A PLAN FOR OREGON COHO SALMON

1. Background

Most of us agree we have a "coho problem." Generally stated, the problem is that our coho salmon populations have slumped to the level we had almost 20 years ago after an apparently successful hatchery program had increased them to a record high in 1976. There is no simple explanation for, or solution to, the coho production problem. If we want to obtain a permanent increase in coho abundance, we must develop an organized and well-founded-program to lead us there. That is why we need a plan.

A plan is like a map—it shows us how to get from one place to another. We are at a point of low coho abundance, and we want to get back to the level of abundance we enjoyed in the early 1970's.

Production is not Oregon's only coho problem. There are many other issues dealing with allocation, harvest, stocks, surplus fish, escapements, habitat, etc. (see 1A). Most of these are interrelated, and many are a part of the coho production problem. Although these are all important considerations in the development of Oregon's coho management plan, the coho production problem has been emphasized.

2. Symptoms of the Coho Production Problem

The most obvious symptoms of the coho problem are that abundance has been low, harvest opportunities have been reduced, and too few spawners have escaped to utilize natural production areas. This has limited recreational opportunities and has imposed economic hardships on fishermen and businesses which support and depend on the recreational and commercial trade.

How Has Abundance Been Affected?

Abundance of adult coho is measured by combining the catches made by fishermen with the escapement of fish back to the spawning grounds and hatcheries. It is difficult to count only Oregon coho in the catch and escapement because coho migrate widely, and Oregon stocks are mixed with stocks from our neighboring states when caught in the ocean and Columbia River. These stocks cannot be visually separated and counted. Furthermore, it is impossible to count all of the coho that enter Oregon tributaries and spawn naturally.

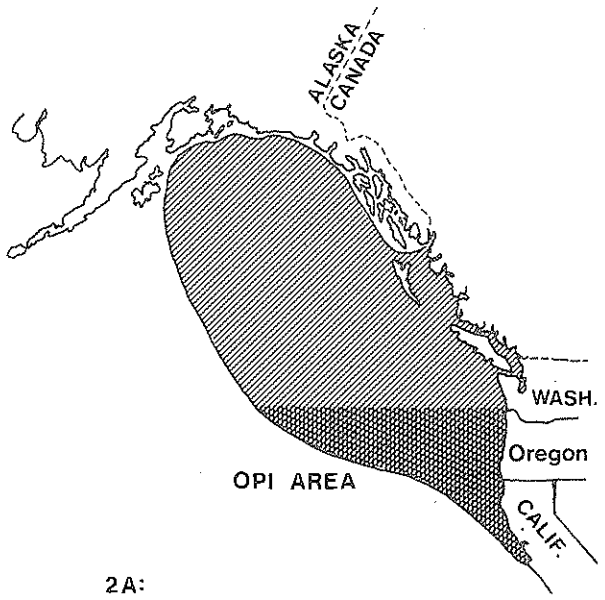
1A:

Management Problems

1. Production of jacks and adults leveled off during 1965-76 and declined in 1977-80 in spite of increased hatchery smolt releases in the OPI area.
2. Fisheries exploiting mixed stocks of salmon often overharvest wild stocks and underharvest hatchery stocks.
3. Spawning stocks of wild coho salmon in coastal watersheds are below optimum escapement levels for maximum production.
4. Stock size predictor needs improvement.
5. Data on the distribution and contribution of stocks in offshore fisheries are inadequate for efficient, effective management of wild and hatchery fish.
6. Survival of hatchery smolts needs improvement.
7. Losses of coho occur when they are caught or hooked but not retained (noncatch fishing mortality).
8. Hatchery coho can adversely impact wild coho and consequently total production.
9. Harvest estimates and the data gathering systems often are inadequate for effective fishery management.
10. Losses from predation reduce the abundance of coho salmon at successive stages in the life cycle.
11. The measurement of coho spawning populations needs improvement.
12. More adult coho salmon return to some hatcheries than are needed to provide eggs for reproduction.
13. Coho produced in Oregon and caught outside of state jurisdiction confound attempts to manage Oregon stocks for the optimum benefit of Oregon's citizens.
14. Wild coho salmon stocks in coastal streams need to be rehabilitated while maintaining genetic integrity and adequate escapement levels.
15. Underharvest of early returning hatchery coho stocks in the Columbia River is occurring.
16. Natural production of coho salmon stocks in lower Columbia River streams needs to be supplemented.
17. The number of commercial fishing vessels in use exceeds the number needed to most efficiently harvest the resource.
18. The proposed management boundaries for coastal coho stocks needs to be refined to help insure optimal production and utilization of wild and hatchery stocks.

Because it is difficult to obtain an accurate measure of Oregon-only coho, we have developed an index of coho abundance that we call the Oregon Production Index (OPI). It is made up of all the catches and that part of the escapement that is counted in a large area where Columbia River and Oregon coastal coho are predominant. This "OPI area" includes Oregon coastal tributaries, the Columbia River and its tributaries, and the ocean south of Ilwaco, Washington (see 2A).

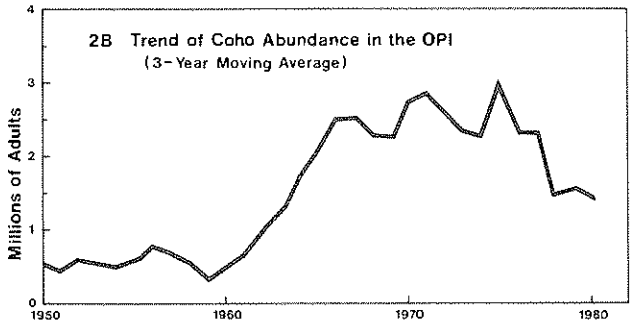
The abundance of Oregon coho, as measured by the OPI, shows a declining trend in the 1970's with very low levels occurring in recent years (see 2B).



2A:
Location of the OPI within the Distribution of Coho Salmon in the eastern Pacific Ocean.

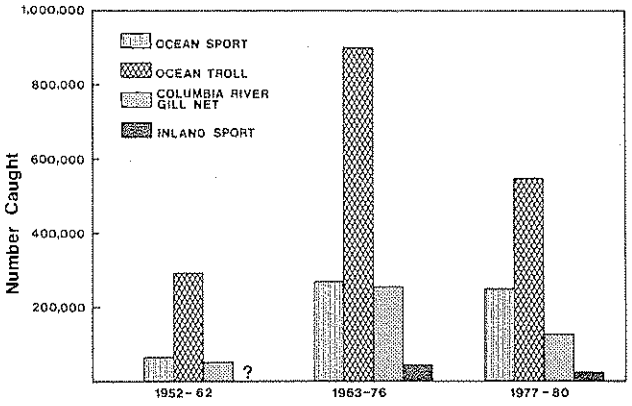
How Has Harvest Been Affected?

There is no question that recent total catches of coho by Oregon fishermen are substantially lower than in the preceding years. We can see this when we compare average catches made since 1976 by the ocean and inland fisheries with the "good old days" (see 2C). Catches in 1977-80 averaged only two-thirds as great as in 1963-76. However, if we compare the 1977-80 catch levels with an even earlier time period (1952-62), present catches are over twice as great. The same trends have generally occurred for all users in both the ocean and in freshwater.



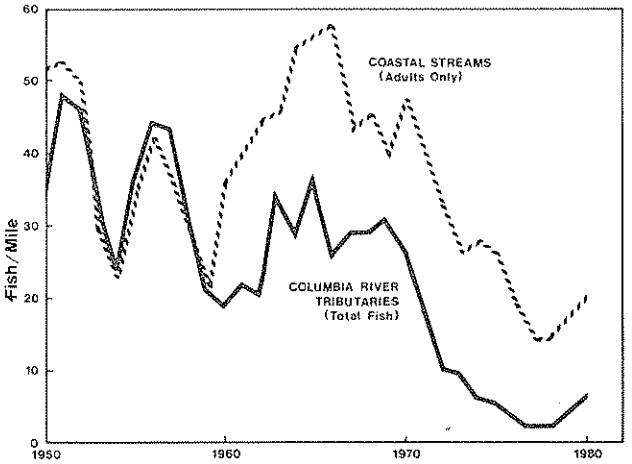
How Has Escapement Been Affected?

The escapement, consisting of coho getting past the sport and commercial fisheries, also shows a recent decline. This is especially true for the escapement of natural spawning stocks. We know this because Oregon biologists have walked established index areas on coastal and Columbia River streams and counted peak numbers of spawners for over 30 years. A continuing decline means that the number of adults returning to spawn is not adequate to replace their parents that spawned 3 years earlier.



2C: Average Yearly Catch of Coho Salmon by Oregon Fishermen.

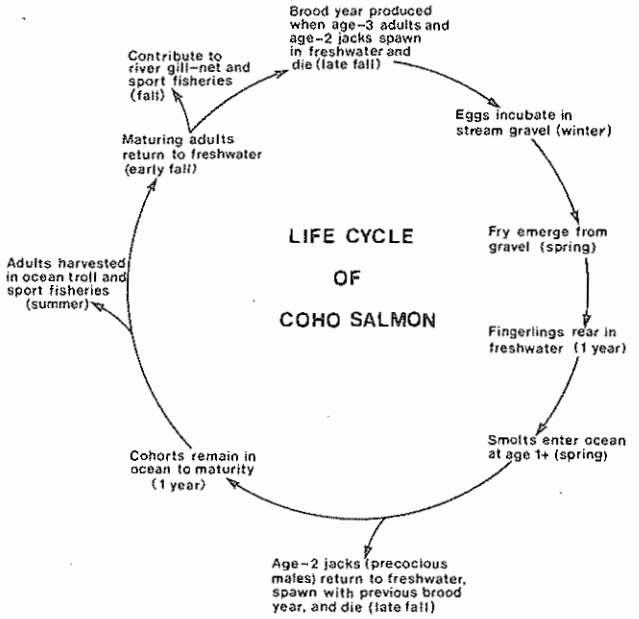
The numbers of coho counted in the index areas each year are shown in 2D. It appears that the number of spawners fluctuated with no apparent trend prior to 1965, except there is a noticeable period of recovery in both coastal and Columbia River areas during the 1960's. After about 1965, a decline in spawners is obvious with counts nosediving about 1970. The number of natural spawners in Columbia River tributaries since about 1960 is noticeably lower than spawners observed in coastal streams even though counts in both areas were similar during the 1950-60 period.



2D: Trends of Counts of Wild Coho Spawning in Oregon Coastal and Columbia River Index Streams, 1950-80.
(3-Year Running Average)

3. A Look at Some Information on Oregon's Coho Runs

Fishermen's catches generally depend on the abundance of coho and, in turn, abundance depends on the success of the coho's reproduction and survival. It is also true that the number of coho escaping for reproduction in any year depends on the rate that they are harvested. It is an endless cycle with the freshwater and marine environments also exerting their ever-present influence on survival (see 3A). The interrelationships of production, escapement, and the environment must be examined to increase our understanding of the coho production problem.



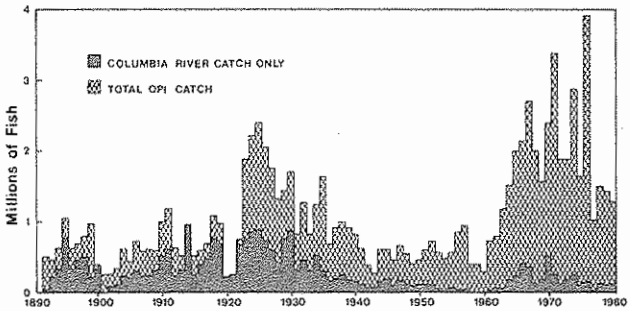
3A: Schematic diagram of the typical life cycle of coho salmon.

How Good Were the "Good Old Days"?

A study of estimated historical catches dating back to 1890 indicates that the number of coho probably never exceeded the level of the late 1960's and early 1970's. These records also strongly suggest that coho abundance has frequently bounced from high to low on a long-term cycle (see 3B).

Catch records are the best continuing indicators of the historical abundance of coho. We recognize that catches do not show the whole picture of abundance and we know that the accuracy of records decreases as we go back in time. Nonetheless, our thorough examination of historical records supports the contention that the early catches realistically represent general levels and trends of abundance.

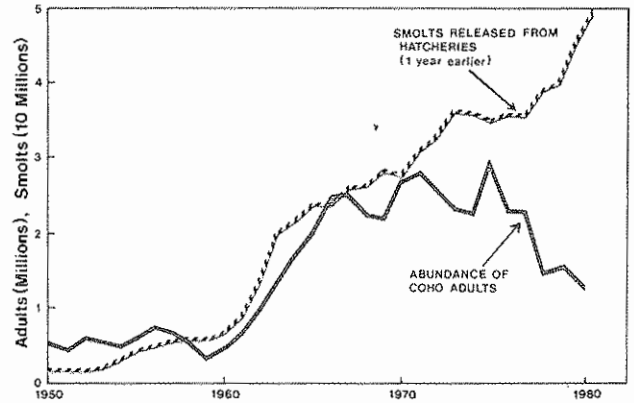
So what does this mean? It certainly points out that we have always had variations in coho abundance and that the low level we are now experiencing might be a part of a natural cycle. However, it does not tell us why it is happening or if abundance can be increased above present or historical levels. Catch trends have helped us define the problem better but give us few clues as to the solution.



3B: Numbers of coho salmon landed in the Oregon Production Index (OPI) area and Columbia River, 1890-1979.

Have Our Hatcheries Increased Coho Production?

Hatcheries have been one of the mainstays of our salmon program since the 1950's. They gained importance as we lost our freshwater environment. Furthermore, most of us have always believed that the vast ocean provides an almost limitless supply of food for salmon and all we needed to do to increase production was to turn more young fish loose. We have made great strides in improving our understanding of the life history of salmon and in rearing quality juveniles by providing better diets and by controlling diseases. Fish agencies of the Pacific Northwest increased their releases of smolts (seaward migrants) from hatcheries in the OPI area during the 1960's, and the number of smolts released appeared to strongly influence the abundance of adults in the OPI area (see 3C). Adult production appeared to reach a high plateau during the late 1960's and early 1970's. However, after 1976, even though the number of smolts released from hatcheries in the OPI area continued to increase, adult production began declining.



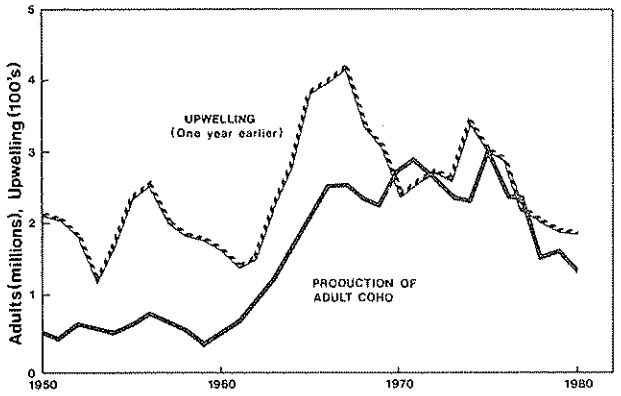
3C: Trends of Coho Abundance Compared with Smolts Released from Hatcheries (3-year moving average) in OPI Area.

How Has the Environment Affected Coho Production?

The freshwater environment has commonly been considered the principal factor limiting salmon production. Activities of man such as logging, gravel removal, water removal, road building, pollution, dams, etc., have all contributed to a well-documented loss of freshwater spawning and rearing areas. As a

result, our efforts to date have been concentrated on protecting and enhancing the aquatic and terrestrial habitat and in maintaining access to and from this habitat. We also recognize that natural environmental variations ranging between floods and droughts have a marked influence upon the survival of coho in freshwater.

We have not been as concerned with the effect of the ocean environment on survival of coho, although we know that this environment influences other populations of fish. Recently, we have found that ocean upwelling, or some factor related to upwelling, appears to have a strong influence upon the production of adult coho 1 year later (see 3D). Basically, upwelling is the movement of deep, nutrient-rich water to the surface. As this water is exposed to sunlight and warmed, increased food production results. Upwelling occurs off Oregon when strong northwest winds blow for extended periods. As shown in 3C and 3D, either or both upwelling and the release of increased numbers of hatchery smolts may have caused the upswing in production of adults in the late 1960's and early 1970's. It is also possible that lower upwelling levels in the 1950's and in the late 1970's may have been responsible for poor adult production.



3D: Trends of Adult Coho Production and Ocean Upwelling in the OPI Area (3-Year Moving Average).

Why Is Emphasis Always Placed on Managing the Harvest?

Our fisheries play a decisive role in the life cycle of coho salmon because the number of adults caught ultimately determines how many are left to spawn. Harvest rates are important because not all stocks of coho are harvested at the same rate by the fisheries. Individual stocks go to different places in the ocean from different locations in freshwater and thus are exposed to different fisheries, or to the same fisheries at different times or periods of time. Consequently, in the ocean and Columbia River where coho stocks are mixed, it is easy for one stock to become overfished while another remains strong.

Many fishermen are confused because our coho fisheries are being restricted even though excessive numbers of adults have returned to some hatcheries. Harvest rates are being reduced to protect wild coho because insufficient numbers are returning to utilize our natural spawning areas. In this instance the problem occurs because hatchery coho have a much higher early-life survival rate than wild fish. This is not really surprising because fertilization of eggs in our hatcheries is carefully controlled, the young live in a place that is to a large degree protected from predators and severe water conditions, and they have planned food and health care. About 80% survive until they are released to migrate to the ocean (see 3E).

3E: Potentials for coho survival under alternative incubation and rearing programs.

Type	Eggs	% to hatch	# hatch	% fry to smolt	# smolts	% smolt to adult	# adults	% egg to adult
Wild coho salmon natural spawning and rearing	2500[a]	3%[b] survival from egg to smolt. Average for 5 streams in Oregon and Washington (Wallis 1961, Moring & Lantz 1975)			75	7.5% most optimistic estimate from Minter Cr. (Salo & Bayliff 1958)	6	0.2
Egg box incubation, released as unfed fry	2500	75-80% for eyed eggs; 48% for green eggs (Dave Heckeroth *pers. comm.*)	1875	5%[c] Same as unfed fry releases (McIsaac 1977 Rothfus et. al. 1974)	94	7.5% Assumed same as wild	7	0.3
				10% Same as wild (Moring & Lantz 1975)	188	Same as above	14	0.6
Public hatchery presmolt released at 200/lb	2500	87.4% Files from several ODFW hatch.	2185	Range: 3-10% Assumed 7.5% (Hostick & McGie 1974; Salo & Bayliff 1958)	164	7.5% Assumed same as wild	12	0.5
Full term public hatchery yearling	2500	87.4 Files from several ODFW hatch.	2185	79.7% (Hublou & Jones 1970)	1741	2.53% (Garrison & Rosentreter-Peterson 1979)	44	1.76
						5.4%[d]	94	3.76

[a] Estimated average fecundity for Oregon coho (Moring & Lantz 1975).

[b] Freshwater survival is density dependent; high egg survival results in low fry to smolt survival. Therefore, freshwater survival is best expressed as egg to smolt survival.

[c] Survival of egg-box fry would probably range from 5% to 10%. Average survival would likely be on the low end of this range since egg-box fry don't undergo the selection process which wild fish undergo in the gravel. As with wild fish, density would also be a factor. Where eggs from hatchery stocks are used, survival would probably be around 5%.

[d] The range of data was 0.07-14.46% (ave. = 2.53% ave. of yearly maximums = 5.4%). Since this table presents potential survival rates the average of the yearly maximums is reasonable. The goal for hatchery smolt survival stated in the plan is 5.7% which is similar to the value presented here.

The young of wild coho do not have it as good. Most of the eggs are fertilized and buried in the gravel. Predators abound from time of spawning and the young must compete with each other and other species for food and a place to live. Perhaps only 3% live to migrate to the ocean. However, there is some compensation because only the hardiest and most aggressive survive. Still, studies show that one pair of hatchery spawners will result in many more offspring growing to adults than will a pair of wild spawners. As a result, we often see a return of adults to hatcheries in excess of reproduction needs while the escapement of wild adult coho is not adequate to replace the parent spawners. That very thing is happening with Oregon coho.

One reason why the problems associated with the harvest of mixed stocks of coho in the ocean have gotten fish managers' attention in recent years is that fishing pressure has increased. The apparent harvest rates by the ocean fisheries of the coho making up the OPI increased from about 75% in the early 1960's to about 90% in the mid-1970's. Actual harvest rates would be lower. Part of the increase in catch rate is due to more boats being attracted to the fishery as coho became more abundant. Part of it is due to fishermen becoming more knowledgeable about coho and their use of better fish-locating equipment. The recent decline in wild coho (see 2D) is due to a combination of increased harvest rates and poorer survival.

4. Diagnosis of the Coho Production Problem

What Has Happened Up to Now?

Soaring coho catches and larger returns of hatchery fish occurring with our expanded hatchery enhancement program in the 1960's generated much optimism. This in turn stimulated more fishing effort and plans for increased smolt releases. Abundance of adult coho began fluctuating after 1967 with no increase in the average level. In 1977 the coho population dropped to its lowest level since 1962, and it has remained low for 5 consecutive years. We are having another poor coho year in 1981, and preliminary information suggests we can expect another bad production year in 1982.

One of our greatest concerns is that the downward plunge of the coho populations occurred in spite of a large increase in the number of smolts released from hatcheries. The cause of this reduced adult production is not readily apparent because it could have been related to several factors. At the same time we saw the decline in our coho abundance, we also saw a drop in the number of wild spawners, an increase in fishing effort, and fluctuations in the ocean environment, in addition to the increase in the number of smolts released from hatcheries.

The survival rate of a brood of coho is apparently determined within a short time after the release of smolts from our hatcheries in the spring. We know this because the survival rate has already been determined when the jacks from those releases return in the fall. We know, too, that the ocean environment, as indicated by upwelling, plays an important part in influencing the changes in survival from year to year. We also know that some sort of limitation on total production of coho seems to be occurring. We do not know why, but we have some ideas.

What Could Be Causing the Production Problem?

Not all people agree where the problem occurs or why (see 4A). Some believe it is related to the Columbia River, its estuary, or its outflow into the ocean (Columbia plume). These are logical assumptions since Columbia River coho have been the dominant stocks in the OPI area. Others say that the decline in production may be related to disease, nutrition or genetic problems, and/or perhaps the overstocking of ponds at our hatcheries. Still others maintain that the loss of natural production has not been adequately offset by the release of additional hatchery smolts.

Any one of these explanations seems reasonable, but the decline in abundance of adult coho has occurred in both the Columbia River and Oregon coastal areas and for both wild and hatchery stocks. This casts doubt on the possibility of the problem being related only to the Columbia River or to either wild or hatchery stocks alone. The widespread nature of the problem also reduces the chances that it occurs in freshwater because it is not realistic that all freshwater areas would be affected by the same problem at the same time. Let's look briefly at two of the more popular and controversial theories about why our coho populations are depressed.

4A:

Possible Explanations For The Coho Production Problem

1. Due to quality of hatchery smolts
2. Related to loss of wild fish
3. Confined to Columbia River
4. Result of density-dependent mortality in freshwater or estuary
5. Natural variation with no density-dependent mortality
6. Result of density-dependent mortality in ocean
7. Due to difficulty of smolts entering ocean through an ideal environmental "window"
8. Some combination of the above

The problem may be due to natural variability. All wild animal populations vary in size from year to year. We see it in ducks, grouse, rabbits, deer, etc. The larger the population, the greater the fluctuation in number of animals in the population. If we had a population of 2,000 animals and it varied by 50% over or below that level, the population size would range between 1,000 and 3,000 animals. On the other hand if we had a population of 20 million animals and it varied by 50% either way, the population would range between 10 million and 30 million.

The fluctuation in numbers of adult coho between 1 million and 4 million may be the result of natural variations. Supporters of this theory say that our hatchery program has increased the average size of the total population. Therefore, large fluctuations in numbers (not percentage) are normal, and the present low level is simply the result of a poorer environment. If we look at the trends of coho abundance during the past 30 years (see 2B and 3B), the present low level is still higher than the previous low level of the 1950's. The evidence would indicate that this explanation is also reasonable.

The problem may be due to density-dependent mortality in the ocean. In simple terms this means that only so many animals or plants can grow in a specified amount of water or land. In other words the ocean has a limit to the number of coho that can live there as smolts. If this is true, then releasing more smolts will not result in any more adults; in fact, it could lower the survival rate of smolts and we could end up with fewer adults. Based on 3C, this could be happening.

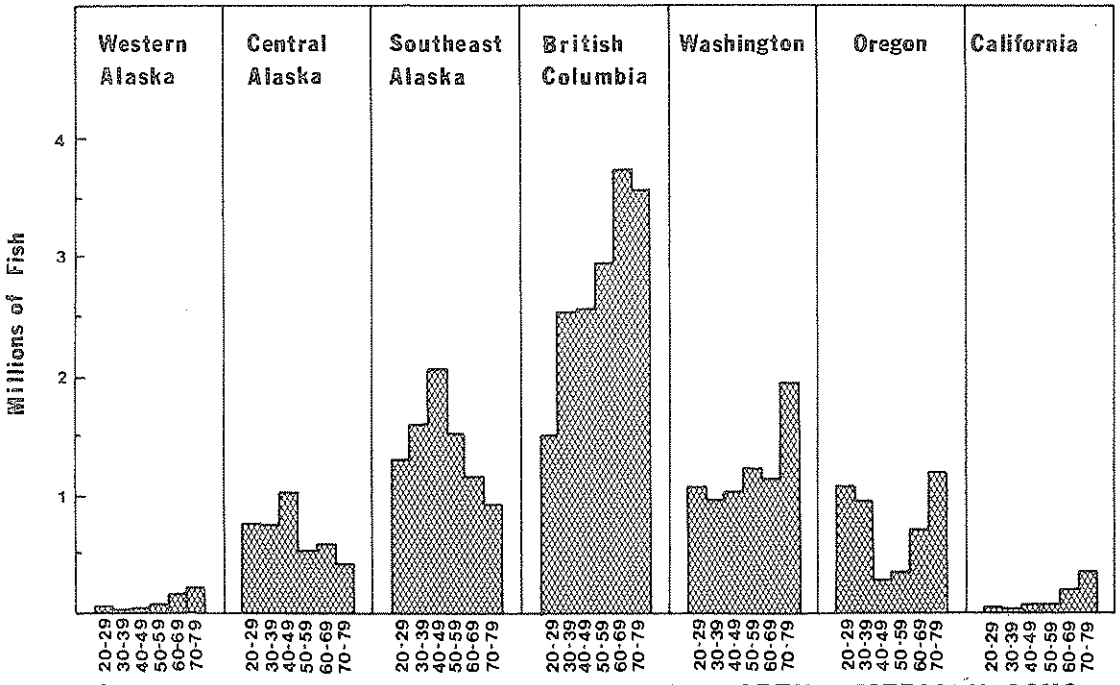
This idea is not new to any of us. Most of us accept that we can raise only so much corn in our garden or so many cows in our pasture. We also know that overcrowding winter ranges will use up the available food supply and lead to high losses in our deer and elk herds, especially in a severe winter.

It is hard to believe that there is not room for more coho in all that ocean. This is partly because we cannot visualize the ocean as we do our land. When we look at the land we see varied habitat—mountains, deserts, forests, plains, and fertile valleys. We do not expect to see antelope in the rain forests of our Coast Range or bluegills and bass in a high mountain lake. When we look at the ocean, we see only the surface. However, we do know, for example, that flatfishes live on a sandy bottom and tuna near the surface. Is it not reasonable that coho smolts also have a specific living area that is as limited as for any animal we can see on land?

How Does Oregon's Coho Habitat Compare With Other Areas?

Biologists recognize that the best conditions for survival of any critter is in the center of its range. Conditions for survival gradually get worse as the edge of the range is approached until conditions are intolerable and that species cannot survive. The freshwater distribution of coho is from Alaska to Monterey Bay, California. Practically speaking, there are very few coho south of northern California. Oregon is very near the southern end of the coho's freshwater range. Oregon is also near the southern end of the marine distribution of coho. This is best illustrated by the historical distribution of the commercial catch along the coast of North America (see 4B). Peak catches occur off British Columbia and always have for any of the time periods on record. Are we expecting too much from a species at the edge of its range?

There are other questions that can be asked re-



4B: AVERAGE ANNUAL COMMERCIAL CATCH OF NORTH AMERICAN COHO SALMON, BY REGION AND DECADE, 1920-29 TO 1970-77

garding the importance of Oregon's geographical location. Why do Columbia River and Oregon's north coast chinook turn right and migrate north? Why do south coast chinook turn left or stay off southern Oregon? Why do we find a southern distribution of maturing coho early in the season with a northward movement as they near their spawning time? Why don't salmon from other areas flock to Oregon's offshore area like they do to the British Columbia-Alaska and California waters? Is it because we do not have what they need off Oregon?

Our research staff has come up with some interesting information. Forage-type fishes have their greatest abundance north of Oregon (mostly herring and sandlance) with a smaller peak of abundance off California (mostly herring and anchovies and formerly sardines). This information is important because: (1) that is where our salmon go; (2) food studies show the larval forms of these fishes make up over half of the diet of coho smolts, and the adults of these species are a favorite food of adult salmon; and (3) the abundance of these fishes off California parallels the abundance of our coho. Could Oregon's geographical location be an important determinant of our future potential for coho?

How Do We Explain What Has Happened?

There are many possible explanations of the coho problem (see 4A). Although some explanations do not appear very likely, none were excluded as possible contributors. Neither could any single explanation be considered as the sole factor responsible for the coho decline. The problem is very likely the outcome of several factors decreasing survival and ultimately production of adults. What do you believe is responsible for the decline in coho abundance in recent years?

5. Selecting a Remedy

How do we go about preparing a plan for resolving a problem when we do not know the cause? Preparation of a plan for proper management of Oregon's coho salmon resource is contingent upon first establishing the policies and constraints necessary to guide its development. In addition to administrative guidelines which have been set forth by legislation, Commission policies and ODFW administrative directives, nine policies (see 5A) were established which will apply specifically to coho management.

We began preparing a plan by establishing six objectives (see 5B) necessary to reach our anadromous fish goal. These objectives can be divided into three primary areas of concern related to managing the resource: production, escapement, and harvest, including allocation (see 5C).

Next, we identified 18 major and, to various degrees, interrelated problems (see 1A) needing to be resolved to reach the six management objectives. This list of problems is not intended to be all inclusive. Several of the problems, and actions necessary to overcome the problems, will require the development of additional detailed management and research plans.

There are also several important concepts and philosophies which helped guide the development of the plan and which must be followed to assure that we achieve the greatest immediate and long-term benefits from our coho populations. We want to briefly review some of those which we know are of great importance to you and which are of utmost concern to us.

5A: Management Policies

1. Traditional fisheries will be maintained, but not necessarily in historical importance.
2. Fisheries will be managed to obtain optimum yield from the resource including quantity and value of food produced, fishing opportunity, and other social and aesthetic benefits.
3. The coho resource will be allocated based on escapement requirements, legal constraints, established user group shares, and other socioeconomic criteria.
4. When attempting to rehabilitate natural production, the agency will give equal consideration to harvest management, habitat improvement and protection, and to the use of some form of artificial propagation.
5. Coastal streams will be primarily managed to maximize natural production, and Columbia River tributaries will be primarily managed for hatchery production.
6. Available aquatic habitat will be managed to maximize fish production.
7. Hatchery production must increase adult abundance to be accepted as a viable management program.
8. Enhancement, rehabilitation, and supplementation of natural production must utilize only coho believed to be genetically compatible with existing regionally defined stocks.
9. Hatchery and wild stocks will be managed considering the need for genetic diversity.

The Importance of Individual Wild Stocks

The characteristics by which we identify various groups of animals have evolved through the process of natural selection until each group has become adapted to survive in a particular environment. For example, halibut do not run down their food. Instead, they live on sandy bottoms where they dig in for better concealment until their prey swims by. They lie on only one side, perhaps to become less visible, and their bodies have become flattened. Only the upper side is camouflaged and the bottom eye has migrated to the top side so they can see better. All of these specialized characteristics are for the most part genetically controlled.

5B:
Management Objectives

Objective 1
Achieve an annual average of 2.5 million adults in the OPI area consisting of 1.77 million hatchery and 0.73 million wild coho salmon.

Objective 2
Attempt to increase the average production of adult coho salmon in the OPI area beyond 2.5 million adults.

Objective 3
Achieve by 1987 an average annual escapement of 200,000 wild adult spawners in coastal rivers to optimize natural production.

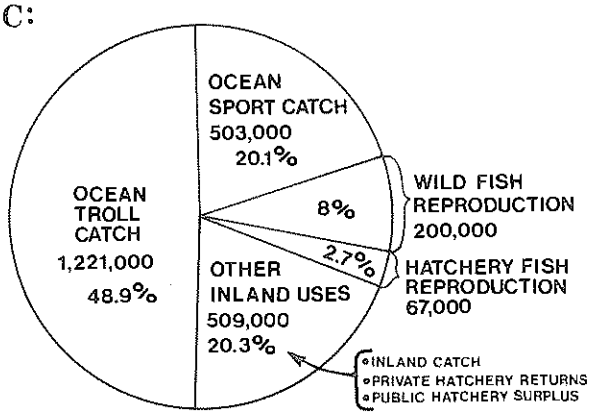
Objective 4
Maximize the utilization of coho returning to Columbia River and Oregon coastal public hatcheries.

Objective 5
Provide an opportunity to harvest an annual average of 2.2 million adults in the OPI area consisting of 1.67 million hatchery and 0.53 million wild coho salmon.

Objective 6
Allocate the annual harvest in the OPI area between the ocean and in-river fisheries based on an average ocean harvest rate of 69%. The average harvest sharing percentages through 1985 would be:

Ocean catch	78%
In-river catch (sport, gill-net and private hatchery returns)	22%

5C:



ALLOCATION OF OPI PRODUCTION OBJECTIVE OF 2,500,000 ADULT COHO.

Salmon also have evolved to utilize special environments. Most notable is that they reproduce in freshwater streams and migrate to the ocean to mature. Most of us are familiar with some of the more obvious differences between the species of salmon such as appearance, size, flesh quality, time of migration, feeding behavior, etc. Few of us recognize that equally important differences occur within a single species such as the coho. These differences are determined by the nature of their natal stream in freshwater and where they go in the ocean.

Groups of the same species spawning in the same areas at the same time that commonly interbreed are called stocks. Each stock has developed specialized characteristics in tune with its particular home stream because of another strong, genetically controlled instinct to return to that stream for generation after generation. It is important for us to recognize, too, that stocks also have characteristics in tune with their saltwater life. Some examples of stock characteristics are ability of those fish to live in the environment of their native stream, size and time at which juveniles enter saltwater, location of ocean nursery and feeding areas and the time they should be there, time that they should reenter freshwater, time of spawning, size of adults, disease resistance, and so on.

As an obvious example, we could not expect a coho whose ancestors spawned between December floods in a short, coastal stream to reproduce 500 miles up the Columbia River in a tributary choked with anchor ice in the winter and with a snow-pack runoff in May. Even if these obvious problems could be circumvented, most coastal coho stocks could not survive in the Columbia system because they have no natural immunity to the disease *Ceratomyxa shasta* as do the native fish of that system. While it is true that differences in stocks are not as important or as apparent in streams close to one another, it is the things we do not see or know about that can cause serious problems in transfers of fish from one place to another. Management boundaries proposed for Oregon coastal coho stocks are shown in 5D.

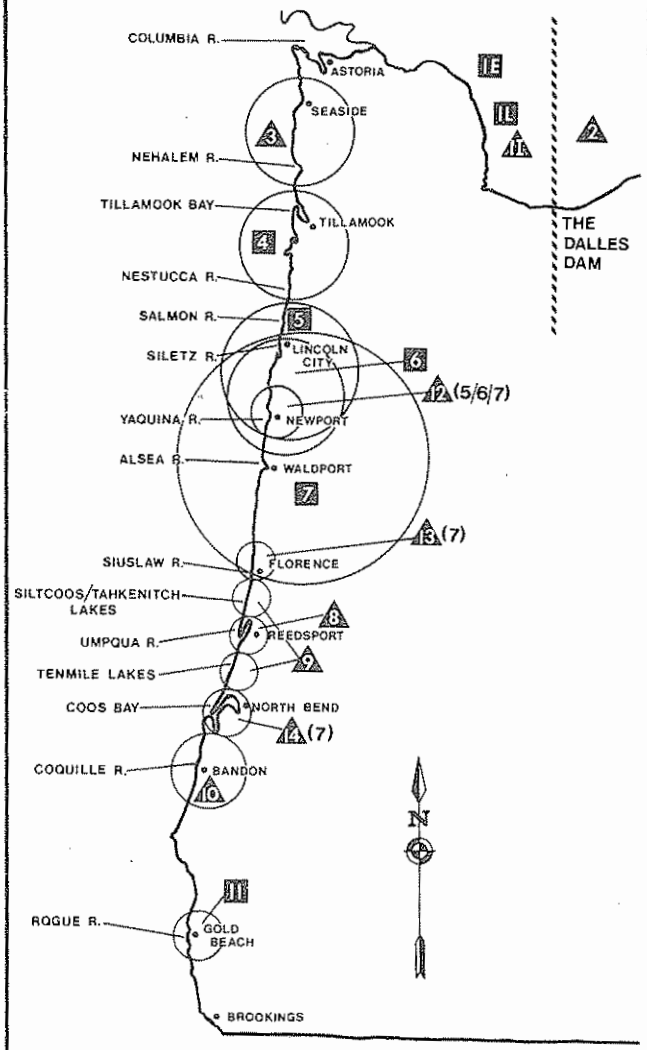
Our wild stocks of coho are extremely valuable to us for many reasons. Because mother nature has continually selected the best-suited individuals for each stream, that stock should survive better and produce more adults than any other stock we put in that stream. The danger we face in moving stocks around is that new fish we put in that stream will not survive as well or produce as many adults; and when the introduced stock interbreeds with the locally adapted stock, it could also lower survival of the native stock. Thus, stock transfers of wild or hatchery coho must be carefully controlled if production is to be optimized.

Our natural spawning stocks of coho are also important because they reproduce every 3 years at no additional expense to any of us. The fact that they are in our streams helps justify maintaining streamside vegetation, water quality, and general aesthetic beauty of Oregon's streams. Another important service is that they provide a genetic reserve for creating new hatchery stocks.

Getting the Greatest Benefit from the Resource

More is not always better. There is an optimum point where we get the most for our money. An Oregon corn farmer knows his yield will be "zilch" if he plants one seed per acre, but he also knows he will get "zilch" if he covers the ground an inch deep with seeds. He knows how many seeds he must plant and how far apart they need to be to get the most from his land. He will plant the right number of seeds each

5D:



1. Lower Columbia R. stocks
2. Upper Columbia R. stock
3. Nehalem R. stock (Fishhawk-2)
4. Trask R./Cedar Cr. (Nestucca R.) stock
5. Salmon R. stock
6. Siletz R. stock
7. Alsea R. stock
8. Smith R. stock
9. Tenmile Lake stock
10. Coquille R. stock
11. Rogue stock
12. Oregon Aqua Foods, Inc. (OAF) stock
13. Domsea stock
14. OAF/Anadromous, Inc., stock

Proposed hatchery stock management boundary goals. Stock numbers (1-11) refer to the preferred hatchery stock for release in a specific area. Stock preferences should be considered interim recommendations, in some cases, until genetic characterization and straying surveys are completed. Stock numbers (12-14) refer to developing private hatchery brood stocks which are a mixture of Oregon coastal and Puget Sound stocks. The numbers in parentheses represent interim recommendations for stocks to be interbred with the existing private hatchery brood stocks. Recommendations for private hatchery brood stocks are also subject to change based on surveys and evaluations in progress and development of alternate public hatchery brood stocks. Streams not contained by a boundary are to be managed primarily for chinook salmon and steelhead trout and are not recommended for stocking with coho salmon.

year, do what he can to give them the best chance for survival and growth, and hope for good weather. So it is with coho.

Coho salmon must have the right amount of food and space in their freshwater life. The young set up territories which they vigorously defend against intruders. The intruder is frequently forced to move on; therefore, a stream will raise only so many coho based on the amount of rearing area it contains. Spawning area is important to assure that enough young hatch to utilize the available rearing space. More eggs or young will buy us nothing if the stream is seeded to capacity.

The right number of young of the right stock will yield us the most fish to harvest as adults. Harvesting too many adults will result in underseeding our streams. Underharvesting the adults will not improve next year's run since we cannot stockpile fish in excess of the system's carrying capacity. Our biologists have estimated how many adults we believe should escape from the fisheries each year to get the greatest benefit from our resource on a continuing basis.

Coho Management Must Be Flexible

Fishery management is not easy, and it has become more difficult. Situations often arise where two or more policies appear inconsistent. An example is our apparently different management philosophy on wild stocks of coho in coastal as opposed to Columbia River tributaries. Our basic policy is that we will allow the fisheries to harvest coho only in excess of the number needed for reproduction in natural streams. The apparent inconsistency is that we are proposing to do this in coastal streams, but not necessarily in Columbia River tributaries. Why the difference? It is because we think it will give the wisest utilization of the resource.

Oregon coastal streams are the stronghold of Oregon's wild coho stocks, and public hatcheries play an important but relatively minor role. On the other hand, the production potential for wild fish is limited in the Columbia system; and at least 90% of the coho production is from hatcheries. If we regulate the fisheries to achieve proper harvest of wild stocks, adults in excess of brood stock needs will occur at public hatcheries. In the Columbia River the policy is to attempt to harvest the excess hatchery coho because their numbers greatly overshadow the wild stocks present.

This compromise lends itself to a fair allocation of coho to all of the fisheries. An average harvest rate of about 69% by the ocean fisheries would leave an escapement to natural spawning streams that is adequate for reproduction and harvest by the small sport fisheries those streams now support.

Private hatcheries would have sufficient fish returning to them to continue to operate and consequently augment the numbers of fish available for harvest in the ocean in the future. Surpluses at coastal public hatcheries would be available for appropriate off-station stocking programs on underutilized streams. The commercial gill-net fishery on the Columbia River would receive a share by being

allowed to crop the surplus destined for public hatcheries in that system. This would result in overcropping wild stocks present at the time the gill-net fisheries occurred in the Columbia system; however, we would attempt to maintain some level of natural production by a continuing program of augmenting these streams with hatchery fish. Some wild stocks that enter the river after October would avoid excessive fishing effort and should maintain themselves.

6. Recommendations

There are many actions necessary to attain the objectives and overcome the problems identified in the coho plan (see 6A). The actions required by the plan can be categorized as those needed to increase coho production, to improve harvest management, to improve the data base needed for management decisions, and to complete and implement the plan.

Actions to Increase Coho Production

The present low level of abundance of adult coho may be due to any one or more of several possible causes which we believe are affecting the survival of smolts during their first months after leaving freshwater nurseries. We believe that if we are to realize any permanent increase in numbers and reduce some of the fluctuation in stock size of adult coho, under the variable ocean conditions we expect to continue, we must broaden our production base and improve the chances for our wild and hatchery coho to survive. We think that the above can be achieved in three ways: restore and optimize our natural production, improve the quality of our hatchery production, and diversify our hatchery production. We believe that this approach has the best chance of permanently increasing the numbers of coho available for harvest regardless of the reason for the decline.

Restore Our Natural Production. The use of our streams for producing coho is a renewable benefit we can count on only if we use our land, water, and fish resources wisely. We recommend increasing the number of coho from natural production by taking the following actions:

1. **Rehabilitate our wild stocks.** We can restore production of our wild stocks to the optimum level by increasing the escapement of adults and by artificially assisting the populations already present. Artificial assistance can be provided by installing egg boxes and by releasing presmolts, smolts, and adults of the native or **suitable** donor stock (see 5D). In this program we must be careful not to introduce genetic characteristics with our donor stock or increase competition that could threaten the existing stocks or reduce the overall survival rates. Artificial assistance should be given only in those streams that are underutilized and only as long as necessary to restore natural production. The STEP program will be the cornerstone of this effort.

2. **Maintain and restore our habitat.** Our wild populations depend on good habitat. Not only must we protect what we have, we need to improve it and create new habitat to the degree possible. The STEP program will play a major role in habitat improvement work. ODFW biologists will continue to develop cooperative programs with other land and water management agencies and with private landowners.

6A: Specific Actions

The following is a summary of some of the more important specific actions required to achieve the objectives of the plan and resolve the major problems:

1. Develop a more reliable measure of spawning escapement of wild stocks in coastal watersheds.
2. Determine the optimal levels of smolt releases in the OPI area.
3. Reduce the exploitation rate in ocean fisheries to a maximum of about 69% (77% of the OPI), unless higher or lower rates are found to be needed to meet optimum spawning escapements for wild adults.
4. Develop smolt production goals for each major water course within a river system.
5. Improve in-season management capabilities.
6. Continue to improve and maintain fish habitat and passage at barriers.
7. Develop a plan for and initiate a rehabilitation program for coastal coho salmon.
8. Improve distribution and contribution information for major wild and hatchery stocks.
9. Develop a plan for and initiate a program for diversifying and developing hatchery brood stocks.
10. Develop and initiate management strategies for using hatchery stocks.
11. Continue to measure ratio of wild and hatchery fish in ocean fisheries.
12. Develop and follow annual allocation goals.
13. Expand educational programs and seek broader public input on all aspects of coho salmon management.
14. Design and conduct experiments to identify and circumvent cause of mortality of smolts in ocean.
15. Continue to improve quality of hatchery smolts.
16. Continue to improve accuracy of forecast of coho salmon in OPI area.
17. Improve count of hatchery coho returning to spawn.
18. Supplement natural production of coho in lower Columbia River tributaries.
19. Continue to refine stock-recruitment relationship for wild coastal coho.
20. Refine stock characteristics information to determine management units of stocks for assessment, production, and stock transfer purposes.

3. **Increase the escapement of adults to our natural spawning areas.** The greatest survival of smolts to adults from any given stream will be from local adapted stocks. Harvest rates must be reduced and maintained at the level necessary for the optimum numbers of wild adults to spawn in most of our coastal streams.

Improve the Quality of Hatchery Production. Our department has one of the most progressive hatchery programs on the Pacific coast. Only Washington releases more coho from hatcheries. In spite of that, fish health and nutrition continue to be problems because of difficult-to-treat diseases and a decline in the quality of fish food ingredients. We must continue our fish disease and nutrition programs. In addition, we must be more innovative in our fish production techniques. Hatchery practices must be made more flexible to accommodate a greater diversity in the stocks of fish used. A more diverse set of migration or behavioral characteristics in our hatchery stocks may improve their chance of surviving.

Diversify the Release of Coho from Our Hatcheries. One of our major concerns is the poor survival of smolts following their release from hatcheries. Juvenile coho released in large numbers from hatcheries prior to smolting are known to compete with wild coho and other species for food and rearing space in freshwater, unless the stream is underutilized. Large numbers of hatchery smolts could compete with wild smolts or other hatchery smolts in the estuary or ocean nursery areas since all stocks migrate to the ocean at or near the same time. Little data are available on the early life history of salmon smolts after they enter saltwater. Until these data are available from research, techniques for improving survival must be based on factors affecting their freshwater life and causing variations in their survival to adults.

We propose to diversify hatchery production using techniques which will change smolt releases in four basic ways: numbers, time, area, and stocks.

1. **Numbers.** Of the possible factors affecting smolt survival, one of the most controversial is the number of juvenile coho salmon released from hatcheries. Scientists generally agree that there is a biological limit to the number of coho smolts that can survive and rear in the ocean. The controversy involves whether or not the present level of smolt releases has already exceeded the capacity of the ocean nurseries for juvenile coho salmon in the OPI area. We do know that releasing more smolts in recent years has not increased production of adults. However, we cannot say that the increased releases have not helped to maintain production during a period of relatively poor conditions in the ocean for juvenile coho survival. The most important consideration at this time is to increase adult production and information on factors affecting smolt survival without increasing the chances of further depressing the resource and reducing the harvest.

We considered three basic alternate strategies for the number of smolts to be released in the future: (1) Some scientists believe that maintaining smolt releases at the 1977-80 level (43-48 million) until after environmental conditions have improved will show if carrying capacity has been exceeded without increasing the risk of further depleting the resource or wasting scarce dollars. (2) Others believe that decreasing smolt releases to the level where best production occurred (25-35 million) would reduce the

risk of depressing adult production if too many smolts are already being released. This approach might be less expedient in providing information on carrying capacity. (3) The final alternative would be to continue to increase the number of smolts released above the present production level. Scientists generally agree that this is the fastest way of determining if a "carrying capacity" problem exists in the nearshore ocean, but this alternative maximizes the risk of depressing adult production of wild and hatchery coho and harvest opportunity even further if too many smolts are already being released.

The department recommends that smolt releases be held at the 43-48 million level beginning in 1982 for at least 3 years with the release program to be evaluated annually. If this option is selected it can only be implemented with the cooperation of other governmental agencies and private hatchery operators.

Hatcheries have tended to propagate large numbers of coho smolts from a small number of stocks in a relatively restricted geographic area. If the critical factor affecting survival of coho smolts is related to overcrowding a specific area at some critical time, then it is reasonable to expect that the use of more stocks, possessing different migration or timing characteristics, over a wider geographic area may reduce this overcrowding or increase the chances of some fish finding better environmental conditions. Private hatcheries could be a valuable tool in this regard. Changes in stocks and release procedures must be carefully evaluated to assure that new stocks and/or methods contribute at least as well to Oregon fisheries as the existing stocks.

Actions to Improve Harvest Management

The stated objectives of the "Coho Plan" in terms of production and harvest cannot be achieved without improvements in harvest management procedures and techniques. Proposed increases in natural production are believed to require reductions in harvest rates to about 69% resulting in potential public hatchery surpluses in some areas. At the same time, new harvest and release strategies must be developed to utilize the harvestable surplus. In addition, the increasing demand for salmon among competing user groups requires development of fair and equitable allocation schemes to insure an orderly harvest of the coho salmon resource. In order to meet these needs, harvest management strategies must be developed to:

Adjust Harvest Rates. Actions recommended for increasing natural production will be unproductive unless adequate numbers of wild fish are allowed to return to fully use natural spawning and rearing

2. **Time of release.** The upwelling phenomenon appears to be related to ocean survival of coho smolts in three ways: intensity, duration, and timing. There seems to be considerable merit in delaying the time of release until upwelling is established along the Oregon coast. At present, scientists have no way of predicting upwelling. Consequently, we recommend a wider range of release dates to decrease the chance of competition within this species and to increase the opportunity of encountering optimum survival conditions.

3. **Area and stocks.** Information suggests that survival of coho smolts could be affected in the nearshore areas of the ocean. Strategies being considered for increasing survival of smolts include diversifying areas for release. For example, some Columbia River coho smolts might be barged to the estuary or to offshore areas.

areas. Although it is recognized that the increasingly intensive ocean fisheries have not caused the overall coho production problem, they have tended to compound it by overharvesting wild stocks in recent years. Harvest rates are being reduced and must be maintained at a level compatible with escapement needs.

Implementation of the plan will require reduction of the exploitation rate in ocean fisheries to a maximum of about 69%. This equates to an optimum annual escapement of 200,000 wild adult coho to coastal streams after they are rehabilitated. Restoration of the needed escapement of wild coho will be achieved in a stepwise process by 1987 in order to minimize impacts on the ocean fisheries.

Improve Utilization of Harvestable Fish. Harvest regulations designed to enhance natural production and protect other stocks of salmon mixed with coho result in underharvest of some stocks. Management strategies must be developed that will maximize the harvest potential and benefits to users. Such activities include: (1) improving information on distribution and timing of migrations of wild and hatchery fish, (2) modifying hatchery brood stocks to increase harvest potential, and (3) harvesting hatchery coho in known stock or terminal fisheries.

In addition, the combined ocean and in-river harvest capabilities exceed the current and probably the potential production of coho salmon. These competing fisheries need to be assured of a reasonable opportunity to share in the available harvest. To most efficiently and effectively utilize the harvestable surplus, it will be necessary to develop equitable allocation schemes between competing user groups and support the development of an effort reduction program by the commercial salmon fisheries.

Actions to Improve Data Base

Effective management of coho salmon stocks relies upon data to make decisions. Faulty or incomplete data may result in poorly conceived management actions. Although the basic data required to manage coho stocks are fundamentally sound, additional information and refinements are still needed to improve short- and long-term management decisions and their effectiveness in achieving management objectives. Improvements in the data base will require work in three broad areas.

Stock Size Predictions. The Oregon Production Index (OPI) provides a reliable measure of the abundance of adult and hatchery coho salmon that can be predicted 1 year in advance by hatchery jack returns. However, additional data are needed to assess the catch and escapement of the wild fish component of the OPI. Estimates of the escapement of wild fish are a particular concern since they are currently absent in the OPI even though wild fish are included in the catch. Improved escapement estimates will strengthen the overall production estimates of adults supporting fisheries in the OPI area and help determine if escapement goals are being met. Further analyses are also needed to improve forecasts of private hatchery fish as they attain greater significance in the ocean catch.

Distribution and Contribution. The distribution and contribution of individual wild and hatchery stocks are vital concerns in regulating fishing zones, gear, seasons, and interception by neighboring states and Canada. Stocks often display individual differences in their migration patterns in the ocean. We may be able to take advantage of these differences to enhance various fisheries by area or time. However, the differences are often poorly documented in hatchery stocks and unknown among wild stocks. Adequate tagging programs are required for wild and hatchery stocks coupled with effective coast-wide tag-recovery efforts.

Harvest Estimates. Catch statistics are an important source of data needed to judge the effectiveness of management decisions. Simple totals alone are often inadequate since the catch includes many components; i.e., hatchery, wild, private, Columbia River, coastal, port, zone, etc., that are impor-

tant concerns for effective management. The catch by major fisheries such as commercial gill-net, ocean troll, ocean sport, inland sport, and Indian fisheries must also be adequately determined to meet management objectives.

Decisions based on detailed data require effective sampling programs and timeliness in disseminating the information to the managers. To properly function, a smooth organizational structure is needed to assure efficient collection, transmission, and utilization of the information. As the fisheries and management requirements become more complex, additional emphasis will be needed on in-season data collection systems for prudent changes in management decisions.

Actions to Complete and Implement the Plan

Oregon's coho production is comprised of a mosaic of stocks each interacting with its habitat. The habitat may be a natural or altered stream or a hatchery. Although the coho plan gives guidance on management concepts and sets limits on the scope of management goals and objectives, there is considerable latitude for tailoring the implementation of the plan to each major basin or stock in Oregon. This is as it should be for two reasons:

1. Any plan to be effective needs to give specific direction to the implementor as to the tasks and activities that need to be carried out to achieve the goals of the plan. To attempt to include a detailed description of specific problems and tasks by stock and basin in the comprehensive plan would result in a document too large and too complex to be read, let alone understood and followed.

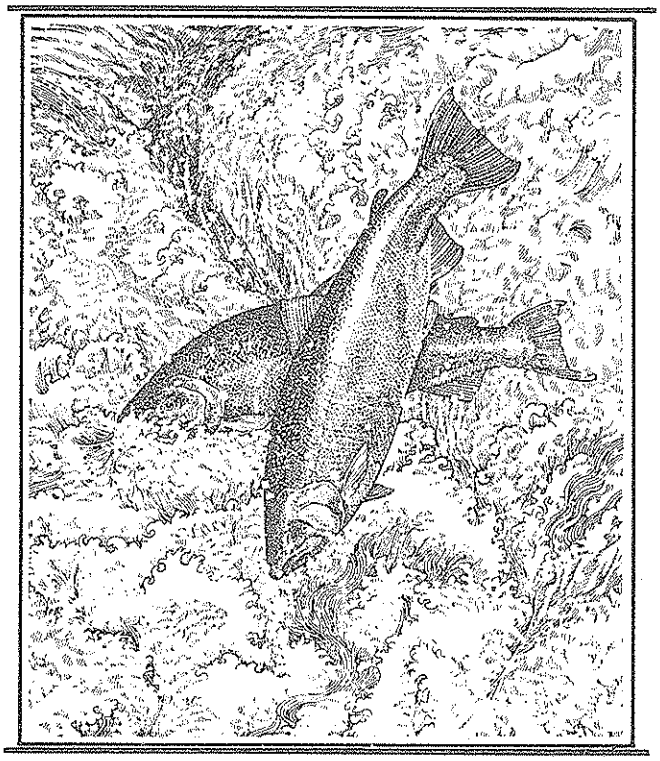
2. The plan should be developed in a systematic pattern starting with statewide goals, problems, and strategies that give direction to the development of basin/stock plans which in turn direct the development of specific jobs. In this way the individual biologists can concentrate their efforts on the particular problems in their specific areas (district or research areas) and still be assured that their individual efforts are contributing to the solution of the broader statewide problems.

Ideally, the procedure would be to complete and approve the basin plans; then the aggregate of the problems identified in the basin plans should give priority and direction to the development of research plans. In the interim, before the basin and/or stock plans are completed and approved, there are statewide programs and research and management plans to be continued or adopted. These include:

1. The continuation of all ongoing coho salmon programs and activities unless specifically modified by the *Coho Salmon Plan.*

2. A management plan for implementing the 48 million release limitation. This plan will require the cooperation of state, federal, and private aquaculture programs.

3. The *Coho Salmon Plan* has identified several problems that are either entirely statewide in scope or contain elements that are statewide. These problems are 1, 2, 4, 5, 6, 7, 9, 11, 13, 14, and 18. Management and research plans should be written for those problems before basin plans have progressed very far. It is important to achieve or to complete the statewide research and management plans first in order to assure maximum direction to the development of the individual basin plans.



4. A timetable and format for basin plans need to be written and approved. To be sure that the basin plans are compatible with and contribute to the system, a specific set of guidelines for the basin plans needs to be developed.

5. Assign responsibility for the completion of all plans and periodically review (quarterly or semi-annually) progress.

When Would the Plan be Implemented?

Some of the specific actions in 6A are ongoing activities of the Department and only need to be continued or modified in some way. The Governor's original Salmon Enhancement Program submitted to the 1981 legislature contained many items related to the coho plan. Despite depressed state revenues and decreased availability of federal funds, some activities were funded and others partially funded by the legislature. Some funds, for example, are available for expanding our efforts to rehabilitate wild stocks of coho: STEP ($352,000), development of new brood stocks ($38,000), and habitat improvement ($552,000—statewide/trout and salmon).

Limited funds were also provided for improving our data base; for example, $37,000 for expanding spawning fish surveys and $30,000 for juvenile fish and habitat surveys in coastal streams to better determine the status of the resource and identify rehabilitation needs.

Some progress is possible for all 20 specific actions listed in 6A, barring any unforeseen budget crisis, if these are deemed to be appropriate and a priority in addition to maintaining basic ongoing programs in fish propagation, habitat protection and management provided for by the 1981 legislature.

Some of the specific actions can be accomplished relatively easily, and others will require several years to complete. For others there will be only a gradual improvement in understanding and management capability that will translate into more fish and fishing opportunity for any given environmental and economic constraints present at the time.

It is our intent to move as quickly as possible to implement the plan once it is approved. We expect to realize some improvement in the fisheries each year independent of environmental variation. It should also be understood that with or without a plan or any change in programs, better ocean conditions would also result in increased survival of our wild and hatchery coho.

The coho plan is far from a perfect document and it is not a solution in itself to the problems that affect the fish and fisheries, but it is an attempt by your Department to develop an organized approach for resolving some of the problems and communicating our thoughts and intended actions to you.

You can make it a better plan by carefully considering what is presented and then providing your constructive comments in writing or orally to the Commission when they hold a public hearing on the plan. It is also our intent to hold a series of public information meetings in mid-October to explain the plan and to try to answer questions that you may have prior to the Commission hearing.

The tentative schedule calls for meetings during the week of October 12 along the coast (Brookings, Coos Bay, Newport, Tillamook and Astoria) and in Portland on October 19.

FOREWORD

We share a common concern. Columbia River and Oregon coastal coho populations are at their lowest level since the early 1960's, and this has gone on for 5 consecutive years. My staff is already predicting another poor year in 1982. The above, in part, has resulted in less fishing opportunity and a direct impact on people that depend on coho for their livelihood or recreation. We know you are concerned and looking to us for help. We are trying to help.

We know that the ocean environment is playing a major role in what is happening to our coho, but we are optimistic there are ways to improve the runs. We do not see a single easy solution, but let me emphasize that my staff and I are dedicated to trying to improve the fish runs and fisheries.

The development of private hatcheries, court decisions on Indian fishing rights in the Columbia River and elsewhere, the passage by Congress of the Fishery Conservation and Management Act of 1976, and subsequent regulations of salmon fishing beyond the 3-mile limit by the Pacific Fishery Management Council present both challenges and opportunities for improving the fisheries and our management of them.

We believe that our coho plan is a good start to resolving a multitude of interrelated problems affecting our fisheries. This plan explains how we approached the "coho problem," some of the information we looked at, and our general assessment of what we think has happened. We briefly discuss some of the policies and ecological principles which guided the development of the plan up to this time; and finally, we present our recommendations regarding the approach and specifications we feel are necessary to restore the coho runs.

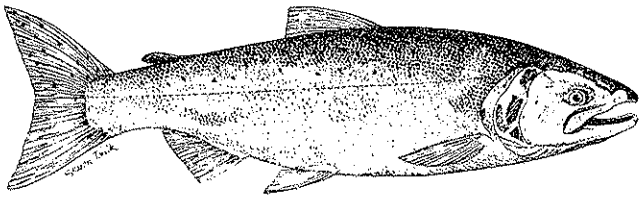
We need your help if we are to develop a plan that will work. Please read what we have to say, and then tell us if you think we are on the right track. If you feel our approach is wrong, tell us why it is wrong and what you think we should do. The Commission plans a public hearing on the afternoon of October 22, 1981, and your comments in writing or in oral testimony are welcome. To become part of the official record, written comments should be sent to the Chairman of the Commission at P.O. Box 3503, Portland, Oregon 97208, before October 22.

Let me leave you with this thought. The first concern for any management scheme has to be for the resource. Without healthy stocks capable of reproducing themselves and producing a harvestable surplus, there will be no fishery. This agency and this plan are dedicated to the goal of increasing the sustained yield of both naturally produced and hatchery stocks of coho salmon.

Sincerely,

John R. Donaldson, PhD
Director

COMPREHENSIVE PLAN FOR PRODUCTION AND MANAGEMENT OF OREGON'S ANADROMOUS SALMON AND TROUT



PART II. COHO SALMON PLAN

Oregon Department of Fish and Wildlife
Fish Division
Anadromous Fish Section

October 1, 1981

PUBLIC DRAFT

OREGON
Fish & Wildlife

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