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John W. Sigler, PhD

MANAGER, ENVIRONMENTAL
SCIENCES GROUP

128 North Main
Logan, Utah 84321
(801) 753-8933

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HISTORY OF FISH HATCHERY DEVELOPMENT IN THE GREAT BASIN STATES OF UTAH AND NEVADA

J. W. Sigler[1] and W. F. Sigler[1]

Abstract.—Fish hatchery systems in both Utah and Nevada are now an integral part of the fishery management scheme. Historic development of hatcheries, including the early stocking of exotics, is presented. Disease control and dry pelleted feed are discussed in historical perspective and present status.

Waters in the Great Basin area were probably first fished by wandering bands whose ancestors had crossed the Bering Strait to Alaskan shores and subsequently inhabited a vast portion of what is now the western United States. These people were present on the shores of ancient Lakes Bonneville and Lahontan about 8,000 to 10,000 years ago. Recently published archaeological evidence indicates, however, that these people were not the direct ancestors of the Pyramid Paiute Indians who now inhabit the area surrounding Pyramid Lake, the remains of ancient Lake Lahontan, nor of the Indians found near Great Salt Lake by explorers in the early 1800s. These Indian tribes had been preceded by people of the Desert Culture as early as 10,000 years B.P. (before present) (Sigler and Sigler 1987).

Early History

When great numbers of white men arrived in the valleys of the Great Basin from 1847 to 1870, the streams and lakes in the area supported large populations of native fishes. Utah, Sevier, and Bear lakes in Utah, and Pyramid, Walker, and Tahoe lakes in Nevada, as well as the major streams of the basins (the Bear, Weber, Logan, Blacksmith Fork, Ogden, Jordan, Provo, and Sevier rivers in Utah, and the Truckee, Carson, Humboldt, and Walker rivers in Nevada), supported substantial numbers of native cutthroat trout, *Salmo clarki*, as well as endemic suckers, whitefishes, and chubs (minnows). These populations were essentially unexploited, in the present-day sense of the word, by the nomadic Indians who utilized them. Harvests of the fish during the spawning runs each year provided the Indian tribes with subsistence diets for much of the year. Some trading of excess fish occurred among the tribes and the early white explorers and trappers, but the fish populations were never endangered by the Indians.

The influx of whites in 1859 in Nevada following the discovery of the Comstock Lode, and the arrival of the Mormon pioneers in Utah in 1847, however, exerted heavy pressure on the fish populations in both states. The easily harvested fish, present by the thousands during spawning runs, became an integral part of the diet of the settlers near major lakes and streams of the Great Basin (Townley 1980, Yarrow 1874, Madsen 1910, Carter

[1]W. F. Sigler & Associates Inc., 309 East 200 South, Logan, Utah 84321.

1969). Methods used to harvest fish included the use of "giant powder," dams, nets, and traps. At the same time, changes in water use patterns (for irrigation and industry) began to adversely affect the fish populations. Streams were blocked, and large numbers of mature fish were taken prior to spawning. Young-of-the-year fish were lost to irrigation canals. As a result, populations of native fish in some areas were drastically reduced. Additionally, the native populations were threatened by the unregulated introduction of nonnative species of fish into many of the waters of the Great Basin.

Initial Fish Stockings

In both Utah and Nevada, early fish introductions were made primarily for the purpose of increasing the food supply in the territories. This encouraged a wide and somewhat unstructured program of stocking whatever species were available. Prior to, or in some cases concurrent with, the development of "hatching stations," exotic species were distributed throughout the easily accessible waters of the two states.

Common carp, *Cyprinus carpio*, was one of the most frequently introduced fish. It was brought into the United States in 1876 by Rudolph Hessel (Hessel 1878). Utah received its first shipment of carp from the Washington, D.C., U.S. Fish Station in 1881, when 130 adult carp were distributed in five Utah counties and H. G. Parker, the first Fish Commissioner of Nevada, in his biennial report to the governor in 1878, expressed his intent to stock the waters of that state with this "superior food fish."

Over the next several years, thousands of carp were planted in streams in Utah and Nevada, sometimes as many as 17,000 annually. The shipments into Utah continued until 1903, and intrastate stockings from established populations persisted for several more years. In Nevada the stocking of carp continued until 1889, when George Mills became the third fish commissioner. Mr. Mills made public his sentiment concerning carp in his report to the governor, stating:

> Several years ago, during the carp furor, the general government, while not entirely to blame, was "particept criminis" in foisting upon this state, and in polluting our waters with, that undesirable fish, the carp. True, application for some were made by many of our citizens ignorant of the qualities and habits of the fish and unsuspecting as to the ruin their introduction would bring. Time has now established their worthlessness, and our waters are suffering their presence. As a food fish they are regarded inferior to the native chub and sucker, while their tenacity to life and everlasting hunger gives them a reputation for "stayers and feeders" unheard of in any fish reports I have seen to date. A resident of Humboldt, an "old Humboldter" informs me they have not only devoured all the fish food in the Humboldt River, but also the duck food and a band of sheep grazing along the banks.

Carp are now present at lower elevations in all the major drainages in Utah (Popov and Low 1950, Sigler and Miller 1963) and in Nevada (Miller and Alcorn 1945, La Rivers 1962).

HATCHERY DEVELOPMENT IN UTAH

The Period 1850–1900

In 1856 Utah's Deseret Agricultural and Manufacturing Society strongly supported fish planting programs. Salt Lake City raised capital to create the first private hatchery in the area by selling shares in the venture. Spawners (presumably cutthroat trout) were procured from the headwaters of the Weber River and from Utah Lake, and eggs were hatched.

Albert Perry Rockwell, warden of the Utah Territorial prison from 1862 to 1871, used prisoners to raise fish at what is now 2525 South 1100 East in Salt Lake City, Utah. Rockwell received more than 100,000 "salmon" eggs from the hatchery at McCloud River in California between 1877 and 1879.

The need for a state hatchery in Utah was first documented in the 1894 fish and game commissioner's report to the legislature. Joseph Musser, Fish and Game commissioner, stated:

> fish can be artificially multiplied almost indefinitely at very nominal cost. It is a great pity that Utah has not a liberally endowed hatchery system. Other states and territories have each from one to eight or ten public or private hatcheries. . . . From a well equipped hatchery, millions of choice fry could be annually distributed. This would mean thousands of dollars for the good of the territory.

In his 1897–98 report, John Sharp, Utah State Fish and Game warden, notes that distribution of trout (plantings) has been "comparatively insignificant to what it should be and will necessarily continue to be so until a state hatchery is established and provision

- density % increase of wild
Bachman - - duration of unnatural density
- Review - Vincent - O'Dell ...
- Nelson - flows
what you think?
- Klein, Marshall
Poudre
rec. - stocked - unstocked
model Poudre

Divisional Correspondence Only

STATE OF COLORADO
DIVISION OF WILDLIFE
DEPARTMENT OF NATURAL RESOURCES

DATE: July 28, 1989

TO: Tom Powell

FROM: Barry Nehring

SUBJECT: Stocking of catchable trout on top of wild stream trout populations

This question engenders the substance of a controversy that has been raging among fishermen and fishery biologists for a minimum of two decades. The issue was elevated to the level of a national controversy (among the stream trout fishery community) in the early 1970's with the publication of the results of a "scientific" study done in Montana that purportedly demonstrated the negative effects of the stocking of large numbers of catchable hatchery rainbow trout on top of wild trout populations. The study results were first published as a popular article in the magazine TROUT, a quarterly publication put out by Trout Unlimited. The study was conducted by E. Richard Vincent, a stream research biologist with the Montana Department of Game, Fish, and Parks, who has recently published his results in the scientific literature (Vincent 1987).

However, many fisheries professionals that are more than casually familiar with the circumstances under which the study was done consider the conclusions of the study to be somewhat suspect and not totally valid. The study was not well designed and controlled in the most rigorous sense. It is true that the stocking of catchable size rainbow trout was eliminated in a section of the Madison River in 1970 and the wild brown and rainbow trout populations seemed to respond with increased biomass. Similarly, when stocking was resumed the wild trout populations declined and then increased again after stocking ceased. This, on the surface, seems to indicate a direct negative effect of stocking hatchery catchable size trout on top of wild stream trout populations. But, powerful extenuating and mitigating circumstances were also going on in the water management of the Madison River in the late 1960's and early 1970's that had profound and enduring effects on the wild rainbow and brown trout population of the Madison River. Vincent (1987) has largely ignored and/or discounted these effects in his professional publication of the study in the North American Journal of Fisheries Management. On the other hand, another Montana biologist (and a peer of Dick Vincent) has presented strong evidence that streamflow regulation and manipulation of the Madison River out of Hebgen Lake (headwaters of the Madison River just downstream from Yellowstone National Park) has had a profound impact on reproductive success and survival of young trout in the Madison River. Fred Nelson provides strong statistical evidence that the minimization of flow fluctuations in the Madison River during the brown trout spawning and egg incubation period leads to strong year classes, and wild fluctuations in streamflow during this critical period leads to severely depressed year-class strength. The results of this study (Nelson 1984) are published in the proceedings of the WILD TROUT III Symposium. These symposia have been sponsored by Trout Unlimited since the 1970's. Unfortunately, many members of Trout Unlimited have been less than diligent in looking objectively at all of the evidence available to them regarding the catchable trout/wild trout issue. This has only served to create more controversy. Several papers in the WILD TROUT III Symposium proceedings (Vincent 1984; Nelson 1984; and Petrosky and Bjornn 1984) present all sides of the story and are well worth reading.

I consider the findings of Nelson (1984) to be much more valid in explaining the fluctuations in the wild rainbow and brown trout populations in the Madison River in the late 1960's and early 1970's. Suffice it to say that the flow fluctuations had at least as large an impact on the wild trout populations (if not larger) than any negative impacts that were allegedly the result of catchable rainbow trout stocking. Other professional fishery biologists either agree with this assessment or believe there were far too many extenuating and uncontrolled mitigating circumstances that affected Vincent's study to invalidate his conclusions. A brief list of professional fishery biologists who have expressed this opinion includes the following:

Mr. Dick Klein, Fisheries Research Leader (retired), Colorado Division of Wildlife, Fort Collins, Colorado

Dr. Ted Bjornn, Fisheries Research Co-op Unit Leader, University of Idaho, Moscow, Idaho

Dr. Robert Behnke, Fisheries Biologist and Professor, Colorado State University, Fort Collins, Colorado

Dr. Robert White, Fisheries Co-op Unit Leader, Montana State University, Bozeman, Montana

Dr. C.E. Petrosky, Idaho Department of Fish and Game, Boise, Idaho

Dr. Kurt Fausch, Professor, Colorado State University, Fort Collins, Colorado

Indeed, what really lends credence to this argument is Vincent originally reported strong positive impacts on the survival of wild trout when flows increased out of Hebgen Lake during the winter months (December through April) in his Federal Aid progress reports (Vincent 1968, 1969, 1970). This led to dramatic increases in spawning success and survival of young rainbow and brown trout in the late 1960's that in turn became the population of two year old and older rainbow and brown trout that Vincent was monitoring in 1970 and beyond.

Indeed, Vincent (1987) shows that there were very strong positive statistical correlations between the numbers of yearling brown trout and increased flow levels in both the non-stocking and catchable stocking years. Two year old and older brown trout did not spontaneously generate themselves out of river rocks when catchable trout stocking was eliminated. They came from natural reproduction that was greatly increased as a result of the stabilized streamflows in the Madison River in the spring of 1968. Thus, the results of this increase in recruitment and survival of yearling rainbow and brown trout manifested itself in the two year old and older wild trout population in 1970 and 1971. The elimination of catchable rainbow stocking in 1970 most likely had no effect on the increased biomass of wild trout. Actually, it is impossible to really discern what was responsible for the improvement-- elimination of catchable stocking, and/or improved streamflows and habitat conditions. It is noteworthy that Vincent apparently ignores the streamflow effects after 1971 in his publication (Vincent 1987) even though he uses trout population data from 1974 through 1976 (a three year post-catchable stocking period) to support his conclusion that the elimination of catchable stocking was the "true" causative agent. Nelson (1984) on the other hand demonstrates that a statistically significant correlation exists between yearling brown trout numbers and lowest mean monthly flows in the Varney Bridge section of the Madison River (Vincent's primary catchable effect study area) for the period 1967-1983 (17 years)! This indicates the strongest impact on the wild brown trout population was due to flow manipulations and depletions and much less the result of catchable rainbow stocking on the wild trout population.

The stocking density of catchable-size rainbow trout in Vincent's study was approximately 45/acre. Stocking densities of catchable-size trout in Colorado streams, such as the Fryingpan and South Platte rivers, at one time exceeded 300 trout per acre. When this was eliminated on sections of these two rivers and the angling regulations remained unchanged, the wild rainbow and brown trout populations dramatically declined. The rainbow trout (the more vulnerable of the two species to angling) almost disappeared from the population. Thus, in Colorado we found catchable rainbow trout actually buffer the wild trout population from angler harvest.

Finally, to my knowledge, the <u>most</u> <u>definitive</u> research into the impacts of catchable trout stocking on top of wild trout populations has been done in Idaho. Petrosky and Bjornn (1988) exonerated the effects of stocking large numbers of catchable size (6-9") hatchery rainbow trout on top of high densities of wild rainbow and cutthroat trout. The study was very well designed from a scientific and statistic standpoint. The results of their three-year study showed no measurable effects of catchable trout stocking on wild trout growth, annual mortality, emigration, or survival. They take considerable exception to Vincent's (1987) conclusions, and I believe, justifiably so.

This SHOULD NOT be construed by anyone to mean that I consider the stocking of catchable-size rainbow trout on top of wild trout populations in streams to be wise management. On the contrary, it is foolhardy for many reasons.

lg

der the Endangered Species Act is attributed to Congress's fa

ment solutions. Congress, which received the report in Janu-
)89, will be the forum for debate and determination of these
. Congress will have its own set of concerns that must be
ved before it takes action. The thrust of considerations re-
ng solutions to the greenhouse effect has evolved, therefore,
scientific to political form.

Consequently, what has been a problem of establishing the
tific case of the greenhouse effect, now becomes one of bal-
ng the affected policy interests. The probable response to the
nhouse effect will likely require an unparalleled commitment
sources. At the same time, due to its nature, the risk of harm
ciety will be slow to materialize. Congress, with knowledge of
factors, will be charged thereby with incrementally appro-
ting the resources needed to address the greenhouse effect
out the "benefit" of observable consequences for years to
e.

Environmental Law
Fall 1990
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COMMENTS

PRESERVING THE GENETIC DIVERSITY OF SALMONID* STOCKS: A CALL FOR FEDERAL REGULATION OF HATCHERY PROGRAMS

By
MICHAEL L. GOODMAN**

The Endangered Species Act of 1973 embodies a national policy of preserving genetic diversity. In crafting the legislation, Congress focused on the two greatest threats to genetic variation at the local population level—hunting and habitat degradation. A reactive listing mechanism was chosen as the best means of providing federal agencies with the management tools to protect vulnerable species. The listing process is based on the assumption that genetic diversity is destroyed primarily through the elimination of individual populations and that extinction is a gradual, or at least foreseeable, process evidenced by reductions in population size. This Comment documents the failure of the present reactive approach to protect salmonid populations affected by artificial propagation programs. After discussing the nature and significance of salmonid genetic diversity, the Comment identifies insidious genetic changes occurring within salmon and trout

* The family *Salmonidae* is composed of three subfamilies: *Salmoninae* (trout, salmon, chars); *Coregoninae* (whitefish, ciscos); and *Thymallinae* (graylings). *See* B. McKeown, Fish Migration 55 (1984). Most artificially propagated species belong to the subfamily *Salmoninae*, which includes the genera *Salmo* (Atlantic salmon, rainbow trout/steelhead, cutthroat trout, brown trout), *Oncorhynchus* (six species of Pacific salmon) and *Salvelinus* (brook trout, lake trout, Dolly Varden, Arctic char).

** Attorney, Stoel Rives Boley Jones & Grey, Portland, Oregon. J.D. 1989, Harvard Law School; B.S. (Fishery Science) 1986, University of Washington. The author would like to thank Bill Bakke of Oregon Trout for his helpful comments and encouragement.

Public Lands & Native Fish

Use opportunity to take look - progress - changes in public perception environment - interest - laws - role T.U.

40 yrs. - 1959 T.U. - 1957: UCB

- Nev: Lahontan cutt extinct - shame, but that's life attitude

1957 AFS L.V. - phone booth

1997 AFS Monterey - whole day cutthroat trout - 1973 ESA - stimulate

CFG NFG slide

- TU - George Griffith - Au Sable (8.9 mi. Holy waters)

catchable trout vs. wild trout (wild brook brown, rb nonnative (grayling) -

- Mich. Fish Div. under control fish culturists - George Comm - dangerous man

Great Triumph - 1963 - 62 Rep. win governor Romney - $12,000/mo. * not sound sci. sound politics

Blue Ribbon panel - * move fish culturist working put-grow in Gt. Lakes MDNR now!

TU expands

- point: T.U. original mission: wild trout - a catchable in fish mgt. emphasis - NOT ANTI HATCHERY

bad news comeback good news

40 yrs - how do? Return to this, but - - not good news

- However: - T.U. has become highly successful, nationally recognized organiz. despite failure in original mission. Why?

- Public Laws affecting environment: Lag time - reforming, fed agencies by legal action or threat of legal - force to do what supposed to do (Environmental coalitions) power.

- 1957-60 - Great Basin - Nev. - Maggie Crk, Susie Crk overgrazing livestock - gutted out drainages; BLM USFS -

How could this be? - - Part of intellectual heritage on use of Nat. Res. - public perception of nature - as commodities - extraction - direct benefits -

utilitarian - commodities - instrumental values

Single use - goals - Foresters - max. bd. ft. timber - Range - AUMs, Water Resources Hydrologists - beneficial water - impound - out of river, power, irrigation

Fish. hatcheries native? technological fixes

water running to sea or to Pyramid L. = waste. How agencies operated - by tradition, precedent; enormous environ. damage;

Species of plants & animals: good, beneficial; bad, nonbeneficial, vermin, pests, predators (bounties); - other - 'useless'

Today? Don Young Congress AK: last year: Good animal: eat it, hunt it, shoot it, or wear it - otherwise useless. - Nev. ID

1

slides

— Local ex. Reno - Truckee R. ~ 18,000 mil light cows

2 3. four

— Sierra Sportsman 1982. 1920s Pyramid L. 11 fish 23 lb & 22 lb max 39 lb. - world's largest cutthroat trout. — What happened. Bur Rec. 1902. Green arid west! (Take all water feasible out of rivers put to beneficial use on land). 1905 Newlands Proj. Truckee R. Derby Dam (30 mi. below $6,000 vs. 10,000 fishway) 1920s el. gen - yr.-round 1950s - 70 ft. ↓

first B.R. Dir.

Comm. Francis Newlands - "distills prevailing attitude" "Pyramid L. exists only to satisfy the thirsting sun" Paiute reservation, world's largest cutthroat, Cui-ui, (Indians - - Cui-ui eaters - gave Fremont trout). 1833 - "Fish & Indians don't vote"

Fishery people accepted reality — J.O. Snyder 1911-13. - Agr. & industry priority for water any measures for protect - propagation if interfere w/ "must be abandoned."

reality to present

— Now = ~~after~~ - WW II more ~~environmental~~ awareness of enormous environment prob. caused by focusing single use. - ~~feel regulation~~ were to success

Congress

1960 - M.U.S.Y.A. - "Nat. Res. on USFS lands shall be managed without impairment of the productivity of the land - Consideration must be given to relative values of all of the various resources, not necessarily the use that gives greatest dollar return or greatest unit output. - Vague, but..

Ecosyst. Mgt. - holistic intersections of all, & components of land - one use not damage oth

— Log Time - 1960 - 1966 USDA F.S. & S.C.S.

Humboldt R. NV. - Water for irrigation - increase beneficial / nonbeneficial. Vegetation - lots transpire water - riparian, wetlands - beneficial = what livestock ate Cottonwood 1 or - 4 a.f.

— intersections, ramifications? - - rip. wildlife - stream channels - fish habitat. — True transpiration net loss runoff - but perennial flows, even out hydrographs water quality — law suits - birds now rip. wetland veg. almost sacred. -

21 > 2x

88) 1155

176

90

1972 TU SCS symp. channeliz. - - stream destruct. S.
37 yrs. no idea channel - to

1969 N.E.P.A. any major action of fed. agency requires review -
for irretrievable loss. - . Write EIS (EA) review, sue!

Native LCT-Elko BLM ... 1980

1973 E.S.A. (1964) L.C.T. - Talk about long time - Nev. - ranchers
Quinn R. - 5 + 10 extinct. E.D.7. ←

1986 - FERC single purpose dam/power - on license - must consider other ... flows fish
(Unbelievable Edwards Dam Kennebec - removed) -

This is great successes of TU on national level
- use of laws, coalitions - well-founded sci. basis claims - (1960 1st TU President Casey Westfall)

BAD NEWS

30% on 1989 were going - hatcheries ... habits ... not S. - 55%

- Catchable trout - What happened. - Why more difficult problem? - Elements of class warfare: wealthy fly-r elitists vs. common worker / everyman - children - elderly - handicapped / disabled. / ID public meeting: 'youth turn to drugs & crime' - - '1983 - 50% ... 1992 ... most ...'

barbless hook no-kill,

- - D.J. - Wallop Breaux (... 5 yrs ago) - $ for catchables - restoration?
- - Stream Advocacy / > 50% of ST. professional ... culture: Public - ...
- Public perception - Leavenworth Salmon Festival $100 = 10# lb.

Self interest! Govt. agencies, socialism - labor unions coal mining.
- - But hatch. vs. catchables - - no loss jobs. -
- Mich. - 1998 - 1948 - more hatchery workers now - but not ...

Ex. - Nev. 1983: 885,335 1996 1,850,259 = 22x - 549,757 lb.
113,837 licenses: for each license 5 lb. $15 $17 catchables / 30% not for trout?

97% wt. on hatchery fish

- revenue ... 2 mil. 1.5 = 75% of license revenue. / - waste!
1958 - Leopold - Needham Rep. - Great Waste! - S. ... Birch Crk.
- Art Newman 1989 Trout - Million/yr. Great waste invoke $2.85/lb. - how figured??
- On top of bull trout (ESA): Why native trout are still neglected by state.
7-8% Calif. 40% total inland fish budget 97% catch. 8 mil. catch. weighing 3.7 mil lbs
10% for wild trout strategic plan - 300% increase by 2010!

why not native ... keep ... catch ... Calif. 60 mils ... rehabilit... 20 ... any ... management ... fund:

Calif. 7 mil lbs ... 300% increase 2010

T.U. - license - no catch. / willingness to pay. -

outside pressure necessary 1. catch. - 2. ... - 2020 purpose of hatcheries? - ... success - failure

Siekkinen 10/31 [Available on EScience server]

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IS CAPTIVE BREEDING AN EFFECTIVE SOLUTION FOR THE PRESERVATION OF ENDEMIC SPECIES?

Jean Claude Philippart*

University of Liège, Zoological Institute, 22 quai Van Beneden, B-4020 Liège, Belgium

Abstract

Captive breeding and the release of captive-bred individuals into the wild are among the techniques used for the conservation of rare and endangered fish species. After a brief description of the methods of captive breeding and the establishment of breeding stocks, this paper provides examples of the application of these techniques to endemic fish species of arid regions in south-western USA and examines some current cases and the future possibilities for their use in the Mediterranean region. Special attention is given to the analysis of the strict constraints imposed on fish breeding for conservation purposes, in which the aim is to produce fish with all the morphological, behavioural and genetic characteristics of the taxa to be conserved, and which are capable of effectively adapting to the natural environment when introduced. In terms of genetic management of captive populations, the fundamental problems which are faced involve the categorization of the species-resources to be conserved (identification of cases of inter- and intra-specific introgression), the establishment of founder stocks that contain the maximum genetic diversity depending on the genetic structure of the species (strong intra- or inter-population variability), and the retention of genetic variability during captive breeding (the need to reduce to the minimum the phenomena of genetic drift, inbreeding and unintentional selection of non-adapted genotypes). Because of these difficulties and risks in terms of genetic conservation, captive breeding should remain a temporary safeguard measure, while awaiting the implementation of measures for protecting species in their restored original habitat or translocation to strictly protected substitute habitats. With this aim in view and in conclusion, the paper suggests methods for organizing a critical plan to safeguard the most endangered species or subspecies in the Mediterranean region by captive breeding.

Keywords: endemic, captive breeding, conservation, fish.

INTRODUCTION: THE ROLE OF CAPTIVE BREEDING IN FISH CONSERVATION

With fish, as with other groups of animals, captive breeding and its logical extension — reintroduction to the wild — is a tool that can contribute to the conservation of species, subspecies, varieties (referred to hereafter as species or fishes) or populations and strains that are threatened with extinction. In the USA, about 35 species of fish from the arid southwestern regions have been recognized as being in need of artificial propagation to protect them from extinction (Rinne *et al.*, 1986). In Europe, according to Lelek (1987), captive breeding, artificial propagation and reintroduction of hatchery-reared fish into the wild could help conserve several endangered and vulnerable taxa: Acipenseridae (*Acipenser sturio, A. güldenstaedti, A. nudiventris, A. ruthenus, Huso huso*), Salmonidae (*Hucho hucho, Stenodus leucichthys leucichthys* and *S. l. nelma, Thymallus thymallus*), Cyprinidae (*Aspius aspius, Leuciscus idus, Leuciscus (Telestes) souffia, Phoxinus phoxinus, Rhodeus sericeus, Scardinius erythrophthalmus*), Esocidae (*Esox lucius*), Cobitidae (*Misgurnus fossilis, Noemacheilus barbatulus*) and Siluridae (*Silurus glanis*).

Captive breeding and stocking have produced positive results with fishes of all sizes, from a large variety of habitats and in all regions of the world. During the last 20 years, the culture of fish for conservation and/or stocking and subsequent fishing has developed to the point where it forms an activity in its own right, with its own concepts, methods, problems, constraints and challenges (FAO/UNEP, 1981; Ryman, 1981; Smith & Chesser, 1981; Rinne *et al.*, 1986; Ryman & Utter, 1987; FAO, 1988; Le Cren, 1990; Minckley & Deacon, 1991; Nyman, 1991).

Despite its considerable potential and the role that it has played for a long time in maintaining inland fisheries (for the European situation, see Philippart, 1990*a*), artificial propagation of fish must never be considered as an effective means for the long-term safeguard of most species and strains (Nehlsen *et al.*, 1991). In particular, this technique poses risks in conserving the integrity of genetic resources (Ryman, 1991) and it must be used mainly when all other possibilities aimed at conserving a species in its natural environment have been exhausted. Captive breeding must also be used as a temporary measure, while waiting for the restoration of habitats suitable for controlled reintroduction and the reconstitution of self-sustaining populations. The priority activities to be carried out in the field involve reducing negative effects on the species or populations endangered by various human factors, such as pollution, water diversion, overfishing, introduced species or planting of non-native stocks of the same species (Lelek, 1987; Lowe-McConnell, 1990; Moyle & Leidy, 1992).

*Research Associate at the National Scientific Research Foundation (FNRS).

When it is difficult to take effective action against these threats, or if such action cannot be taken sufficiently quickly compared with the imminence of the threat, one option to avoid extinction of an endemic species is translocation or relocation. This involves transplanting wild individuals of the threatened species into a new natural habitat, either previously unoccupied or occupied, where they have a chance of adapting without damaging the local fauna (Williams & Williams, 1989; Wikramanayke, 1990; Hendrickson & Brooks, 1991; Minckley, 1994). If this is impossible, it is then necessary to have recourse to the most extreme form of relocation, which involves transfer of wild imperiled fish to the entirely artificial habitat of the captive breeding station.

Following this review of the role of captive breeding among the range of available techniques for the conservation of endangered fish species, we will examine several aspects of fish culture for conservation and restocking, focusing on three main points.

(1) A brief description of the techniques currently used in fish culture and their present or potential applications to endangered species in European and Mediterranean fresh waters, with an evocation of some examples in southwestern USA;
(2) A presentation of specific genetic constraints imposed on fish culture for conservation and general methods of genetic management to be developed for cultured stocks; and
(3) An overview of the high biological quality criteria (essentially behavioural, genetic and health aspects) required by cultured fish destined to be restocked in natural water bodies for the reconstruction of self-sustaining (naturally breeding) populations or for the enhancement of populations suffering a demographic decline due to spawning or recruitment failure.

CAPTIVE BREEDING TECHNIQUES FOR IMPERILED FISH

Breeding programmes and facilities

Captive breeding programmes for the conservation of rare or endangered species that are operating throughout the world are based on the use of three main types of facilities:

(1) *Aquaria-indoor installations* which may be organized into networks, which ensure the maintenance of species that breed readily in captivity in small tanks (Maitland & Evans, 1986). This method is used for the production of endangered tropical ornamental fishes (and for the conservation of small endemic Cichlidae from various African lakes such as Lake Malawi and Lake Victoria; Reid, 1990). Captive breeding of the endangered haplochromine species from Lake Victoria is currently carried out at the Universities of Leiden, Holland and Bielefeld, Germany and at the Horniman Museum, London, where a Fish Rescue and Breeding Centre was set up in 1986 (Reid, 1990). According to Ingram *et al.* (1990), the rainbow fish *Melanotaenia eachamensis* endemic to Lake Eacham in Australia owes its survival to the building up of an aquarium captive breeding stock in 1980.
(2) *Semi-natural water bodies* such as ponds where fish reproduce naturally. This technique is especially valuable for small-bodied and short-lived species inhabiting standing or slow-flowing waters. It is used for several Poecilidae or livebearers (*Gambusia amistadensis, G. gaigei, Poeciliopsis occidentalis occidentalis, P. o. sonorensis*) Cyprinodontidae or pupfishes (*Cyprinodon bovinus, C. elegans, C. macularius macularius, C. pecosensis*) and certain spring and small riverine Cyprinidae (*Cyprinella f. formosa, C. f. mearnsi, Plagopterus argentissimus*) from North American desert regions (Pister, 1990; Johnson & Jensen, 1991). It has also been suggested for the conservation of some species (e.g. the bitterling *Rhodeus sericeus*) in Germany (Schmidt, 1990).
(3) *Fish hatcheries and farms* where fish are bred by artificial means, reared in various outdoor–indoor facilities (stagnant or flowing water ponds, tanks, raceways, in flow-through troughs and recirculation systems) and generally fed with prepared pelleted feeds. This technique is widely used to conserve lake (limnophilous) and river (rheophilous) fishes of several families:
    (a) species, subspecies and local rare forms or stocks of Salmonidae in North America (*Oncorhynchus apache, O. gilae*; Rinne, 1990) and Scandinavia, e.g. landlocked salmon *Salmo salar m. sebago* (Westman & Kallio, 1987), original stocks of brown *Salmo trutta m. fario* and lake trout *S. trutta m. lacustris* (Gjedrem, 1981; Skaala *et al.*, 1991) or relict populations of arctic charr *Salvelinus alpinus* (WWF Finland, pers. comm.).
    (b) Cyprinidae from the temperate regions of South Africa (e.g. several *Barbus* spp. from Olifants River, South-West Cape), from arid regions in southwestern USA (*Ptychocheilus lucius, Gila elegans, G. cypha, G. ditaenia, G. nigrescens, G. pandora, G. purpurea* and three subspecies of *G. robusta*) (Johnson & Jensen, 1991), *Aspius aspius* in Finland (Kaukoranta & Pennamen, 1990) and, to a certain extent, running water cyprinids *Alburnoides bipunctatus, Barbus barbus, B. meridionalis, Chondrostoma nasus, Leuciscus idus*, all species classified as vulnerable in Europe by Lelek (1987) in Belgium at the Tihange Fish Breeding Centre (FBC) (Philippart, 1982, 1990*b*).
    (c) other families, especially Acipenseridae in Eurasia and North America (Rochard *et al.*, 1990), Catostomidae (*Xyrauchen texanus, Catostomus bernardini, Chasmistes brevirostris, C. cujus, Deltistes luxatus*) and Percidae

From: Adrian Spidle and Paul Bentzen
Marine Molecular Biotechnology
3707 Brooklyn Ave. NE
Seattle, WA 98105
Phone: 206-685-6883

25 January, 1996

To: Trygve Sletteland
Sierra Club Legal Defense Fund
705 2nd Ave. Suite 203
Seattle WA, 98104

Dear Mr. Sletteland:

We have enclosed our critique of WDFW's discussion of the possible genetic effects a new steelhead hatchery on Grandy Creek in the Skagit River drainage might have on existing wild steelhead runs. In the environmental impact statement for the Grandy Creek Hatchery WDFW relies on a number of simplifying assumptions that fail to adequately address the enormous uncertainty present in calculating the potential for non-native hatchery fish to adversely affect existing wild steelhead.

Sincerely,

Adrian Spidle Paul Bentzen

Adrian Spidle and Paul Bentzen

Critique of WDFW's analysis of possible genetic impacts on existing wild steelhead in the environmental impact statement for a steelhead hatchery proposed for Grandy Creek

Introduction

Washington Department of Fish and Wildlife (WDFW) has proposed to increase the number of steelhead stocked into the Skagit River drainage by building a new hatchery at the confluence of Grandy Creek and the Skagit River, according to the 1994 final environmental impact statement (FEIS) for the project. WDFW's draft steelhead management plan (FEIS appendix A-3) calls for minimizing introgression of alleles from hatchery fish into the wild runs they are used to supplement. WDFW's expectation that Chambers Creek stock steelhead will not adversely affect the gene pool of wild Grandy Creek or Skagit River steelhead relies on two assumptions: 1) Nearly all hatchery fish not taken into the hatchery for broodstock will be taken in either sport or commercial fisheries; any hatchery fish that do escape to spawn in the wild will do so before wild winter steelhead return to spawn, and therefore will not interbreed with them; and 2) The fitness of hatchery fish that spawn in the wild will be so low that natural selection will eliminate them from the gene pool, removing any threat they pose to the wild runs. These assumptions are not reliably supported by available evidence.

The present report will summarize the information in the FEIS relevant to assessing the potential impact of Chambers Creek steelhead on native winter steelhead. It will also review the biological basis of the distribution of genetic variation in Pacific salmon, as well as current knowledge on the genetic effects of hatchery salmonids on wild populations and, finally, highlight uncertainties and gaps in the assumptions made by WDFW. The state's position in the FEIS, that increased stocking of hatchery-produced non-native steelhead will only minimally affect the biological integrity of wild steelhead runs, fails to acknowledge serious uncertainties presented below.

Background at Grandy Creek

The proposed Grandy Creek hatchery would be used to produce a domesticated Chambers Creek steelhead stock, which has been selectively bred into an early winter run in order to minimize overlap in the spawning periods of the hatchery fish and the wild winter steelhead. Grandy Creek does have a wild winter steelhead run. WDFW anticipates that hatchery production will lead to adaptation of the Chambers Creek stock to the environment of the Skagit, resulting in a "new" stock of early winter steelhead adapted to the Skagit River. Chambers Creek steelhead are currently being stocked into the Skagit drainage at WDFW's Marblemount hatchery. The Chambers Creek stock exhibits 40% spawner overlap with wild winter steelhead, i.e. 40% of hatchery females have not yet begun spawning by the time the wild run begins spawning in February (p. 43, appendix A-6 FEIS). Therefore 40% of hatchery females minus fishing mortality and hatchery taking will be available to spawn with Grandy Creek wild males. Because males are not gamete limited, they tend to stay in freshwater longer than females, and therefore have greater opportunities to reproduce than do females. If the hatchery males remain in freshwater until there are no more females to spawn with, 100%, minus fishing mortality and hatchery taking, of the Chambers Creek males would then be present when the wild winter steelhead population returns to spawn. Some level of gene flow from Chambers Creek stock to wild Skagit winter steelhead has therefore been occurring ever since hatchery supplementation began in the Skagit drainage. Finally, WDFW assumes that hatchery strays that successfully spawn will retain their artificially selected run timing. There is no reason to believe that Chambers Creek fish that stray into in Grandy Creek will retain their artificially selected run time when released from hatchery selection.

The US National Research Council discourages artificial selection in hatchery production for reasons including the following: 1) intentional selection reduces within population genetic variation 2) ability to accomplish selection is largely unknown, and uncertain at best, given the lack of information on selection for different traits that occurs outside the hatchery and 3) we do not at this point know which distributions of phenotypes and genotypes are required to assure long term fitness in the range of environments encountered by individual anadromous salmonids over the lifetime of the individual fish as well as the hatchery population over the service life of the hatchery (NRC 1995).

Gene flow and distribution of genetic variation in salmonids

The seven anadromous species of salmonid in the Pacific northwest all home to their natal streams with varying levels of precision. Gene flow among populations results when homing fish stray away from their target stream but manage to reproduce successfully in their new stream. Successful reproduction means that the offspring of strays must themselves return to spawn successfully in the new stream, or else the genes of the original stray fish will not remain in the new population. Stray fish that do not successfully spawn do not contribute to gene flow among populations. Salmonid populations are structured within a drainage according to the degree of fidelity spawners have for the stream in which they were born. A metapopulation is defined as a collection of populations among which there is a constant, normal level of gene flow, which in the case of salmonids roughly equates to a drainage containing multiple runs of fish but with some level of straying (in time or space) among the runs. Metapopulations of precisely homing salmonids such as sockeye (*O. nerka*), chinook (*O. tshawytscha*), and steelhead trout tend to be composed of a large number of small but distinct runs, connected by low levels of gene flow. Metapopulations of species such as chum (*O. keta*) or pink (*O. gorbuscha*) salmon, which home less precisely, or to a larger general area, tend to be composed of fewer larger populations connected by greater levels of gene flow. The distribution of genetic variation within and among metapopulations dictates the ability of species to respond to variation in environmental conditions.

In metapopulations consisting of many small, isolated populations, precise local adaptations can be developed in each population and maintained because of the low level of gene flow. Such finely-tuned populations are particularly well adapted to the range of natural variation in the specific environment in which they occur. The low levels of straying serve mainly to salvage parts of the gene pool of that population in the event of a catastrophe, such as the eruption of Mt. St. Helens. If constant gene flow increased among such populations the local adaptations that foster sustainability would be lost, resulting in an overall decrease in fitness and production of each individual population, and an increase in susceptibility to normal environmental extremes. The maintenance of natural genetic variation is therefore crucial to maintenance of self-sustaining salmonid populations. WDFW has recognized this requirement in formulating their steelhead management plan (FEIS appendix A-3).

Effects of straying hatchery salmonids on natural genetic variation

The effects of hatchery salmonids on natural genetic variation will vary according to state and size of the wild run, and size and origin of the hatchery run. A recent workshop addressed the genetic effects of non-native hatchery fish straying into wild populations of salmonids (NMFS 1995). The panel of experts convened for this workshop concluded that the following factors are particularly important: 1) rate at which hatchery fish stray; 2) gene flow, meaning the proportion of spawners that are non-native; 3) genetic effective population size of the wild run; and 4) the level of natural selection on different genotypes of fish. Each of these factors are discussed below in the context of the Grandy Creek run.

1) The rate at which hatchery fish will stray into Grandy Creek and adjacent habitats in the Skagit River and its tributaries is not specified in the FEIS. Some estimate of this parameter or the range of values it might assume is necessary to determine the potential for hatchery Chambers Creek steelhead to stray into Grandy Creek and surrounding areas.

2) Level of gene flow: The specific number of spawners that could be of hatchery origin is unknown, and obviously related to (1) above. As stated above, up to 60% of the hatchery fish will have already spawned by the time the wild Grandy Creek run returns to spawn. WDFW anticipates 16,020 hatchery adults returning to Grandy Creek. At least 6,400 hatchery fish will not have returned by the time the Skagit's native winter run has begun. The mean run size of Skagit River winter steelhead from 1977-78 through 1991-92 was reported in the FEIS to be 9,565 for the whole river (FEIS appendix A-1). Further research demonstrates that the winter steelhead run in the Skagit River has been undergoing large fluctuations over the past several years. Spawning escapement of Skagit winter steelhead has decreased to only 2,934 in 1991 and 3,920 in 1992 (1992 Washington State Salmon and Steelhead Stock Inventory). The

mean figure used in the FEIS, therefore, does not reflect the range of run sizes that have been documented to occur in the Skagit from year to year. The size of the run in Grandy Creek is not stated in the FEIS. Presumably the Grandy Creek run consists of a few hundred fish at most.

3) Genetic effective population size (Ne) determines the rate at which new alleles brought in by gene flow from hatchery fish will spread through the existing population. Given that Ne is commonly 0.1 to 0.3 of total population size, Ne of the entire Skagit winter steelhead run could range from a low of 290 to a high of 2,870. The Grandy Creek run's Ne is undoubtedly much lower. This suggests that hatchery alleles (i.e. genetic traits from hatchery fish) could rapidly penetrate the wild Grandy Creek run.

4) Natural selection will determine the extent to which hatchery strays can survive and reproduce in Grandy Creek and the Skagit in general. Alleles with strongly deleterious effects will be removed from the population quickly. Alleles with slightly deleterious effects may persist or spread because of random breeding effects associated with low Ne of the wild fish acting in combination with high gene flow from hatchery fish.

From the perspective of the panel convened by NMFS in summer 1995, much critical information on the Skagit River population in general and the Grandy Creek run in particular is not presented in the FEIS, and is probably not available. At the very least the size of the Grandy Creek run must be determined. Establishing the genetic effective population size of the winter steelhead runs in Grandy Creek in particular and the Skagit drainage in general is required to assess the susceptibility of current populations to future introgression from non-native hatchery fish. In-depth analysis of genetic variation in the Skagit River winter steelhead run could reveal the extent to which introgression from the existing Marblemount facility into wild winter steelhead runs has already occurred. Current information on genetic variation in Skagit River steelhead, and possible hatchery introgression is **unclear at best** (appendix A-2 FEIS).

Discussion of WDFW's plan to conserve genetic variation

The draft of WDFW's steelhead management plan for 1993 (appendix A-3 FEIS) allows gene flow among hatchery and wild stocks to the extent that long term reproductive potential of the wild stock is maintained "at a minimum of 90% of its natural level" (p.10 appendix A-3 FEIS). The model used to determine the effect of gene flow among hatchery and wild populations, "Genetic conservation of wild steelhead in Washington streams: A genetically based conservation and management model to integrate hatchery and wild production" (GCM), is presented in appendix A-5 of the FEIS (Hulett and Leider 1992). GCM invokes a number of simplifying assumptions that reflect current limits in our knowledge of population genetics of Washington state steelhead populations and factors contributing to overall fitness in populations of fish, whether wild or domestic. Regarding such assumptions, the authors state in advance that "conservation of genetic resources has been called a 'crisis discipline' (Soule 1985) where 'one must act before knowing all the facts' and 'tolerating uncertainty is often necessary'". The level of uncertainty that remains in the GCM as it is currently written, however, is so great as to leave the model with very little meaningful predictive ability. This absence of predictive power is not meaningfully discussed in the FEIS.

The authors of GCM use a single study (Reisenbichler and McIntyre 1977) suggesting that F1 crosses between hatchery and wild steelhead are intermediate in fitness between the parental types, measured by growth and survival, to justify the assumption of a single-locus, two allele model with intermediate fitness of heterozygotes. GCM then uses an index of adaptation based on a subjective ranking of several stock history traits to calculate the predicted ratio of reproductive success of hatchery fish relative to wild fish. The degree to which various factors are used to weight the categorical traits is apparently based upon no data at all. This index ensures that fitness of hatchery fish is extremely low in the natural environment. GCM's index of fitness agrees with the one study with information on the relative reproductive success of hatchery and wild fish spawning in nature (Leider et al. 1990). Using a single-locus two allele model, however, drastically underestimates the complexity of the range of characteristics that differentiate hatchery from wild strains of steelhead.

While the majority of genes from hatchery fish contributed to wild populations are no doubt selectively neutral, some will have a very low fitness, some will have a slightly deleterious effect, and others may even have some positive effect. WDFW's GCM ignores all possibilities but the second, that hatchery fish will have a low fitness. This is the simplest approach for a number of reasons, not least being that nearly all such traits are quickly swept from the gene pool by natural selection and need not concern future managers. The evolutionary hazard presented by fixation of slightly deleterious alleles has been modeled in a recent simulation study (Lande 1994). Traits that reduce fitness somewhat but still allow survival and some level of reproduction are particularly insidious because such traits are reduced by selection at a slower rate than they are spread through the population by reproduction. The extent to which deleterious alleles are recessive further masks them from the effects of selection. Eventually the overall fitness of the entire population drops without any single lineage being dramatically affected. Accumulation of alleles that are only slightly deleterious has been shown to substantially increase the probability of a population's extinction relative to alleles with strong negative fitness consequences (Lande 1994, Lynch et al. 1995). These crucial issues are not addressed in the FEIS.

There are two main weaknesses with WDFW's projections of how newly stocked Chambers Creek steelhead will affect the current wild run of Grandy Creek winter run steelhead. First, the number of hatchery fish that will stray from the hatchery and manage to spawn with wild steelhead, in spite of the sport and commercial fisheries, is unknown. Second, the impact of the straying hatchery fish on the reproductive potential of the wild stock cannot be predicted with any precision from the model presented in the FEIS (GCM). GCM as it currently exists is less useful than it could be because the genetic basis of "hatchery" and "wild" adaptations is drastically oversimplified. The assumption that all hatchery adaptations are linked (i.e. presented as the equivalent of a single gene in GCM) and will be removed by natural selection is not founded and helps to underestimate the potential impact of hatchery fish on the wild population. Most alleles and traits introduced to the Grandy Creek steelhead run will in fact persist through generations and may lower the overall run fitness through their own action as well as through interruption of existing coadapted gene complexes. The risks that these oversimplifications pose for the conclusions of the FEIS are ignored.

Conclusion

In summary, the FEIS has no estimate of the size of the winter steelhead run in Grandy Creek, and no estimate of the extent to which Chambers Creek early winter hatchery steelhead will stray into Grandy Creek and surrounding areas. The extent of overlap in spawning time between the hatchery and wild fish suggests that wild fish will encounter hatchery fish while spawning. A stray rate as low as 5% would result in 800 Chambers Creek fish seeking spawning opportunities in Grandy Creek. Simply crowding that many additional fish into the creek will affect the number of suitable sites physically available for redd construction. If 40% of those strays (ignoring males that came in early but leave late in the season) overlap with the wild run, then approximately 320 of the hatchery fish will be directly competing with wild fish for spawning sites and opportunities. Gene flow from the hatchery to wild populations could be quite high.

The absence of information on the genetic effective population size for either the Skagit River runs in general or the specific Grandy Creek run of winter steelhead make it difficult to estimate the effect of introgression on the wild populations. A high level of Ne would enable the wild runs to withstand a relatively high level of gene flow from the hatchery fish. A low level of Ne would increase susceptibility of the wild runs to gene pool changes caused by introgression from hatchery fish. Given the low size of winter steelhead runs in the entire Skagit River the last few years (1992 Washington state salmon and steelhead stock inventory), Ne is likely to be even lower. The computer model used by WDFW is overly simplistic in allowing effects of introgression to vanish in a single generation (i.e. all fish born in the wild are considered homozygous wild fish for fitness purposes, regardless of their actual parentage). WDFW does not know the extent to which Skagit River winter steelhead have already been introgressed from Chambers Creek steelhead currently stocked at the Marblemount facility.

On the basis of the information presented in the FEIS, none of four parameters, identified as significant in estimating the effect of hatchery straying on the gene pools of wild fish by the NMFS workshop (1995), are known accurately enough to predict what final effect the proposed new hatchery would have on the Grandy Creek winter steelhead runs or on the Skagit River in general. Finally, the US National Research council suggests that the strategy of using hatchery production to increase commercial and recreational catch (the stated goal of the proposed Grandy Creek hatchery) has contributed to the decline of salmonid populations in the past and is not likely to succeed in providing self-sustaining populations of hatchery fish over the long term (NRC 1995). For this and other reasons the NRC has proposed that hatcheries be avoided in the future unless a clear-cut institutional decision has been made either 1) to use the hatchery as one facet of an ecosystem-level management strategy designed to rehabilitate salmonid populations to self-sustaining levels or 2) to devote a given watershed exclusively to intensive production of large numbers of fish. In the former case the goal is to rehabilitate natural self-sustaining populations and in the latter the goal is to provide maximum production through artificial means. From the FEIS it is not clear that the WDFW has made such an institutional decision.

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SIERRA CLUB LEGAL DEFENSE FUND, INC.

4/20/96

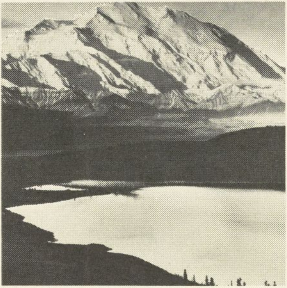
Dr. Behnke:

I thought you might want to comment. The Seattle Times' address is: P.O. Box 70, Seattle, WA 98111.

Best regards,

Tryg Sletteland

printed on recycled paper



Trygve B. Sletteland
Salmonid Resource Analyst
SIERRA CLUB LEGAL
DEFENSE FUND, INC.
203 Hoge Building
705 Second Avenue
Seattle, WA 98104-1711
(206) 343-7340
(206) 343-1526 FAX
EMAIL: scldfwa@igc.apc.org
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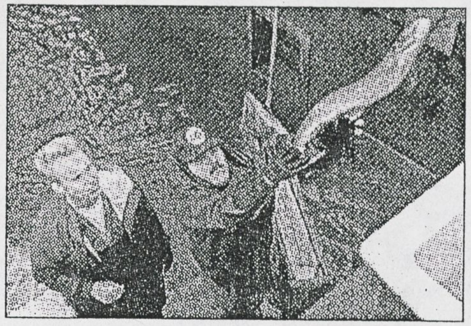
HATCHERIES CATCHING HEAT



Scientist *Chris Wageman tosses a steelhead into a recovery tank after taking flesh and sca samples at the Kala Falls Fish Hatchery. Kurt Spiegel assists the procedures.*

his week n The Times

omorrow

lany White River pring chinook ever get near the Vhite River — nd that's how iologists are try- ng to save them.

uesday cience

almon carcasses ay be unpleas- nt, but scientists nd they're impor- ant for stream cosystems.

◆ *THE HAND OF MAN hasn't helped Northwest's wild-fish runs much, research shows.*

By Eric Pryne
Seattle Times staff reporter

Oregon's wild coastal coho salmon are in trouble, slated for a spot on the endangered species list. State officials once thought they could rebuild those runs by planting millions of young hatchery coho in coastal rivers to breed with and boost the native stocks.

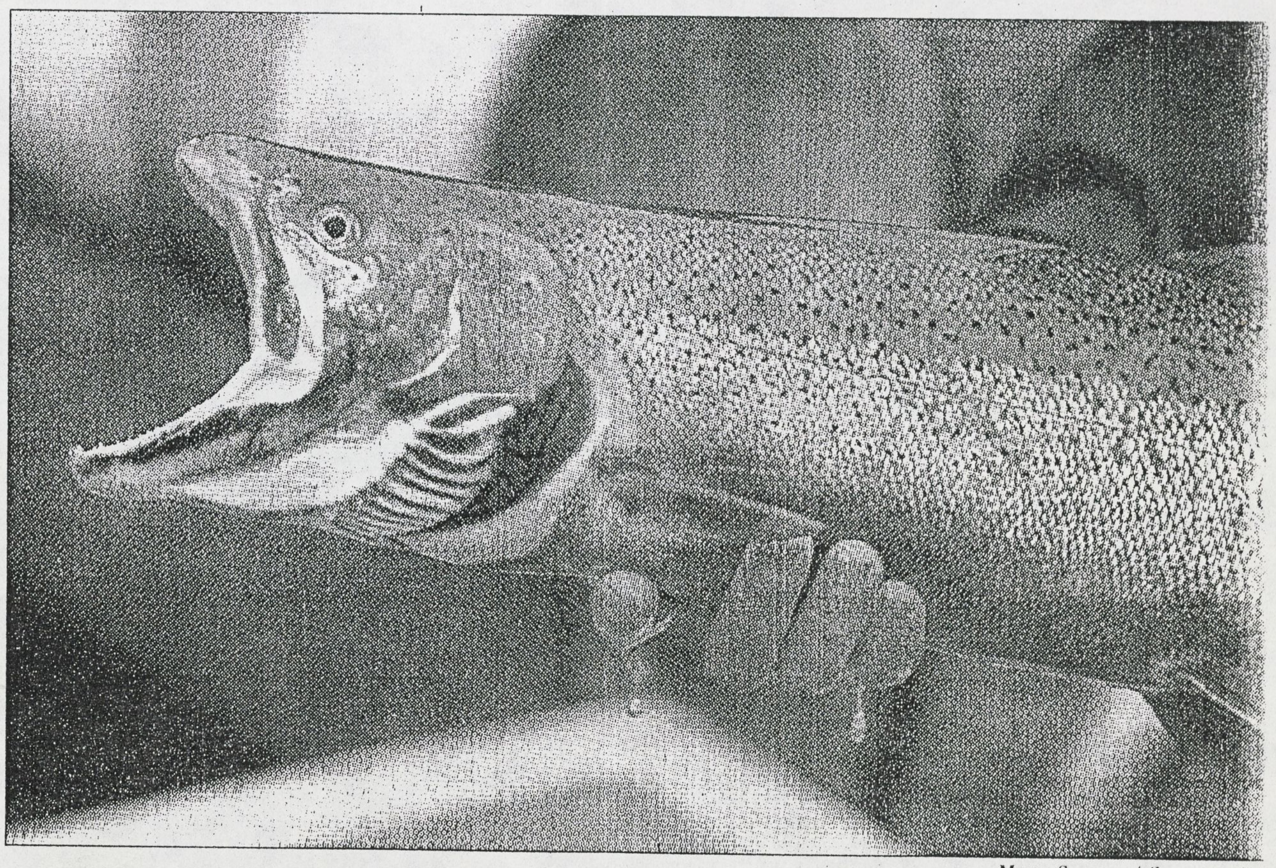
Sometimes, they learned, more really gets you less.

After the stocking program began in the early 1980s, state scientists compared 15 stocked and 15 unstocked streams to see if the project really produced more fish.

It didn't. Several years after the hatchery fish were planted — after that generation had matured, gone to sea, returned, spawned and died — the scientists found *fewer* second-generation young coho in the stocked streams than in the creeks that had been left alone.

Why? Because the hatchery coho were different, the scientists concluded. They quickly displaced many wild fish, something no one planned. Over the long run, however, they

Please see *Hatcheries* on A 14



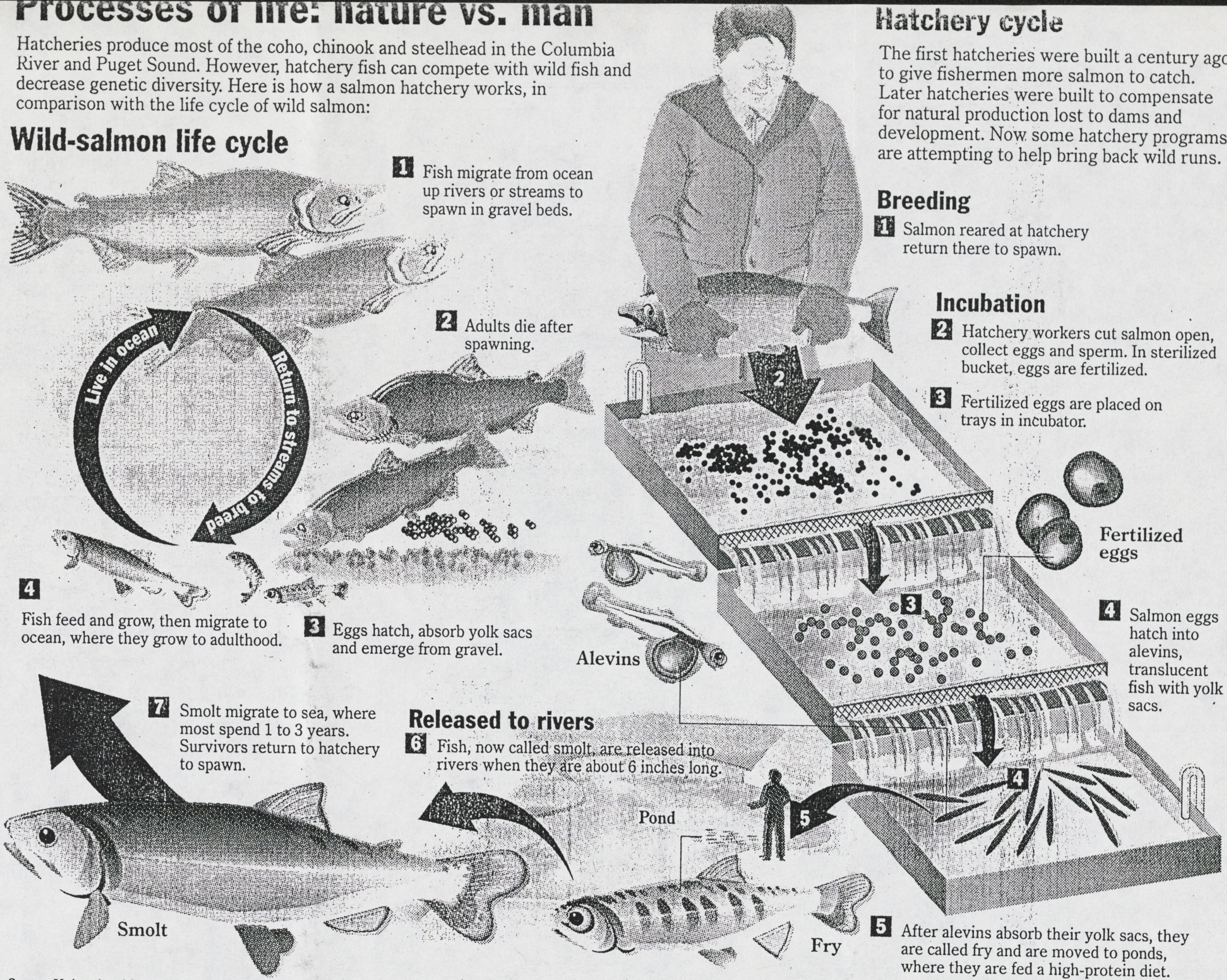
Mike Siegel / Seattle Ti

Hatchery fish *have largely replaced wild fish on the Kalama River, where a long-term study of hatchery-wild interactions is under way. After tissue samples were taken, this steelhead was returned to the river.*

1)

Processes of life: nature vs. man

Hatcheries produce most of the coho, chinook and steelhead in the Columbia River and Puget Sound. However, hatchery fish can compete with wild fish and decrease genetic diversity. Here is how a salmon hatchery works, in comparison with the life cycle of wild salmon:



Wild-salmon life cycle

1 Fish migrate from ocean up rivers or streams to spawn in gravel beds.

2 Adults die after spawning.

3 Eggs hatch, absorb yolk sacs and emerge from gravel.

4 Fish feed and grow, then migrate to ocean, where they grow to adulthood.

Hatchery cycle

The first hatcheries were built a century ago to give fishermen more salmon to catch. Later hatcheries were built to compensate for natural production lost to dams and development. Now some hatchery programs are attempting to help bring back wild runs.

Breeding

1 Salmon reared at hatchery return there to spawn.

Incubation

2 Hatchery workers cut salmon open, collect eggs and sperm. In sterilized bucket, eggs are fertilized.

3 Fertilized eggs are placed on trays in incubator.

4 Salmon eggs hatch into alevins, translucent fish with yolk sacs.

5 After alevins absorb their yolk sacs, they are called fry and are moved to ponds, where they are fed a high-protein diet.

Released to rivers

6 Fish, now called smolt, are released into rivers when they are about 6 inches long.

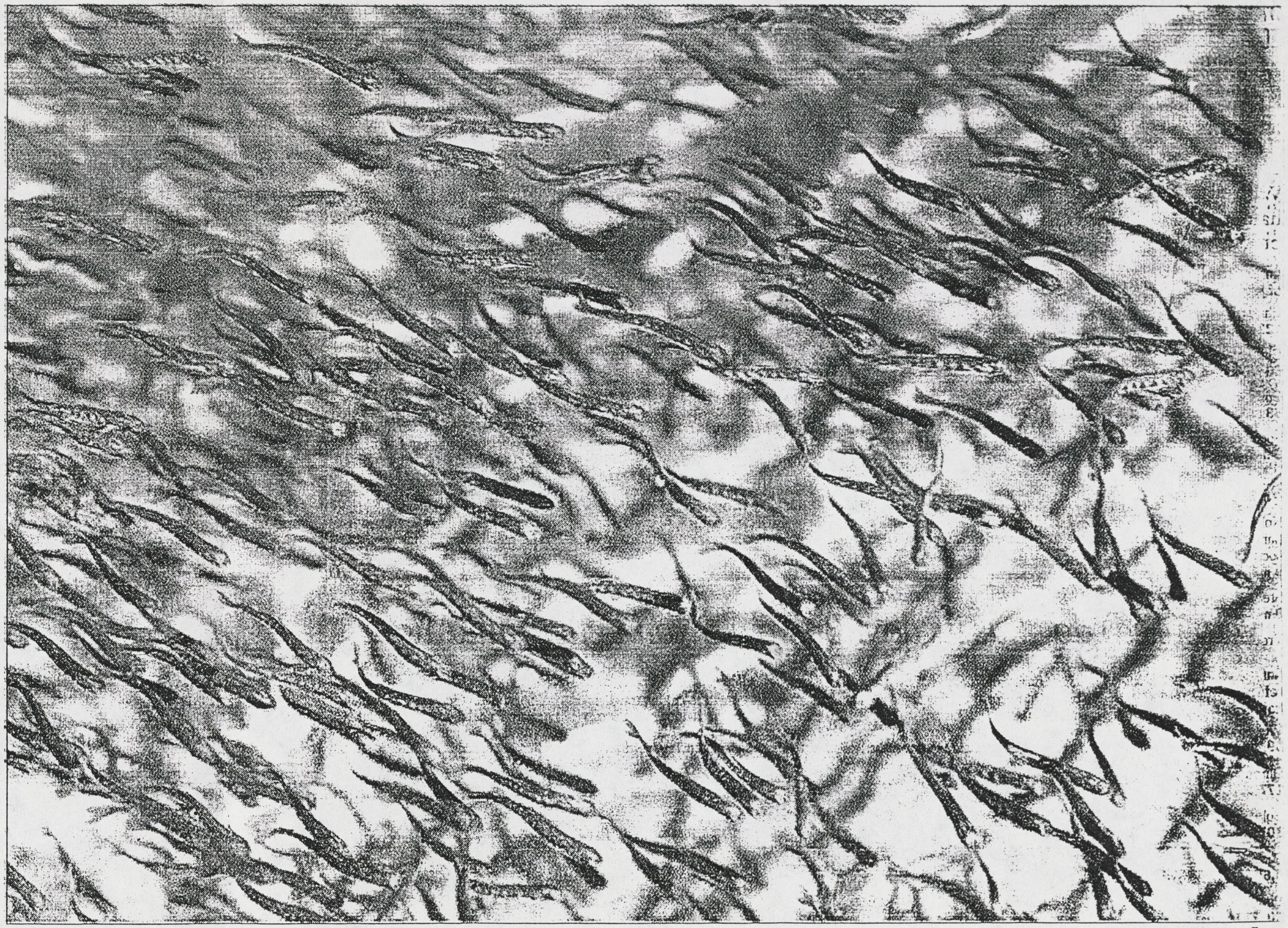
7 Smolt migrate to sea, where most spend 1 to 3 years. Survivors return to hatchery to spawn.

Source: University of Oregon, Washington State Department of Fish and Wildlife

CHRIS SOPRYCH / SEATTLE TIMES

2

In hatcheries, even not-so-fit survive



MIKE SIEGEL / SEATTLE TIMES

Thousands *of 3-month-old chinook salmon swim at the Hupp Springs Fish Hatchery near Purdy.*

(4)

Hatcheries

CONTINUED FROM PAGE A 1

couldn't replace them.

For decades, hatcheries have been hailed as a solution to the Northwest's salmon woes. Now many say they're part of the problem.

The most recent blast comes from the National Academy of Sciences. After a three-year, congressionally mandated review of the salmon problem, an academy panel concluded last winter that hatcheries not only had failed to compensate for the drop in wild-salmon and steelhead production but also had unintentionally contributed to it.

Hatcheries have been cited by federal scientists in Endangered Species Act reviews as one factor in the decline of wild West Coast coho and steelhead, as well as Snake River chinook.

Even the Washington Department of Fish and Wildlife, which runs 90 hatcheries, acknowledges in a draft wild-salmon-protection policy that hatchery-related programs have caused problems for wild fish.

How serious are those problems? What should be done about them? Do hatchery programs require an overhaul, or just a tune-up?

Fisheries agencies are wrestling with those questions. Their decisions will affect not only the salmon, but those who love them and those whose livelihoods depend on them.

Some say hatchery production should be cut drastically. It's part of what's needed to allow wild stocks to recover and, ultimately, increase overall abundance, the National Academy of Sciences panel wrote.

That view is making some inroads among policy-makers. The draft federal recovery plan for endangered Snake River salmon, for instance, calls for limits on hatchery releases throughout the Columbia River Basin.

But hatcheries now produce most of the coho, chinook and steelhead in the Columbia and Puget Sound. For at least the short term, fewer hatchery fish would mean fewer jobs, less food, less recreation — and more political turmoil.

No state has invested in hatcheries more heavily than Washington. Since the first facility opened a century ago, the state's hatchery system has evolved into the world's largest: State, tribal, federal and private hatcheries released 270 million young salmon and steelhead into streams in 1994.

That's 50 fish for every man, woman and child.

The people who run those programs are proud of their productivity. They say some of the criticism to which hatcheries have been subjected is Monday-morning quarterbacking, judging yesterday's decisions by today's science and values.

"They say hatcheries haven't protected wild fish," says Andy Appleby, a biologist in the state Fish and Wildlife Department's hatchery program. "We weren't asked to (protect them) until the past 10 years."

But Appleby and his colleagues also acknowledge mistakes have been made. They say they do things differently now, and are open to more change. Hatcheries, when run right, can coexist with wild fish, even help them, they maintain.

No one argues that hatcheries are solely responsible for the wild salmon's demise. Rivers have been dammed, diverted and polluted, watersheds logged, grazed and paved over. Salmon and steelhead have been harvested in ocean, bay and river at unsustainable rates.

Apportioning responsibility is no easy task.

But Sequim fisheries consultant Jim Lichatowich, co-author of an influential 1991 report that highlighted the precarious condition of many wild-salmon populations, contends hatcheries deserve a special place in hell.

They provided a century of intellectual cover for all the other assaults, he argues: People could catch too many fish and dam thousands of miles of river, all the while reassuring themselves hatcheries would make up for the losses.

We thought we could have our fish and eat them, too. History suggests we can't, Lichatowich says.

Genetic diversity threatened

The case against hatcheries boils down to three central arguments:

- Hatchery fish are different from wild fish.
- Hatchery fish harm wild fish.
- Without wild fish, salmon and steelhead are doomed to continued decline, perhaps extinction.

Few, if any, fisheries biologists will tell you salmon could persist indefinitely if production depended entirely on hatcheries. Some have churned out fish successfully for a half-century or more; in some watersheds, there would be no salmon without hatcheries. But no one can foretell if that success will continue. for another 100 years. In the wild, in contrast, salmon and steelhead have been spawning since the ice sheets retreated.

And hatcheries can't duplicate or replace the wild salmon's most valuable resource: genetic diversity.

Because most salmon return to their native streams to spawn, they have evolved over centuries into hundreds of distinct, locally adapted stocks. The disappearance of many populations — salmon now are extinct in 40 percent of their historic range on the West Coast — represents a huge blow to that diversity.

Most scientists say it's essential to preserve what diversity remains, partly to provide "risk insurance" against new diseases or changing environmental conditions, such as an El Niño or a Mount St. Helens eruption.

It's more than an academic concern. Reg Reisenbichler of the National Biological Survey draws parallels with agriculture: Several widely planted crops would have been devastated by disease if scientists had not found resistant genes in obscure, wild varieties of the plants.

All hatchery fish are descended from wild fish. But over the past century, hatcheries have done more to eliminate genetic diversity, within populations and between them, than to preserve it.

For decades, many scientists and managers didn't understand the importance of local populations; a fish was a fish. Eggs and young fish routinely were transferred between hatcheries and between rivers, homogenizing populations.

Hatchery managers also diminished genetic diversity by trying to build a better salmon. They often spawned only the largest or oldest adults, released only the largest smolts, or used the sperm of a single male to fertilize eggs from many females.

Sometimes such artificial selection was unintentional. Many hatchery coho spawn earlier than their wild counterparts because hatchery managers didn't take eggs from late-returning fish; their quotas already had been met.

Hatchery managers now generally acknowledge the error of those ways. "The technocratic arrogance of the past, that was just wrong," says Kevin Amos, fish health manager for Washington's hatchery program.

But scientists such as Reisenbichler and Robin Waples of the National Marine Fisheries Service argue that, despite reforms, hatchery fish always will be different because the hatchery environment is so different from the wild.

"There's water in both of them; that's about all they have in common," says Reisenbichler.

Hatchery fish are fed. Wild fish must compete for space and food.

Wild fish must avoid predators. Fish in hatch-

PLEASE SEE *Hatcheries* ON A 15

HATCHERIES CATCHING HEAT

Status of state's wild salmon and steelhead spawning populations

Statewide:
43% healthy,
28% depressed,
3% critical,
26% unknown

By region:

Puget Sound:
45% healthy,
21% depressed,
5% critical,
29% unknown

Coastal:
57% healthy,
7% depressed,
0% critical,
37% unknown

Columbia River:
26% healthy,
63% depressed,
1% critical,
10% unknown

By species:

Chinook (108 spawning populations):
50% healthy,
32% depressed,
5% critical,
13% unknown

Chum (72 spawning populations):
67% healthy,
4% depressed,
3% critical,
25% unknown

Coho (90 spawning populations):
41% healthy,
38% depressed,
1% critical,
20% unknown

Pink (15 spawning populations):
60% healthy,
13% depressed,
13% critical,
13% unknown

Sockeye (nine spawning populations):
33% healthy,
44% depressed,
11% critical,
11% unknown

Steelhead (141 spawning populations):
26% healthy,
31% depressed,
1% critical,
43% unknown

Source: Washington State Salmon and Steelhead Stock Inventory, 1993.

Note: *Percentages may add up to slightly more than or slightly less than 100 percent because of rounding of figures.*

In 1992-93, 88% of all steelhead harvested in Washington were hatchery fish.

Between 1986-91, more than 70% of the Puget Sound coho catches were hatchery fish.

Source: Washington Dept. of Fish and Wildlife Wild Salmonid Policy, first draft, 1995

By 1987, hatchery fish accounted for more than 95% of the coho, 70% of the steelhead, and well over half the chinook adults returning to the Columbia River Basin.

Source: Columbia Basin Fish and Wildlife Authority, 1990

hatchery production

Annual releases of juveniles

Chinook salmon:
121 million

Chum salmon:
60 million

Coho salmon:
58 million

Sockeye salmon:
9 million

Pink salmon:
4 million

Kokanee (landlocked sockeye):
9 million

Steelhead:
8 million

Trout: **11 million**

Annual adult returns to hatcheries

Chinook salmon:
99,000

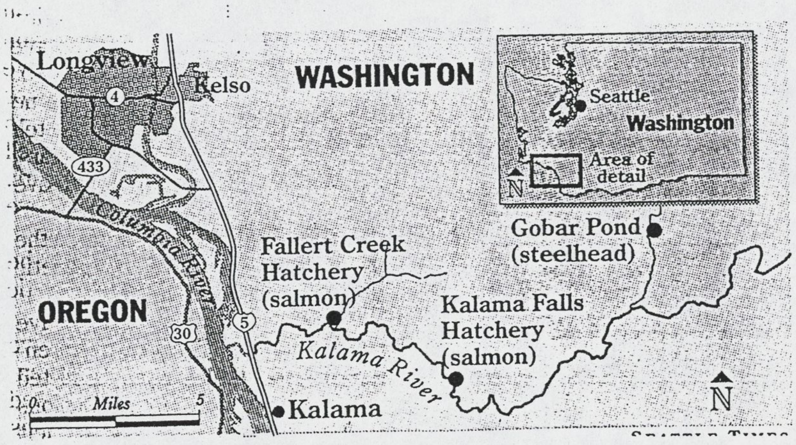
Chum salmon:
177,000

Coho salmon:
307,000

Sockeye salmon:
9,600

Pink salmon:
20,000 (odd-numbered years only)

Source: Washington Department of Fish and Wildlife



Hatcheries

CONTINUED FROM PAGE A 14

eries have none.

Some studies suggest the hatchery environment domesticates salmon, producing fish more genetically fit for survival in artificial surroundings than in the wild.

There's another genetic concern, one that stems from the chief advantage hatcheries hold over nature.

Hatcheries almost always do a better job of producing young fish. In most hatcheries, well over half of all eggs survive to become smolts, ready to migrate to salt water. Less than 10 percent of wild fish live that long.

In nature, only the fittest survive. In hatcheries, so do the not-so-fit. That represents "a tremendous relaxation in natural selection," says Waples.

Hatchery defenders dispute that point. Most hatchery fish do spend most of their lives in the wild. "You can't say hatchery fish don't experience natural selection," says Appleby.

Whatever their magnitude, the differences between hatchery and wild fish wouldn't matter much if the fish never came into contact with each other, never occupied the same habitat at the same time.

Trouble is, they do.

Like loaded guns

In the 1970s, the Stillaguamish River's wild-pink-salmon run crashed, dropping more than 80 percent. Biologists were perplexed; pinks experienced no similar downturn in the Skagit River to the north or the Snohomish to the south.

As Jim Ames, the state fisheries manager in charge of Puget Sound pink stocks, searched for an explanation, his attention turned to the Tulalip Tribes' new salmon hatchery just south of the Stillaguamish.

The hatchery was releasing coho smolts into the estuary, Port Susan, in early May, the same time much smaller young pinks from the Stillaguamish swam into the bay to feed.

Ames had no direct evidence, but he suspects the coho were eating the pinks.

In the early 1980s, he persuaded Tulalip hatchery managers to delay releasing their coho smolts until mid-June, after most of the young pinks had left Port Susan. The Stillaguamish pink run quickly rebounded to pre-hatchery levels.

Two decades of studies show predation is just one way hatchery salmon can harm wild fish. They can alter their behavior; they can compete for food and territory.

That's what happened with the ill-fated Oregon coastal coho planting project, scientists concluded. The young hatchery fish planted in the stocked streams were, on average, half again as large as the wild juveniles already living there. They probably out-competed and displaced many wild fish.

But, through decades of artificial propagation, those hatchery fish inadvertently had been bred to spawn several weeks earlier than their wild counterparts. When they returned as adults to the coastal streams to spawn, fall floods probably washed their eggs away.

The result: fewer fish than before the planting program started.

Hatchery and wild fish also mate. Some researchers warn that such interbreeding may introduce genes not adapted to local conditions

Reisenbichler conducted some of the earliest research, in the 1970s. He found hatchery-wild hybrid steelhead in Oregon's Deschutes River didn't survive as well as wild fish.

Perhaps the best-documented avenue through which hatchery fish can indirectly harm wild fish is something managers call the "mixed-stock fishery."

Because hatcheries outdo nature in rearing young fish, fewer spawning adults are needed to sustain production. That means more can be caught; in some hatchery-dominated fisheries, the harvest rate has topped 90 percent.

But wild fish often are commingled with hatchery fish and subjected to the same intense fishing pressure, a harvest rate no wild stock can sustain. Biologists in every camp acknowledge mixed-stock fisheries have hurt wild coho in the Lower Columbia, Willapa Bay, South Puget Sound and the Nooksack River.

But that's not a hatchery problem, hatchery defenders argue; like most ills blamed on hatcheries, it's a *management* problem.

Hatcheries simply produce fish, they say; the facilities can't be held responsible for the bad decisions managers make in using those fish.

Hatcheries are only a tool, says Ross Fuller, assistant chief of the state Fish and Wildlife Department's hatchery division:

"A poor workman blames his tools."

Ray White, an Edmonds fisheries consultant, former Montana State University professor and hatchery critic, offers another analogy. Hatcheries are like loaded guns, he says:

"It's not the guns, it's the dummies that use 'em. But if there were fewer of 'em, maybe there wouldn't be as many mistakes made."

Some hatchery programs are changing. Managers are allowing more fish to decide on their own when to leave hatchery ponds. They are releasing more fish as smolts, ready to migrate straight to sea, to minimize contact and competition with wild fish in streams.

They are marking more hatchery fish for easy identification. They are using more locally derived brood stock, so any breeding with wild fish won't take place across a vast genetic chasm.

More changes may be in the works. The Northwest Indian Fisheries Commission and state Fish and Wildlife Department are drafting wild-salmon-protection policies. The state agency's first draft calls for a review of all hatchery programs by July 1997.

But it also says big cuts in hatchery production may not be necessary to save wild fish. Other changes, such as more selective fishing methods or greater separation between hatchery and native spawners in the wild, could be sufficient.

Such a course clearly would inflict less short-term pain. Hatchery critics question whether it would produce much long-term gain.

"We keep hearing this refrain that they know how to do it better now," Lichatowich says. "There's still that quest for the silver bullet. I guess I don't have much faith that it can be done."

Details of the NAS report, including a lengthy executive summary, can be found via the Seattle Times Top Stories Web site at: http://www.seattletimes.com

6

Case study: Kalama River

By Eric Pryne
Seattle Times staff reporter

KALAMA, Cowlitz County — If the state Fish and Wildlife Department stopped putting hatchery salmon and steelhead in the Kalama River, "the Kalama would have no fish in it," says Mike Eckert, who owns a tackle shop on Kalama River Road.

He's exaggerating. But not by much.

Over the past 15 years, two state salmon hatcheries on the Kalama have released an average of 10 million young coho and chinook into the river each year.

At the same time, the National Marine Fisheries Service says, wild coho on the Kalama and other Lower Columbia tributaries in Washington probably have become extinct. State biologists say few wild chinook remain.

Besides the salmon, the state plants about 180,000 young hatchery steelhead annually in the Kalama. But the wild summer run has been in trouble for years; it's officially classified as "depressed."

Why have the Kalama's wild fish disappeared? There's no simple explanation, no single cause.

But the hatcheries played a part, many scientists say.

Salmon hatcheries are under attack throughout the Northwest. The Kalama provides a case study of some of the reasons why.

No river in Washington has a longer history of artificial propagation. And on no river have interactions between hatchery and wild fish been studied more intensively.

Hatchery fish have largely replaced wild fish on the Kalama. They haven't transformed it into a river of plenty, however.

Salmon production throughout the Lower Columbia has taken a nosedive in recent years. Adult returns of coho and chinook to the Kalama have declined despite big cutbacks in ocean and river harvest.

Some scientists attribute the drop to changes in the ocean environment that affect hatchery and wild fish alike. Others say it raises questions about whether hatchery production is truly sustainable.

"The biodiversity of the Kalama River was just thrown away," says Bill Bakke, former

executive director of the conservation group Oregon Trout and a hatchery critic. "We thought we could manufacture fish like you would make canned peas or brown shoes. Now we're paying the price."

Wild fish overwhelmed

Washington's first salmon hatchery, Fallert Creek, was built on the Kalama for $5,000 in 1895.

The river's second hatchery, built upstream at Kalama Falls in the 1950s, was one of more than 30 built to compensate for production lost to Columbia River dams.

For the most part, the ancestors of the Kalama's hatchery fish weren't native to the river. The coho, for instance, are genetic stews, mostly derived from Toutle and Cowlitz river stock.

Other Washington hatcheries on the Lower Columbia rear the same fish; egg transfers among them are common. So much mixing has occurred that coho from all the hatcheries now are managed as just two stocks.

Little effort was made to keep those homogenized hatchery salmon separate from the Kalama's wild fish. Until recently, millions of young hatchery coho were planted in tributaries away from the hatcheries.

Such "outplants" were common throughout the Lower Columbia; the National Marine Fisheries Service says managers often released more coho fry and smolts than stream habitat could support.

Over time, scientists agree, the more numerous hatchery coho simply overwhelmed any wild fish remaining in the Lower Columbia, breeding with them, perhaps outcompeting them.

Any wild coho that did survive the competition and genetic dilution likely were caught in fisheries that targeted hatchery fish.

When the National Marine Fisheries Service announced in 1991 that it could find no surviving wild Lower Columbia coho, it got no protest from state officials.

"This should not have been a surprise to anyone," one state biologist wrote, "since the entire Columbia River system has been a hatchery fish management zone for about three decades."

Coho and chinook do still spawn naturally in the Kalama. But federal and state biologists say almost all are hatchery strays or returning hatchery outplants that apparently have little success reproducing in the wild.

Close down the hatcheries, scientists say, and the natural spawners would mostly disappear.

The hatcheries don't exert their influence in a vacuum, however. Overfishing, logging and development already had taken a big toll on the Lower Columbia's wild salmon by the 1960s, when hatchery production intensified.

It's possible the wild salmon would have disappeared even if the hatcheries had never been built. But there's no way to untangle those threads now.

'This is a hatchery river'

The old state Game Department, now part of Fish and Wildlife, began planting hatchery steelhead in the Kalama in the 1950s. Twenty years later, it opened a research station on the Kalama to learn what effect those hatchery fish were having on natural production.

That station has since generated some of the most troubling research in the world on interactions between hatchery and wild fish.

The Kalama's hatchery summer steelhead are imported from the state's Skamania Hatchery on the Washougal River, 50 miles away. Skamania steelhead were derived from Washougal and Klickitat River fish 40 years ago.

The stock has been planted in rivers as far away as Puget Sound, North Carolina and Rhode Island.

Over two decades the Kalama researchers learned that:

• While they are outnumbered 4 to 1 by hatchery spawners, each wild summer steelhead that returns to the Kalama on average produces eight times as many adult offspring as a hatchery fish.

• Wild and hatchery summer steelhead interbreed. While hatchery fish on average spawn a month earlier than wild fish, there is significant overlap.

Put those findings together, Kalama researchers Pat Hulett and Steve Leider say, and they spell trouble for wild fish:

Hatchery steelhead may be introducing the genes responsible for their poor survival into the wild stock, decreasing its fitness and, ultimately, its future.

Critics of Hulett's and Leider's work contend that, while the Skamania summer steelhead fared poorly in the Kalama, a more genetically compatible, locally adapted hatchery stock might do much better.

What's more, they say, the Kalama team hasn't provided the missing link: conclusive proof that hatchery genes in fact are harming the fitness of the wild population.

True, Hulett acknowledges. But the Kalama's wild summer steelhead population has been down for years. He suspects a connection.

To boost wild steelhead numbers, the state now requires that Kalama anglers release all wild fish they catch.

But the Fish and Wildlife Department continues to release young hatchery steelhead into the Kalama each year. Bakke, the former Oregon Trout leader, says that's unconscionable, especially in light of Hulett and Leider's work.

Dan Rawding, the state's regional steelhead-management biologist, says a new wild-salmon protection policy his agency is preparing almost certainly will require changes to protect the Kalama's steelhead.

That could take the form of a new, locally derived hatchery stock, to minimize the genetic impact of interbreeding. Or steps to ensure wild and hatchery fish don't spawn in the same place at the same time.

Or, Rawding acknowledges, a drop in hatchery steelhead plants.

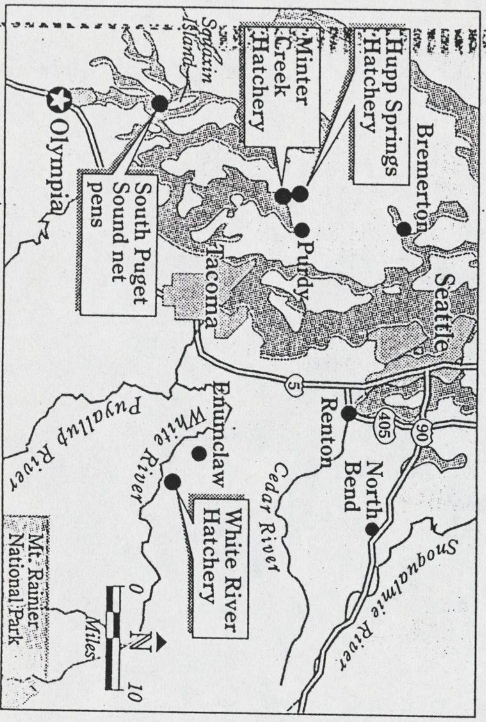
That last alternative is political TNT. "It wouldn't be very popular with the fishermen who enjoy catching those fish," Hulett says.

Eckert, the Kalama tackle-shop owner, concurs. "This is a hatchery river now," he says.

SEATTLE TIMES 5.13.96

GENETIC GAMBLE OR SALMON'S BEST BET?

◆ *IN 1977, the White River was virtually devoid of spring chinook. Nearly two decades later, hatchery scientists are having some success nurturing the population back to life. Last year, about 200 of the hatchery-bred fish that were released in the White River returned to spawn there. But critics say even the best efforts will change the stock that scientists are trying to save.*



MIKE SIEGEL / SEATTLE TIMES

A White River spring chinook *raised at the Hupp Springs Fish Hatchery near Purdy.*

BY ERIC PRYNE
Seattle Times staff reporter

PURDY, Pierce County — They're still called White River spring chinook. But most of the threatened salmon no longer begin or end their lives in that tributary of the Puyallup.

Many never come near it.

Some spend their first months and last days in the state's Minter Creek and Hupp Springs hatcheries near Purdy, across Puget Sound, in plastic trays and concrete ponds protected by netting and electric fences.

Others hatch and spawn at the Muckleshoot Tribe's White River Hatchery near Enumclaw. Still more spend their entire lives in captivity, in net pens off Squaxin Island near Olympia.

State, federal and tribal biologists removed most White River spring chinook from the White River 20 years ago. Extinction seemed imminent; in 1977 just 50 adults returned to the river to spawn.

Dams and logging along the White had pushed the fish to the brink. Until habitat conditions improved, the scientists concluded, the protected hatchery environment was the stock's best bet for survival.

Many fisheries biologists call such use of hatcheries to bring back declining wild runs "supplementation." Some say it's the wave of the future. Several dozen such programs are under way in Washington.

Scores of Washington's wild salmon and steelhead populations are in trouble; biologists classify 134 as critical or depressed.

Almost everyone agrees it's important to rebuild those stocks. There's no similar consensus on how it should be done.

Hatcheries are part of that debate. Supporters say supplementation can play a part. Skeptics say it's a high-stakes gamble that may do more harm than good.

PLEASE SEE ***Hatcheries*** ON A 8

1

Hatcheries

CONTINUED FROM PAGE A1

In a sense, supplementation offers redemption for hatcheries. Critics say they are partly responsible for driving wild fish into decline. Even staunch hatchery backers say mistakes were made.

Hatcheries for years were managed with little regard for maintaining the genetic diversity most biologists now say is so vital to salmon. Hatchery fish have eaten wild fish, competed with them, bred with them, subjected them to unsustainable fishing pressures.

What better atonement for hatcheries than to serve as emergency rooms for threatened native stocks?

"We're not Mother Nature," says Denis Popochock, manager of the Minter Creek hatchery complex. "But if hatcheries can keep the fish in good health, follow good genetic guidelines and minimize our impact on them, then it's a tool we can use."

Critics argue that supplementation may pose long-term genetic risks for wild fish. What's more, they say, there's little evidence yet that it really works.

"Hatcheries are like chameleons, always willing to make superficial changes to respond to what people want," says Sequim fisheries consultant Jim Lichatowich, a hatchery critic. "Now they're the endangered-stock saviors."

Supplementation programs differ from traditional hatcheries in at least one important respect: If they succeed, they eventually will put themselves out of business.

Conventional hatcheries are expected to produce fish forever. Most supplementation efforts aim to re-establish healthy, self-sustaining populations in the wild. Hatchery support would be unneeded.

But some scientists argue that even the best-designed hatchery supplementation program can't help but change the stock it aims to save.

Several studies suggest the hatchery environment may alter fish genetically, making them more aggressive, for instance, or less adept at avoiding predators. And fish that wouldn't survive in the wild survive in the more benign hatchery setting, although most do die after release.

"It's inevitable there will be genetic change that will increase the longer (more generations) they're in the hatchery," says Robin Waples of the National Marine Fisheries Service.

Such change may affect the stock's survival. Reg Reisenbichler of the National Biological Survey believes damage can be done in just one generation in the hatchery.

Supplementation advocates say careful management and selection of broodstock can minimize such problems. "Sure, there are risks," says John Sayre, executive director of Long Live the Kings, a Woodinville-based nonprofit group involved in several supplementation programs, "but there also are benefits.

"Where you have disappearing salmon runs, what are the options?"

The White River spring chinook supplementation program may be Washington's oldest. It demonstrates such programs' promise and uncertainty.

"If this project can't recover a stock with 20 years of work, . . . not one of them has a prayer," says Andy Appleby, a Fish and Wildlife Department biologist who sits on the program's technical team.

Adult spawners were so rare in the program's early years that Popochock, the Minter Creek manager, remembers scraping spilled eggs up off the hatchery floor with a maple leaf: "They were as scarce as chicken's teeth."

The population has rebounded strongly from that precarious beginning to more than 2,000 adults. Biologists began returning some young hatchery-bred fish to the White in 1992. About 200 of them returned to the river to spawn last year.

Appleby says scientists have worked to minimize genetic change and possible domestication, in part by rotating broodstock for the net-pen captive-breeding program.

But the fish have changed in at least one respect: More now return later to spawn. No one knows why. Some unknown influence in the hatchery environment may be responsible, Appleby acknowledges. It also could be something in Puget Sound or the Pacific.

Another concern: Despite 20 years of supplementation, biologists admit the White River spring chinook population still hasn't recovered sufficiently to sustain itself without hatchery support.

Critics and supporters do agree on one thing: Supplementation programs are certain to fail unless the underlying cause of the wild stock's demise is corrected.

If overfishing persists, or if habitat remains so degraded it can't support salmon, "hatcheries are a waste of time," says Lichatowich, the Sequim fisheries consultant.

On the White River, a tunnel at one dam and fish screens at another are being improved so more young fish can survive the journey downstream.

Crews have torn out erosion-prone logging roads in the mountains and taken other steps to improve habitat. President Clinton's Northwest Forest Plan allows little logging on national-forest lands in the watershed, partly to protect the chinook.

The Northwest hasn't made up its mind about supplementation. The Yakama Indian Nation is pushing a program for the Yakima Basin; environmentalists and some sport anglers fear it may harm wild fish more than it helps them.

Hatcheries already are part of a federal plan to rebuild endangered Snake River sockeye and chinook; Columbia Basin tribes say federal managers should be employing supplementation more.

The state Fish and Wildlife Department tried unsuccessfully this year to capture returning Lake Washington steelhead for a pilot supplementation project. Bruce Sanford, the state official in charge, hopes to try again. But he is approaching supplementation cautiously.

"It's breaking new ground . . . ," he said. "I don't know if whatever we're able to do is going to work."

Anglers, environmentalists tangle over hatchery plan

Anglers agree there should be more salmon and steelhead in the Northwest's rivers.

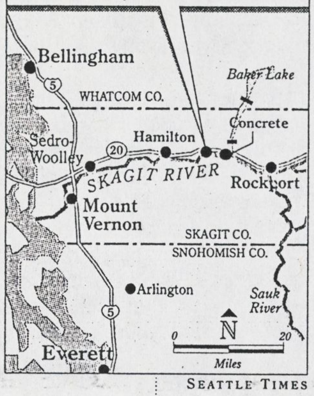
They sometimes disagree on how to get them there.

Witness the fight over the state Department of Fish and Wildlife's proposed Grandy Creek steelhead hatchery on the Skagit River.

Some sport fishermen worked hard to persuade the Legislature to appropriate money for it. Other sport fishermen, allied with environmentalists, are working just as hard to kill it.

Grandy Creek

Proposed site for a steelhead fish hatchery.



SEATTLE TIMES

Not long ago, salmon and steelhead hatcheries were politically sacrosanct. Grandy Creek reflects a new political reality.

Hatcheries still enjoy substantial support from fishermen, politicians and the public. But Curt Smitch, former director of the state Wildlife Department (now part of Fish and Wildlife) says Grandy Creek may be the last hatchery the state builds.

Hatcheries increasingly are coming under fire. "Grandy Creek is a microcosm of the whole problem we face," says Pete Soverel, who chairs the Federation of Fly Fishers' steelhead committee and opposes the Skagit hatchery. "How do we get out of this mess? Do we continue on down the hatchery trail? Or do we take a deep breath and say, 'This hasn't worked; more than that, it's been harmful.' "

Soverel and other foes of the hatchery fear that the fish it produces will breed with the Skagit's wild winter steelhead, threatening their fitness and, perhaps, their survival.

The wild population isn't what it once was, but state and tribal biologists still classify it as healthy.

State biologists agree that some hatchery and wild fish probably will mate, but contend the overall impact on the wild stock should be minimal.

Most new hatchery programs aim to rebuild depressed wild runs. Grandy Creek aims simply to provide anglers with more fish to catch.

There's nothing wrong with that, says Don Collen, a director of the Wildcat Steelhead Club in Sedro-Woolley, the group most responsible for Grandy Creek. He points to state forecasts of increasing demand for recreational-fishing opportunities as population grows.

The Wildcat Steelhead Club started lobbying the Legislature for money for the hatchery in 1988. Then-Gov. Booth Gardner didn't want to build it. Nor did the state Wildlife Department, which managed the state's steelhead before its merger with Fisheries.

"It seemed to be the last gasp of the old way of thinking, the idea that you build a hatchery, you pump more (young) fish out and we'll have more (adult) fish," says Smitch, the department's director at the time.

The 550-member steelhead club had friends in the Legislature, however. Sen. Mary Margaret Haugen, D-Camano Island, is a longtime member. Former Sen. Jack Metcalf, R-Langley, now a U.S. House member, is an honorary member.

Both were helpful, Collen says. The Legislature allocated $4.7 million for Grandy Creek in 1991.

"I think there's huge support for hatcheries," says Haugen. "Anybody who takes a look at the whole growth pattern in Puget Sound has got to realize the natural habitat isn't going to return to the way it used to be."

The state already trucks about 210,000 young winter steelhead from other hatcheries to the Skagit for release each year. Grandy Creek would produce 534,000.

The hatchery is expected to provide the Skagit's tribal and recreational fishermen with about 16,000 adult steelhead annually. That's a big increase over the river's winter steelhead catch in recent years.

Once the Legislature decreed that Grandy Creek would be built, Smitch says, planners tried to minimize its impact.

The Grandy Creek broodstock has been bred over generations in other hatcheries to return to spawn early. State environmental studies say the run will peak in November and December.

The Skagit's wild winter steelhead run doesn't peak until March and April. That means opportunities for stray hatchery steelhead to mate with wild fish will be scarce, state officials say; they won't be in the river at the same time.

The Fish and Wildlife Department believes interbreeding won't affect the reproductive potential of the wild winter stock by more than 10 percent.

Critics question whether that's adequate, or accurate. Paul Benson, a University of Washington fisheries professor, says the department's conclusions aren't well-supported.

Kurt Beardslee, executive director of the conservation group Washington Trout, says the department should have considered spending the hatchery money on habitat improvements for wild fish.

Washington Trout, the Federation of Fly Fishers and six other groups went to court two years ago to block Grandy Creek. They dropped the suit after the 1994 Legislature acted to postpone construction until a Fish and Wildlife Department wild-salmon protection plan and two other statewide studies are completed.

The 1995 Legislature dropped those conditions. The Fish and Wildlife Department applied for permits for Grandy Creek late last year. Opponents vow to fight those permits, appeal them and take them to court. Final action could take years.

— Eric Pryne

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Fish hatcheries

Story is an example of rotten journalism in The Times

"Hatcheries catching heat" is another example of rotten journalism practiced by The Times. Eric Pryne uses just enough material from hatchery people to make it look as if he's being objective but he never gives us the definition of what a wild fish is. For the record, a wild fish is one that is successfully reproducing in a river system. It can be from hatchery or native stock. Pryne never bothers to tell the readers that every river system has a wild fish population that began in a hatchery.

A good example is the South Fork of the Skykomish River. There was never a run of salmon or steelhead above Sunset Falls until about 1950. The Department of Fisheries stocked the upper river with salmon and steelhead and built a trap below the falls to catch the returnees. Last year a record was set for returning fish and it's been 12 years since the upper river was last planted. By definition, this is a wild run even though a hatchery started it. Another example is the steelhead our state sent to Michigan. They were from a hatchery and today those fish have infested every available river that drains into the Great Lakes. Every state that borders the Great Lakes refers to this as a hatchery success story.

For the record, the world's foremost fish guru, Dr. Robert John Behnke, utilized a hatchery to recover the endangered greenback cutthroat trout in Colorado. If we are to believe what was printed in your paper, as suggested by those well-known hatchery haters, the hatchery environment genetically changed those greenbacks to something other than greenbacks?

The Times should have considered making this a two-part issue. One reporter pro-hatchery and the other anti-hatchery. But as usual, the editors took the low road in an attempt to polarize those who do not understand the wild/native/hatchery fish issue going on in our state.

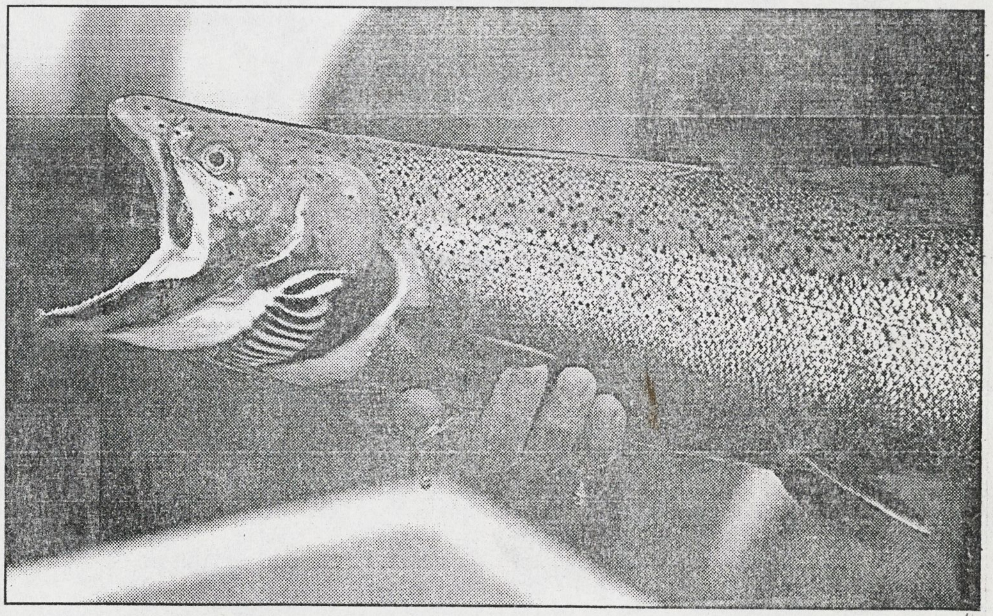
JIM LEDBETTER, PRESIDENT, KING COUNTY OUTDOOR SPORTS COUNCIL
Seattle

Story provides vital serv

Thank you for Eric Pryne's fine j ism in "Hatcheries catching heat." You have provided a vital service to the citizens of our state. Pryne accurately and fairly gives both sides of the story. The hatchery folks are doing a lot better, and we can't live without hatcheries, but yes, old-fashioned hatchery operations have been a driving force in intentionally wiping out many healthy wild stocks. Better research is now giving us substance for a more intelligent dialogue among all the interested parties.

We have learned that ponds, reservoirs and some lakes are good places for hatchery fish. Freshwater streams do better, at much less cost, with wild, native fish. The toughest problems of all are streams with salmon steelhead. To heal them will take more incisive journalism like Pryne's, an informed, demanding public and a minor lobotomy on the greed centers in our brains.

ROGER CONTOR, MEMBER, WASHINGTON FISH AND WILDLIFE COMMISSION
Ellensburg



MIKE SIEGEL / SEATTLE TIMES

Hatchery fish *have largely replaced wild steelhead on the Kalama River.*

Fish hatcheries

Story is an example of rotten journalism in The Times

"Hatcheries catching heat" is another example of rotten journalism practiced by The Times. Eric Pryne uses just enough material from hatchery people to make it look as if he's being objective but he never gives us the definition of what a wild fish is. For the record, a wild fish is one that is successfully reproducing in a river system. It can be from hatchery or native stock. Pryne never bothers to tell the readers that every river system has a wild fish population that began in a hatchery.

A good example is the South Fork of the Skykomish River. There was never a run of salmon or steelhead above Sunset Falls until about 1950. The Department of Fisheries stocked the upper river with salmon and steelhead and built a trap below the falls to catch the returnees. Last year a record was set for returning fish and it's been 12 years since the upper river was last planted. By definition, this is a wild run even though a hatchery started it. Another example is the steelhead our state sent to Michigan. They were from a hatchery and today those fish have infested every available river that drains into the Great Lakes. Every state that borders the Great Lakes refers to this as a hatchery success story.

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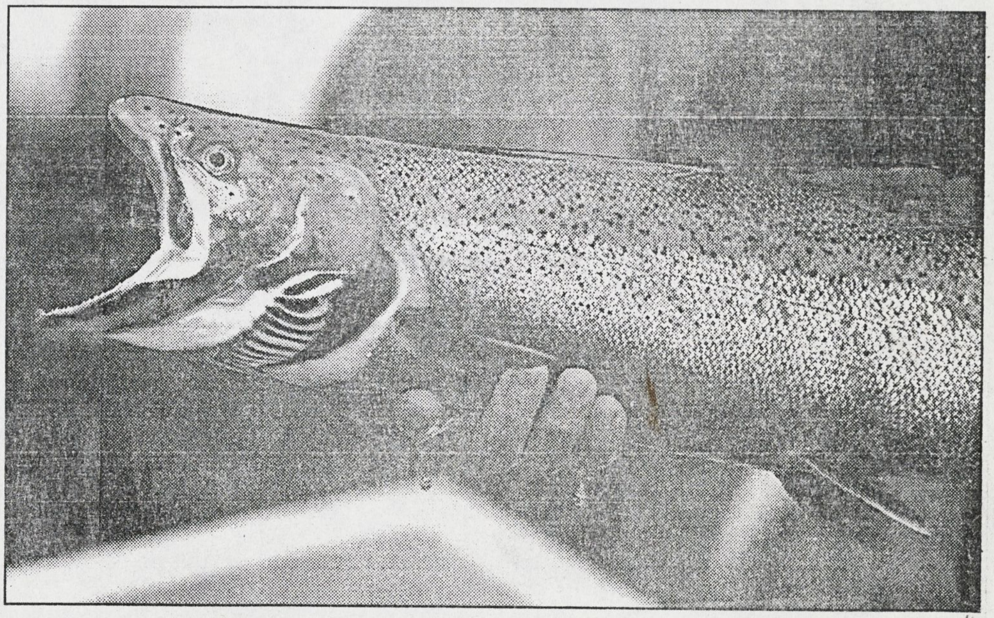


MIKE SIEGEL / SEATTLE TIMES

Hatchery fish *have largely replaced wild steelhead on the Kalama River.*

17:4 missing

North American Journal of Fisheries Management 17:474–476, 1997

Comparison of Creel Returns from Rainbow Trout Stocked at Two Sizes

JODY P. WALTERS, TOM D. FRESQUES, AND SCOTT D. BRYAN
Arizona Game and Fish Department
2221 West Greenway Road, Phoenix, Arizona 85023, USA

Abstract.—Creel returns of stocked rainbow trout *Oncorhynchus mykiss* are often below management objectives. In the Hoover Dam tailwater, Colorado River, predation by striped bass *Morone saxatilis* limits creel returns of stocked rainbow trout. On two occasions, we stocked large (33-cm) and small (21–25-cm) rainbow trout into the tailwater to compare returns to the creel. Angler return rates for the two stockings were 47% and 22% for the large fish and 1% and 2% for the small fish. Costs of large fish returned to the creel were US$6.02 and $12.86 per fish for the two stockings. Costs of small fish returned to the creel were $59.00 and $29.50 per fish for the two stockings. Annual survival of large rainbow trout did not increase compared with small fish. Stocking large rainbow trout is a cost-effective option for the Hoover Dam tailwater and may improve creel returns in other waters where predation limits survival of stocked fish.

Millions of rainbow trout *Oncorhynchus mykiss* are stocked annually in western North American streams. In some streams, few of these fish return to the creel. For example, return rates of rainbow trout (≥21 cm total length, TL) exceeded the management objective of 50% in only 3 of 24 streams evaluated in Wyoming (Wiley et al. 1993a). Our objectives were to (1) compare the return to the creel of large (33-cm) and small (21–25-cm) rainbow trout stocked in the Hoover Dam tailwater, Colorado River, (2) determine if annual survival was higher for the large fish, and (3) determine the costs of fish returned to the creel for each size-group.

Put-and-take rainbow trout stocking has been critically reviewed and biologists have encouraged investigation of options to improve stocking practices (Needham 1959; Haskell 1965; Wiley et al. 1993a, 1993b; Johnson et al. 1995). Creel returns have been improved by stocking catchable (≥21-cm) versus subcatchable (<21-cm) fish (Needham 1959; Cresswell 1981; Wiley et al. 1993a). Creel returns have also been improved by stocking strains that show increased catchability (Moring 1982), stocking during the fishing season (Needham 1959), and raising hatchery-spawned fish in a stream environment prior to release (Miller 1958).

Predation is one factor that limits creel returns of stocked rainbow trout (Deppert and Mense 1980; Wiley et al. 1993a, 1993b). Small fish can be more vulnerable to predation than larger fish (Werner et al. 1983). The return rate for rainbow trout planted in Seminoe Reservoir, Wyoming, increased as larger fish were planted because smaller fish were vulnerable to predation by walleyes *Stizostedion vitreum* (Wiley et al. 1993a). Therefore, stocking large (33-cm) rainbow trout may increase creel returns in systems where predators prey on small (21–25-cm) fish.

Hoover Dam impounds Lake Mead on the Colorado River in northwest Arizona and southeast Nevada. Cold water (maximum 12–14°C) released from the hypolimnion of Lake Mead is suitable for year-round survival of rainbow trout for 42 km downstream from Hoover Dam. Each month, Willow Beach (Arizona) National Fish Hatchery and the Nevada Division of Wildlife release rainbow trout (21–25 cm) into the tailwater. No natural recruitment of rainbow trout occurs. Common carp *Cyprinus carpio*, razorback suckers *Xyrauchen texanus*, channel catfish *Ictalurus punctatus*, and striped bass *Morone saxatilis* are the only other fish species that regularly inhabit the tailwater.

The Hoover Dam tailwater has been managed to provide a put-grow-and-take rainbow trout fishery. During 1994 and 1995, Walters et al. (1996) found that return to the creel of stocked rainbow trout averaged 2.6% (range = 0–15%) and that annual survival of stocked fish was near zero. They also determined that striped bass predation was one factor in this poor survival.

In March 1995, we freeze branded (with liquid nitrogen) 1,770 large (mean TL = 33 cm, SD = 2 cm) and 1,855 small (21 cm, SD = 3 cm) rainbow trout (Mighell 1969; Raleigh et al. 1973; Refstie and Aulstad 1975). The fish were stocked at Willow Beach Marina (18 km downstream from Hoover Dam) in April 1995. In August 1995, we freeze branded 1,023 large (33 cm, SD = 2 cm) and 1,014 small (25 cm, SD = 2 cm) rainbow trout. These fish were stocked in September 1995 at Willow Beach Marina. All four groups of fish were marked

Date: Mon, 09 Nov 1998 11:37:01 -0700
From: Scott Saunders <scott@oldcolo.com>
Reply-To: scott@oldcolo.com
Organization: Arrowhead Ranch
X-Mailer: Mozilla 4.06 [en] (Win95; I)
To: "Dr. Robert Behnke" <fwb@picea.cnr.colostate.edu>
Subject: Deliver to Robert Behnke

Dr. Behnke,

Thank you for the two articles, "We're Putting Them Back Alive," and "Wild Trout and Native Trout: Is There a Difference?" We spoke briefly about the difficulty of reliable information and both articles brought this home for me.

I've been an advocate of barbless hooks for several years without really

knowing whether it made any difference in mortality rates. I just assumed that it had to. I would say, however, that from my experience, it is much easier to release a fish from a barbless hook then any other type hook.

I am very interested in learning more about the terminal size and age restrictions of the section of stream I manage and what, if anything, I can do to help nature get back to its optimum potential. Having fished the stream for 25 years I thought I could pretty well guess what the terminal size and age were. But, after catching a brown trout over 30" last season, inadvertently using an 8" brown for bait, I have excitedly had to up my terminal size and age guesses.

Our management over the last 5 or so years has focused mainly on habitat

and I have seen remarkable recovery of bank stability, willow resurgence, grass/meadow health and the return of an active beaver population. This, hopefully, would explain the improved fishing in the last two years and will continue long into the future.

The stream contains a non-native, but "wild" population of brown trout. These fish have been predominate for many years. I do not know when they were first stocked or how they got here. They have been "the" fish

for at least 25 years from my experience and probably for a number of decades before that. They are certainly self sustaining and have undoubtedly acquired adaptive traits for this environment. I want very much to keep it that way. My grandfather used to occasionally stock rainbows in the stream. None have ever become resident or survived that

I am aware of.

I was always very opposed to stocking in the stream. It caused many an argument, regretfully, between me and my grandfather. I never had convincing scientific data for him and he couldn't appreciate what nature was capably of if left alone. He had always felt that we knew what was best and I always felt that nature did. And that the real problems were where we meddled in the process too much. Our cattle management has been very hard on the grasslands and the stream. The whole of South Park has, undoubtedly, been poorly managed for a century.

Anyway, I've ordered your books and am looking forward to reading them. Thank you for your willingness to help me learn. Is there any way I can get you
to come to the ranch next summer, fish and evaluate the habitat for me? I do not
have much to offer you, but I would be very happy to extend a fishing club
membership to you in 1999, which can be used as much or as little as you like
in an effort to thank you and have you see what we're doing and get your further
input. I am passionately interested in the stream environment and want to help
it be the best it can be. The ranch is 10 miles south of Fairplay, in South Park,
on hwy. 285. It contains 3,000 acres, over five miles of the South Fork of the
South Platte and four lakes. Will you accept?

Sincerely,

Scott Saunders
1221 Hermosa Way
Colorado Springs, CO 80906
719-634-2946
scott@oldcolo.com

California Department of Fish & Game
8530 W. Roosevelt Ave.
Visalia, CA 93291
(559) 651-1710

February 22, 1999

Mr. Bob Behnke
Department of Fishery and
Wildlife Biology
Fort Collins, CO 80523-1474

Dear Bob,

I have enclosed earlier Wild Trout Project newsletters. I hope you don't mind a few recycled newsletters. This has been a "mom and pop" operation and we hope to improve the quality of the newsletter in the future. However, the newsletter has improved communications with the supporters of the Wild Trout Project—and we have many. We should have a Wild Trout Page on the DFG Web Site any time now (http://www.delta.dfg.ca.gov). We have an employee (seasonal) who has worked very hard at this task and done and excellent job. The past newsletters are on the web page by topic (when it gets online).

The DFG has just initiated a Heritage Trout Program to draw attention to native trout in California. That's the good news. Unfortunately there are no additional employees or funding for the project. It has been assigned to the Wild Trout Project—all seven of us. Two of us, Bill Somer and myself, are involved with Piute and golden trout recovery efforts and have been for some time. The Heritage Trout Program fits into the Wild Trout Program, but there are concerns about making it successful given the shaky start.

As far as the Trout Strategic Plan, I have no idea where it is headed. This all came about, I'm sure you know, as the result of the TU law suit over stocking hatchery trout on top of wild trout. I think the problem is that Jim Hopelain is trying to produce a product that will please everyone. The Wild Trout folks provide input, but what happens to the input and the end product is beyond our control.

It's an honor to hear from you and I hope you enjoy these newsletters. If you have additional questions, please feel free to telephone me at the number on the letterhead.

Best Regards,

Stan

Stan Stephens

Department of Fish and Game
Wild Trout Project

Vol. 4, No. 1 **Winter 2000**

North Coast Region News

By Mike Dean
Northern California & North Coast Region

Fall River: Significant progress is being made to reverse the damage caused to Fall River by the large volume of sediment which has buried areas of aquatic vegetation. The Department completed the California Environmental Quality Act process for the restoration of Bear Creek Meadow and formally adopted the final Mitigated Negative Declaration for the project. The only negative comments received came from the Fall River Wild Trout Foundation. No legal action was initiated, and the project was completed in late September, well ahead of schedule. The project was not only completed ahead of schedule, but turned out exceptionally well. We will conduct significant monitoring with the landowner over the next few years, and will wait until next spring before judging success or failure. The project is intended to dramatically reduce erosion from the incised stream channel through Bear Creek Meadow and to reconnect Bear Creek to the floodplain, both serving to reduce sediment input to Fall River; other benefits are anticipated as well. The landowner, Mr. Peter Stent, and his staff deserve monumental credit for this undertaking: A host of others also deserve credit. Additional actions underway to benefit Fall River include several projects to protect the form and function of upper Bear Creek, additional cattle exclusion fencing and riparian planting along Fall River, efforts to control muskrat damage, and work toward two experimental sand removal projects in areas of Fall River most impacted by the recent sediment deposits.

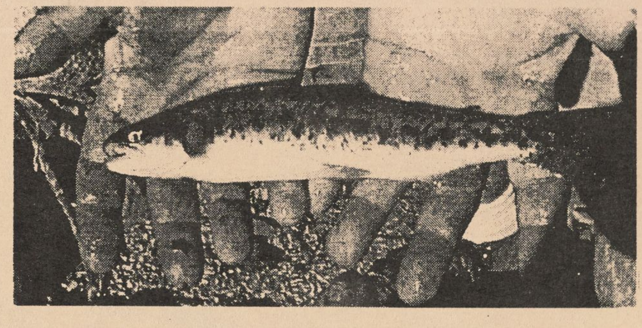
Upper Sacramento River: The Department released a draft Fishery Management Plan for this water on November 1, 1999. All interested persons are encouraged to comment on this draft plan and to voice their desires for a future management strategy. Copies of the plan are available from the Redding office ((530) 225-2300), or check our web page (www.dfg.ca.gov), under What's New, Upper Sac Plan. The Deadline for comments is January 31, 2000. The Department planted about 16,000

Continued on page 6...

Heritage Trout Program

By Sharon Shiba
Wild Trout & Heritage Trout Program

The California Fish and Game Commission (CFGC) and the Department of Fish and Game (CDFG) has launched the California Heritage Trout Program as part of the Wild Trout Program. To this end, the CFGC amended its existing policy on Wild Trout to include designation of Heritage Trout waters as a special subset of Wild Trout waters. Heritage Trout waters will be monitored and managed by the CDFG's Heritage and Wild Trout Program staff (see related article on page 3, *We've Changed Our Name*). Heritage Trout waters will be selected under the same criteria and will receive the same commitment for management as Wild Trout waters, except that all Heritage Trout waters must be within the historic drainage of native trout, and angling must be consistent with native trout conservation.



Lahontan cutthroat trout

The purpose of the California Heritage Trout Program is to provide a link between restoration, conservation, and angling opportunities specifically for native trout. The objectives of this new program are to: (1) expand angling diversity by restoring and increasing opportunities to fish for secure populations of native trout; (2) inform and educate anglers and the general public about the importance of native trout and their habitats; (3) build public support for native trout restoration programs by emphasizing education and outreach activities; and (4) solicit public participation in restoration projects.

Continued on page 6...

Wild Trout Project Newsletter

Published by the California Department of Fish and Game
8530 W. Roosevelt Ave.
Visalia, CA 93291
(559) 651-1710
(559) 651-1703 FAX
sstephen@dfg2.ca.gov

The Wild Trout Project Newsletter is published bi-annually. However, there was no newsletter this summer and we apologize. We will make ever effort to get back on schedule.

Any correspondence regarding the newsletter should be directed to Stan Stephens at the above address. Comments and recommendations are always welcome. Please pass the newsletter on to a fellow angler when you have finished reading it.

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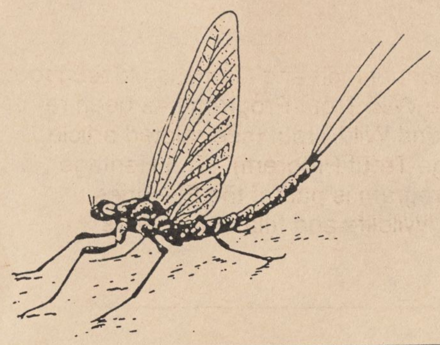


Protecting the Resource

By Roger Bloom
South Coast Region

I have been an angler all my life. Angling has provided me with countless days of enjoyment and has enriched my life a great deal. I have made lifelong friends from coast to coast. Angling has influenced my choice in education, as well as career goals. Some say it is my passion; I say it is a way of life. I have, however, seen in recent years a growing polarization within the angling community. I have pushed this issue aside for years, but with the growing number of anglers in the state and dwindling resources, the problem needs to be addressed.

On average, most anglers have their roots in bait angling. After initiation into fishing, some anglers may choose to explore different types of angling. This may come in the form of deep sea fishing on charter boats, bass fishing with lures in reservoirs, or fly-fishing in the high country. All of these facets are unique unto themselves but have a common denominator in that they all are a form of fishing. As with any multifaceted sport, there are individuals who think that the only way to participate is the way they do it. Unfortunately, this type of segregation can breed contempt and ill feelings. Having served as the Wild Trout Program's stream survey crew leader, I have had the opportunity to speak to anglers from all over and have noticed this type of polarization in fishermen throughout the state. This is not to say every angler feels this way, but in the age of political correctness, every person's feelings must be addressed.

Anglers in California are facing a multitude of issues regarding reduced fishing opportunities and habitat degradation. It would help California anglers if they had a consolidated front to address these issues, but instead they are represented by small splintered factions that, as a whole, do not speak for the masses. This is not to say that conservation groups do not protect the resource, rather that they may not represent all the parties involved. If anglers were, as a whole, better educated in the status of the resource, then they could make more informed decisions about fisheries issues. The Wild Trout Program, along with the new Heritage Trout Program, is making it a priority to inform anglers about fisheries issues throughout the state. This may come in the form of a brochure on the Heritage Trout Program, angling opportunities and survey information on the new Wild Trout Program web site, or the statewide newsletter!

There is a misconception that the Wild Trout Program is an elitist group that restricts and closes waters to anglers other than flyfishers. This is far from the truth! The goal and mission of the Wild Trout Program is to protect and enhance the wild trout fishery within the state for all anglers. This may come in the way of special regulations, but the regulations are only a management tool aimed at protecting the fishery. Conventional gear and liberal bag limits are a historical part of trout fishing in California but, in the present day, may not provide sustainable wild trout populations now or in the future. Waters with special regulations make up only small percent of the total stream miles and lakes in the state. These waters are some of the most productive waters in the state; thus, they get most of the pressure. Increased population is an issue that anglers in California must deal with. Veteran anglers are going to remember when they had "glorious days on the water with not a soul in sight." Those days are rare now, and we, as anglers, must understand that. Protection of the resource is the only way to provide for the future. As an angler, I would much rather take an adaptive approach to fisheries issues and have a viable wild trout fishery for future generations.

...Continued on page 5

Rush Creek

By Dave Lentz

Looking for an uncrowded, easy to access wild trout stream?

Rush Creek, flowing between Grant Lake and Mono Lake, south of Lee Vining is worth trying. Restored stream flows and some habitat restoration improvements have had a few years to operate on this aquatic system. A few anglers have discovered that these measures are providing improving fishing for wild brown and rainbow without a lot of company from fellow anglers. The regulations are catch-and-release only, zero-bag limit with artificial lures and flies with barbless hooks.

There are a couple of dirt roads that access the stream, upstream of Highway 395, from the north end of the June Lakes Loop Road. In this reach of stream above the highway there is a mixture of open meadow areas and short reaches in a shallow canyon with abundant riparian tree cover. Rush Creek, downstream of Highway 395, can be reached on an unmarked, gravel/dirt road, "Rush Creek Road", located more than a mile north of where Rush Creek crosses under the Highway. There is a sign on Highway 395, indicating "Oil Plant Road" (to the west), and on the opposite (east) side is the unmarked, dirt road leading to more meadow reaches of lower Rush Creek. Several spur roads lead out into meadows that are lightly used by wild trout anglers.

Rush Creek anglers report good "fast-action" fishing for mostly six to ten-inch browns and rainbows. There are some larger trout present however. Please report your angling results at the survey boxes located along Rush Creek Road and upstream of the highway, along the road just south of the creek, near the old bridge visible from the highway.

Rush Creek in the Eastern Sierra Nevada

A New Face in the Heritage and Wild Trout Scene

Effective October 1, 1998, the Wild Trout Program not only received a new name (Heritage and Wild Trout), but also took on a new staff member. Associate Fishery Biologist Sharon N. Shiba filled the position that was vacated when the legendary John Deinstadt ("Mr. Wild Trout") retired. Ms. Shiba has been a Department employee for ten years, having had previous assignments with the San Joaquin Chinook Salmon Project (Region 4 - Fresno), CEQA Documentation Unit (Marine Resources Division - Long Beach), Triploid Grass Carp Program (Region 5 - Chino Hills), and most recently as Invertebrates Coordinator for the Native Fish Conservation Program (Inland Fisheries Division - Rancho Cordova). Before she came to work for the Department, Ms. Shiba held positions as Environmental Biologist for Occidental College's Fish Encounters Group, Curatorial Assistant at the Los Angeles County Museum of Natural History, temporary Taxonomist for Tetra Tech, and another tour of duty with Occidental College as Environmental Biologist with the Vantuna Research Group. Ms. Shiba was born, raised, and educated in Los Angeles. She earned her degree in Biology from Occidental College, and received her post-baccalaureate education at Occidental College and Mount Saint Mary's College.

"I feel very fortunate to have the opportunity to be a part of the [Heritage and] Wild Trout Program," said Ms. Shiba. "It will be a great challenge to fill John Deinstadt's shoes, but with everyone's help, we can accomplish a lot of good things. I look forward to working with such a great team, and our enthusiastic constituency."

We've Changed Our Name

The Department of Fish and Game is pleased to announce that the Wild Trout Program has been re-named Heritage and Wild Trout (see related article, California Heritage Trout Program). The Heritage and Wild Trout program is part of the Fisheries Program Branch, Wildlife and Inland Fisheries Division.

RICHTER BILL (AB1625)

By Chuck Knutson
Senior Biologist Supervisor, Heritage and Wild Trout Program

Increased penalties for illegal planting aquatic nuisance species

One of the positive outcomes of the 1997 California Department of Fish and Game's (CDFG) chemical treatment that removed northern pike, *Esox lucius*, from Lake Davis near Portola was the passage of AB 1625 (Chapter 431), authored by Assemblyman Bernie Richter-R, in the fall of 1998. This measure improves protection for California's native flora and fauna by substantially increasing the fine from $1,000 to $50,000 for any person who places, plants, or causes to be placed or planted, nonindigenous aquatic nuisance species into California waters. An "aquatic nuisance species" means a nonindigenous species that threatens the viability or abundance of a native species, the ecological stability of waters inhabited by those species, or the viability of commercial, agricultural, or recreational activities, which depend on those waters.

Hundreds of plants and animals from around the world have invaded California by air, land, and sea, threatening native species, clogging waterways, and damaging commercial and recreational fisheries. It is clear that more has to be done to prevent future introductions of unwanted species. This new law is definitely a step in the right direction! By elevating the seriousness of the crime, this new law can only help to discourage people from illegally planting aquatic nuisance species. In addition to the increased maximum fine, punishment includes the possibility of county jail imprisonment for up to six months. Violators will be liable to pay for damages caused to property, commercial and sport fisheries, public communities which depend upon those fisheries, and all public and private response, treatment, and remediation efforts to eradicate aquatic nuisance species. Costs can be enormous! For example, eradication of nonnative white bass, *Morone chrysops,* from Lake Kaweah (Tulare County) in the fall of 1987 cost $7.5 million.

There are many examples of nonnative fish introductions gone awry. The presence of the golden shiner, *Notemigonus crysoleucas,* has had major consequences for certain put-and-grow trout fisheries in cold-water lakes. Trout biomass has been reduced up to 90 percent following golden shiner introduction. The golden shiner is native to the eastern United States and became widely distributed in California after 1950, following its introduction in 1891. The main reasons for its spread were anglers who use shiners as live bait and deliberate introductions to provide forage for warm-water gamefish. Shiners compete with trout for food and may aggressively eat other fish, as they grow larger. During the 1968-86 period, golden shiners were one of the top target organisms for chemical treatments. Today, many trout lakes are dominated by golden shiners, which necessitates the planting of expensive "put-and-take" catchable-sized trout for immediate harvest rather than "put-and-grow" fingerling or subcatchable trout which are less expensive to raise and often grow to trophy size in the absence of competitors like golden shiners. Introducing golden shiners means poorer growth and survival of trout, and fewer and smaller trout for the angler to catch.

The brown bullhead, *Ameiurus nebulosus*, was introduced from the eastern United States to California in 1874 and is now the most numerous and widely distributed of the three-bullhead species present here. It is a sought-after sport species and is illegally spread by anglers wishing to establish a fishery in other areas. However, it is very prolific, often resulting in stunted populations, which compete with other desirable species, such as trout. It can occur in mountain lakes up to 7,000 feet elevation, where it is usually regarded as a nuisance species. In many instances, the CDFG has eradicated them by chemical treatment.

It may come as a surprise that the legal and illegal movement of trout, deemed by many as desirable sport species, has nearly wiped out some native aquatic species. In the Sierra Nevada, native trout species such as the California golden trout, *Oncorhynchus mykiss aguabonita,* Little Kern golden trout, *Oncorhynchus mykiss whitei,* Lahontan cutthroat trout, *Oncorhynchus clarki henshawi,* and Paiute cutthroat trout, *Oncorhynchus clarki* seleniris, are threatened with extinction by other trout species which are nonindigenous to the area. Brown trout, *Salmo trutta,* native to Scotland and Europe, have invaded the upper drainage of the South Fork Kern River, where they are predators on California golden trout, our designated state fish. A series of chemical treatments were conducted and fish barriers constructed to eradicate and block upstream migration of brown trout, but some reinvasion has occurred due to failing barriers and possible illegal movement of fish. Treatments and barrier maintenance cost millions of dollars. Some anglers prefer to catch brown trout because of their large size, but they do the public a great disservice when they move them into golden trout habitat for their own personal gain.

Brook trout, *Salvelinus fontinalis,* a char from the eastern United States and Canada, can spawn very successfully in lakes as well as streams — so successfully that they often become overpopulated and stunted, especially at higher elevations. In streams, they out compete and displace native Lahontan cutthroat and Paiute cutthroat trout, both federally threatened species. In the Upper Truckee River, which drains into Lake Tahoe, brook trout were recently eradicated by chemical treatment and the river was restocked with pure strain Lahontan cutthroat trout. Several years of monitoring by snorkeling and electrofishing indicated no brook trout were present, until suddenly some brook trout were detected near a trail crossing. We suspect that an angler planted them, probably because of a preference for catching brook trout over cutthroat trout. However, this is a poor trade for anglers, since cutthroat trout generally grow much larger than brook trout. Unfortunately, the cutthroat trout restoration program for this water is now in jeopardy.

Coastal rainbow trout, *Oncorhynchus mykiss irideus*, although native to many California rivers that flow to the Pacific Ocean, may be a greater problem than either brook or brown trout because they are able to hybridize with native cutthroat and golden trout. Rainbow-golden trout hybrids have been collected in the Kern River drainage, as have rainbow-Paiute cutthroat hybrids in the Silver King Creek drainage. Once again, expensive chemical eradication of rainbow trout and hybrids, followed by planting of genetically pure native trout and barrier construction has been necessary. Illegal stocking of rainbows, whether intentional or out of ignorance as to the consequences, continues to undermine some of our native trout restoration programs, in spite of public outreach efforts to educate the public otherwise. If not halted, it may drive additional native species onto the endangered species list.

It is important to recognize that brown trout, brook trout, and rainbow trout are great gamefish *in the appropriate waters*; in other words, where they provide high quality angling, but do not wreak havoc on other desirable species, especially native aquatic species.

The Sacramento pikeminnow (formerly know as Sacramento squawfish), *Ptychocheilus grandis,* is native to California's Central Valley but recently became established in the Eel River system, where it has become a major contributing factor to salmon and steelhead population declines. People generally think of minnows as being small in size, but this one may attain a length of three feet or more and is highly predacious on juvenile fish. They appeared first in the headwaters at Lake Pillsbury, where they spread into the tributaries and downstream into the Eel River. Speculation is that an angler(s) illegally used them as live bait in Lake Pillsbury and some escaped alive into the lake, grew to adult size, and subsequently reproduced in the system.

The time has come to spread the word about the damage done by the indiscriminate movement and planting of aquatic nuisance species. Although the increased penalties resulting from the passage of AB 1625 in 1998 may seem somewhat drastic and excessive to some, they are necessary to turn the tide in favor of native and other desirable species protection and restoration. It will also save millions of dollars in future restoration costs.

The new law may dissuade some individuals from making intentional introductions, but public awareness regarding the consequences of indiscriminant stocking is required to stem the tide. What you can do is: 1) become aware of what constitutes an aquatic nuisance species and where they are located; 2) don't spread them yourself; 3) make friends and family aware; and 4) report your knowledge of any illegal introductions to the CDFG at 1-888-CALTIP.

CalTIP

1-(888)-DFG-CALTIP
(1-888-334-2258)

CalTIP (Californians Turn In Poachers and Polluters) is a confidential secret witness program to encourage the public to provide Fish and Game factual information leading to the arrest of poachers and polluters. The caller is eligible for a cash reward if his/her information leads to a citation or an arrest. The toll free telephone number operates 24 hours a day, 7 days a week.

...Continued from page 2

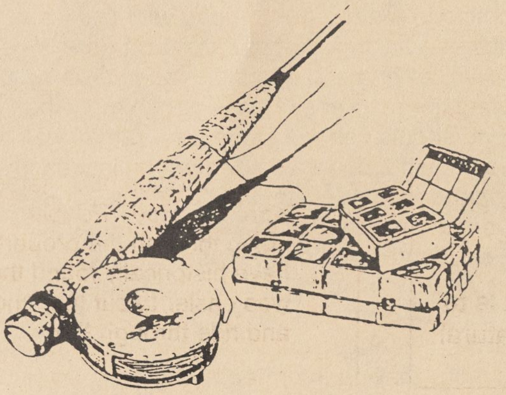
Some of readers may think that I am preaching to the choir! This may be true, but the backlash against current special regulations and future designations are coming to the forefront. Along with this issue, the gap between anglers that use different gear is getting larger. We, as anglers, must join together in protecting the resource. This is not to imply that everyone should fish the same way, rather that anglers should focus their attention on issues that threaten the resource. So, the next time you see a fellow angler, regardless of the type of gear they are using, be friendly and courteous. Talk to fellow anglers about joining conservation groups and volunteer groups. If you are not aware of any groups in your area, contact your local fisheries biologist for information. Staying informed and getting involved is paramount in the protection of our angling resources! Good luck, and tight lines!!

...North Coast, continued from page 1

catchable trout in the Dunsmuir area this past fishing season, while the remainder of the river and tributaries were managed as a zero limit, wild trout fishery. All hatchery trout were marked with an adipose fin clip, and Department staff conducted a creel survey in the Dunsmuir area; results should be available early in 2000. We are very interested in the number of hatchery vs. wild trout caught in the Dunsmuir area. Also, when fishing many wild trout waters, including the upper Sac., be sure you complete an angler survey card for each day you fish. These simple little cards are easy to complete, and allow anglers to help us better manage the fishery: This is a good opportunity for you to be an active player in data gathering and fishery management.

Eagle Lake: The California Fish and Game Commission (Commission) formally designated Eagle Lake as one of the first waters in the new Heritage Trout Program for the unique, native eagle lake trout. These trout can tolerate alkaline waters with a pH lethal to other trout species. Work is ongoing to restore spawning and rearing habitat for these fish in an effort to reestablish naturally spawning populations. Early indications are that angling for these large trout will be good to excellent this fall.

New Waters? Region Wild Trout staff is investigating several waters for possible future designation by the California Fish and Game Commission as Catch-and-Release waters, including Butte Creek and Trout Lake (Siskiyou Co.), Stuarts Fork Trinity River (Trinity Co.), Big Lagoon (Humboldt Co.), and several waters in Modoc Co. Twenty-three miles of Hayfork Creek (Trinity Co.) were formally designated by the Commission this fall for outstanding winter steelhead angling. Try this stream this winter, a few days following a healthy rainstorm. Action on other waters is on-hold pending further research.



...Heritage Trout, continued from page 1

Increasing Angling Diversity

California has historically supported 12 kinds of native trout. However, angling opportunities for California's native trout have existed in limited, specific waters for a number of years. Many of our native trout have experienced long-term declines in abundance within their historic ranges. The widespread introduction of non-native fishes such as brook trout and brown trout has caused competition and predation, which have displaced native trout. Introduced rainbow trout have hybridized with cutthroat trout and golden trout, reducing pure populations. Several of our native trout are currently listed under the Federal Endangered Species Act, and the bull trout (*Salvelinus confluentus*), is now extinct in our state.

What Has Been Done Thus Far to Help Native Trout

Over the years, the Department has made major strides in restoring native trout populations through its Threatened Trout Program. Examples include Lahontan cutthroat trout in Heenan Lake (Alpine County) and the Upper Truckee River (El Dorado and Alpine counties), and Paiute cutthroat trout in a major portion of the Silver King drainage. These waters and the native trout that inhabit them are a special part of the state's natural heritage. The Threatened Trout Program is committed to continuing these native trout recovery efforts. In addition, a new state law passed in 1998 has increased the penalty for moving aquatic nuisance species to a $50,000 fine, up to six months in prison, and monetary liability for eradication costs.

With your support and participation, we can make a lot of good things happen. As restoration efforts succeed, opportunities for native trout angling under the Heritage Trout Program will follow.

Selection of Heritage Trout Waters

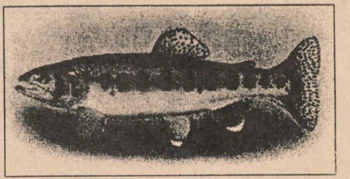
All designated Heritage Trout waters must be open to angling. Therefore, some waters, which are too small, lack suitable angling conditions, or have a critical "sanctuary" role will not be considered for designation, but will continue to be part of the broader Heritage Trout program.

Designated Heritage Trout waters may need special angling regulations to assure that the fishery will provide a suitable angling experience without compromising the integrity of the population or habitat. Thus, waters that are important refugia for native trout, often supporting small populations, may be limited to zero-limit, "catch-and-release" angling only. Recently restored populations of native trout that have been reopened to angling for the first time would be similarly protected.

Six Waters Receive Heritage Trout Designation

In 1999, the Fish and Game Commission designated six State waters as the first Heritage Trout Waters. These waters are: Golden Trout Creek, from Whitney Meadows to Kern River; Upper Kern River, from forks of the Kern upstream to Tyndall Creek; Upper Truckee River, at Meiss Meadow; Clavey River; and Eagle and Heenan Lakes.

The Golden Trout Creek drainage, the home for California golden trout, includes the tributaries from the Kern River upstream to the headwaters. It is located within Tulare County. The Clavey River, which supports an abundant population of coastal rainbow trout, is located within the Stanislaus National Forest and Tuolumne County. Eagle Lake, the sole source of Eagle Lake rainbow trout, is located north of Susanville, in Lassen County. Heenan Lake, located near Markleeville and Monitor Pass in Alpine County, is famous for its Lahontan cutthroat trout. The Upper Kern River, from Forks of the Kern upstream to Tyndall Creek, is the stronghold of Kern River rainbow trout. The Upper Kern River is located within Sequoia National Park and Tulare County. The Upper Truckee River, one of the sites recently restored for the stream-resident form of Lahontan cutthroat trout, includes tributaries upstream from the confluence of Showers Creek. The Upper Truckee River runs through both El Dorado and Alpine counties.



California golden trout

What is a California Heritage Trout?

A California Heritage Trout is a pure-strain native trout that exists naturally in the home waters of their ancestors in a particular stream, lake, or watershed within our state. Its ancestors arrived there by natural means. The ancestral trout may have migrated there by chance through connecting waters when the climate and geology of the region were much different from that of the present. Over time (thousands of generations), geographically isolated populations have developed into discrete strains, subspecies, or even species. Having evolved in a specific locality, our heritage trout are uniquely adapted to their habitat, and are an integral part of the natural history and ecosystem of their home waters. To preserve California Heritage Trout is to preserve a diversity of natural adaptations.

South Fork Kern River Fenced

By Stan Stephens
San Joaquin Valley and Southern Sierra Region

The Department purchased property in Monache Meadows, in the southern Sierra Nevada, which includes approximately one mile of the South Fork Kern River. The original reason for the purchase was to protect deer habitat, but it also protects a short segment of stream habitat from the impacts of cattle grazing. The property is surrounded by land owned by the Inyo National Forest.

Monache Meadows is a popular recreational area for 4-wheel drive users, campers and anglers. A grazing permit allows the use by about 900 cow/calf pairs. To prevent the use of the Department's property by these domesticated bovine, the fence surrounding the property must be put-up and let-down each season.

This year, the fencing system was converted to a "let-down" fence. Small metal clips were installed on the fence posts, which allow the three strands of barbed wire to be held in place by a nail. By removing the nail, the fence can easily and rapidly be let down each winter.

In addition, four gates were installed. People riding through the property have historically found that it was easier to cut the fence and ride through the property than to ride around the property (even though there were gates, they apparently were not in the right location). This was big job, because of the changes to the fencing system. Twenty-five enthusiastic volunteers accomplished the work. Volunteers came from the Aquabonita Flyfishers out of Ridgecrest and the Kern River Fly Fishers out of Bakersfield. The project would most likely not have been completed before the cows came on July 1st, without their greatly appreciated help.

This is not the first time these two clubs have provided person power for projects on the South Fork Kern River. They have been involved with maintenance of the fence in the past, as well as project that involved habitat improvement.

Volunteers install a gate on Department property in Monache Meadows

California Department of Fish & Game
Wild Trout Project
8530 W. Roosevelt Ave.
Visalia, CA 93291-9458

BAKERSFIELD CA 933 PM 13 MAR 2000

Dr. Robert J. Behnke
Dept. of Fish & Wildl. Biol.
Colorado State Univ.
Fort Collins, CO 80523

This is what it could look like (w/o the line mark) COPY

[Date Unknown]

FISHERIES MANUSCRIPT REVIEW SHEET

Manuscript Number: D97-026-1.

Author(s): McIntyre — for Fisheries, hatchery bashing issue

Reviewer Number: 1

Jack wrote in style and subject matter of a noncontroversial, nonconfrontational manner. I expect this issue will be a "feel good" attempt to conclude that there is no grounds for hatchery bashing, so let's cease this evil practice.

Recommendation:

___X___ Accept essentially as submitted (copy editing only)

_______ Accept with minor revisions (as indicated)

_______ Major revisions required; then resubmit

_______ Unacceptable for Fisheries; possible candidate for submission to:

Comments: Please indicate the reasons for your recommendation

I assume this contribution will fit the Fisheries theme on the role of hatcheries with an aim to dampen "hatchery bashing." What is said, (that hatchery fish should not be stocked where they threaten native fish) should be noncontroversial. If specific examples are highlighted concerning continued forced mixing of nonnative hatchery chinook, coho, and steelhead with native populations, then a reader would better understand that this is an on going problem. Also, the pro hatchery point of view could respond and discuss what is being done to avoid this problem.

For inland fisheries, "hatchery bashing" mainly concerns the proper role of catchable trout in a total fisheries program. Enclosed is a review I wrote on an assessment of California Fish and Game's hatchery program. Disregarding the somewhat inflammatory tone (I've been accused of "hatchery bashing"), the questions raised on cost/benefits are valid and need to be addressed. I expressed my disappointment that the assessment failed to do so. I have doubts that the forthcoming issue of Fisheries will delineate the hard questions in need of critical discussion on the role of hatcheries in the twenty first century and the issue will remain polarized.

[Date Unknown]

CHANGES IN ANGLER EXPECTATIONS AND ETHICS IN A HATCHERY-SUPPORTED FISHERY OR THE FISHERIES COMMUNITY'S RESPONSIBILITY TO DEFINE AND MAINTAIN THE ANGLING LEGACY THROUGH A DIVERSE AND RESPONSIVE MANAGEMENT

by

BILL McMILLAN
36607 N.E. Washougal River Road
Washougal, Washington 98671

What is angling? That's a question I've often asked myself and have been asked by others. A comfortably accurate answer has always been elusive although I've long known that it's a sliding definition relative to the time span applied to the sport and has increasingly less to to with reducing a fish to possession, even momentarily, as time goes on.

Perhaps the most complete answer to a definitive query on angling was that given by Piscator to the questioning Venator in Izaak Walton's *The Complete Angler* published in 1653:

> ". . . Angling is an art, and an art worth your learning: the question is rather whether you be capable of learning it? for Angling is somewhat like Poetry, men are to be born so: I mean with inclinations to it, though both may be heightened by discourse and practice; but he that hopes to be a good Angler must not only bring an inquiring, searching, observing wit, but he must bring a large measure of hope and patience, and a love and propensity to the art itself; but having once got and practised it, then doubt not but Angling will prove to be so pleasant, that it will prove to be like virtue, a reward to itself."

While not precisely a definition, certainly Walton has accurately conveyed that angling, reduced to a mere "blood sport" by some critics, is essentially a gentle sport for the contemplative mind and is not necessarily dependent on death for pleasure, " . . . for Angling will prove to be . . . like virtue, a reward to itself," with angling being that activity of searching with an inquiring observation and under the glow of love, patience, and hope. The varying moods of the activity are their own rewards — fish or no.

Even the ever-practical Thoreau, who was disinclined to kill for enjoyment or favor those who did, saw through the surface of angling to give a penetrating description of an old angler who regularly visited the river in *A Week On The Concord And Merrimack Rivers*, published in 1849:

> ". . . his fishing was not sport, nor solely a means of subsistence, but a sort of solemn sacrament and withdrawal from the world, just as the aged read their Bibles."

Even 200 years later Thoreau, himself not a serious angler, could isolate and describe those same values essential to angling so aptly conveyed by Walton.

Certainly one of the most lyrical attempts to describe the essence of angling was given by Romilly Fedden in 1919 within *Golden Days — from the Fishing Log of a Painter in Brittany:*

> "Oh, if this were only easy! But the nature of a fisherman's joy is a subtle quality. It cannot be adequately expressed in written characters, nor is it occasioned by the mere catching of fish. Birds come into it, and flowers and the spring sunshine, and there is nature magic, too, which even winged words would fail to touch."

These are not the isolated quotas from a few elitists as volume after volume of angling literature gently but firmly adheres to the the same theme: angling is much more than merely catching fish. It's from this core of angling literature that spans five centuries that the gradual changes in fishing methods and tackle have originated, increasing the angler's range and ability to catch fish. As angling efficiency has risen, so too has the angling population increased, anglers have had to accept gradually reduced catches, and today many have enthusiastically embraced the "no-kill" fishery commbined with tackle restrictions that may make landing of fish somewhat more difficult but will ensure the least damage to the fish as a counteraction to increases in angling pressure and increases effectiveness. What originated as a speculative theme throughout angling literature — angling being more than simply walking away from the streambank with a heavy bag — has finally born a proof, and that theme now seems almost like direction and even prophecy.

Angling's ability to absorb or resist massive cultural and environmental change by remaining a philosophical whole with its medieval literary heritage is a credit to the strict acceptance of a tradition guided always by self-restraint that allows a plastic malleability to modify catch and tackle in order to preserve both the quarry of angling's search and that indefinable essence of angling itself that somehow seems entirely independent of that quarry being reduced to angler possession — an interesting Mr. Spock-like contradiction attributal only to the "weak" illogic deep in the human soul.

Now, in the late 20th century, we need to assess the possibility that this traditional angling legacy may be doomed by a fishery science that has become increasingly, and often unneccessarily, dependent on hatchery management. Sport fishery management often tends to deny having a social responsibility toward maintaining the traditions of angling

Idaho, is managing harvest rates river by river. Research has shown anglers in Canada *can* overharvest wild winter steelhead runs, but it has been assumed in Oregon and Washington that anglers were too ineffective to overharvest a winter run due to periods of unfavorable fishing conditions. The individual angler may well be inefficient, just as a single commercial fisherman is, but recent large increases in effort promoted by unlimited entry policies of management agencies, have allowed harvest efficiency to increase.

It is the harvest rate that precludes effective restoration of wild stocks. The more that harvest rates are based upon hatchery production, the more harm the fisheries are able to exact on wild stocks. Management of this kind removes all possibility that wild stocks will continue to contribute to the fisheries, that they will be part of the aggragate production. The result is that the fisheries are less diverse, there is biological harm done to the stocks, and the river, depleted of strong wild runs, are fair game on the open market of resource exploitation.

Hatcheries have become a problem, and, to the extent that we rely on hatcheries, we have failed as stewards of a natural and complex resource. Perhaps we have been too eager to settle for the low bid in the development of the western landscape. The public, the owners of the salmonid fortune, are not aware of the loss. They become aware only when the stick is whittled to the point of breaking. But then the hatchery has helped to mask the decline, and in many instances, it has camouflaged the total loss of the wild salmonid resource so, as on the Columbia River, people get excited only when the hatcheries and the fisheries are about to be knocked off the welfare rolls.

To the extent that fish and game departments sell production type, hatchery-based steelhead fisheries which generate more license sales and emphasize harvest over intelligent use of the fisheries, but fail to manage for a differential harvest of wild stocks and fail to protect habitat, the wild steelhead fisheries, if not the fish themselves, are headed for extinction.

The sport fisherman is being asked through his participation in this approach to fish management to sacrifice the diversity, the character and distinction of the rivers he fishes, and the fish they contain. He is ultimately sacrificing the meaning of his sport at the alter of production fisheries.

Roderick Haig-Brown had this to say:

> "The real truth is that sport is made by and exists in just three things: tradition, ethics, and restraint. Reduce, remove, and destroy these and nothing useful is left. It may be enough to satisfy newcomers to the sport for a little while, but it cannot hold them long — there will be nothing to grow on, nothing to advance to . . . Most of the arguments about harvesting the run or taking the crop makes a measure of sense — some more, some less — if one accepts a single premise: that the main purpose of sport is killing. The logical mind of the scientist charged with the management of a fishery leads him into this misconception."

To the extent that fishermen have become addicted to what Helle (1976) calls the "Rhetoric about the benefits of hatcheries, there will be complacency about the protection and management of natural streams and river systems." They will fail to realize that "these diverse environments provide us with diverse stocks of salmonids." The fish which are adapted to take advantage of local environments and contribute to the fisheries in ways that hatchery fish do not and cannot will be, as they are, replaced by hatchery fish.

"Our natural watersheds are our 'gene banks' for salmonid fishes. Hatcheries are not a panacea" cautions Narver (as cited by Helle 1976).

Larkin (1978) asks, "Where is the management plan into which the distinction between hatchery and wild fish is incorporated? How would the distinction into a comprehensive scheme of resource use: Is it really a sensible thing to do in the broader context of social compromise? The answers seem to be lacking, in which case it is reasonable to conclude that even if it were not a technological nightmare (which it is), the management of salmon with distinction of hatchery and wild salmon would be ill-advised unless previously justified as an integral part of a broad management plan."

The steelhead's purpose is to survive. Our purpose, to the extent that it is different from that of the fish, will cause the fish runs to decline. What is our purpose in fish management? If it is to serve the needs of fisheries or to the degree it only serves the needs of fisheries, it will promote the decline of wild stocks. We must learn to work with natural systems rather than impose our will upon them, and by doing so act as if limits didn't exist. What we want from a fish population may not be as useful as what it seeks for itself — survival.

Fishermen need to understand that to have wild steelhead they will have a more durable, interesting fishery, but to have it will require that they learn how to give, not just take, from the rivers they fish.

The fishery manager needs to make sure the wild steelhead remain a productive component of the fishery which means that some changes are to be made in harvest management, stock management, and by taking a tougher position on habitat protection.

But the decision to protect wild salmonid production takes place within a broad social context where the gang-leaders Politics and Compromise hang out. Fishermen must quit hammering at each other in the attempt to gain a harvest advantage and begin working together so that larger, better financed bullies don't kill the rivers. The scientific community needs to take a stand for the fish rather than chasing research grants and playing safe.

As to whether we can maintain both components of the run, the wild and hatchery steelhead, in today's fishery, I have to say not in the same river. Another question is: Can we maintain wild steelhead at productive levels while other salmonid species are being enhanced? Probably not, if we contine to do it as we have done.

Unknown Event-Date

Economic Value of Native Coldwater Fish

Cindy S. Swanson

Economics focuses not just on resources, goods services, jobs, and income provided through private businesses. It analyzes the contribution to our well-being from the natural, social, and public environments. Some of this consists of "gifts of nature." All of these contributions must be taken into account in analyzing our economic well-being.

National Overview(1996)

- 35.2 million adult anglers; greater than golf or tennis
- Supports 1.2 million jobs; more than 1% of American workforce
- Adds $2.4 billion to state tax revenues; nearly 1% of all annual state tax revenues

Contribution to Gross National Product (Billion $s) - 1985

• Construction	$182.2
• Mining	122.8
• Agriculture	91.5
• Fishing	28.1
• Recreation	19.6
• Timber Production	19.6
• Nonconsumptive Wildlife Use	14.3
• Hunting	10.1
• Commercial Fisheries	6.8

Trout Fishing Mean Bids for Current Conditions (1988)

River Name	Mean ($) per trip
Beaverhead	$188
Big Hole	218
Bitterroot	59
Blackfoot	133
Bighorn	159
Clark Fork	86
Kootenai	38
Gallatin	180
Madison	228
Rock Creek	92
Smith	153
Stillwater	85
Upper Yellowstone	150
Middle Yellowstone	74

Values Per Day for Fishing in Montana (1988)

	Net Economic	Expenditures
Lake		
Resident		$ 32
Non-resident		50
Average	$ 70	38
Total		$ 47.3 million
Stream		
Resident		$ 22
Non-resident		116
Average	$102	48
Total		$ 52.4 million

Value of Recovering Columbia River to 10-16 Million Fish

- 125 to 237 million pounds available to harvest
- $254 to $507 million of personal income annually
- 13,000 to 25,000 full time equivalent annual jobs

Quality of Montana Trout Fishing (1988)

- Montana anglers prefer large rivers (31% of time) over small rivers (25%) and lakes (10%)
- Avid anglers ranked wild trout as a very important factor to trip satisfaction
- 72% of anglers favored protection of trout habitat
- Value per trip of $90.74 ($170.28 for avid anglers/$7.56 for casual anglers)
- Anglers would pay $101.77 for larger trout and $97.52 for double catch

Value of Threatened and Endangered Fish (1993)

• Arctic Grayling/Cutthroat Trout	$10.06
• Pacific Salmon & Steelhead	31.29
• Colorado Squawfish	8.42
• Striped Shiner	6.04