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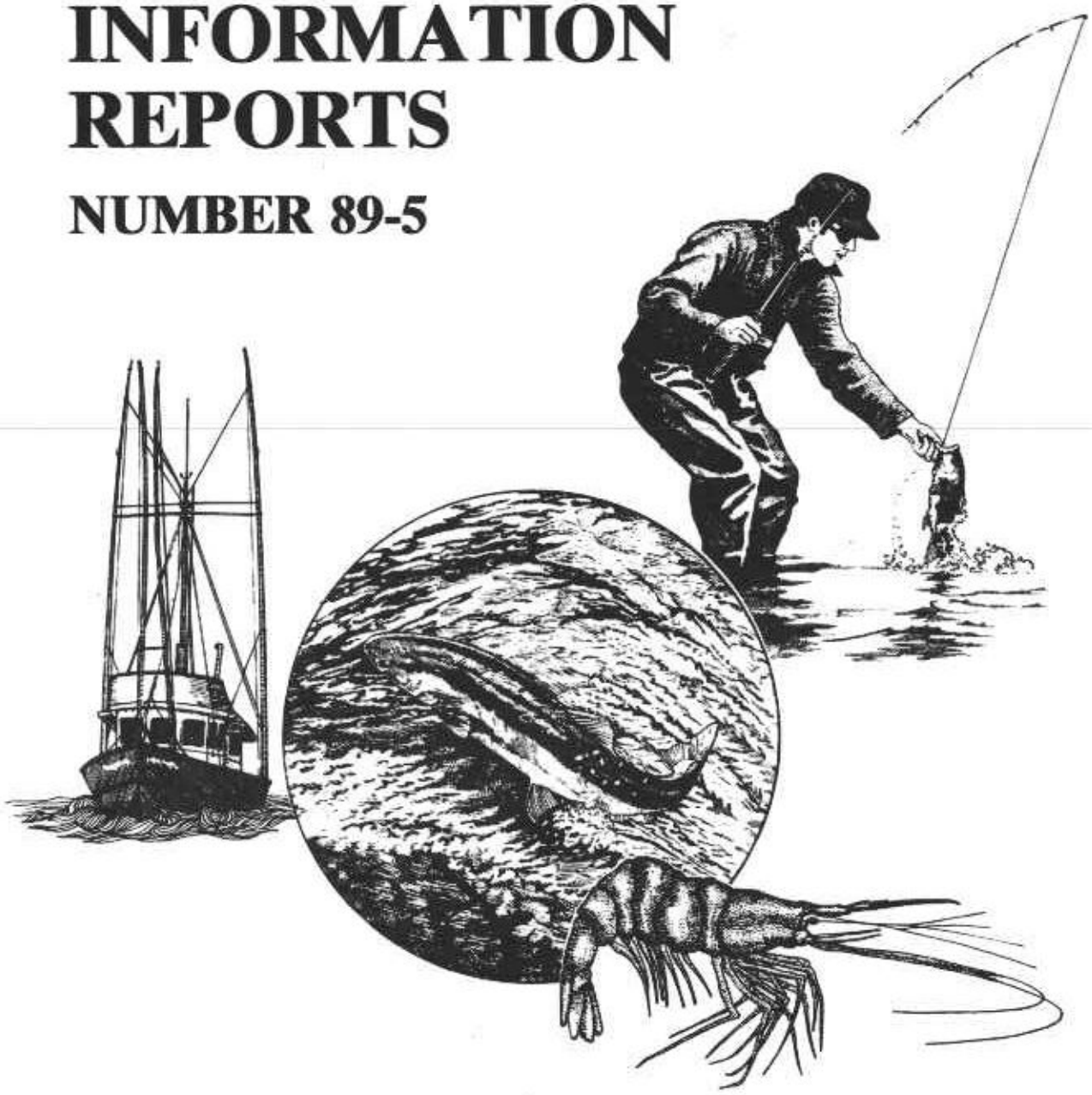

FISH DIVISION

Oregon Department of Fish and Wildlife

Management of Wild and Hatchery Coho Salmon
in the Tenmile Lakes System

Management of Wild and Hatchery Coho Salmon in the Tenmile Lakes System

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CONTENTS

INTRODUCTION

Over the last decade fishery managers have debated various approaches to management of wild and hatchery salmonids to meet production needs and maintain the long-term survival and genetic integrity of wild stocks. During the recent review of the 1982 Fish Management Plan for Tenmile Lakes, these approaches were also considered for management of coho salmon *Oncorhynchus kisutch*. This stock of coho salmon has traditionally contributed well to ocean recreational and commercial fisheries and the recreational fishery in Tenmile Creek and the large lakes in the system (McGie 1979). Because of the former abundance of this stock, it is considered to be one of the premium wild stocks on the coast of Oregon. Interest in restoring this stock to a higher level to regain at least some of the former level of fishery benefits is great. The selection of an approach to enhancement is critical to avoid adverse effects that may be associated with hatchery production.

Examples of genetic differences between wild and hatchery stocks of salmonids have been documented (Reisenbichler and McIntyre 1977; Chilcote et al. 1986; Allendorf and Ryman 1987; Fleming and Gross 1989). Differences were observed in survival and in observed traits of the fish. As a result, when hatchery programs are used to supplement or rehabilitate wild stocks, the wild stock may be subject to an additional risk that offsets the intent of a well-meaning hatchery program. Hatchery fish may reduce the survival of wild fish when they return and interbreed with them. They may also adversely affect wild fish by competing for spawning and rearing sites and by interfering with the natural life history of the wild stock.

Three main strategies have been used to meet the demand for additional fish and provide various degrees of protection for wild stocks, but none is entirely satisfactory. The first

approach has been to designate some streams as "wild" and others as "hatchery" in order to keep the stocks separated. This avoids problems in the wild streams by not having direct hatchery releases, but it means that certain stocks may remain depressed. It also means that the potential value of certain stocks to fisheries may not be achievable because of low abundance. Isolating important wild stocks for protection in this way may also set them up for further depression if the ocean harvest rate on mixed hatchery and wild stocks is allowed at a level necessary to obtain a high catch of hatchery fish. Conversly, limiting harvest rate to protect weak, wild stocks prevents the desired harvest of more abundant hatchery stocks.

The second approch is to make hatchery programs "compatible" with wild stocks. This has usually meant starting hatchery programs with broodstock from the wild population, using a large number of parents, mimicking the natural life history in rearing and release regimes, limiting the proportion of hatchery fish that spawn with the wild population, and periodically reinfusing wild stock into the hatchery program. This is an important step toward comanaging wild and hatchery populations, but many depressed wild stocks would be seriously affected by removal of the broodstock necessary to avoid a genetic founder effect in starting a hatchery program. Other problems arise because mate selection in broodstock development projects is artificial and may not be broad enough or occur in combinations that are appropriate for that stock.

Some changes in the stock as it is converted from wild to hatchery may be unavoidable and may occur at various stages in the hatchery program. Changes may also occur fast enough that obtaining or even identifying wild fish for future broodstock collection may be difficult when hatchery fish are mixed in the wild spawning population. How quickly the wild population is affected by the hatchery program probably depends on the level of success in the hatchery program. Success may also be self-defeating in the long run because

availability of a hatchery egg source from returnees creates pressure to use those eggs and expand programs rather than reinfuse wild broodstock that may be increasingly difficult to find and capture.

The third approach is to ignore the differences between wild and hatchery stocks, move ahead with aggressive hatchery programs to meet fishery needs, and hope for the best. This approach is often what we would like to do because it would solve many of the short-term conflicts and problems of fishery management and make a lot of fishermen happy. However, long-term consequences to this approach may exist that will ultimately satisfy neither fishermen nor managers. Unfortunately, hatchery stocks have not shown that they can be consistently successful. Many examples of hatchery successes can be cited, but unexplained failures and examples of early success followed by a general level of poor survival can also be cited. The long-term existence of wild stocks may be important to rejuvenate hatchery programs or may be needed for entirely different approaches to management and enhancement in the future. Now is not the time to compromise future options by altering or eliminating remaining wild stocks.

The purpose of this paper is to describe a slightly different approach to enhancement that I believe captures the best of the above three approaches. It allows aggressive management of both the hatchery and wild populations and still protects future options with the wild stock. This approach is possible in the Tenmile Lakes system largely because of the geography of the three largest lakes in the system (Tenmile Lake, North Tenmile Lake, and Eel Lake) (Figure1). However, the approach may also have application in other coastal lakes or some streams where protection and enhancement of wild stocks of coho salmon are desired.

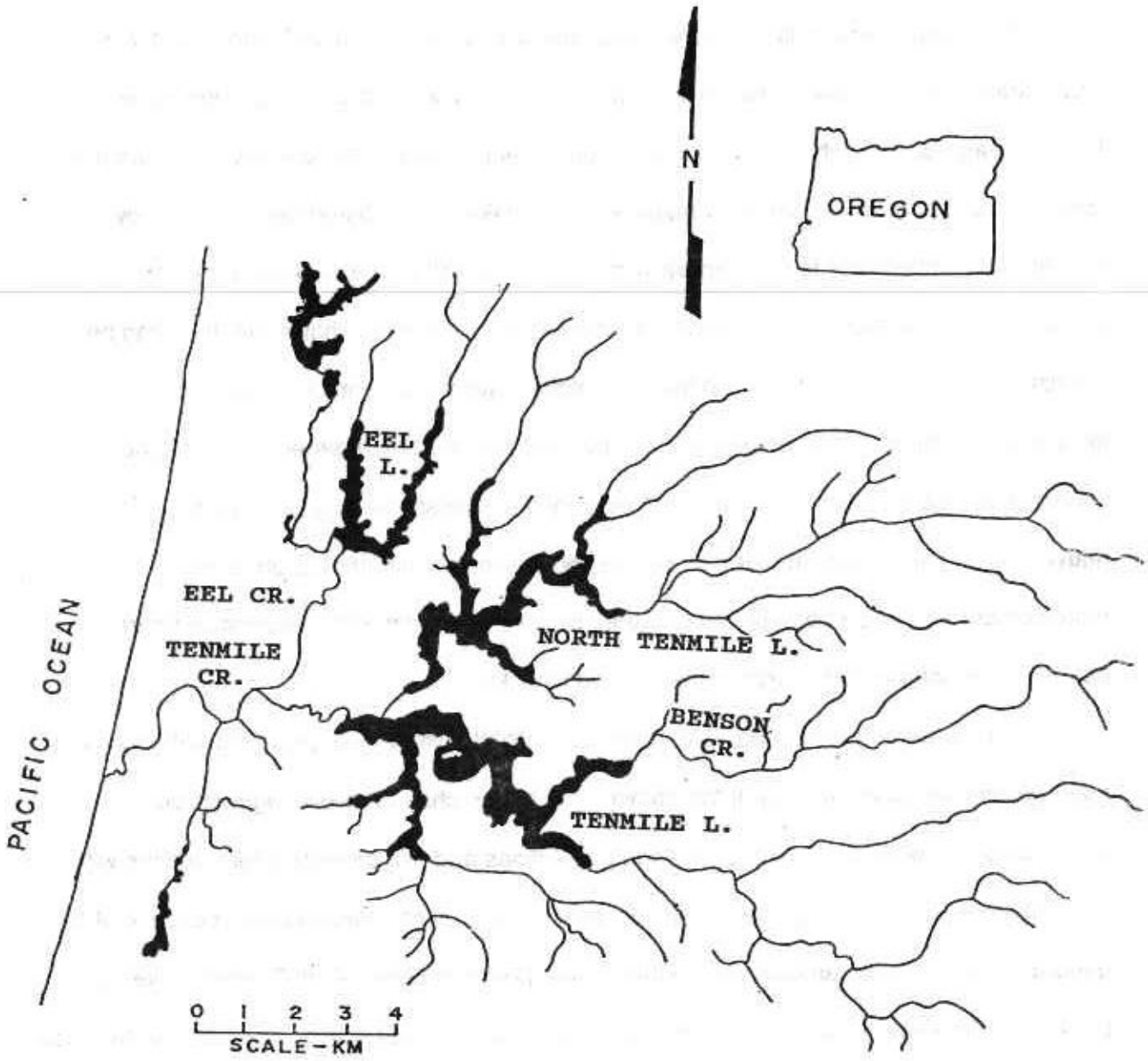

Figure 1. Map of the Tenmile Lakes system.

HISTORICAL PERSPECTIVE

Historically, the Tenmile Lakes system was an excellent producer of coho salmon and may have been the largest producer on the coast of Oregon. Incomplete commercial seine and gillnet records in Oregon Department of Fish and Wildlife (ODFW) files suggest runs up to 75,000 adults per year around the turn of the century. Records of the Master Fish Warden indicate that nearly 73 million eggs were collected from coho salmon in the Tenmile Lakes system in the period from 1935 to 1946 (Anonymous 1935 to 1946). The peak egg collection was 21.8 million in l938. These eggs were shipped to hatcheries all over Oregon.

Annual run estimates of Tenmile Lakes coho salmon started in 1949 and have continued to date. These estimates are obtained from a relationship between direct population estimates from tag and recapture studies and spawning survey counts (Morgan and Henry 1959; McGie 1971). Runs in the 1950 to 1959 period averaged 22,850 adults and in the 1960 to 1969 period averaged 12,200 adults (Figure 2). The productive lake habitat was the key to the former large production where most coho salmon fry moved out of the spawning tributaries and spent the next year rearing in the lakes before they went to sea as smolts. The number of returnees from smolts that reared in the lakes for a full year was large compared with the number of returnees from smolts produced in the tributary streams. Competition with warmwater fishes in the lakes was assumed but not proven to be a factor in the reduction of coho salmon abundance and was one of the reasons for the fish eradication project in 1968 (Werner 1966).

In 1967 the Fish Commission of Oregon and Oregon State Game Commission collected a cross-section of the native stock of Tenmile Lakes coho salmon by taking 325,000 eggs from spawners and salvaging 679,500 fry by seining and trapping. These were placed in two hatcheries and reared to smolts during the rotenone treatment of the lakes in 1968

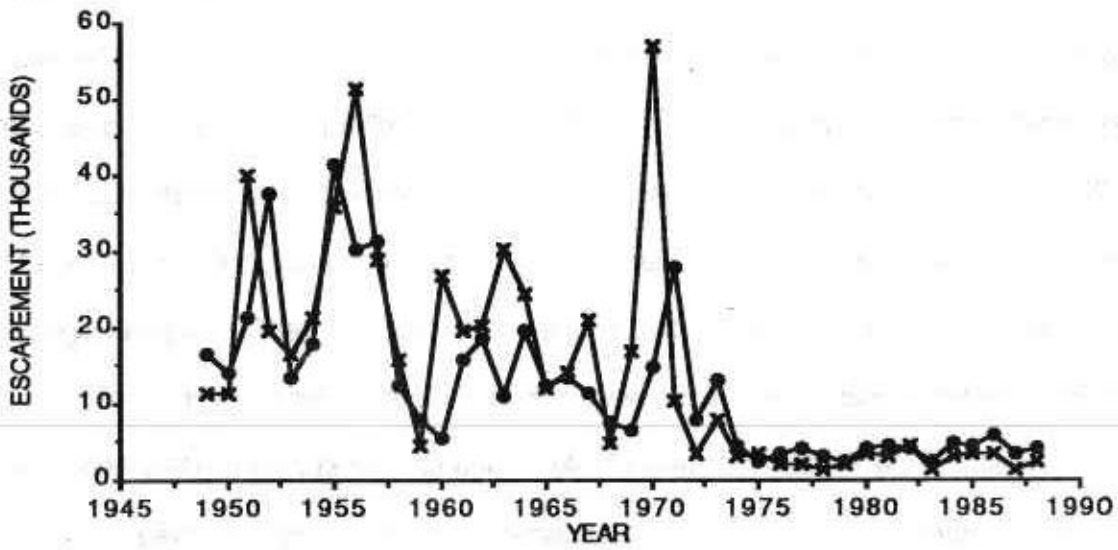

Figure 2. Estimated spawning run of adult and jack coho salmon in the Tenmile Lakes system, 1949-88. ● - adults; x - jacks.

(McGie 1968). A total of 930,136 smolts was released back into the lakes (McGie 1970). The smolt releases in this one-time hatchery program produced good returns (McGie 1979), but the returns from the first brood of wild coho salmon living in the barren lakes produced even better returns in 1970 as jacks (57,000) and in 1971 as adults (28,000) (McGie 1974). However, over the next three years the population quickly declined to a new low level as populations of bluegill *Lepomis macrochirus* and brown bullhead *Ictalurus nebulosus* rebuilt in the lakes following treatment and after the largemouth bass *Micropterus salmoides* was introduced in 1971. The time association between the introduction of largemouth bass and reduced levels of coho salmon spawners in the last 15 years is dramatic. As coho salmon fry enter the lakes from the tributary streams, they are subject to a high level of predation. Their life cycle apparently ends shortly after entering the lake, and the natural production of wild smolts is now limited to those fry that remain in the tributary streams for rearing. Movement of

fry to the lakes no longer benefits this population, and the lakes are used mainly as a passageway to the ocean for smolts from the tributaries.

The low, stable population of wild coho salmon has averaged 3,867 adults per year since 1974. The average escapement goal of 4,270 adults listed in the Statewide Coho Salmon Plan has been exceeded in only 5 out of the last 15 years. Ocean fisheries with high exploitation rates may be having an additional depressing effect on the already small spawning escapement (Figure 3) and may be preventing full seeding of natural stream habitat in the system. Knowledge of the degree of use of stream habitat for rearing by wild coho salmon is needed to assess the escapement goal for the system.

The 1982 Fish Management Plan for Tenmile Lakes called for increasing the abundance of coho salmon. Two approaches were suggested: (1) releasing hatchery smolts, and (2) releasing hatchery presmolts that are large enough to no longer be shoreline dependent and thus exposed to largemouth bass predation. Presmolts have been released in late May or early June at a size of about 150 fish/lb. However, fish of this size still make some use of the shoreline areas, and predation by largemouth bass during warmwater periods occurs. Presmolts continue to feed along the edges of the lakes as well as move into the open-water areas. Presmolt coho salmon released in summer are also prey for the striped bass-white bass hybrid *Morone saxatilis-M. chrysops.* As a result, reaching the former level of natural lake production for coho salmon during warmwater periods will probably never again be possible. However, based on a small program with salvaged fry reared in pens in 1988, coho salmon will be able to use the natural productivity of Tenmile Lake and North Tenmile Lake during autumn, winter, and spring. Presmolts released in late October or early November at a size of about 30 fish/lb will continue to grow and survive in the lake during the coldwater period when warmwater fishes are inactive.

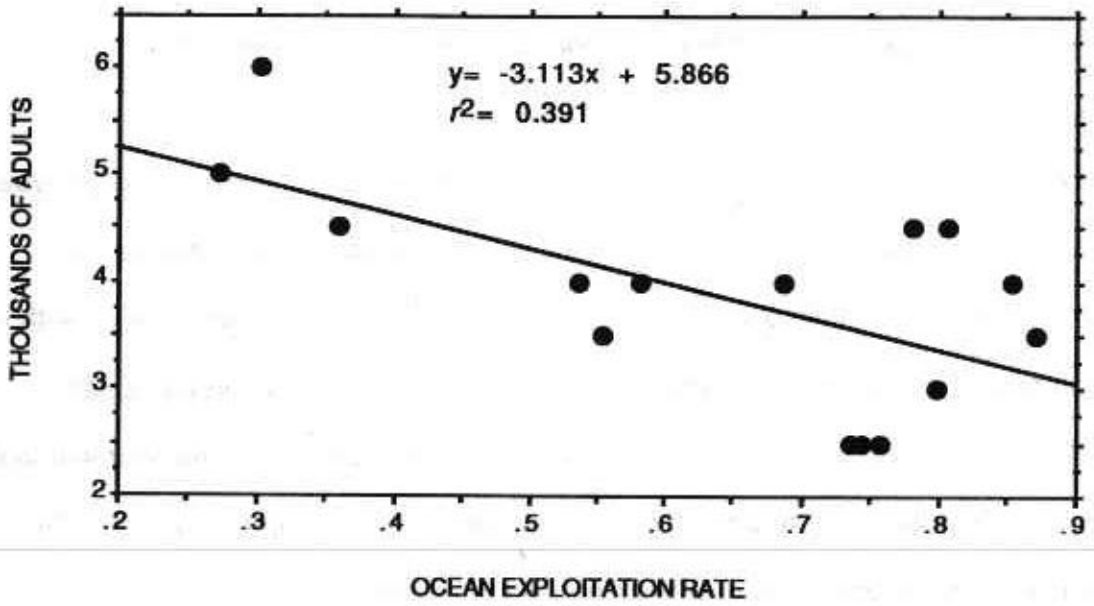

Figure 3. Relationship between the rate of ocean fishing and the number of adult coho salmon that returned to Tenmile Lakes,1974 to 1988.

Interest in enhancing coho salmon in the Tenmile Lakes system in order to contribute more fish to the ocean recreational and commercial fisheries and to the recreational fishery in the lake system is high. Hatchery releases of coho salmon smolts at Eel Lake have contributed to the ocean fisheries in traditional areas in Oregon and northern California during midsummer (Garrison 1987). Catch-to-escapement ratios for small lots of coded-wire tagged fish have varied considerably, but despite survival problems in several years, the potential exists to achieve a larger level of fishery benefits by increased production (Table 1).

Reaching a higher overall level of total production of Tenmile Lakes coho salmon will require development of a major hatchery program. A hatchery broodstock development program was started at Eel Lake in 1980. A Salmon and Trout Enhancement Program (STEP) project was started at Benson Creek on Tenmile Lake in 1981. Both programs were started by collecting wild broodstock either as eggs from adult spawners or as fry salvaged from tributary streams in areas that dry up in summer. Combinations of eggs from returning

Table 1. Estimated ocean fishery contribution and return of coho salmon from coded-wire tagged (plus adipose-only) smolts released at Eel Lake, 1980 to 1985 broods.

Brood year	Release number	Ocean catch	Jack return	Adult return	Percent survival
1980	16,477	614	128	67	4.91
1981	17,526	189	50	160	2.28
1982	25,738	40	9	181	0.89
1983	26,320	52	8	67	0.48
1984	26,919	205	90	22	1.18
1985	55,327	882	156	586	2.94

hatchery fish and additional collections of eggs from wild spawners and fry from natural streams have been used to produce smolts and presmolts for Eel and Tenmile lakes (Table 2). Releases to date have been relatively small, but interest is increasing to more quickly reach the goal of larger runs and increased fishery contribution. This has led fishery managers to a concern that a major hatchery program and a large STEP program in the Tenmile Lakes system may cause harmful effects on the remaining wild stock.

Proposals to accelerate enhancement have included collecting more wild spawners as an egg source, planting additional hatchery fish directly in the tributary streams, and raising a large number of hatchery smolts and presmolts for release in the lakes. Although the goal of more Tenmile Lakes coho salmon should be pursued, none of the previous approaches to enhancement have been entirely satisfactory in terms of protection of the wild stock. The concern for a way to meet the desire for larger total production and larger runs of wild fish led ODFW fishery managers to a slightly different approach to enhancement.

Table 2. Number of coho salmon released from hatchery rearing programs in the Tenmile Lakes system, 1980 to 1987 broods .

Brood year	Eel Lake		Tenmile Lake	
	Smolt	Presmolt	Smolt	Presmolt
1980	23,353	–	–	–
1981	17,644	9,000	4,500	–
1982	27,468	–	16,000	–
1983	64,429	–	3,000	–
1984	178,596	23,000	48,000	–
1985	99,930	124,595	23,500	–
1986	82,969	76,132	8,275	135,910
1987	106,092	114,174	12,630	142,167

THE ENHANCEMENT APPROACH

The approach developed for enhancement of coho salmon in the Tenmile Lakes system combines the best elements of the previous enhancement efforts in the Tenmile Lakes system and structures them in such a way as to achieve the goal of larger runs, greater fishery contribution, and long-term protection of the wild stock from harmful effects of the program for enhancement. The approach also allows for direct increases of the wild population and monitoring of changes in the survival and observed traits of the naturally produced wild population.

The four key elements of the enhancement approach involve (1) a large hatchery program with marked presmolts and smolts isolated in Eel Lake; (2) the capture of wild fry as they enter Tenmile and North Tenmile lakes or that are stranded in intermittant streams; (3) the rearing of wild fry for release as marked presmolts in Tenmile and North Tenmile lakes on 1 November; and (4) the expansion of natural summer rearing habitat in the tributaries of Tenmile and North Tenmile lakes (Figure 4).

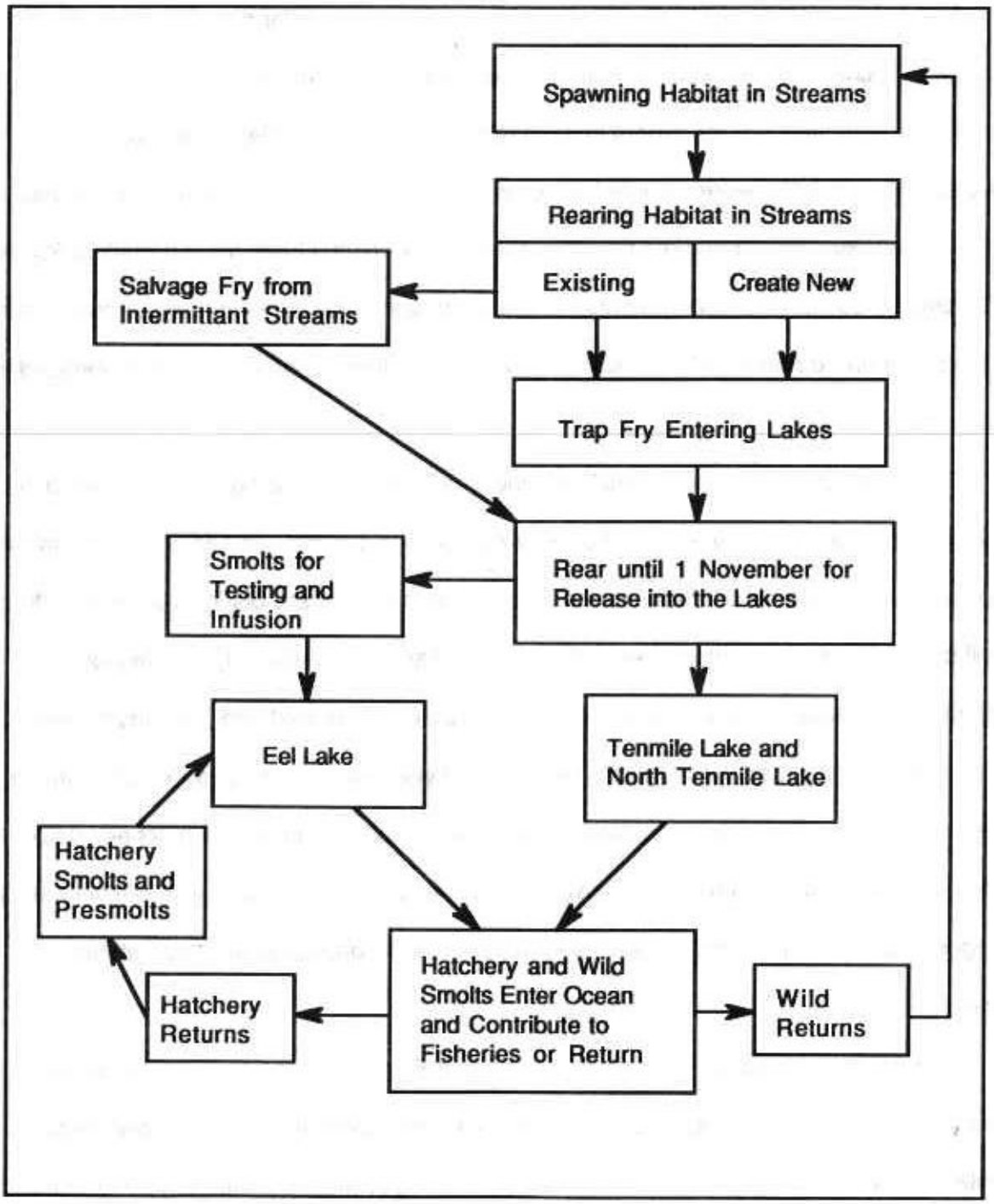

Figure 4. Flow diagram showing the relationship of differemt parts of the enhancement approach for wild and hatchery coho salmon in the Tenmile Lakes system.

Isolating the hatchery stock solves one of the big concerns for harmful effects on the wild stock. Hatchery coho salmon released at Eel Lake appear to "home" well based on observations of marked fish elsewhere in the basin. Data in ODFW files for the last 5 years show that 543 carcasses were sampled on spawning surveys in tributaries of Tenmile and North Tenmile lakes, but no marked fish were found. At Benson Creek traps 8 marked fish out of 919 sampled could have been potential strays in the last 5 years. All but one of these came from the same brood and carried the same mark as a small group of hatchery fish released in Benson Creek in 1986.

This separation of wild and hatchery stocks provides an assured source of wild fish that will be available to infuse into the hatchery program as needed. In addition, wild fish will also be available if new or different approaches to enhancement are discovered in the future. We will be able to monitor differences in the survival, fishery contribution, age distribution, timing, migratory pattern, body size, fecundity, and other traits of wild and hatchery stocks. Capture of wild fry for rearing to smolts in each brood year will provide a source of returning wild eggs and sperm in the first generation to be used in testing against the hatchery stock. If monitoring of survival and other traits shows differences between the wild and hatchery stocks, then eggs and sperm from wild stock should be routinely incorporated into the hatchery program.

While a major hatchery program is going on at Eel Lake to the limits of our rearing facilities and the natural rearing potential of the lake, enhancement of the wild population in Tenmile and North Tenmile lakes can also be proceeding to increase the number of natural spawners. By capturing naturally spawned wild fry in traps before they enter the lakes or by seining them from intermittant stream areas, we will be able to obtain wild stock and avoid problems of depletion of natural spawners, artificial selection of mates, and a small number of

family groups. Capture of naturally spawned fry should provide wild fish that are not genetically different from the rest of the wild stock residing in the tributary streams. Fry that become trapped in intermittant stream areas are probably a cross section of the wild population that were unlucky enough to take up residence in a low-flow area. Fry that drift downstream to the lakes are the result of random dispersal at emergence from their gravel redds and the outcome of social adjustments of stream populations in relation to fish growth and the availability of food and space (Chapman 1962; Mason and Chapman 1965). Downstream drift of fry is common in all stream populations of coho salmon; however, prior to 1971 in the Tenmile Lakes system, reaching the lakes meant finding the "ultimate pool" and high survival.

Naurally spawned wild fry can be reared for a short period of their life through the summer and released into Tenmile and North Tenmile lakes on 1 November when they can survive and complete their natural life cycle. Returns should distribute themselves among all tributary streams and spawn with the naturally produced wild fish. The genetic differences between these two groups of "wild" fish should be minimal. However, even starting with wild stock and rearing them for only a period of time to November may lead to some modifications to the genetic structure of the population. Survival of certain genotypes that usually do not survive well in the natural environment may be enhanced . Other genotypes may not survive as well in captivity. Problems for the naturally produced population of coho salmon are not expected to be large as long as the proportion of these partially cultured fish does not exceed the proportion identified in the 1989 revised Wild Fish Management Policy. However, differences should be monitored between these partially cultured wild fish and those produced entirely in the natural environment to assure compliance with the Wild Fish Management Policy and as an opportunity to gain further insight about approaches to comanagement of

natural and enhanced populations.

This enhancement effort will increase the abundance of natural spawners in tributaries of Tenmile and North Tenmile lakes, and the natural stream rearing areas will become seeded on a routine basis. As increased summer rearing area in the streams is colonized by progeny from natural spawning, the number of naturally produced wild smolts from the tributary streams will increase to the capacity of winter habitat to hold them. The amount of winter habitat in the Tenmile Lakes system is not likely to be limiting because the lakes are available as prime winter habitat beyond the amount available in the tributary streams.

The number of fry that can be trapped moving into the lakes from the tributaries should also increase each year as the spawning population increases. The number of fry available to be salvaged from areas that dry up may also increase unless habitat improvement can allow these areas to maintain flow during the summer. The net effect of this enhancement effort can be progressive increases in program level and increases in the spawning population in each successive generation up to the limits allowed in the 1989 revised Wild Fish Management Policy.

Rearing a portion of each new generation of naturally spawned wild fry for a limited time should have much less of a tendency to produce genetic shifts in the naturally produced wild population than would releasing presmolts obtained from egg takes in a traditional hatchery program. Combining a program of rearing wild fry with a strong program for increasing natural stream rearing habitat should maintain the genetic composition and the ability of the wild population to perpetuate itself naturally. In the short run, the harmful effect on those wild fish that are produced entirely in the natural streams should be slight, but the naturally produced population should be monitored closely. This approach to management,

which involves the hatchery stock on Eel Lake and the wild stock on Tenmile and North Tenmile lakes, will allow for substantial increases in the runs and major increases in the fishery contribution of coho salmon from the Tenmile Lakes system. The information obtained by monitoring differences between returns to Eel Lake and returns to Tenmile and North Tenmile lakes will be important to future management of hatchery and wild populations in this system and elsewhere.

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