1985年に日本が実施したさけ・ます調査研究の要約

Summary report on Japanese salmon investigations in 1985

高　木　健　治

Kenji Takagi

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水　　産　　庁

Fisheries Agency of Japan

た。合計6,895尾を漁獲し、2,921尾を標識放流した。魚種別標識放流尾数は、ベニザケ245尾、シロザケ1,714尾、カラフトマス203尾、ギンザケ632尾、マスノスケ83尾及びスチールヘッド44尾であった。 1984年に比べて、ベニザケ・シロザケ及びカラフトマスの放流尾数が減少した。海域別にみると、北太平洋北緯46度以南水域における放流尾数587尾及びベーリング海における放流尾数256尾は、それぞれ1984年の放流尾数より減少した。主な理由は、調査船の運航に関する日ソ間の合意が大幅におくれたため、当初計画の前半に相当する4～5月の調査が実施できなかったことにある。ベーリング海における標識放流は、前述の通り、1隻の調査船が流網漁獲効率推定を主目的として実施した。

1984～85年に北太平洋及びベーリング海において放流したさけ科魚類から30尾の新しい再捕例並びに1980～84年放流から1980年再捕3尾、1983年再捕4尾、及び1984年再捕82尾の追加再捕例が得られた。これらの再捕による主な結果を魚種別に要約すると以下の通りである。

ベ ニ ザ ケ

1984年5月11日に44° 31' N、171° 28' Wにおいて放流された1尾が、 同年8月12日にバンクーバー島北東岸において再捕され、従来知られていたジョンストン海峡地域起源ベニザケ成熟魚の分布限界(46° 33' N、173° 34' W)を南方へ拡大した。

1984年7月18日にベーリング海55° 21' N、177° 37' Wにおいて放流された1尾が、1985年7月4日にKuskokwim川において再捕され、Kuskokwim 起源ベニザケ未成熟魚のベーリング海における分布を初めて示した。

これらの他13尾の北米沿岸再捕が得られ、いずれも既往知見の範囲内であった。

シ ロ ザ ケ

1980年7月27日にベーリング海58° 00' N、176° 03' Eにおいて放流された1尾が、1983年7月23日にアムール河において再捕され、従来知られていたアムール河起源シロザケ未成熟魚の分布限界(56° 30' N、166° 31' E)を北東へ拡大した。

1980年5月29日に42° 42' N、179° 32' Wにおいて放流された1尾が、1983年8月7日に北東カムチャッカ沖合においてソ連トロール船によって再捕された。この付近に回帰したものと仮定すると、従来知られていた北東カムチャッカ起源シロザケ未成熟魚の分布限界(47 29' N、17 29' E)を南東へ拡大したことになる。

1983年7月26日に60° 30' N、175° 30' Wにおいて放流された1尾が、1984年にカラギンスキー地区において再捕され、従来知られていた東カムチャッカ起源シロザケ未成熟魚の分布限界(56° 00' N、177° 00' W)を北東へ拡大した。

1984年5月7日に45° 30' N、171° 33' Wにおいて放流された1尾が、同年8月20日に北東カムチャッカにおいて再捕され、従来知られていた同地域起源シロザケ成熟魚の分布限界(46°27' W、163° 33' W)を南方へ拡大した。

これらの他5尾のソ連沿岸再捕及び44尾の日本沿岸再捕が得られ、いずれも既往知見を一層裏

づけた。

カラフトマス

1984年5月10日に43° 30'N、178° 30'Eにおいて放流された1尾が、同年8月4日にボリシャヤ川において再捕され、従来知られていた西カムチャッカ起源カラフトマスの分布限界（45°29'N、178°29' E）を南東へ拡大した。

1984年5月26～29日に43°25'～43°33'N、156°01'～158°58' Eにおいて放流された2尾が、同年7月22日及び8月10日に西カムチャッカにおいて再捕され、従来知られていた同地域起源カラフトマスの160°E以西水域における分布限界（44°21'N、154°30'E）を南方へ拡大した。

1984年5月16～20日に、44°29'～47°30' N、168°33'～168°33'Wにおいて放流された2尾が、同年北東カムチャッカにおいて再捕され、従来知られていた同地域起源カラフトマスの分布限界（47°31'N、173°28'W）を南東へ拡大した。

1984年5月20～21日に、43°25'～43°29'N、166°26'～168°04'E において放流された2尾が、同年Korfa Bayにおいて再捕され、従来知られていた北東カムチャッカ起源カラフトマスの分布限界（44°29'N、177°30'E）を南方へ拡大した。

これらの他15尾のソ連沿岸再捕が得られ、いずれも既往知見を一層裏づけた。

ギンザケ

1984年7月30日にベーリング海58°28'N、179°32'Wにおいて放流された1尾が、同年ソ連沿岸において再捕され、従来知られていたソ連起源ギンザケのベーリング海における分布限界(54°53'N、171°13'E）を東方へ拡大した。

この他5尾のソ連沿岸再捕が得られ、いずれも既往知見を一層裏づけた。

スチールヘッド

2尾の北米沿岸再捕が得られ、いずれも既往知見の範囲内であった。

3. さけ科魚類の分布及び起源並びに海洋学的条件に関する追加情報

1985年にC網によって得られた調査船漁獲データを検討した。調査活動が8月に終了したばかりであり、生物学的資料をまだ編集中なので、以下の結果は暫定的なものである。

ベニザケ

6月に1.0以上のCPUE（1反当り漁獲尾数、以下同様）が46° N以北においてみられ，アッツ島西側の太平洋海域の値は高く、ベーリング海の値は全般的に低かった。7月にアリューシャン列島南側に東西に連続した主要分布域がみられ、ベーリング海のCPUE値は低かった。

シロザケ

6月に調査範囲内の南東部に相当する水域に1.0以上のCPUEが多くみられた。7月のCPUEは前月に比べて全般的に高くなった。ベーリング海では調査範囲内の北東部におけるCPUEが

高い傾向を示し、最高は 4.1 であった。

カラフトマス

5月に 1.0 以上のCPUEが日本200海里内調査水域の 40°N以北においてみられた。 6月の太平洋 51°N以南におけるCPUEは170°E以東では低く、対照的に、 170°E以西では高く、最高はE 5444 における 12.0 であった。アッツ島水域のCPUEも高かった。7月に 1.0 以上のCPUEがみられた水域はアッツ島南側を除けばすべて 167°E以西に限られた。 最高はE 5544 における 12.7 であった。

ギンザケ

6月に調査範囲内の南東部に相当する水域に 0.5 以上のCPUEが多くみられた。7月に出現水域は北方へ拡がり、主要分布域は 44°〜 49°N、 166° E 〜 178°Wにみられ、特にE 6948 及びE 7047 におけるCPUEは 3.0 以上という高い値を示した。 8月の調査においても引続き 2.0 以上の高いCPUEが認められた。

マスノスケ

6月に 0.01 以上のCPUEが調査水域内の 160° E以東において広くみられた。 7月に出現水域が増し、CPUEが 0.1 以上の水域は、ベーリング海で2区画及び太平洋で5区画であった。

スチールヘッド

6月における魚の出現は調査範囲内の南東部に相当する水域に多くみられた。7月における出現水域は、 42°〜 51°N及び 169°E 〜 177°Wによって囲まれた北太平洋中部であった。最高CPUEはE 7748 における 0.4 であった。

1972 〜 83 年に日本調査船によって収集された生物学的資料に基づき、北太平洋におけるスチールヘッド、トラウト及びカムチャッカン、トラウトの季節的分布と豊度を調べた。溯上地域及び溯上時期との関連から、オホーツク海や北太平洋西部において漁獲されたものの大部分はカムチャッカン・トラウトであったものと考えられた。西部水域における雌の出現頻度が高いことから、両種では雌雄の降海性に違いがあるものと推論された。未成熟魚の主要分布域は、夏季に北太平洋中部に広く出現すると推定された。

両種の遺伝的分化を 37 遺伝子座における対立遺伝子頻度に基づき検討した。北米大陸のカスケード山脈を境にして海岸集団と内陸集団の2群が対立遺伝子頻度の差異から識別され、遺伝的距離からみて北米海岸集団は北米内陸集団よりむしろカムチャッカン・トラウトの方に近い。この研究結果及び両種が脊椎骨数の差によってのみ分けられる事実は、スチールヘッド・トラウトとカムチャッカン・トラウトは同種とみるべきことを示す。推定された分化年代に基づき、上記3集団の最終氷期における避難場所及び後氷期の分散経路について検討した。

1974 年沖合水域において漁獲された起源未知のマスノスケ 1.2 年未成熟魚を対象として、系群

識別のため鱗相分析を行なった。基準群として1975年漁獲の1.3年成熟魚及び1976年漁獲の1.4年成熟魚を用いた。ソ連提供のカムチャッカ川及びボリシャヤ川標本だけではアジア基準群としての代表性が低いと判断されたので、日本調査船が5～7月に165°E以西海域において採集した成熟魚標本を基準群に加えた。日本調査船は1977年以降ソ連200海里内における活動を行なっていないので、それ以前に採集された標本しか利用できず、分析対象年がその点から制約された。

分析結果をMyers他（1984）と比較すると、6～7月の太平洋側水域において中部アラスカ群の混合割合が大幅に低下し、アジア群の割合が高くなったことがみとめられた。6～7月のベーリング海では西部アラスカ群が最も卓越している点は同様であった。母船式及び基地式漁業におけるアジア起源群の漁獲尾数推定値は、Myers他（1984）の推定値の2倍以上となった。

しかし、この分析結果は予備的なものであり、最終的なものとはいえない。その理由は、材料や方法によって分析結果が左右され易く安定しないこと、今回のアジア基準群もまだ北東カムチャッカ標本が欠如していると判断されること、誤判別確率が10％以下になるよう判別保留域を設定した場合に保留される標本割合が大きいこと、などによる。起源未知標本をどの基準群と最も良く、〝類似する〟かによって判別する鱗相分析の結果のみで系群識別をするには限界があり、他の分析手法による結果と合わせて総合的判断を下す必要がある。

ギンザケの鱗相分析に際し、アジア基準群として日本調査船がソ連沿岸域において1975年に採集した資料を用いた。分析結果によると1975年の北西太平洋に分布するギンザケの多くはアジア起源群であり、他方北米起源群は7月の175°E以東、50°N以北の海域にみられた。

1956～84年における標識放流調査結果と比較すると、175°E以西海域からの標識放流魚が北米沿岸において再捕された例が全くないのに対し鱗相分析結果では同海域に10～30％の北米起源群がみられることなど矛盾点が多い。誤判別確率10％以下になるよう判別保留域を設定した場合、保留域に入る個体の割合は40～50％と非常に高いものであった。

これらのことは鱗相分析結果のみから大陸陸起源判別を行うことは困難であることを示し、得られた数値の取扱いは慎重に行うべきである。

シロザケ鱗相分析を継続した。まず前報（石田他1984）において採用した5形質を用いてCook法及び線形判別関数法による結果を比較した。基準群の判別精度は大差ないが、沖合標本では海区により、これら2つの方法による判別結果はかなり異なった。沖合標本の判別に際して、基準群で判別精度の高い分析方法が必ずしも安定した推定値を与えないと考えられた。

つぎに、日本調査船によって採集され、従来の標識再捕知見よりソ連起源と判断される5月及び6月の160°E以西の沖合鱗標本とソ連から提供されている沿岸・河川の鱗標本とを比較した。その結果、2つの計量形質（第1年帯及び第2年帯の幅）よりむしろ2つの計数形質（第1年帯及び第2年帯のサーキュリー数）の方が、系群識別に有効な鱗相形質であると判断された。

最後に、有効形質として選択された2形質を用いた判別結果を先の5形質を用いた沖合標本の判別結果とを比較したところ、アメリカ起源と判別される個体は減少し、多くの海区においてソ連起源及び日本起源と判別される個は増加することがみとめられた。

採用する分析方法及び形質により沖合標本の判別結果はかなり変動するので、判別結果の解釈に際してこのような推定値の不安定さを考慮しておく必要がある。今後、鱗相分析によって得られた結果を妥当なものと判断するには、他の異なる分析手法による裏付けが必要である。

1985年7月3～15日の期間にアリューシャン列島南側水域においてC網によって漁獲したベニザケ未成熟魚の漁獲量及び生物学的資料を分析した。これは従来の標識放流調査によって大部分ブリストル湾起源であることが知られているベニザケ未成熟魚に関して、1972年以降現在まで毎年、その相対的豊度及び年令組成を監視するために企画された継続的調査である。 1985年に得られた研究水域内におけるＣＰＵＥの算術平均値は、海洋1年魚0.82及び海洋2年魚0.39であった。

さけ・ます流網の漁獲効率を推定する際、2セットの流網による平行投網実験において次の2点が仮定された（石田 1984）。（1）さけ・ますの移動方向が流網に直角であること。（2）流網の漁獲作用の及ぶ範囲が流網の長さ、さけ・ますの遊泳速度及び操業時間の長さによって決まること。しかし、これらの仮定が十分に満たされていない場合、漁獲効率の推定結果に誤差が生じる。そこで、仮定（1）の問題点を解決するために2セットの流網による直角投網実 験を、また仮定（2）の問題点を解決するために3セットの流網による平行投網実験を実施した。

6～7月のベーリング海における直角投網実験より推定された羅網方向は、定点により魚種により異なる。全定点の平均をみると、ベニザケ、シロザケ、カラフトマスともに340°方向の羅網が最も多く、これに次いで多い羅網はベニザケでは70°方向、シロザケでは250°方向であり、3魚種ともに160°方向の羅網が最も少なかった。4方向のＣＰＵＥ合計を340°と160°方向のＣＰＵＥ合計で割った値（Ｓ）は、ベニザケ1.78、シロザケ1.77及びカラフトマス1.53であった。

3セット平行投網実験より推定された漁獲効率の平均値は、ベニザケ0.674、シロザケ0.403及びカラフトマス0.691であった。さけ・ますの移動距離（Ｖｔ）は、それぞれ4.279Km、6.028Km、及び13,753Kmであった。

今回のモデルでは移動距臨(Vt)が直接推定できたが、前報（石田1984）ではさけ・ますの移動距離を遊泳速度（Ｖ）と操業時間（ｔ）との積Ｖ・ｔとして求め、Ｖは標識再捕データより推定した。今回得られたＶｔから判断すると、前報におけるｔまたはＶの推定値は過大であった可能性がある。

上述のＣＰＵＥ補正係数（Ｓ）、漁獲効率、移動距離及び流網1反の長さを用いて求めたＣＰＵＥと魚群密度の関係における変換係数（Ｑ）は、ベニザケ12.34、シロザケ14.57及びカラフトマ3.22であった。 今後、これらの係数の精度の検討と資源尾数推定の試みが必要である。ここに述

べた実験結果は暫定的なものであり、無断引用は禁じられている。

1985年夏季における北太平洋の海洋学的条件を検討した。

西部亜寒帯水塊の張り出しは、南方・東方とも平年よりやや弱かった。

アラスカ海流の西方張り出しは、平年よりやや強かった。

表面水温は平年より低温であった。特に6月から7月にかけての昇温が小さく、7月は北西太平洋のほぼ全域にわたって平年より低温となった。

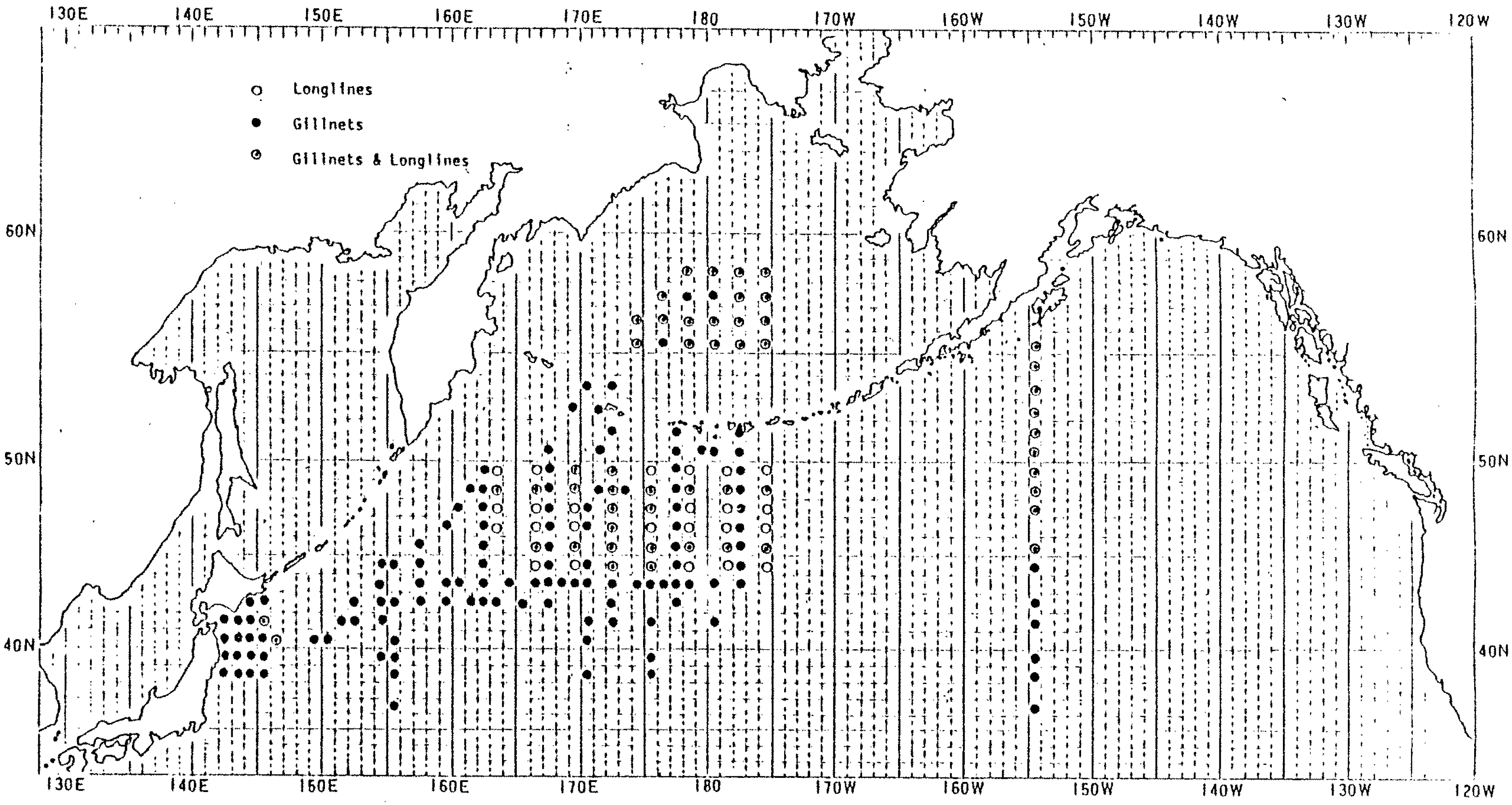

Figure 1. Fishing locations of Japanese salmon research vessels by gillnets and longlines, 1985.

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SUMMARY REPORT ON JAPANESE SALMON INVESTIGATIONS IN 1985

Kenji Takagi

Fisheries Agency of Japan

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1. Outline of Japanese investigations in 1985

(a) Salmon

(i) Research on board research vessels

Japanese salmon investigations in 1985 were conducted by eight research vessels. The research period was from May to August which was different from that in the previous year. The research in May was limited to the Pacific Ocean coastal areas within the Japanese 200 mile zone and in June was mainly in the North Pacific Ocean and Bering Sea west of 175°W. Some research was also conducted in the northeastern Pacific Ocean including the Gulf of Alaska (Fig. 1).

Fishing gears used were gillnets and longlines, the type and number of which varied according to purpose of the survey. The vessels *Hokushin maru*, *Iwaki maru*, *Kaiun maru*, *Wakatake maru*, *Riasu maru No. 2*, and *Hokuho maru* were engaged in research to obtain information on distribution and abundance on salmon in the northwestern Pacific Ocean, Aleutian region, and Bering Sea. They used research gillnets (hereafter called "C" nets) with 10 different mesh sizes (48, 55, 63, 72, 82, 93, 106, 121, 138, and 157 mm) and commercial type gillnets (hereafter called "A" nets).

Two vessels, *Riasu maru No. 2* and *Hokuho maru*, were engaged in tagging experiments for study of the continental origin of salmon distributed in the southern North Pacific including south of 46°N. These research vessels used mainly longlines in order to catch salmon for tagging and "A" and "C" nets as well as longlines at some research stations.

The *Wakatake maru* conducted research to estimate the sampling efficiency of gillnets in the Bering Sea using longlines as well as "A" and "C" nets. The vessels *Oshoro maru* and *Hokusei maru* were engaged in collecting information and biological data on pelagic fish including salmon, squids, etc. using gillnets (hereafter called "F" nets) with special mesh sizes (19, 22, 25, 29, 33, 37, 42, 179, 204, and 233 mm) in addition to "A" and "C" nets and in the case of the *Oshoro maru* longlines for tagging. All vessels conducted oceanographic surveys and carried out research on animals (fishes, squids, sea birds, and marine mammals) which were incidentally caught by the fishing gear.

Gillnet research

The gillnet research in 1985 commenced on May 4 and was completed on August 5. A total of 258 research operations (351 in 1984) were conducted during this period of time. In the northwestern Pacific Ocean outside the Japanese 200 mile zone, the gillnet research was basically conducted at 5° intervals of longitude while moving in south-north directions. Effort was conducted to investigate immature sockeye salmon in waters on the south side of the Aleutian Islands during July and on salmon distributed in the central Bering Sea during July.

In May, four research vessels made 79 gillnet operations in Pacific Ocean coastal areas within the Japanese 200 mile zone. In June, seven research vessels made a total of 63 gillnet operations in the North Pacific Ocean west of 175°W and one vessel made six gillnet operations in the central Bering Sea. In July, eight research vessels conducted investigations in three areas. That is, six research vessels made a total of 274 gillnet operations in the North Pacific Ocean west of 177°W, one vessel made a total of 16 gillnet operations in the central Bering Sea, and one research vessel made a total of 16 gillnet operations along 155°W. In August, one research vessel made four gillnet operations, continuing those in July.

Longline research

The longline operations in 1985 commenced on May 22 and ended on July 27. During this period, a total of 107 longline operations (125 in 1984), including 99 tagging experiments (123 in 1984), were conducted. Effort of the longline research operation was expended mainly to clarify the continental origin of salmon distributed in the southern North Pacific Ocean including waters south of 46°N. In the central Bering Sea, tagging experiments for the main purpose of estimating the sampling efficiency of gillnets were conducted.

Some tagging experiments were also conducted in the eastern North Pacific Ocean including the Gulf of Alaska. In May, one research vessel made three operations within the Japanese 200 mile zone. In June, one research vessel conducted 12 operations in the central North Pacific Ocean between 44° and 50°N and 178°E and 175°W and another vessel conducted four operations in the central Bering Sea. In July, two research vessels conducted 64 operations in the North Pacific Ocean between 44° and 50°N and 163°E and 178°W and another vessel conducted 13 operations in the central Bering Sea. In addition, one vessel conducted 10 operations along 155°W.

(ii) Research on board motherships

The mothership salmon fishery in 1985 was conducted by four motherships and 172 catcher boats (43 catcher boats per mothership). The mothership fleets left Hakodate on June 5 and returned between August 1 and 5. Landings to the motherships by catcher boats commenced on June 12 and finished on July 27 to 30 for a total of 164 operations. In June, there were 11 operations on the high seas in the North Pacific Ocean between 170°E and 175°E and 54 operations in the U.S. Fishery Conservation Zone. In July there were 76 operations in the U.S. Fishery Conservation Zone and 23 operations on the high seas in the Bering Sea.

Daily catch statistics were collected on board the four salmon motherships. Records of biological data such as fork length, body weight, gonad weight, and sex and collection of scales were made for up to 60 sockeye salmon and up to 30 of each other species on each mothership every landing day. The numbers of salmon measured on motherships in 1985 were 23,651 in all, consisting of 9,750 sockeye, 4,889 chum, 4,430 pink, 1,493 coho, and 3,089 chinook. Oceanographic observations were made each day at noon from the motherships.

(iii) Investigations by U.S. observers

During the 1985 fishing season, one U.S. salmon observer and one U.S. marine mammal observer were aboard each of the four motherships and two U.S. observers for marine mammals stayed aboard each of two catcher boats for a total of four observers, making the total number of U.S. observers 16 in all. Of the U.S. personnel, the former group was to monitor the salmon fishing operations in the U.S. Fishery Conservation Zone as well as to collect scale samples and biological data. The latter were to conduct investigations of marine mammals, particularly Dall's porpoise, incidentally caught by salmon gillnets. The U.S. observers stayed aboard each of the four motherships for a period of 35 to 44 days (a total of 155 days). Five U.S. scientists were aboard the Japanese research vessels for Japan-U.S. joint surveys including investigations on young salmon.

(b) Other studies on anadromous salmonids

Eighty-nine records were added to the recovery of fish tagged prior to 1985 and there were 30 records of recoveries in 1985 up to August 1985. Information on distribution and origin of salmonids obtained from Japanese tagging experiments on the high seas was updated.

Recent studies on steelhead trout in the North Pacific Ocean were summarized to provide information for this special topic of the Sub-Committee on Salmon.

Analysis of scale patterns of chinook salmon in offshore areas in 1974 was newly conducted for stock identification of chinook salmon. Analysis of coho salmon scale patterns from the northwestern Pacific Ocean, based on data obtained in 1975, was also newly conducted.

Studies on stock identification of chum salmon by scale pattern characters using discriminant functions were continued. Relative abundance and age composition of immature sockeye salmon in the Aleutian Islands region in 1985 were investigated to assist in prediction of runs and age composition of Bristol Bay sockeye salmon.

Two sets of parallel and three sets of right angle gillnet operations were conducted in the central Bering Sea during the period 1985 June 24 to July 17 in order to estimate the catch efficiency of salmon gillnets.

(c) Oceanography

Oceanographic conditions in the northwestern North Pacific Ocean were studied. Data collected during June to July in 1985 were analyzed with respect to the conditions of Western Subarctic Water, the location of the westward extension of the Alaskan Stream, and surface water temperatures.

2. Review of results of studies on continental origin

(a) Results of tagging experiments on the high seas

Japanese research vessels conducted salmon tagging experiments during four separate cruises from 1985 May to July in the North Pacific Ocean, Bering Sea, and the eastern North Pacific including the Gulf of Alaska. Salmonids were captured by longlines, tagged, and released in waters between 44°29'N and 49°32'N and 163°31'E and 175°30'W in the North Pacific Ocean, in waters between 55°28' and 58°31'N and 174°30'E and 175°23'W in the Bering Sea, and in waters between 47°58' and 54°53'N and 155°02'W and 155°06'W in the eastern North Pacific Ocean including the Gulf of Alaska. In total, 6,895 salmonid species were caught by longlines and 2,921 were tagged and released. The number of fish tagged by species was 245 sockeye, 1,714 chum, 203 pink, 632 coho, 83 chinook and 44 steelhead trout. Compared with 1984, numbers of releases of sockeye, chum, and pink decreased. By release area, the numbers released in waters south of 46°N in the North Pacific Ocean (587) and in the Bering Sea (256) decreased from the previous year. The main reason was delay in agreement between Japan and U.S.S.R. regarding the cruises of research vessels. Thus, investigations in April and May which were equivalent to the early half of the original research plan were not able to be conducted. As mentioned before, tagging in the Bering Sea was conducted by one research vessel for main purposes of estimating the catch efficiency of gillnets.

Thirty new recoveries from salmonids released in the North Pacific Ocean and the Bering Sea during 1984 to 1985 were made in 1985. A total of 89 additional recoveries from the 1980 to 1984 releases were reported: three recoveries in 1980, four recoveries in 1983, and 82 recoveries in 1984. The new information gained from these recoveries was as follows--

Sockeye salmon

One sockeye released at 44°31'N, 171°28'W on 1984 May 11 was recovered off the northeast coast of Vancouver Island on 1984 August 12. This was a southward extension of the known southern limit (46°33'N and 173°34'W) of mature sockeye salmon originating in Johnstone Strait.

One sockeye released at 55°21'N, 177°37'W in the Bering Sea on 1984 July 18 was recovered at the Kuskokwim River on 1985 July 4. This recovery was the first indication of the distribution of immature sockeye salmon in the Bering Sea originating from the Kuskokwim River.

Additionally, thirteen coastal recoveries were obtained which confirmed known findings.

Chum salmon

One chum salmon released at 58°00'N, 176°03'E in the Bering Sea on 1980 July 27 was recovered at the Amur River on 1983 July 23. This was a northeastward extension of the known northeastern limit (56°30'N, 166°31'E) of immature chum salmon originating in the Amur River.

One chum salmon released at 42°42'N, 179°32'W on 1980 May 29 was recovered by a U.S.S.R. trawler off northeastern Kamchatka on 1983 August 7. On the assumption that this fish was migrating to near this area, this was a southeastward extension of the known distribution limit (47°29'N, 172°29'E) of immature chum salmon originating in northeastern Kamchatka.

One chum salmon released at 60°30'N, 175°30'W on 1983 July 26 was recovered at the Karaginskii district in 1984. This was a northeastward extension of the known distribution limit (56°00'N, 177°00'W) of immature chum salmon originating in eastern Kamchatka.

One chum salmon released at 45°30'N, 171°33'W on 1984 May 7 was recovered at northeastern Kamchatka on 1984 August 20. This was a southward extension of the known distribution limit (46°27'N, 163°33'W) of mature chum salmon originating in the northeastern Kamchatka.

Additionally, five U.S.S.R. coastal recoveries and forty-four Japanese coastal recoveries were obtained, which confirmed known findings.

Pink salmon

One pink salmon released at 43°30'N, 178°30'E on 1984 May 10 was recovered at the Bolshaya River on 1984 August 4. This was a southeastward extension of the known distribution limit (45°29'N, 178°29'E) of pink salmon originating in West Kamchatka.

Two pink salmon released at 43°25'N to 43°33'N and 156°01'E to 158°58'E on 1984 May 26 to 29 were recovered at west Kamchatka on 1984 July 22 and August 10. They showed a southward extension of the known distribution limit (44°21'N, 154°30'E) of pink salmon in waters west of 160°E originating in West Kamchatka.

Two pink salmon released at 44°29'N to 47°30'N and 168°33'W to 168°34'W on 1984 May 16 to 20 were recovered at northeastern Kamchatka in 1984. They extended southeastward of the known distribution limit (47°31'N, 173°28'W) of pink salmon originating in northeastern Kamchatka.

Two pink salmon released at 43°25'N to 43°29'N and 166°26'E to 168°04'E on 1984 May 20 to 21 were recovered at Korfa Bay in 1984. They showed a southward extension of the known distribution limit (44°29'N, 177°30'E) of pink salmon originating in northeastern Kamchatka.

Additionally, fifteen U.S.S.R. coastal recoveries were obtained, which confirmed known findings.

Coho salmon

One coho salmon released at 58°28'N, 179°32'W in the Bering Sea on 1984 July 30 was recovered at the U.S.S.R. coast. This was an eastward extension of the known distribution limit (54°53'N, 171°13'E) of coho salmon in the Bering Sea originating in the U.S.S.R.

Additionally, five U.S.S.R. coastal recoveries were obtained, which confirmed known findings.

Steelhead trout

Two coastal recoveries of North American steelhead trout were obtained which confirmed known findings on steelhead distribution.

3. Additional information regarding distribution, origin, and oceanographic conditions

The catch data obtained by the research vessels with "C" nets in 1985 were examined. Since the research activities were only completed in August, the biological data are not yet compiled. Preliminary results obtained from the research data are:

Sockeye salmon

In June, CPUE of 1.0 or more (fish/tan--hereafter called the same) was observed in waters north of 46°N. Values in the North Pacific Ocean on the west side of Attu Island were high, but in the Bering Sea were generally low. In July, the main area of distribution of sockeye salmon which extended from east to west was observed to be on the south side of the Aleutian Islands and CPUEs in the Bering Sea were low.

Chum salmon

In June, CPUEs of 1.0 or more were widely observed in waters to the southeastern portion of the research area. In July, CPUEs were generally higher than in the previous month. In the Bering Sea, CPUEs in the northeastern portion of the research area showed a high trend, with highest value of 4.1.

Pink salmon

In May, CPUE of 1.0 or more of pink salmon was observed in waters north of 40°N in the research area within the Japanese 200 mile zone. CPUEs in waters south of 51°N in the Pacific Ocean in June were low in waters east of 170°E, and in contrast, were high in waters west of 170°E; highest was 12.0 in Area E5444. CPUEs in the Attu area were also high. Waters where CPUEs of 1.0 or more were observed in July were all limited to waters west of 167°E except on the south side of Attu Island. The highest CPUE value was 12.7 in Area E5544.

Coho salmon

In June, CPUEs of 0.5 or more were widely observed in waters in the southeastern portion of the research area. In July, the area of occurrence expanded further north than in the previous month. Main distribution was observed at 44° to 49°N and 166°E to 178°W and, in particular, CPUEs in Areas E6948 and E7047 showed high values over 3.0. CPUEs of 2.0 or more were also observed in the research area in August.

Chinook salmon

CPUEs of 0.01 or more were widely observed in waters east of 160°E in the research area in June. In July, the area of occurrence of chinook salmon expanded and areas where CPUE of 0.1 or more were observed were two areas in the Bering Sea and five areas in the Pacific Ocean.

Steelhead trout

In June, occurrence of steelhead trout was widely observed in waters in the southeastern portion of the research area. The area of occurrence in the central North Pacific Ocean was encompassed by 42° to 51°N and 169°E to 177°W. The highest CPUE value was 0.4 in Area E7748.

The distribution and seasonal abundance of the steelhead trout, *Salmo gairdneri*, and the Kamchatkan trout, *Salmo mykiss*, in the North Pacific Ocean were examined based on some biological data collected by Japanese research operations from 1972 through 1983. Operation data showed that the individuals identified as steelhead trout were distributed in the western waters of the North Pacific from spring to summer. However, some of the individuals might have been Kamchatkan trout because the two species are separable only by the difference in vertebral counts. Judging from the time of return and endemic range of the Kamchatkan trout, it is considered that most of individuals caught in the Okhotsk Sea and the western waters of the North Pacific were the Kamchatkan trout. Since females tend to occur predominantly in the western waters of the range in all months, it is suggested that there are significant differences in anadromy by sex between both species. The differentiation of mature and immature forms of the fish was estimated from the seasonal change in the gonad weight distribution. This indicated that high concentrations of immature fish occur widely in the central North Pacific in summer.

Genetic divergence between the steelhead trout and the Kamchatkan trout was also examined based on allelic frequencies at 37 genetic loci. As two major geographic units divided at the crest of the Cascade Mountains, namely coastal and inland populations of the steelhead are defined in North America based on the differences of allelic frequencies, in terms of genetic distance the coastal group of the steelhead trout in North America was closer to the Kamchatkan trout than to the inland group of steelhead trout. This finding as well as the fact that the two species are separable only by the difference in vertebral counts strongly indicates that the Kamchatkan trout and the steelhead trout should be recognized as a single species. Refuges for the Kamchatkan trout and the above two groups of the steelhead trout during the last glacial period and their postglacial dispersal are discussed based on their estimated divergence time.

Scale pattern analyses

(a) Chinook salmon

Analyses of scale patterns for immature chinook of age 1.2 caught in offshore areas in 1974 was made for stock identification. As standard groups, mature fish of age 1.3 caught in 1975 and mature fish of age 1.4 caught in 1976 were used. Since it was judged that the samples from the Kamchatka River and Bolshaya River provided by the U.S.S.R. were low in representativeness as an Asian standard group, samples of mature fish collected by Japanese research vessels in waters west of 165°E from May to July were added to the standard group. As the Japanese research vessels have not conducted research activities in the U.S.S.R. 200 mile zone since 1976, only samples collected prior to that time were used and the analysis conducted was restricted from that point of view.

A comparison of the results of analyses with those of Myers et al. (1984) shows the mixing proportion of the central Alaskan group greatly decreased in the Pacific Ocean side during June to July, and presence of a high proportion of Asian groups. There was good agreement that in the Bering Sea during June to July, the western Alaskan group was the most dominant. The estimated number of the Asian origin group caught in the mothership and landbased salmon fisheries was more than twice the value estimated by Myers et al. (1984).

However, the results of the analyses are preliminary and conclusions are not final for the following reasons: results of the analyses are easily influenced by the materials and methods that are not standardized, the recent Asian standard group is believed to lack adequate northeastern Kamchatka samples, and the proportion of fish samples when misclassification probability was limited to 10% or less was large. Since there are some reservations regarding analyses of scale pattern which classify samples of unknown origin by degree of similarity to standard samples, a comprehensive determination must be made taking into account also results from the other methods.

(b) Coho salmon

For analyses of scale pattern of coho salmon, data collected by Japanese research vessels in U.S.S.R. coastal areas in 1975 were used as the Asian standard group. According to the results of analyses, most of the coho distributed in the northwestern Pacific Ocean in 1975 were of Asian origin and North American origin fish were determined to be in waters east of 175°E and north of 50°N in July.

A comparison between these results and those of tagging during 1956 to 1984 showed many contradictions. For example, although no tagged fish from waters west of 175°E were recovered at North American coastal areas estimates of presence of North American origin groups as high as 10 to 30% were observed in the same area according to the results of the scale pattern analyses. When a doubtful region was established in order that misclassification probability be limited to 10% or less, the proportions of individuals which were placed in this category were extremely high (40 to 50%).

These facts indicate that it is difficult to determine continent of origin only from results of scale pattern analyses and results obtained should be carefully considered.

(c) Chum salmon

Analyses of scale patterns of chum salmon were continued. The results using Cook's method and the linear discriminant function method were compared using five characters adopted in a previous report (Ishida et al. 1984). The accuracy of classifications for standard groups was much the same, but results from these two methods for offshore samples were substantially different by area. In the classification of offshore samples, it is considered that analytical methods of high discriminant accuracy in standard samples do not always give a stable estimation for standard groups.

Secondly, offshore scale samples collected by Japanese research vessels in waters west of 160°E during May to June and determined to be of U.S.S.R. origin from tag recoveries and scale samples from coastal and river areas provided by the U.S.S.R. were compared. The results showed that two counted characters (number of circuli in the first year zone and second year zone) gave more effective classifications in scale pattern analysis than the two measured weighted characters (width of the first year zone and second year zone).

Finally, the comparison of results from discriminant function results using two characters selected as most effective with the discriminant functions results for offshore samples using the original five characters, shows a decrease in individuals classified as of American origin, but an increase in individuals classified as of U.S.S.R. and Japanese origin in many areas.

The results of analysis of offshore samples varied substantially by analytical methods and characteristics, thus it is necessary to take account of such instability when interpreting discriminant function estimates. It is necessary from now on, therefore, to confirm by other analytical methods whether or not the results obtained by the scale pattern analyses are appropriate.

Immature Sockeye

Catch and biological data on immature sockeye salmon caught by "C" nets on the south side of the Aleutian Islands during the period 1985 July 3 to 15 was analyzed. This was a continuation of research which has been conducted each year since 1971 to monitor relative abundance and age composition of immature sockeye salmon. The arithmetic mean CPUE in 1985 for ocean age 1-year fish was 0.82 and for ocean age 2-year fish was 0.39.

Estimation of catch efficiency

In estimating the catch efficiency of salmon gillnets, the following two points were assumed for parallel net operations (Ishida 1984)--(1) the swimming direction of salmon is at right angles to the gillnet, and (2) the fishing range of a gillnet is defined by the length of the net, the moving speed of salmon, and the net-soaking time. However, when these assumptions are not completely fulfilled, errors in estimating the fishing efficiency seem to be unavoidable. Therefore, in order to solve the problems, for assumption (1), two sets of right angle gillnet operations were conducted and for assumption (2), three sets of parallel gillnet operations were conducted.

The direction of entanglement of salmon estimated with the right angle gillnet experiments in the Bering Sea during June to July varied by species and station. In the average for all stations, the entangled direction towards 340° was most frequent for sockeye, chum, and pink salmon, followed by 70% for sockeye and 250° for chum salmon. Entanglement in the direction of 160° was least for the three species.

The values for the sum(s) of CPUE for four directions divided by the sums of CPUE for 340° and 160° directions were 1.78 for sockeye salmon, 1.77 for chum salmon, and 1.53 for pink salmon.

The average value of fishing efficiency estimated from three sets of parallel gillnet experiments was 0.674 for sockeye, 0.403 for chum, and 0.691 for pink salmon. The migration distance of salmon (Vt) was 4.279, 6.028, and 13.753 km, respectively.

In this model it was possible to estimate the migration distance (Vt) of salmon directly, but in the previous report (Ishida 1984), the migration distance obtained as the product (V.t) of the migration speed (V) and the operation time (t), and the value of V was estimated from tag recovery data. Judging from V.t values obtained in this study, the estimated values of t or V in the previous report were possibly overestimated.

The conversion coefficient (Q) in the relationship between CPUE and density of fish schools obtained using the above correction coefficients of CPUE (S), catch efficiency, migration distance, and the length per tan of gillnet, was 12.34 for sockeye, 14.57 for chum, and 3.22 for pink salmon. From now, consideration of the accuracy of these coefficients and examination of the estimated population numbers are needed. The results of the particular experiments described here are preliminary and should not be cited.

Oceanographic conditions

Oceanographic conditions in the northwestern Pacific in the summer of 1985 were reviewed. The southward and eastern extension of Western Subarctic Water were somewhat weaker than in average years. The westward extension of the Alaskan Stream was somewhat stronger than in average years. Surface water temperature was lower than usual. In particular, the increase in water temperature was small from June to July and surface water temperatures in July were lower than those in average years throughout the northwestern Pacific Ocean.

FIG. 1 IS IN ENGLISH IN THE JAPANESE DOCUMENT