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21. SALMON RANCHING IN OREGON

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RÉSUMÉ

L'Etat d'Oregon a délivré des permis à douze firmes privées pour relâcher 180 millions de juvéniles de saumon Coho, Chinook et Chum dans le cadre d'opérations de sea ranching. En ajoutant les lâchers des écloseries d'Etat, la production totale future doit atteindre 258 millions. En 1978, cette production a été de 84 millions de juvéniles de saumon. Actuellement, l'Oregon contribue pour environ 3 % au nombre de juvéniles de saumon produits artificiellement et relâchés dans l'Océan Pacifique Nord. On pense que l'augmentation de l'activité de sea ranching en Oregon va de pair avec l'augmentation dans d'autres états ou pays, et les plans de l'Oregon pour le futur sont de se maintenir à une participation d'environ 3 % de la production. Les captures de saumons Coho et Chinook ont tendance à augmenter en Amérique du Nord grâce à la production des écloseries qui est en pleine expansion. La production de saumons Chum en écloserie connaît également une expansion rapide mais il est encore trop tôt pour affirmer son impact bénéfique sur la récolte. Les règlementations régissant la production de saumons en écloserie varient selon les juridictions des états. Quelques états ont limité le droit de production de juvéniles de repeuplement aux écloseries publiques. La législation la plus libérale a été choisie par l'Oregon pour favoriser le sea ranching du saumon par des entreprises privées.

The Oregon Legislature passed a law in 1971 authorizing private salmon ranching firms to release chum salmon. The law was amended in 1973 to add coho and chinook salmon.

Twenty permits have been issued to private salmon ranching firms in Oregon for release of juvenile salmon into the North Pacific Ocean. Locations of authorized release sites are shown on Figure 1. Numbers of smolts authorized for release include :

Chum salmon	100 million
Coho salmon	38 million
Chinook salmon	42 million
	180 million

The number of salmon released by private firms has remained modest (Figure 2). Release numbers are expected to remain below authorized levels for a number of years due primarily to scarcity of brood stock.

Growth of private salmon ranching comes at a time when smolt releases from Oregon public hatcheries have tended to level off. Present smolt releases and outlook for increased releases from public hatcheries are summarized below :

Millions of Smolts from Public Hatcheries

Species	Present	Outlook
Chum	4	4
Coho	15	16
Chinook	53	58
	72	78

Should private salmon ranching achieve authorized levels, about two-thirds of salmon smolts from Oregon hatcheries would come from the private sector and one-third from the public sector in future years. Regardless of the origin of smolts, all fish remain a public resource available for harvest by commercial and recreational fishermen while in public waters. Private hatcheries are required by regulation to release fish directly into estuaries or the ocean, thus returning fish do not make significant contributions to river fisheries.

COHO SALMON

Unpublished data suggest that about 80 percent of coho salmon caught by American sport and commercial fishermen off the Pacific Northwest originate from hatcheries. Recovery of tagged coho salmon smolts released into Yaquina Bay, Oregon, by a private firm shows that returning adults were caught by commercial and recreational fishermen off California, Oregon, Washington, and British Columbia (Figure 4). To date returning adults were most abundant off the central Oregon coast near Yaquina Bay. The total contribution of these fish to commercial and recreational fisheries is under evaluation by fisheries agencies. Preliminary comparisons of tagged fish from private and public hatcheries indicate similar contribution rates.

There was a six-fold increase (14 to 88 million) in the number of coho smolts released from Pacific Northwest hatcheries over the period 1960 to 1977. The harvest of coho salmon by commercial and sport fisheries increased substantially during the same period (Figure 5). The commercial harvest of coho salmon in the Pacific Northwest in 50 % higher today than in the 1930s, when wild stocks contributed most of the fish caught. Upward trend of commercial harvest of coho in the Pacific Northwest is in sharp contrast to the downward trend in Alaska, where the fishery is supported by wild rather than hatchery stocks. Even though the Canadian harvest is buffered by large numbers of fish from Pacific Northwest hatcheries, their commercial catch is also trending downward, probably from loss of wild stocks.

Continued growth of the Oregon private hatchery program to the presently authorized level of 38 million coho smolts would increase by about 40 % the number of hatchery smolt released in 1977 by the United States and Canada. These additional smolts should contribute substantially to continued growth of public ocean fisheries (sport and commercial) primarily in the offshore waters of Oregon, Washington, and California.

CHINOOK SALMON

Public hatcheries in California, Oregon, Idaho, Washington, British Columbia, and Alaska released 217 million juvenile chinook salmon in 1977. Due to large scale releases from public hatcheries, the commercial harvest of chinook salmon in North America is higher today than historically. Catch statistics indicate that Canada has benefited most from increased commercial catches (Figure 6), even though 97 % of hatchery fish come from hatcheries in California, Oregon and Washington.

Oregon private hatcheries have been authorized to release 42 million chinook smolts. Attainment of this authorized level would increase by about 20 % the number of hatchery smolts released in 1977 by the U.S. and Canada. Recapture of tagged chinook indicates that commercial and sport fishermen from California to Alaska will benefit.

Projected growth of salmon ranching in Oregon is symptomatic of growth else-where around the North Pacific rim. Approximately 2.8 million juvenile salmon were released in 1978

from hatcheries in Japan, USSR, Canada, and USA. Smolts from Oregon public and private hatcheries accounted for about 3 % of these releases. The outlook is for releases from North Pacific rim countries to more than triple by 2000, which is comparable to the outlook for Oregon. It appears, therefore, that Oregon's share should remain at about 3 % of the total, even with continued growth of private hatchery releases to levels now authorized (Figure 3).

CHUM SALMON

It has been more than 30 years since chum salmon have made a significant contribution to Oregon's economy (Figure 7). Scarcity of fish helped trigger complete closure of commercial net fishing for chum salmon south of the Columbia River in 1962. Private hatcheries were first authorized to release chum salmon in 1971, but scarcity of eggs has impaired efforts to re-establish runs. Increased releases in 1979 (Figure 2) are due primarily to transplantation of chum salmon from Sakhalin Island, USSR, to Oregon.

Chum salmon contribute almost 30 % of the poundage of salmon harvested commercially in the North Pacific Ocean. Chum salmon are grown successfully in hatcheries, mostly in Japan and the USSR. A successful chum salmon hatchery program would create new opportunities for economic growth in Oregon.

DISCUSSION

Public hatcheries in Oregon released 72 million juvenile salmon in 1978. Projected additions to the public hatchery program are expected to boost production to 78 million, for a modest 8 % increase over the next several years. However, implementation of the planned private hatchery program would add 180 million smolts and would boost combined output from public and private hatcheries in Oregon to 258 million - a 358 % increase over 1978 production. This large projected increase has raised a number of questions, some of which are addressed below :

1. *Capacity of marine waters to grow salmon.* The catch of coho and chinook salmon in North America is somewhat above historic levels, even though natural production remains depressed from land and water use activities and overfishing. There is no conclusive evidence of density-dependent growth and/or mortality from limited analyses to date associated with observed levels of recruitment of hatchery smolts to marine waters. Capacity of marine waters to grow salmon is affected by climate, food organisms, and predators. Intensive fishing has reduced abundance of competitors, and ocean-rearing capacity is probably much above present stocking rates of salmon.

2. *Competition with other species.* Salmon are carnivores and feed at the same level in the food chain as most marine fin fish and many shellfish. The biomass of potential fin fish competitors of salmon is probably more than 10 times greater than the biomass of salmon and could be more than 20 times greater. It is unlikely that the impact of hatchery smolts on competitors could be measured at present levels of production with existing natural variability in abundance of competitor species and food organisms. It is variability in abundance of competitor species and food organisms. It is difficult to predict if a three - to four - fold increase in smolt production will provide a basis to measure effects of competition with other species.

3. *Genetic effects on wild stocks.* When salmon are removed from their natural environment, spawned artificially, and raised in the controlled environment of a hatchery, they become exposed to new sets of environment experiences. The hatchery environment minimizes many of the stresses which greatly reduce egg-to-fry survival in nature, but the hatchery can impose other stresses (e.g., disease) which are not experienced to the same degree by wild fish under less crowded conditions. The genetic problem of greatest concern is whether or not the hatchery will cause loss of adaptive genetic variability which might affect the ability of fish to adapt to changing environmental conditions upon release. Even though this is largely an untested hypothesis, rules governing private hatchery operations empower fishery agencies to control practices which could affect genetic make-up of stocks.

4. *Economic impact on existing fisheries.* Recapture of tagged coho suggests that Oregon commercial and sport fisheries will benefit most from the private hatchery program, with significant benefits also accruing to Washington and California (see Figure 4). If one assumes an average 5 % marine survival for coho smolts from private hatcheries and a 70 % exploitation rate by combined commercial and sport ocean fisheries, the release of 38 million coho smolts by private firms in Oregon would add :

	1,330,000	coho caught by commercial and sport fishermen
+	570,000	coho caught by salmon ranchers
	1,900,000	coho contributed to the economy.

Exploitation rate by combined commercial and sport ocean fisheries has been higher than 70 % in recent years, but management agencies are attempting to reduce exploitation to levels which will minimize overfishing of wild fish. The harvest of coho in ocean fisheries off Oregon, northern California, and southern Washington has averaged about 2 million fish over the last 20 years. Implementation of the private hatchery program in Oregon shows promise of nearly doubling the harvest while providing an opportunity to reduce exploitation rate in order to conserve wild stocks.

Preliminary results of tagging indicate that chinook salmon released by private hatcheries in Oregon will have beneficial impacts on ocean commercial and sport fisheries similar to coho. However, smolts tagged at Oregon hatcheries and recaptured in ocean fisheries show that chinook are more widely distributed in public fisheries in British Columbia and Alaska than coho.

Chum salmon are not expected to benefit existing public fisheries to the same extent as coho and chinook. This is because chum tend to remain seaward from near-shore waters where fishing effort is cented more than coho and chinook.

5. *Protection of wild populations from overfishing.* Artificial propagation raises questions vital to conservation of wild populations of salmon, especially where naturally and artificially propagated fish intermingle in a common property fishery. Wild populations can typically withstand 50 to 70 % rate of exploitation. Artificially propagated populations, on the other hand, can withstand 90 to 95 % rate of exploitation. Thus, the fishery manager faces a dilemma : If on the one hand, a manager permits the common property fishery to remove hatchery fish surplus to the needs of reproduction, any intermingled wild populations will be overfished and rapidly depleted. If on the other hand, a manager holds down exploitation to conserve wild population, surplus hatchery fish will return for the benefit of terminal fisheries. Primary beneficiaries of terminal fisheries include sportsmen, Indians, commercial gillnet fishermen, and private hatcheries.

The problem of managing fisheries on mixed populations is very basic to the conservation of wild populations whether or not artificial propagation is practiced. Inability to resolve this problem is one important factor contributing to depletion of wild populations.

6. *Institutional arrangements for salmon ranching.* Institutional arrangements are undergoing rapid change. Much of the change is directed toward economic efficiency. An important question is whether or not fish returning to hatcheries can repay the cost of artificial propagation.

Salmon released into the ocean by private firms are a public resource while in public waters. They contribute to commercial and recreational fisheries the same as wild fish and public hatchery fish because fish from all three sources intermingle freely on ocean fishing grounds.

In such mixed stock fisheries, wild populations are much more vulnerable to overfishing than hatchery populations. This is because egg-to-smolt survival is relatively high in a hatchery and relatively low in a stream, thus producing several times more fish returning to a hatchery than to a natural stream per pair of spawners. Where fishery managers attempt to conserve wild stocks, there are typically resultant surpluses of fish returning to hatcheries. Such surpluses force a public hatchery system to enter the salmon market by selling fish or to dispose of them by some other means, such as transplanting hatchery fish to streams.

Private hatcheries offer an opportunity to utilize hatchery fish in a cost-effective fashion.

They relieve government of the necessity of harvesting and selling fish. They reduce the necessity for taxpayers to subsidize increased public hatchery programs. They free fishery management agencies of the burden of operating more costly salmon hatcheries. And, they allow fishery management agencies to concentrate their efforts on managing stocks and fisheries rather than on raising more fish.

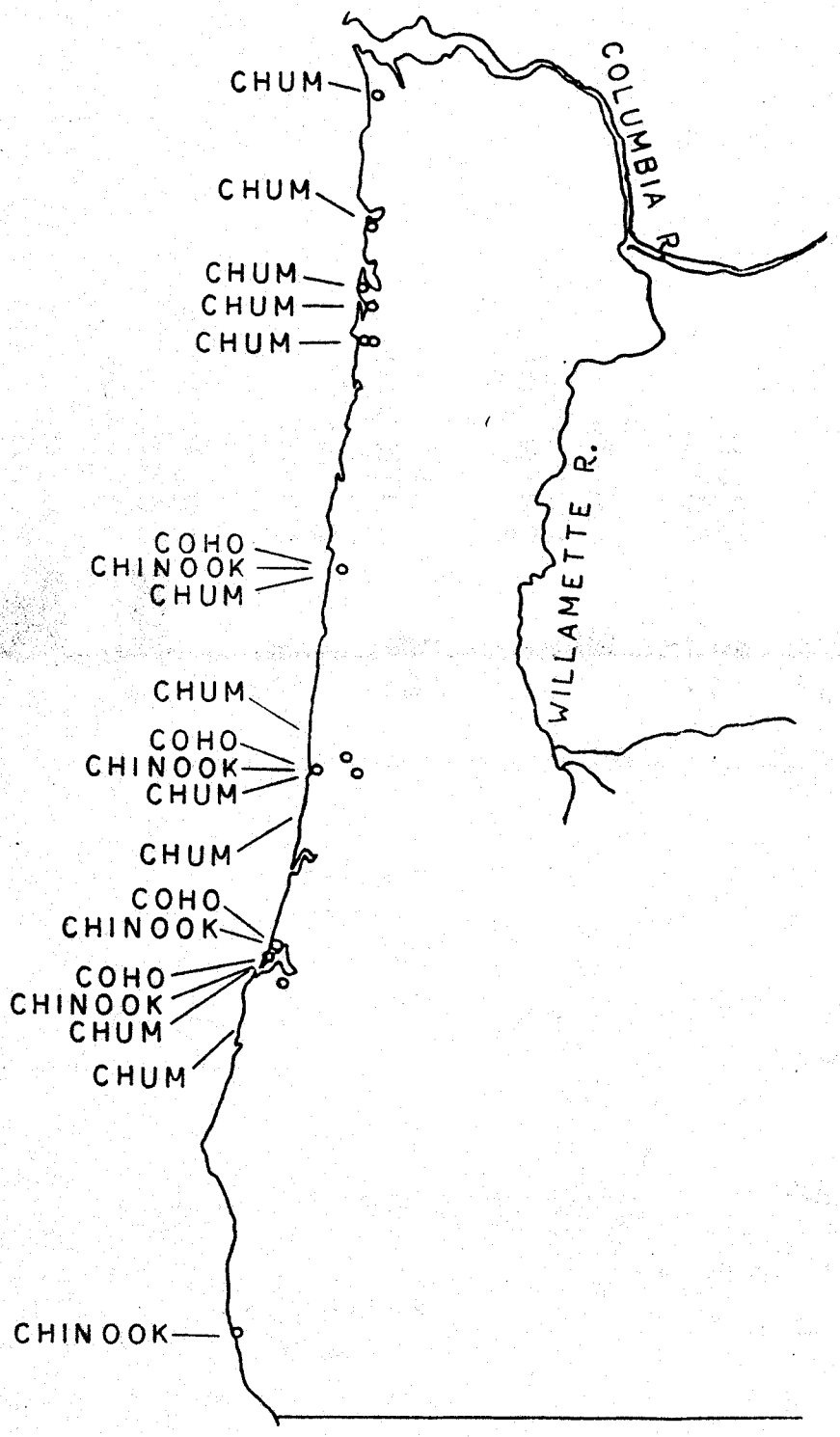

Fig. 1. Locations of authorized private salmon hatcheries in Oregon.

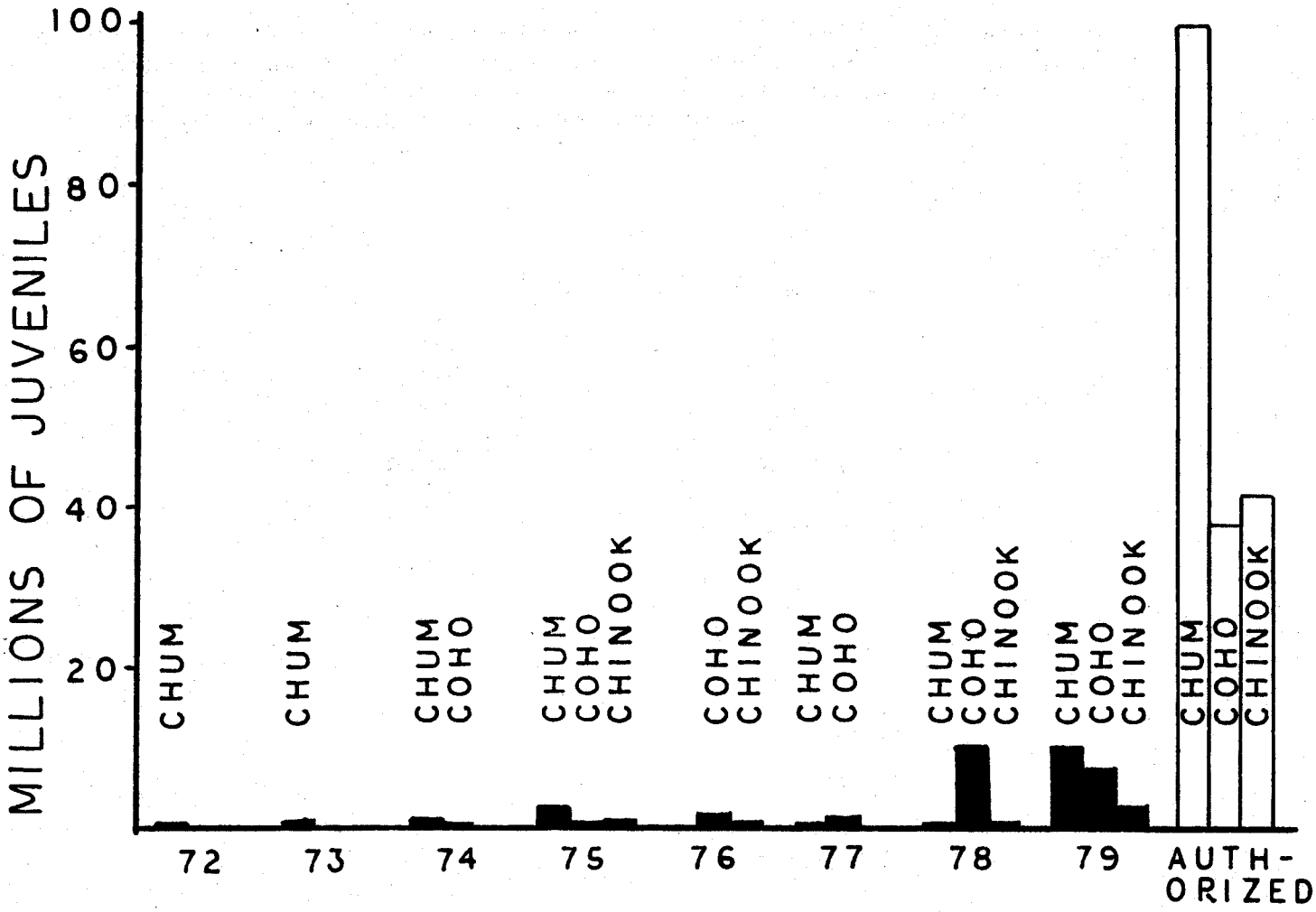

Fig. 2. Releases of chum, coho, and chinook smolts by private salmon ranching firms and authorized releases (1979 values are estimated).

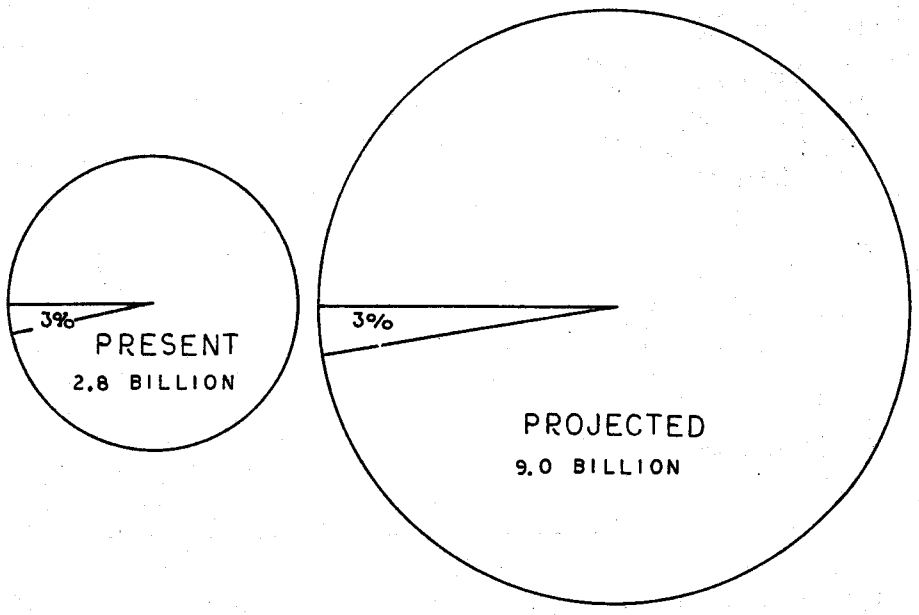

Fig. 3. Present and projected Oregon contribution to release of hatchery smolts into the North Pacific Ocean.

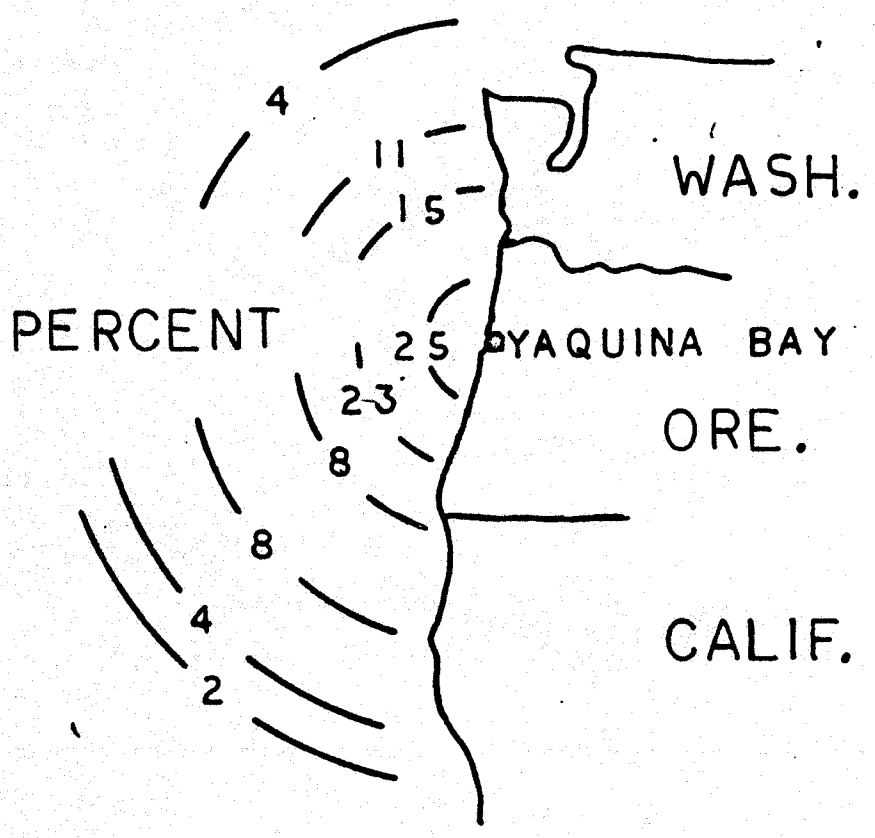

Fig. 4. Relative percentages of tagged coho salmon released into yaquina bay, Oregon, and recaptured by commercial and sport fishermen.

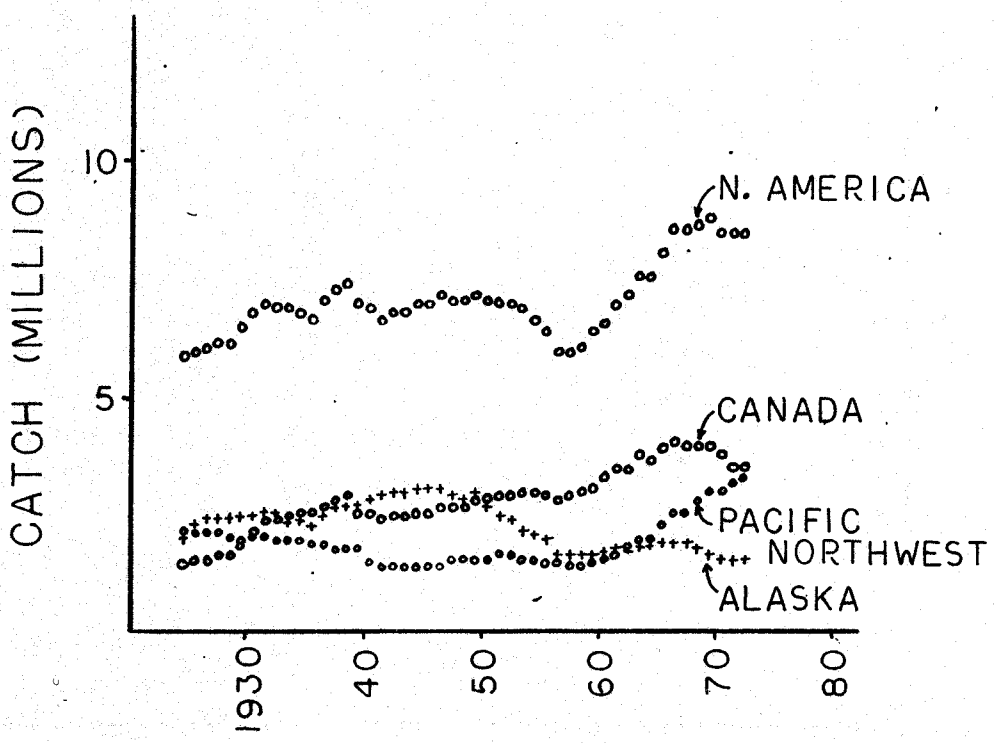

Fig. 5. Ten-year moving average of commercial catch of coho salmon.

Fig. 6. Ten-year moving average of commercial catch of chinook salmon

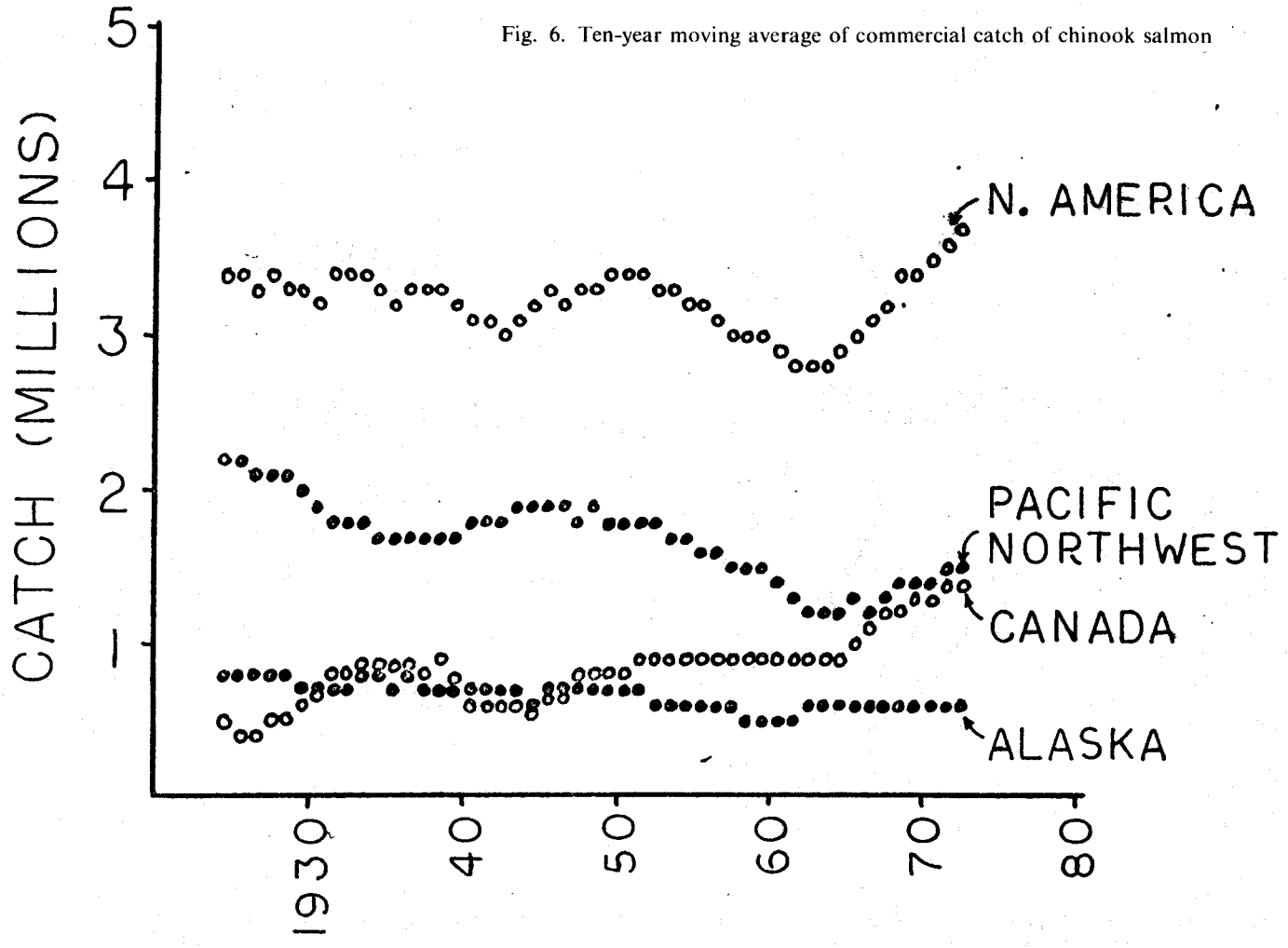

Fig. 7 . Ten-year moving average of catch of chum salmon in Oregon.