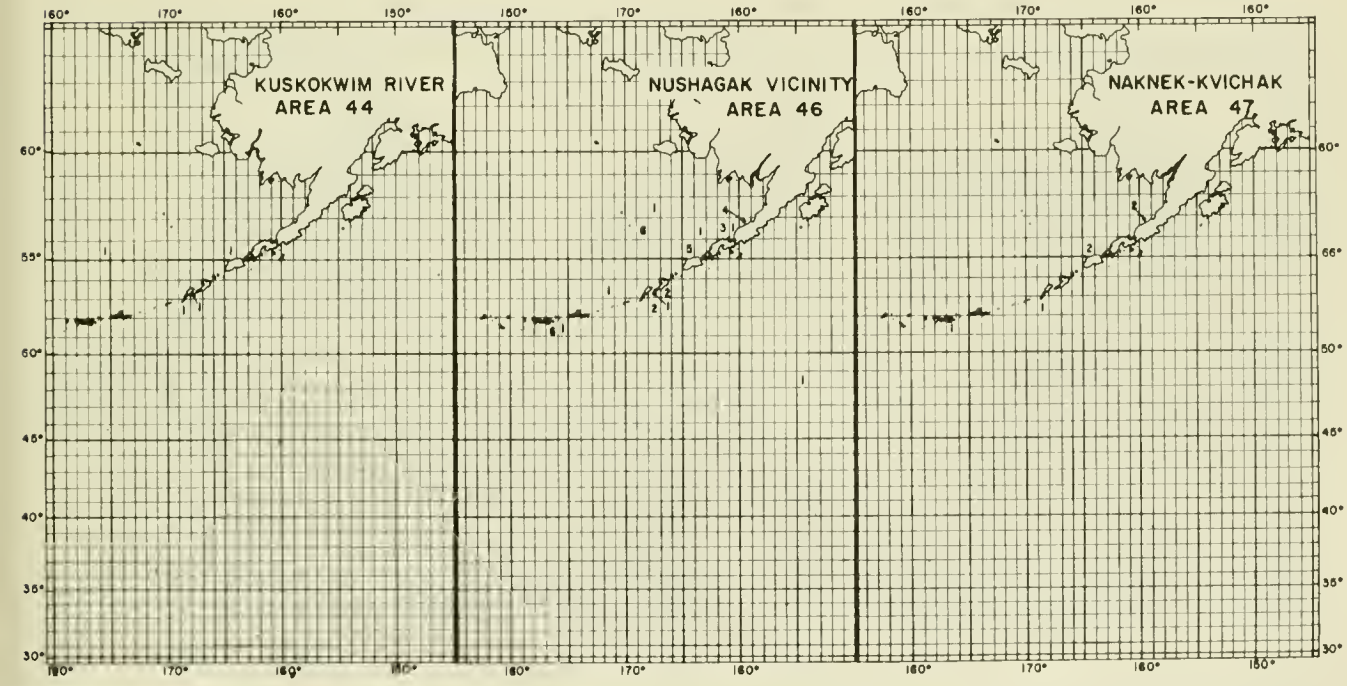

Figure 80.—Tagging locations of maturing pink salmon recovered in the Kuskokwim River, Nushagak vicinity, and Naknek-Kvichak.

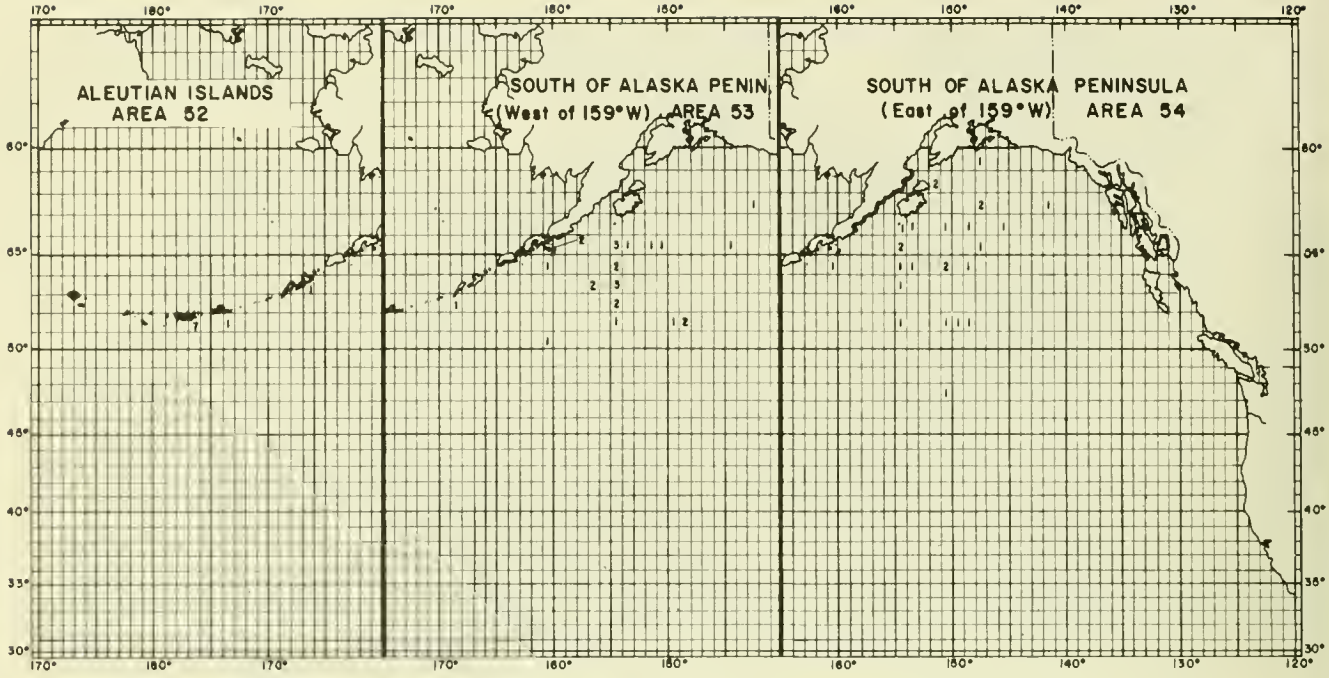

Figure 81.—Tagging locations of maturing pink salmon recovered in the Aleutian Islands and south of the Alaska Peninsula.

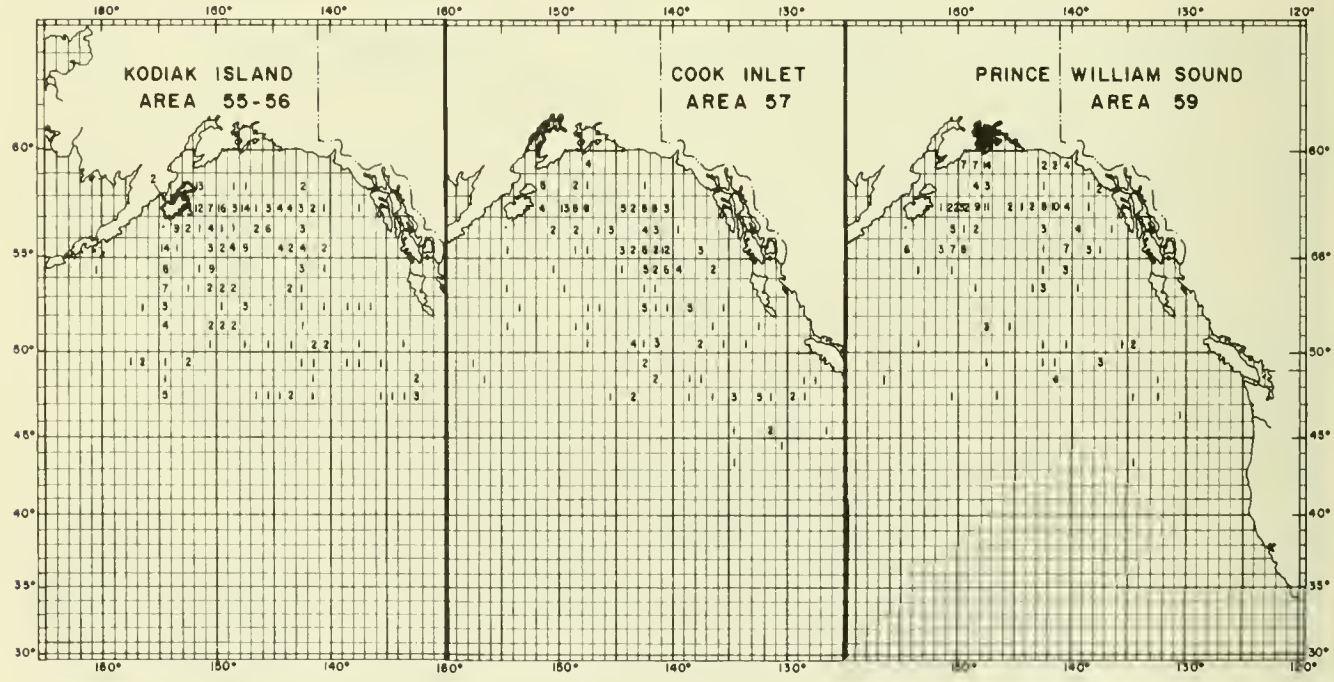

Figure 82.—Tagging locations of maturing pink salmon recovered in Kodiak Island, Cook Inlet, and Prince William Sound areas.

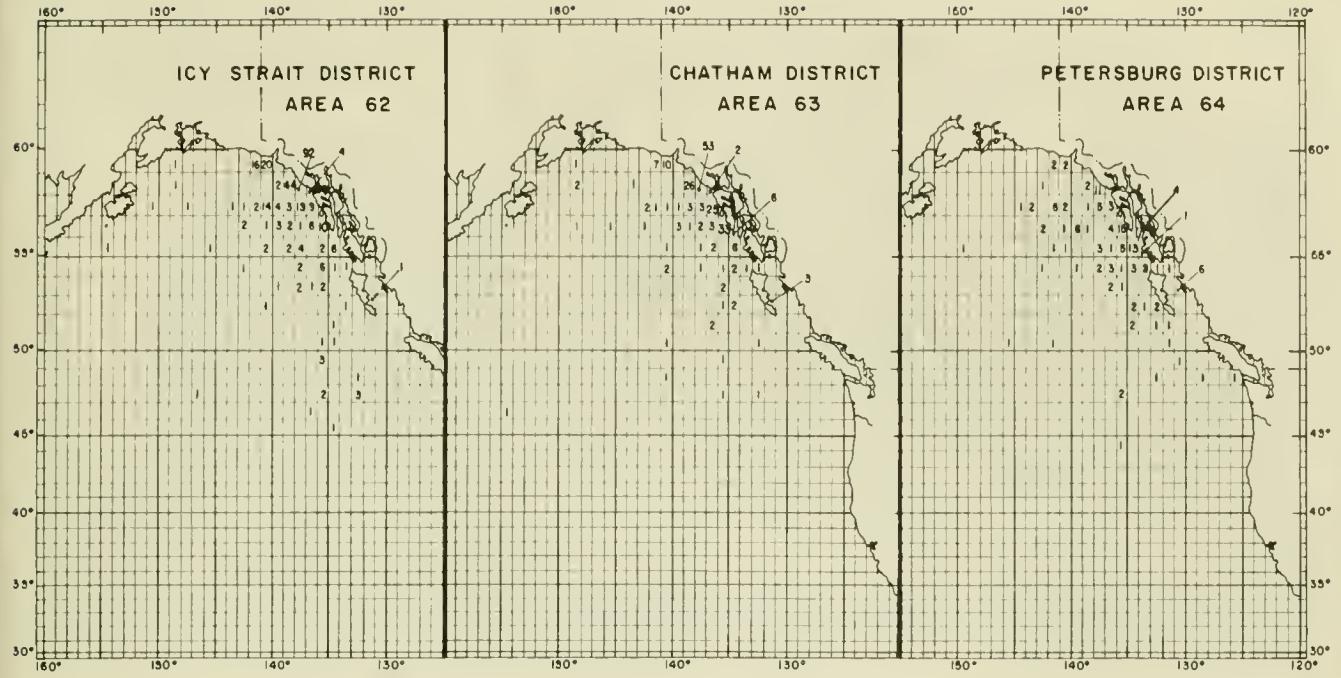

Figure 83.—Tagging locations of maturing pink salmon recovered in Icy Strait, Chatham, and Petersburg districts.

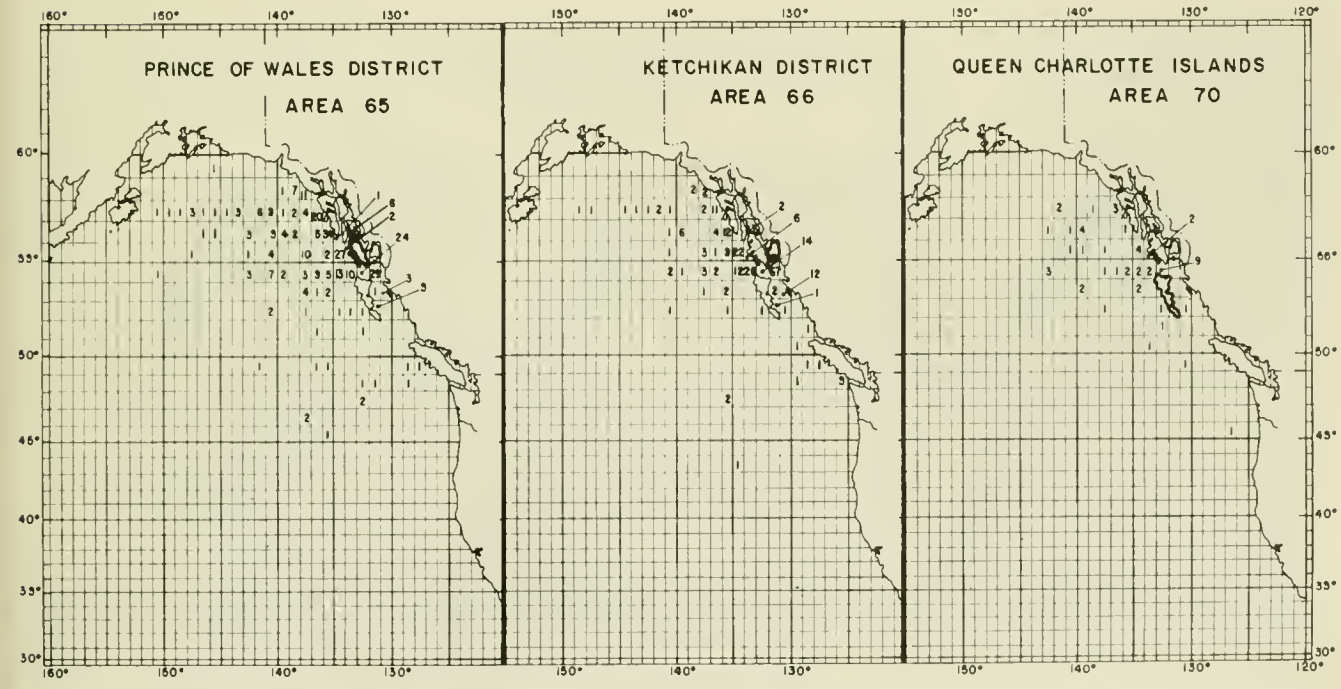

Figure 84.—Tagging locations of maturing pink salmon recovered in Prince of Wales district, Ketchikan district, and Queen Charlotte Islands.

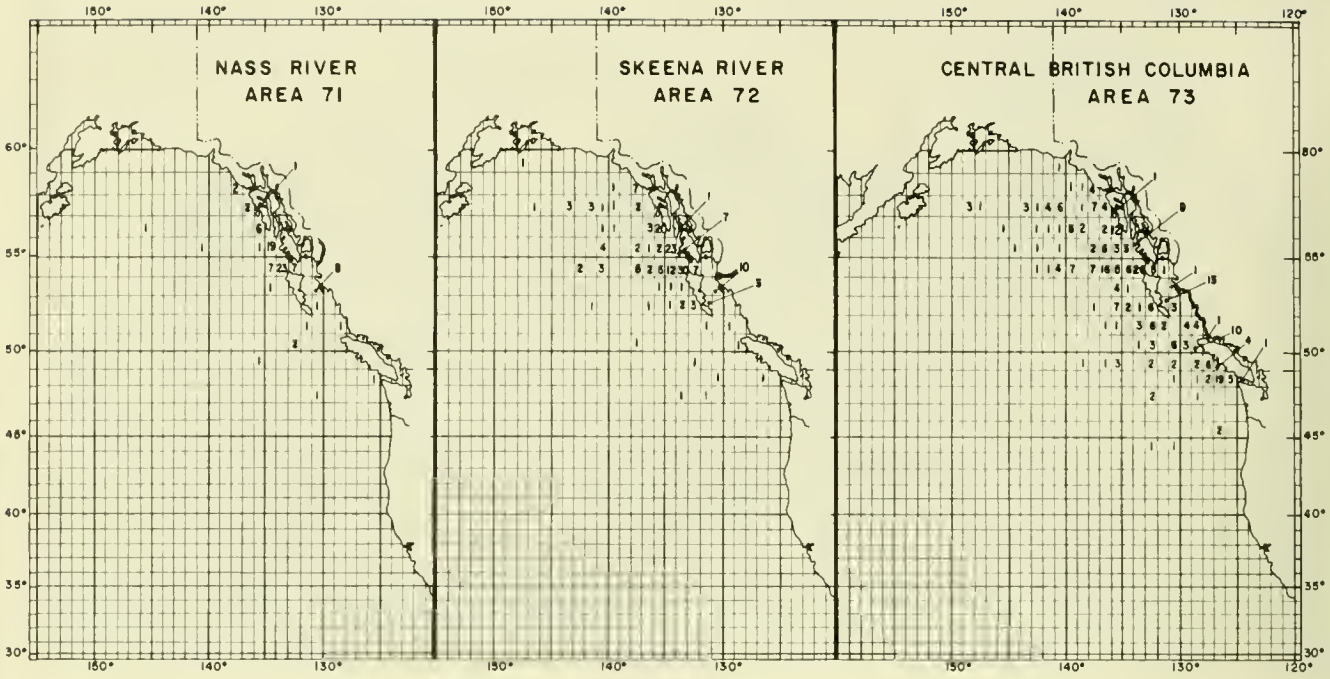

Figure 85.—Tagging locations of maturing pink salmon recovered in the Nass River, Skeena River, and central British Columbia.

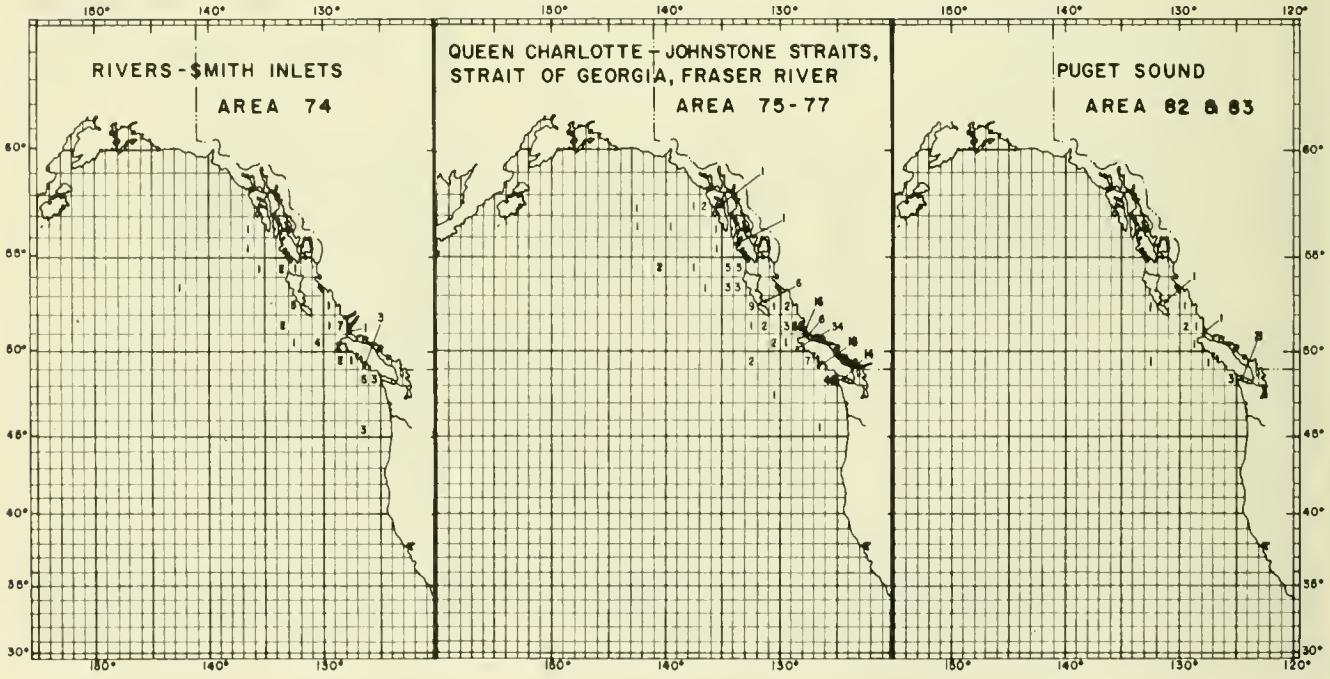

Figure 86.—Tagging locations of maturing pink salmon recovered in Rivers-Smith inlets, Queen Charlotte-Johnstone straits to Fraser River, and Puget Sound.

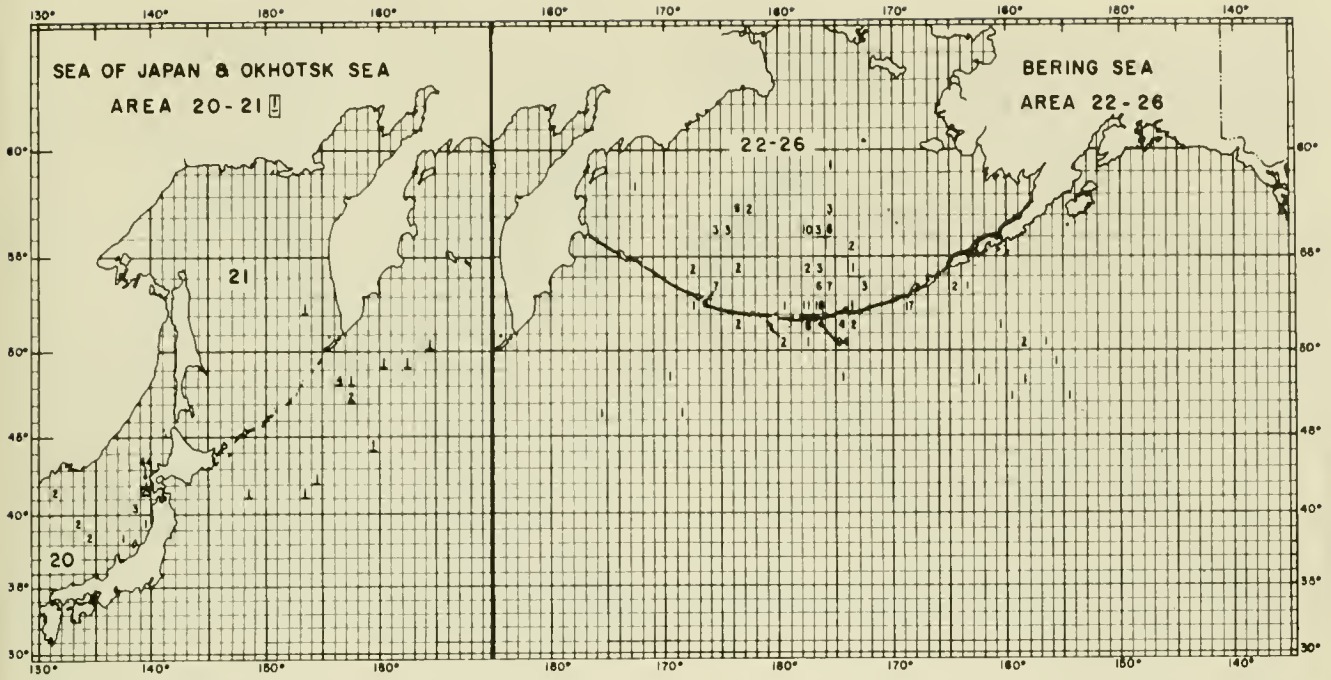

Figure 87.—Tagging locations of maturing pink salmon recovered in the Sea of Japan and Okhotsk Sea and in the Bering Sea.

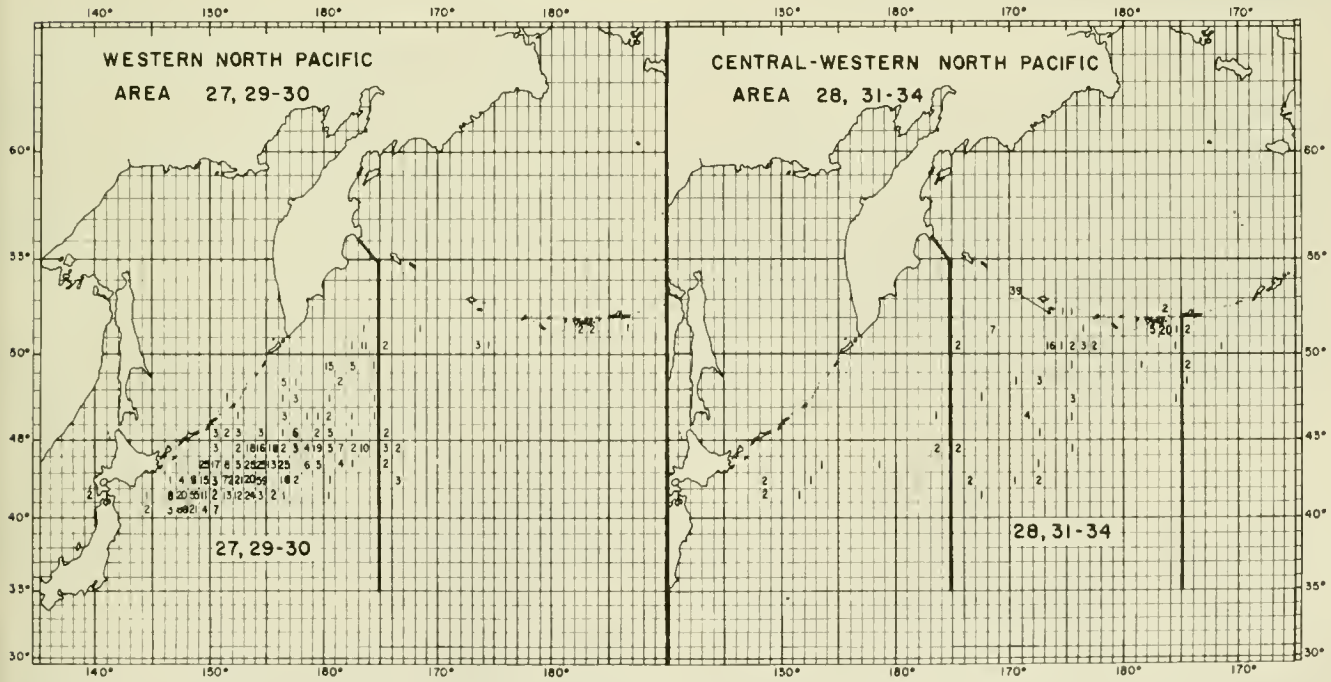

Figure 88.—Tagging locations of maturing pink salmon recovered in the western North Pacific and central-western North Pacific.

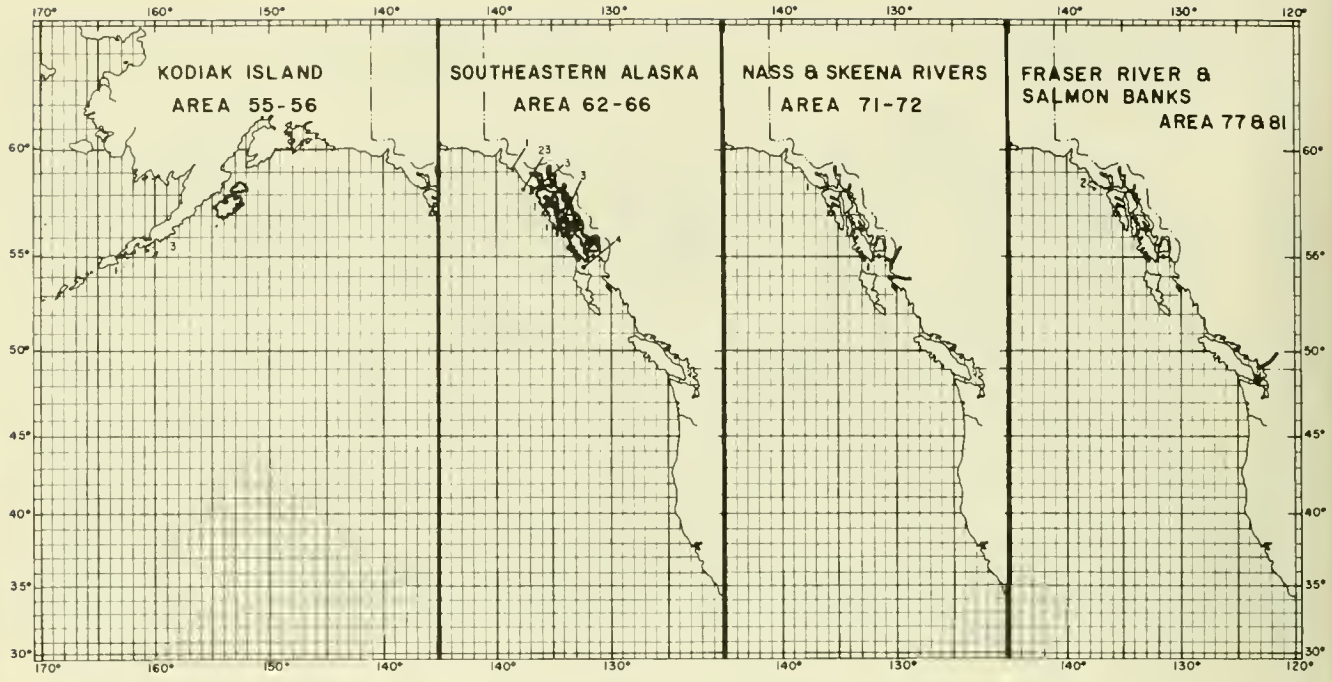

Figure 89.—Tagging locations of pink salmon recovered subsequent to year of tagging in Kodiak Island, southeastern Alaska, Nass and Skeena rivers, and the Fraser River and Salmon Banks.

COHO SALMON

Figures 90-104

Coho salmon are produced in Asia and North America in numerous small streams as well as in tributaries of larger rivers. In Asia, coho salmon occur at least as far north as the Anadyr River and occur in mainland streams southward to the Amur Firth and the Islands of Sakhalin and Hokkaido. In North America, coho salmon occur from at least as far north as Cape Thompson in the Chukchi Sea south to streams tributary to Monterey Bay, Calif. (Godfrey 1965).

Although accurate estimates of the size of either Asian or North American stocks are virtually impossible to determine, it has been estimated (on the basis of commercial and sports catches) that North American stocks are somewhat larger than Asian stocks. The ratio of average annual catches of coho salmon for the period 1954-61 has been in the order of 5 million fish in Asia and 7 million fish in North America (Godfrey 1965).

Coho salmon as a rule spend but one winter in the ocean, and the high-seas tagging experiments were on the maturing individuals which return to spawn that same year. During 1964-69 the Fisheries Research Institute, University of Washington, fished in coastal waters with small mesh purse seines for the purpose of capturing and tagging age .0 fish. Coho salmon from these taggings would return the following year as matures.

Coastal Recoveries in Year Tagged

The tagging effort for coho salmon (Fig. 90) as well as the total returns from tagging (Fig. 91) indicates that the ocean distributions of Asian and North American coho salmon do not overlap extensively. The several returns from immediately south of the central Aleutians (long. 175°W-177°W), however, produced several returns to both Asia and North America. Only two returns were from releases in the Bering Sea.

Asian stocks (Figs. 92, 93).—Returns of coho salmon to Asian streams (Fig. 92) were from tag releases in the northwestern Pacific Ocean mainly north of lat. 48°N and west of long. 170°E. Eleven returns were from the Aleutian Islands area. Nine returns were from tagging south of the central Aleutian Islands which compares with 12 returns in northern and western Alaska from this area (see Fig. 94). This particular area constitutes the known area of overlap of Asian and North American stocks.

Sakhalin Island to west Kamchatka.—Tagged coho salmon recoveries in streams emptying into the Okhotsk Sea (Sakhalin Island to west Kamchatka (Fig. 93)), with two exceptions, came from releases south and east of the southern tip of Kamchatka Peninsula. The single fish recovered in Sakhalin Island was from a release near lat. 52°N and long. 168°E, and one recovered in west Kamchatka was released near lat. 49°N and long. 169°E; those were the easternmost points for releases recovered in a Okhotsk Sea tributary.

East Kamchatka to the Siberian coast.—Coho salmon tag recoveries in the areas from east Kamchatka to the Karaginskii District (all but one from east Kamchatka and the Kamchatka River) were primarily from tagging in the northwestern Pacific Ocean east of the Kamchatka Peninsula and from the central Aleutian Islands area (Fig. 93). The northernmost recovery of a tagged coho salmon was made in the Karaginskii District from a release south of Adak Island in the central Aleutian Islands.

Although the difference was not pronounced, the distribution of coho salmon from east Kamchatka was slightly north of those from west Kamchatka which in turn were slightly north of the fish returning to the Okhotsk Sea coast and Shelekhova Bay.

North American stocks (Figs. 94-101).—Recoveries of tagged coho salmon in North America were made from the Yukon River in northern Alaska to California (Fig. 94). The westernmost tagging location of a coho salmon returning to North America was near long. 177°W, south of Adak Island. Most tagged coho salmon returning to North America were from the northeastern Pacific Ocean.

The only area of intermingling of Asian and North American maturing coho salmon, shown by the tagging data as explained previously, was south of the central Aleutian Islands between long. 175°W and 177°W.

Northern and western Alaska.—Recoveries made in northern and western Alaska are illustrated in Figure 95. The coho salmon from the Yukon and Kuskokwim rivers came from the same general tagging points, south of Adak Island and in the northeastern Pacific Ocean south of lat. 49°N and east of long. 154°W. The recoveries illustrate extensive migrations of these stocks. Returns to Bristol Bay streams show three returns to the Nushagak River from tagging south of Adak Island and one return to the Ugashik River from tagging south of Kodiak Island.

Northeast Pacific coastal areas.—Tag recoveries of coho salmon in coastal areas from south of the Alaska Peninsula to Puget Sound (Figs. 96-101) indicate that the distribution of these stocks is in the northeastern Pacific Ocean. With one exception all returns were from tagging east of long. 156°W. The exception was the recovery on Kodiak Island of a fish released south of the central Aleutian Islands (Fig. 96). Although the returns were relatively few they illustrate that coho salmon were distributed

throughout the northeastern Pacific east of long. 155°W.

The distribution of coho salmon in areas from southeast Alaska (Chatham District) southward to Rivers and Smith inlets (Figs. 98-100) was generally east and south of the distribution of stocks from more northern areas.

The returns to areas near Vancouver Island and Puget Sound were, with few exceptions, from nearby tagging areas, and the distribution of stocks was shown to be not as widespread as other coastal stocks (Fig. 101).

Washington coast to California.—Coho salmon tag returns to the coastal areas of Washington, Oregon, and California are illustrated in Figure 101. Fish returning to coastal Washington streams showed the widest ocean distribution of the three States; the most distant returns were from off southeastern Alaska and from the northeastern Pacific Ocean near long. 143°W, lat. 47°N. Most returns were from tagging off Vancouver Island. Columbia River returns of tagged coho salmon were from releases off the river itself and from near Vancouver Island. Oregon and California coastal returns with two exceptions came from tagging locations off Washington and Vancouver Island. One Oregon return was tagged due west of the northern part of the State about 670 km offshore. The single tagged coho salmon recovered in California was tagged in the northeastern Pacific near long. 133°W and lat. 45°N.

High-Seas Recoveries in Years Tagged

The only high-seas recoveries of tagged coho salmon in the year tagged were those in the Japanese high-seas fishing area south of the Aleutian Islands and west of long. 180°. These, of course, would be maturing fish. Recoveries of tagged coho salmon in the northwest Pacific Ocean (areas 27, 29-30) were, with one exception, fish tagged within the recovery area (Fig. 102). One coho salmon was tagged in the adjacent area to the east. Recoveries near the central North Pacific (areas 28, 31-34) were mainly from a group of fish tagged in the same area between lat. 45°N and 42°N and between long. 169°E and 177°E (Fig. 102). No inshore recoveries have been made from this particular tagging area.

Coastal Recoveries Subsequent to Year of Tagging

Asian stocks.—To our knowledge, no age .0 coho salmon were tagged in coastal waters of Asia; consequently, no recoveries were made of tagged coho salmon following the year of tagging.

North American stocks (Figs. 103, 104).—During purse seine fishing along the coast of North America juvenile coho salmon were tagged resulting in several returns of tagged maturing fish in the following year (Hartt, Smith, and Dell 1967; Hartt, Smith, Dell, and Kilambi 1967; Hartt et al. 1969, 1970; Rothschild et al. 1971). These coastal recoveries were reported only from tagging locations relatively close to the shore of Washington, British Columbia, southeastern Alaska, and central Alaska.

Cook Inlet to California.—Recoveries of tagged coho salmon subsequent to the year of tagging were made in areas from Cook Inlet in central Alaska to California (Figs. 103, 104). Generally only a few recoveries were made in each area and with very few exceptions, the tagging locations were north or westward along the coast from the point of recovery. Some of the tagging locations and subsequent recoveries indicated fairly long coastal migrations during the juveniles' first summer at sea. Fish returning to northern and central British Columbia (Fig. 103) showed juvenile migrations to the northern Gulf of Alaska. Similarly, returns to southern British Columbia and the Puget Sound area were tagged as far north as off southeastern Alaska and the northern Gulf of Alaska. Several tagged coho salmon that had been tagged as juveniles in northern coastal areas were taken along the west coast of Vancouver Island and from Washington to California (Fig. 104).

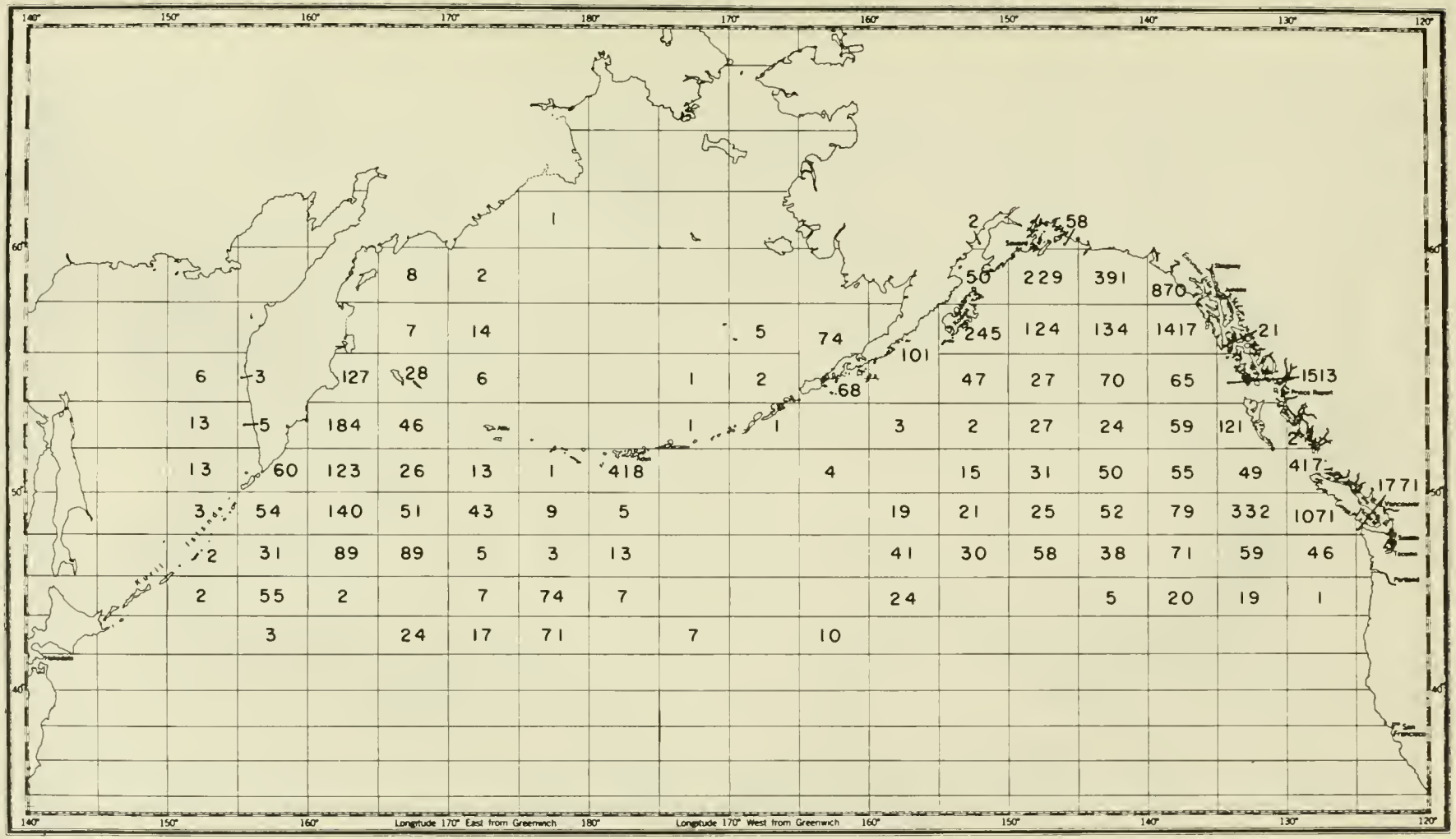

Figure 90.—Numbers of immature and maturing coho salmon tagged by Canada, Japan, and the United States, 1956-71 (source of data: Harold Godfrey, Fisheries Research Board of Canada, Nanaimo, British Columbia).

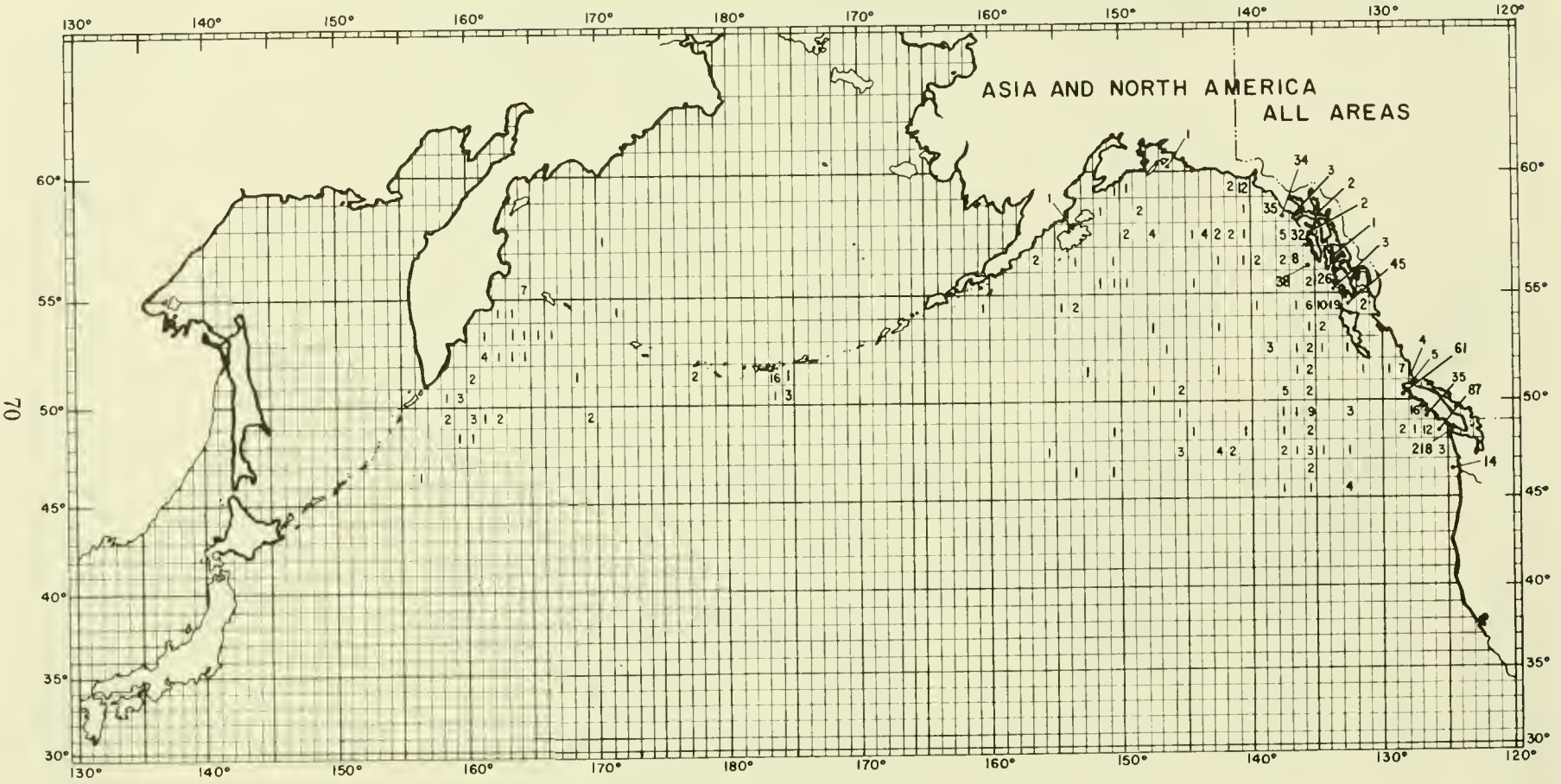

Figure 91.—Tagging locations of coho salmon recovered in Asia and North America.

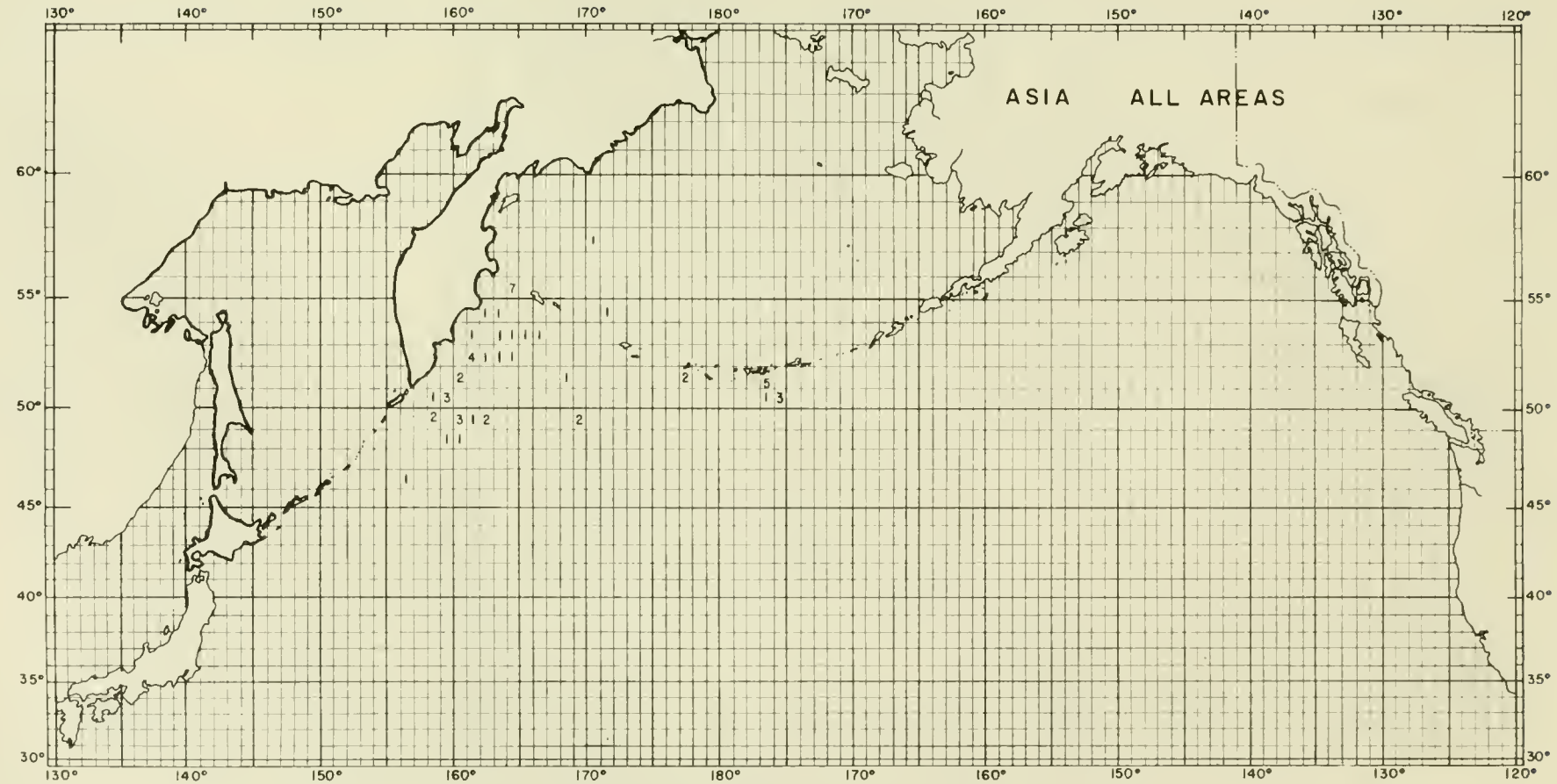

Figure 92.—Tagging locations of maturing coho salmon recovered in Asia.

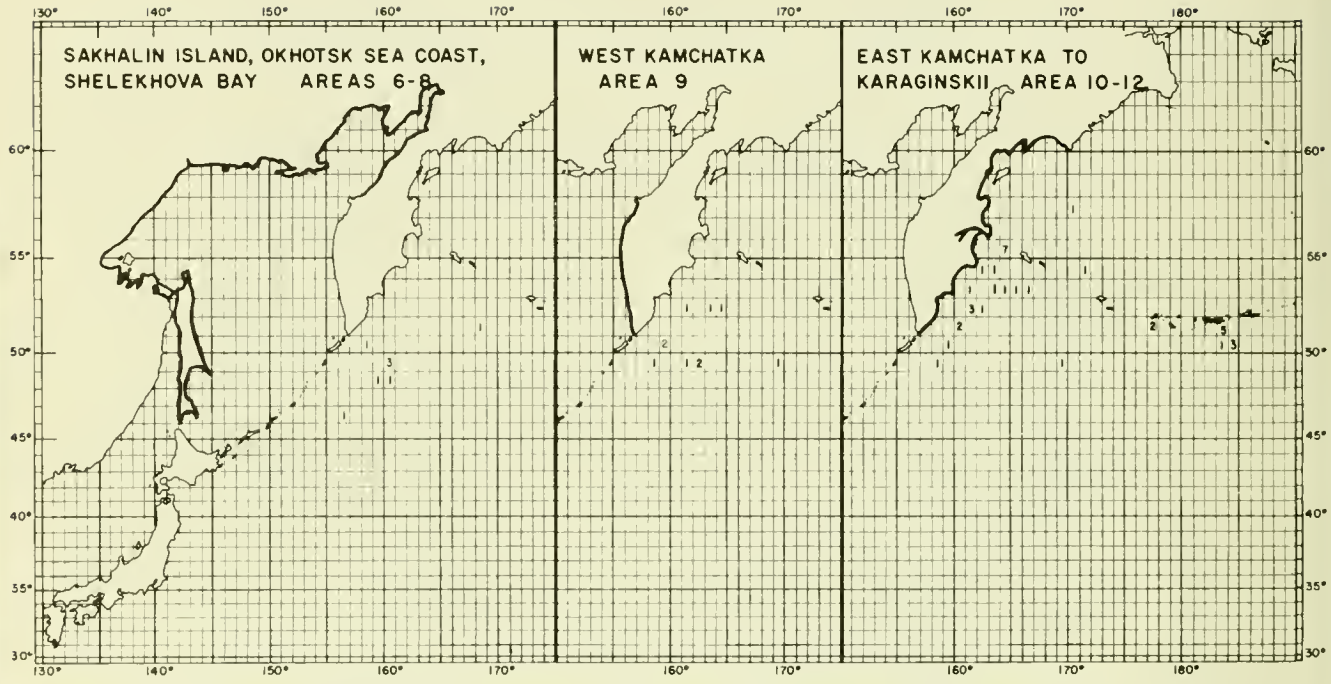

Figure 93.—Tagging locations of maturing coho salmon recovered in Sakhalin Island, Okhotsk Sea coast, and Shelekhova Bay; in west Kamchatka; and from east Kamchatka to Karaginskii.

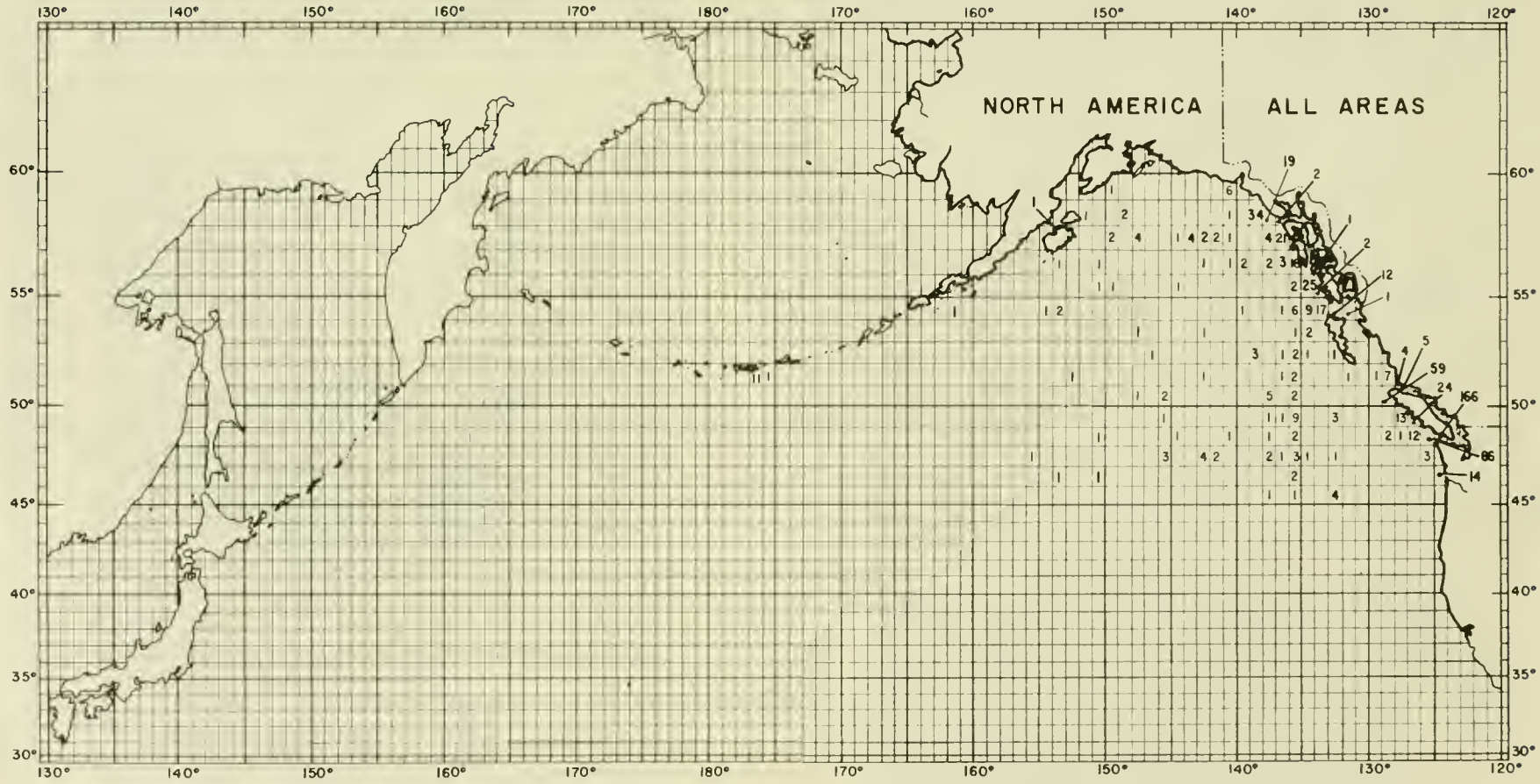

Figure 94.—Tagging locations of maturing coho salmon recovered in North America.

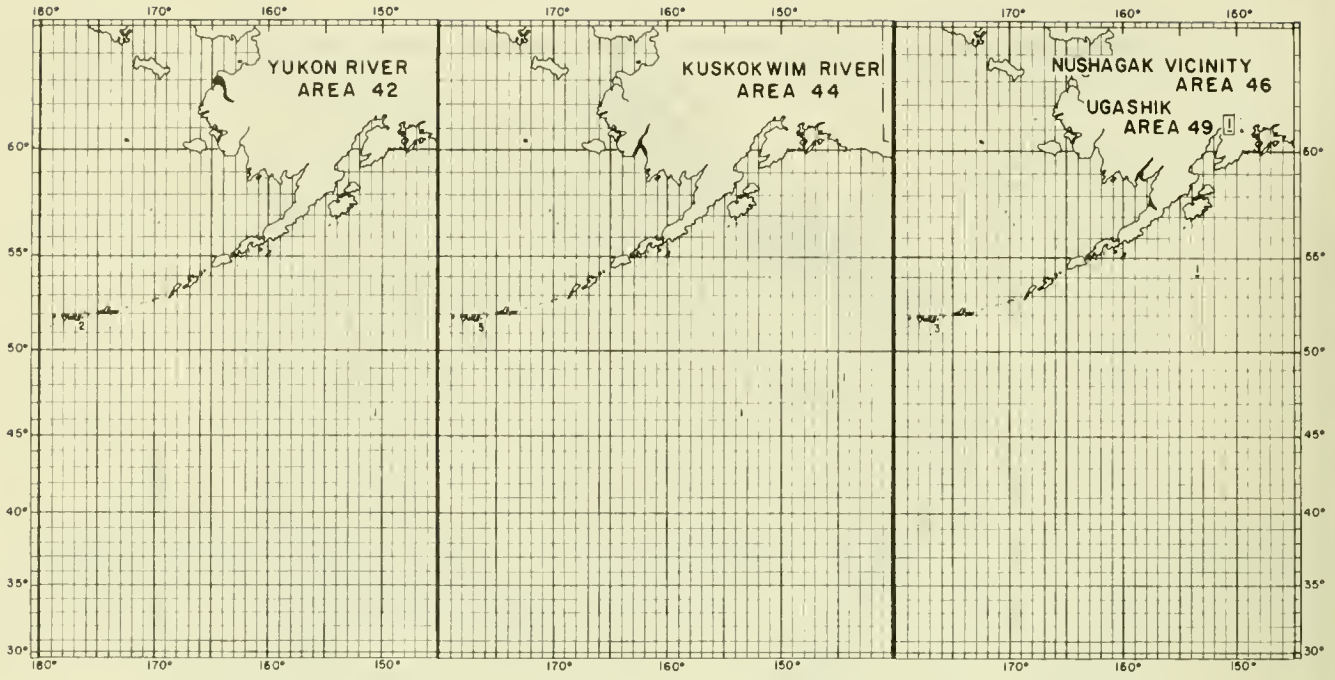

Figure 95.—Tagging locations of maturing coho salmon recovered in the Yukon River, the Kuskokwim River, and the Nushagak vicinity and Ugashik.

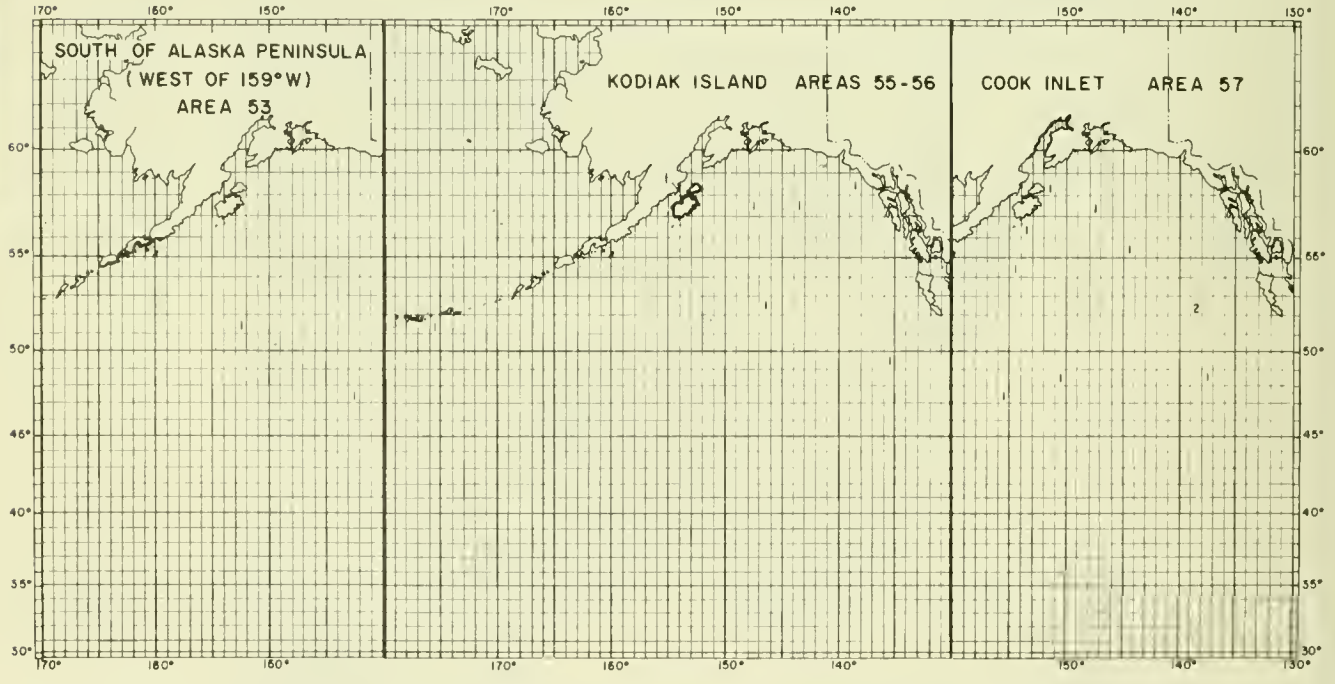

Figure 96.—Tagging locations of maturing coho salmon recovered from south of the Alaska Peninsula, Kodiak Island, and Cook Inlet.

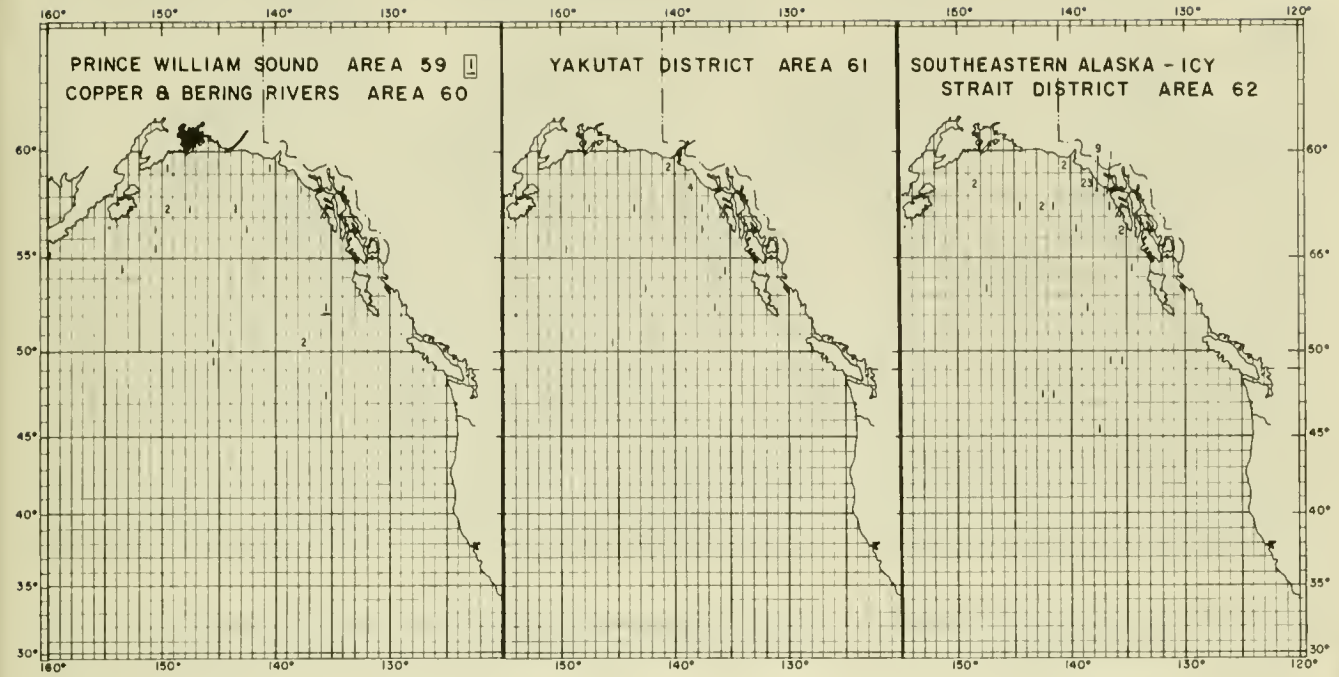

Figure 97.—Tagging locations of maturing coho salmon recovered in Prince William Sound and Copper and Bering rivers; Yakutat district; and southeastern Alaska-Icy Strait district.

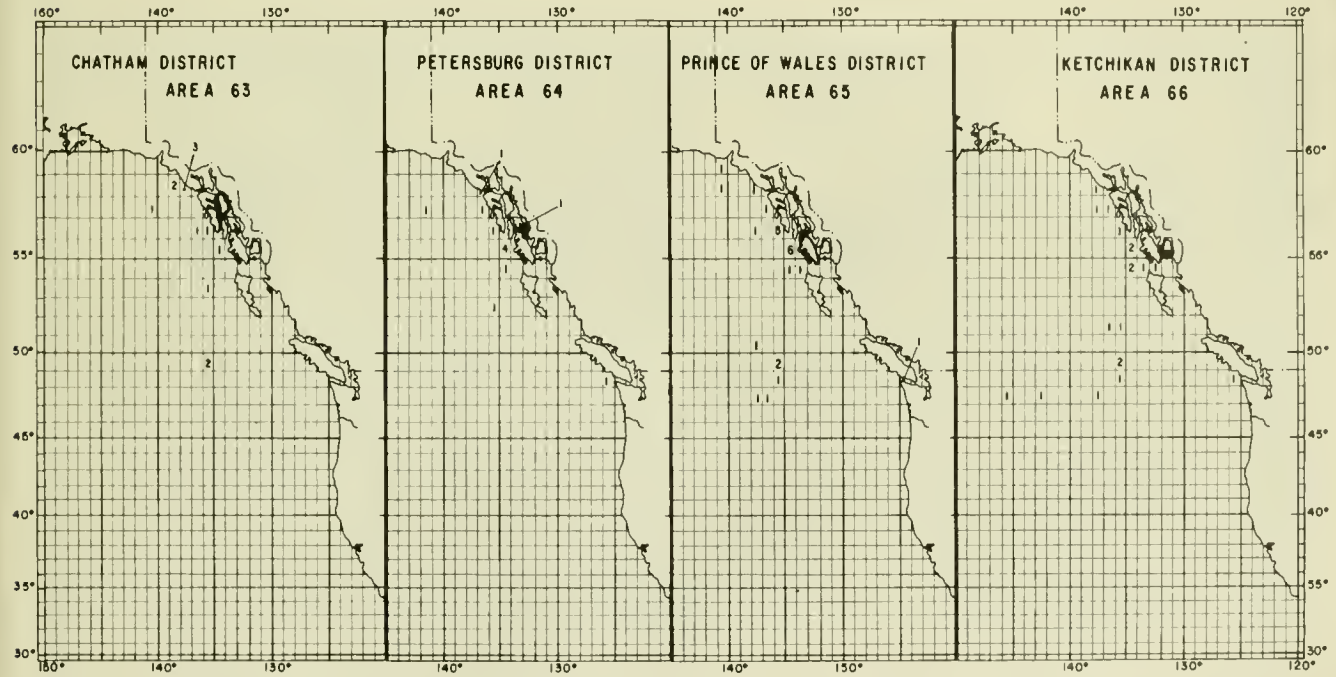

Figure 98.—Tagging locations of maturing coho salmon recovered in the Chatham, Petersburg, Prince of Wales, and Ketchikan districts.

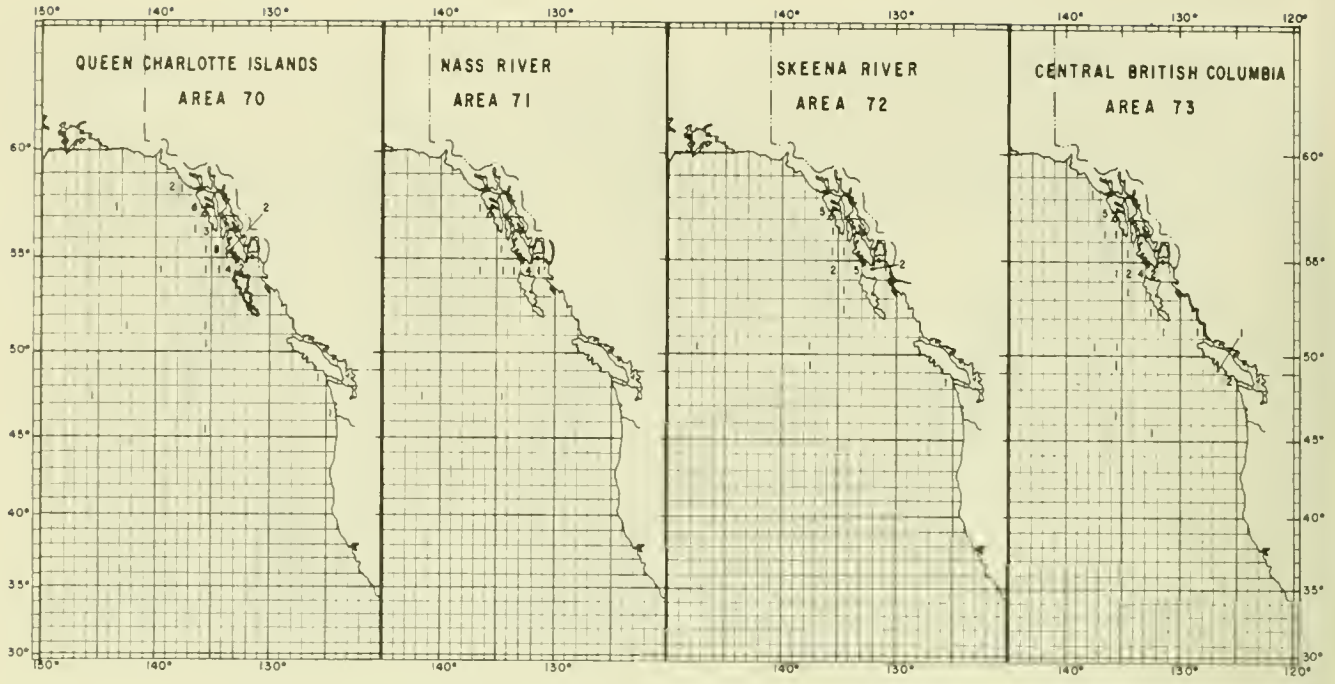

Figure 99.—Tagging locations of maturing coho salmon recovered in the Queen Charlotte Islands, Nass River, Skeena River, and central British Columbia areas.

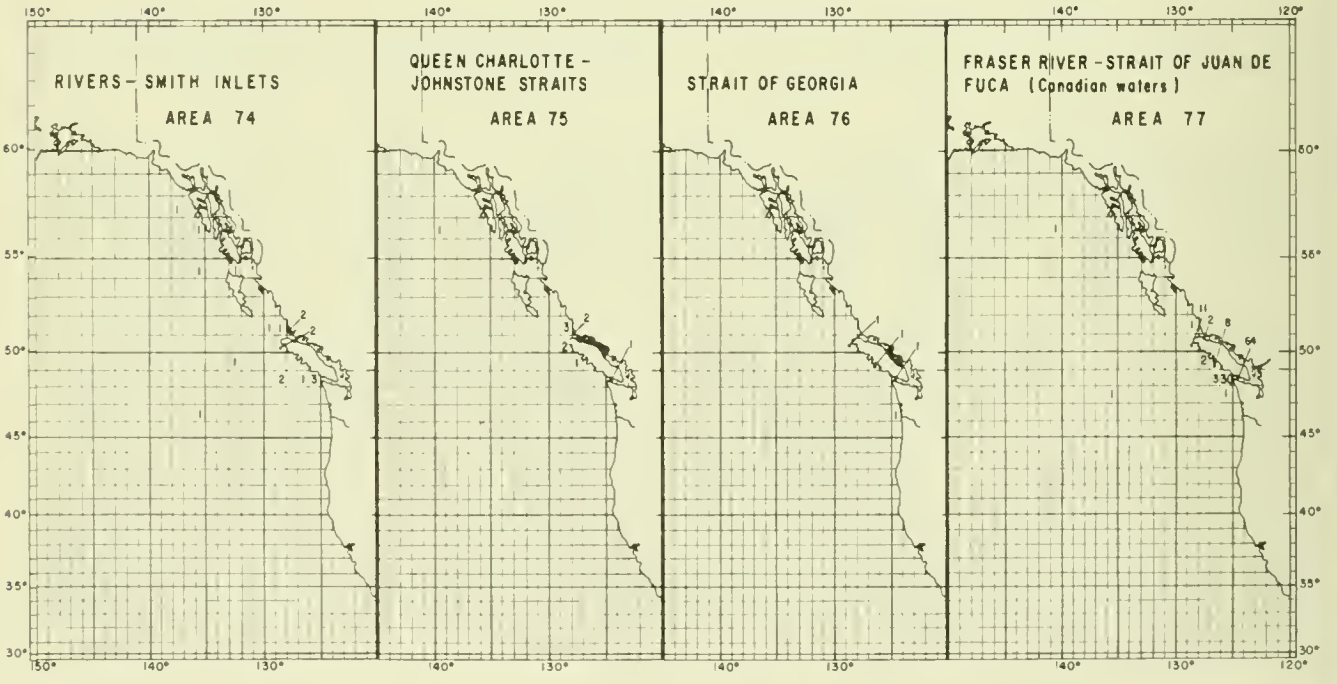

Figure 100.—Tagging locations of maturing coho salmon recovered in Rivers-Smith inlets, Queen Charlotte-Johnstone Straits, Strait of Georgia, and Fraser River-Strait of Juan de Fuca (Canadian waters).

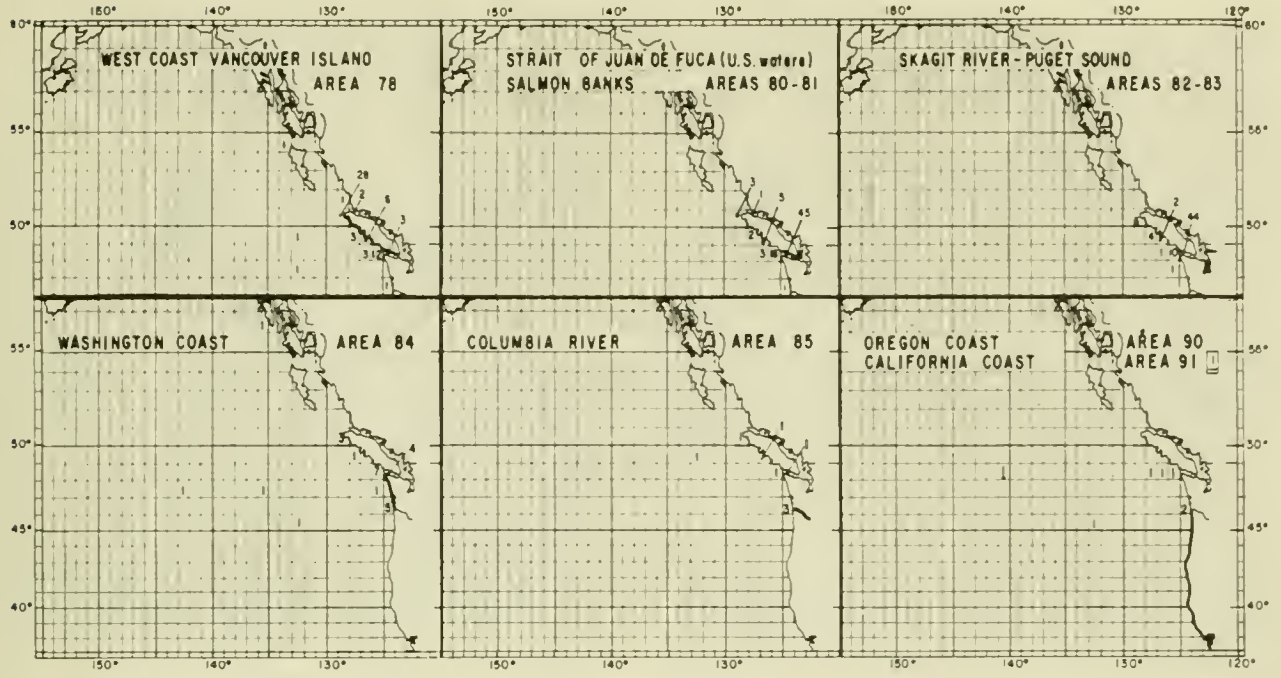

Figure 101.—Tagging locations of maturing coho salmon recovered in the west coast of Vancouver Island, Strait of Juan de Fuca (U.S. waters) and Salmon Banks, Skagit River-Puget Sound, Washington coast, Columbia River, and Oregon and California coast areas.

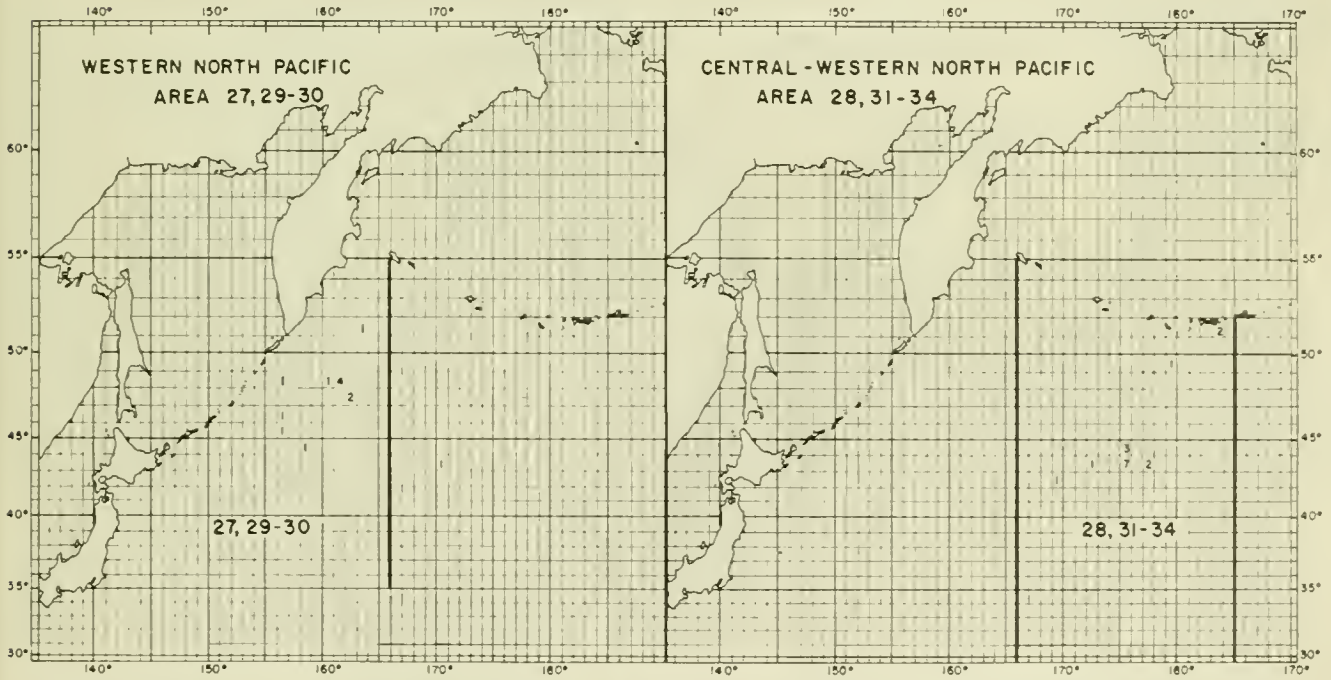

Figure 102.—Tagging locations of maturing coho salmon recovered in the western North Pacific and central North Pacific.

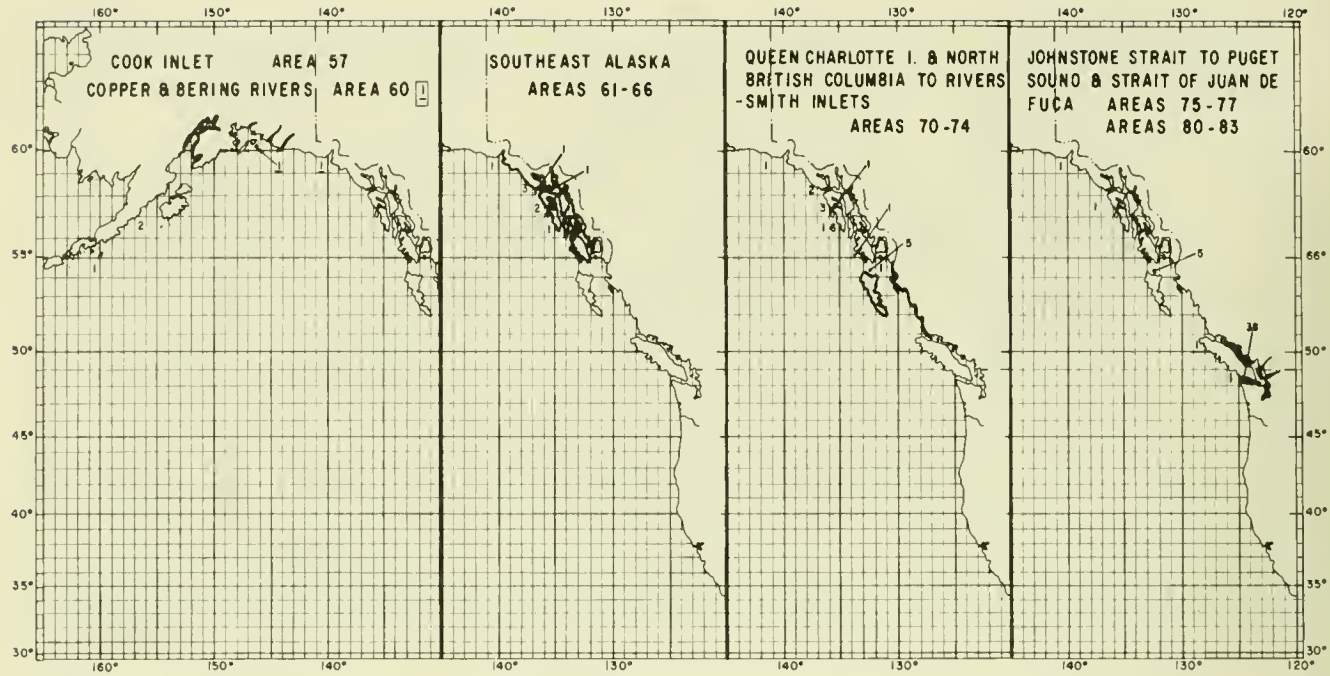

Figure 103.—Tagging locations of coho salmon recovered subsequent to year of tagging in Cook Inlet and Copper and Bering rivers; southeastern Alaska; Queen Charlotte Islands and northern British Columbia to Rivers-Smith inlets; and Johnstone Strait to Puget Sound and Strait of Juan de Fuca areas.

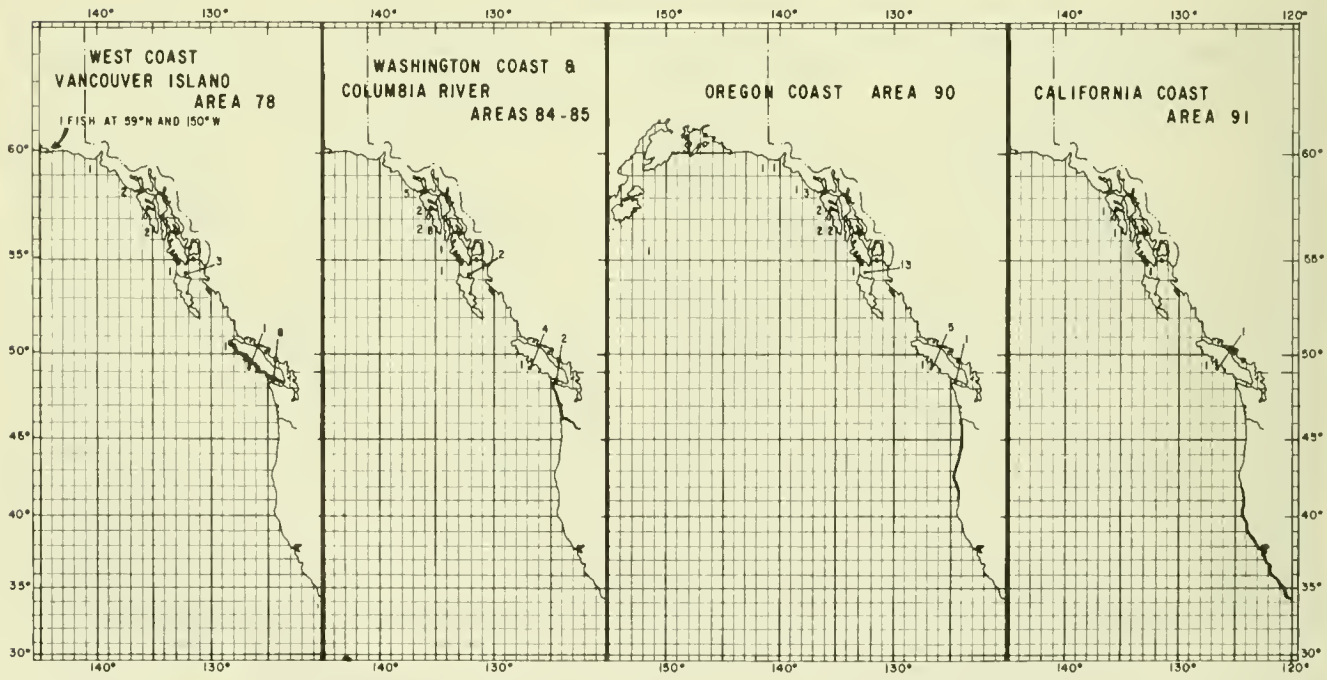

Figure 104.—Tagging locations of coho salmon recovered subsequent to year of tagging in the west coast of Vancouver Island, Washington coast and Columbia River, Oregon coast, and California coast areas.

CHINOOK SALMON

Figures 105-111

Chinook salmon, with the exception of masu salmon, *O. masou*, are considerably less numerous than the other species of Pacific salmon, and possibly for that reason, relatively few chinook salmon were tagged during the high-seas research cruises or were subsequently recovered. A comparison of total chinook salmon landings show that North American catches greatly exceed Asian catches. In the period 1954-61, the combined commercial catches of Japan and Russia varied from 96,000 to 250,000 chinook salmon compared with 2,456,300 to 3,664,200 fish in North America (Mason 1965). In Asia, chinook salmon occur on Hokkaido and Sakhalin islands northward, at least to the Anadry River. In North America they have been found from the Ventura River in California, north to the Chukchi Sea (Mason 1965).

The relatively few tag recoveries were nearly all from North America (Fig. 105); a single Asian recovery resulted from a tag released south of Hokkaido. North American recoveries were mainly from tagging in the Bering Sea, in waters along the Aleutian Islands, and off the coast of North America from Yakutat to the State of Washington.

Coastal Recoveries in Year of Tagging

Asian stocks.—The single recovery of a tagged chinook salmon in Asia was made on Hokkaido Island from a release point fairly close to shore south of Hokkaido (Fig. 105).

North American stocks (Figs. 106, 107).—Recoveries of maturing tagged chinook salmon in North America were, in many instances, from tagging in coastal or near coastal waters and often relatively near the point of tagging (as was also observed for the single Asian recovery). Of the two recoveries in western Alaska (Fig. 106), the one recovery in Egegik was from tagging at the approaches to Bristol Bay; the other recovery was from a release made south of the central Aleutian Islands. The pattern of recoveries being relatively close to the area of tagging was especially noted for recoveries in areas from southeastern Alaska southward to Puget Sound in Washington (Figs. 106, 107), although one chinook salmon recovered in northern British Columbia was tagged in the northern Gulf of Alaska.

Recoveries from coastal areas of Washington (including the Columbia River), Oregon, and California were from more distant areas, compared to fish at other recovery points, coming from releases north of recovery areas mainly off British Columbia (Fig. 107). These returns indicated a northward movement of the fish sometime prior to their reaching maturity.

Tag recoveries of maturing fish were insufficient to indicate the ocean distribution of the various chinook salmon stocks.

High-Seas Recoveries in Year of Tagging

High-seas recoveries in the year of tagging were limited to two chinook salmon recoveries from releases within the respective recovery areas (Fig. 108).

Coastal Recoveries Subsequent to Year of Tagging

Recoveries of chinook salmon tagged as immatures, although few in number, better illustrate the extensive migrations that some chinook salmon make during their life at sea than do the recoveries of maturing fish. The returns to northern and western Alaska came from immatures released in waters of the central and western Bering Sea (Fig. 109). These returns combined with the recovery of a fish tagged as a mature in the central North Pacific Ocean demonstrate the wide ranging areas of the ocean occupied by some chinook salmon of northern and western Alaska and the extensive migrations they undertake. Similar extensive migrations were demonstrated for chinook salmon from southeastern Alaska and the Columbia River by returns to these areas from tagging south of the central Aleutians (Figs. 109, 110). Returns to the Columbia River also came from as far away as the northern Gulf of Alaska as did one tagged fish to central British Columbia (Fig. 110).

The Columbia River recoveries, tagged as juveniles, indicated the northwestward movement along the coast of the juveniles during their first summer at sea (Hartt et al. 1970).

High-Seas Recoveries Subsequent to Year of Tagging

High-seas recoveries of tagged chinook salmon following the year of tagging (Fig. 111) show recoveries mainly in the same areas as the fish were tagged. The one exception was the recovery in the central North Pacific Ocean from tagging in the northwestern Bering Sea.

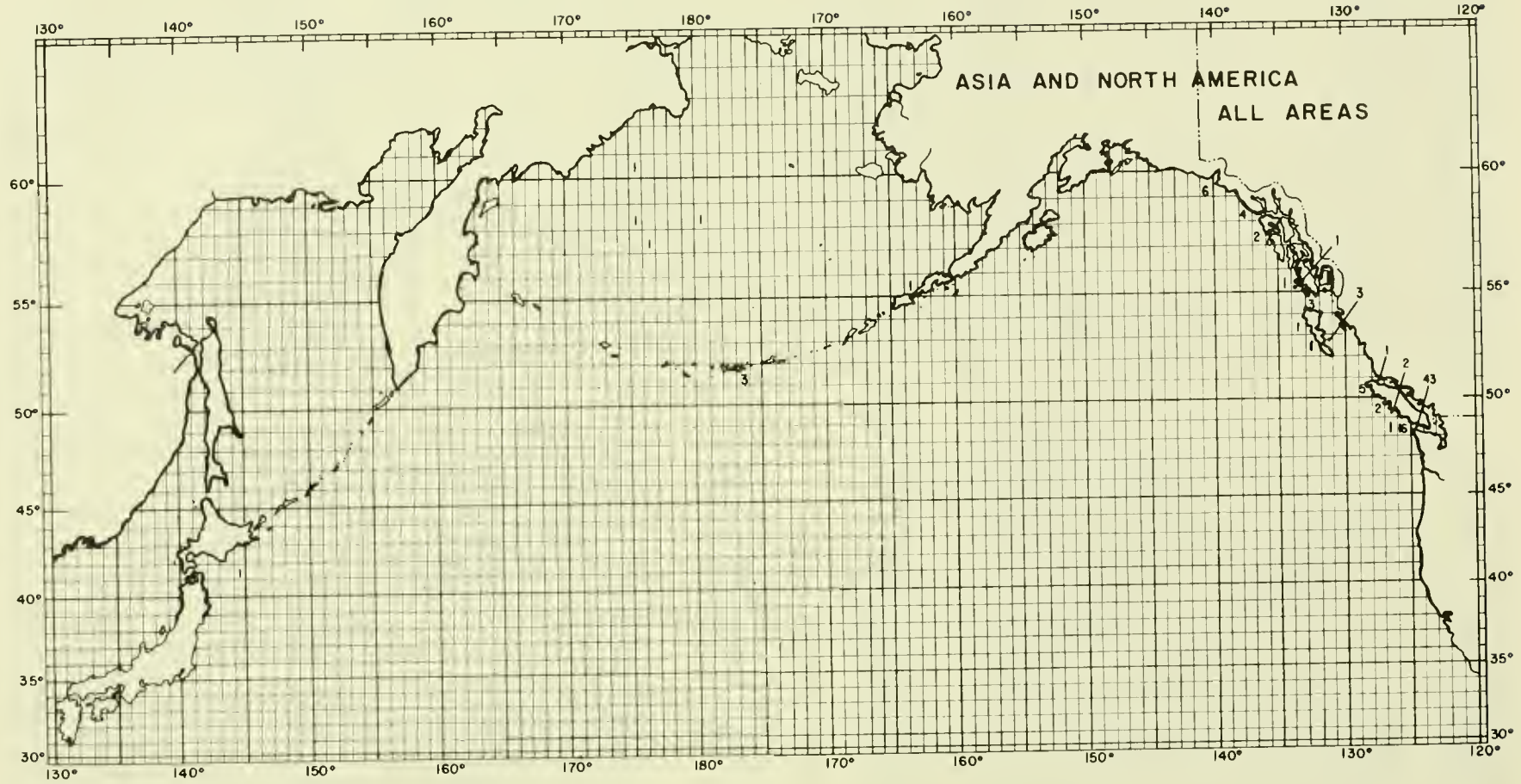

Figure 105.—Tagging locations of chinook salmon recovered in Asia and North America.

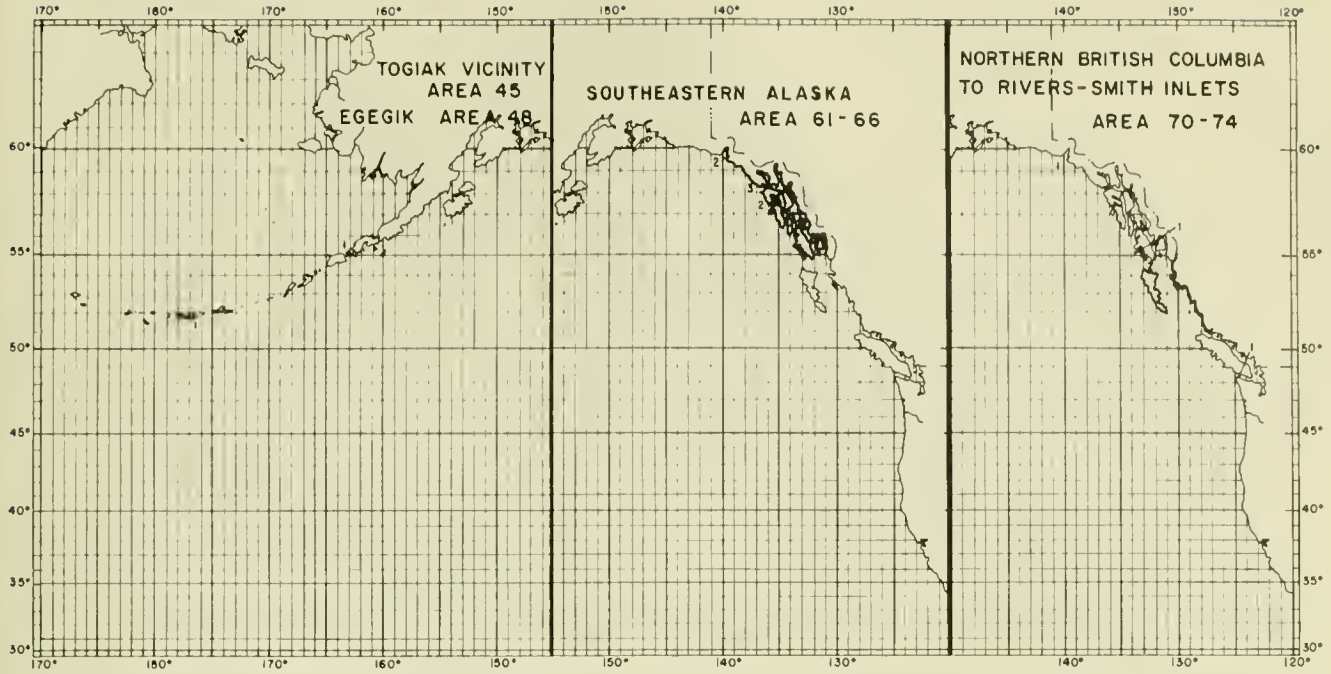

Figure 106.—Tagging locations of maturing chinook salmon recovered in Togiak vicinity and Egegik; southeastern Alaska; and northern British Columbia to Rivers-Smith inlets.

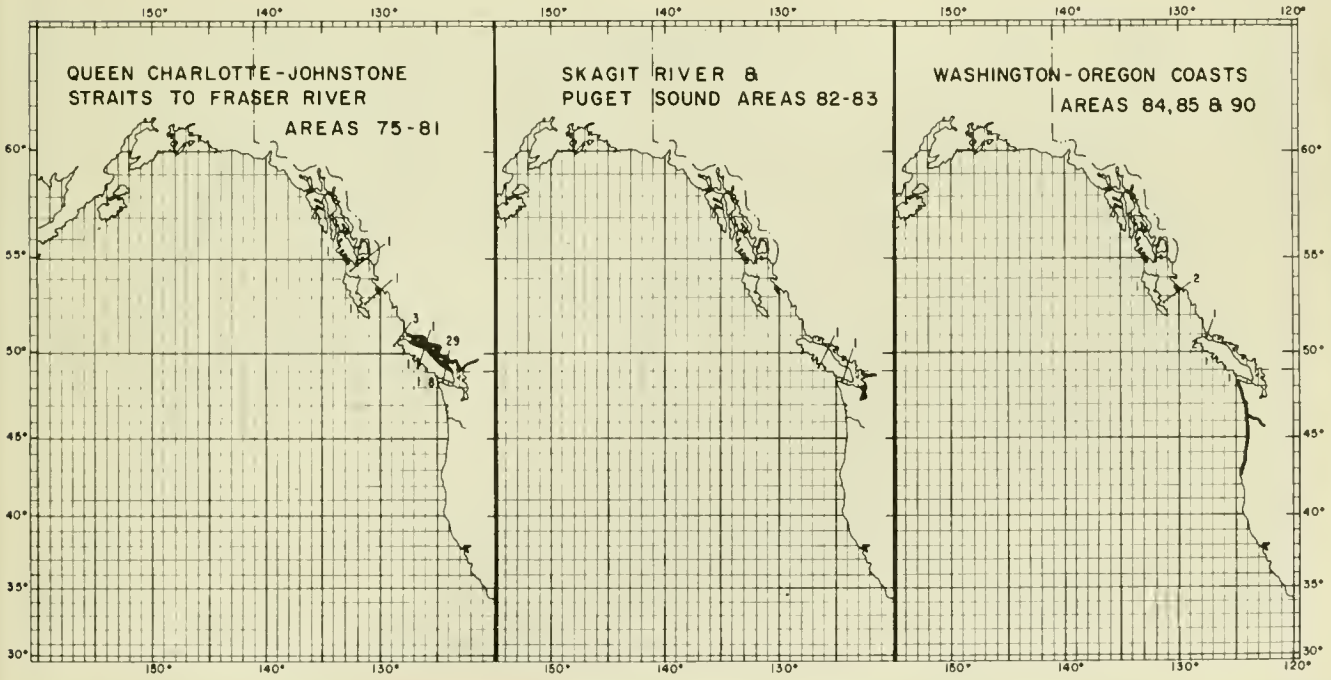

Figure 107.—Tagging locations of maturing chinook salmon recovered from Queen Charlotte-Johnstone Straits to the Fraser River; Skagit River and Puget Sound; and Washington-Oregon coasts.

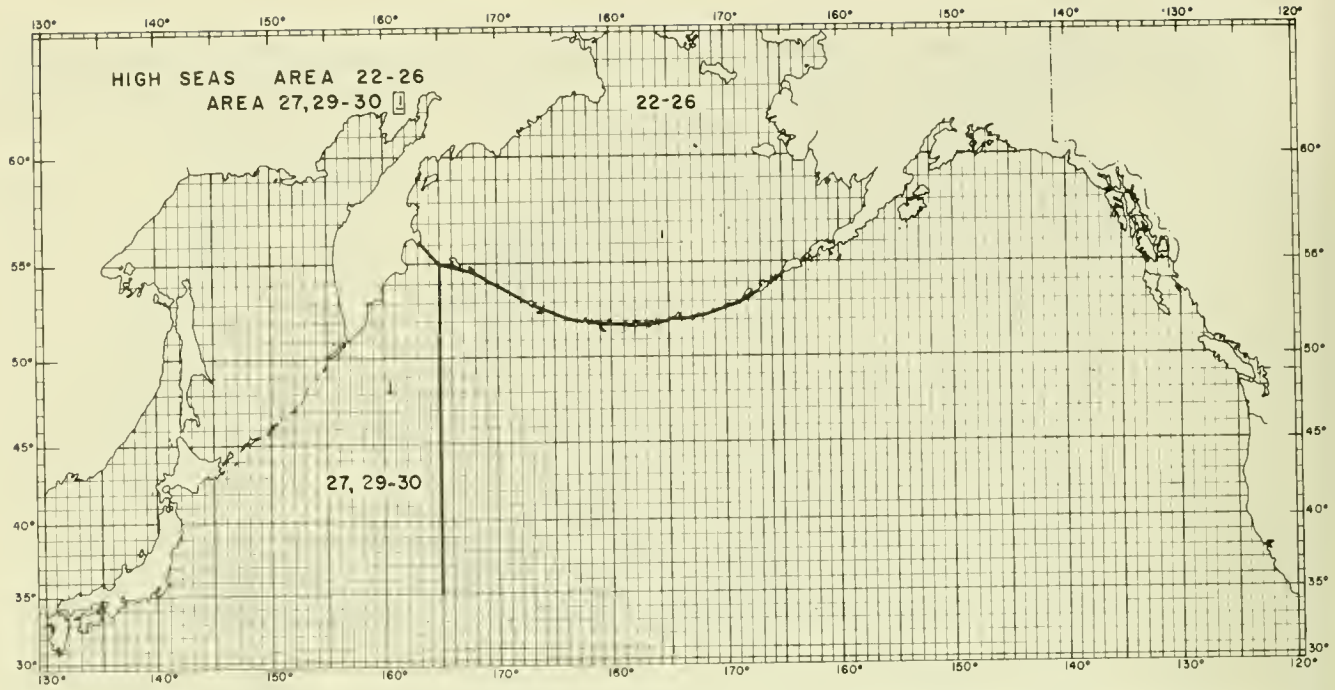

Figure 108.—Tagging locations of chinook salmon recovered in the Bering Sea (immature) and western North Pacific (maturity unknown).

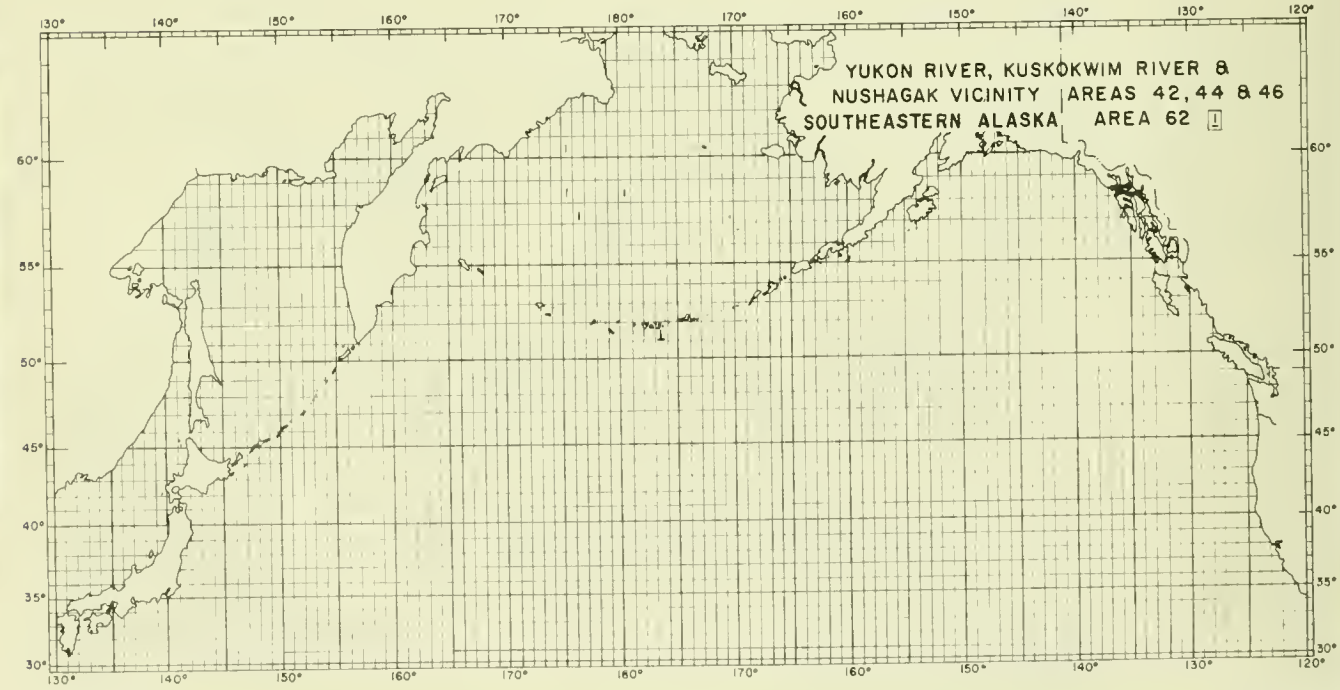

Figure 109.—Tagging locations of chinook salmon recovered subsequent to year of tagging in the Yukon River, Kuskokwim River, Nushagak vicinity, and southeastern Alaska.

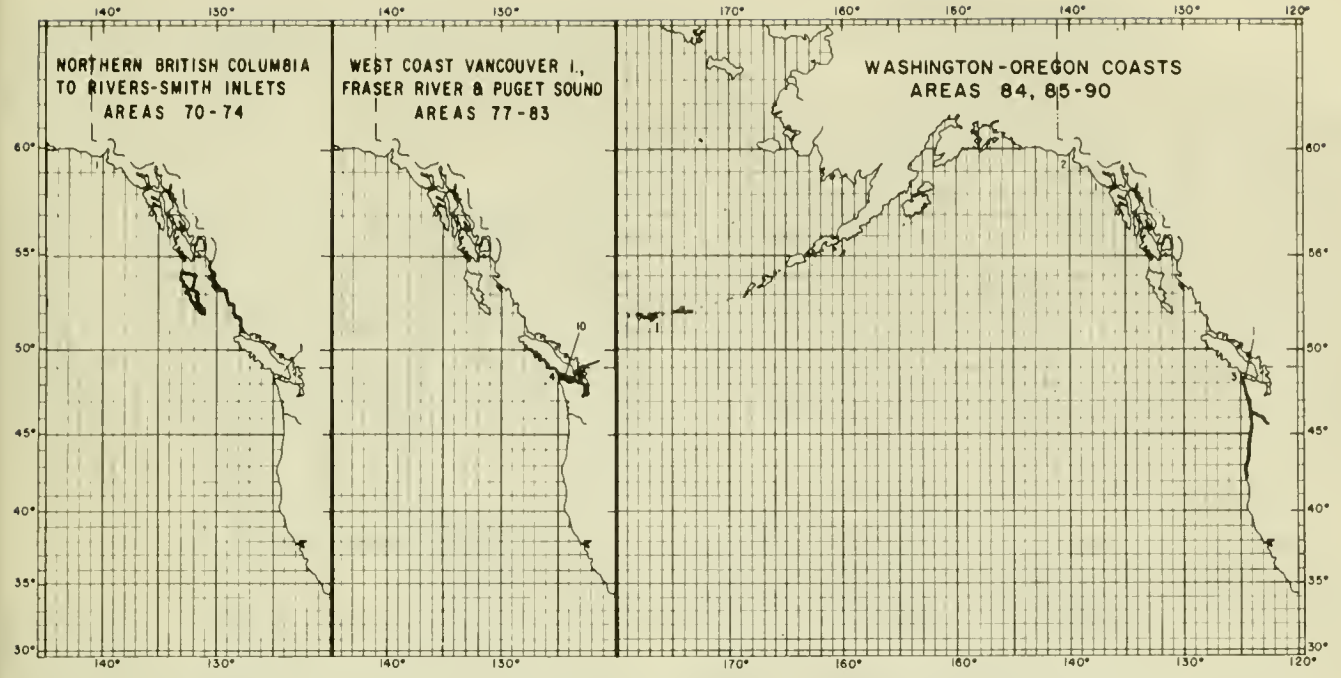

Figure 110.—Tagging locations of chinook salmon recovered subsequent to year of tagging from northern British Columbia to Rivers-Smith inlets; west coast Vancouver Island, Fraser River, and Puget Sound; and Washington-Oregon coasts.

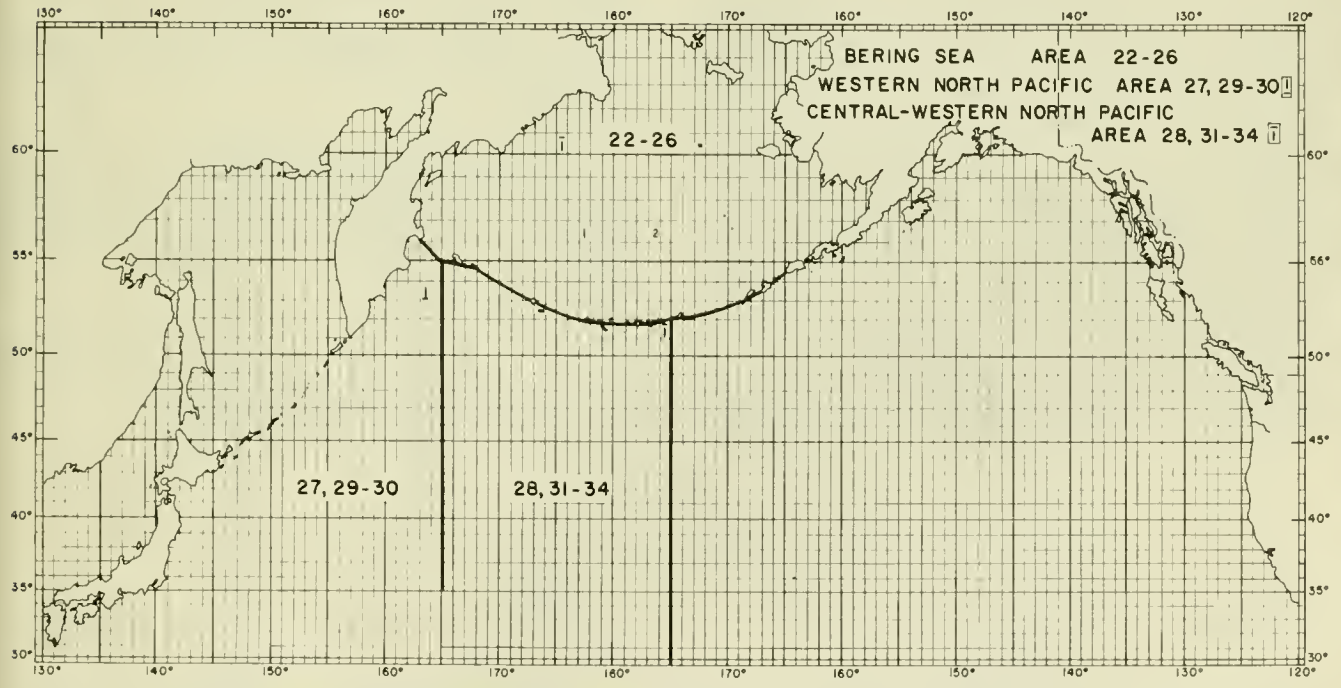

Figure 111.—Tagging locations of chinook salmon recovered subsequent to year of tagging in the Bering Sea, western North Pacific, and central-western North Pacific.

STEELHEAD TROUT

Figures 112-117

A total of 64 tagged steelhead trout were recovered in inshore areas from high-seas tagging experiments during 1956-69. All of these tag recoveries were in North American waters; steelhead trout are not known to be distributed in Asian streams. All recoveries were in the areas from British Columbia to northern California and were from releases in the northeastern Pacific Ocean (Fig. 112). Although steelhead trout are known in Alaskan streams tributary to the Gulf of Alaska, lack of recoveries from these areas is probably because of lack of recovery effort by commerical and sports fishermen.

Coastal Recoveries in Year of Tagging

Steelhead trout tag recoveries made within the year of tagging (maturing fish) were almost entirely from releases throughout the northeastern Pacific Ocean east of long. 160°W and were north of lat. 44°N (Fig. 113). A few recoveries were from tagging in the northern part of the Gulf of Alaska. One fish came from a release in the central Aleutian Islands area. These inshore recoveries included those made throughout the winter following the summer of tagging since maturing steelhead trout enter streams during the winter for the spring spawning period.

North American stocks (Figs. 113-116).—Based on the returns of tagging experiments, maturing steelhead trout from British Columbia and those from Washington, Oregon, and northern California were distributed in different areas of the northeastern Pacific Ocean. Returns to British Columbia were mainly from waters north of lat. 50°N and extending westward to about long. 150°W (Figs. 114, 115). Steelhead trout from Washington, Oregon, and California were from areas primarily south of British Columbia, fish with releases concentrated between lat. 45°N and 50°N (Figs. 115, 116). Exceptions to this were some returns to the Columbia River and Oregon which came from north of lat. 50°N. The westward range of release points varied between States, with that from Washington being the farthest west (to long. 160°W) and those from California the least (to about long. 145°W). A segment of maturing steelhead trout may also range into more northern waters since one recovery in Oregon came from the Gulf of Alaska north of lat. 55°N. An unusually distant return (Fig. 113) was recovered in Washington from a steelhead trout tagged south of the central Aleutian Islands. The specific area of recovery in Washington is unknown.

The longest migration was recorded for a steelhead trout tagged in the summer of 1970 and recovered during spring of 1971.[4] This fish was tagged on 6 September south of Kiska Island in the western Aleutian Islands area and recovered in the Wynoochee River (which empties into Grays Harbor, Wash.) the following spring, 5 March. This particular fish traveled a minumum of about 4,800 km during the approximately 180 days (a minumum of 27 km per day) it was at liberty.

Coastal Recoveries Subsequent to Year of Tagging

Recoveries of tagged steelhead trout subsequent to year of tagging (immature fish) were relatively few (Fig. 117). Three recoveries were made in British Columbia, one each in the Nass and Skeena rivers and one in the Queen Charlotte and Johnstone straits area. These were from taggings close to the recovery area and from near the central Gulf of Alaska. The three recoveries from the Washington coast and Columbia River were from releases made well offshore in the northeastern Pacific Ocean. Recoveries from Oregon and California were from tagging throughout the northeastern Pacific and showed long migrations as immature fish.

One recovery (not illustrated) was made in the high seas, far to the west near lat. 47°N and long. 167°30′E. This steelhead trout had been tagged near lat. 51°30′174°W.

The available tag recoveries fail to illustrate the complete ocean distribution of steelhead trout; main concentrations of steelhead trout are located in the northeastern Pacific Ocean but they also range far westward to the central and northwestern Pacific (Sutherland 1973).

[4]This fish was tagged by Japan in 1970, a date beyond the period encompassed in this report. Because of the unusual migration for this species, the tagging data are included here.

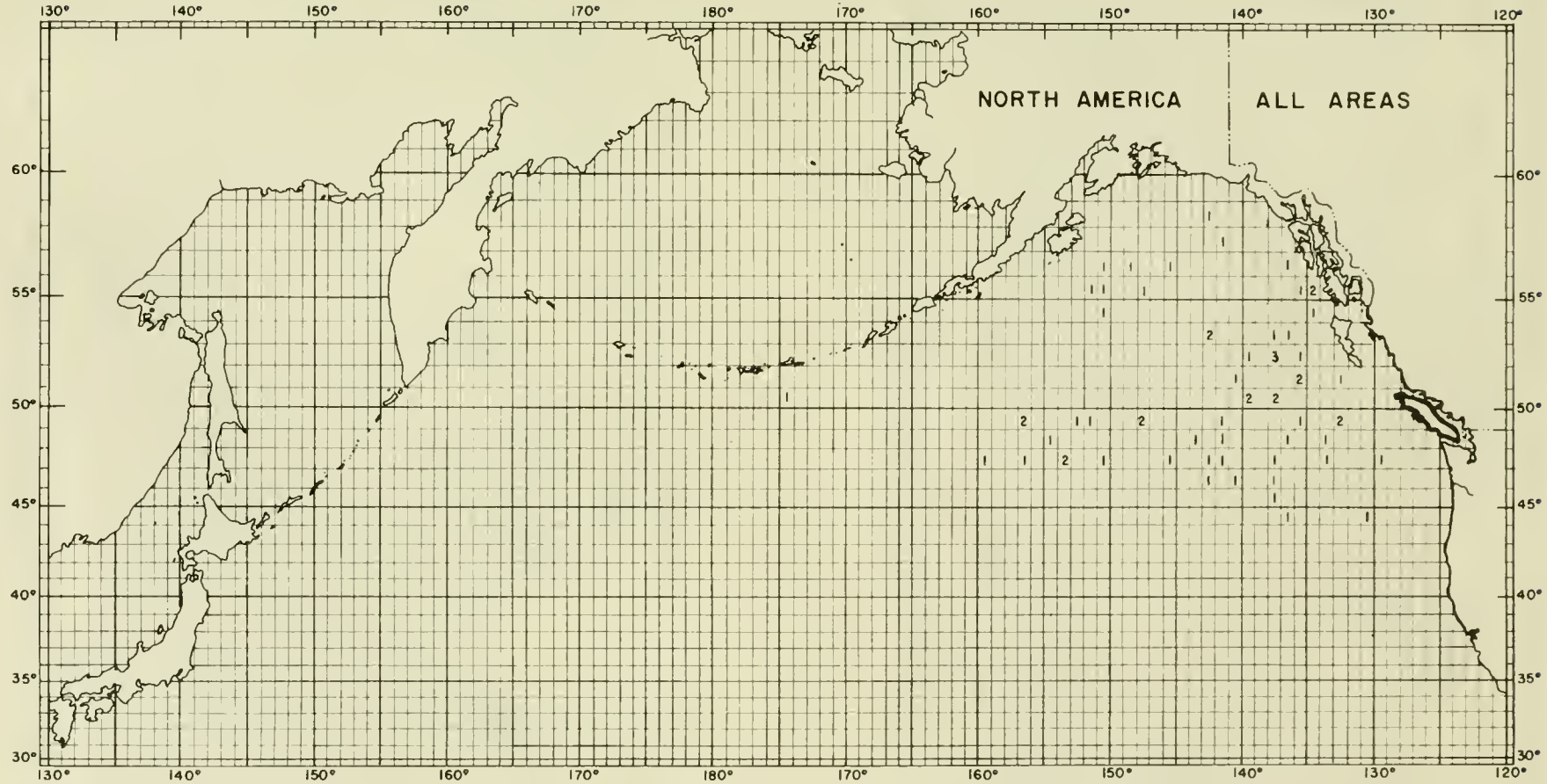

Figure 112.—Tagging locations of steelhead trout recovered in North America.

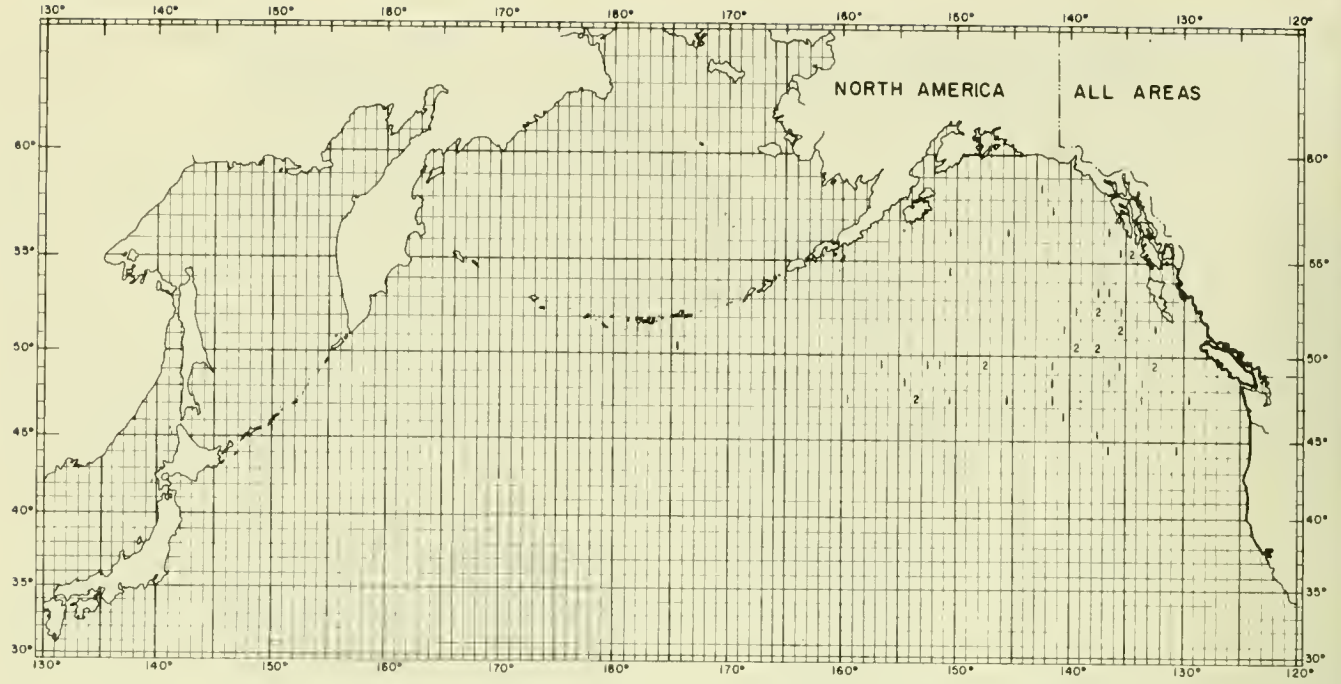

Figure 113.—Tagging locations of maturing steelhead trout recovered in North America.

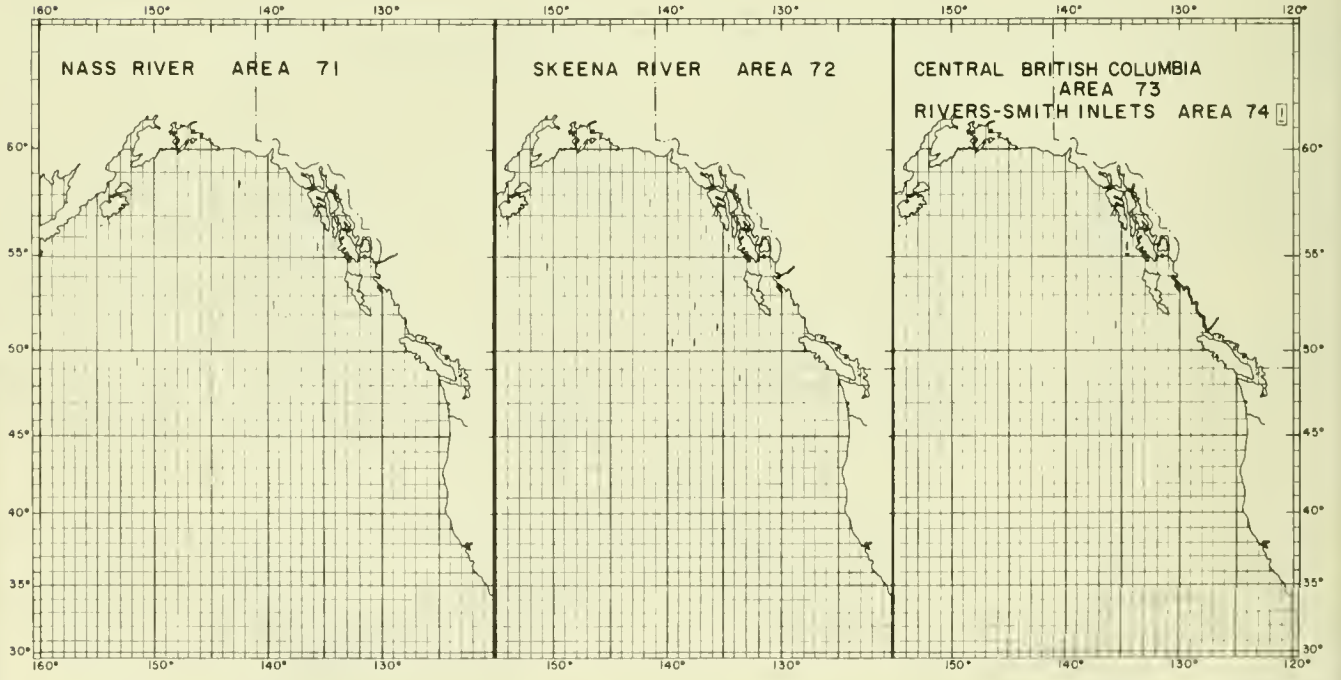

Figure 114.—Tagging locations of maturing steelhead trout recovered in the Nass River, Skeena River, and central British Columbia and Rivers-Smith inlets.

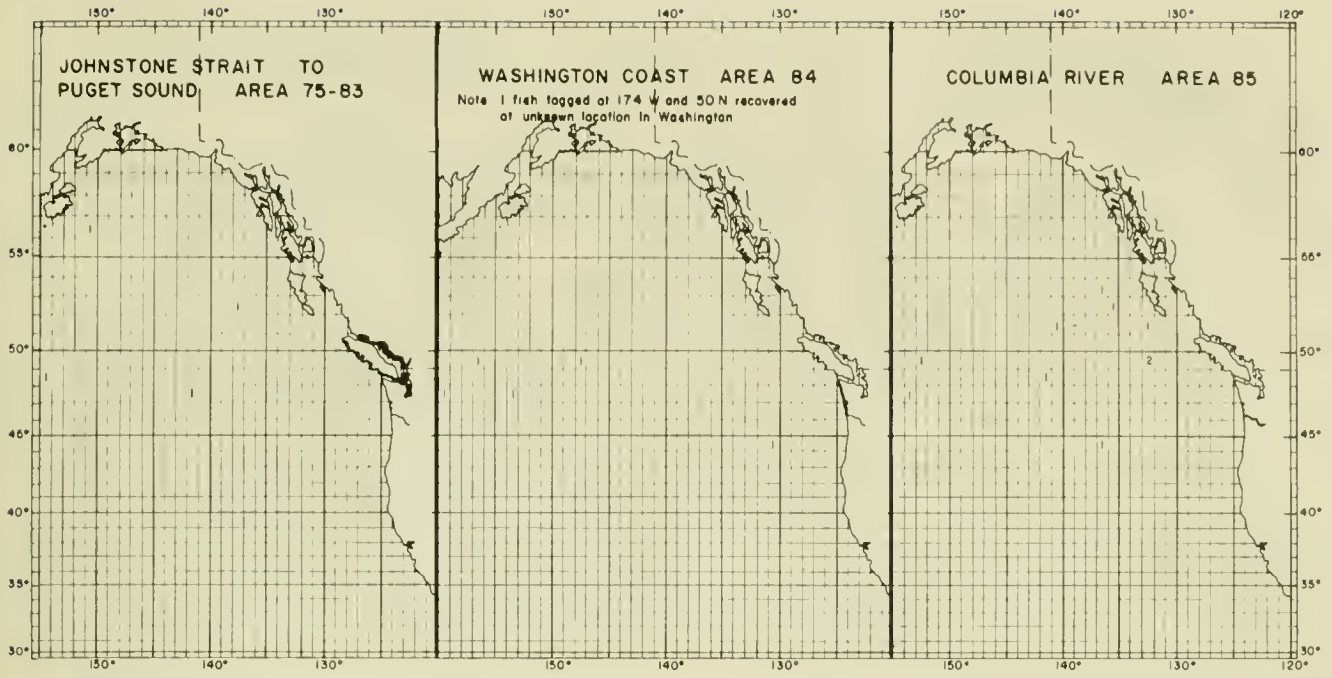

Figure 115.—Tagging locations of maturing steelhead trout recovered in Johnstone Strait to Puget Sound, Washington coast, and Columbia River areas.

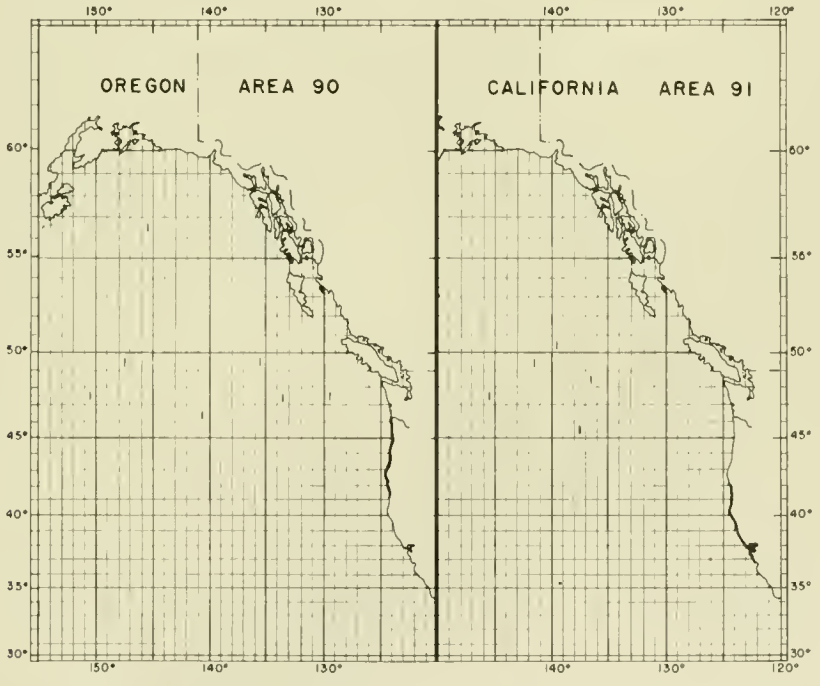

Figure 116.—Tagging locations of maturing steelhead trout recovered from the coasts of Oregon and California.

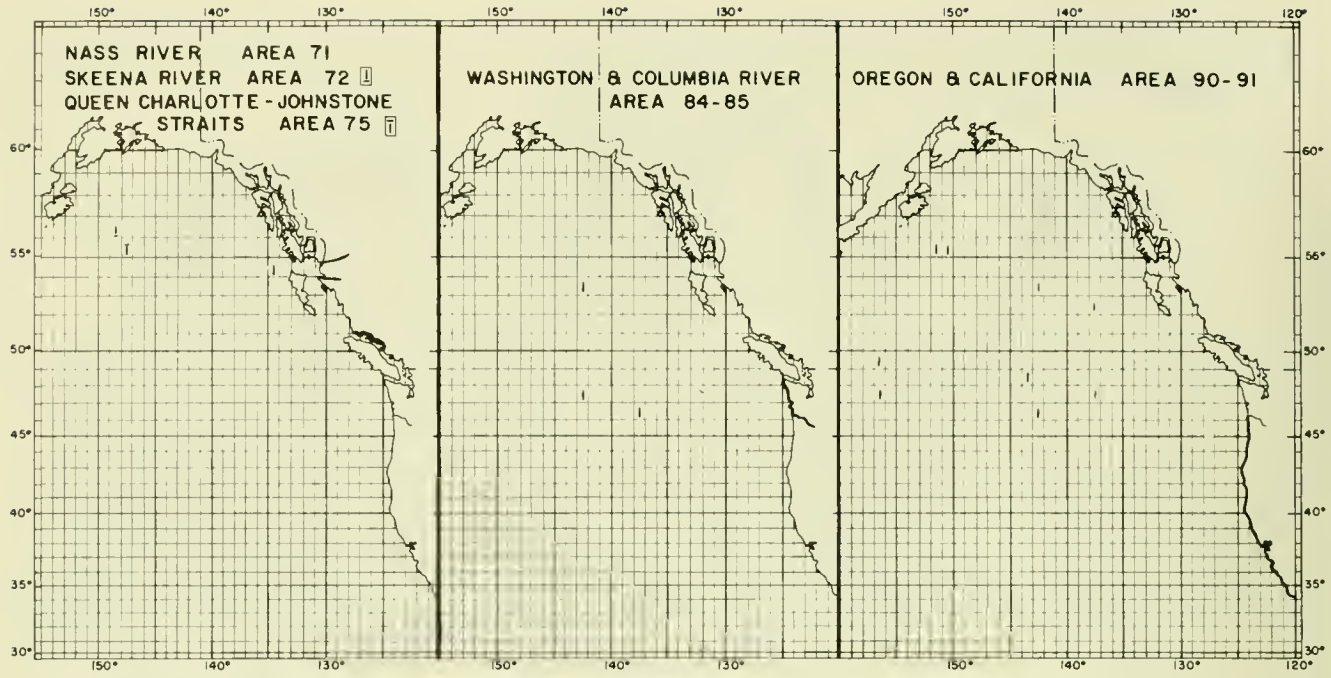

Figure 117.—Tagging locations of immature steelhead trout recovered subsequent to year of tagging in Nass River, Skeena River, Queen Charlotte-Johnstone Straits; Washington coast and Columbia River; and Oregon and California coasts.

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