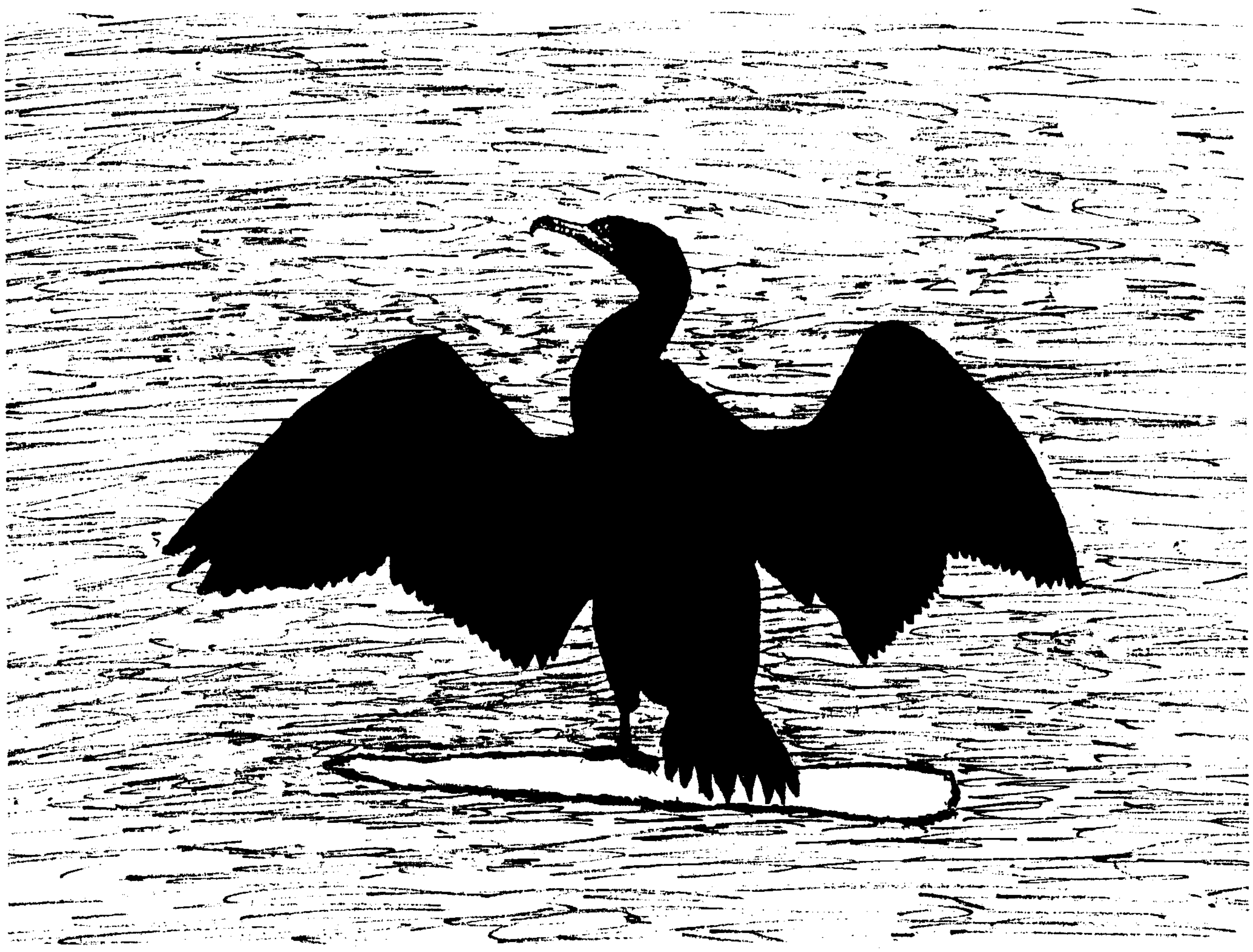
Studies in Oregon Ornithology
No. 6

The Cormorant/Fisherman Conflict in Tillamook County, Oregon

Range D. Bayer



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1989

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COVER: Double-crested Cormorant "drying" its wings.

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Abstract

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The cormorant/fisherman issue is not limited to Tillamook County in 1988-1989 but is symptomatic of a widespread conflict of some fishermen with fish-eating animals.

Predators, specifically cormorants, have been blamed for the "ruin" of the Tillamook fisheries, but the effects of cormorant predation have been exaggerated. Actually, current salmon and steelhead catches are similar to or greater than many catches prior to 1972, when several "predators" (including Double-crested Cormorants) were not protected by law. Although it is clear that cormorants can eat some smolts in Tillamook Bay, it is unreasonable to assume that they eat as many as has been suggested. For example, when figures that appeared in a Tillamook newspaper are added up, cormorants in Tillamook Bay in 1988 were suggested to eat nearly three times as many smolts as were released there!

Because a few Tillamook County fishing guides and fishermen felt that cormorants were destroying their salmon and steelhead fisheries, they pressured the Oregon Department of Fish and Wildlife (ODFW) into giving them permits to harass (but not kill) cormorants in the spring of 1988 on public waters of Nehalem and Tillamook Bays. The permittees were not supervised to be sure that they did not disturb or harm nontarget wildlife (i.e., wildlife other than the targeted cormorants) or did not kill cormorants.

After the ODFW announced in late November 1988 that they would not be issuing cormorant harassment permits in 1989, a few Tillamook fishing guides and fishermen worked to pass House Bill 3185 during the 1989 Oregon Legislative session. House Bill 3185 would have allowed cormorant harassment along the entire Oregon Coast any time during the year, but the Bill failed. Then, in July 1989, the Oregon Fish and Wildlife Commission refused to consider granting harassment permits to fishing guides and fishermen. Thus, cormorant harassment in 1989 was not legalized, although some harassment apparently occurred illegally.

Cormorant harassment in Tillamook County does not currently meet the requirements to justify an animal damage control program. For example, one criterion of such a program is that there be minimal compensatory predation (i.e., prey saved from the controlled predator is taken by noncontrolled predators). But if cormorants are harassed, there are many other predators that could eat the "saved" smolts, including adult coho and chinook salmon, steelhead, cutthroat trout, and striped bass that may eat millions of salmon and steelhead smolts along the Oregon Coast each year.

Current information indicates that documented smolt losses from cormorant predation may not compensate the economic, biological, aesthetic, and social costs of harassment. Biological costs include disturbance to nontarget wildlife such as waterfowl or threatened and endangered birds like the Bald Eagle and Brown Pelican; disturbance would unavoidably accompany cormorant harassment. One social cost of interest is that predator control of cormorants to "save" salmon is arbitrary and capricious, since salmon are themselves a significant predator of young Dungeness crabs and fish important to other Oregon commercial and sports fishermen.

Alternatives to cormorant harassment exist and would address all smolt predation, not just that by cormorants. These alternatives include changing hatchery practices, so that smolts survive better after release. These

alternatives should be at least considered.

Biologists may have somewhat defused the cormorant harassment issue if they were more able to communicate with nonbiologically-trained fishermen, but even so, there are a few fishing guides and fishermen who refuse to believe any information that does not agree with their own opinions.

Keywords: Animal Damage Control, Chinook, Coho, Cormorants, Fisheries, Oregon Legislature, Predation, Predators, Salmon, Smolts, Steelhead.

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Preface

The purpose of this monograph is document the 1988-1989 episode of a few fishing guides and fishermen trying to legally harass cormorants from Oregon coastal streams and estuaries. These guides and fishermen believed that cormorants were destroying **their** salmon and steelhead runs; salmon and steelhead, however, are a public resource.

Hopefully, this monograph will make the reader aware that decisions about wildlife management can be significantly dictated by politics and emotions, not scientific studies, logic, or reason. What is most important in swaying issues like this are personal contacts and the ability to be personally persuasive, not necessarily facts.

Hopefully, when this issue comes up again, and it will, the reader can use this monograph to be aware of what issues may be involved. I wish I had something like this available before I became involved in this episode of the very old conflict between fishermen and fish-eating animals.

Range (Richard) D. Bayer 20 September 1989

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I thank Marilyn Guin, Susan Gilmont, and Janet Webster of the Oregon State University (OSU) Marine Science Center Library for providing some obscure references and for having such a well-stocked fisheries and wildlife library.

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I am also very thankful for constructive comments on earlier drafts by Steve Johnson (ODFW), Roy Lowe (USFWS), Jon Anderson (USFWS), Michael Davis (OSU), Stacia Sower (University of New Hampshire), and Bill Pearcy (OSU).

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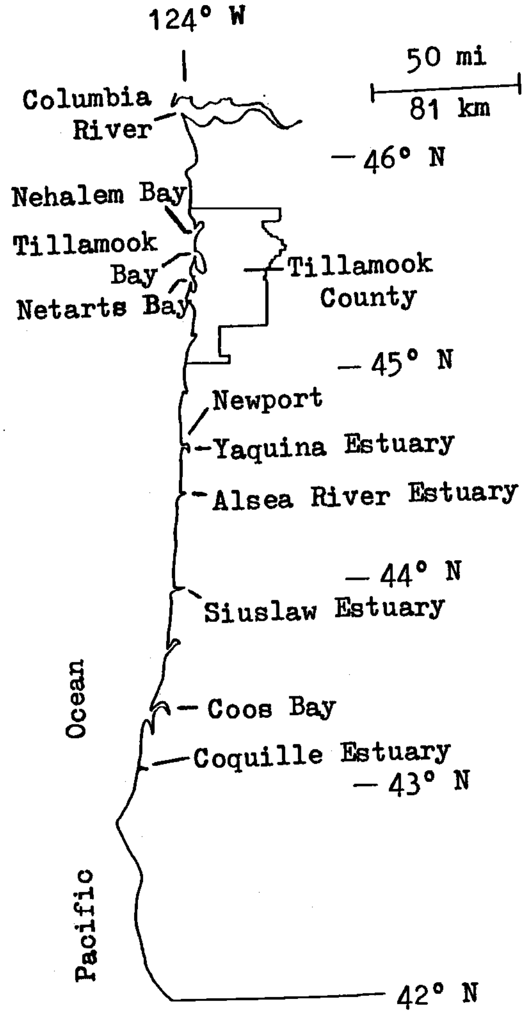
Conventions Used in this Monograph

Scientific names of animals cited are in Appendix I.

Throughout this monograph, Tables, Figures, sections, and subsections are labeled first by the Chapter in which they occur and then by their numerical or alphabetical order within a chapter. Thus, Table 3.5 refers to the fifth table in Chapter 3. Further, 4-D refers to Chapter 4, section D; and 5-E-2 refers to Chapter 5, section E, subsection 2.

Unless otherwise specified, all locations mentioned in the monograph are along the Oregon Coast. See the following map.



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Chap. 1. Chronology of the Cormorant Harassment Issue

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1-A. Introduction

Because cormorants and other fish-eating birds eat fish, fishermen have suspiciously regarded these birds for centuries. Thus, the cormorant/fisherman issue is not confined to Tillamook County, Oregon, in the 1980's.

Some fishermen have been upset at cormorants elsewhere in Oregon (e.g., Anderson and Gates 1983, Fies 1984, Shotwell 1984, 1989) and elsewhere around the world (e.g., Mattingley 1927, Mendall 1936, Bowmaker 1963: 3-4, 18 [good review], DesGranges and Reed 1981, Maine Cormorant Study Committee 1982, Winkler 1983, Vermeer and Rankin 1984, Craven and Lev 1987, Draulans 1987, Findlholt 1988, Broadway 1989, Trayler et al. 1989). Accordingly, some anglers have sought ways to illegally or legally control cormorants.

Since this issue is not unique to Tillamook County or to the 1980's, the historical control of fish-eating animals in North America and Oregon is examined in the following sections to provide some historical background. In subsequent sections, the legal requirements for harassment in Oregon, the known involvement of U.S. Dept. of Agriculture Animal Damage Control (ADC) personnel, Salmon and Trout Enhancement Program (STEP) volunteers, and Oregon Department of Fish and Wildlife (ODFW) permittees in the 1988 cormorant harassment at Nehalem and Tillamook Bays are listed. Then, efforts in the Oregon Legislature and Oregon Fish and Wildlife Commission in 1989 to allow harassment are discussed.

1-B. Historical Control of Fish-eating Predators

1-B-1. Fish-eating Predator Control in North America

Fish-eating animals have been legally or illegally harassed or killed for decades, if not centuries, in North America.

The extent of predator control has probably been best documented in Alaska. Bounty programs there for salmon predators were used prior to 1960; bounties were paid for more than 100,000 Bald Eagles, about 400,000 seals, and millions of predatory fish (Hubbs 1941, Meachem and Clark 1979). The bounty system there, as has been found elsewhere, was often abused and is not a recommended means of predator control (Hubbs 1941, White 1957, Cain et al. 1972, Meachem and Clark 1979).

Predatory fish in North America have often been considered the most frequent predators of salmon (Meachem and Clark 1979). Accordingly, it is not surprising that there have been many programs of control of predatory fish (including coho salmon and trout)(Foerster and Ricker 1941, Hubbs 1941, Vladykov 1943, M. W. Smith 1968, Shetter and Alexander 1970, Hadley 1979, Meachem and Clark 1979).

Fish-eating birds (particularly Common Mergansers and Belted Kingfishers) have also been subjected to predator control programs in North America (E. R. Hall 1925, Mendall 1936, White 1936, 1937, 1938, 1939a, 1953, 1957; Munro and Clemens 1937, Salyer and Lagler 1940, Huntsman 1941, Vladykov 1943, Elson 1962, Mills 1967, M. W. Smith 1968, Shetter and Alexander 1970, Erskine 1972, Alexander 1979, DesGranges and Reed 1981, Maine Cormorant Study Committee 1982, Vermeer and Rankin 1984, Craven and Lev 1987, Draulans 1987, Findholt 1988, Broadway 1989).

Marine mammals have also been controlled in attempts to increase salmon runs (e.g., Meachem and Clark 1979, Fiscus 1980, Everitt and Beach 1982).

1-B-2. Fish-eating Predator Control in Oregon

I have not found any records of bounties being placed on either predatory fish or fish-eating birds in Oregon. Bounties for both seals and sea lions or just for seals were paid from about 1919-1933 throughout Oregon and from 1936-1972 on the Columbia River in Oregon (Oregon Fish Commission 1919, 1923, 1972; Everitt and Beach 1982). Bounties were recorded for over 10,600 marine mammals in Oregon (Mate in Everitt and Beach 1982:269). Killing of sea lions, without bounties, around the mouths of nine coastal streams was legal from 1947-1970 (Oregon Fish Commission 1970:9). Today, a major cause of mortality for seals and sea lions is still shooting (Stroud and Roffe 1979), most of which is probably illegal.

The only documentation that I have found for the informal or formal involvement of the Oregon Fish Commission, Oregon Game Commission, or their successor, the ODFW, in fish-eating bird control away from fish hatcheries is in Anderson and Gates (1983:10) and Shotwell (1989). K. Roach reported that in 1938 the Oregon Game Commission Director supplied Roach and three other men with a case of 600 shotgun shells and suggested that they shoot the nesting Double-crested Cormorants at Crane Prairie Reservoir in Deschutes County in central Oregon (Anderson and Gates 1983:10). The four men used all their shells during five hours on one day to shoot cormorants; the men then climbed nest trees and killed cormorant nestlings and destroyed their nests (Anderson and Gates 1983:10). Roach estimated that they killed about 1,300 cormorants (Shotwell 1989).

This may not have been an isolated instance, and there may have been other situations where the Oregon Fish Commission or Oregon Game Commission supplied ammunition or personnel to either kill or destroy nests of fish-eating birds.

Although formal programs for fish-eating bird control away from hatcheries appear to have been lacking in Oregon, fish-eating birds have been harassed or killed for years by private citizens. For example, Gabrielson and Jewett (1940:98) indicate that cormorants were subjected to continual persecution by sports and commercial fishermen along the Oregon Coast. Some of this persecution was legal because all cormorants, Common and Hooded Mergansers, and kingfishers could be legally killed through 1958 (Oregon State Game Commission 1957, 1959). Further, Belted Kingfishers and Double-crested Cormorants could be legally killed in Oregon until 1972 (Oregon State Game Commission 1971). Even today when these birds are supposedly protected, illegal shooting of fish-eating birds is a continuing significant problem (e.g., Eltzroth 1986, Eltzroth letter dated 17 October 1988).

The history of legal or illegal harassment or killing of fish-eating birds is long in Tillamook County. In the early 1900's, boats used to go to Three Arch Rocks for Sunday excursions to shoot nesting seabirds (Mathewson 1986:7). In the 1930's, Reed Ferris noted that fishermen were still killing or destroying nests of gulls, Double-crested Cormorants, and maybe other seabirds on Haystack Rock or at Cape Lookout (Ferris 1940, Bayer and Ferris 1987:108, 111).

Oregon fishermen's concerns about cormorants are not restricted to the Oregon Coast. In the 1980's, some fishermen have been highly upset about cormorants at Crane Prairie Reservoir in central Oregon (Fies 1984, Shotwell 1984, 1989; Anderson and Gates 1983). There, anglers would also like means of controlling cormorants (Shotwell 1989).

1-C. Legal Requirements for Cormorant Control in Oregon

In Oregon, all cormorants could be killed without permit prior to 1958; later, Double-crested Cormorants could legally be shot until 1972 (Oregon State Game Commission 1957, 1959, 1971; USFWS 1969, Schmidt 1972).

Since mid-1972, cormorants have been legally protected; however, this does not mean that they have been safe from shooting and harassment. In Maine (Maine Cormorant Study Committee 1982:7), and probably also in Oregon, some fishermen have regarded the illegal shooting of cormorants as their prerogative.

Enforcement of nongame wildlife laws is lax in Oregon because there are too few game police, and enforcement is concentrated on game and fishery violations, not nongame violations. The existence of illegal shooting of fish-eating birds and raptors is indicated by these birds often being brought to bird rehabilitators with gunshot injuries (Eltzroth 1986, Eltzroth letter dated 17 October 1988), and it is unknown how many birds have been injured or killed and not brought to rehabilitators.

Illegal shooting or harassment of cormorants without the violators being caught would be relatively easy during the waterfowl hunting season when shooting is expected. But in April-June (when cormorant harassment is proposed), shooting is "out of season," so poaching of waterfowl or illegal shooting of nongame wildlife would be more conspicuous to police and to the general public. Accordingly, it is wise for people interested in shooting or harassing cormorants to do so legally, which requires that they contact government agencies and acquire the proper permits.

To kill cormorants, permits would be required from both the U.S. Fish and Wildlife Service (USFWS) and the Oregon Department of Fish and Wildlife (ODFW). The USFWS was contacted about issuing permits for killing cormorants or other fish-eating birds in the Tillamook area, but the USFWS indicated that such permits would not be authorized (Thomas M. Riley, USFWS Law Enforcement, letter dated 12 October 1988).

Thus, the only recourse to individuals wishing to control cormorants legally is to harass (haze) them. To harass cormorants, permits must only be issued through the State of Oregon because the U.S. Migratory Bird Treaty Act (50 CFR 21.4[a]) does not require a federal permit to harass migratory birds unless they are threatened or endangered (Thomas M. Riley, USFWS, letter dated 12 October 1988).

Oregon harassment permits must be authorized by the Oregon Fish and Wildlife Commission (see section 1-J) or, in cases of emergency, the ODFW Director. This authority arises from Oregon Statute ORS 498.006, which was passed by the Oregon Legislature and states:

> "Chasing or harassing wildlife prohibited. Except as the [Oregon Fish and Wildlife] commission by [Oregon Administrative] rule may provide otherwise, no person shall chase, harass, molest, worry or disturb any wildlife except while engaged in lawfully angling for, hunting or trapping such wildlife."

If the ODFW Director believes an emergency exists, the Director apparently has the authority to issue such permits under Oregon Statute ORS 496.118 (2), which states:

> "In times of emergency, the [ODFW] director may exercise the full powers of the [Oregon Fish and Wildlife] commission until such times as the emergency ends or the commission meets in formal session."

(These and other Oregon Statutes relating to wildlife are available to the general public in the "Oregon Wildlife and Commercial Fishing Codes" book at ODFW offices and in some public libraries.)

To authorize cormorant harassment on public waters and lands, the Commission would have to amend or make new Oregon Administrative Rules (OAR). The applicable Administrative Rules (OAR 635-43-105 and 635-43-110) only authorizes harassment permits to a landowner (or his or her agents) for harassing animals that are causing damage on his or her personal property.

1-D. 1985 and 1988 ADC Involvement in Cormorant Harassment

1-D-1. Scope of ADC

To reduce wildlife damage, personnel from the Animal Damage Control Program (ADC), which is part of the U.S. Department of Agriculture, can provide some harassment supplies and training in the use of supplies. But their personnel do not do harassment nor supervise the people to whom they give supplies or training (T. R. Hoffman, Oregon ADC Director, letter dated 5 October 1988). Further, the ADC requests users to purchase additional supplies at their own expense (Hoffman, letter dated 5 October 1988).

Although the ADC does not and can not issue permits for harassment, it has been actively involved in the cormorant harassment issue in Tillamook County. In the following sections, ADC involvement is outlined.

1-D-2. Harassment Supplies Provided by the ADC

The ADC has supplied harassment supplies (cracker shells for 12 gauge shotguns and audio distress calls) and/or instructions for using them to Salmon and Trout Enhancement Program (STEP) volunteers and private citizens that have harassed cormorants at Nehalem and Tillamook Bays (Hoffman, letter dated 26 September 1988).

ADC records indicate that in 1985, hazing supplies were issued by the ADC to the President of the Nehalem STEP group to be used by STEP volunteers in harassing cormorants (Hoffman, letter dated 13 October 1988). These supplies may have been issued in March 1985 (Hoffman and Hall 1988, which is reprinted in Appendix XI). The ADC does not have any records that indicate if these supplies were used or not. Doug Taylor, ODFW Wildlife Biologist at Tillamook, was not aware of any permit being issued by the ODFW to these STEP volunteers or any other individuals in 1985 or 1986 to legally harass cormorants (Taylor, letter dated 9 December 1988).

Although representing themselves as STEP volunteers to the ADC (e.g., Hoffman and Hall 1988), the harassers acted outside the authority of STEP because harassment has not been a STEP project and STEP staff was not contacted for approval of harassment (Rick Klumph, former STEP Biologist at Tillamook, letter dated 19 October 1988).

The ADC does not have any records in their files that indicate that they assisted anyone in the harassment of cormorants in 1986 or 1987 (Hoffman, letter dated 13 October 1988).

In 1988, the ADC gave two boxes of cracker shells for 12 gauge shotguns to Jim Erickson to be used in cormorant harassment (Hoffman, letter dated 13 October 1988). Also in 1988, the ADC was involved in the following study.

1-D-3. The ADC "Cormorant Study"

On 27 April 1988, ADC personnel participated in a "study" (Hoffman and Hall 1988, which is reprinted in Appendix XI) that has been used as "proof" that cormorants were eating substantial numbers of smolts (Erickson 1988b, McAllister 1988). The results of this study are also discussed in section 2-F-5.

Unfortunately, this "study" was marred by faulty methods. Although it was publicized that Brandt's Cormorants were collected (Hoffman and Hall 1988, McAllister 1988), color slides of some of the cormorants that were collected during the study and shown by Jim Erickson at the 28 November 1988 ODFW meeting (section 1-G) revealed that many, if not all, were actually Double-crested Cormorants.

Secondly, smolts found in the cormorants appear to have been misidentified. McAllister (1988) reported and Hoffman (letter dated 21 October 1988) concurred that most smolts were chinook smolts. However, at the 28 November 1988 ODFW meeting (section 1-G), Hoffman indicated that the ADC's identification of smolts may have been incorrect. Since coho smolts were the only juvenile salmonid released into the Tillamook Basin prior to the ADC study that would have contained 3-4 inch (7.6-10.2 cm) fish (unpubl. data), the "salmon" smolts found in cormorants were probably coho. A further indication that most salmon smolts may have been coho was that they formed the vast majority of all smolts released with 0.84 million released into the Tillamook Basin on 11 and 15 April 1988 (T. E. Cummings, ODFW Staff, letter dated 16 December 1988).

Finally, it is questionable if the techniques of dissection during this "study" were adequate to find otoliths of other fish that the cormorants may have been eating (e.g., see Appendix IX). Slides shown at the 28 November 1988 ODFW meeting (section 1-G) showed cormorants laying on the ground with their viscera spilled out on the grass, which is where they were evidently dissected. Reportedly, a pen knife was used to open up the cormorants. But to find and save otoliths, dissections need to be carefully done in a laboratory. Thus, the assertion in McAllister (1988) that these cormorants were only eating smolts is debatable.

While this study appears to have been done haphazardly, the blame does not rest solely on ADC personnel. Some STEP volunteers (again acting without official approval) had given ADC personnel the impression that this "study" was not only condoned by the ODFW but that ODFW biologists were going to help with the dissections and analysis (Hoffman, letter dated 21 October 1988, pers. comm.). The ODFW did not provide such assistance; it is also not clear if the ODFW knew of this "study" far enough in advance to provide such assistance. One ODFW employee did show up after some cormorants had been collected, but left shortly thereafter (Hoffman, letter dated 21 October 1988).

1-E. 1985 and 1988 STEP Involvement in Cormorant Harassment

Part of the confusion in the cormorant predation issue has been the involvement of STEP volunteers in harassment. Supposedly, STEP projects must have the approval of the ODFW (ODFW 1985b) before they can be conducted. But harassment is not included as a project in the STEP objectives (ODFW 1985b).

STEP volunteers apparently first became involved in cormorant harassment in 1985 when the President of the Nehalem STEP group received supplies from the ADC to be used by Nehalem STEP volunteers (section 1-D-2). It is unknown if these STEP volunteers harassed cormorants; if they did, they may have done so illegally because they apparently did not have a permit (section 1-D-2).

In 1988, the harassment of cormorants by permit at Nehalem and Tillamook Bays was neither approved nor requested by ODFW personnel in charge of STEP, and they were not contacted for assistance (Rick Klumph, 1988 STEP Biologist at Tillamook, letter dated 19 October 1988). Participants in 1988 cormorant harassment, who were also STEP volunteers, were conducting harassment as private citizens, not as official representatives of STEP (Klumph, letter dated 19 October 1988).

The problem has been that some private citizens, who are also STEP volunteers, have been actively involved in harassment and have made it clearly known that they are with STEP. The inference then becomes that STEP is actively involved with harassment and that the ODFW implicitly approves all activities of STEP volunteers.

This problem has been clearest in the communication of STEP volunteers with ADC personnel (section 1-D-2). The ADC felt that actions of citizens identifying themselves as STEP volunteers were condoned by the ODFW (T. R. Hoffman, ADC Oregon Director, letter dated 5 October 1988; Hoffman and Hall 1988). But ADC personnel were not the only ones that were told that STEP volunteers were conducting harassment because STEP volunteers were also cited as being involved in the 1988 Nehalem Bay harassment in the Portland "Oregonian" newpaper (McAllister 1988).

1-F. 1988 Cormorant Harassment by ODFW Permittees

In the spring of 1988, the ODFW Director, Randy Fisher, authorized the issuance of a series of permits to allow individuals to harass cormorants at Nehalem and Tillamook Bays. There has been some debate as to whether the ODFW Director had the authority to issue such permits, but as pointed out in section 1-C, it appears that the Director can declare an emergency, assume the powers of the Oregon Fish and Wildlife Commission, and issue such permits.

Details about the permits and known details about the harassment are given in the following sections.

WHO.--Permits were issued to Jim Erickson and his crew of two for harassment of cormorants at Nehalem Bay and to Sam Gallino and his crew of six for harassment at Tillamook Bay (Doug Taylor, ODFW Wildlife Biologist at Tillamook, letter dated 16 November 1988). Both Erickson and Gallino are fishing guides in the Tillamook area (Anonymous 1988a).

WHICH BIRD SPECIES.--The permits do not specify what species of cormorants are to be harassed, so all cormorants could be hazed with these permits (Taylor, letter dated 16 November 1988).

WHEN.--A series of permits, each lasting about two weeks, for 8 April-6 June 1988 at Nehalem Bay and 21 April-20 June 1988 were issued for Tillamook Bay (Taylor, letters dated 16 November and 9 December 1988).

WHERE.--The permits were to harass cormorants from "tidewater areas" of Nehalem and Tillamook Bays (Taylor, letter dated 16 November 1988). These are also the areas referred to as being where harassment occurred in newspaper articles (Hendrickson 1988a, McAllister 1988). Thus, cormorants were harassed from public waters.

WHAT.--The permits are for "hazing only" (Taylor, letter dated 16 November 1988). Killing of birds is not specifically noted as being prohibited in the permit, but permittees were probably told that killing was not allowed.

HOW.--Copies of two permits provided by Taylor (letter dated 16 November 1988) state that hazing is to be by "cracker shell only" or "shell cracker only."

Cracker shells (or shell crackers) commonly refer to shells that are shot in 12 gauge shotguns (Hawthorne 1980, Mott 1980, Salmon et al. 1986, McAllister 1988). These shells contain a firecracker that is projected about 50-1DO yd (45-9D m) before exploding (Hawthorne 1980, Mott 198D, Salmon et al. 1986).

At the 13 April 1989 hearing before the Oregon House Agriculture, Forestry and Natural Resources Committee (section 1-I-2), Erickson (1989c) passed a cracker shell around to members of the Committee and testified about cracker shells:

> "They're a 12 gauge shotgun shell. Inside of them, if you peel back this tape, is a firecracker that is ignited when the shotgun shell goes off. It goes about 80 yards and goes off, with a bang. It's about a M-60 firecracker, is what it amounts to."

Cracker shells were available to permittees. Two boxes of cracker shells for 12 gauge shotguns were given to Jim Erickson (one of the permittees) in 1988 by the ADC (Hoffman, letter dated 13 October 1988), and the Parks Foundation also purchased cracker shells for shotguns for the 1988 harassment program (Loren Parks, letter dated 21 September 1988).

Cracker shells were also used. Erickson and others during the 1988 harassment program were reported as using cracker shells shot from 12 gauge shotguns to harass cormorants (McAllister 1988).

At the 28 November 1988 ODFW meeting (section 1-G), Jim Erickson indicated that a starter's pistol was also used to shoot screamer shells or modified cracker shells to harass cormorants. In Erickson's oral (Erickson 1989c) and written (Erickson 1989d, which is reprinted in Appendix XV) testimony for the April 13 Hearing, he indicated that screamer shells were also used in harassing cormorants. These shells have a shorter range of 35-75 yd (33-69 m) but are less expensive and are easier to handle than cracker shells (Salmon et al. 1986).

In summary, all these shells were shot from firearms, and their purpose was to create enough noise to scare away birds (especially cormorants), not to kill them.

SUPERVISION OF PERMITTEES.--Permittees were apparently not observed by the ODFW to see if they abided by their permits (Bill Haight, ODFW Nongame Management, letter dated 17 October 1988). USFWS personnel also did not watch permittees to see if any threatened or endangered wildlife were intentionally or accidentally harassed (Thomas M. Riley, USFWS Law Enforcement, letter dated 12 October 1988). And as previously mentioned, it is not the policy of the ADC to supervise people to whom they give harassment supplies (Hoffman, letter dated 5 October 1988).

1-G. 28 November 1988 ODFW Meeting About Cormorant Harassment

On November 28, the ODFW held a meeting at their Portland headquarters to discuss the cormorant harassment issue. Proponents of harassment (including Jim Erickson and Loren Parks) and opponents (including myself) were represented and expressed their viewpoints.

At the meeting, state, federal, and private biologists explained that while many species of mammals, fish, and birds prey on smolts, the actual impact of cormorants on salmon and steelhead returns is probably very small (ODFW News Release dated 1 December 1988).

At the end of the sometimes contentious meeting, Randy Fisher (ODFW Director) announced that the ODFW would not be issuing harassment permits to private citizens in 1989 as they did in 1988.

In spite of testimony that cormorants were probably causing little damage to smolts, harassment proponents were not satisfied and indicated that this issue might be brought to the Oregon Legislature (see section 1-I).

1-H. Cormorant Harassment in 1989

The ODFW did not issue any harassment permits for the spring of 1989, so any harassment then would have been illegal. Nevertheless, reports have continued of cormorants being targets of shots or harassment at both Nehalem and Tillamook Bays.

At Nehalem Bay, one individual that wishes to remain anonymous reports that some anglers used boats to deliberately chase away cormorants and other water birds. Other evidence that boats were used sometimes to harass cormorants was provided by Loren Parks (1989), a harassment supporter (section 6-I). In oral testimony before the House Agriculture, Forestry and Natural Resources Committee on 13 April 1989, Parks (1989) stated that:

> "Now [as of April 13, 1989] a lot of the smolts have already been released. And we have people that are out there. And what they say, they're just out in boats, and they can go into where the smolt ball is and shoo away the birds but as soon as the boat leaves the birds are right back on them."

At Tillamook Bay in 1989, cormorants have also been reported to have been shot at by fishermen. In mid-April 1989, Jo Walin (pers. comm.) found a dead cormorant that had been shot and that had washed up on the beach just north of Nehalem Bay.

In summary, there appears to have been some cormorant harassment in Tillamook County in 1989, but the degree of harassment is unknown.

1-I. Oregon House Bill 3185

1-I-1. Introduction

Since the Oregon Fish and Wildlife Commission already had the authority by Oregon Statute to issue cormorant harassment permits (section 1-C) and harassment proponents wanted to start harassment in April 1989, it isn't clear why proponents went to the Oregon Legislature in the spring of 1989, instead of the Commission after the November 1988 ODFW Meeting. The Legislature has never been known for acting speedily, so it is difficult to believe that proponents thought that their Bill would pass fast enough to allow them to harass cormorants in the spring of 1989.

In any case, House Bill (HB) 3185 was introduced to the Oregon House of Representatives at the request of Jim Erickson (Appendix XII). The Bill was sponsored by three Representatives and two Senators (Appendix XII); four of the five sponsors represented coastal districts.

The main points of the original HB 3185 (Appendix XII) were:

1) The Oregon Fish and Wildlife Commission shall issue no more than three permits to haze cormorants in 1989 and in 1990.
2) All cormorants, not just Double-crested Cormorants, could be harassed.
3) Harassment would be authorized in all Oregon coastal rivers.
4) There was no restriction on when harassment could occur during the year.
5) Permits would not authorize killing or trapping of cormorants.

Thus, HB 3185 broadened the scope of the cormorant harassment issue from being concerned with cormorants in Tillamook County during the spring to all Oregon coastal streams throughout the year.

The first reading of this Bill in the House was on March 3, and it was referred to the House Agriculture, Forestry and Natural Resources Committee on March 7.

1-I-2. House Hearing

The first Committee hearing for this Bill was held on April 13. The chief sponsors, State Representatives Paul Hanneman (R-Tillamook) and Larry Sowa (D-Oregon City), spoke in favor of the Bill as did Jim Erickson, Loren Parks, and Jason Boe. Because Boe was President of the Oregon Senate for about eight years, he is quite knowledgeable about maneuvering bills through the Oregon Legislature, where he has been a paid lobbyist since 1983 (McDonough 1980, Ota 1987).

Oral or written testimony given at this Hearing is available in the State Archives or in the Oregon Legislative Library.

1-I-3. House Work Session

On April 20, 1989, the Committee held a work session. In view of some opposition to HB 3185 at the April 13 hearing (section 6-E-4), amendments to the Bill were suggested by Jason Boe.

The important amendments to HB 3185 (see Appendix XIII) were:

1) Items 3) and 4) in the original Bill were changed, so that harassment would be limited to rivers flowing into Nehalem Bay or Tillamook Bay from the time of release of hatchery smolts until June 30.
2) Harassment would be monitored by the ODFW.

After some discussion, the amended HB 3185 was passed on April 20 by a vote of 7 to 1 with one Committee member absent.

The language of these amendments is surprising because they were drafted by Hanneman and Boe, but, if passed, the amended HB 3185 would not have allowed harassment in Nehalem and Tillamook Bays, but only on rivers that flow into them. Harassment in 1988, however, occurred within both Bays (section 1-F "Where").

1-I-4. House Vote

On May 1, the amended HB 3185 passed the

Oregon House of Representatives by a vote of 56 to 4. A discussion of the reasons for the one-sidedness of this vote is in sections 6-E and 6-F.

1-I-5. Senate Action

On May 2, the amended HB 3185 had its first reading in the Oregon Senate, and on May 5, it was referred to the Senate Agriculture and Natural Resources Committee. When the Senate adjourned July 4, this Bill had not even been scheduled for a Hearing by the Senate Committee.

1-I-6. Misinformation

On June 11, perhaps to broaden support for this Bill and to extract it from the Senate Committee, a misleading article in Oregon's largest newspaper (the Portland "Oregonian") mistakenly indicated that HB 3185 would allow cormorant harassment in central Oregon (Shotwell 1989). Central Oregon fishermen were reported to be excited about the passage of this Bill (Shotwell 1989); this article may have encouraged them to contact their legislators to pass it. Prior to this time, most supporters were only from Tillamook County.

1-I-7. Adjournment of Legislature

This Bill died, when the Oregon Legislature adjourned, without passing HB 3185.

1-J. Oregon Fish and Wildlife Commission

The Oregon Fish and Wildlife Commission is composed of seven private Oregon citizens that are appointed by the Governor and confirmed by the Senate. Each Commissioner has a term of four years and can be reappointed.

As pointed out in section 1-C, the Commission could authorize cormorant harassment permits by making or changing Administrative Rules. Perhaps because HB 3185 was taking so long getting through the Oregon House, Jim Erickson formally requested the Commission to consider issuing harassment permits on 24 April 1989 (Erickson 1989e, which is reprinted in Appendix XIV). Since there is a requirement that there be a 30 day public notice of such items, the first Commission meeting for which the permit issue could be considered was on June 3, 1989. The hearing on this issue was duly scheduled for June 3 during the Commission's regular meeting, but on May 19 the hearing was delayed to July 21 at the request of a harassment proponent (Rod Ingram, ODFW Staff, letter dated 19 May 1989).

The original purpose of the July 21 hearing was to take oral and written public testimony and to make a decision on whether or not to change Oregon Administrative Rules to allow harassment (hazing) permits to private individuals for coastal rivers and estuaries. Harassment was not proposed to be limited within a year (e.g., spring) or to place (e.g., Nehalem and Tillamook Bays). It was proposed that the harassment would require monitoring by ODFW personnel at a cost of about $8,000/river estuary for 3.5 months.

On 11 July 1989, the purpose of the July 21 hearing was changed by the ODFW. Instead of deciding on whether or not to allow cormorant harassment, the new purpose would be for Commissioners to reconsider (without public testimony) accepting the petition for issuing permits for cormorant harassment. If the Commission decided to accept the petition, then another hearing date would be set up in which public testimony would be accepted about giving permits to harass cormorants.

The ODFW changed the purpose of the July 21 hearing in response to the passage of HB 2735 that directed the ODFW to study the dietary habits of smolt predators and methods of increasing smolt survival rates (Rod Ingram, ODFW staff, letter dated 14 July 1989).

At their July 21 meeting, the Commission decided not to accept the petition to allow cormorant harassment permits.

Chap. 2. The Cormorant Predation Issue was Inevitable in Tillamook County

2-A. Introduction

Taken separately or together, the reasons outlined above form the ingredients that have made cormorant predation of smolts an explosive and unadvoidable issue among a few Tillamook County fishing guides and fishermen. Below, each of these ingredients is examined.

2-B. Conflict Among Fishermen: A Few Coastal Stream Sports Fishermen Feel They Are Not Getting Their Share of Salmon and Resent Predators Taking Any Salmon

2-B-1. Conflicts Among Fishermen

Salmon and steelhead are no longer an unlimited resource, and there is competition among various groups for a better "share" of the catch. Along the Oregon Coast, the various fishing interests include ocean commercial troll fishermen, ocean sports fishermen, ocean charter boat operators, private salmon aquaculture companies, coastal stream sports fishermen, and coastal stream fishing guides.

While sometimes these various groups agree, they often fight among themselves to increase each's own share of the salmon "pie" and are often suspicious of each other's motives (e.g., C. L. Smith 1979, Wright 1981, K. Johnson 1983, Walker et al. 1983, Hanneman 1986a, b; Martin 1986, Anonymous 1988d)(also see Table 2.1).

One example of the conflict between commercial and sports fishermen is the efforts by the Northwest Steelheaders (a sports fishing group) to eliminate the commercial gill net fishery for spring chinook in the Columbia River (Anonymous 1987c). Further evidence of a rift between commercial and sports fishermen is that the Executive Director of Northwest Steelheaders has indicated that salmon should be managed more for the recreational fishery (Anonymous 1988d), which can only happen at the expense of the commercial fishery.

Further, at least one sports fisherman (Dodrill 1989), who formerly resided in Tillamook County, worries that there are too many river guides who commercially exploit salmon and steelhead.

Some coastal stream fishermen are also concerned about coastal stream fishermen overfishing returning fish in Tillamook County. For example, fisherman Dodrill (1989) thought that the Portland "Oregonian" newspaper was too explicit in pointing out good fishing areas and techniques for Tillamook streams. Subsequently, returning salmon and steelhead may not have much of a chance of escaping to spawn because they could be caught by a gauntlet of stream fishermen (Dodrill 1989).

Because there are so many different special interest fishing groups, it is not surprising that they often disagree. For example, some sports fishermen and fishing groups such as Oregon Trout want wild salmon and steelhead to be more protected (e.g., Bakke 1989). In contrast, other fishermen and fishing groups are only concerned with catching more fish now, even if wild fish are irrevocably harmed and the loss of wild fish may result in lower future catches (e.g., see Appendix VIII).

It is apparent that it is impossible for the ODFW to manage salmon fisheries to everyone's satisfaction with such discordant interests. Thus, it is inevitable that the ODFW's management of the salmon and steelhead fisheries will be severely criticized, no matter what the ODFW does (Gunsolus 1980)(also see 6-D).

2-B-2. Fishermen's Resentment

Some coastal stream sports fishermen may feel slighted because they get so few salmon (usually less than 3%) compared to the ocean commercial or ocean sports fisheries (Table 2.1). Stream fishermen have tried to get a bigger share of the salmon "pie" without success, so some of them may feel frustrated and, subsequently, resentful of predators. It is easier to take their frustration out on predators than on other fishermen.

Table 2.1. Coho salmon catch by Oregon ocean commercial troll, ocean sports, and coastal stream sports fishermen. Data are from ODFW (1987) and McQueen et al. (1988).

Coho Salmon Fishery	Thousands of Coho..... 1977	1980	1982	1985	% of Total Coho...... 1977	1980	1982	1985
Ocean Commercial Troll	446	383	522	84	68	53	73	30
Ocean Sports	195	326	175	182	30	46	25	64
Coastal Stream Sports	14	6	15	16	2	1	2	6
TOTAL	655	715	712	282	100	100	100	100

2-C. Emotional Involvement of STEP Volunteers in Raising Salmon

Another reason that the cormorant issue was inevitable is the growth of the Salmon and Trout Enhancement Program (STEP) in Tillamook County. Tillamook County volunteers have included individual fishermen, fishing groups, school classes, prison inmates, and interested individuals (e.g., Anonymous 1984a, 1985a, 1986a, 1986c, 1987b, 1988b, c; Hendrickson 1988b, c).

Some STEP volunteers monitor hatchboxes and release juvenile fish. Some of these volunteers, like farmers or parents, are naturally going to feel a strong emotional tie to the fish they raise and are going to be upset if any of "their" fish may be eaten by predators.

STEP supervisors can explain to volunteers that predation is a natural process and that many of the fish will survive and produce the good catches of recent years (Figs. 2.1-2.6 in 2-D-7). However, some volunteers may intellectually understand but not emotionally accept this and be resentful of predators.

2-D. Perception that Salmon and Steelhead Runs Are Approaching Ruin

2-D-1. Introduction

Some Tillamook fishing guides and fishermen have argued that control of salmon predators is necessary to save salmon and steelhead runs from ruin (e.g., B. C. 1986, Erickson 1986, 1988a, b; Hendrickson 1987, 1988a). For example, Loren Parks (1989) testified at the 13 April 1989 House Agriculture, Forestry and Natural Resources Committee Hearing:

> "At first, I think that a lot of people don't realize what the problem is. The problem is that fishing stinks, the fishing for steelhead salmon and for silver [coho] salmon. The steelhead fishing has been especially bad. It's gone downhill year after year. The silver salmon seasons have been shortened until they were really very short last year."

Fishermen may feel that the runs are declining because the total number of fish caught is declining, because the number of fish per fisherman is declining, or because the length of the seasons is decreasing. Each of these possibilities is examined in the following subsections.

2-D-2. Total Catches Are Not Decreasing

Recent catches of salmon or steelhead are not at disastrous levels at Nehalem or Tillamook Bays (Figs. 2.1, 2.3, and 2.5 in 2-D-7) or along the Oregon Coast as a whole (Figs. 2.2, 2.4, and 2.6). For example, current ocean catches of coho generally surpass those before 1970 (Appendix III) and are similar to those of 1966, 1968-1969, 1972-1973, 1975, and 1977-1979 (Fig. 2.2, Appendix III). Recent commercial and sports catches of chinook are better than most years since 1970 (Fig. 2.2, Appendix IV). Further, the value of commercial troll caught coho and chinook in 1988 had only been surpassed in two of the previous 17 years (Fig. 2.4).

Recent winter steelhead catches are also better than in many past years, and summer steelhead catches are similar to many other years during the 1970's and 1980's and are higher than those in the 1960's (Figs. 2.5-2.6).

The only "problem" salmon or steelhead fishery along the Oregon Coast is the coastal stream sports fishery for spring chinook, but even recent catches for this fishery are at levels comparable with several other years beginning in 1969 (Fig. 2.3, Appendix IV-D).

Some fishermen may dwell on being gloomy about salmon fisheries because they may fondly remember the exceptional coho catches of some of the 1970's and especially the outstanding coho catch of 1976 (Figs. 2.2, Appendix III). What has been forgotten is that these catches were an anomaly due to very favorable ocean conditions that are infrequent and irregular (see 2-I-5). Fishermen may also forget that current coho catches are similar to those of 1966, 1968-1969, 1972-1973, 1975, and 1977-1979 (Fig. 2.2).

Fishermen may disagree among themselves on what constitutes a "good" fishing year. For example, commercial troll fishermen would have thought 1985 was disastrous compared to 1982 because their 1985 coho catches were low, but ocean sports and coastal stream fishermen would both have regarded 1985 as somewhat better than 1982 (Table 2.1). Further, in spite of similar total coho catches for 1977, 1980, and 1982; commercial troll and coastal stream fishermen would have considered their 1977 and 1982 catches better than in 1980, but ocean sports fishermen could vigorously disagree because their coho catch in 1980 was markedly better than in 1977 or 1982 (Table 2.1).

In summary, salmon and steelhead catches fluctate from year to year, they are currently in reasonable condition, and it is probably impossible to simultaneously satisfy all salmon and steelhead fishing interests.

2-D-3. Sports Fishermen: Fishing Effort and Catch Per Unit Effort Do Not Appear to be Declining

Even if the total number of fish remains relatively unchanged, fishermen can believe that there are fewer fish. This can result if the number of fishermen increases so that each fisherman catches fewer fish or if fishing effort increases without a commensurate increase in catches.

Using the number of ocean salmon fishing trips as an index of fishing effort, the number of trips dipped in 1984 but has increased since then to levels still below that of 1979 and 1980 (Fig. 2.7) The number of coho or chinook caught per fishing trip has remained relatively constant since 1979 and is certainly not declining yearly (Fig. 2.7). Data on the number of ocean fishing trips prior to 1979 are available but are not comparable because those trips includes nonsalmon fishing trips (McQueen et al. 1988:40).

There are no data available to determine if the salmon catch per unit effort for coastal stream sports fishermen has declined in Oregon. There are, however, data about steelhead catches and fishermen's effort for one Oregon coastal stream, the Alsea River (Kenaston 1987). For the Alsea, it is clear that the total number of steelhead caught and the number of steelhead caught/100 hours of fishing is not declining, even though the number of fishing hours has been increasing in recent years (Fig. 2.8). The strong relationship between catch and fishing effort is apparent from Alsea catch data because for the 1960-1961 through 1986-1987 seasons, there was a significant correlation between the total number of steelhead caught and total hours fished ($r=0.84$, two-tailed $P<0.01$) or between total steelhead caught and steelhead caught/100 hours ($r=0.77$, two-tailed $P<0.01$)(calculated from Kenaston 1987:5).

2-D-4. Commercial Fishermen: Fishing Effort and Catch Per Unit Effort Are Not Declining

Unfortunately, data about commercial troll fishing effort and catch per unit effort (CPUE)(i.e., coho or chinook per boat day) are not available prior to 1979. Nevertheless, it is apparent that fishing effort (Fig. 2.9) and CPUE's for coho or chinook (Fig. 2.10) are not declining. In fact, fishing effort was greater in 1988 than in 1979-1987 (Fig. 2.9), and recent chinook CPUE's have increased (Fig. 2.10). In spite of poor coho CPUE's in 1984 and 1985, recent coho CPUE's are similar to 1979-1983 CPUE's (Fig. 2.10).

2-D-5. Salmon Seasons Are Not Unlimited

There is no question that commercial and ocean sports salmon fisheries are currently more restricted and shorter than in the past (e.g., McQueen et al. 1988:4-7, 34-35). So even though total catches and catches per unit effort are not approaching ruin, some fishermen and charter boat owners perceive the shortened seasons as evidence that salmon runs are poor and want longer seasons.

Although obvious short-term solutions to this problem is to extend seasons, increase harvest rates, or increase the number of salmon; these solutions all have problems. For example, extending seasons without having more fish will just lead to a bonanza 1-2 years and then a marked decline in available salmon because of overfishing. Increasing the percentage of salmon that are caught will lead to overfishing of wild fish, which may be detrimental to the long-term health of the salmon fisheries (section D-4 in Appendix VIII). Finally, increasing hatchery releases has not led to an increased number of returning adults (e.g., Pearcy 1988), so increasing the number of available salmon may be more under the control of nature (e.g., upwelling, section 2-I-5) than of humans.

Another reason that just increasing the number of salmon for fishermen won't help solve this problem is that if there were more salmon to be caught, fishing effort and the number of sports fishermen would increase commensurately (see section 6-K). The result would be the same: regulations and shortened seasons would have to be reinstated to save salmon from overfishing, and some fishermen would again be complaining that the runs are poor.

Public relations and communication are the most important ways of dealing with the problem of restricted seasons and regulations. ODFW fisheries managers need to inform fishermen that total catches and catches per unit effort are good and that the ocean doesn't have an unlimited supply of salmon. Fishermen need to be made aware of the concept of carrying capacity, and the fact that the supply of salmon will probably never be adequate to satisfy their demand.

2-D-6. Perceptions Can Be More Important than Facts

When catch statistics are examined, it is apparent that fishermen's catches along the Oregon Coast are not approaching ruin as some fishermen claim. On the contrary, catches in some salmon fisheries are at levels higher than when predators were not protected. However, facts such as catch statistics make no difference, if a few fishermen refuse to believe them because they don't support their feelings or if they want unlimited fishing seasons.

2-D-7. Figures for Section 2-D

Figure 2.1. Sports coho catches in the Nehalem or Tillamook Basins for 1970-1986. Nehalem Basin=Nehalem River and Bay and tributaries including North Fork Nehalem River, Salmonberry River, Cook Creek, and Rock Creek. Tillamook Basin=Tillamook River and Bay and tributaries including Kilchis River, Miami River, Trask River, South Fork Trask River, North Fork Trask River, Wilson River, Little North Fork Wilson River, and Devils Lake Fork Wilson River. Data are from Berry (1981) and ODFW (1987); 1986 preliminary data are from Ron Williams (ODFW Biologist, pers. comm.).

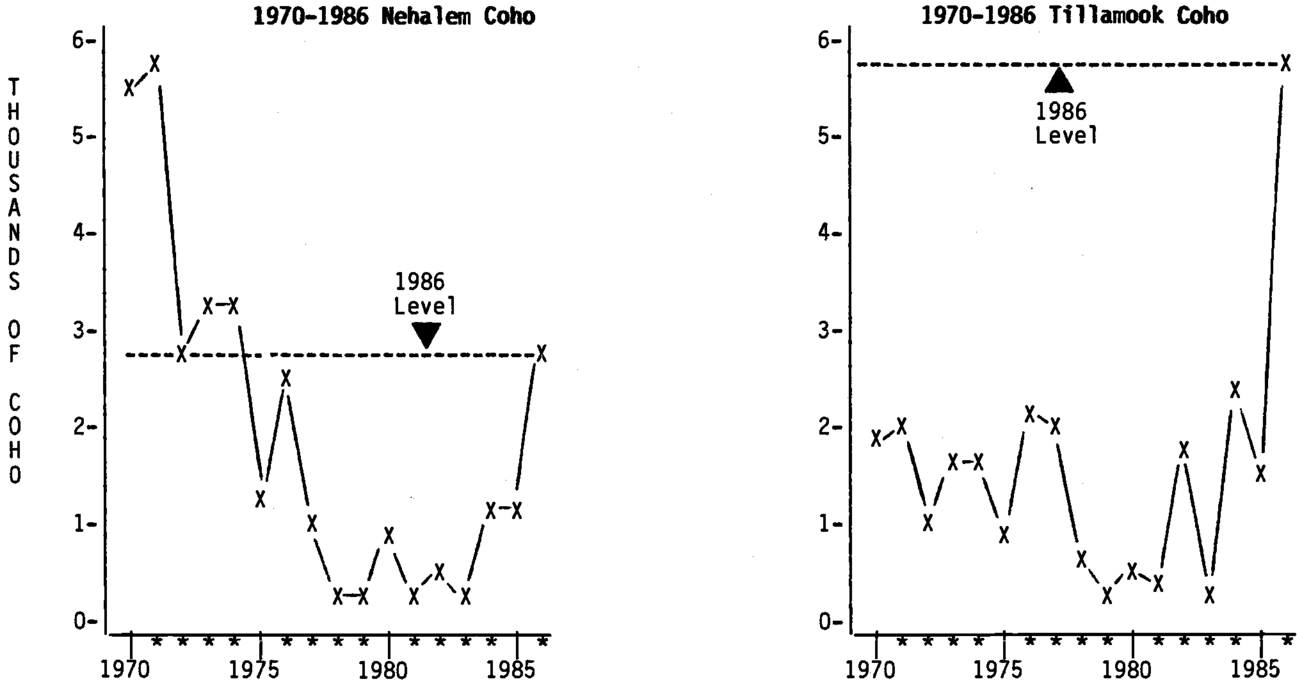


Figure 2.2. Oregon ocean commercial troll, ocean sports, and coastal stream sports catches of coho or chinook. Data are from Berry (1981), Mullen (1981), K. Johnson (1983), ODFW (1987), and McQueen et al. (1988); preliminary 1986 coastal stream sports data are from Ron Williams (ODFW Biologist, pers. comm.), and preliminary 1988 ocean catch data are from Laimons Osis (ODFW Biologist, pers. comm.). Coastal stream data do not include catches in the Columbia River or its tributaries. 1987-1988 coastal stream sports catch data are not available, so 1987-1988 records underestimate the total catch in 1987 and 1988. For separate analyses of ocean commercial, ocean sports, and coastal stream sports catches, see Appendix III for coho and Appendix IV for chinook.

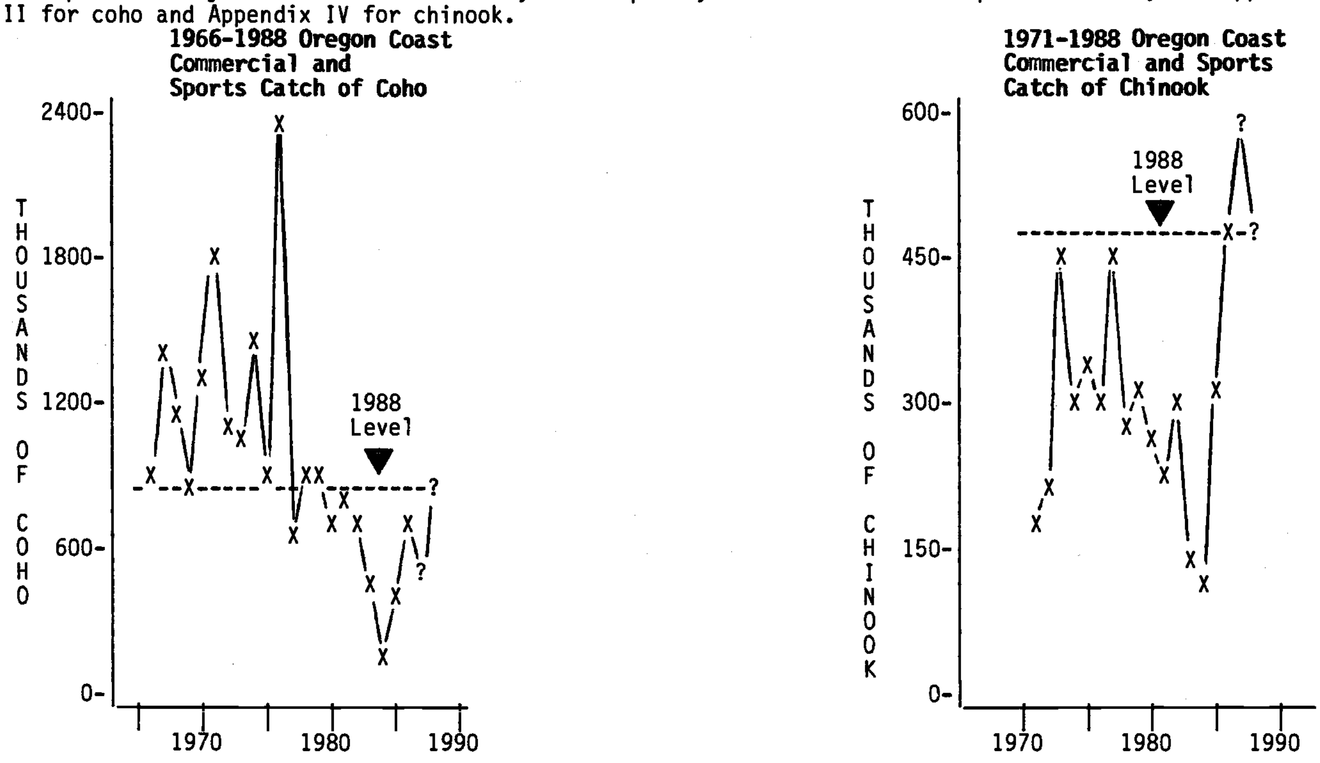


Figure 2.3. Sports fall or spring chinook catches in the Nehalem or Tillamook Basins for 1970-1986. See Fig. 2.1 legend for areas included in these Basins. There is no spring chinook run in the Nehalem Basin. Data are from Berry (1981), ODFW (1987), and Nicholas and Hankin (1988); 1986 preliminary data are from Ron Williams (ODFW Biologist, pers. comm.).

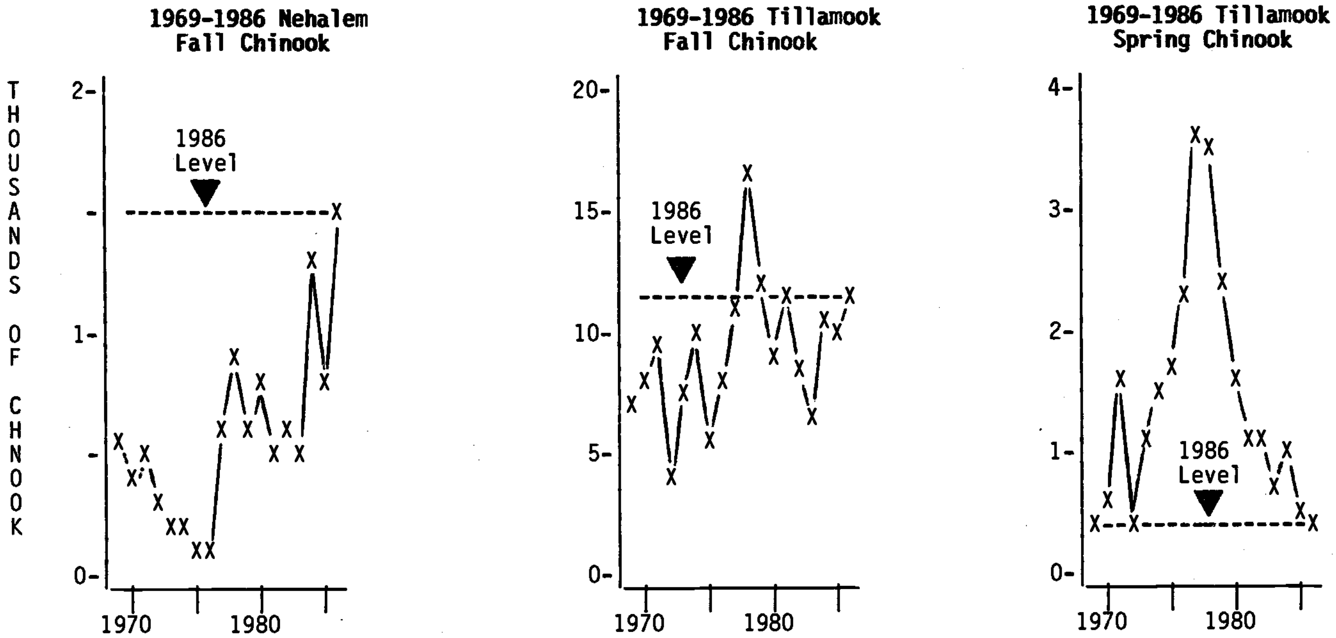


Figure 2.4. Value to Oregon ocean commercial troll fishermen at landing of coho and chinook catches for 1971-1988. 1971-1987 data are from PFMC (1988), and preliminary 1988 data are from B. Hall (1988). The value for each year, except 1988, are in terms of the value of 1987 dollars.

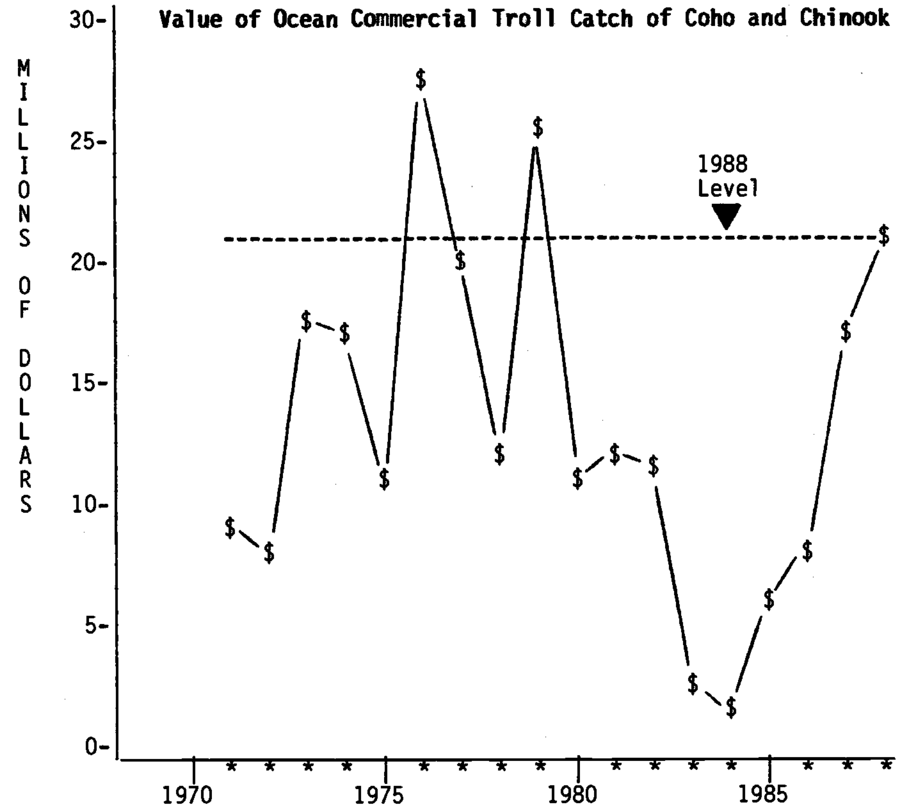


Figure 2.5. Sports winter or summer steelhead catches in the Nehalem or Tillamook Basins. Data for winter steelhead are for the 1970-71 through 1984-85 run years; data are not yet available for the winter steelhead 1985-86 run year. Data for summer steelhead are for the 1970-71 through 1985-86 run years. See Fig. 2.1 legend for areas included in these Basins. The summer steelhead catch in the Nehalem Basin is negligible (i.e, less than 100/year). Data are from Berry (1981) and ODFW (1987); 1986 preliminary data for summer steelhead are from Ron Williams (ODFW Biologist, pers. comm.).

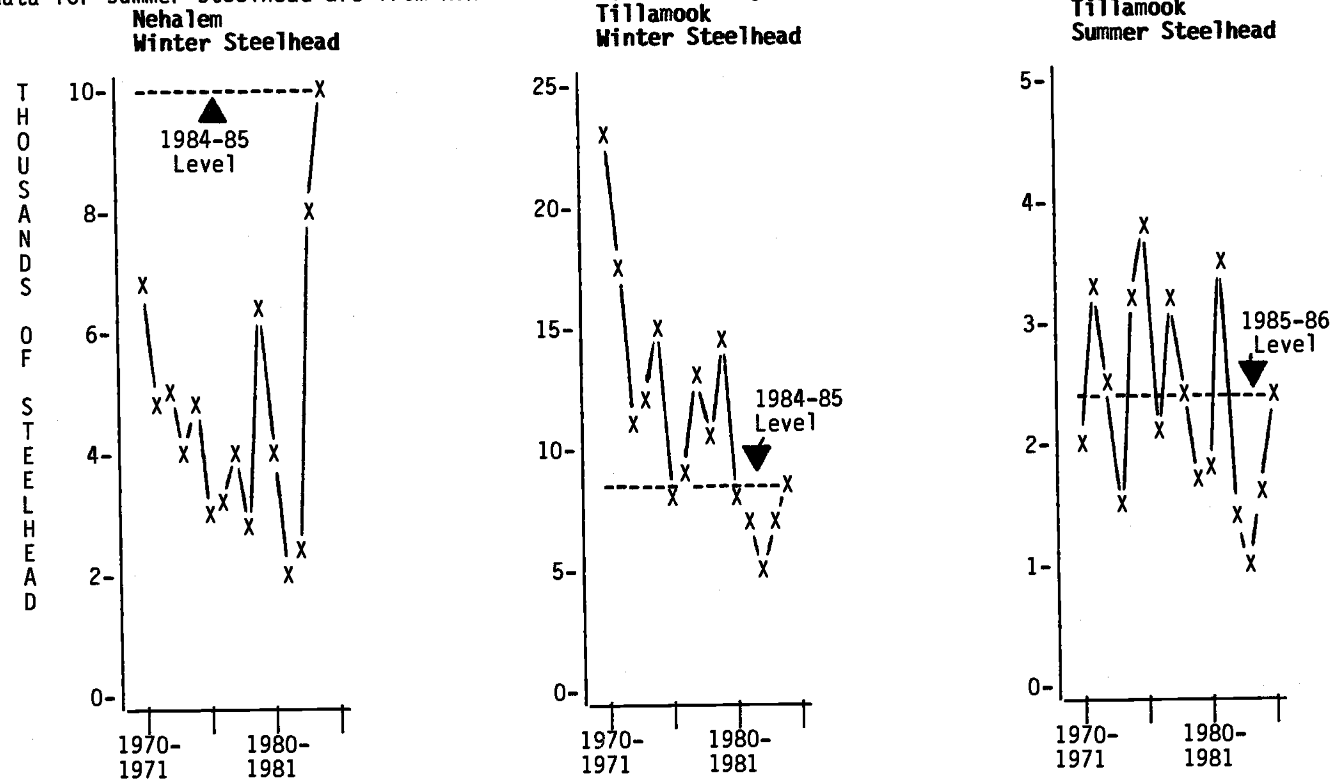


Figure 2.6. Oregon coastal stream sports catches of summer (S) or winter (W) steelhead for 1962-1985. Data are from ODFW (1986) and do not include catches in the Columbia River or its tributaries.

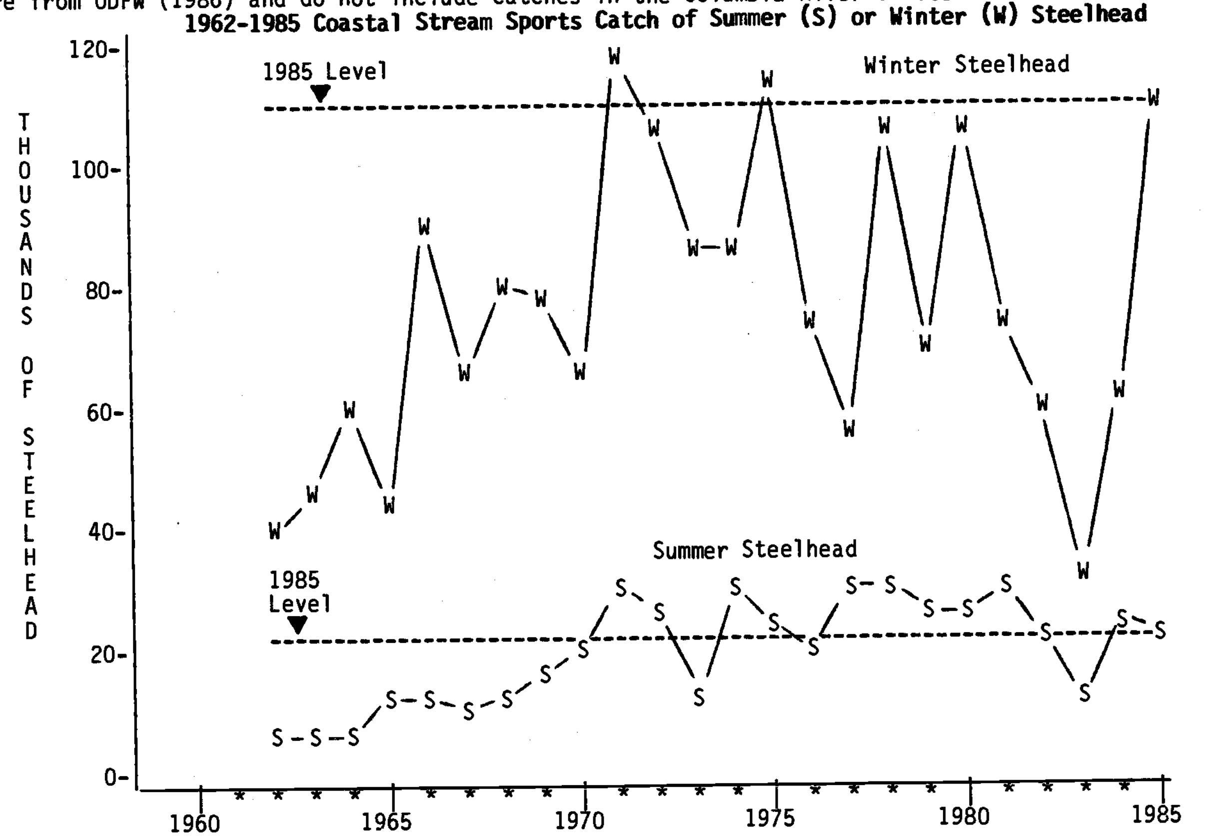
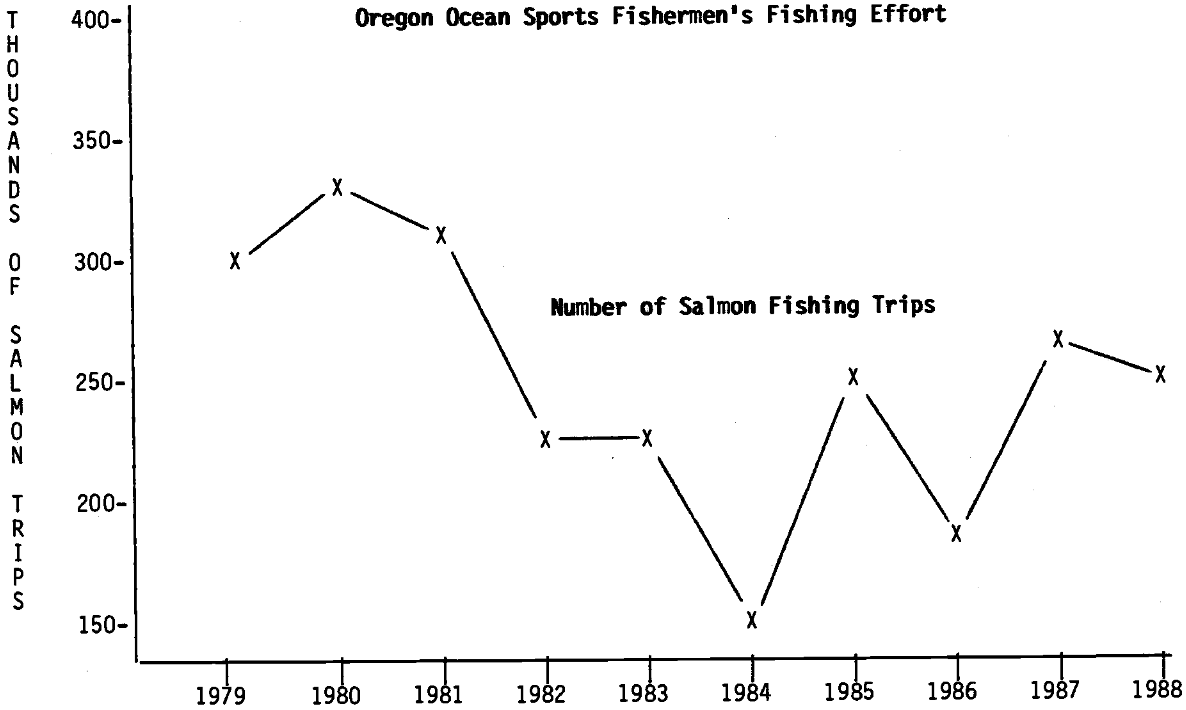


Figure 2.7. Number of salmon fishing trips and number of coho or chinook caught per fishing trip by Oregon ocean sports fishermen. 1979-1987 data are from McQueen et al. (1988:40); preliminary 1988 data are from Laimons Osis (ODFW Biologist, pers. comm.). Data prior to 1979 are available but are not comparable because they include nonsalmon fishing trips (McQueen et al. 1988:40).



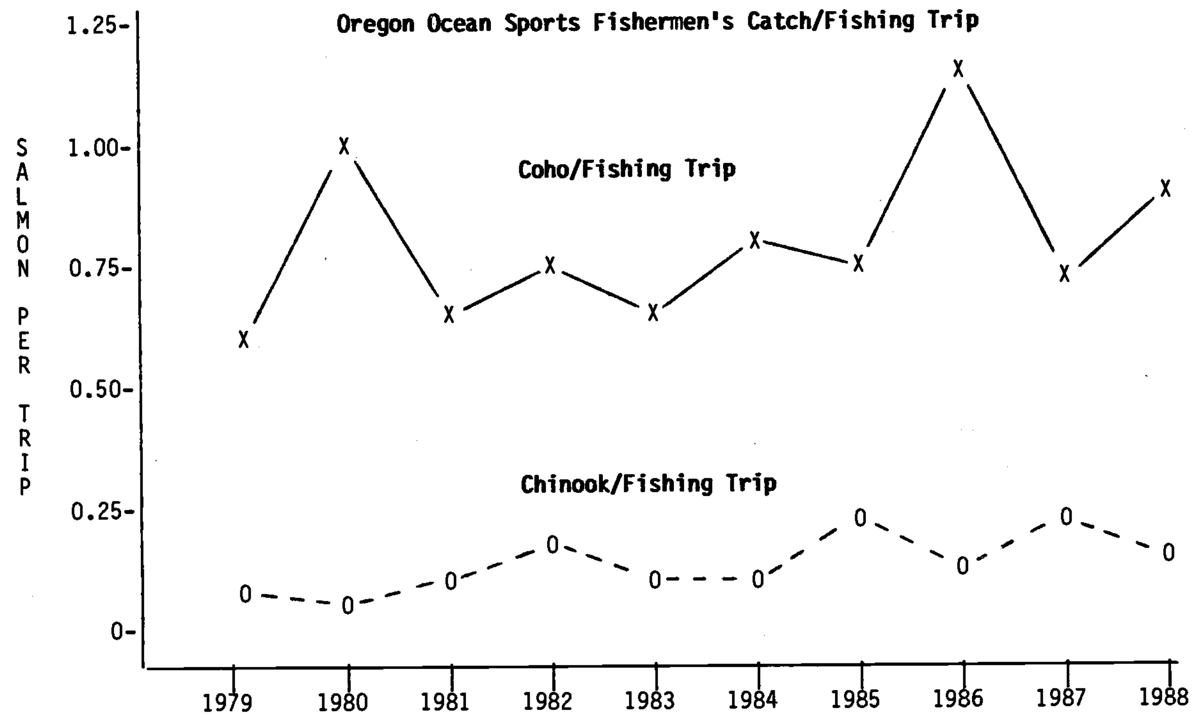


Figure 2.8. Total steelhead caught, steelhead caught/100 hours of fishing, and total hours of fishing on the Alsea River for the 1960-1961 through 1986-1987 fishing seasons. These data are derived from Kenaston (1987:5). There are no data for the 1970-1971 through 1974-1975 seasons.

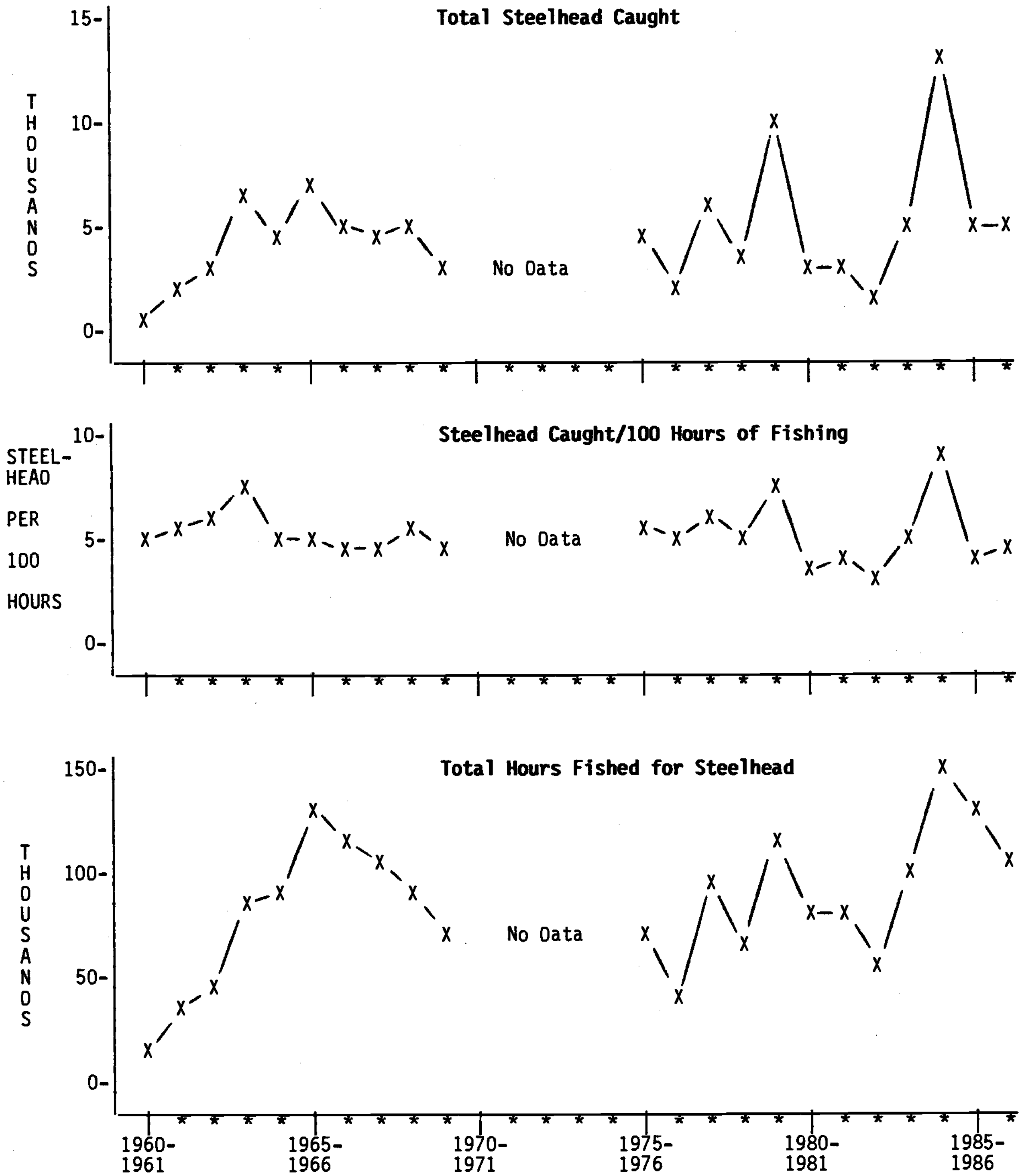


Figure 2.9. Fishing effort (thousands of boat days) by Oregon ocean commercial troll fishermen.

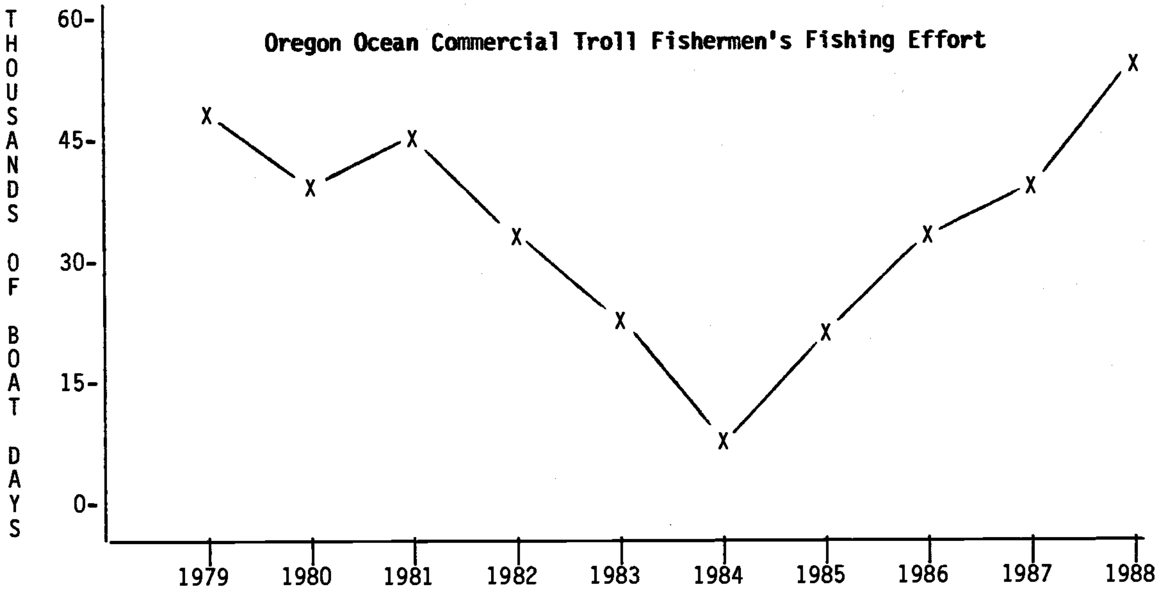
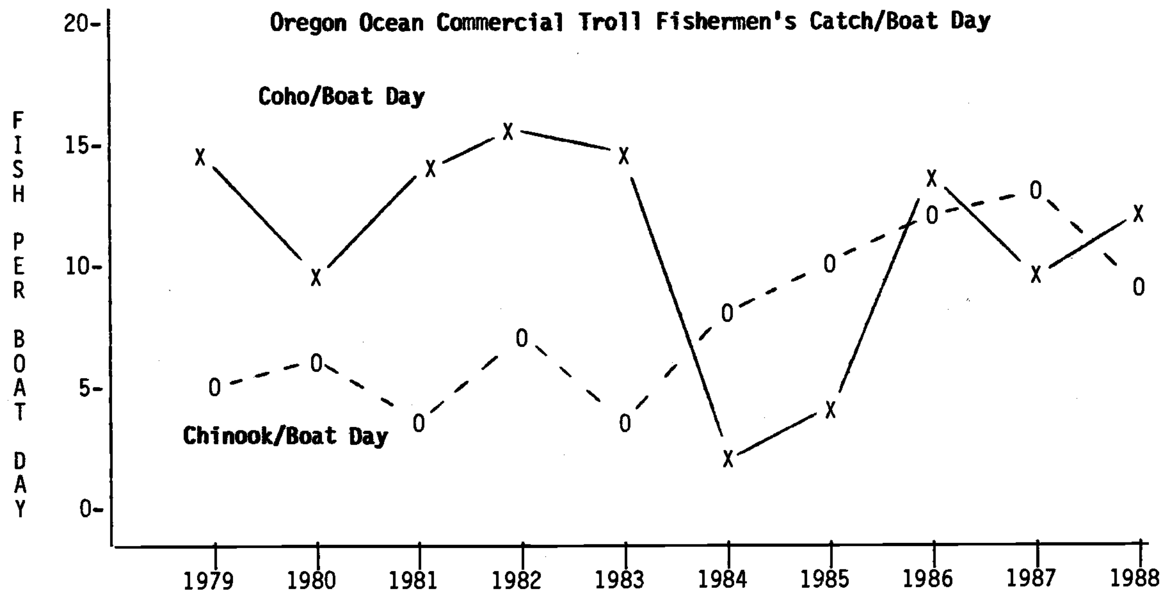


Figure 2.10. Coho or chinook caught per boat day by Oregon ocean commercial troll fishermen. 1979-1987 data are from McQueen et al. (1988:14), and preliminary 1988 data are from Laimons Osis (ODFW Biologist, pers. comm.).



2-E. Perception that Predators Are Destroying Salmon and Steelhead Runs

2-E-1. Predators to be Controlled

Smolt "predators" that have been publicly mentioned by a few Tillamook County fishing guides and fishermen as possibly needing to be controlled include marine mammals (Anonymous 1986b, Erickson 1986, 1988a; Hendrickson 1987), cormorants (Erickson 1988b, Hendrickson 1988a, McAllister 1988), Brown Pelicans (Tillamook Anglers 1988), and Great Blue Herons (fisherman at the 28 November 1988 ODFW meeting, section 1-G). Another fisherman (B. C. 1986) writes that even ducks are a problem:

> "The biologists seem to forget about all the smolt they release to the fish, ducks and seals. The predators get most of them before they get to the mouth of the ocean."

At Tillamook and Nehalem Bays, one fishing guide, Jim Erickson, recognizes that gulls can also be smolt predators. During a video presentation at the 13 April 1989 House Hearing (section 1-I-2), Jim Erickson (1989c) testified:

> "Now you can see the cormorants. Now these are coming in from out in the ocean and also flying in, and you got the sea gulls right on top of them. The cormorant is the key element in this smolt predation because they drive them [the smolts] to the top, and the sea gulls are in there along with the cormorants and eating them up, like you can't imagine it."

What Erickson has overlooked is that gulls can also prey on smolts, even if cormorants were absent. After smolt releases in Yaquina Estuary, I commonly observed gulls feeding on smolts, without any cormorants or other diving birds being nearby. Gulls would often just sit on the water, look around, and grab a smolt when it jumped nearby. Further, predatory fish can also drive smolts to the surface where they are available to gulls.

Since fish-eating birds attracted to a smolt release are so conspicuous but predatory fish are not visible, some proponents of cormorant harassment fail to realize that many smolts are also being eaten by predatory fish. For example, striped bass and adult and subadult salmonids are known to prey extensively on salmon smolts (section 3-E); in fact, adult coho predation of coho smolts has been suggested to be a major reason for reduced coho smolt survival (e.g., Nickelson 1986). Although some fishermen feel that striped bass should be controlled because they are a smolt predator, other anglers disagree because they like catching striped bass (Monroe 1989).

2-E-2. Lack of Relationship Between Predator Control and Catches

Paranoia about smolt predators is not borne out by Oregon catch statistics of salmon and steelhead, since catches by fishermen do not appear to bear any relationship with predator protection. Elsewhere, control of bird predators of Atlantic salmon has not been found to increase fishermen's catches of adult salmon (section 3-A).

Protection of marine mammals, Belted Kingfishers, and cormorants by Oregon or U.S. law did not become fully implemented until the Marine Mammal Protection Act of 1972 and changes in the Migratory Bird Treaty Act in May 1972 (USFWS 1969, Anonymous 1971, Schmidt 1972).

Catch data actually indicate that some of the best Oregon Coast catches of coho, chinook, and steelhead came **after** marine mammals, kingfishers, and cormorants were fully protected by law in 1972 (Figs. 2.1-2.6, Appendices III and IV). Similarly, some recent sports catches of coho at the Tillamook Basin, chinook at Nehalem or Tillamook Basins, winter steelhead at Nehalem Basin, and summer steelhead at Tillamook Basin have also been higher after predator "protection" (Figs. 2.1, 2.3, and 2.5).

Recent coho catches at the Nehalem Basin and winter steelhead at the Tillamook Basin, however, are not as great as 1970-1971 catches (Figs. 2.1 and 2.5). The reason for the lower catches is unclear but may be unrelated to predator "protection." If data prior to 1970 and data for 1987-1988 were available, it might be clear that current catches are comparable to or greater than some of the pre-protection catches for these fisheries, also. Neither fishery appears to be anywhere close to "ruin" (Figs. 2.1 and 2.5).

2-F. Perception that Cormorants Are Destroying Salmon and Steelhead Runs

2-F-1. Introduction

As just pointed out, some catches have been greater since predator protection. Nevertheless, there has been some concern in the Tillamook area about predators, chiefly about marine mammals. Since authority for marine mammals rests with the federal government and not local or state government, a few Tillamook fishing guides and fishermen have concentrated their concern on cormorants because the State of Oregon and its agencies has the sole authority to allow cormorant harassment (section 1-C).

To make a case for harassing cormorants in May 1988, fishing guide Erickson (1988b) suggested that cormorants at Tillamook Bay were taking $93,750/day worth of smolts during the cormorant's nesting season. To support the need for Oregon House Bill (HB) 3185, State Representative Paul Hanneman has written that cormorants were taking up to 80% of hatchery salmon and steelhead smolts (Hanneman 1989b). These figures appear to be based on controversial data and assumptions, which are discussed below.

2-F-2. Species of Cormorants Eating Smolts at Tillamook Bay

To determine the daily consumption of salmonids (Table 2.2 in section 2-F-15) by cormorants, it is obvious that the identity of the predator has to be known. Double-crested, Brandt's, and Pelagic Cormorants all occur in Tillamook County and along the Oregon Coast, and each differs markedly in size and subsequently in the amount of food that each can eat daily (Table 2.3).

Erickson (1988b) did not specify which cormorant was the "problem" at Nehalem or Tillamook Bays. Hoffman and Hall (1988) indicated that Brandt's Cormorants were the cormorant of concern; however, they misidentified these cormorants and most (if not all) of their cormorants were actually Double-crested's (section 1-D-3). Since it is not clear which cormorants are at issue in Tillamook County, the daily food consumption rates for all three are examined in Table 2.3.

2-F-3. Erickson's Estimate of Numbers of Cormorants Eating Smolts along the Oregon Coast or at Tillamook Bay

Erickson (1988a) implied that there were one million cormorants along the Oregon Coast. This seems doubtful because U.S. Fish and Wildlife aerial censuses indicate that there were only about 38,000 nesting cormorants along the Oregon Coast in 1988 (Roy Lowe, USFWS Biologist, unpubl. data).

For Tillamook Bay, Erickson (1988b) indicates that there were 1,000 cormorants every day feeding on smolts; his estimate appears high. Although not trying to census cormorants accurately, Hoffman and Hall (1988)(which is reprinted in Appendix XI) estimated only 250-300 on Tillamook Bay on 27 April 1988, which was within 16 days of when 0.84 million coho smolts were released into the Tillamook Basin (T. E. Cummings, ODFW Staff, letter dated 16 December 1988). Hoffman and Hall's (1988) rough estimate of 250-300 cormorants demonstrates that many less than Erickson's 1,000 cormorants were observed within a month of large hatchery releases.

Another indication that Erickson's (1988b) estimate is high is that after salmon smolt releases in the summers of 1982 and 1983 at the Yaquina Estuary, averages of less than 50 and less than 82 cormorants, respectively, were censused (Bayer 1986).

Because Hoffman and Hall's estimate for Tillamook seems more plausible than Erickson's figure, 300 cormorants are used in Table 2.3 as the number of cormorants that may sometimes be present in Tillamook Bay.

2-F-4. Estimating the Daily Foraging Time of Cormorants

Fishermen concerned about cormorants may see cormorants feeding at different times during a day and assume that they are the same cormorants feeding continuously throughout the day. There is no evidence to support this belief.

Although small birds may seem to feed continuously, large birds such as cormorants actually spend most of their days resting. For example, at Yaquina Estuary, Bald Eagles spent 92% of their time perched at foraging areas (calculated from Bayer 1987). Further, several species of cormorants have been observed to forage only 18-26% of the day (Birkhead 1978, Whitfield and Blaber 1978, Tindle 1984), forage an average of only four hours a day (Cooper 1985b), or spend 2-5 times as much time resting as feeding (Morrison et al. 1978, Hobson and Sealy 1985).

Although capable of feeding throughout the day, most cormorants seem to feed mainly in the morning (Bowmaker 1963, Birkhead 1978, Whitfield and Blaber 1978, Hobson and Sealy 1986).

When not fishing, cormorants often leave foraging areas to go to diurnal roosting sites (e.g., Hobson and Sealy 1985, 1986; Cooper 1985c), where they may be present for many hours.

2-F-5. Estimating the Amount of Smolts Eaten Daily

% of BODY WEIGHT.--Some fishermen have estimated that fish-eating birds may eat over 100% of their body weight daily (Mattingley 1927, Bowmaker 1963). But recent research indicates that large fish-eating birds may only average 9-25% of their body weight daily (Bowmaker 1963, Skokova in Mills 1967:382-383, Junor 1972, Duffy and Siegfried 1987:340, Duffy et al. 1987a:781). Further, stomach contents of some cormorants have averaged 14% or less of the species' average body weight (Bowmaker 1963, Birkhead 1978, B. Miller 1979 [using weights in Winkler 1983:196]). Cummings (1987) may also have estimated daily food consumptions for Double-crested Cormorants, but I have not seen her thesis.

The difficulties in estimating daily food consumptions are discussed in Appendix IX.

POUNDS/DAY.--Some fishermen indicate that a 2.8 lb (1.2 kg) cormorant can eat an incredible 21 pounds (9.5 kg) of fish daily (Mattingley 1927); other reports indicate that a cormorant eats a pound (0.45 kg) of fish a day (e.g., Bartholomew 1942, Erickson 1988a, Anonymous 1989a). All these reports are based on conjecture or rounded off data.

Currently accepted cormorant daily consumption rates (i.e., 15-16% of body weight) indicate that a cormorant present along the Oregon Coast could average 0.6-0.8 lb (0.3-0.4 kg) daily, depending on the size of the cormorant (Table 2.3 in section 2-F-15).

SMOLTS/DAY.--Calculations based on average consumption rates indicate that each cormorant could eat an average of 1.9-9.5 smolts/day, depending upon the species of cormorant and species and average weight of salmonid eaten (Table 2.3). Double-crested Cormorants, which appear to be the cormorant of concern in Tillamook County, could eat an average of about four steelhead or eight coho smolts per day (Table 2.3). But these estimates must be viewed sceptically because cormorants may not eat smolts each and every day (section 2-F-14).

ADC STUDY.--Using the stomach contents of birds to estimate daily food consumption rates is tenuous (Appendix IX). However, Erickson (1988b) seemingly based his estimated cormorant consumption estimates on the ADC study, so an examination of the ADC's results is appropriate, even though the methodology of the ADC study is suspect (section 1-D-3).

Unfortunately, Hoffman and Hall (1988) did not determine the number and species of smolts found in each cormorant at Tillamook Bay on 27 April 1988, but most were predominately 3-4 inch (7.6-10.2 cm) salmon smolts, not 7-8 inch (18-20 cm) steelhead smolts (McAllister 1988; T. R. Hoffman, letter dated 21 October 1988). The identity and size of the smolts has to be known to determine the weight and numbers of smolts eaten daily by a cormorant because smolts differ greatly in size (e.g., a coho smolt only weighs about half of a steelhead smolt) and cost (Table 2.2).

Cormorants leaving Tillamook Bay feeding areas late in the morning or early in the afternoon of 27 April 1988 had an average of 8.0 smolts per cormorant (range 4-16)(Table 2.4). This average is similar to the estimated average of 8.3 coho smolts eaten daily by Double-crested

Cormorants (Table 2.3). This is not surprising because several species of cormorants appear to feed mainly in the morning (section 2-F-4), so cormorants collected during the ADC study at 10:30 AM and 12:30 PM (Table 2.4) may have finished their daily feeding and were going to a roost (section 2-F-4).

Of the seven cormorants collected leaving feeding areas, one had 16 salmon smolts, and another had six steelhead smolts (Hoffman and Hall 1988). This seemingly indicates that these two cormorants took more than their average daily food requirements (Table 2.3). Two cautions need to be noted in making this conclusion.

Firstly, since the weights of smolts found in these cormorants were not specified, smolts found in these two cormorants may have weighed less than the average for the smolts that were released. If the smolts weighed less than average, the total weight of smolts found in these two cormorants may have been closer to the average daily weight consumed by cormorants (Table 2.3) than the number of smolts would indicate.

Secondly, a cormorant may eat more than its daily requirement one day and less the next day (see following subsection). Thus, finding a cormorant with more smolts than its calculated daily average does not indicate that a cormorant would eat that many every day (also see Appendix IX).

MAXIMUM SMOLTS/DAY.--Daily consumption estimates have often been exaggerated by using the maximum number of smolts that a cormorant could possibly take in a day. Using a maximal daily figure for cormorant consumption is not valid in debating the need for harassment because what is at issue is the amount of smolts that each cormorant can eat over a week or more.

Over several weeks, the number of smolts eaten would be much lower than a cormorant's capacity for a single day. For instance, although a starved fish-eating bird can eat much more than the daily average for 1-2 days, it eats much less than average on subsequent days (White 1937, Sanford and Harris 1967, Junor 1972). For example, one starved cormorant ate 36% of its body weight one day, 23% the second day, and didn't eat available food for the next two days; the overall average during the four days was 14.8% of its body weight (calculated from Junor 1972). Thus, a starved Brandt's Cormorant that ate 36% of its body weight one day could eat 22 coho smolts, but it would not sustain this for a week or more.

2-F-6. Erickson's Estimates of the Number of Smolts Eaten Each Day at Tillamook Bay during the Nonnesting Season

25 SMOLTS/DAY.--For Tillamook Bay, Erickson (1988b) indicated that each cormorant daily ate 25 smolts during the nonnesting season, but he did not specify what kind of smolts were eaten. Since the ADC found that seven cormorants leaving smolt feeding areas averaged 8.0 smolts per cormorant (Table 2.4), it is unclear how Erickson derived his estimate; it was clearly not directly from the ADC results, as Erickson (1988b) implies.

45-60 SMOLTS/DAY.--Although Erickson (1988b) wrote that each cormorant averaged 25 smolts per cormorant a day, Erickson (1989c) gave oral testimony at the 13 April 1989 House Hearing that implied that each cormorant may be taking 45-60 smolts each day. Erickson's (1989c) testimony during his video presentation was:

> "So you get each one of those birds [cormorants] is eating about 15-20 smolts, and this is only once a day. You let those birds feed three times a day, and you can see that we got a helluva big problem out there."

It is not clear how Erickson figured that each cormorant was eating 15-20 smolts, since only one of 22 cormorants collected at Tillamook Bay had eaten 16 smolts and no other had eaten more than nine smolts (Hoffman and Hall 1988, which is reprinted in Appendix XI). Erickson implied that cormorants were eating three times daily, but this appears to be unfounded. As pointed out in section 2-F-4, cormorants usually spend little time foraging during a day and appear to eat mainly in the morning. Thus, it is unwarranted to assume that a cormorant would eat three times as much as found in its stomach in late morning or early afternoon, when it was collected by the ADC (Table 2.4).

Another indication that Erickson's (1989c) figures are inflated is that a Double-crested Cormorant weighs an average of 4.5 lb (Table 2.3). Based on weights of ODFW smolts at release (Table 2.2), 60 coho smolts would weigh 5.2 lb (2.4 kg) and 60 steelhead smolts would weigh 10.2 lb (4.6 kg). Thus, if a Double-crested Cormorant was eating 60 smolts daily as Erickson (1989c) suggests, it would be eating 116-227% of its body weight each day, which is untenable (section 2-F-5).

2-F-7. Erickson's Estimate of the Number of Smolts Eaten Each Day at Tillamook Bay during the Nesting Season

Erickson (1988b) stated that cormorants ate three times their normal daily diet during nesting periods, so that they would need 75 smolts per cormorant each day. His estimate appears unrealistic for several reasons. Firstly, his daily (1988b) estimate of 25 smolts/cormorant during the nonnesting season is too high.

Secondly, the daily food requirements for an adult Double-crested Cormorant feeding a brood of nestlings is approximately doubled (Dunn 1975, Walsberg 1983:186), not tripled as suggested by Erickson. Small birds such as sparrows may triple their food requirements when raising nestlings, but large birds such as cormorants don't have such heavy demands (Walsberg 1983:186).

Thirdly, the possibility that cormorants would be feeding exclusively on hatchery smolts during their nesting season is doubtful. Cormorants don't need more food than their own daily maintenance diet until their young have hatched and are growing. Along the Oregon Coast, Double-crested Cormorant chicks begin hatching in late May, and Brandt's and Pelagic Cormorant chicks start hatching in late June (Scott 1973:23, Roy Lowe, USFWS Biologist, unpubl. data). Thus, cormorants would not need extra food to feed their growing young until late May or June, which would be several weeks or more after coho and steelhead smolts were released into the Tillamook Basin (Table 2.2). By June, most smolts have probably either migrated to sea or have learned how to cope with predators. For example, most coho smolts remain in estuaries less than 14 days after release (Nicholas et al. 1979, Myers 1980, Myers and Horton 1982), although chinook smolts may remain longer (Reimers 1973, Nicholas et al. 1979, Reimers and Concannon 1977, Myers 1980, Levy and Northcote 1982, Myers and Horton 1982). Further, Bayer (1986) found that the abundance of bird predators of smolts in 1983 decreased markedly in the first few days following a hatchery smolt release at Yaquina Estuary; this suggests that smolt vulnerability to predators may be greatest only in the first few days after a release (section B in Appendix II).

2-F-8. Erickson's (1988b) Estimate of the Total Number of Smolts Eaten at Tillamook Bay in 1988

Using Erickson's (1988b) estimates of 1000 cormorants each eating 25 smolts daily, cormorants would have eaten 1.53 million smolts in April and May 1988 (i.e., [61 days] X [1,000 cormorants] X [25 smolts/cormorant each day]) and 2.25 million smolts in June during part of the cormorants' nesting season (i.e., [30 days] X [1,000 cormorants] X [75 smolts/day]). This would be a total of 3.78 million smolts eaten by cormorants in Tillamook Bay in April-June 1988!

That is an awesome figure, especially since the ODFW only released a total of about 1.3 million juvenile salmonids into the Tillamook Basin in March-June 1988 (Table 2.2), which is only about 34% of Erickson's estimate that were eaten by cormorants. It is unlikely that cormorants ate 2.48 million wild smolts because most Oregon smolts are from hatcheries; for example, 84-89% of coho smolts in Oregon in 1978-1981 were hatchery fish (Nickelson 1986:534), and Oregon hatchery steelhead smolts now appear to support the steelhead fisheries (ODFW 1986:III.A-17). Thus, it appears unrealistic that cormorants could have found, let alone ate, 2.48 million wild smolts at Tillamook Bay after eating all smolts released by the ODFW.

If 1800 cormorants each ate 60 smolts a day, as Erickson (1989c) suggests, then cormorants would have eaten 3.2 million smolts in 30 days and 9.8 million smolts in April-June. Thus, if true, cormorants ate 7.5 times more smolts in April-June than were released.

2-F-9. Hanneman's Estimates of the Total Number of Smolts Eaten by Cormorants Along the Oregon Coast

At the urging of cormorant harassment proponents, State Representative Paul Hanneman (R-Tillamook) became very concerned about cormorant predation and was the chief sponsor of House Bill 3185 that would allow cormorant harassment (section 1-I-1).

In oral testimony for the 13 April 1989 House Hearing, Rep. Hanneman (1989c) testified about ODFW smolt releases:

> "Our resource [smolts] isn't even reaching the ocean. The cormorants come off the ocean at daylight in the morning, and they don't return back to the ocean again until dark at night. And they work the river until it's a **bloody froth** [boldface added] all the way down for three or four weeks."

There are several problems with Hanneman's testimony. Firstly, it is untenable that cormorants were feeding continuously throughout the day as Hanneman implies. Cormorants spend more time resting than feeding during a day (section 2-F-4). Secondly, cormorants swallow their prey whole without tearing it up (e.g., Bartholomew 1942, Bowmaker 1963), so it is difficult to imagine where the blood comes from that could turn the water into a "bloody froth." But "bloody froth" does evoke a powerful and persuasive image before a House Committee.

Rep. Hanneman believed that cormorant harassment was necessary. In a letter dated 21 February 1989 to K. Confer (Appendix X), Rep. Hanneman wrote:

> "The purpose of the bill [House Bill 3185] is to provide some relief for downstream migrating salmon during their four-week period. **We suspect and believe that we can prove** [boldface added] that less than 50 percent of our expensive, publicly-produced salmon and steelhead are able to reach the ocean."

The tortured language of "We suspect and believe that we can prove . . ." indicates that Hanneman's figure may be an estimate based more on faith than fact.

Since HB 3185 was introduced at the request of Jim Erickson (Hanneman 1989a; Appendices XII and XIII), Erickson's estimates may have also have been used to make this estimate. For example, Erickson (1988b) suggested that 1,000 cormorants ate 25 smolts/day. If this continued for 28 days (four weeks), this would be a total of 700,000 smolts, which is 53% of the 1.33 million smolts released at Tillamook in 1988 (Table 2.2).

Since most cormorants eating smolts at Tillamook Bay appear to have been Double-crested Cormorants and most smolts that were eaten were probably coho smolts (section 1-D-3), an alternative estimate of how many smolts were eaten in four weeks is: (300 Double-crested Cormorants) X (8.3 coho smolts/day [from Table 2.3]) X (28 days)=69,720 smolts. This is 6.7% of the 1.04 million coho smolts and 5.2% of the 1.33 million salmonid smolts released in 1988 (Table 2.2). This may be an overestimate because all 300 cormorants would have to come every day (which is unproven), and they would have to eat only smolts every day, which is also unproven (see subsection 2-F-14, Assumption 1, below).

Hanneman (1989b) also made another claim in a newspaper column about cormorant predation:

> "We **believe** [boldfaced added] that up to 80 percent of all salmon and steelhead are eaten by cormorants before they reach the ocean. Our resource is being destroyed by huge populations of these common birds. . ."

The key word in this statement is "believe"; it is not clear if there are any facts to support this belief. On 19 June 1989, I wrote Rep. Hanneman and asked for any evidence to support this claim, but as of 26 September 1989 I have not received a response.

2-F-10. Erickson's Estimated Cost of Smolts in 1988

Erickson (1988b) stated that the cost of each smolt was $1.25. Actual ODFW figures indicate that the estimated costs for ODFW hatcheries to raise each smolt ranged from about $0.02 for spring chinook to $0.61 for sea-run cutthroat trout (Table 2.2). Coho smolts, which constituted the vast majority of salmonids released into the Tillamook Basin, cost about $0.22 each (Table 2.2).

2-F-11. Erickson's Estimated Daily Cost of Cormorant Predation at Tillamook Bay during the Nonnesting Season

Although Erickson (1988b) stated that cormorants eat $31,250 of smolts each day at Tillamook Bay, alternative estimates are $350-$620 each day, with estimates for Double-crested Cormorants (which appear to be the cormorant of concern) to be less than $550/day (Table 2.3). The variation in estimates depends on the species of cormorant and species of salmonid released (Table 2.3).

Each of these estimates assumes that all cormorants are returning to Tillamook Bay each day and feeding only on smolts; these assumptions are unproven (see subsection 2-F-14 below), so the actual cost of cormorant predation may be much less than even these figures indicate.

2-F-12. Erickson's Estimated Daily Cost of Cormorant Predation at Tillamook Bay during the Nesting Season

Erickson (1988b) estimated that, when cormorants were nesting, they would eat three times as many smolts as during the nonnesting season, so that cormorants would be eating $93,750 worth of smolts daily. This is unrealistic for three reasons. Firstly, Erickson's initial estimate of $31,250 is too great for the reasons previously discussed. Secondly, cormorants don't need more food than their own daily maintenance diet until their young have hatched and are growing, which could be after most smolts have left (see section 2-F-7). Thirdly, cormorants only need twice (not three times) as much food to care for young (section 2-F-7).

2-F-13. Kennedy and Greer's (1988) Study of Predation by Irish Cormorants

One supporter of cormorant harassment has cited Kennedy and Greer's (1988) paper about estimated Great Cormorant predation on Atlantic salmon smolts as evidence that harassment is necessary along the Oregon Coast. It seems obvious that the situation in Irish rivers may be quite different than that along the Oregon Coast, but even if it was directly applicable there are several major shortcomings in Kennedy and Greer's methodology.

Firstly, they assumed that all Great Cormorants that were observed fed only on smolts and trout (Kennedy and Greer 1988:162, 165). Secondly, they collected eight cormorants that had fed on only a few smolts or trout; nevertheless, Kennedy and Greer (1988:164) blithely ignored their data and assumed that these cormorants would have fed to satiation on smolts and trout if they had not been collected. It is not clear why Kennedy and Greer even bothered to collect any cormorants because it appears that they already knew what they wanted their results to be before they started their study.

In spite of their poor data and unsubstantiated assumptions, Kennedy and Greer (1988) estimated that 51-66% of wild Atlantic smolts and 13-28% of hatchery smolts may have been taken by Great Cormorants. Their estimates are debatable.

2-F-14. Implicit Assumptions of Cormorant Harassment Proponents

Proponents of cormorant harassment suggest that cormorant control is necessary because the cost or number of hatchery smolts that cormorants can potentially eat is great. There are, however, four questionable assumptions that proponents implicitly make:

Assumption 1) Each cormorant eats only smolts.
Assumption 2) If a cormorant is present, it is feeding on smolts.
Assumption 3) Cormorants eat smolts continuously all day.
Assumption 4) Smolts not eaten by cormorants will survive.

ASSUMPTION 1.--Although cormorants may eat some smolts on some days, it can not be reasonably assumed that they are only eating smolts every day. Normally, Brandt's or Pelagic Cormorants do not feed on salmonids, and Double-crested Cormorants rarely feed on salmonids under natural conditions (Mendall 1936, Scott 1973, Ainley et al. 1981, Talent 1984, Findholt 1988:249).

While it is true that the release of hatchery smolts attracts cormorants that can eat some smolts at Tillamook Bay (e.g., Hoffman and Hall 1988), hatchery smolts only appear to be highly vulnerable to predators for the first few days after a release (section B in Appendix II). Thus, cormorants present in Tillamook Bay several weeks after a smolt release may be eating their normal non-smolt diet or only taking a few smolts.

Unfortunately, a few fishermen don't realize that cormorants generally feed on nongame fish that the fishermen aren't interested in. Since the focus of a angler's attention is game fish, some anglers assume that game fish are the only kind of fish there are. Thus, these fishermen jump to the conclusion that cormorants must only be eating smolts or other game fish. These fishermen are accordingly alarmed because the daily food consumption of cormorants, if they eat only smolts, would be significant over a month or more, especially if there are many cormorants. This kind of incomplete reasoning can result in exaggerated estimates of smolt consumption by cormorants. But perhaps the pinnacle of the use of this fallacious kind of reasoning has been the ridiculous estimates of Oregon seal and sea lion food consumption on salmon based on the unfounded premise that these marine mammals eat only salmon every day of the year (e.g., Anonymous 1989b).

ASSUMPTION 2.--Cormorants make mistakes and are not always successful fishers, so their presence in a stream may not mean that they are catching smolts.

Fishing is a speculative enterprise for man or cormorant. But to some fishermen the presence of a cormorant diving in an area indicates that it must be catching smolts or it wouldn't be there. Anglers don't realize that cormorants are not always successful. For example, a cormorant has to search for places to feed and if a site fails, it moves on to another feeding location (Bartholomew 1942). If cormorants were perfect fishers at Tillamook Bay, then most of them would have been full of smolts when they were collected on 27 April 1988 (Table 2.4). But 17 of the 24 cormorants collected had an average of less than three smolts each (Table 2.4).

ASSUMPTION 3.--There is no proof that cormorants feed continuously. While some individual cormorants may feed longer than others (Cooper 1985b), cormorants on the average feed for only a few hours each day (section 2-F-4).

ASSUMPTION 4.--It is untenable that smolts not eaten by cormorants will necessarily survive. Since hatchery smolts are stressed by being released and are disoriented, their swimming and escape abilities are impaired; this impairment coupled with their naivete about predators makes them vulnerable to predators (section B in Appendix II).

Because of the smolts' vulnerability, it is not surprising that there are many smolt predators, not just cormorants (section 3-E). Thus, even if cormorants are prevented from eating smolts, smolts can be eaten by many other predators because naive smolts are extremely vulnerable to the first predator they meet (e.g., Ginetz and Larkin 1976, Patten 1977, Wood and Hand 1985, Olla and Davis 1988, 1989), whether that predator be in a river, estuary, or in the ocean.

2-F-15. Tables for Section 2-F

Table 2.2. Size, average weight, approximate cost, estimated number and release date of ODFW hatchery salmonids released in March-June 1988 into the Tillamook Basin. These figures are based on preliminary data from C. N. Carter (ODFW economist, letter dated 4 October 1988) and T. E. Cummings (ODFW Staff, letters dated 25 October 1988 and 16 December 1988).

Species of Smolts	Smolts/ Pound	Cost/ Pound	Cost/ Smolt	No. Released in 1988 (millions)	Release Dates in 1988
coho salmon	11.5/lb	$2.49	$0.22	1.04	4/11, 4/15, 5/1
cutthroat trout	3.3/lb	$2.01	$0.61	0.02	5/2, 5/23
spring chinook	141.0/lb	$2.42	$0.02	0.01	3/31
summer steelhead	5.9/lb	$2.40	$0.41	0.06	4/8
winter steelhead	5.8/lb	$2.18	$0.38	0.20	4/4, 4/5, 4/6

Table 2.3. Estimated number of smolts/cormorant and total cost of daily salmonid consumption by 300 cormorants eating salmonids released into the Tillamook Basin in March-June 1988. These estimates were calculated from the average size and cost of smolts given in Table 2.2. Note that the total number of estimated cormorants was 300, but since the idenity of cormorants is unclear, the estimates below are given as if there were 300 of one species or another, not 300 for every species of cormorant. Most of the cormorants were probably Double-crested's (section 1-D-3). Spring chinook are not included because few were released (Table 2.2), and they were smaller than smolts eaten by cormorants in 1988 (Hoffman and Hall 1988, McAllister 1988). N=number of smolts/day. See Appendix IX for a discussion of methods used in estimating daily food consumption.

	Mean Body Weight[a] (lb)	Mean Daily[b] Food Consumption (lb)	Mean Number of Smolts/Day per Cormorant (N) or Mean Total Cost/Day for 300 Cormorants, if Each Cormorant Only Ate........ Coho.... N	Coho Cost	Cut-throat.... N	Cut-throat Cost	Summer Steelhead N	Summer Steelhead Cost	Winter Steelhead N	Winter Steelhead Cost
Double-crested Cormorant	4.52	0.72	8.3	$538	2.4	$434	4.3	$518	4.2	$471
Brandt's Cormorant	5.43	0.83	9.5	$620	2.7	$500	4.9	$598	4.8	$543
Pelagic Cormorant	3.60	0.58	6.7	$433	1.9	$350	3.4	$418	3.4	$379

[a] From Kury (1968) and Scott (1973:21).
[b] Calculations from Wiens and Scott (1975) indicate that an adult Brandt's Cormorant along the Oregon Coast needs to eat an average of 15.3% of its body weight daily in summer. An average daily consumption rate of 16% of its body weight was used for Double-crested and Pelagic Cormorants, which is about what has been estimated for other cormorants (Junor 1972, Wiens and Scott 1975, Duffy and Siegfried 1987, Schramm et al. 1987). The stomach contents of some cormorants that were shot weighed about 13% or less of their average body weights (calculated from Birkhead 1978, B. Miller 1979 [using cormorant weights in Winkler 1983:196]). Also see Appendix IX for methods of estimating daily food consumptions.

Table 2.4. Predation of cormorants on salmonids at Tillamook Bay. Predation was determined by ADC examination of stomach or esophageal contents on 27 April 1988 of 22 adult and two immature cormorants collected at the mouths of the Wilson, Tillamook, and Trask Rivers in Tillamook Bay (Hoffman and Hall 1988, which is reprinted in Appendix XI). The cormorants were originally identified as Brandt's, but that was in error (section 1-D-3). Incoming=cormorants heading upriver, Outgoing=presumably, cormorants heading downriver, Time=time of collection, Birds=number of cormorants collected, 1+=at least 1, and 8+=at least 8.

	Time of Collection	No. of Birds	% Birds with....... 1+ smolt	8+ smolts	Smolts/Cormorant.. Mean	SD	Range
Incoming	7 AM	7	29	0	1.3	2.2	0-5
	10:30 AM, 12:30 PM	10	90	0	2.6	1.5	0-5
Outgoing	10:30 AM, 12:30 PM	7	100	29	8.0	3.8	4-16

2-G. Perception that Cormorant Harassment Can "Save" Smolts

Harassment proponents have suggested that harassment saves smolts because cormorants were driven from Nehalem and Tillamook Bays (Erickson 1989b, c). Thus, smolts that the cormorants would have eaten must have been "saved."

What harassment proponents have overlooked is the presence of many other predators that can eat smolts "saved" from cormorants (section 3-E). Cormorant harassment may save impaired smolts that are disoriented or adjusting to salt water in the first few days after release (section B in Appendix II), but other predators, especially fish, may still take impaired smolts.

Further, hatchery smolts are naive about predators and appear to remain naive until they first meet predators and have their innate fear aroused through observing some of their brethren being eaten (e.g., Ginetz and Larkin 1976, Patten 1977, Wood and Hand 1985, Olla and Davis 1988, 1989).

2-H. "Proof" that 1988 Cormorant Harassment Was Successful

2-H-1. Introduction

The harassment in the spring of 1988 at Nehalem and Tillamook Bays might have had some effect on the number of returning jacks during the 1988-1989 winter. But the effect on returning adult numbers would not be determinable until the 1989-1990 winter, when adults from smolts released in the spring of 1988 would first start returning to streams and hatcheries where they were released.

Using numbers of returning jacks to "prove" that harassment worked is debatable. The number of salmonid jacks returning to Oregon coastal hatcheries varies markedly from year to year (Leslie Schaeffer, ODFW, letter dated 9 March 1989). This variation can be in response to a number of factors such as stream flow, weather, ocean conditions, number of smolts released, date of smolt release, size of smolts at release, and hatchery practices. It is difficult to determine the cause(s) for changes in jack numbers.

2-H-2. Steelhead Jacks

Erickson (1989a, b) states that proof that cormorant harassment worked during the spring of 1988 at Nehalem Bay is that record numbers of steelhead jacks returned to the ODFW Nehalem Fish Hatchery during the winter of 1988-1989. But this was a record of only 46 jacks (Erickson 1989b), compared to 15 or less in previous years (Leslie Schaeffer, ODFW, letter received 9 March 1989). Since there is so much variability among years in numbers of returning jacks and this increase is so small, it is certainly debatable if this increase can be attributed to cormorant harassment.

Further, the methods of counting jacks (not harassment) may have led to the higher steelhead jack counts during the 1988-1989 season. For example, the dates when the electric weir at the Nehalem Hatchery were operated and when fish were counted differed yearly (Table 2.5 in 2-H-5). These changes in hatchery practices could have affected how many steelhead jacks were counted because steelhead jacks seem to return to the Nehalem Hatchery only in January-March (Table 2.6). The lack of any steelhead jacks returning to the Nehalem Hatchery during the 1986-1987 and 1987-1988 return seasons may have partially been because returning jacks were not counted after January 27 in 1987 and after February 8 in 1988 (Table 2.5).

The yearly variability in when the Nehalem Hatchery stopped counting jacks was because the Hatchery trapped and counted salmon and steelhead only until they had received enough fish, not because fish had stopped returning (Gary Yeager, Nehalem Hatchery manager, letter received 31 March 1989). Prior to the 1988-1989 return season, returning steelhead jacks could have passed the Hatchery without being counted after the electric weir was turned off or after the Hatchery stopped trapping and counting fish (Yeager, letter received 31 March 1989).

The nonoperation of the electric weir may also have caused the increase in steelhead jacks during the 1988-1989 return season. The electric weir was used at the Nehalem Hatchery until 7 December 1987 (Table 2.5) to force returning salmon and steelhead into the Hatchery. This electric weir could have affected the number of steelhead jacks counted at the Hatchery by discouraging some from entering the Hatchery or by killing some of them. During the 1987-88 return season, 12 coho adults and 10 coho jacks were thought to have been killed by the electric weir, which was turned off on December 7 (Yeager, letter received on 31 March 1989). Thus, it is possible that the weir could also have repulsed or killed some steelhead jacks, so that they weren't counted returning to the Hatchery, prior to January 1988.

In conclusion, the "record" return of only 46 steelhead jacks during the 1988-1989 return season could have been from changes in Hatchery procedures or from other factors. There is no conclusive evidence that this increase can only be attributed to cormorant harassment in Nehalem Bay in 1988. Further, there is no factual basis to Erickson's (1989b) statement that all returning steelhead were counted until 1987 because the dates of operation of the electric weir and when returning fish were counted varied yearly, irregardless of whether or not fish were returning.

2-H-3. Coho Jacks

Erickson (1989a, b) did not indicate that fewer coho jacks returned to Nehalem and Tillamook hatcheries from 1988 than from 1987 smolt releases (Table 2.7). If Erickson wishes to argue that cormorant harassment saves smolts and, subsequently, that the number of steelhead jacks increased at the Nehalem Hatchery, then it seems logical that coho jack returns would also have been expected to increase at Nehalem and Tillamook hatcheries. Afterall, their coho smolts would have passed through Nehalem and Tillamook Bays, where cormorant harassment occurred in the spring of 1988. Nevertheless, the number of coho jacks was markedly lower at the Nehalem and Tillamook facilities (Table 2.7).

Erickson (1989b) assumes that the lower return of coho jacks to the Nehalem Hatchery from the 1988 releases was because the electric weir was turned off, which could have allowed coho adults and jacks to go past the Hatchery without being counted. This is possible, but there are no data to support this. Further, the presence of the electric weir at Nehalem does not explain why fewer coho jacks returned to the Trask facilities from the 1988 than from the 1987 smolt releases (Table 2.7) because there was no electric weir on the Trask.

2-H-4. Conclusion

In summary, the number of returning jacks is affected by a number of factors, but there is currently insufficient evidence to prove that cormorant harassment during the spring of 1988 actually increased the number of jacks. In fact, the total number of returning steelhead plus coho jacks was lower from smolt releases in 1988 than in 1987 when there was no cormorant harassment.

2-H-5. Tables for Section 2-H

Table 2.5. Use of an electric weir, dates of counting steelhead jacks, and number of steelhead jacks returning to the ODFW North Fork Nehalem Fish Hatchery. The number of returning jacks in all return seasons except 1988-1989 are from Leslie Schaeffer (ODFW, letter received 9 March 1989); all other data are from Gary Yeager (Nehalem Hatchery manager, letters received on 31 March and 6 April 1989).

Return Season	Electric Weir Turned On	Date Stopped Counting Jacks	Cormorant Harassment	Steelhead Jacks (N)
1985-1986	Sept.-March	March 17	no	15
1986-1987	Sept.-Jan. 21	January 27	no	0
1987-1988	Sept.-Dec. 7	February 8	no	0
1988-1989	**(never on)**	March 6	**yes**	46

Table 2.6. Number of steelhead jacks counted returning to the ODFW North Fork Nehalem Fish Hatchery during the 1985-1986 and 1988-1989 return seasons. Data are from responses to letters written to Gary Yeager (Nehalem Hatchery manager) that were received on 31 March and 6 April 1989. Counting at the Hatchery ceased for the 1985-1986 return season on 17 March 1986 and for the 1988-1989 return season on 6 March 1989. -=counting ceased before any were counted.

	Steelhead Jacks/month 1985-1986	1988-1989
September	0	0
October	0	0
November	0	0
December	0	0
January	5	31
February	7	15
March	3	-
SUM	15	46

Table 2.7. Differences between years in number of returning winter steelhead or coho jacks released as smolts in the spring of 1987 or 1988. These rearing sites made spring releases into the Nehalem Basin (Nehalem Hatchery) or the Tillamook Basin (Trask Pond and Trask Hatchery); cormorant harassment at Nehalem and Tillamook Bays occurred in the spring of 1988. These data were provided by Leslie Schaeffer (ODFW, letter dated 9 March 1989; the 1988 data are preliminary. Net Change= (Number of Jacks from 1988 smolt releases)-(Number of Jacks from 1987 smolt releases).

Rearing Site		No. of Jacks Returning from Spring Releases in.. 1987	1988	Net Change
Nehalem Hatchery	winter steelhead	0	46	**+46**
Nehalem Hatchery	coho	5619	4570	-1049
Trask Pond	coho	55	22	-33
Trask Hatchery	coho	1221	551	-670
	Sum of Coho	6895	5143	**-1752**

2-I. Perception that if Predation is Reduced, then Fishermen's Catches Would Increase

2-I-1. Introduction

A few fishermen favor predator control because they think that it would increase their catches. Other fishermen, however, believe that poor catches have resulted from illegal catches by the high seas drift gill net fisheries or ocean conditions (F. W. Amato 1989).

There are a number of factors, other than predation, that influence the number of salmon and steelhead that fishermen can catch and that cause the variability in the number of fish caught each year (see Figs. 2.1-2.3 and 2.5-2.6 in section 2-D-7). These factors include foreign fisheries, regulations, stream flows, ocean conditions, habitat destruction, deterioration of wild salmonid stocks, and price of salmon. Even if predation is reduced, these other factors may result in no change in the amount of fish available to fishermen. Each of these factors is examined in the following sections.

2-I-2. Salmon and Steelhead Catches by Foreign Fisheries

There are two types of foreign fisheries that could affect salmon and steelhead fisheries: the foreign trawl fishery and the foreign high seas drift gill net fishery for squid.

The foreign trawl fishery (including the joint venture fishery) operates in territorial waters of the United States. It is illegal for this fishery to keep salmon, but an average of about 9,800 salmon/year were incidentally caught in 1978-1985 and in 1986 the preliminary estimate was that 38,500 may have been caught and discarded by foreign and joint venture boats fishing off Oregon, Washington, and California (ODFW 1988:156). Most of these salmon were chinook (ODFW 1988). Salmon caught in this fishery did not survive.

The foreign high seas gill net fishery involves the Taiwanese, Japanese, and Korean squid fleets (Cone 1989, McAllister 1989, Shabecoff 1989). Although conclusive data about the salmon and steelhead catches of this fishery are lacking, their catches may be significant (Cone 1989, McAllister 1989, Shabecoff 1989). According to N. Amato (1989), the National Marine Fisheries Service estimated that over 7 million immature salmon and steelhead may have been harvested by this fleet in 1988. This could have amounted to 20-50% of all immature West Coast steelhead (F. W. Amato 1989).

2-I-3. Effects of Regulations and Agreements on Yearly Changes in Catches

Regulations are designed to prevent overfishing and to allocate salmon among the various fishing interests. The ODFW only controls regulations up to 3 nautical miles (5.6 km) off the Oregon Coast. Farther offshore, regulations are established by the Pacific Fishery Management Council (PFMC)(Gunsolus 1980, PFMC 1982).

Changes in fisheries regulations can obviously result in differences in catches. Over the years, there have been many changes in regulations for Oregon coho and chinook fisheries (Mullen 1981, K. Johnson 1983, McQueen et al. 1988:4, Nicholas and Hankin 1988).

Perhaps, the biggest change in regulations has been the establishment of quotas for the ocean coho fisheries in 1983 and for some of the ocean chinook fisheries in 1984 (McQueen et al. 1988:4). With quotas, the number of salmon that are caught no longer depends on the number of available salmon, per se, but on the fulfillment of a quota. The size of the quota for a particular fishery is based on estimates of the number of salmon that are available to be caught, an estimate of the number of salmon needed to escape and spawn, and an apportionment of the estimated total catch among various salmon user groups in Oregon, Washington, and California.

The number of salmon caught also depends on treaties and agreements between different countries, states, and governmental agencies (Diamond and Pribble 1978). For example, a U.S. treaty with Canada has resulted in more large chinook being caught along the north Oregon Coast (Anonymous 1985b, 1987a). Further, since many adult chinook and coho salmon produced in Oregon streams and hatcheries are not caught in Oregon (ODFW 1982, Nicholas and Hankin 1988, Mathews and Ishida 1989), the number of salmon returning to Oregon streams is also greatly dependent on how many Oregon-produced salmon are caught off British Columbia, Washington, or California.

2-I-4. Effects of Stream Flows on Yearly Changes in Catches

High or low stream flows may affect the ability of wild adult salmon or steelhead (also see Appendix VIII) to spawn naturally or for their young to survive. For example, stream flows have been shown to affect survival and returns of wild coho (McKernan et al. 1950, Scarnecchia 1981). Since hatchery coho smolts are unaffected by stream flows, stream flows today may have little influence on coho runs because in 1978-1981 only 11-16% of coho smolts were wild, whereas in 1960 about 50% were wild (Nickelson 1986).

2-I-5. Effects of Ocean Conditions on Yearly Changes in Catches

Ocean conditions appear to be a major factor influencing the survival and size of salmon. Most research on the importance of ocean conditions has been for coho salmon.

COHO.--Strong upwelling off the Oregon Coast in the spring and summer is directly correlated with an increased survival of hatchery-reared coho smolts, but in years with poor upwelling, hatchery coho have poor survival (Mathews 1984, McGie 1984, Bottom et al. 1986, Nickelson 1986, Pearcy 1988). Strong upwelling appears to be most influential on coho smolt survival from March through June (Pearcy 1988).

The effects of a lack of upwelling was particularly noticeable for coho ocean fisheries during the 1983 El Nino (Pearcy et al. 1985, Pearcy and Schoener 1987, Johnson 1988). Coho fisheries were also low in the poor upwelling year of 1984 (see Fig. 2.2 or Appendix III), when smolt survival was also reduced (Pearcy and Schoener 1987). The effect of poor upwelling on the increased mortality of hatchery coho smolts is so strong that releasing more smolts in years of relatively poor upwelling (e.g., 1977-1984) doesn't help increase adult returns (McGie 1984, Nickelson 1986, Pearcy 1988).

The survival of wild coho smolts has also been found to be significantly correlated to upwelling in 1947-1962 (Scarnecchia 1981) but not in 1960-1981 (Nickelson 1986). However, Nickelson (1986:532) notes that the 1960-1981 data may be in error and that there may indeed be a direct relationship between upwelling and wild coho smolt survival. Even if wild smolt survival isn't influenced by upwelling, 80% or more of the coho smolts are now from hatcheries (Nickelson 1986), and the coho fisheries are now dependent on hatchery smolts (Scarnecchia and Wagner 1980, Nickelson 1986). Thus, poor upwelling would still hurt the coho fisheries even if wild smolts are unaffected by upwelling.

Unfortunately, strong upwelling does not regularly happen off Oregon (McLain 1984); it has occurred in only 25% of the last 40 years (Bottom et al. 1986). Because humans have no control of upwelling, the Oregon coho fisheries can be expected to continue to have extended periods of low catches punctuated by short periods of larger catches (Nickelson 1983).

CHINOOK.--The effects of ocean conditions (i.e., upwelling) on chinook fisheries and smolt survival have received little attention. However, poor upwelling also appears to hurt chinook fisheries, since 1983 and 1984 were poor years for the ocean and coastal stream fisheries (Fig. 2.2 or Appendix IV) as well as for smolt survival (Pearcy et al. 1985, Pearcy and Schoener 1987, Johnson 1988).

STEELHEAD.--Poor upwelling during the 1983 El Nino also corresponded in markedly reduced catches for winter and summer steelhead in 1983 (Figure 2.6).

2-I-6. Ongoing Habitat Destruction

In Oregon coastal streams, more losses in salmon production have occurred as a result of deterioration in habitat rather than from physical barriers to fish passage (PFMC 1979:26). Habitat destruction includes siltation resulting from logging, mining, and agriculture that destroys spawning areas; decreased cover by removing woody debris in logged watersheds that increases water temperatures and makes juvenile salmonids more vulnerable to predators (PFMC 1979, Bryant 1983, Bottom et al. 1985, McMahon and Holtby 1989); lowered water quality from waste discharge by industrial and municipal developments and chemical runoff from agricultural areas (PFMC 1979); landfills in estuaries or other rearing areas that reduces the amount of area available to juvenile salmonids (PFMC 1979); and decreased water flows as a result of irrigation that threatens stream flows vital to juvenile fish (PFMC 1979).

Although these destructive processes are becoming increasingly recognized and there are attempts to reverse some of these processes, habitat destruction continues.

2-I-7. Destruction of Genetically Wild Salmon and Steelhead Stocks

Even if predation of hatchery smolts is reduced, this may not help increase fishermen's catches because hatchery fish can hurt wild fish stocks (Appendix VIII). For example, some hatchery fish stray and interbreed with wild fish, and dilute the genetic variability of wild stocks (Appendix VIII).

Wild fish are important to maintain because the carrying capacity of the Pacific Ocean may be greater for the more diverse wild fish than for hatchery fish (e.g., Parmenter and Bailey 1985:55). Thus, to increase the number of salmonids available to fishermen, maintaining or increasing wild stocks may be essential.

The possible harmful effects of hatchery salmonids on wild salmonids are examined in Appendix VIII.

2-I-8. Price of Salmon

The number of salmon caught by commercial fishermen also depends upon the price they are paid for their catches. When prices for coho and chinook are high, there will be an effort to fish. But when salmon prices are too low, it may not be economically feasible to commercially fish for salmon because of the costs of salmon trolling, wages, etc.

The price of salmon is influenced by many factors including domestic or world market demands for salmon, the availability of cheaper aquaculture salmon, and salmon catches in Alaska or elsewhere.

2-I-9. Conclusion: Cormorant Harassment May Not Affect Catches Even if Harassment Saved Smolts

There are a number of factors influencing the number of salmon and steelhead available to fishermen. Some factors such as drift gill net fisheries and regulations may be changed by humans, but other factors such as ocean conditions are not within human control. It is oversimplistic to think that cormorant harassment, even if it saved any smolts, would improve fishermen's catches because these other factors also control catches. Elsewhere, control of bird predators of juvenile salmon has not increased fishermen's catches of returning adults (section 3-A).

2-J. Spread of Fishermen's Perceptions via News Media and Angler's Clubs

What also has helped bring the cormorant predation issue to prominence in Tillamook County is the spread of some harassment proponents' perceptions via the local newspaper (the Tillamook "Headlight-Herald") and Tillamook County fishing groups (e.g., Save Our Fishing Industry [see Anonymous 1986b, Hendrickson 1987], Miami Anglers, Tillamook Anglers, Nehalem Chapter of Northwest Steelheaders, and Fin and Feather Club).

Terry Hendrickson, a Sports Editor of the "Headlight-Herald" and Secretary of Tillamook Anglers, has also had a few columns in the "Headlight-Herald" that have expressed a one-sided view of salmon predation (e.g., Hendrickson 1987, 1988a). Hendrickson's expression of his own viewpoint is certainly his prerogative and democratic right, but his columns have not helped develop a balanced understanding of the complexity of the predation issue.

The Tillamook newspaper is obliged to print "Letters to the Editor"; unfortunately, some of the letters have contained exaggerations favoring cormorant harassment (e.g., Erickson 1988a, b). The "Headlight-Herald," however, has made an effort to be even-handed in its "Letters to the Editor" section because it has printed letters that have disagreed with Erickson (1988b) or Hendrickson (1988a)(e.g., Confer 1988a, b; Dolan and Dolan 1988, Kvernik 1988, Lerman 1988).

Chap. 3. Is Cormorant Harassment Justifiable Economically or Otherwise?

3-A. Introduction

The subject of predator control has been one of considerable controversy. In recent years, **the consensus of expert opinion** (including reports from Advisory Committees on Wildlife Management or Predator Control to the U.S. Dept. of Interior [Leopold et al. 1964, Cain et al. 1972], the manual on wildlife management techniques by the Wildlife Society [Hawthorne 1980], and the Maine Cormorant Study [1982]) **is that predator control is only justifiable if its tangible benefits outweigh its negative impacts on other wildlife and its economic, social, and aesthetic costs** (also see Berryman 1972, Hornocker 1972, Beasom 1974, Peek 1986:224-230).

If predator control of cormorants along the Oregon Coast is to have any tangible economic benefits, the number of adult salmon or steelhead caught by fishermen must increase as a result of cormorant control. The only research to determine if bird control increased the number of adult salmonids caught in fisheries has been for Atlantic salmon (Huntsman 1941, White 1939a, Elson 1962); none of these studies demonstrated that predator control of birds increased the catches of adult salmon by fishermen (Vladykov 1943:129, Lack 1966:289, Mills 1967:390-391, 1980; Draulans 1987).

Further, catches of Oregon salmon and steelhead have often been as high or higher since predators such as seals, sea lions, and cormorants were protected in 1972 than previously (section 2-E-2). This also indicates that predator control along the Oregon Coast may not affect fishermen's catches.

3-B. Conditions When Predator Control is Justifiable Economically or Otherwise

To determine if animal damage control is advisable requires that all criteria in the following Table 3.1 be satisfied. For example, there must be a proof of need because predator control programs have too often been initiated only on the basis of assumed benefits and unrealistic predator consumption estimates (e.g., Cain et al. 1972) rather than on a real proof of need. As a result, the economic or biological costs of some predator control programs have often been greater than the resulting benefits (e.g., Cain et al. 1972, Beasom 1974, Peek 1986:254-261, Duffy and Siegfried 1987).

Overall, predator control is often of limited benefit in increasing numbers of game animals, especially if not all predators are controlled (Cain et al. 1972, Alexander 1979, Peek 1986).

Table 3.1. Summary of criteria for when animal damage control (including harassment) is justifiable. Criteria are derived from Berryman (1972), Hornocker (1972), Beasom (1974), Alexander (1979), Hawthorne (1980), SERC (1980), Maine Cormorant Study Committee (1982:10), and Peek (1986:254-261).

Criteria to Justify Animal Damage Control

1) If control is done on public lands or waters or if control can harm sensitive nontarget animals, the control should be done by professionals.
2) All predators are controlled so compensatory predation by noncontrolled predators does not result in the same amount of predation as there would be without control.
3) It is reasonable to expect that control will significantly reduce losses.
4) There are no reasonable alternatives to control.
5) The economic loss or impact on the resource by the predator justifies the economic, biological, aesthetic, and social costs of conducting the animal damage control program.

3-C. Arguments for Cormorant Harassment in Tillamook County

Proponents of cormorant harassment have no evidence for the economic benefits of cormorant harassment; instead, they have suggested that the **potential** costs of cormorant predation at Tillamook Bay are significant enough to warrant harassment (see section 2-F). Since their extrapolated estimates for the potential costs seem unrealistically high and are certainly debatable (section 2-F), their estimates do not provide conclusive evidence for a real need for harassment at Tillamook Bay in April-June, let alone for all Oregon coastal streams as proposed in the original House Bill 3185 (section 1-I-1) or to the Oregon Fish and Wildlife Commission (section 1-J).

Further, proponents have not provided evidence that the economic benefits of cormorant harassment would exceed the economic costs of actually doing the harassment (see section 3-G). Supporters have merely assumed that cormorant harassment would pass a cost-benefit test; such an assumption is not sufficient to warrant predator control such as harassment (Cain et al. 1972, Hawthorne 1980, Peek 1986).

Some advocates of harassment argue that it seems such a waste to release hatchery smolts if they are going to be all eaten by cormorants. However, recent salmon and steelhead catches have been good along the Oregon Coast (Figs. 2.1-2.6), so it is clear that cormorants or other predators are not eating all smolts.

3-D. Argument Against Harassment: the Harassers Are Private Citizens

Cormorant harassment in 1988 (section 1-F) was done by private citizens, and House Bill 3185 (section 1-I) also proposed that private citizens harass cormorants on Oregon public waters. But Hawthorne (1980) and others recommend that animal damage control be done only by professionals if it occurs on public lands or waters.

There are a wide variety of game birds and threatened, endangered, or sensitive animals that occur on these public waters that could be incidentally harmed by harassment (section 3-H). This is another reason to allow only professional biologists or professional animal damage control personnel do the harassment (Berryman 1972, Hawthorne 1980:412, SERC 1980).

Finally, only allowing professionals do cormorant harassment is also advisable because it may help reduce the anxiety of the general public, who are concerned about the welfare of nontarget animals.

3-E. Argument Against Cormorant Harassment: Compensatory Predation

The second criterion to justify an animal damage control program is that there be no compensatory predation (i.e., smolts not taken by the controlled predator are taken by noncontrolled predators)(Table 3.1).

Since there is a wide variety of known and possible fish and bird predators of smolts other than cormorants (Tables 3.2 and 3.3 at end of this section), smolts that cormorants would have eaten may simply be eaten by other fish and bird predators. Hatchery smolts are so naive and vulnerable that predators that would not normally take wild smolts will take hatchery smolts (Appendix II). Further, hatchery smolts only learn to be wary of predators by being exposed to them (e.g., Ginetz and Larkin 1976, Patten 1975, Wood and Hand 1985, Olla and Davis 1988, 1989), so they are vulnerable to the first predators they meet, whether that be in an estuary or after smolts arrive in the ocean.

Most concern over smolt predation in Oregon has been about Common Murres (Ward 1983, Bayer 1986, McNeil et al. in press) or cormorants (Erickson 1988b, McAllister 1988). However, fish predators of hatchery smolts have received little attention in Oregon, probably because they don't eat smolts as conspicuously as birds. Elsewhere, there have been ample studies that have found fish predation of salmonids to be significant with 20-25% of smolts estimated to have been eaten by fish predators (Gunnerod et al. 1988). In fact, in some areas, fish predators have been estimated to take several times more juvenile salmonids than birds (Vladykov 1943). Thus, more studies are needed to determine the extent of smolt predation by predatory fish in Oregon (e.g., see Appendix VII).

Although little research has been concerned with fish that eat smolts in Oregon, there has been enough to show that **subadult and adult salmon, steelhead, and cutthroat trout can be very significant predators of juvenile coho and chinook** (Tables 3.4 and 3.5). For example, Fresh et al. (1981:35) estimated that 33% of the diet of subadult steelhead collected in July 1979 in the Pacific Ocean near the mouth of the Columbia River were chinook smolts.

Although each salmon, steelhead, or cutthroat may only eat a few smolts at a time (Table 3.4), these salmonids are very numerous, so that the total number of smolts they eat may be very large. For example, in 1981, 4.29 million smolts may have been eaten by coho, chinook, and steelhead adults and/or subadults (Table 3.5). This estimate may be conservative because the number of smolts eaten by cutthroat trout was unknown and because it was assumed that salmon and steelhead ate smolts only once a year, but they may have done so on several days. If they did so on just three days in 1981, then nearly 13 million salmon smolts would have been eaten just by salmon and steelhead!

Since salmonids eat smolts, it is not surprising that salmon, steelhead, and cutthroat trout can be limiting the survival of salmon smolts, and subsequently diminishing the number of salmon that could be caught by fishermen. For example, Nickelson (1986:533) suggested that adult coho predation of coho smolts could be a significant factor in decreasing smolt survival.

Striped bass can also be significant predators of smolts. For example, Shapovalov (1936:262) reported that six stripers taken in Coos Bay had eaten an average of 15.3 young salmon and trout (range 10-22) that were 4-8.5 in (10.2-21.6 cm) long; most of the salmon smolts were downstream migrating coho. **Thus, striped bass were found to have eaten nearly twice as many young salmonids on the average than cormorants collected by the ADC at Tillamook Bay** (section 2-F-5). Since House Bill 3185 (section 1-I) and the proposal to the Oregon Fish and Wildlife Commission (section 1-J) applied to all Oregon coastal rivers, striped bass need to be considered a compensatory predator, even though their northernmost population along the Oregon Coast is the Siuslaw River (McGie and Mullen 1979).

Catching **and keeping** smolts by Oregon sports fishermen is illegal (i.e., the possession limit is at least 8 in [20.3 cm] from late May through the end of October and at least 12 in [30.5 cm] the rest of the year along the coast [1988 and 1989 Oregon Sport Fishing Regulations]). Nevertheless, sports fishermen are also smolt predators (Table 3.2). For example, at Yaquina Bay, some fishermen have been observed catching and keeping smolts while "jigging for herring" (Bayer, pers. obs.) or catching smolts while using spinners to fish for adult salmon (Roy Lowe, USFWS Biologist, pers. comm.). Lowe noted that smolts caught on salmon spinners were so badly hooked that they were unlikely to survive after being released. The problem of fishermen catching smolts is not limited to Yaquina Bay, since Claveria (1988) also reported this on Oregon's Molalla River.

Table 3.2. Marine or estuarine predators that occur in Oregon waters that have been observed to prey on juvenile coho or chinook. Species are listed alphabetically. Threatened, endangered, sensitive, or potentially sensitive bird species (ONHDB 1987) and salmonid predators of juvenile coho or chinook are **boldfaced.**

Known Predator	Reference(s)
INVERTEBRATE	
crab, red rock	Mills (1977)
FISH	
bass, striped	Shapovalov (1936), Morgan and Gerlach (1950), Shapovalov and Taft (1954:257), Stevens (1966)
hake, Pacific	Anonymous (1959)
lamprey, Pacific	Roos et al. (1973)
lamprey, river	Beamish (1980), Myers (1980:171), Roos et al. (1973)
lingcod	Anonymous (1959), Olla and Davis (1989)
pollock, walleye	Hart (1973:229)
rockfish, black	Pearcy (1988:71)
rockfish spp.	Anonymous (1959)
salmon, chinook	Anonymous (1959), Burck (1965), Fresh et al. (1981), McCabe et al. (1983)
salmon, coho	Angstrom and Reimers (1964), Fresh et al. (1981), Stuart (1984), Stuart and Buckman (1985)
sculpin, buffalo	Levings (1984), Macdonald et al. (1988)
steelhead	Fresh et al. (1981)
sturgeon, white	Merrell (1961)
trout, cutthroat	Anonymous (1959), Brodeur et al. (1987a:9), Hart (1973)
BIRD	
Auklet, Rhinoceros	Simenstad et al. (1979)
Cormorant, Brandt's	Bayer (1986)
Cormorant, Double-crested	ADC Study (section 1-D-2)
Cormorant, Pelagic	Bayer (1986)
Duck, Harlequin	Mace (1983:13)
Guillemot, Pigeon	Bayer (1986)
Gull, Bonaparte's	Levings (1984), Mace (1983)
Gull, Glaucous-winged	Mace (1983)
Gull, Heerman's	Roy Lowe (pers. obs.)
Gull, Ring-billed	Roy Lowe (pers. obs.)
Gull, Western	Bayer (1986)
Heron, Great Blue	Myers (1980:172)
Kingfisher, Belted	Bayer (pers. obs.)
Loon, Pacific	Mace (1983)
Merganser, Common	Wood (1987), Wood and Hand (1985)
Murre, Common	Bayer (1986), Matthews (1983), Ward (1983)
Murrelet, Ancient	Mace (1983)
Murrelet, Marbled	Mace (1983)
Pelican, Brown	Bayer (1986)
Scoter, Black	Mace (1983:13)
Scoter, Surf	Mace (1983:13)
Scoter, White-winged	Mace (1983:13)
Tern, Caspian	Bayer (1986)
MAMMAL	
fishermen[a]	Claveria (1988), Bayer (pers. obs.), R. Lowe (pers. obs.)
seal, harbor[b]	Graybill (1981:42)

[a] In Yaquina Estuary, Bayer observed some fishermen "jigging for herring" and catching salmon smolts. Also at the Yaquina, Lowe saw fishermen catching smolts on spinners that were designed to catch adult salmon.

[b] Graybill found salmon smolts to be a minor prey item of seals in Coos Bay; Fiscus (1980) and Simenstad et al. (1982:355) knew of no records of predation on juvenile salmonids by harbor seals or sea lions.

Table 3.3. Marine or estuarine predators that occur in Oregon waters that **may be** predators of juvenile coho or chinook. These species feed on baitfishes (e.g., Pacific herring or northern anchovies), and thus may feed on juvenile hatchery-released coho or chinook, which can be similar in appearance and size to baitfish. Thus far, research after a hatchery release has been inadequate to determine all predators of juvenile coho or chinook (also see Appendix VII). Species are listed in alphabetical order. Threatened, endangered, sensitive, or potentially sensitive bird species (ONHDB 1987) and possible salmonid predators of juvenile coho or chinook are **boldfaced.** Some freshwater predators are listed in section B of Appendix II.

Possible Predator	Reference
FISH	
albacore	Pinkas et al. (1971)
cod, Pacific	Clausen (1981)
croaker, white	Morejohn et al. (1978:74-75)
dogfish, spiny[a]	Mace (1983:54), Ketchen (1986:17)
flounder, starry	Orcutt (1950)
mackerel, jack	Grinols and Gill (1968)
sablefish	Grinols and Gill (1968)
salmon, chum	Bakkala (1970)
sanddab, Pacific	Morejohn et al. (1978:74-75)
sculpin, Pac. staghorn[a]	Simenstad et al. (1979:148), Mace (1983:54)
shark, blue	Morejohn et al. (1978:74-75), Harvey (1979)
shark, soupfin	Ripley (1946), Hart (1973:40)
shark, thresher	Hart (1973:31)
sole, petrale	Morejohn et al. (1978:74-75)
sole, sand	B. S. Miller (1967)
BIRD	
Egret, Great	Schlorff (1978)
Grebe, Horned	Palmer (1962:79)
Grebe, Red-necked	Ainley and Sanger (1979:106)
Grebe, Western	Ainley and Sanger (1979:106)
Kittiwake, Black-legged	Simenstad et al. (1979:244)
Loon, Common	Ainley and Sanger (1979:106)
Loon, Red-throated	Ainley and Sanger (1979:106)
Merganser, Red-breasted	White (1939b), Simenstad et al. (1979:235)
Puffin, Tufted	Ainley and Sanger (1979:103)
Shearwater, Short-tailed	Ainley and Sanger (1979:107)
Shearwater, Sooty[b]	Wiens and Scott (1975:447)
Tern, Arctic	Simenstad et al. (1979:245)
Tern, Common	Simenstad et al. (1979:244)
MAMMAL	
dolphin, Pac. white-sided	Mitchell (1975), Morejohn et al. (1978:74-75)
otter, river	Toweill (1974), Alexander (1979)
porpoise, Dall's	Norris and Prescott (1961), Morejohn (1979)
porpoise, harbor[c]	G. J. D. Smith and Gaskin (1974), Morejohn et al. (1978:74-75)
seal, elephant	Morejohn et al. (1978:74-75)
sea lion, California	Morejohn et al. (1978:74-75)
sea lion, northern	Mate (1981:450)

[a]This species can become quite abundant near a release site (Mace 1983:54).
[b]Sooty Shearwaters are abundant off the Oregon Coast (Wiens and Scott 1975:441), and several million have been estimated off the Columbia River.
[c]Harbor porpoises are occasionally seen near or in Oregon estuaries (Bayer 1985b) near the sites of salmon smolt releases.

Table 3.4. Predation of juvenile coho or chinook by subadult or adult salmonids. Note that prey listed as "salmon" below were probably juvenile chinook but may have also included juvenile coho. Predation was determined by stomach contents, which indicates recent predation, not daily or yearly predation. N=number of predators sampled for stomach contents, MAX=maximum number of juvenile salmon per predator.

Predator	Prey	N	Predators with coho or chinook (%)	Number of coho or chinook/ predator Mean	MAX	Reference
chinook salmon:						
subadult	chinook	?	10	0.1	?	Fresh et al. (1981)
adult	chinook	2	?	1.5	2	Burck (1965)
coho salmon:						
subadult	chinook	?	11	0.8	?	Fresh et al. (1981)
adult	salmon	2	100	1.5	2	Angstrom & Reimers (1964)
adult	chinook/salmon	6	100	?	3	Angstrom & Reimers (1964)
adult	coho	141	25	2.2	6	Stuart & Buckman (1985)
adult	coho	61	8	1.2	2	Stuart & Buckman (1985)
adult	coho	37	5	1.0	1	Stuart & Buckman (1985)
cutthroat trout:						
adult	chinook/salmon	?	?	?	3	Brodeur et al. (1987a:9)
steelhead:						
subadult	chinook	?	20	1.0	?	Fresh et al. (1981)
subadult	steelhead	?	?	?	4	Shapovalov and Taft (1954)

Table 3.5. Estimate of number of smolts eaten by salmonid predators (except cutthroat trout) in 1981 along the Oregon Coast. The number of smolts/predator is estimated from the average number of smolts found in stomachs of salmon and steelhead in Table 3.4. The number of adult salmon and steelhead in 1981 is estimated from ocean commercial and sport recreational catches off Oregon (McQueen et al. 1988), from coastal stream catches (ODFW 1987), and from Columbia River estimated run sizes (PFMC 1988). The number of subadult salmon and steelhead in 1981 is estimated from the catches for the previously mentioned fisheries in 1982 (i.e., 1981 subadults were all assumed to survive until being caught in 1982). These estimates may underestimate the actual number of smolts eaten in 1981 because fish predators can eat and digest smolts more than once each day (see Peterson et al. 1982) and fish predators may have eaten smolts on more than one day. Further, these also may be underestimates because the number of salmon or steelhead that died without being landed by fishermen, escaped to spawn in coastal streams, or moved into waters off Washington or California are unknown. Estimates of the number of cutthroat trout present off Oregon were not available.

Predator	Age-class	Smolts/ Predator	No. of Predators (millions)	Total Smolts (millions)
Chinook	subadult	0.1	0.84	0.08
"	adult	1.5	0.68	1.02
Coho	subadult	0.8	1.15	0.92
"	adult	2.2	0.99	2.18
Cutthroat	adult	3.0	?	?
Steelhead	subadult	1.0	0.09	0.09
				SUM= 4.29 million smolts

3-F. Argument Against Cormorant Harassment: Alternatives

The fourth criterion for justifying animal damage control such as cormorant harassment is that there are no alternatives (Table 3.1). There are, however, several alternatives to cormorant harassment that may reduce smolt losses to all predators, not just cormorants (see Chap. 4). As recommended in the Maine Cormorant Study (1982:10), alternatives should be explored before control is implemented.

3-G. Argument Against Cormorant Harassment: Economic Costs

3-G-1. Expenses of Doing Harassment

The fifth criterion for an animal damage control program is that the economic loss or impact caused by predators justifies the economic, biological, aesthetic, and social costs of conducting the damage control program (Table 3.1). There are no conclusive data to indicate that smolt losses justify the economic costs of cormorant harassment, which includes the expenses of doing and monitoring the harassment as well as possible economic losses to the coastal tourist industry.

Expenses include the cost of cracker shells or other shells to scare cormorants, transportation costs for harassers to patrol an estuary, liability insurance to cover the costs of accidental injury to harassers or bystanders on public lands and waters, and wages if harassment is done by government employees.

To do a fish-eating predator control program properly, the area to be protected needs to be patrolled frequently. This may not be too much of a problem if only a small area such as a pond or hatchery is patrolled, but when miles of a coastal stream or estuary are to be patrolled, the cost grows rapidly.

Control of fish-eating predators may be economically feasible in simple situations such as at fish hatcheries or if there are only 1-2 predators involved. At fish hatcheries, however, it has long been recognized that shooting or harassing bird predators is simply not an effective solution to bird predation; the solution is to screen and enclose ponds so that the predators can't get in (Lagler 1939, Pough 1940, 1941, 1949; Cottam and Uhler 1945, Morrison 1975, Randall 1975, Mott 1978, Hawthorne 1980, Salmon et al. 1986, Draulans 1987, Parkhurst et al. 1987).

Since killing or harassment of fish-eating birds at hatcheries is known to not work effectively and screening estuaries is not possible, it is questionable if harassment would be cost-effective along a stream or an estuary.

3-G-2. Expenses of Monitoring Harassment

During cormorant harassment at Nehalem and Tillamook Bays in the spring of 1988, the fishing guides and fishermen that harassed cormorants were not monitored or supervised (section 1-F). Because harassment opponents were concerned that harassers would disturb or harm nontarget wildlife (see section 3-H), House Bill 3185 was amended to allow ODFW supervision of harassers (section 1-I-3), and the proposal to the Oregon Fish and Wildlife Commission also included a provision for ODFW supervision (section 1-J). The ODFW estimated that monitoring would cost about $8,000/river or estuary for 3.5 months (section 1-J).

It is unclear if harassment would actually result in any more salmon or steelhead (section 2-H), let alone result in an increase worth $8,000 or more per river or estuary.

3-G-3. Losses to Tourism

Since cormorant harassment would occur in public waters of coastal streams and involve the shooting of firearms, harassment would be highly conspicuous to tourists.

Tourists come to the Oregon Coast for its aesthetic values and to get away from the noise and turmoil of their normal lives. Many may not appreciate harassment or its accompanying shooting; many may also worry for their personal or family's safety about being in the vicinity of harassers using shotguns or other firearms to shoot noise-making shells at cormorants (also see section 3-I-2). Accordingly, some tourists may leave areas where there is harassment, which could hurt local residents who depend on these tourists for their livelihood.

In fact, some residents of Nehalem Bay have expressed their fears that their businesses may be hurt by cormorant harassment. In early June 1988 at Nehalem Bay, a marina owner and also a motel owner/manager independently approached Roy Lowe (USFWS Biologist), who was in USFWS uniform, and complained that they thought that the 1988 harassment at Nehalem Bay was bad for their businesses because part of their clientele came to the Oregon Coast to enjoy wildlife and did not appreciate birds being harassed.

3-G-4. Economic Losses from Doing Cormorant Harassment

Presently, the economic loss from cormorant predation is unknown but is probably much less than cormorant harassment proponents have suggested (see section 2-F). These losses may be offset, in part, by some possible, but unproven, benefits that may result from cormorant predation. For example, cormorants may primarily prey on weakened, sick smolts that could spread disease or parasites to healthy smolts (Vladykov 1943:127, Mills 1967:387).

Second, by taking smolts that are most vulnerable and are also easily detectable by other predators, cormorants can make it more difficult for other predators to detect healthy smolts and prey on them.

Third, cormorants may also be eating fish besides salmonids that are competitors or predators of salmonids. Elsewhere, predator control has sometimes been found to increase numbers of other harmful animals that the predator normally ate (Vladykov 1943, Mills 1967:388, Campbell 1979).

Finally, newly released smolts are naive about predators. There is evidence that smolts learn from seeing others being eaten and subsequently become much less vulnerable to predation (e.g., Ginetz and Larkin 1976, Patten 1977, Wood and Hand 1985, Olla and Davis 1988, 1989). Thus, it is possible, but unproven, that the overall survival rate of smolts that are first exposed to cormorants in coastal streams and estuaries (which would make the survivors more wary) may be higher than if the smolts are not exposed to predators until they reach the ocean where there are lots of predators.

3-H. Argument Against Cormorant Harassment: Biological Costs

3-H-1. Introduction

A biological cost of cormorant harassment is that it can affect nontarget animals, including threatened, endangered, or sensitive species and game birds. Even if harassers shot cracker shells only at cormorants, other birds and animals will subsequently also be disturbed because animals avoid sites of shooting. For example, anyone that has observed duck hunting knows that after a shot, many birds, not just the one shot at, are disturbed and fly away.

Because 1988 harassment occurred in tidewater areas of estuaries (section 1-F) and is proposed to continue there, nontarget birds that use tidewater areas such as the threatened or endangered Bald Eagle, Peregrine Falcon, and Brown Pelican; game birds such as Brant, and other birds could be harassed from areas that they normally use.

The intentional or inadvertent disturbance of nontarget birds is harmful because it can result in birds spending more time flying (which is energetically demanding), birds feeding for shorter periods of time, or birds being forced to leave good feeding areas to feed at poor sites (Henry 1980, Henry and Springer 1981, Burger 1981, 1986, 1988; Kaiser and Fritzell 1984, Knight and Knight 1984, Stalmaster 1987:160-169). Since harassment of cormorants is proposed for April-June, the subsequent disturbance to nontarget species would be during their spring migration or nesting season.

Some nontarget bird taxa that would be adversely affected by the harassment of cormorants are listed below; threatened, endangered, and sensitive birds species are from ONHDB (1987). Note that emphasis is placed on birds at Nehalem and Tillamook Bays because that is where most interest for cormorant harassment has been. Netarts Bay is included because STEP volunteers have taken over the Whiskey Creek fish hatchery there, and some volunteers have already expressed a desire to control or harass birds at Netarts Bay.

Information about birds at other Oregon coastal sites is also included because harassment was requested for all coastal streams in the original House Bill 3185 (section 1-I-1) and in the proposal to the Oregon Fish and Wildlife Commission (section 1-J). Since few data exist for birds at Nehalem and Tillamook Bays, information about birds at other coastal estuaries is also helpful in elucidating which species may be affected by harassment at Nehalem and Tillamook Bays.

Most information about birds given below is for the April-June period, when harassment has usually been proposed, but incidental notes about bird presence throughout the rest of the year is also given because the period of harassment was not specified in the original House Bill 3185 (section 1-I-1) or in the proposal to the Oregon Fish and Wildlife Commission (section 1-J).

3-H-2. The Threatened Bald Eagle

Bald Eagles are very susceptible to human disturbance, especially gunshots (Mathisen et al. 1977, Stalmaster and Newman 1978, Stalmaster 1983, 1987:160-169; Knight and Knight 1984). Since Oregon coastal streams and estuaries support only a small number of breeding Bald Eagles that apparently remain throughout the year (Isaacs et al. 1983, Bayer 1987), the intentional or unintentional disturbance of these eagles should be of concern. Disturbance in March-August would be particularly detrimental to eagles because this is when they are incubating eggs or have young in the nest (Isaacs et al. 1983).

Incidental observations indicate that Bald Eagles are present at Nehalem, Tillamook, and Netarts Bays (Table 3.6 in section 3-H-9), and Bald Eagles are regularly present during winter, at least at Tillamook Bay (Table 3.7).

3-H-3. The Endangered Peregrine Falcon

Peregrines appear to be making a comeback in western Oregon, and many use coastal estuaries (Tables 3.6 and 3.7; Roy Lowe, USFWS Biologist, unpubl. data).

3-H-4. The Endangered Brown Pelican

At least a few Tillamook fishermen view Brown Pelicans as a threat to smolts because they were discussed as "predators" at the 3 August 1988 Tillamook Anglers/ODFW "Town Hall" meeting in Tillamook (Tillamook Anglers 1988).

In former years, Brown Pelicans were rare along the Oregon Coast in May but not in recent years (Table 3.6, Bayer unpubl. data). Pelicans are regularly within Yaquina Estuary in June (Appendix V), where they reach their peak of abundance in September or October (Bayer 1983b, 1986). Some remain until mid-December (Bayer 1988).

3-H-5. Other Sensitive Species or Species of Special Concern

COMMON LOON.--The Common Loon is a USFWS Sensitive Species (ONHDB 1987:9). At Yaquina Estuary, they commonly overwinter, their spring migration peak is in February or April, some are present in May and June, a few oversummer, and they increase in abundance in October (Appendix V, Bayer 1983b). Since the Common Loon is a diver like cormorants, they can be found in the same areas as cormorants.

HORNED GREBE.--The Horned Grebe is a proposed State Sensitive Species (ONHDB 1987:8). Horned Grebes are common at Yaquina Estuary from September through May with peak numbers in fall (October or November) or spring (February-April)(Appendix V, Bayer 1983b). They are a diving species that can be found in the same areas as cormorants.

RED-NECKED GREBE.--The Red-necked Grebe is a proposed State Sensitive Species (ONHDB 1987:8). It is a diver found in Oregon estuarine waters from about October through May (e.g., Bayer 1988) with cormorants.

MERLIN.--The Merlin is a proposed State Sensitive Species (ONHDB 1987:9). Since they often feed on shorebirds, they would be expected to be present during the spring shorebird migration peak in late April and early May and during fall shorebird migration (see section 3-H-7).

BUFFLEHEAD.--The Bufflehead is a Species of Concern (ONHDB 1987:8) that can be commonly found from about mid-October through mid-May in Oregon estuaries (e.g., Appendix V, Bayer and Lowe 1988:12). In April, an average of 119-260 was found at Nehalem, Tillamook, or Netarts Bays (Table 3.8).

GREATER YELLOWLEGS.--The Greater Yellowlegs is a shorebird Species of Concern (ONHDB 1987:8). 80 were at Tillamook on 18 April 1987 (Table 3.6); if there had been more censuses, more would probably have been found.

MARBLED MURRELET.--The Marbled Murrelet is a proposed State Sensitive Species (ONHDB 1987:8). Since it is rare inside Yaquina Estuary (although it can be found just outside its mouth, Bayer 1986) and there are no data for its occurrence in Nehalem, Tillamook, and Netarts Bays; it is unclear if they would be affected by the harassment of cormorants.

CASPIAN TERN.--The Caspian Tern is a species for which more information is needed to determine if its status should be of special concern (ONHDDB 1987:12). At Yaquina Estuary, they are present in April-October, with peak numbers in July through August (Appendix V, Bayer 1984, 1988).

3-H-6. Game Birds/Waterfowl

Because waterfowl are regularly hunted, shooting would probably disturb them. Waterfowl mainly use the Siuslaw and Yaquina estuaries from about September or October through April (Bayer 1983b, 1987; Bayer and Lowe 1988:13), which is typical of many Oregon estuaries (Roy Lowe, USFWS Biologist, unpubl. data). In April, substantial numbers of several waterfowl are still present at Nehalem, Tillamook, or Netarts Bays (Table 3.8).

If waterfowl are inadvertently harassed during spring migration, it may adversely affect their nesting success and, subsequently, the numbers available to hunters in the following fall. Harassment may also hurt the nesting success of Mallards (the only regularly nesting, native waterfowl in Oregon estuaries) or Canada Geese, which have been introduced and now nest at several sites along the Oregon central coast (e.g., Bayer and Lowe 1988:50).

Waterfowl would be vulnerable to disturbance in April at Nehalem Bay, Tillamook Bay, or Netarts Bay because substantial numbers of several species are still present then (Table 3.8). Unfortunately, there are no May or June censuses available for these Bays, but May and especially June numbers for most waterfowl would probably be low. For example, only a few Buffleheads (discussed in 3-H-5) are present at Yaquina Estuary in early May, and none were present in June (Appendix V). But 200 scaup and 30 Black Scoters were at Tillamook Bay in late May 1975 (Table 3.6), so some waterfowl can linger.

BRANT.--Brant overwinter at Tillamook and Netarts Bays (Roy Lowe, USFWS Biologist, unpubl. data), and these Bays, along with Yaquina Estuary (Bayer 1983b), are the only sites along the Oregon Coast where they regularly winter in any numbers (Bayer and Krabbe 1984, Bayer and Lowe 1988).

Brant are particularly vulnerable to shooting and disturbance (Henry 1980, Henry and Springer 1981). Shooting, in fact, has been considered to be the major reason why Brant seldom now overwinter at Humboldt Bay or at any other site in California (Henry 1980:4). Because of all the disturbance to Brant in California, more now overwinter in Tillamook Bay, Netarts Bay, or Yaquina Estuary (Bayer 1983b, USFWS unpubl. data, Christmas Bird Counts for Tillamook Bay) than any location in California (Henry 1980). It would be unfortunate if cormorant harassment caused Brant to abandon their last three Oregon overwintering sites because deserted wintering sites do not appear to be used again (see Henry 1980).

If cormorant harassment occurred only in spring, migrating Brant could still be disturbed by shooting. For example, in April, there were still many Brant at Tillamook and Netarts Bays (Table 3.8).

Even if overwintering Brant are not affected, the spring migrating Brant would certainly be disturbed by the shooting of harassers. Brant are routinely present at Yaquina Estuary into May, and sometimes oversummer into June (Appendix V). They probably also oversummer at Tillamook and Netarts Bays, since even incidental observations indicate that Brant were found at Tillamook Bay in late May 1975 and 1984 (Table 3.6).

3-H-7. Shorebirds

The spring migration peak of small ("peep") shorebirds occurs in late April-early May at Yaquina Estuary (Appendix VI), Coquille Estuary (Hodder and Graybill 1984:15), and other estuaries in Washington and California (Page et al. 1979, Herman and Bulger 1981, Widrig 1981:49, Kalinowski et al. 1982:109, Buchanan 1988). At Tillamook Bay, there have been few observations, but 5,000 Western Sandpipers were still present on 8 May 1976 (Table 3.6). Many "peeps" are also present at Oregon estuaries during fall migration and winter (Hodder and Graybill 1984, Bayer unpubl. data).

Many Whimbrels have been found at Nehalem and Tillamook Bays in May (Table 3.6). At Yaquina Estuary, their spring migration peak is in late April or early May (Appendix VI), and many oversummer through June (Appendix VI, Bayer 1984).

Censuses of shorebirds other than peeps and Whimbrels at Yaquina Estuary indicate that their numbers also peak during spring or fall migration (Bayer unpubl. data). At the Coquille Estuary, some also overwinter (Hodder and Graybill 1984). Sporadic observations of shorebirds other than peeps and Whimbrels indicate that they are commonly at Tillamook Bay in May (Table 3.6). At Yaquina Estuary, the abundance of these "other shorebirds" also peaks in late April or early May (Appendix VI).

3-H-8. Other Waterbirds

Harassment of cormorants in April-June could also affect other waterbirds, especially nesting residents. For example, Great Blue Herons and Western Gulls nest at Oregon estuaries (Bayer and McMahon 1981, Bayer 1983a).

3-H-9. Tables for Section 3-H

Table 3.6. Selected April-June bird records for Nehalem, Tillamook, and Netarts Bays from "American Birds" (AmB) and "Oregon Birds" (OB) and unpublished USFWS aerial observations of Bald Eagles and Peregrine Falcons. USFWS records were kindly provided by Roy Lowe, USFWS Biologist.

NEHALEM BAY
5-18-1974. 31 Whimbrels (1974 AmB 28:842).
2-4-1988. 2 adult Bald Eagles (USFWS).

TILLAMOOK BAY
5-12-1974. 16 Whimbrels (1974 AmB 28:842).
5-24-1975. 5 Brant, 200 Greater Scaup, 30 Black Scoters (1975 AmB 29:847-848).
5-8 to 5-15-1976. 40-70 Whimbrels (1976 AmB 30:880).
5-8-1976. 5000 Western Sandpipers (1976 AmB 30:880).
5-10-1976. 143 Red Knots (1976 AmB 30:880).
3-19-1979. 2 Bald Eagles (USFWS).
4-28-1979. 250 Semipalmated Plovers (1979 AmB 33:800).
late August 1980. 1 Peregrine Falcon (1980 OB 6:192).
1-17-1981. 1 Peregrine Falcon (1981 OB 7:71).
3-21-1981. 1 Peregrine Falcon (1981 OB 7:71).
5-10-1981. 15 Red Knots was "high count in Oregon" (1981 AmB 35:855).
1-9-1983. 1 adult Bald Eagle (USFWS).
5-7-1983. 23 Red Knots (1983 AmB 37:905).
5-9-1984. 200 Short-billed Dowitchers, several hundred Dunlin (1984 OB 10:89).
5-19-1984. 35 Brant (1984 OB 10:86).
5-19-1984. 2 Brown Pelicans (1984 AmB 38:949).
5-25-1984. 75 Red Knots (1984 OB 10:89).
4-14-1985. 80 Short-billed Dowitchers (1985 OB 11:176).
summer 1985. Peregrine Falcon in Tillamook area all summer (1986 OB 12:134).
1-6-1986. 2 adult Bald Eagles (USFWS).
2-6-1986. 1 immature Bald Eagle (USFWS).
3-3-1986. 2 immature Bald Eagles (USFWS).
4-3-1986. 1 immature and 1 adult Bald Eagle (USFWS).
4-30-1986. 1000 Least Sandpipers (1986 AmB 40:516).
4-30 to 5-14-1986. 200 Semipalmated Plovers (1986 AmB 40:515).
1-5-1987. 1 Peregrine Falcon (USFWS).
1-7-1987. 2 adult Bald Eagles (USFWS).
2-5-1987. 3 immature Bald Eagles (USFWS).
12-15-1987. 1 Peregrine Falcon and 1 adult Bald Eagle (USFWS).
12-19-1987. 2 Peregrine Falcons (1988 OB 14:287).
4-18-1987. 80 Greater Yellowlegs (1987 OB 13:449).
5-6-1987. 135 Whimbrels (1987 OB 13:449; 1987 AmB 41:479).
11-2-1987. 1 Peregrine Falcon (USFWS).
2-4-1988. 2 adult Bald Eagles (USFWS).
2-10-1988. 1 adult Bald Eagle (USFWS).
2-24-1988. 1 adult Bald Eagle (USFWS).
3-3-1988. 1 adult Bald Eagle (USFWS).

NETARTS BAY
5-9-1979. 49 Ruddy Turnstones (1979 AmB 33:800).
5-21-1984. 4 Brown Pelicans (1984 OB 10:84; 1984 AmB 38:949).
4-5-1985. 1 adult Bald Eagle (USFWS).

Table 3.7. Bald Eagles and Peregrine Falcons recorded during Tillamook Bay Christmas Bird Counts (CBC) in December. Data are compiled from "American Birds." FREQ=percentage of CBC's with a taxon present.

		Years	FREQ (%)	Number..... Mean	Range
Bald Eagle	1973-1979	7	86	3.1	0-6
	1980-1986	7	86	2.9	0-4
Peregrine Falcon	1973-1979	7	86	2.1	0-4
	1980-1986	7	100	2.6	1-4

Table 3.8. U.S. Fish and Wildlife Service (USFWS) aerial waterfowl censuses at Nehalem, Tillamook, or Netarts Bays in April. No censuses are available for May or June. See Bayer and Lowe (1988:2) for methods. Unpublished censuses kindly provided by Roy Lowe, USFWS Biologist. Taxa are listed alphabetically.

Nehalem Bay	April						
Year	1979	1982	1983	1985	1986		Max-
Day	4-19	4-19	4-7	4-5	4-3	**Mean**	imum
Brant	45	0	0	0	0	**9**	45
Bufflehead	150	112	188	53	210	**143**	210
Coot, American	200	50	0	0	5	**51**	200
Duck, Ruddy	30	0	0	0	0	**6**	30
Gadwall	0	0	0	0	2	**1**	2
goldeneye spp.	0	1	0	0	8	**2**	8
Goose, Canada	0	0	5	0	0	**1**	5
Mallard	0	2	4	65	26	**19**	65
merganser spp.	70	63	70	95	23	**64**	95
scaup spp.	0	45	45	0	20	**22**	45
scoter spp.	0	42	17	38	10	**21**	42
Shoveler, Northern	0	65	10	75	10	**32**	75
Teal, Green-winged	0	0	0	35	14	**10**	35
wigeon spp.	0	10	209	170	208	**119**	209
TOTAL	495	390	548	531	536	**500**	-

Tillamook Bay	April						
Year	1979	1982	1983	1985	1986		Max-
Day	4-19	4-19	4-7	4-5	4-3	**Mean**	imum
Brant	0	181	245	50	230	**141**	245
Bufflehead	40	142	113	20	280	**119**	280
Coot, American	150	0	0	0	5	**31**	150
Duck, Ring-necked	45	0	0	0	12	**11**	45
Gadwall	0	0	0	0	150	**30**	150
goldeneye spp.	0	20	0	0	4	**5**	20
Goose, Canada	0	0	6	1	5	**2**	6
Mallard	20	78	1	69	132	**60**	132
merganser spp.	50	37	56	178	31	**70**	178
Pintail, Northern	0	3	0	0	25	**6**	25
scaup spp.	145	32	145	5	217	**109**	217
scoter spp.	405	185	93	33	172	**178**	405
Shoveler, Northern	0	0	0	0	20	**4**	20
wigeon spp.	135	137	439	829	2772	**862**	2772
TOTAL	990	815	1098	1185	4055	**1629**	-

Netarts Bay	April						
Year	1979	1982	1983	1985	1986		Max-
Day	4-19	4-19	4-7	4-5	4-3	**Mean**	imum
Brant	1940	200	191	0	670	**600**	1940
Bufflehead	470	158	185	34	453	**260**	470
Duck, Ruddy	160	0	0	0	0	**32**	160
Duck, Wood	0	0	5	0	0	**1**	5
goldeneye spp.	0	2	0	0	8	**2**	8
Goose, Canada	0	0	0	0	4	**1**	4
Mallard	85	0	0	0	4	**18**	85
merganser spp.	135	2	29	244	69	**96**	244
Pintail, Northern	65	0	0	0	0	**13**	65
scaup spp.	95	60	25	0	200	**76**	200
scoter spp.	0	3	149	161	429	**148**	429
wigeon spp.	225	0	59	10	0	**59**	225
TOTAL	3175	425	643	449	1837	**1306**	-

3-I. Argument Against Cormorant Harassment: Aesthetic and Social Costs

3-I-1. Introduction

The fifth criterion to justify animal damage control is that the economic impact of a predator exceeds the aesthetic and social costs of conducting the program (Table 3.1). Cormorant harassment presents several aesthetic and social costs.

3-I-2. Aesthetic Cost of Cormorant Harassment

It simply would not be aesthetically pleasing for harassers to shoot noise-making shells with 12 gauge shotguns or other firearms at cormorants in coastal streams or estuaries.

The shooting of firearms and the explosion of noise-making shells used in harassing cormorants could also disturb local residents. For example, the use of such noise-making devices was objectionable to homeowners at a reservoir in California where gulls were being harassed (Amling 1980). If cormorant harassment is allowed, the tourist industry may also be hurt (see section 3-G-3).

Oregon estuaries are used by a wide variety of people for recreational uses such as clamming, fishing, crabbing, boating, and bird watching. The pleasure of their recreational experience would be disturbed by the shooting of firearms in the non-hunting season. After hearing such shooting, some people could also justifiably worry about the safety of their families and themselves because they may wonder if real ammunition is being used.

Since coastal streams and estuaries are public property, everyone should be able to enjoy them without worrying about their safety or being disturbed by the shooting of harassers.

3-I-3. Social Cost of Cormorant Harassment: Not Listening to All Constituencies

Attitudes towards wildlife have undergone great change in recent times and will continue to change as wildlife nonconsumptive use (i.e., viewing wildlife without killing it) continues to expand. Now the number of Oregonians who enjoy watching wildlife is greater than the total number of fishermen (Aney and Cowan 1975). The ODFW has recognized this change in their constituencies and anticipates that by the year 2000 that wildlife viewing will be as important as consumptive uses (Anonymous 1987d).

Since salmon and steelhead smolts after release are a public resource that occurs in public waters, the wishes of all the public of Oregon should be taken into consideration when debating the advisability of cormorant harassment.

3-I-4. Social Cost of Cormorant Harassment: Adoption of an Inconsistent Predator Policy Because Salmonids and Other Game Fish are Also Predators Causing Economic Damage

Harassing cormorants because they sometimes eat hatchery smolts is inconsistent because game fish such as salmon, steelhead, and cutthroat trout also eat smolts (section 3-E), but they are not controlled. For example, striped bass have been found to eat nearly twice as many salmon and trout on the average than cormorants (section 3-E), and striped bass also eat steelhead smolts (Monroe 1989). Yet, striped bass are managed as a sport fishery (Monroe 1989), not as a "predator."

A decision to allow cormorant harassment because they are a "predator" is also inconsistent and arbitary because salmon themselves are significant predators of Dungeness crabs and commercially important fish (Table 3.9 at end of this section).

In fact, there is evidence that the California Dungeness crab fishery has been hurt by Oregon hatchery releases of coho (Reilly 1983, Thomas 1985). This is plausible because one adult coho caught off Oregon had eaten 809 Dungeness crab larvae, and 97% of coho collected in June off Oregon had eaten these crab larvae (Anonymous 1949). Further, Heg and Hyning (1951) found that coho off Oregon ate Dungeness crab larvae from June through September, with larvae forming an average of 24% of the September coho diet. Consumption of Dungeness crab larvae is not limited to adult coho because these larvae are also eaten by juvenile coho and chinook (Peterson et al. 1982) and adult chinook (Table 3.9).

If an analysis similar to Erickson (1988b) is calculated for the cost of coho salmon predation of crabs, the cost is great. For example, if each of the 0.99 million adult coho caught in Oregon in 1981 (Table 3.5) ate 809 Dungeness crab larvae for just 10 days in 1981, coho would have eaten 8.0 billion Dungeness crab larvae. If just 0.1% of those survived and were sold for $1.83 each (i.e., the 1986 price on landing for Oregon commercial crabbers averaged $1.41/lb [Lukas and Carter 1988]; and each crab weighed an average of about 1.3 lbs according to retail store advertisements in 1988), **the value of Dungeness crabs eaten by adult coho in 1981 alone could have been about 15 million dollars!**

Of course, this analysis has the same problems as Erickson's (1988b) figures and assumptions (see section 2-F), but it does demonstrate that coho predation has the potential for being costly. Therefore, if cormorants are to be harassed because they are a "predator," why not initiate predator control programs for salmon, steelhead, cutthroat trout, and striped bass because they are also significant predators (section 3-E)? Elsewhere, the significance of coho predation has been recognized, and, in one lake in British Columbia, coho salmon were killed because of their heavy predation on other salmon (Foerster and Ricker 1941).

Table 3.9. Chinook and coho salmon predation on some important fish or invertebrates caught in other Oregon fisheries.

Predator	Commercially Valuable Prey	Reference(s)
chinook	Dungeness crab	Heg and Hyning (1951), Reilly (1983), Brodeur et al. (1987a)
	flatfishes	Brodeur et al. (1987a)
	Pacific herring	Heg and Hyning (1951), Fresh et al. (1981), Brodeur et al. (1987a)
	lingcod	Merkel (1957)
	rockfish spp.	Heg and Hyning (1951), Fresh et al. (1981), Brodeur et al. (1987a)
	salmon	Table 3.2
	squid	Brodeur et al. (1987a)
coho	Dungeness crab	Anonymous (1949), Heg and Hyning (1951), Reilly (1983), Brodeur et al. (1987a, b), Thomas (1985)
	Pacific herring	Heg and Hyning (1951), Reimers (1964), Brodeur et al. (1987a, b)
	flatfishes	Heg and Hyning (1951), Brodeur et al. (1987a)
	rockfish spp.	Heg and Hyning (1951), Reimers (1964), Brodeur et al. (1987a)
	salmon	Table 3.2
	squid	Morejohn et al. (1978)

3-I-5. Social Cost of Cormorant Harassment: Encouragement of Illegal Shooting or Harassment of other Nongame Wildlife

Permitting harassment would give a signal to some people that if cormorants are considered a predator significant enough to be legally harassed, they "deserve" to be also illegally harassed or shot. As it is, many cormorants may already be shot because some Oregon fishermen may believe, as do fishermen in Maine, that illegal shooting of cormorants is a fishermen's prerogative (Maine Cormorant Study Committee 1982:7). Such illegal shooting does occur in Tillamook County because Jo Walin (pers. comm) in mid-April 1989 found a dead cormorant on a beach just north of Nehalem Bay that had been shot.

Some people could also use the legalization of cormorant harassment to justify illegally harassing or killing other fish-eating birds or raptors because they are also "predators." This would be unfortunate because illegal shooting of nongame wildlife is already a significant problem in Oregon (Eltzroth 1986, Eltzroth letter dated 17 October 1988). In fact, the "protection" supposedly given to many nongame animals in Oregon as well as nationwide is inadequate because animals such as Great Blue Herons (Bayer 1981), eagles, hawks, and owls (Eltzroth 1986, Eltzroth letter dated 17 October 1988; Soucy 1988); and seals and sea lions (Stroud and Roffe 1979) either are often illegally shot or survive much better at National Wildlife Refuges where they are better protected.

3-J. Conclusion: Cormorant Harassment Currently Does Not Satisfy the Criteria for an Animal Damage Control Program

Criteria that should be met to justify an animal damage control program are given in Table 3.1. Although proponents argue that harassment is justified, there is no substantial evidence that the need for cormorant harassment currently satisfies any of the criteria for animal damage control at Tillamook Bay during spring smolt releases, let alone for all Oregon coastal streams throughout the year as requested in the original House Bill 3185 (section 1-I-1) or in the proposal to the Oregon Fish and Wildlife Commission (section 1-J).

Chap. 4. Alternatives to Cormorant Harassment to Reduce Smolt Losses

4-A. Introduction

Animal damage control is necessary if there are no alternatives to control (Table 3.1). For example, when Double-crested Cormorants appeared to be a problem with trout releases at Crane Prairie Reservoir in Deschutes County, Oregon, the ODFW chose not to control cormorants but to reduce the problem by doing releases at night and by releasing trout all around the Reservoir, not at just one site (Anderson and Gates 1983, Fies 1984, Shotwell 1984, 1989).

There are a number of alternatives to cormorant harassment that could reduce predation by all smolt predators, not just cormorants, along the Oregon Coast. These alternatives may reduce predation by decreasing the detectability of smolts, increasing the wariness of smolts, or improving the ability of smolts to escape or avoid predators. These alternatives are examined throughout the rest of this Chapter.

4-B. Alternatives to Reduce Predation That Are Currently Promising

4-B-1. Holding Smolts in Net Pens after Release to Allow Smolts to Adapt

Smolts are stressed during a release by being forced down a tube or out of a pond. Such stress (Sylvester 1972, Coutant 1973, Macdonald et al. 1988, Sigismondi and Weber 1988, Olla and Davis 1989) can increase their Stage I mortality (Appendix II) by making them more vulnerable to predation shortly after a release. Unpublished research indicates that smolts can behaviorally recover from the actual stress of release within about three hours (Michael Davis, Hatfield Marine Science Center, Newport; unpubl. data).

Besides the actual stress of release, another short-term stress suffered by some smolts is adapting to salt water. Smolts reared at ODFW hatcheries have lived only in freshwater, so when they reach estuaries they may take about 100 hours to acclimate (Harry Wagner, ODFW, oral testimony at 20 April 1989 Oregon House Agriculture, Forestry and Natural Resources Work Session on House Bill 3185). During this time, ODFW smolts act "sick" and have an impaired ability to avoid predators (Wagner, ibid.). In contrast, private aquaculture facilities in Oregon hold their smolts for a week or more in estuarine water; these smolts have thus had a chance to adjust to variable salinities before they are released.

If smolts are kept in predator-proof net pens until they have recovered from the stress of release or the stress of adapting to salt water, smolts may have a much better chance to evade predators. For ODFW releases, this may require trucking smolts from a freshwater hatchery to net pens in estuaries where smolts may be held for about 100 hours. For private aquaculture facilities, holding smolts in net pens may only be useful for about three hours.

The logistics of trucking and holding smolts in net pens from which smolts can be easily released have yet to be worked out. There will undoubtedly be some smolt mortality associated with these procedures, but this mortality may be offset by lower predation of smolts. The increased handling mortality may also be reduced as techniques are more fully developed.

4-B-2. Barging Smolts Offshore

If most predation occurs in or at the mouth of estuaries, then barging smolts offshore might help reduce predation and increase smolt survival.

OREGON BARGING RESULTS.--So far, barging off the Oregon Coast has had mixed results with barged coho smolts often having lower adult returns than nonbarged coho (Table 4.1 at end of this section, Gowan 1988, Pearcy 1988, McNeil et al. in press). These results may be because the techniques of barging off Oregon have not yet been perfected (Gowan 1988, McNeil et al. in press) or because there are more smolt predators in the Pacific Ocean than in estuaries (e.g., Macdonald et al. 1988).

The relative failure of barging smolts off Oregon may not be because of technique. ODFW barging studies have been with coho smolts transported in tanks with recirculating seawater on a boat (Anonymous 1984b, Steve L. Johnson, ODFW Biologist, pers. comm.). In Norway, Gunnerod et al. (1988) similarly transported Atlantic salmon smolts in tanks, but the Norwegian barging results showed barging to be helpful, while returns for ODFW barged coho were poorer than for nonbarged fish (Table 4.1).

Perhaps this geographic difference is because there are many more predators offshore of Oregon than offshore of Norway, so that any benefits of Oregon barging is negated. Since barging does not improve a smolt's wariness of predators nor increase it's ability to escape a predator, barged smolts would still be very vulnerable to marine predators. Further, after barging, smolts may move inshore where they may be vulnerable to the same predators as they would have been without barging.

One factor that may have been overlooked in the inconsistent success of Oregon private aquaculture barging studies (Gowan 1988, Pearcy 1988, McNeil et al. in press) is the inclusion of many small fish that are not truly smolted (i.e., the process whereby a young salmon or steelhead becomes physiologically able to live in salt water). While many undersized or nonsmolted fish released by private aquaculture into estuaries can remain in estuaries or go upstream into freshwater (i.e., "wrong-way smolts," Jonasson 1983, Nicholas and Herring 1983) until they are ready for life in salt water, these fish would have no place to find freshwater if they are barged offshore.

Since 20-40% of some private aquaculture smolts that have been released into estuaries were below the critical size for survival (Parker and Stohr 1983) and size as well as "smoltification" is important in determining smolt survival (Folmar and Dickhoff 1980, 1981; Bilton et al. 1982, S. L. Johnson 1982, Mahnken et al. 1982, 1984; Gowan and McNeil 1984, Zaugg et al. 1985, Gowan 1988, Ward and Slaney 1988), these undersized fish may need to be culled, if barging is to be of any consistent benefit.

UPWELLING.--Barging has been hypothesized to improve smolt survival most in years with poor upwelling (Pearcy 1988). Pearcy (1988) based his hypothesis on data that only 40% of barged coho groups by an Oregon private salmon company had much better returns than nonbarged fish in two years of poor upwelling off the Oregon Coast.

Unfortunately, the data used by Pearcy (1988) were for barging studies whose techniques differed among years (McNeil et al. in press). Thus, it is not clear if barging technique or poor upwelling was responsible for the better returns. McNeil et al. (in press) present follow-up barging data to that presented by Pearcy (1988) but do not indicate what effect, if any, the amount of upwelling had on barging success.

Contra Pearcy's (1988) hypothesis, the results of ODFW barging studies, which used the same methods each year, indicates that the strength of upwelling may have little effect on the returns of barged fish (Table 4.1). In the two years of the ODFW's study with weak upwelling, the return of the best barged group of smolts was only 71-81% of the return for nonbarged fish released within the Columbia River; in the year with moderate upwelling, the return for the best barged group was, similarly, 74% of the nonbarged group (calculated from Table 4.1).

STRAYING.--Besides not always improving adult returns and the increased cost, another problem with barging is that straying by adult salmon (i.e., adults that do not return to their natal release site or hatchery) increases with barging (Johnson et al. 1985, Solazzi and Johnson 1986, Solazzi et al. 1987b, Gunnerod et al. 1988, Jacobs 1988, McNeil et al. in press). For example, the 1985 barging of smolts offshore of Newport by a private aquaculture company approximately doubled the amount of coho straying (Jacobs 1988:22). As a result of straying, more hatchery adult fish could interbreed with wild fish, which can hurt wild fish stocks (Appendix VIII).

Table 4.1. Contribution to ocean and Columbia River fisheries by ODFW barged coho salmon smolts. Coho smolts were released in the Columbia River Estuary at Tongue Point, in the Pacific Ocean 10 mi (16 km) offshore in the Columbia River plume, 10-12 mi (16-19 km) offshore and 12-15 mi (19-24 km) north of the Columbia River plume, and 24 mi (39 km) offshore (beyond the Columbia River plume). Offshore releases were made from closed system tanks on a boat (Anonymous 1984b). 1983 release data are from Johnson et al. (1985), 1984 data are from Solazzi and Johnson (1986), and 1985 data are from Solazzi et al. (1987a). The strength of upwelling is from Pearcy (1988:70).

				Percentage of Release Caught by Fisheries for Smolts Released at.................			
				Columbia	Offshore in Pacific Ocean...		
Year of Re-lease	Dates of Re-lease	Smolt Size at Re-lease (g)	Strength of Upwelling	River at Tongue Point (%)	10 mi W & in plume (%)	10-12 mi W & 12-15 mi N of plume (%)	24 mi W & past plume (%)
1983	June 2-9	33-34*	weak	0.35	0.23	0.25	0.19
1984	May 25-31	36-38	weak	1.54	1.24	0.72	0.56
1985	May 24-31	32-33	moderate	10.57	5.47	7.85	4.36

*At Tongue Point in 1983, the average size at release was only 24 g.

4-B-3. Culling Smolts that Are too Small or Not Truly "Smolted"

It appears that hatcheries often release fish when an **average** length or weight criterion is reached. Fish smaller than average, if they are below the critical size for survival (see Mahnken et al. 1982, Parker and Stohr 1983), may not survive because they are not yet ready for salt water.

This problem does **not** appear to apply to recent ODFW smolts; for example, calculations of length frequencies of samples of 200 or more coho smolts released at Trask Hatchery or Trask Pond on 8 April, 15 April, or 1 May 1988 indicated that 33%, 1%, and 0% of the smolts, respectively, were below Mahnken et al.'s (1982) critical size for survival of about 13.5 cm on 26 April 1978 (T. E. Cummings, ODFW Fish Propagation, letter dated 3 March 1989). The 33% estimated for the 8 April 1989 release is probably an overestimate because the critical size decreases earlier in the season (Mahnken et al. 1982, Parker and Stohr 1983), and Mahnken et al. (1982) did not give a critical size for earlier than April 26.

Further, the average size of coho smolts released in 1981 at the ODFW's Big Creek Hatchery near the Columbia River was not significantly different from the average for returning adults (Mathews and Ishida 1989), so most smolts that were released were large enough to survive.

In contrast to the relatively large ODFW smolts, 20-40% of smolts in some releases by the Newport private aquaculture facility were estimated to be less than the critical size for survival (Parker and Stohr 1983). Wilson (1986), according to Mathews and Ishida (1989:1225), also found survival of smolts from this facility to be size dependent. Estimated sizes of smolts at release for coho adults returning to this private facility are also given in Nicholas et al. (1982:18).

At a Coos Bay private facility, the average size of smolts at release in 1982 was also significantly less than the average for returning adults (Mathews and Ishida 1989). Thus, many smolts released from this facility were also too small for maximal survival.

If there are many fish below the critical size for survival, overall smolt survival may be improved by culling out small fish. Culling may help because fish that are too small are less healthy, are less adaptable to salt water, and probably are less able to evade predators. Accordingly, undersized fish may be more likely to attract predators than larger smolts; once attracted, the predators may then also feed on larger smolts. Thus, sorting and culling out fish below the critical size for survival may reduce predation of larger smolts (see Washington 1982).

Additional research is required, however, to determine if culling would actually improve overall smolt survival rates because the stress induced with sorting and culling could cause some mortality among the larger smolts.

4-B-4. Changing Feed or Feeding Methods of Hatchery Fish

Presently, hatchery smolts are fed by sprinkling pellets on the water surface. This teaches smolts to eat pellet-like objects on the water surface that are unlike food items in the wild. Since some smolts have a difficult time adjusting to natural food (section C-2 in Appendix II), changes in hatchery practices may help fish forage better after release. If smolts can be taught to forage better and spend less time at the surface looking for pellets, they would also be less vulnerable to predators (Appendix II).

One technique that may help hatchery fish adjust would be to feed them live or dead food items that they would normally eat after release. Even if this was only done for the last day or so that fish were held in a hatchery, it may help them get used to the smell and shape of natural food.

A second way to improve the post-release feeding ability of hatchery smolts would be to develop a way of distributing food pellets underwater rather than broadcasting pellets on the water surface. Since smolts have been entrained to expect food on the surface, they jump at inappropriate objects like styrofoam and pine needles and in so doing they are more easily detected by predators (see section C-2 in Appendix II). Unfortunately, distributing food underwater may not be practical.

There has been much work done on improving the dietary quality of salmon smolt diet pellets (e.g., Gowan and McNeil 1984). Nevertheless, diets appear to have been mainly developed to improve survival and growth of fish in hatcheries. More research about diets is needed to determine if diets can be improved to enhance smolt survival after they are released.

4-B-5. Providing Cover for Smolts in Estuaries

Oregon estuaries and coastal streams formerly had lots of woody debris that provided cover to migrating smolts (Benner and Sedell in press). This cover could be important in protecting smolts from predators, especially while smolts are adjusting to their new environment (e.g., Maser et al. 1988, McMahon and Holtby 1989, McMahon and Hartman in press).

Since marina docks are currently about the only cover for smolts left in Oregon estuaries, the attraction of smolts to docks (section 4-B-8) may indicate a normal response by smolts to use the only available cover.

The problem with trying to increase the amount of cover in Oregon estuaries to possibly enhance smolt survival is that such cover would impede boat navigation. Debris that could be used by smolts would have to be available during all tide stages, so it must be located in subtidal channels of estuaries, which are also heavily used by commercial shipping, commercial fishermen, and recreational boaters. Such debris would probably be considered an impediment to navigation that would be removed by the U.S. Army Corps of Engineers or the U.S. Coast Guard.

4-B-6. Teaching Smolts to Avoid Predators

If hatchery fish could be taught to be wary of predators before they are released, their losses to predatory fish and birds may be much reduced. Subsequently, many more could survive to adulthood and contribute to the fisheries.

TEACHING SMOLTS WITH LIVE PREDATORS.--It may be possible to train juvenile salmonids at hatcheries to be wary of predators with live predators. For example, juvenile hatchery coho that survived exposure to a lingcod in a tank were less vulnerable to lingcod predation than fish that were not exposed (Olla and Davis 1988, 1989). Further evidence of the importance of exposure to live predators is that juvenile salmonids that had been previously exposed to predators survived better than naive ones (Ginetz and Larkin 1976, Patten 1977, Wood and Hand 1985, Suboski and Templeton 1989).

One way to train fish about predators would be to have a fish predator in a plexiglass tank separated from juvenile salmonids. Then the salmonids could see a predatory fish attacking them, but not be eaten (Olla and Davis 1988). This technique, however, may not be practical at a hatchery because it would be difficult to have a plexiglass tank containing predators within a production hatchery pond. Further, this technique may not help teach fish about bird predators, although if hatchery fish learn to become wary of one predator, they may also become more wary of all predators, including birds.

A second method of training juvenile salmonids would be to introduce a live predatory fish or bird into each hatchery pond shortly before the fish are released. The loss of a few fish to a single predator that could not eat many of the thousands of fish in a pond could be offset by making the surviving fish less vulnerable to predators after release. A problem with this method is that an introduced predatory fish would be difficult to retrieve until the time of release; a predatory bird, however, might be more retrievable because it could be tethered like cormorants used by fishermen in the Orient.

The major problem with both these methods is that they need to be actually used and developed in hatchery production ponds to see if they are practical and if they will indeed improve smolt survival (e.g., see Quinn 1988).

TEACHING SMOLTS WITH MODELS.--Models of fish predators, some electrified, have been used to improve the ability of salmon fry to avoid fish predation (Thompson 1966, Kanayama 1968). As fish get older or larger, though, models do not appear to be effective in teaching fish to avoid predators (Kanayama 1968, Fraser 1974). For example, Fraser (1974) observed young brook trout simply avoid an electrified model of a Common Loon by just moving aside; obviously, the young trout did not associate the model with being eaten, and after release, the survival of trained trout was no better than for untrained trout (Fraser 1974).

4-B-7. Releasing Smolts at the Optimal Time of Day to Avoid Predators

There may be an optimal time of day to release hatchery fish to reduce predation immediately after they are released (Fresh et al. 1982, Mace 1983, Gowan 1988). For example, at the private aquaculture site in Yaquina Estuary, smolts used to be only released at night because day-time releases of stressed and disoriented smolts almost immediately attracted a host of bird predators (Bayer, pers. obs.). In 1989, however, smolts at this site were sometimes released during daylight (Anonymous 1989c), perhaps because it is then logistically easier to release smolts.

At a private aquaculture facility in Coos Bay, it has been documented that adult returns for smolts released during daylight were greater than for those released at night (Gowan 1988). The reason for this is not clear and should be explored to determine the optimal time of day for releases.

Optimizing the time of day for release may not be as important in reducing predation of ODFW smolts. In contrast to private aquaculture smolts that spend their last week or so in salt water before release, ODFW fish are reared only in freshwater. Accordingly, when ODFW smolts are released, it may take them about 100 hours to adapt to salt water; during this time they are "sick" and vulnerable to predators (Harry Wagner, ODFW, oral testimony at 20 April 1989 Oregon House Agriculture, Forestry and Natural Resources Work Session on House Bill 3185). Nevertheless, if ODFW smolts are released at a time of day when they aren't exposed to predators for several hours, their overall survival may still be improved if they have a chance of at least recovering from the initial shock of release (section 4-B-1).

4-B-8. Changing the Configuration of Marina Lights

At the 28 November 1988 ODFW meeting in Portland to discuss the cormorant issue (section 1-G), it was mentioned that lights at a marina in lower Nehalem Bay attracted smolts at night. It was suggested that this attraction could make smolts more vulnerable to predation, but this is unproven. In fact, the docks may actually provide the only available cover to smolts to help them avoid predators (see 4-B-5), so the presence of smolts under docks may improve rather than decrease smolt survival.

If research indicates that marina lights make smolts more vulnerable to predation, then, as suggested at the meeting by Sara Vickerman (Defenders of Wildlife representative), an obvious solution would be to do something about the marina's lights. For example, the lights (especially those that are unnecessary) could be turned off, or light receptacles could be changed so that light does not shine down into the water and attract fish.

4-B-9. Reducing Catches of Smolts by Fishermen

As pointed out in section 3-E, fishermen are also smolt predators, although catching and keeping smolts by Oregon sports fishermen is illegal. Even if smolts are released after being caught, many probably die. Thus, smolt predation may also be enhanced by better educating fishermen about not catching hatchery smolts and by also better enforcing fishing laws to protect hatchery smolts.

4-B-10. Selecting an Optimal Date of Release

The date of release can affect smolt survival or the number of fish caught by fishermen (Bilton et al. 1982, Parker and Stohr 1983, Martin and Wertheimer 1987, Gowan 1988, Irvine and Ward 1989, Mathews and Ishida 1989). However, it may not be practical to hold smolts until the optimal release time. Further, it may be difficult to predict the optimal time because it can change yearly or because it may only be determinable long after it has passed.

4-C. Alternatives to Reduce Predation That Are Not Currently Promising

4-C-1. Introduction

The following methods have been tried but do not appear to improve smolt survival. They are listed here because it is important to know what has been tried and failed so that the same mistakes are not repeated. It is possible, however, that even some of these methods may be improved and could help reduce smolt predation.

4-C-2. Releasing More Smolts

Just releasing more hatchery smolts in an attempt to increase the numbers of returning adults has been tried and failed. For example, through most of the late 1970's and early 1980's, the number of coho smolts released was increasing, but the number of returning adult coho remained about the same or even decreased (e.g., Pearcy 1988).

One reason why increasing the number of coho smolts released has not increased the number of adults is that smolt survival may be density-dependent (i.e., smolt survival decreases as smolt density increases). However, the density-dependence of coho is controversial (McCarl and Rettig 1983, McGie 1984, Nickelson 1986, Pearcy 1988, Peterman 1989). The mechanisms for density-dependence could be predation of adults on young as suggested by Nickelson (1986)(also see section 3-E) or competition among juveniles for food (see section C in Appendix II).

Finally, a speculative reason why increased smolt releases has not helped is that the carrying capacity of the ocean for hatchery fish may have been reached. Since hatchery fish are less genetically diverse than wild fish (Appendix VIII), the ocean carrying capacity for hatchery fish may be less than for wild fish (Parmenter and Bailey 1985). In the past, the diversity of life styles of wild fish may have allowed many more to co-exist than is possible with today's less diverse hatchery fish.

4-C-3. Exercising Smolts

Hatchery smolts receive little exercise while in hatchery ponds, so after they are released they may not be able to easily avoid predators or to swim efficiently (Besner 1980, Besner and Smith 1983, Smith et al. 1983, 1985; Shchurov et al. 1986). So far, exercising juvenile salmonids at hatcheries has not been demonstrated to increase their survival after release (Evenson and Ewing 1984). This failure may be because exercise has no effect on smolt survival, because the techniques of exercising fish have not been developed sufficiently to get improved results, or because hatchery fish are genetically inferior to wild fish in swimming skills (Smith et al. 1985).

4-C-4. Providing Predators with Buffer Prey Populations

If alternate prey are provided predators when smolts are released, then predators may eat the alternate prey and leave the smolts alone (e.g., Lagler 1939, Salyer and Lagler 1940, White 1957, Barlow and Bock 1984, Draulans 1987). If this happens, the alternate prey would have "buffered" the smolts from predation.

In effect, such buffering may already have occurred inadvertently because 20-40% of smolts released by the Newport private aquaculture facility have sometimes been too small to survive (Parker and Stohr 1983). The small smolts may have buffered the predation of larger smolts because undersized smolts have lower survival, perhaps because they are more vulnerable to predators (Bilton et al. 1982, S. L. Johnson 1982, Mahnken et al. 1982, Gowan and McNeil 1984, Gowan 1988, Ward and Slaney 1988). Since current predation is considered a problem, providing buffer prey may not be useful in reducing predation of viable smolts.

4-C-5. Releasing Smolts after Predators Have Migrated

One problem with waiting to release smolts until after predators have left is that hatcheries are limited in how long they can hold fish, and it is also expensive to hold smolts.

In British Columbia, fish were released after migratory birds that fed on juvenile salmonids had left (Mace 1983). In Oregon, this would not work because murres, cormorants, and gulls (i.e., the major bird predators) do not depart the Oregon Coast in April-June, which is when cormorant harassment has been proposed.

Since the Japanese release some of their salmon after fish predators have migrated away (Bilton et al. 1982), this may also work in Oregon. But first, there needs to be more research in Oregon about fish predators of salmon and steelhead smolts (e.g., see Appendix VII) to see if it is possible to time releases to avoid them.

4-C-6. Volitional Releases of Smolts

One way of reducing stress to smolts during a release would be to let fish leave ponds when they feel like it (i.e., a volitional release, Washington 1982), instead of forcing them out. If smolts were less stressed, they may be better able to avoid predators (section B in Appendix II). Another advantage of volitional releases is that perhaps only fish physiologically ready for release would leave. So far, however, research indicates that smolt survival has not been improved with volitional releases (Mace 1983, Evenson and Ewing 1984, Gowan and McNeil 1984, Ewing and Evenson 1986, Gowan 1988).

4-C-7. Decreasing Pond Densities

Densities of smolts in hatchery ponds are much higher than they would be in the wild, which could affect their behavior and physiology (e.g., Schreck et al. 1985, Patino et al. 1986). Accordingly, it has been suggested that decreasing pond densities may increase smolt survival after release. Returns of adults from ponds with reduced densities, however, have not been consistently greater than from ponds with high densities (e.g., Washington 1982, Fagerlund et al. 1983, Gowan and McNeil 1984).

Chap. 5. If Done, Cormorant Harassment Should Have Guidelines

5-A. Introduction

Although cormorant harassment in Tillamook County does **not** appear to be economically, biologically, aesthetically, or socially justifiable; it may prove to be politically expedient. If cormorant harassment is allowed, the guidelines in Table 5.1 should be considered in regulating harassment. These guidelines are explained in the following sections.

Table 5.1. Guidelines for cormorant harassment in Oregon estuaries. These guidelines are based on Leopold et al. (1964), Berryman (1972), Cain et al. (1972), Hawthorne (1980), Knight and Knight (1984), Stalmaster (1987), and McGarigal (1989).

Guidelines for Cormorant Harassment

1) Harassment should be done only by government biologists or personnel.
2) Harassment should be strictly limited to times when and sites where smolts are vulnerable to predation.
3) Harassment should not disturb foraging or resting game birds or threatened, endangered, or sensitive wildlife. This may require harassment to be at least 0.3 mile (0.5 km) away from areas where nontarget animals are known to forage or rest.
4) Harassment should not disturb nesting birds. This may require harassment to be at least 0.5 mile (0.8 km) from nesting birds.

5-B. If Done, Cormorant Harassment Should be Done by Professionals

As discussed in section 3-D, if cormorant control is deemed necessary, it is clear that it should be done by governmental biologists or animal damage control personnel, not by private citizens. One reason for the involvement of only professionals is that cormorant harassment would occur on public lands and waters and involves a public resource. A second reason is that threatened, endangered, and sensitive species as well as game birds could be harmed by cormorant harassment (section 3-H). Berryman (1972), Hawthorne (1980:412), and SERC (1980) indicate that only professionals should do animal damage control under these circumstances.

The major concern about private citizens killing or harassing predators on public property is that they may intentionally or inadvertently harm nontarget wildlife. Private citizens, especially those using exaggerated data and inflammatory rhetoric to justify harassment (e.g., section 2-F), are not going to be trusted by everyone to protect nontarget wildlife.

STEP (Salmon and Trout Enhancement Program) volunteers should also not be harassers because predator control is not within the scope of STEP (ODFW 1985b). Further, predator control should not be included as a STEP project because STEP volunteers are not closely enough supervised to be sure they don't exceed their authority (section 1-E). Since STEP volunteers include some individuals who appear unduly biased towards anything that they feel is a "predator," STEP volunteers would also not be trusted by the general public to protect nontarget animals if they conducted cormorant harassment.

If the political situation dictates that private citizens do harassment, private harassers must have a permit to do so. Permittees should not have any ODFW, USFWS, or NMFS (National Marine Fisheries Service) game or nongame violations because violators could be suspected of further violations. Further, private harassers should be carefully monitored by ODFW personnel to be sure that they don't exceed their authority and that nontarget wildlife are not harmed. Such monitoring should be random and unannounced with private harassers losing their permit if they disturb nontarget wildlife. Violators should also face prosecution for violations of state or federal laws. Further, the USFWS should be notified of any harassment of threatened or endangered species, and NMFS should be informed of any harassment of marine mammals.

5-C. If Done, Cormorant Harassment Should be Limited to Specific Times and Sites

Animal control should be limited to times when and places where damage can occur (Leopold et al. 1964, Cain et al. 1972, Hawthorne 1980). Thus, cormorant harassment should occur only when and where smolts are being caught by cormorants because harassment is costly and also annoys some people. Further, the chances of harming nontarget wildlife increases as the amount of harassment expands.

Cormorant harassment may be limited to the period of time when they are catching most smolts, which may be within two weeks after a release because smolts are then most vulnerable and naive (Appendix II). For example, Bayer (1986) found that numbers of fish-eating birds during the 1983 El Nino were greatest in the first three days after a hatchery release of smolts at Yaquina Estuary.

5-D. If There is Cormorant Harassment, There Should be Buffer Zones to Protect Nontarget Animals

5-D-1. Introduction

Unfortunately, there has not been any research to determine how to avoid disturbing nontarget birds during harassment. Guidelines #3 and #4 in Table 5.1 give estimated distances within which harassment of cormorants should not be permitted. Since birds are more sensitive to gunshots (e.g., cracker shells shot with a shotgun) than some other forms of human disturbance, these distances may need to be extended to adequately protect nontarget animals.

5-D-2. Buffer Zones around Foraging or Resting Areas

To minimize the impact of cormorant harassment on threatened, endangered, or sensitive animals or game birds, cormorant harassment should not take place within at least 0.3 mile (0.5 km) of where these animals feed or rest.

This is important because nontarget animals may avoid areas of cormorant harassment and subsequently increase their energetic demands by flying or decrease their feeding efficiency by being driven from prime feeding areas to feed in marginal areas (section 3-H). Since cormorant harassment is proposed in April-June during the time of migration and nesting, unrestricted cormorant harassment could result in decreased nesting success for nontarget animals.

The size of the buffer zone for foraging or resting birds is based on the research of Knight and Knight (1984) in Washington, and McGarigal (1989:106) along the lower Columbia River in Oregon. To protect Bald Eagles at feeding areas, they recommended that boaters should be kept at least 0.25-0.28 mile (0.41-0.45 km) away from where eagles forage. Since Stalmaster and Newman (1978) found that Bald Eagles in Washington are easily disturbed by gunshots (which would be equivalent to the shooting of cracker shells by cormorant harassers), a restriction zone of 0.3 mile (0.5 km) may **not** be adequate to protect Bald Eagles or Brant (Henry 1980) that are also sensitive to gunshots.

5-D-3. Buffer Zones around Nesting Areas

Nontarget nesting birds should also be protected from cormorant harassment. Nesting species that could be adversely affected in Oregon estuaries include Bald Eagles, Mallards, Canada Geese (Bayer and Lowe 1988), and Great Blue Herons; all would be nesting throughout the April-June period suggested for cormorant harassment. The size of buffer zones to protect nesting birds has been most studied for Bald Eagles, but not allowing harassment within 0.5 mile (0.8 km) of nests may be adequate to protect other nesting species, too.

To protect nesting areas of Bald Eagles, Stalmaster (1987:166) indicated that a commonly used system involves territory zoning with both a primary and a secondary zone. In this system, no human activity is allowed within a primary zone of 0.06 mile (0.1 km) of the nest throughout the year. Human activity is also restricted in a secondary zone around alternate nests, perches, or roost trees during seasons when they are used by eagles. The shape and size of the secondary zone depends on the habits of the nesting pair and the amount of cover in the area; it can be as much as 0.6 mile (1 km) from the nest (Stalmaster 1987:166). Since Bald Eagles can use nest sites throughout the year in Oregon (Isaacs et al. 1983) and specifically along the Oregon Coast (Bayer, pers. obs.), this means that the secondary zone around eagle nests should also be protected from people harassing cormorants throughout the year.

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Chap. 6. Epilogue: Learning from the Cormorant Harassment Issue

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6-A. Introduction

Trying to understand the cormorant/fisherman conflict is an educational as well as a philosophical experience. This conflict is not limited to Tillamook County in 1988-1989; it is an ancient conflict that will probably continue as long as there are fishermen and cormorants. In the following sections, various points that can be learned from this conflict are examined.

6-B. Variable Definitions of Wildlife and Conservation

While working with this issue, I became increasingly aware that "wildlife" and "conservation" mean quite different things to different people. To some, "wildlife" only includes game or commercially important animals. "Conservation" of wildlife to these people means the enhancement of game or commercially important animals. For example, a fisherman or state fish and game department may consider clearing streams or lakes of "trash" fish as "conservation" of "wildlife," even though such "conservation" kills the nongame species of "trash" fish.

Because their focus is on game or commercially important animals, sportsmen and state fish and game departments often believe that money raised from licenses or fees on sportsmen and spent on game animals automatically benefits nongame animals (e.g., Gladson 1982, Hamilton 1984). This may often not be true, especially for nongame species whose needs either conflict with or are markedly different from the needs of game animals.

Keeping the diversity of definitions in mind is important in trying to communicate or understand an issue. Otherwise, people may not mean the same thing when they talk at each other.

6-C. Exaggerated Claims Can be Counterproductive

"The squeeky wheel gets the grease"; so some harassment proponents may have felt the only way that they would be heard is if they exaggerated by claiming that cormorants were destroying salmon and steelhead runs. This strategy worked to a certain point, as the exaggerated claims and effective lobbying managed to get House Bill 3185 passed in the Oregon House by a vote of 56 to 4.

The problem with using exaggerated claims is that eventually they, and perhaps their promulgators, lose credibility. The day of reckoning came in the Oregon Senate, where proponents' claims were apparently more carefully scrutinized and were seen to be more rhetoric than substance. HB 3185 could not muster the votes to be even heard in a Senate Committee (section 1-I-5).

If proponents had relied more on facts and less on rhetoric, they may have been more effective in building support. If proponents had used only the actual, not the imagined, results of the ADC study (e.g., section 2-F-5) and showed their videos illustrating large numbers of cormorants at Tillamook and Nehalem Bays, they may have been more successful. As it was, the exaggerations and the unpolitic public relations of some proponents seemed to undermine the proponents' credibility about salmon management, to turn potential supporters into opponents, and to make some opponents committed to opposing the proponents' plans.

6-D. The ODFW's Public Relations Could be Improved

6-D-1. The ODFW is in a No-win Situation

Salmonid management is a thankless, no-win chore. A Washington State salmon manager (Darwin in Wright 1981) had the following to say about his job:

> "At the end of eight years, I realize what a thankless task it is to try to preserve a great natural resource for a country. . . . In the Senate Chamber in 1919, at a public hearing on the fisheries code, which I prepared and which would have curtailed the fishing for both mature and immature salmon, one of the spokesmen for one of the fishermen's organizations declared that any person who would put forward a proposal for curtailing fishing should be beheaded."

The situation remains the same today as 70 years ago, and it is nearly impossible to satisfy all fishing interests (see section 2-B). Thus, the ODFW is stuck with a no-win situation in managing salmon and steelhead (e.g., Gunsolus 1980).

6-D-2. ODFW Handling of Cormorant Issue

While I sympathize with the ODFW's predicament and its public relation problems with salmonid management, I have also been dismayed by the ODFW's handling of the cormorant harassment issue. Instead of countering exaggerated claims by harassment proponents (e.g., smolts cost $1.25 each and salmon and steelhead fisheries are approaching ruin) with facts that the ODFW had, ODFW officials often seemed evasive or remained silent and in so doing gave credibility to the claims of harassment proponents.

It appears that current ODFW policy is not to confront and debate such claims, no matter how unrealistic they may be. Evidently, the ODFW hopes that such issues will just go away, but the cormorant harassment issue is a clear example of an issue that hasn't and probably won't.

If the ODFW chooses not to respond to such claims in newspaper articles, it should at least try to hold public or "townhall" meetings in which such claims are countered (e.g., see Colvin et al. 1983). This issue may have been somewhat defused if there had been more of an effort by the ODFW to explain in public forums in the Tillamook area the complexity of the smolt predation problem.

6-D-3. The ODFW Needs Diverse Biologists

To deal with the cormorant issue, it would also have helped if the ODFW had at least one biologist with expertise about fish-eating birds; presently, the ODFW has many fisheries biologists, but their knowledge and perspective about bird predators sometimes appears limited and one-sided.

For example, the ODFW's Harry Wagner (who has a fisheries background) told me after the April 20 House Agriculture, Forestry and Natural Resources Committee Work Session that some ODFW fisheries biologists trying to determine the reason for the decline of wild coho salmon in the Yaquina Basin had concluded, without any evidence, that bird predation must be the culprit. This frame of mind and conclusion may be expedient for fishery biologists such as Wagner because they would rather blame birds than consider that the long-term straying of private hatchery coho in the Yaquina (and nearby Basins) had hurt wild coho stocks (see Appendix VIII).

6-D-4. Need for Better ODFW Public Relations

Whether it likes it or not, the ODFW needs to recognize that it is going to increasingly become more involved in public relations. The number of consumptive and nonconsumptive wildlife user groups is growing and diversifying; there are conflicts among some consumptive user groups (e.g., among salmon fishermen, see section 2-B) and between some consumptive and nonconsumptive user groups. In the future these conflicts will increase, not decrease, because wildlife resources cannot grow commensurately with population increases and subsequent habitat destruction.

Dealing with these conflicts is going to require improved ODFW public relations because conflicts may not be solvable by changing wildlife management practices. The ODFW needs to explore ways of actively dealing with public relations problems as they are first developing rather than waiting until they become blown out of proportion. Training should include dealing tactfully with citizens that disagree, sometimes vehemently, with ODFW policies (e.g., see Colvin et al. 1983). Such training is necessary because in controversies such as salmonid management it is impossible for the ODFW to satisfy all fishing interests, and salmonid fishermen appear to be particularly vociferous and adamant.

Although ODFW personnel at local offices may be able to handle most public relations issues, they can't be expected to deal with festering problems like the cormorant issue. Accordingly, ODFW administration needs to recognize this and be able and willing to send "reinforcements" to local areas. These "reinforcements" should be specially trained to actively address and explain issues such as the cormorant issue at public forums or in other meetings with reporters or the general public.

6-E. Legislative Debate of House Bill 3185 about Cormorant Harassment

6-E-1. Introduction

Although I have attempted to use reason and facts in discussing the cormorant harassment issue in this monograph, most of the debate about this issue in the Oregon Legislature involved politics and persuasiveness.

My impression of how House Bill 3185 was discussed in the Legislature is given in the following sections.

6-E-2. Background of the 1989 Oregon Legislature

Currently, the Legislature meets every other year. In 1989, it met for 177 days and considered 3,020 bills. There is no way that a legislator can be knowledgeable about every bill, nor have the time to study each bill. Accordingly, legislators are open to the influence of lobbyists and political maneuvering on determining how to vote.

Because legislators can not keep up with all issues, their ignorance about some issues can sometimes show up during Committee hearings, work sessions, or floor debate. For example, during the House Agriculture, Forestry and Natural Resources Committee Hearing on April 13, a discussion began about shags (=cormorants) roosting in trees along the Rogue River in southwestern Oregon. One Committee member, Rep. Robert Shiprack (D-Beavercreek) laughed at this idea and argued that it was impossible for cormorants to roost in trees because cormorants had webbed feet, and thus could not grasp tree limbs with their feet (Shiprack 1989). Perhaps to avoid embarrassing Shiprack, no other Committee member that was present disputed Shiprack's assertion. Shiprack and perhaps other Committee members may not have been aware that Double-crested Cormorants routinely roost and nest in trees in central Oregon (Anderson and Gates 1983, Shotwell 1984, 1989) or can even perch on power lines (Bartholomew 1942).

During the 1989 Legislative session, the Spotted Owl/old-growth forest issue also flared up. Many legislators feared that if Spotted Owls became a federally threatened species with a subsequent curtailment of old-growth logging then there would be a great loss of jobs in the logging and lumber industries. Some legislators were so incensed about "environmentalists" and Spotted Owls that House Bill 3491 was introduced to put a $500 bounty on live-captured Spotted Owls; this Bill had wide support and was sponsored by 25 Representatives and 11 Senators. The Spotted Owl debate was acrimonious, and it is unclear if some of the rage about the Spotted Owl controversy (about which the Oregon Legislature could really do nothing because it was a federal matter) spilled over to the consideration and subsequent passage of HB 3185 in the Oregon House, a bill that irate Legislators could pass to get back at "environmentalists."

6-E-3. Efforts to Pass House Bill 3185

Proponents of harassment were very effective in getting HB 3185 through the Oregon House. Perhaps much of the credit for this should go to Rep. Paul Hanneman (R-Tillamook), who was chief sponsor of this Bill. He evidently persuaded several other Oregon legislators from the Oregon Coast to be co-sponsors, so that it appeared as if the Bill had wide coastal support. Additional leverage to persuade other Representatives to favor the Bill was achieved by having Rep. Larry Sowa (D-Oregon City) from the Willamette Valley as an active co-sponsor. Since Hanneman and Sowa were influential members of the House Ways and Means Committee, any Representative sponsoring a bill needing funding could be open to persuasion by Hanneman and Sowa.

Another key player was Jason Boe, a paid lobbyist (Ota 1987). Boe was very familiar with how to get things done in the Oregon Legislature because he had been Senate President from 1973-1981 (McDonough 198D, Ota 1987).

Loren Parks also appeared to be effective in persuading Representatives to pass HB 3185. Parks spoke in favor of the Bill at the April 13 House Agriculture, Forestry and Natural Resources Committee Hearing. Parks is a successful businessman (see section 6-I); businessmen seem to have more clout in the Legislature than biologists.

Although many of his claims are debatable (sections 2-F and 2-H), Jim Erickson was also a capable supporter of HB 3185. At the April 13 House Hearing, Erickson presented his side of this issue convincingly and energetically; his self confidence may have won legislators to his side.

6-E-4. Efforts Opposing House Bill 3185

Even though HB 3185 was easily passed by the Committee and House, there was substantial, although perhaps ineffective, opposition to it. Each and every Representative was contacted or received at least once piece of mail opposing this Bill.

ODFW.--ODFW staff testified against HB 3185 at the April 13 House Hearing, but the only ODFW official (Harry Wagner) to speak at the April 20 Work Session of the House Agriculture, Forestry and Natural Resources Committee was very equivocal and seemed to speak as much in favor of HB 3185 as against it.

The ODFW may have not been able to oppose this Bill as much as they could have because the ODFW Biennial Budget had not yet been passed. Since Reps. Hanneman and Sowa of the House Ways and Means Committee were sponsors of HB 3185, ODFW administrators may have felt that if they strongly opposed this Bill that their Budget may have been hurt. Since the ODFW's Budget is up for debate each legislative session, the ODFW is then vulnerable to political decisions about wildlife that are not based on biological data or sound wildlife management.

The ODFW may also not have opposed HB 3185 as much as they could have because the ODFW appeared to be somewhat split about cormorant harassment. In dealing with various ODFW staff, it was my impression that some ODFW personnel (e.g., Kunkel in Hendrickson 1988a, Harry Wagner during April 2D House Committee Work Session [see 6-D-3]) actually favored cormorant harassment. I would expect ODFW harassment supporters to most likely be fisheries biologists or fish propagationists, while ODFW wildlife or nongame biologists are more apt to oppose harassment, especially if the need for harassment is based only on exaggerated evidence.

ENVIRDNMENTAL GROUPS.--Although it might be supposed that many environmental groups would have been active in their opposition to House Bill 3185, most environmental groups seemed to shy away from this issue in the Legislature. For example, at the House Agriculture, Forestry and Natural Resources Committee Hearing on April 13, only five private citizens testified against the Bill. Only one of the five represented a large environmental group (Marc Liverman, a lobbyist representing the Portland Audubon Society); of the remaining four, one was from Tillamook County and three (including myself) were from Lincoln County. Further, the only written testimony submitted to this Committee for this Hearing from large environmental groups was from the Portland Audubon Society and from the Corvallis Audubon Society.

The lack of oral or written testimony at the April 13 hearing was not because environmental groups were unaware of House Bill 3185 or the April 13 Hearing. On 8 March 1989, I mailed informational flyers about HB 3185, and, on April 5, I mailed notices of the April 13 Hearing along with copies of my 37-page written testimony for the Hearing (see following subsection) to numerous representatives of environmental organizations including the Sierra Club, Oregon Environmental Council, Greenpeace, Oregon Natural Resources Council, each Oregon Audubon Chapter, Wildlife Defense NW, a few bird rehabilitators, and several other environmental groups.

The passage of HB 3185 by a vote of 56-4 in the House on May 1 is clear evidence that environmental groups did not get seriously involved in trying to defeat this Bill in the Oregon House. Large Oregon environmental organizations have their bases in the Portland, Salem, and Eugene metropolitan areas; which is also where most Representatives were from. In spite of having about 15 Representatives endorsed by the Oregon League of Conservation Voters from these areas, only four of them voted against HB 3185. Surely, if there had been some concerted effort by the large environmental groups, more Representatives would have opposed this Bill.

There are several reasons why many environmental groups may not have publicly opposed HB 3185 in the Oregon Legislature. Firstly, some groups may not have had the time or energy to get involved, or they may have been focusing their efforts on other issues; there are so many environmental issues it is not possible to be active in them all.

Some groups may have chosen not to become involved with this Bill because cormorants are not a "glamour" bird like Bald Eagles, Osprey, or Great Blue Herons. What these groups overlooked is that these birds could also be affected by cormorant harassment (section 3-H) or that some anglers would want to extend harassment to birds such as Great Blue Herons once cormorant harassment was allowed. Further, if HB 3185 passed, then some fishermen in central Oregon would also want to harass cormorants (Shotwell 1989) and if they were allowed to do so, the more glamorous Osprey and other birds in the Crane Prairie Reservoir would certainly also be intentionally or unintentionally disturbed.

Thirdly, other groups may not have wanted to get involved because they did not want to alienate fishermen by publicly opposing HB 3185. Since some environmental groups are made up of a coalition of various groups, including fishing organizations, this issue could split some environmental groups.

Fourthly, individuals in other groups did not wish to oppose fishermen wanting HB 3185 because they were fearful that fishermen might not then oppose high seas drift gill nets (section 2-I-2) or oil drilling and mining off the Oregon Coast, which were issues that were coming up that some environmental groups felt much more strongly about than cormorant harassment.

The final reason why some environmental groups did not publicly oppose HB 3185 is that they had bills pending before the Oregon Legislature. Such groups may not have wanted to risk angering Reps. Hanneman and Sowa on the Ways and Means Committee, which could mean the death of their bill.

While large environmental groups did not appear to do much about HB 3185 in the Oregon House, their nonpublic efforts may have helped cause the demise of this Bill in the Oregon Senate. In spite of sailing through the House, a Hearing wasn't even scheduled for this Bill in the Senate Agriculture and Natural Resources Committee, and this Bill never made it out of this Committee (section 1-I-5).

One lesson to be learned from the HB 3185 affair is that politics is involved not only in the Legislature but also in which environmental groups will become involved or how much effort they will put into an environmental issue. Politics is not limited to politicians.

Another lesson is that individuals or small environmental groups can influence the Legislature. The small group most involved in opposing HB 3185 was the Wildlife and Environmental Defense Network, with members in Tillamook and Clatsop Counties; some members of Yaquina Birders and Naturalists (with members mainly in Lincoln County) were also involved. In spite of being few in number, opponents influenced HB 3185 in the House Agriculture, Forestry and Natural Resources Committee. Opponents gave oral testimony at the April 13 Hearing (four of five private citizens speaking against the Bill were from these two groups), wrote letters to Committee members, and submitted written testimony for the April 13 Hearing.

This opposition apparently resulted in HB 3185 proponents amending the Bill, so that it would be more palatable to opponents. For example, one amendment required the ODFW to monitor fishermen harassing cormorants (section 1-I-3), which could reduce the chance that other wildlife would be disturbed. Another amendment limited harassment to Tillamook and Nehalem Bays in spring, not the entire Oregon Coast throughout the year (section 1-I-3).

MY EFFORTS.--On 6 March 1989, I wrote a letter opposing HB 3185 to the Representative of my district, Rep. Hedy Rijken; I never received a response. On April 1, I talked with Rep. Rijken at her Newport "Townhall" meeting, and she was candid that she didn't know how she would vote on HB 3185. I know that a lot of her constituents also wrote or contacted her about voting against HB 3185. Nevertheless, she voted for HB 3185 in the House Agriculture, Forestry and Natural Resources Committee and also in the House. Since Rep. Rijken had only submitted one bill to the Legislature and it required revenue, the influence of Reps. Hanneman and Sowa on the House Ways and Means Committee, who were also chief sponsors of HB 3185, may have more influenced Rijken's decision about HB 3185 than the will of her constituents.

On 8 March and 5 April 1989, I mailed informational flyers about HB 3185 and the April 13 Hearing to numerous representatives of environmental organizations. Since most of these groups did not become involved, my effort to involve them does not appear to have been effective.

For the 13 April 1989 Hearing (section 1-I-2), I submitted 37 pages of written testimony to the House Agriculture, Forestry and Natural Resources Committee. This testimony discussed the fallaciousness of many of the claims made by harassment proponents and included much of the material in Chaps. 1-3 of this monograph. I also gave oral testimony at the April 13 Hearing that countered some of the oral testimony given by harassment proponents at the Hearing. But my research and efforts were for nought, as the 7-1 vote in the Committee on April 20 attests.

On April 13 after the Hearing, I hand-delivered written materials opposing HB 3185 to the staffs of 20 Oregon House Representatives, who had been endorsed by the Oregon League of Conservation Voters during the 1988 General Election, and who were not on the House Agriculture, Forestry and Natural Resources Committee. I also delivered written materials to the staffs of five Senators, including the Senate President, and four of the seven members of the Senate Agriculture and Natural Resources Committee.

The written material included my 37 pages of written testimony as well as three pages of written testimony by Dan Varoujean (Research Associate at the University of Oregon) and also one page of written testimony by Lynne Krasnow (graduate student at Oregon State University). These testimonies had also been submitted for the April 13 Hearing of the House Agriculture, Forestry and Natural Resources Committee. Varoujean had studied seabird and seal predation of hatchery smolts along the Oregon Coast for several years, and Krasnow conducted research on seabird feeding habits for five years while employed by the U.S. Fish and Wildlife Service. Based on their professional expertise, both Varoujean and Krasnow opposed HB 3185.

On 12 April 1989, I also mailed a three-page letter to the remaining 31 Representatives not on the Committee or not endorsed by the League of Conservation Voters. In this letter, I condensed my 37 pages of written testimony to just the major points of why I opposed HB 3185.

In spite of my personal testimony to the nine Representatives of the House Agriculture, Forestry and Natural Resources Committee and my writing all other Representatives, HB 3185 passed by a vote of 56-4. Clearly, my efforts had little effect on Representatives. This may have been because my name, "Range Bayer," was not familiar to Representatives, and they may thought it, or me, a joke. Further, since I was not affiliated with a governmental agency, university, or corporation or a successful businessman; they may have felt that my opinions were not worth considering.

I may have been more effective in my opposition if I had set up appointments and personally met with Representatives or their staffs. Personal contact and persuasion may have been much influential than long letters that ended up being buried and forgotten in files.

My letters to environmental organizations and Representatives may also have been more persuasive if I had kept the letters very brief and just used "zingers" (short clauses that catch the reader's attention). In my flyers and letters, I tried to explain the complicated cormorant harassment issue; my writings may have been too long and taken too much of a reader's time.

6-F. Success of House Bill 3185 in Oregon House

HB 3185 passed the House because supporters were more persuasive than opponents. Supporters included several Representives; opponents did not have any Representative actively opposing this Bill. Further, Jason Boe was a very effective lobbyist supporting this Bill and apparently engineered an amended HB 3185 that seemed more reasonable to Representatives.

Although many arguments of HB 3185 supporters were largely nonscientific and emotional (e.g., sections 2-F through 2-H), opponents were not able to counter these arguments sufficiently to influence Representatives. The collision of nonscientific and scientific arguments in debates of wildlife management are not unique to cormorant harassment because it is also currently happening with the Spotted Owl/old-growth forest controversy (see Simberloff 1989).

6-G. Failure of House Bill 3185 in Oregon Senate

HB 3185 was never considered at a Senate Hearing. I don't know the reason(s) why it wasn't, but Senators on the Senate Agriculture and Natural Resources Committee may not have been as vulnerable to lobbying by Jason Boe or Reps. Hanneman and Sowa as were Representatives. Secondly, Senators may have examined HB 3185 and found it to be based mainly on emotions, rather than facts. Thirdly, individuals representing large environmental organizations may have played a key role in nonpublicly pointing out problems with this Bill to members of the Senate Committee. Fourthly, there was a letter-writing campaign to the Committee opposing this Bill. Finally, in opposition to HB 3185, I also sent my 37 pages of written testimony along with the written testimony of Krasnow and Varoujean to most members of the Senate Committee; perhaps, our written testimony may have helped these Senators realize that this Bill was neither as simple nor as necessary as supporters claimed.

6-H. Failure of Biological Data to Persuade Legislators: Biologists Need to Better Communicate With Nonbiologists

From my experience with the cormorant harassment issue, it seems apparent that private and ODFW biologists as well as environmentalists need better training in communicating with legislators or the general public, if they wish to be wildlife advocates. Biologists need to be able to skillfully debate emotional, off-the-cuff arguments that are presented clearly and forcefully in public forums, or biologists may be surprised to find themselves, and wildlife, the losers.

ODFW and private biologists also need to be better able to persuade the general public or legislators, who may be more concerned with personal or political concerns than biological ones. Thus, biologists need broader training in public relations skills such as writing, speaking, and negotiating (e.g., see Colvin et al. 1983) because wildlife managers of the future will be dealing more with the management of people than wildlife.

Biologists also need to recognize that they may be faced with nonscientific arguments presented as being scientific (e.g., Colvin et al. 1983, Simberloff 1989) or individuals who refuse to accept any scientific information if it contradicts their personal beliefs and feelings. For example, it is apparent that no matter how many studies are conducted on cormorant predation, there are some anglers who won't believe the results unless they indicate that cormorants should be controlled (e.g., Shotwell 1989). Accordingly, biologists should be also cognizant of other belief systems: while biologists may believe science, some fishermen only believe their own feelings.

Arguments such as those presented to support cormorant harassment may seem so exaggerated that ODFW or private biologists may not consider them worthy of consideration. But to ignore, not confront, these arguments is to invite a long battle such as that about cormorant harassment in Tillamook County in 1988-1989. To deal with such issues where beliefs are firm and not based on facts, biologists need to be patient and reiterate their arguments if they hope to be persuasive (e.g., see Colvin et al. 1983).

6-I. Is Oregon Wildlife or Wildlife Management for Sale?

While being involved in the cormorant harassment issue, I have learned that money can **not** buy Oregon wildlife or wildlife management directly, at least not yet. But, in my opinion, it appears that people who make large donations to fish or game programs may have undue sway over Oregon wildlife or its management.

Loren Parks has been an active and forceful supporter of cormorant harassment (e.g., Parks 1989). He also has donated a lot of money to support Oregon fisheries; for example, Jim Erickson (1989c) testified at the 13 April 1989 Hearing before the House Agriculture, Forestry and Natural Resources Committee:

> "Now getting to the point of how this [cormorant harassment] is funded. Mr. Parks has funded it in the past year. He's donated a lot of money, we are talking about millions, over the years to enhance the fisheries. And he wants to see this fishery protected."

Further, Jason Boe (1989) testified at the same 13 April 1989 Hearing:

> "I am going to introduce first, Mr. Loren Parks. Mr. Parks is the owner of Parks Medical Electronics industry of the Aloha area. He is a philanthropist, an entrepreneur, and a person who has a deep interest in the fishing and the quality of the fishing in the State of Oregon. He has personally donated a great [pause] large sums of money to the public good of providing fishing spaces and land for fishing **and is prepared to do more of that type of thing but he does have some concerns over the operations of the ODFW** [boldface added] and particularly with respect to House Bill 3185."

Loren Parks (1989) also testified at the same Hearing that:

> "While I was buying land for the bank fishermen and for putting in boat ramps so that we could get to these public waters, I've stopped doing that because it doesn't make any sense to do it if there aren't any fish there or not sufficient numbers of fish. And so I thought it would be better to put my efforts toward getting some fish in the river rather than more boat ramps and things."

In my opinion, all citizens may be equal before the Oregon Legislature, but after hearing Erickson's, Boe's, and Parks' testimony and seeing the results before the Committee to which they testified, I have the impression that some citizens are more equal than others. With the House Committee vote of 7-1 and the House vote of 56-4 in favor of House Bill 3185 that he supported, the publicity of Mr. Parks' donations certainly doesn't appear to have hurt his cause.

I am not suggesting any wrong-doing by Mr. Parks, but I am suggesting that the influence of his donations or those of others may excessively influence wildlife and wildlife management.

Donations of money or time and effort may be "free" when given, but they have their own peculiar long-term costs because the donor (e.g., philanthropist or STEP volunteer [sections 1-E and 2-C]) may feel that he or she has more of a claim to wildlife or decisions affecting wildlife than other citizens. Thus, "donations" can be quite expensive in the long run.

6-J. When is Predation by a Smolt Predator Significant?

One source of profound disagreement between proponents and opponents in the cormorant harassment issue is defining when a smolt predator causes "significant" damage. Is it when a predator eats 1% of the smolts? 10%? 30%? 50%? Unfortunately, there is currently no objective, practical standard as to what constitutes a "significant" predator.

To some harassment proponents, **any** predation of smolts by cormorants or other birds in estuaries is "significant." These proponents feel that if smolts escaped predators, then smolts have a chance of returning as adults that fishermen could catch. What proponents overlook is that there are other predators (section 3-E) or other causes of death (Appendix II). Thus, even though there is a chance that a smolt "saved" from one predator would survive, the chance may be remote.

Other people may set a criterion for a "significant" predator; for example, a predator that eats 20% of the smolts released. Such criteria may not be useful because smolts that are eaten may not have survived anyway. Further, there currently are not enough data to accurately determine how many smolts are eaten.

To objectively determine if a predator species is "significant," it would seem reasonable that the number of smolts a predator eats that would otherwise survive and return as adults or contribute to fisheries must be measured or estimated. With such information, a "significant" predator could be defined as one that adversely affected fisheries. Unfortunately, there is inadequate information to determine how many smolts are eaten by predators such as cormorants or to determine how many smolts eaten by a predator would have died from other causes before returning as adults or being caught in fisheries. Thus, this definition isn't presently practical.

In conclusion, some proponents of cormorant harassment argue that **any** cormorant predation is "significant" and that harassment gives smolts that would have otherwise been eaten a chance for survival. Proponents argue that any chance is better than no chance at all.

Some opponents of harassment argue that there currently isn't sufficient evidence to indicate that cormorants are a "significant" predator (i.e., a predator that affects fishermen's catches). Additionally, opponents argue that the chance that smolts saved by cormorant harassment would survive to return as adults is so remote that harassment doesn't compensate its economic costs, the harm that harassment would cause nontarget animals, or the annoyance that harassment would be to tourists or residents.

6-K. Can There Ever be Enough Salmon or Steelhead?

One of the underlying causes of the cormorant/fisherman issue has been the desire by fishermen to find ways (e.g., cormorant harassment) of increasing the number of salmon and steelhead that they could catch.

There is no doubt that the supply of salmon and steelhead is currently far short of the demand. Although not a staple food item, their fisheries are important in coastal economies and also provides recreation, so there is a strong desire for more fish.

But can there ever be enough salmon or steelhead? I think not. If fish numbers increase, the number of fishermen, charter boats, and fishing effort will increase commensurately; so that demand will still exceed the supply.

Even though the demand can't be met, a goal of increasing the number of salmon and steelhead can be worthwhile, if the effort is realistic and cost-effective. In other words, costs to increase fisheries shouldn't exceed the revenue to support fisheries. To remain cost-effective, it may only be possible to keep fisheries at recent levels and be aware that unfavorable ocean conditions or other uncontrollable factors may cause catches in some years to be reduced.

Efforts to increase the number of fish must also be coupled with continually informing fishermen about the status of catches. Currently, some fishermen believe that salmon and steelhead fishing along the Oregon Coast is disastrous, even though the actual catches are not (section 2-D). Without publicity, it wouldn't make any difference how much fishermen's catches are increased, if fishermen believe that they are catching less fish.

6-L. The Cormorant Issue Will Continue in North America

Probably because of reduced human disturbance, Double-crested Cormorants are expanding their range and increasing in numbers in various parts of North America (e.g., Maine Cormorant Study 1982, Vermeer and Rankin 1984, Craven and Lev 1987, Findholt 1988). Because most conflicts of cormorants with aquaculturists (e.g., Schramm et al. 1987, Broadway 1989) or fishermen are with the Double-crested Cormorant, there will be continued requests for cormorant control.

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Appendix I. Scientific names for common names of animals mentioned in this monograph.

Common Name	Scientific Name
INVERTEBRATES	
crab, Dungeness	**Cancer magister**
crab, red rock	**C. productus**
squid	**Loligo opalescens**
FISH	
albacore	**Thunnus alalunga**
anchovy, northern	**Engraulis mordax**
bass, smallmouth	**Micropterus dolomieni**
bass, striped	**Morone saxatilis**
cod, Pacific	**Gadus macrocephalus**
croaker, white	**Genyonemus lineatus**
dogfish, spiny	**Squalus acanthias**
flounder, starry	**Platichthys stellatus**
hake, Pacific	**Merluccius productus**
herring, Pacific	**Clupea harengus pallasi**
lamprey, Pacific	**Lampetra tridentatus**
lamprey, river	**L. ayresi**
lingcod	**Ophiodon elongatus**
mackerel, jack	**Trachurus symmetricus**
perch, yellow	**Perca flavescens**
pollock, walleye	**Theragra chalcogramma**
rockfish, black	**Sebastes melanops**
sablefish	**Anoplopoma fimbria**
salmon, Atlantic	**Salmo salar**
salmon, chinook	**Oncorhynchus tshawytscha**
salmon, chum	**O. keta**
salmon, coho	**O. kisutch**
sanddab, Pacific	**Citharichthys sordidus**
sculpin, buffalo	**Enophrys bison**
sculpin, Pac. staghorn	**Leptocottus armatus**
shark, blue	**Prionace glauca**
shark, soupfin	**Galeorhinus zyopterus**
shark, thresher	**Alopias vulpinus**
sole, petrale	**Eopsetta jordani**
sole, sand	**Psettichthys melanostictus**
squawfish, northern	**Ptychocheilus oregonensis**
steelhead	**Salmo gairdneri**
sturgeon, white	**Acipenser transmontanus**
trout, brook	**Salvelinus fontinalis**
trout, cutthroat	**Salmo clarki**
walleye	**Stizostedion vitreum**
BIRD	
Auklet, Rhinoceros	**Cerorhinca monocerata**
Brant	**Branta bernicla**
Bufflehead	**Bucephala albeola**
Coot, American	**Fulica americana**
Cormorant, Brandt's	**Phalacrocrax penicillatus**
Cormorant, Double-crested	**P. auritus**
Cormorant, Great	**P. carbo**
Cormorant, Pelagic	**P. pelagicus**
Dowitcher, Short-billed	**Limnodromus griseus**
Duck, Harlequin	**Histrionicus histrionicus**
Duck, Ring-necked	**Aythya collaris**
Duck, Ruddy	**Oxyura jamaicensis**
Duck, Wood	**Aix sponsa**
Dunlin	**Calidris alpina**
Eagle, Bald	**Haliaeetus leucocephalus**
Egret, Great	**Casmerodius albus**
Falcon, Peregrine	**Falco peregrinus**
Gadwall	**Anas strepera**
goldeneye spp.	**Bucephala islandica/clangula**

Common Name	Scientific Name
BIRDS (continued)	
Goose, Canada	**Branta canadensis**
Grebe, Horned	**Podiceps auritus**
Grebe, Red-necked	**P. grisegena**
Grebe, Western	**Aechmophorus occidentalis**
Guillemot, Pigeon	**Cepphus columba**
Gull, Bonaparte's	**Larus philadelphia**
Gull, Glaucous-winged	**L. glaucescens**
Gull, Heerman's	**L. heermanni**
Gull, Ring-billed	**L. delawarensis**
Gull, Western	**L. occidentalis**
Heron, Great Blue	**Ardea herodias**
Kingfisher, Belted	**Ceryle alcyon**
Kittiwake, Black-legged	**Rissa tridactyla**
Knot, Red	**Calidris canutus**
Loon, Common	**Gavia immer**
Loon, Pacific	**G. pacifica**
Loon, Red-throated	**G. stellata**
Mallard	**Anas platyrhynchos**
Merganser, Common	**Mergus merganser**
Merganser, Hooded	**Lophodytes cucullatus**
Merganser, Red-breasted	**M. serrator**
Merlin	**Falco columbarius**
Murre, Common	**Uria aalge**
Murrelet, Ancient	**Synthliboramphus antiquus**
Murrelet, Marbled	**Brachyramphus marmoratus**
Osprey	**Pandion haliaetus**
Owl, Spotted	**Strix occidentalis**
Pelican, Brown	**Pelecanus occidentalis**
Pintail, Northern	**Anas acuta**
Plover, Semipalmated	**Charadrius semipalmatus**
Puffin, Tufted	**Fratercula cirrhata**
Sandpiper, Least	**Calidris minutilla**
Sandpiper, Western	**C. mauri**
scaup spp.	**Aythya marila/affinis**
Scaup, Greater	**A. marila**
Scoter, Black	**Melanitta nigra**
Scoter, Surf	**M. perspicillata**
Scoter, White-winged	**M. fusca**
Shearwater, Short-tailed	**Puffinus tenuirostris**
Shearwater, Sooty	**P. griseus**
Shoveler, Northern	**Anas clypeata**
Teal, Green-winged	**Anas crecca**
Tern, Arctic	**Sterna paradisaea**
Tern, Caspian	**S. caspia**
Tern, Common	**S. hirundo**
Turnstone, Ruddy	**Arenaria interpres**
Whimbrel	**Numenius phaeopus**
wigeon spp.	**Anas americana/penelope**
Yellowlegs, Greater	**Tringa melanoleuca**
MAMMALS	
dolphin, Pac. white-sided	**Lagenorhynchus obliquidens**
otter, river	**Lutra canadensis**
porpoise, Dall's	**Phocoenoides dalli**
porpoise, harbor	**Phocoena phocoena**
seal, elephant	**Mirounga angustirostris**
seal, harbor	**Phoca vitulina**
sea lion, California	**Zalophus californianus**
sea lion, northern	**Eumatopias jubatus**

Appendix II. Sources of mortality for currently-raised hatchery fish.

II-A. Introduction

Juvenile hatchery salmonids do not survive as well when released as do wild salmonids (Fraser 1974, Reisenbichler and McIntyre 1977, Gunsolus 1980, Dickson and MacCrimmon 1982, Ersbak and Haase 1983, Bachman 1984, Piggins and Mills 1985). The lowered survival of hatchery smolts appears to be because they are vulnerable to predation and/or because they may not feed efficiently enough to survive.

If the rearing of hatchery smolts was changed so that they could better adapt after release to feeding conditions and predators (see Chap. 4), hatchery smolts might not attract the predators that they now do, and cormorant predation might be less of an issue.

The two main sources of smolt mortality that have been suggested are limited food or predators (e.g., Pearcy 1988). These mortality factors are probably synergistic and should be considered for two separate time frames: Stage I (shortly after release when smolts are very naive, stressed, disoriented, and extremely vulnerable to predation) or Stage II (several days or more after release when smolts are less stressed, more wary, and less detectable by predators)(see Table II.1 at end of this Appendix).

Dividing the time of mortality into two Stages is important because the cause of mortality can differ between Stages. Further, it may be easier to improve the survival of smolts if the Stage when most mortality occurs can be resolved. Presently, there are no data to determine if most smolts die in Stage I or II or if most smolts that die in Stage I could have survived anyway (i.e., some may have been too small to survive, Mahnken et al. 1982, Parker and Stohr 1983, Wilson 1986, Mathews and Ishida 1989:1224, 1225).

II-B. Stage I Mortality: Vulnerability of Currently Raised Hatchery Smolts to Predation Shortly After Release

Shortly after release, juvenile salmonids are stressed and disoriented because they have been forced into an unfamiliar environment (Macdonald et al. 1988). The stress of release can impair the ability of smolts to avoid predators or diminish their swimming abilities (e.g., Sylvester 1972, Coutant 1973, Sigismondi and Weber 1988).

Smolts may also have to adjust to salt water, which can make them act "sick" and impair their ability to escape predators. ODFW hatchery fish are reared in freshwater, so after they are released and move into estuaries, it may take about 100 hours for them to adapt to salt water; during this time they are physiologically stressed (Harry Wagner, ODFW Staff, oral testimony at the 20 April 1989 Work Session on House Bill 3185 before the House Committee on Agriculture, Forestry and Natural Resources). In contrast, private aquaculture smolts in Oregon are held in salt water for several days before being released, so that they don't have to adapt to increased salinities after release.

Recently released salmonids are easily detectable to predators because some smolts behave inappropriately in their new environment. Since hatchery salmonids are familiar only with feeding on pellets spread on the water surface, many smolts come to the surface to feed shortly after release and in so doing are easily seen by potential predators. Secondly, newly released smolts appear to often jump out of the water. Whatever the reason for their jumping, the result is that jumping makes them vulnerable to predators. For example, at Yaquina Estuary, I observed gulls sitting on the water catch and eat newly released smolts as they jumped near the gulls. A third way that salmonid juveniles act inappropriately is that they tend not to disperse after release, so that they remain in schools near the surface where they can be easily found and eaten by predators (Vincent 1960, Fresh 1983:74).

Recently released salmonids are particularly vulnerable to predation because they are also not wary of predators (e.g., Vincent 1960, Thompson 1966, Kanayama 1968, Fraser 1974, Patten 1975, 1977; Ginetz and Larkin 1976, Olla and Davis 1989, Suboski and Templeton 1989). Salmonid juveniles, however, may be capable of being trained to avoid predators (section 4-B-6), although this has not been attempted at hatcheries.

Since juvenile salmonids in hatcheries usually receive little exercise, their stamina appears to be less than for wild salmonids (e.g., L. S. Smith et al. 1983, 1985). This makes it more difficult for them to avoid predators and may impair their ability to feed and position themselves in the water column after release (Besner 1980, Besner and Smith 1983, L. S. Smith et al. 1983, 1985; Shchurov et al. 1986).

The combination of all these factors results in newly released hatchery smolts being vulnerable to predation. Thus, it is not surprising that a host of fish and bird predators in estuaries or the ocean (section 3-E) or in freshwater (e.g., northern squawfish, Brown and Moyle 1981, Buchanan et al. 1981; yellow perch, Dahle 1979; smallmouth bass, Nigro 1983, Pflug and Pauley 1984; and walleye, Nigro 1983, Maule and Horton 1984) that do not normally feed on juvenile salmonids may do so after hatchery releases.

II-C. Stage II Mortality: Mortality of Hatchery Smolts Because of a Synergistic Relationship Among Food Abundance, Inefficient Feeding, and Predation

II-C-1. Introduction

After several days, smolts are much less vulnerable because once exposed to predators or predator models they can become more wary (Thompson 1966, Kanayama 1968, Patten 1975, 1977; Ginetz and Larkin 1976, Wood and Hand 1985, Olla and Davis 1988, 1989; Suboski and Templeton 1989). Further, smolts apparently disperse so that they are not concentrated in schools near the surface; thus, predators can't detect them as easily.

Although Stage I mortality of some naive, hatchery smolts shortly after they are released may primarily be by predation; Stage II mortality factors may be synergistic and include inefficient feeding, a lack of food, and predation (Table II.1), especially in years with poor ocean conditions.

Below, problems that hatchery smolts have with feeding are discussed, and then the synergistic relationship between feeding and predation is examined.

II-C-2. Feeding Difficulties of Hatchery Smolts

Feeding of hatchery smolts may be impaired because they are unfamiliar with identifying and catching natural prey or because of increased physiological demands. Although not currently used, some methods of improving the ability of hatchery fish to feed after they are released are discussed in section 4-B-4.

PROBLEMS WITH PREY IDENTIFICATION AND PREY CAPTURE BY NEWLY RELEASED SMOLTS.--Since current hatchery salmonids are only familiar with eating pellets spread on top of a hatchery pond, it is understandable that they may have a problem shortly after release in finding natural food (e.g., Sosiak et al. 1979, Ersbak and Haase 1983, Bachman 1984, Kennedy et al. 1984, Suboski and Templeton 1989). This problem may be aggravated because hatchery fish position themselves higher in the water column than wild fish, so hatchery fish may not be located where appropriate prey are most abundant or are easiest to catch (e.g., Dickson and MacCrimmon 1982).

Some studies of salmonid smolts in aquaria have demonstrated that hatchery fish can quickly learn to catch natural prey (Paszkowski and Olla 1985, Stradmeyer and Thorpe 1987). But hatchery fish may do more poorly in the wild than these studies indicate because finding and catching sufficient prey to survive and prosper in the wild would be much more difficult than doing so in an aquarium (Stradmeyer and Thorpe 1987).

Identifying and catching prey clearly appears to be a problem for newly released chinook smolts. At Tillamook Bay and Yaquina Estuary, chinook smolts a week after release had stomachs that were much less full than those of wild smolts collected at the same time (Forsberg et al. 1975:26, Myers 1980:154). At Yaquina Estuary, Myers (1980:152) also found that stomachs of recently released chinook smolts often contained extraneous material such as pine needles, seeds, wood and paint chips, and pieces of plastic and styrofoam. At Puget Sound, L. S. Smith et al. (1970) found that recently released chinook smolts had little but pieces of wood or debris in their stomachs.

Coho smolts may not have as much difficulty in adapting to natural food. At Yaquina Estuary, Myers (1980:91) found that hatchery smolts were apparently quickly feeding on natural prey, but, at Siuslaw Estuary, Nicholas et al. (1979) found that most hatchery coho smolts had empty stomachs.

Studies of hatchery coho smolts in aquaria indicate that 69% can quickly identify and catch natural prey (Paszkowski and Olla 1985). But Paszkowski and Olla (1985) also found that the other **31% did not adapt** and suggested that such a minority of nonadaptive smolts could contribute to the poor survival and feeding performance often reported for hatchery salmonids.

FEEDING INEFFICIENCY OF SMOLTS.--Hatchery smolts not only need to learn to identify and catch wild prey, they need to do so efficiently enough to at least maintain their body weight. Inefficient feeding has been a recognized problem for hatchery smolts (Ersbak and Haase 1983) that may be aggravated because hatchery fish may have higher energy and food demands than wild fish. For example, food requirements of recently released hatchery fish may be greater than for wild smolts because hatchery smolts are adapted to digesting food pellets and may not be able to efficiently digest natural food (Kennedy et al. 1984). Further, the basal metabolism of hatchery fish may be higher than for wild fish (Ersbak and Haase 1983), and hatchery fish may expend more energy in searching and catching prey than wild fish (e.g., Bachman 1984, Paszkowski and Olla 1985).

The length of time that it takes hatchery smolts to become as efficient in feeding as wild smolts is unclear and may differ among smolts (see Paszkowski and Olla 1985). For Atlantic salmon, some hatchery smolts took up to two months before they had the variety or amount of prey as wild smolts (Sosiak et al. 1979, Kennedy et al. 1984).

II-C-3. Synergism Among Food Abundance, Feeding Inefficiency, and Predation

Food limitation, by itself, may not cause smolt mortalities because most smolt mortalities appear to occur within a few months or perhaps even within the first month after release (Gunsolus 1980, Pearcy 1988). In fact, death occurs in such a short time that starvation is probably not the proximate cause of mortality (Steve Johnson, ODFW Biologist, pers. comm.).

The growth, condition, and average stomach fullness of live smolts that were netted during years with poor upwelling conditions and poor smolt survival was similar to good upwelling years (Pearcy and Schoener 1987, Pearcy 1988). This would seem to indicate that smolts were adequately feeding. Unfortunately, data collected from smolts that were captured alive only provides information about the condition of surviving smolts, not those that died. Since the problem is to determine why smolts die during poor ocean conditions, data are needed about the health of smolts that died, not just the survivors.

It is probable that during the 1983 El Nino, when ocean upwelling conditions were poor for smolt survival, that food abundance for smolts may have been reduced. At least there was a major change in the diet of smolts in 1983 compared with other years (Pearcy et al. 1985, Pearcy and Schoener 1987). There are no data to determine if the prey used during the El Nino were as nutritious as normal prey; if they were not, then smolts would have to catch more prey to maintain themselves or grow.

Since hatchery smolts appear to be less adaptable in switching between available prey than wild fish (e.g., Sosiak et al. 1979, Ersbak and Haase 1983), hatchery smolts may have been particularly vulnerable during the El Nino when switching among prey may have been essential for survival. While some hatchery smolts might not have had much difficulty in switching, the 31% of hatchery coho smolts that were found to be nonadaptive feeders (Paszkowski and Olla 1985) may have been particularly hard-pressed. Thus, while studies such as Walters et al. (1978)(but see Peterson et al. 1982:849-850) suggest that there is much more food available for salmon smolts than they use, some or many hatchery smolts may not be able to take advantage of the abundance of food.

During poor upwelling conditions, many smolts (perhaps the 31% of Paszkowski and Olla 1985) may not eat sufficient food to maintain themselves or may also become susceptible to disease. Since predators are known to take weak or impaired prey (Curio 1976), these smolts may accordingly be very vulnerable to predation, especially since hungry hatchery coho juveniles expose themselves more to predators when they are hungry (Dill and Fraser 1984). Thus, food limitation because of either low prey abundance or inefficient smolt feeding may be the underlying, ultimate cause of death of many smolts in Stage II during poor ocean conditions, although predation may be the actual, proximate cause of death.

Table II.1. Possible major causes of smolt mortality after release. It is assumed that fish are healthy when they are released, which may not always be the case (see Mace 1983); otherwise, Stage II mortality may also result from disease alone or in combination with predation. Note that these factors can be synergistic.

Time When Mortality Occurs		Synergistic Factors Causing Death of Smolts
Stage I	Shortly After Release	Stress of Handling[a] Stress of Adapting to Salt Water[a] Predation of Naive, Stressed Smolts
Stage II	Several Days Post-release	Parr Reversion[a] Feeding Inefficiency of Some Smolts Food Shortage Predation

[a] Some private aquaculture coho smolts (e.g., 20-40%) appear to have been released below their critical size for survival (Parker and Stohr 1983, Wilson 1986, Mathews and Ishida 1989:1224), so they may revert to parr (Mahnken et al. 1982) and/or be vulnerable to other mortality factors or disease.

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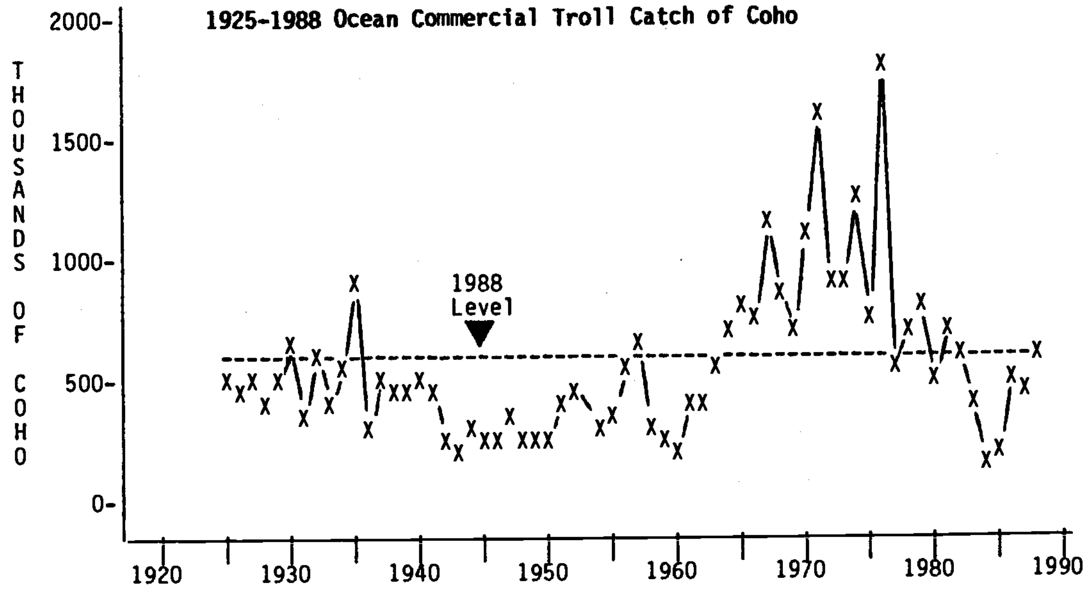
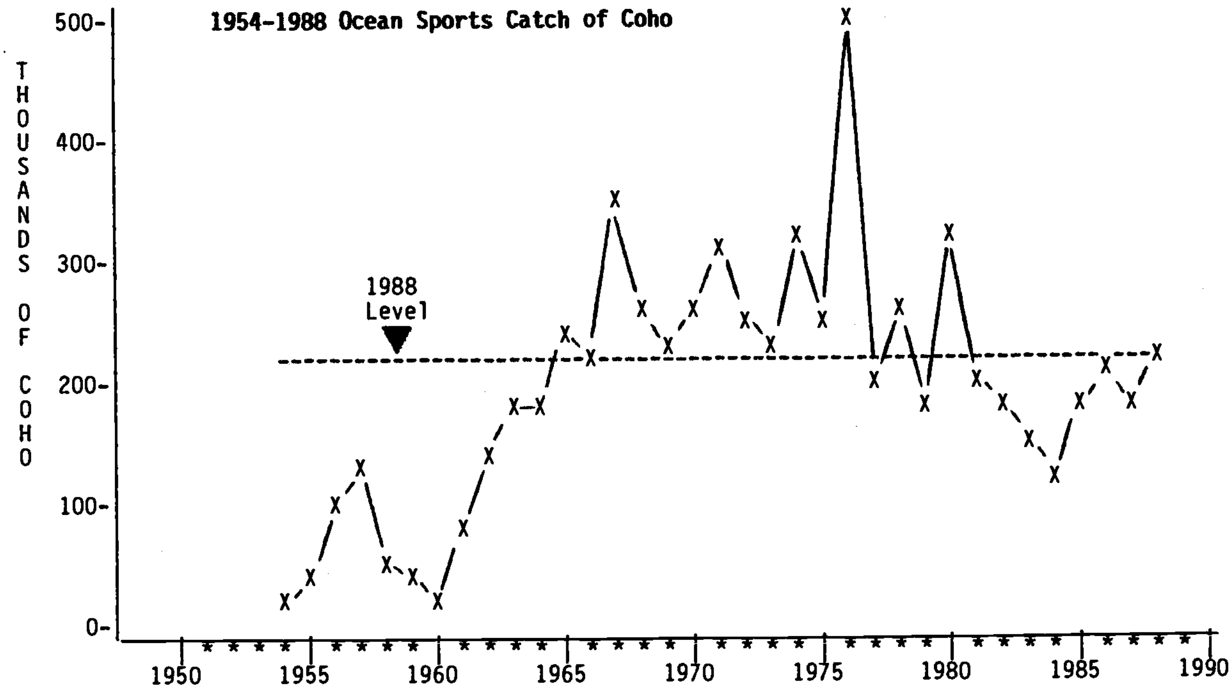
Appendix III. Ocean and coastal stream catches of coho salmon. Also see section 2-D-2.

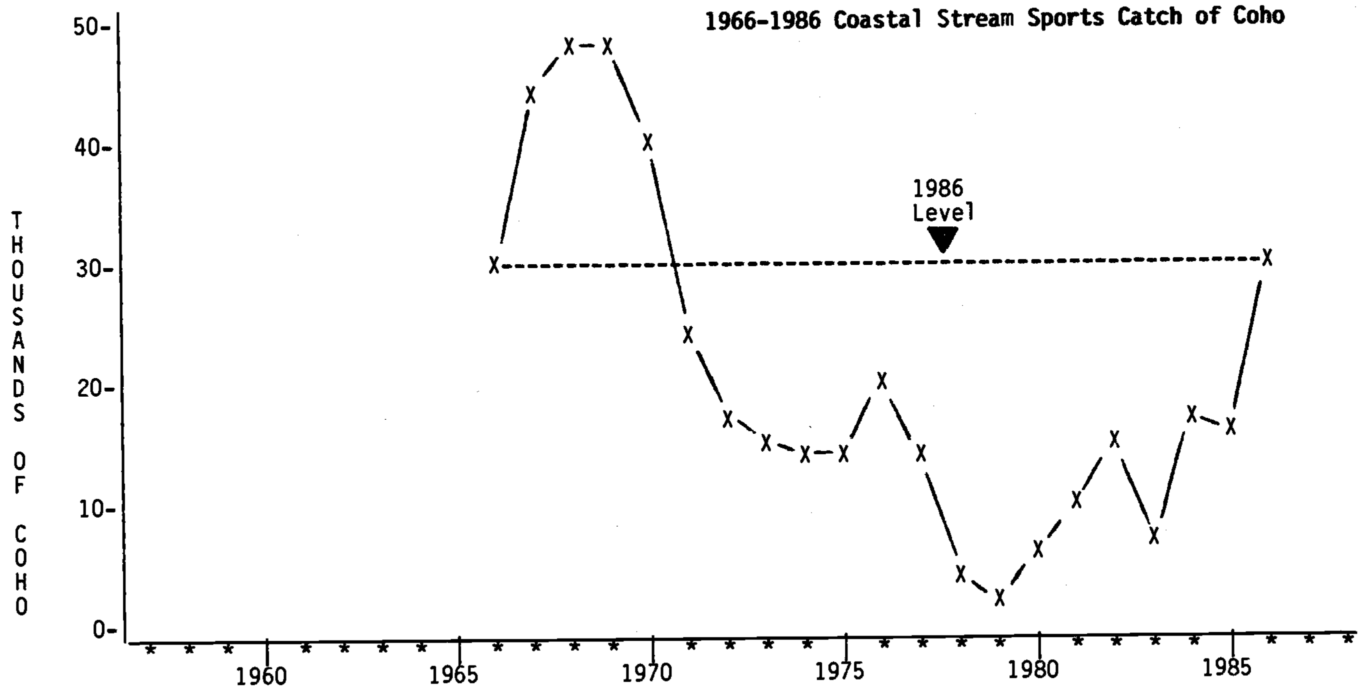
A). Oregon ocean commercial troll catches of coho for 1925-1988. Data are from Mullen (1981), K. Johnson (1983), and McQueen et al. (1988:14); 1988 preliminary data are from Laimons Osis (ODFW Biologist, pers. comm.).



B). Oregon ocean sports catches of coho for 1954-1988. Data are from K. Johnson (1983) and McQueen et al. (1988:40); 1988 preliminary data are from Laimons Osis (ODFW Biologist, pers. comm.).



C). Oregon coastal stream sports catches of coho for 1966-1986. Data are from Berry (1981), K. Johnson (1983), and ODFW (1987); 1986 preliminary data are from Ron Williams (ODFW Biologist, pers. comm.). These data do not include the Columbia River or its tributaries.



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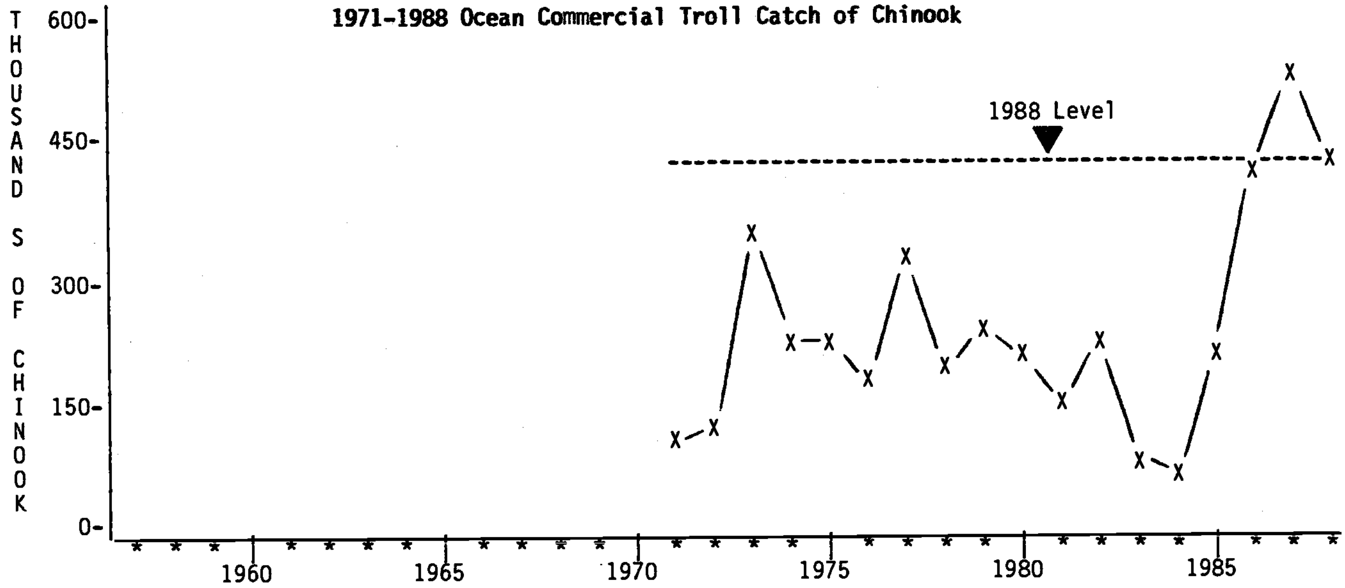
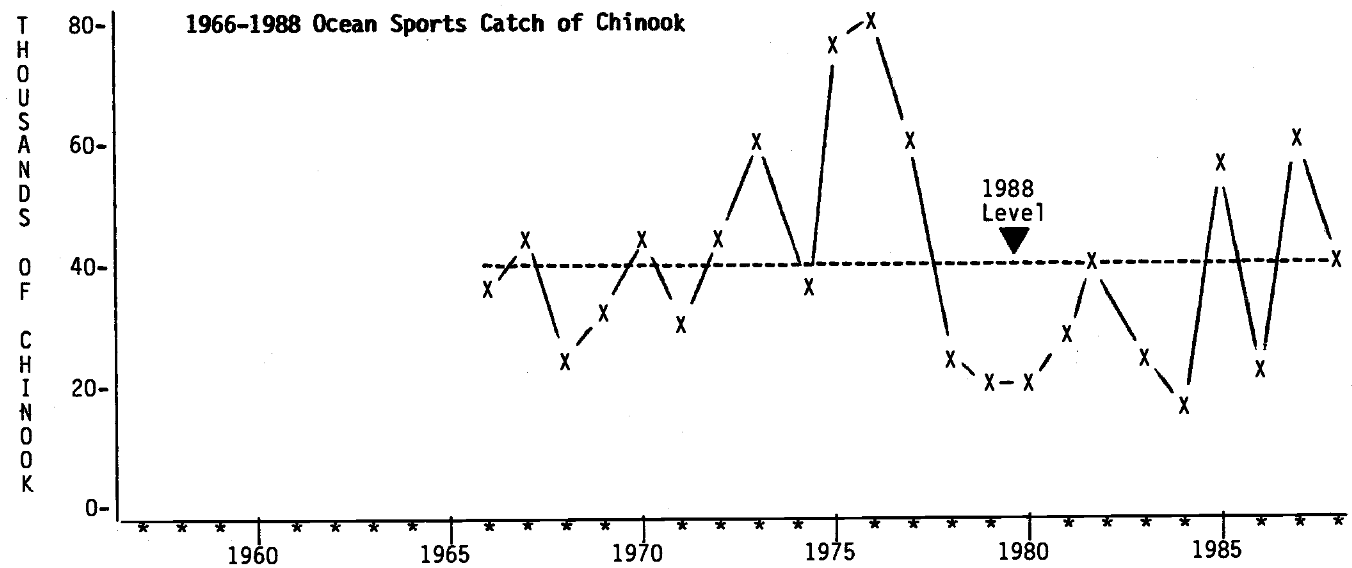
Appendix IV. Ocean and coastal stream catches of chinook salmon. Also see section 2-D-2.

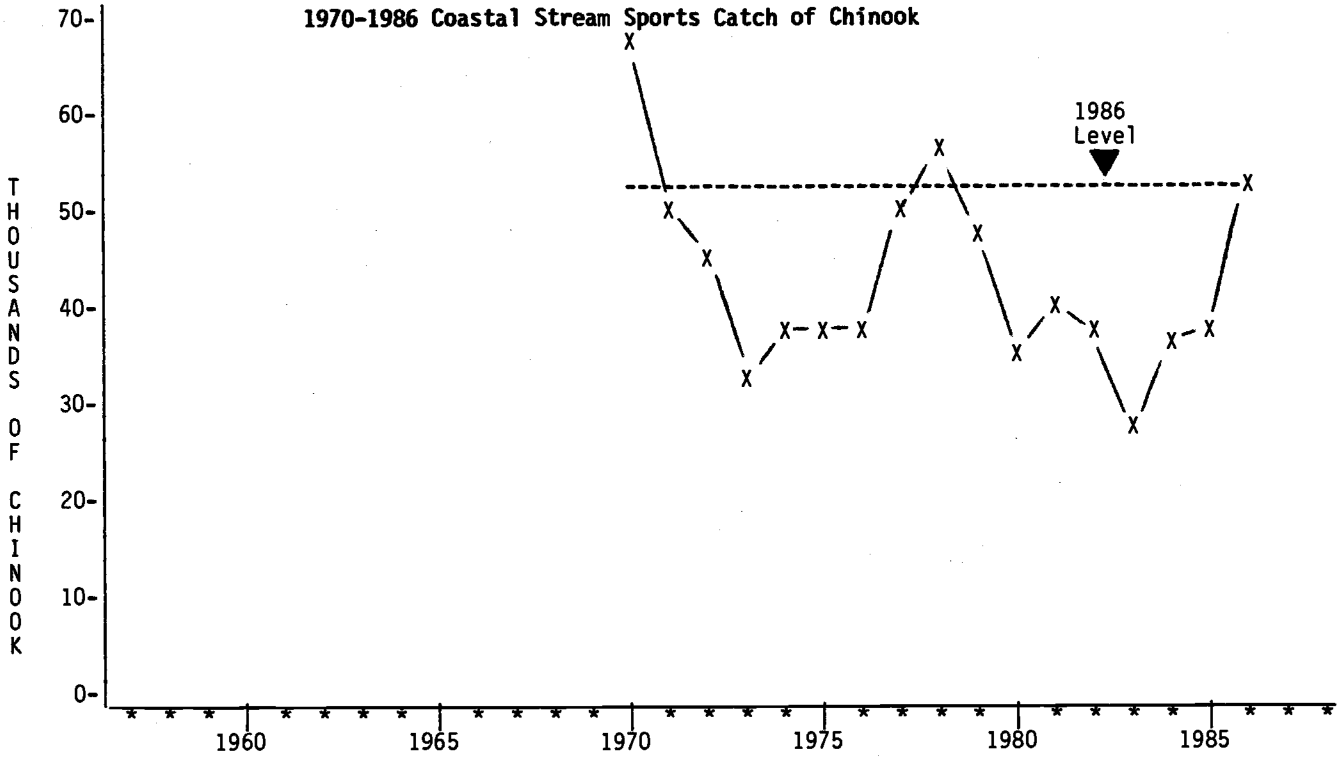
A). Oregon ocean commercial troll catches of chinook for 1971-1988. Data are from McQueen et al. (1988), and 1988 preliminary data are from Laimons Osis (ODFW Biologist, pers. comm.).



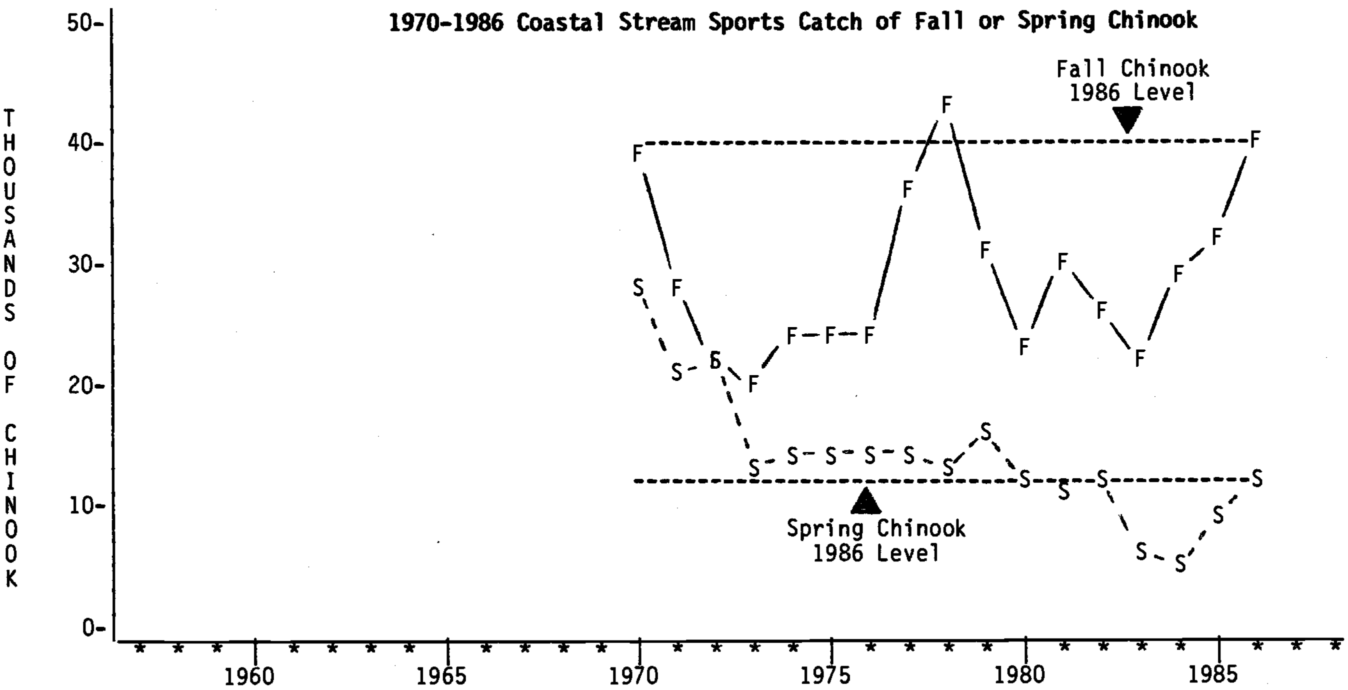
B). Oregon ocean sports catches of chinook for 1966-1988. Data are from McQueen et al. (1988), and 1988 preliminary data are from Laimons Osis (ODFW Biologist, pers. comm.).



C) Oregon coastal stream sports catches of chinook for 1970-1986. Data are from Berry (1981) and ODFW (1987); 1986 preliminary data are from Ron Williams (ODFW Biologist, pers. comm.). These data do not include the Columbia River or its tributaries. See D) below for separate coastal stream catches for fall and spring chinook.



D). Oregon coastal stream sports catches of fall or spring chinook for 1970-1986. Data are from Berry (1981) and ODFW (1987); preliminary 1986 data are from Ron Williams (ODFW Biologist, pers. comm.). These data do not include the Columbia River or its tributaries.



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Appendix V. Maximum number of Brown Pelicans, Common Loons, Horned Grebes, Brant, Buffleheads, and Caspian Terns censused at Yaquina Estuary in early (1-15th) or late (16th or later) April-June. Areas censused for Brown Pelicans and Brant were the estuary mouth and embayments in Bayer (1983b:79), areas censused for Common Loons and Horned Grebes were the estuary mouth, embayments, and upper estuary below A in Bayer (1983b:79); and areas censused for Buffleheads and Caspian Terns were only the embayments in Bayer (1983b:79). Censuses were by R. D. Bayer. Note that Tillamook Bay is more than twice as large as Yaquina Estuary, so bird numbers at Tillamook Bay would probably be much larger than those given below. -=no census made. Also see section 3-H.

		Brown Pelican...			Common Loon.....			Horned Grebe..........			
		1980	1982	1983	1979	1980	1981	1979	1980	1981	1984
April	early	0	-	-	39	39	42	65	52	86	134
	late	0	0	0	24	49	31	55	71	67	72
May	early	0	0	0	14	6	10	3	0	1	10
	late	0	1	1	6	11	3	0	2	1	0
June	early	0	8	84	-	-	-	-	-	-	-
	late	20	59	27	0	8	-	0	-	-	-

		Brant..........			Bufflehead		Caspian Tern..........			
		1981	1982	1984	1984	1985	1982	1983	1984	1985
April	early	630	691	294	484	582	-	-	-	0
	late	174	427	167	250	355	-	-	-	10
May	early	12	67	206	58	17	-	-	-	0
	late	0	2	9	0	0	-	-	-	16
June	early	0	3	-	-	0	19	30	28	9
	late	-	-	-	-	-	22	49	40	71

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Appendix VI. Maximum number of shorebirds censused at Yaquina Estuary in early (1-15th) or late (16th or later) April-June. Shorebird categories include Whimbrels, "small" shorebirds (i.e., sandpipers, Semipalmated Plovers, and other shorebirds less than about 7 inches [18 cm] long), and "other" shorebirds (i.e., medium and large shorebirds larger than about 7 inches [18 cm], except Whimbrels). Censuses were at the embayments shown in Bayer (1983b:79) and were by R. D. Bayer. Note that Tillamook Bay is more than twice as large as Yaquina Estuary, so bird numbers at Tillamook Bay would probably be much larger than those given below. -=no census made. Also see section 3-H-7.

		Whimbrel..		Small Shorebirds		Other Shorebirds	
		1984	1985	1984	1985	1984	1985
April	early	-	18	-	585	-	48
	late	77	216	3800	2260	86	536
May	early	150	172	4760	420	86	21
	late	79	6	0	0	1	0
June	early	18	9	0	0	3	0
	late	23	-	0	-	3	-

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Appendix VII. Are additional studies to study smolt predators warranted?

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VII-A. Introduction

Research to determine that one species of animal or another can be a significant predator of smolts will not solve the predation problem. This is because a host of bird, fish, and marine mammal species have the potential to be significant predators (section 3-E). Even if one, two, or three species of predators were effectively stopped from preying on hatchery smolts, the remaining predators appear capable of taking the "saved" smolts because smolts may remain unwary of predators until after they are exposed to them (Ginetz and Larkin 1976, Patten 1977, Wood and Hand 1985, Olla and Davis 1988, 1989), whether that be in a river, estuary, or the ocean.

It should also be noted that additional research or studies will not solve the "predation" issue to the satisfaction of some fishermen unless the research shows that predators or potential predators should be controlled. Some fishermen "know" that predators are a problem, and no amount of research or scientific studies will convince them otherwise (e.g., Shotwell 1989). Thus, the only way that these fishermen will accept the results of these studies is if the results support their beliefs.

VII-B. Studies of Bird Predators

There have been ample studies in Oregon that have determined that Common Murres, cormorants, and other seabirds are predators of smolts (Matthews 1983, Ward 1983, Bayer 1986, Hoffman and Hall 1988). These studies did one or more of the following: count birds, observe birds to see if they were eating smolts, collect birds to determine how many smolts had been eaten, or use a bird's estimated daily food intake (see Appendix IX) to determine how many smolts could have been eaten. Based on the numbers of birds that can be present, the naiveness of hatchery smolts (section B in Appendix II), and the number of smolts each bird can take, it is already clear that birds have the **potential** of eating many hatchery smolts.

There seems to be no point in doing more of these kinds of studies because they only provide very rough estimates of smolt predation. Since predators such as Common Murres and Brandt's Cormorants do not normally feed on smolts in Oregon (Scott 1973, Matthews 1983), these birds may clearly not feed on smolts every day. Further, it can not be reasonably assumed that all birds counted at a site where smolts could be present are eating only smolts because these birds may be eating other kinds of prey or may not be catching any smolts at all (section 2-F-14).

These kinds of studies also do not indicate the total number of birds that are feeding on smolts at a site because birds are coming and going at different times throughout the day. Thus, a census of birds at one time can inaccurately estimate the total number of individuals that may feed at a site throughout a day.

Studies to try to determine exactly how many smolts birds are eating is not currently possible. Such research would have to determine if individual birds are feeding throughout the day, every day, on hatchery smolts and how many smolts each individual bird is eating each day over a period of weeks or months. For this kind of research, significant numbers of birds have to be individually marked, each followed throughout a day for weeks to see where they are feeding, and the actual diet of each bird has to be determined each day without killing the bird. This kind of research is simply not possible with today's technology.

VII-C. Studies of Predatory Fish

Although further research to simply determine that birds eat smolts in Oregon seems redundant, research to determine the potential significance of fish predators of smolts might be informative. Since fish predators have elsewhere been estimated to take 20-25% or more of smolts (Gunnerod et al. 1988), fish predators in Oregon may also be significant.

Preliminary observations in Oregon (e.g., Stuart 1984, Stuart and Buckman 1985) already indicate that at least adult coho salmon can be a significant predator of coho smolts (Nickelson 1986:533). But other predatory fish such as chinook, steelhead, cutthroat trout may also be significant smolt predators (section 3-E).

Studies using divers to observe fish predators of hatchery smolts in the days following a release (e.g., Anonymous 1959) could be helpful in discovering if smolts are vulnerable to predatory fish. Divers could work near the release site or at potential bottlenecks for smolt migration such as at a narrow mouth of an estuary.

Research to determine the stomach contents of predatory fish in estuaries or near the mouths of estuaries within 14 days after hatchery releases may also be valuable in establishing that predatory fish are eating smolts. This could be done by having ODFW salmon samplers or researchers check the stomach contents of salmon or predatory fish (e.g., black rockfish and lingcod) caught by fishermen and brought to public docks, marinas, charter boat docks, or dive shops to be gutted and cleaned. Since a major cost of research is to collect predatory fish, sampling fish brought in by fishermen could reduce research costs.

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Appendix VIII. Harmful effects of hatchery salmonids on wild salmonids.

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VIII-A. Introduction

Wild fish stocks have not been prospering in recent years, and the number of spawning wild coho has been markedly declining in coastal streams and in the Columbia River and its tributaries (ODFW 1985a:5). Competition with hatchery fish appears to be one cause for the decline of wild stocks.

In spite of the possible deleterious effects of the hatchery fish, they are necessary to support these fisheries (Fresh 1983, ODFW 1985a). For example, in 1977-1982, hatchery coho accounted for about 75% of the ocean fishery off Oregon (Nickelson 1986:528).

Fishermen disagree about the management of wild salmon and steelhead. Some fishermen want the ODFW to abandon its current wild fish policy, so that the harvest rate could be increased and fishermen could thus catch more fish now, even though this would harm wild fish (see following VIII-D-4). Other fishermen and some fishing groups such as Oregon Trout recognize the importance of wild fish and feel that the ODFW should do more to protect wild fish (Bakke 1989). This conflict is another example of a no-win situation that the ODFW is stuck with (also see sections 2-B-1 and 6-D.

In the following sections, the benefits of wild stocks and then the harmful effects of hatchery stocks on wild fish are examined.

VIII-B. Definition of "Wild" Fish

"Wild" fish can be variously defined. Three possible definitions include fish that have naturally spawned and reared in a given stream system:

1) for more than 10 generations.
2) for at least three generations (i.e., Type A wild fish in ODFW 1985a:4).
3) for one generation (i.e., Type B wild fish in ODFW 1985a:4).

Category #1 of wild fish includes the most pristine of native stocks adapted to a particular stream. Categories #2 and #3 can include progeny of hatchery fish brought in from distant non-native stocks. For example, natural spawning of non-native hatchery coho strays (i.e., adults not returning to their natal release site or hatchery), and their probable interbreeding with native coho in the Yaquina Basin has occurred for at least eight years (e.g., Nicholas et al. 1982, Nicholas and Van Dyke 1982, Jacobs 1988). Accordingly, it is doubtful if any pristine category #1 "wild" coho now exist in the Yaquina Basin, although category #2 and certainly #3 "wild" coho may be widespread.

In the following sections, "wild" fish refer to category #1 or #2 wild fish.

VIII-C. Benefits of Wild Salmonids

Although wild salmonids have aesthetic value and are also protected by law or policy (Dentler and Buchanan 1986), they are also important for more practical reasons. For example, wild fish don't cost taxpayers (including nonfishermen).

Secondly, wild salmonids produce proportionately more smolts than naturally spawning hatchery fish (Reisenbichler and McIntyre 1977, Chilcote et al. 1986, Bakke 1989).

Thirdly, juvenile hatchery salmonids do not survive as well after release as wild fish (Fraser 1974, Reisenbichler and McIntyre 1977, Gunsolus 1980, Dickson and MacCrimmon 1982, Ersbak and Haase 1983, Bachman 1984, Piggins and Mills 1985).

Fourthly, because of their genetic diversity and adaptation to the local conditions of a natal stream, wild fish may better withstand unfavorable environmental conditions, such as periods of low upwelling, than hatchery fish (Nickelson 1986). Thus, protecting wild fish to maintain their genetic diversity has been recognized to be important (Reisenbichler and McIntyre 1977, Stabell 1984, ODFW 1985a, L. S. Smith et al. 1985, Chilcote et al. 1986, Dentler and Buchanan 1986, Bakke 1989).

Fifthly, the ocean may also have a greater carrying capacity for wild than for hatchery fish because wild fish stocks are more genetically diverse (Parmenter and Bailey 1985). Thus, if wild fish stocks are further depleted, fisheries may subsequently decline.

Sixthly, wild salmon also benefit some fishermen because wild salmon distribute themselves more evenly along a stream (Dentler and Buchanan 1986), so that coastal stream anglers can have a better chance of fishing for them in solitiude. In contrast, fishermen for hatchery fish may have to fish "elbow to elbow" at sites near or below a hatchery where the fish were released and have subsequently returned (Dentler and Buchanan 1986).

Finally, wild salmonids are also useful as environmental indicators in detecting changes in water quality. Hatchery salmonids are not as suitable because they are less dependent on freshwater streams throughout their life (Dentler and Buchanan 1986).

VIII-D. Harmful Effects of Hatchery Salmonids

VIII-D-1. Competition of Juveniles

Hatchery salmonid pre-smolts or smolts can compete with wild smolts for food, space, or shelter (Nicholas et al. 1979, Myers 1980, Myers and Horton 1982, Fresh 1983, Nicholas and Herring 1983). Such competition has been found to decrease the abundance of wild coho juveniles (Solazzi et al. 1983, ODFW 1985a:8, Johnson and Solazzi 1986, Nickelson et al. 1986). This competition can be increased if some private hatchery smolts migrate upstream into juvenile rearing areas, which has occurred (e.g., Jonasson 1983, Nicholas and Herring 1983).

To reduce such competition, releases into streams are regulated by the ODFW. Since some

STEP volunteers exceeded their authority by becoming involved in cormorant harassment (section 1-E), one wonders if some STEP volunteers may have also released juvenile salmon at sites that they were not supposed to. Such unauthorized releases could harm wild fish stocks, perhaps irreparably (Nickelson 1981, Johnson and Solazzi 1986, Nickelson et al. 1986).

VIII-D-2. Hatchery Juveniles May Increase Predation on Wild Juveniles

Wild juveniles spread themselves out more than hatchery fish (Fresh 1983), so when wild smolts migrate to the ocean they are not as conspicuous or as available to predators. In contrast, the conspicuousness, the naivete, and the abundance of mass releases of hatchery juveniles attract many predators that don't normally prey on salmonids (sections 3-E and B in Appendix II). Once predators are attracted and form a "search image" for hatchery salmonids, they may also then prey on adjacent wild migrating juveniles. For example, in Ireland, Kennedy and Greer (1988) found that Great Cormorants preyed on hatchery and wild Atlantic salmon smolts.

VIII-D-3. Hatchery Fish May Introduce Diseases

Hatchery salmonids may also spread disease to wild salmonids (Dentler and Buchanan 1986). This could occur by the release of hatchery pre-smolts or smolts or by hatchery adults straying to spawn naturally.

VIII-D-4. Overharvesting of Wild Fish

Increasing fishing rates on hatchery salmon can also result in overharvesting wild salmon. Subsequently, too few wild salmon may escape to spawn, so that wild fish can't maintain their numbers (Gunsolus 1980, McGie 1984, Dentler and Buchanan 1986). Wild salmon may only be able to withstand a harvest rate of 67%, but harvest rates have been as high as 90% in 1976-1977 and 77-78% in 1981 and 1983 (Gunsolus 1980, ODFW 1985a:16).

VIII-D-5. Dilution of Genetic Variation and Competition of Adults for Spawning Areas

Current opinion favors using hatchery stocks derived from native wild stocks. While this may help reduce genetic loss, there may still be some loss of genetic diversity because hatchery fish are selected for ease of rearing under hatchery conditions (Ersbak and Haase 1983). Thus, hatchery fish of the same stocks as wild fish generally show a reduction of genetic variation (Lindsay et al. 1988:4).

Hatchery smolts that return as adults but stray from their natal release site can create problems by competing with wild fish for limited spawning areas (Nicholas et al. 1982). Further, the natural spawning of hatchery strays can reduce the number of salmonids produced in streams because hatchery fish spawning naturally do not produce as many young as wild fish (Reisenbichler and McIntyre 1977, Chilcote et al. 1986, Bakke 1989).

Adult hatchery strays can also interbreed with wild fish and thus dilute the gene pool of the wild fish (Lindsey et al. 1988:4, Bakke 1989). This dilution is important because wild fish have evolved to be most efficient at spawning, growing, and returning to each local stream (Dentler and Buchanan 1986); such genetic dilution appears to be irreversible.

Adult straying, especially from some private hatcheries, can be significant. For example, beginning in the 1970's, private hatchery coho smolts were released into the Yaquina Basin and have recently been documented as constituting a significant percentage of all naturally spawning adult coho in the Yaquina (44% in 1980, 74% in 1981, and 91% in 1985)(Nicholas et al. 1982, Nicholas and Van Dyke 1982, Jacobs 1988).

Further, it was estimated that 73% of all naturally spawning coho in 1985 from the Salmon River at the southern border of Tillamook County to the Yachats River just north of the Siuslaw Estuary were from the private hatchery in the Yaquina Basin (Jacobs 1988). With hatchery fish constituting so many of the naturally spawning coho in the Yaquina Basin for so many years, it seems questionable if there are any genetically pure wild coho in the Yaquina Basin and perhaps also in other nearby coastal streams.

Appendix IX. Estimating the daily food requirements of fish-eating birds.

IX-A. Introduction

Although it may seem easy to determine how much food a bird eats daily, this, like so many other questions, is one that becomes more difficult as one more closely examines it. Currently, only estimates are available; these indicate that a fish-eating bird needs to eat an average of about 9-25% of its body weight daily (section 2-F-5). Cummings (1987) may also have estimated daily food intakes for Double-crested Cormorants, but I have not seen her thesis.

The various methods of estimating daily food consumption are briefly discussed below.

IX-B. Digestion Can Affect Prey Size Determination

Several methods of determining daily food consumption involve analyzing the stomach contents of dead or live birds or examining bird pellets or feces.

Unfortunately, one problem common to all these methods is that a bird's digestion can impair a researcher's ability to determine all prey or prey sizes (e.g., Bowmaker 1963, Duffy and Jackson 1986:5-6). For example, fish may be partially digested, so that measuring prey size directly may not be possible. Further, some prey species may be entirely digested, so that they may be absent from a sample. For instance, birds can sometimes digest some fish within a few hours of ingestion (Bowmaker 1963, Jackson and Ryan 1986, Laugksch and Duffy 1986, Gales 1988). For a discussion of the digestion of fish by a cormorant, see Bowmaker (1963).

Oftentimes, prey species or size are determinable only from prey hard parts such as fish otoliths, fish eye crystals, or invertebrate hard parts such as squid beaks. The degree of digestion of fish otoliths or eye crystals may depend on meal size, prey species, prey size, and digestion time (Miller 1979:80, Duffy and Laurenson 1983, B. L. Furness et al. 1984, Duffy and Jackson 1986:6, Jackson and Ryan 1986, Furness and Monaghan 1987:24, Gales 1988).

If partially digested, otoliths can inaccurately estimate fish size (Duffy and Laurenson 1983, Gales 1988). For example, Gales (1988) found that prey size derived from otoliths can be significantly underestimated only 1-2 hours after ingestion and that some otoliths have been totally digested within one hour of ingestion.

If not all prey are found or if prey size can't be accurately determined, then it is not possible to accurately estimate the amount of food eaten. Thus, hardparts can only be used for determining relative diet and then only with caution.

IX-C. Shooting Birds and Using Stomach Contents

Waterbirds have been shot and their stomach contents examined and weighed (e.g., Bowmaker 1963). Then each bird's daily food consumption has been estimated by using a multiplier factor to guess how much food would have been eaten in the rest of the day.

One problem with this procedure is that a multiplier factor is based on assumptions (e.g., that a bird would continue to eat at the same rate for the rest of the day). Since some waterbirds can eat at variable rates throughout the day or may only spend a few hours daily foraging and perhaps not eat the rest of the day (section 2-F-4); it is difficult to accurately use a bird's stomach contents to estimate how much it would have eaten the rest of the day. Further, part of the food may be partially digested so determination of prey species and size may be difficult (section IX-B).

A second problem is that stomach contents may sometimes overestimate a bird's average daily food needs. For example, starved fish-eating birds can eat much more than average for 1-2 days and then not eat for a couple of days (section 2-F-5, "Maximum Smolts/Day").

The result is that shooting birds to determine their daily food consumption is unreliable (Mills 1967:383, Guillet and Furness 1985). However, stomachs of shot birds may be used to determine a bird's relative diet (e.g., Duffy and Jackson 1986:3).

IX-D. Live Capture of Birds and Use of Stomach Contents

IX-D-1. Capturing Birds

Cormorants or other waterbirds may be most easily caught at nesting or roosting areas using slip nooses or traps (e.g., Tenaza 1966, Foster and Fitzgerald 1982, Duffy and Jackson 1986:3-4). Further, at Yaquina Estuary, I was once able to walk at night with the aid of only part of a flashlight beam and use only my hands in catching a Pelagic Cormorant that was roosting on rocks, so catching birds at night roosting areas can be successful.

At foraging areas, net guns have been used to catch waterfowl or Marbled Murrelets (Mechlin and Shaiffer 1980, Varoujean and Williams 1987:4). Although the use of tranquilizer guns to capture mammals is common, it is not a method mentioned for birds (Duffy and Jackson 1986:3-4), perhaps because it may be too difficult to select a dose that doesn't harm a bird.

IX-D-2. Determining Stomach Contents of Live Birds

Once caught, the preferable method for determining stomach contents appears to be using a stomach pump, not emetics that cause regurgitation (Wilson 1984, Duffy and Jackson 1986:4-5, Ryan and Jackson 1986, Gales 1987). Birds may also be physically forced to regurgitate (Pilon et al. 1983, Cooper 1985a, Craven and Lev 1987:66). An experienced worker can use a stomach pump to obtain nearly all stomach contents without killing a bird.

IX-D-3. Problems with Estimating Daily Food Consumption of Live Birds

One problem with using stomach contents is that a bird may partially regurgitate before its stomach contents can be collected (Duffy and Jackson 1986:4). The main problem, though, is that it is unknown how much more food a bird would have eaten during the day, if it is caught early in the day; or how much food may have already been digested, if the bird is caught late in the day. Accordingly, stomach contents may reflect only what a bird has eaten recently.

Also, a bird's stomach contents may not be typical of its average daily food intake. For instance, starved fish-eating birds can eat much more than average for 1-2 days (e.g., section 2-F-5 "Maximum Smolts/Day).

IX-E. Using Pellets or Feces to Determine Daily Food Consumption

IX-E-1. Introduction

The advantage to using pellets or feces is that they do not involve shooting or catching birds.

The major problem with using pellets and especially feces to determine the diet or daily food consumption of birds is that many hardparts may have been digested (section IX-B).

IX-E-2. Pellets

Some birds, including cormorants, regurgitate pellets that may contain hard parts of fish (e.g., otoliths or eye crystals) or invertebrate prey (e.g., squid beaks)(Ainley et al. 1981, Duffy and Laurenson 1983, Pilon et al. 1983, Duffy and Jackson 1986:5, 6; Whitfield 1986, Craven and Lev 1987:66, Duffy et al. 1987b:830). One advantage to using pellets for cormorants is that it appears that they only cast about one pellet with food remains daily (Miller 1979:82, Duffy and Laurenson 1983).

IX-E-3. Feces

Fish or invertebrate hard parts may also sometimes be found in bird feces (Duffy and Jackson 1986:5, 6). But waterbirds may defecate more than once daily at variable intervals (e.g., Great Blue Herons, Bayer unpubl. data), so it is not possible to relate a feces sample with how much a bird may have eaten daily. Further, prey hard parts are more likely to have been digested before being passed in feces than are prey hard parts found in bird stomachs or pellets, so many prey may not be represented in feces.

IX-F. Using Stomachs of Beached Birds

Some researchers have used birds found dead on beaches to estimate seabird diets (see Duffy and Jackson 1986:3). Since some of these seabirds may have been starving or most of their food may have been digested before death, prey remains may be overrepresentative of prey with exceedingly hard parts such as squid beaks (e.g., B. L. Furness et al. 1984). Another problem is that prey found in beached birds may not be typical of their normal diet (Duffy and Jackson 1986:3).

IX-G. Direct Observation of Food Eaten by Wild Birds

There are several major difficulties with estimating the daily food consumption of birds from observations of foraging birds.

Firstly, not all prey may be identified. Since many diving birds can swallow food underwater, not all prey may be observed. Further, even if observable, many prey may not be correctly identifiable (Cezilly and Wallace 1988).

Secondly, many fish-eating birds forage over large distances, so it can be logistically difficult for researchers to be always able to keep an individual bird under close enough observation during a day to observe all prey that it may catch and swallow. If a bird is a night-forager, making accurate estimates of prey are much more difficult, if not impossible.

Thirdly, if a bird is only closely watched for part of a day to determine what prey it catches, then the prey it may have eaten the rest of the day can only be grossly guessed. It can't be assumed that a bird will eat at a constant rate throughout the day because some fish-eating birds may forage mainly in the morning or for only a few hours daily (section 2-F-4).

Fourthly, since starved fish-eating birds can eat much more than average for 1-2 days (section 2-F-5, "Maximum Smolts/Day"), it is important that the daily food consumption of each bird be followed for several days. Food consumption during a single day may seriously over- or underestimate a bird's average daily food consumption. If following a bird for one day is difficult, following it for several days is even more so.

Finally, to determine daily food consumption by direct observations, it is essential that the size of prey be estimated accurately. Estimating prey size by comparison with bill length has been a common technique that has not received much critical evaluation. But, especially for large prey, using bill length may not be very accurate in determining prey length (Bayer 1985a). Errors in estimating prey length would be greatly magnified in estimating prey weight because the length-weight relationship is exponential (Bayer 1985a). Further, if prey vary greatly in body shapes, errors in prey identification, even if prey length is correctly estimated, may lead to gross errors in estimating prey weights (Bayer 1985a, Cezilly and Wallace 1988).

IX-H. Estimating Daily Food Consumption of Wild Birds from Captive Birds

A common way of estimating daily food

consumptions of wild birds is to use food intakes or to measure metabolic rates of captive birds. Since captive birds aren't as mobile as wild birds, these measurements are then converted by use of various multiplicative factors to account for various types of locomotive activities or the estimated energetic cost of molting or nesting (Bowmaker 1963, Wiens and Scott 1975, Kendeigh et al. 1977, Ellis 1984, R. W. Furness 1984, Wiens 1984, Briggs and Chu 1987, Cummings 1987, Duffy and Siegfried 1987, Furness and Monaghan 1987).

To reasonably apply these methods to estimate the daily energetic requirements of wild birds, it is still necessary to observe wild birds to determine the typical duration of each type of activity (e.g., flying or diving), so that the energetic costs of each activity can be estimated (e.g., Kendeigh et al. 1977). Since daily metabolic rates can be influenced by ambient temperatures, weather, photoperiods, or a bird's energy-conserving activities; these factors must also be measured or included (Kendeigh et al. 1977, Wiens 1984, Furness and Monaghan 1987).

Once the daily energy requirements are estimated, then it is necessary to estimate the amount of food necessary to acquire this energy. This involves estimating conversion factors for prey live weights to dry weights and then dry weights to caloric content; these conversion factors can vary among prey (Dunn 1975, Marsault 1975, Wiens and Scott 1975:447, Swennen 1977:32, Duffy and Siegfried 1987). Then a bird's assimilation efficiency (which can also be variable) must be estimated to determine how much of the food's caloric content can be utilized in satisfying the bird's energetic demands (Dunn 1975, Kendeigh et al. 1977, Wiens 1984, Briggs and Chu 1987, Duffy and Siegfried 1987). With estimates at each stage of calculation, it is difficult to know how accurate the final estimated daily food consumption is.

With variability in prey caloric content, bird assimilation, and bird energetic needs, it is also clear that the amount of food eaten daily can vary (e.g., Marsault 1975). These sources of variation in daily food intake have, thus far, only received anecdotal consideration (e.g., Marsault 1975, Swennen 1977:32).

IX-I. Measuring Energy Consumption of Wild Birds

To avoid problems with using energy requirements of captive birds in estimating wild bird requirements, it has been proposed that the energy consumption rates of wild birds be measured directly by catching wild birds, inserting heart rate biotelemetry devices or radioisotopes, and releasing the birds to let them live normally (Kendeigh et al. 1977:199, R. W. Furness 1984:122, Furness and Monaghan 1987:75). If radioisotopes are used, then each bird has to be recaptured, and the isotope measured within a pre-determined length of time.

Even if these methods can be used, problems remain in converting the measured energy consumption into the amount of prey needed to be ingested daily because of variability in nutritive content of prey and variable bird assimilation rates (section IX-H).

****

Appendix X. Letter from Oregon Representative Paul Hanneman to Kathleen Confer. Note the language in the second paragraph. Reprinted with permission of Kathleen Confer.
****

PAUL A. HANNEMAN
TILLAMOOK, WASHINGTON, YAMHILL,
POLK AND LINCOLN COUNTIES
DISTRICT 3

REPLY TO ADDRESS INDICATED:
☐ House of Representatives
Salem, Oregon 97310-1347
☐ 35010 Resort Drive
Cloverdale, Oregon 97112

COMMITTEES
Member:
Ways and Means
General Government Subcommittee
Natural Resources/
Economic Development Subcommittee

HOUSE OF REPRESENTATIVES
SALEM, OREGON
97310-1347

February 21, 1989

Kathleen Confer
4905 Ellen Avenue
Tillamook, OR 97141

Dear Kathleen:

I'm sorry it has taken me until now to respond to your letter. I wanted to let you know that we have introduced legislation which, if approved, would allow the Oregon Department of Fish and Wildlife to issue not more than three permits statewide during each of calendar years 1989 and 1990 for hazing cormorants in inland waters.

The purpose of the bill is to provide some relief for downstream migrating salmon during their four-week period. We suspect and believe that we can prove that less than 50 percent of our expensive, publicly-produced salmon and steelhead are able to reach the ocean.

The bill does not authorize anyone to physically harm the birds.

Thank you for your input and concern on this issue.

Very truly yours,

Paul

Paul Hanneman
State Representative,
District 3

ph/ms

****

Appendix XI. Reprint of Hoffman and Hall's (1988) U.S. Dept. of Agriculture, Animal Damage Control Program interoffice memorandum about their cormorant collection on 27 April 1989. Note that the Brandt's Cormorants were misidentified, and there are some other problems with their study (sections 1-D-3 and 2-F-5).

****

United States Department of Agriculture | **Animal and Plant Health Inspection Service** | **Animal Damage Control** | **727 N.E. 24th Avenue Portland, OR 97232**

Date: May 18, 1988
To: File
From: Thomas Hoffman, State Director
Thomas Hall, Wildlife Biologist
Subject: Tillamook Trip Report Regarding Smolt/Cormorant Problem

Since March 1985, Animal Damage Control has been involved in cooperating with various private individuals in the Nehalem Bay area assisting them in hazing cormorants feeding on salmon and steelhead smolt. Participation has focused on the Nehalem River system and the smolt produced in this area. Cooperators from the Northwest Steelheaders Association and the Cooperative Salmon and Trout Enhancement Projects (STEP) were provided technical expertise and hazing supplies for scaring cormorants from smolt vulnerable to depredation. Our past involvement evolved from our previous fish-eating bird work with Federal and State fish rearing facilities. The Oregon Department of Fish and Wildlife (ODFW) was indirectly involved in 1985 and 1986 thru contacts with the North Fork Nehalem Fish Hatchery and State Fishery Biologists.

On April 27, 1988 we (T. Hoffman and T. Hall) assisted concerned cooperators in the Tillamook area by surveying the problem of cormorant depredations and collecting a limited number of birds to help understand the feeding habits of cormorants in this tidal area. We collected 24 birds during the day at various times to see differences in feeding behavior. All birds collected were necropsied and grossly examined for esophageal and gizzard contents. An observation of the number of birds using the area was also determined. These observations will be discussed, but first, background information will be given.

BACKGROUND

Most of the salmon and steelhead consumption by cormorants occurs from March to May. During this time cormorants are formidable predators and can consume large quantities of wild and hatchery-reared fish. Although an estimate of smolt consumption is unavailable, the percentage of smolt consumed is potentially high.

Steelhead and salmon are vulnerable to predation their entire lives. As smolts, predation vulnerability is much higher as they are not "streetwise" and are of a size preferred by many predators. Cormorants are potentially the most significant predator to the smolt in the early stages, though several predators are present, such as seals, herons, gulls, and murres. Other predators are present in the ocean as well after they make their transition from rivers to the sea. This toll plus natural mortality greatly reduces the return of these anadromous fish.

It is hard to say which predator has the greatest impact on the Nehalem and Tillamook salmon and steelhead, but cormorants are the first in line to significantly feed on them and it is easy to see they could potentially be a large problem. The cormorants fly upstream to release sites and start feeding on the smolt as they migrate toward the ocean. From here they follow the schools downstream to the ocean. The fish take a few months to complete this journey because they must acclimate to the changing salinity levels. Therefore, depending on a few other factors such as population size and time of release, cormorants could have a significant impact on the population of smolt.

The primary cormorant that nests along the Oregon coast is the Brandt's cormorant. Double-crested and pelagic also occur at lower numbers. Brandt's cormorants are primarily restricted to the coast. They nest in dense colonies on flat surfaces of rocky islands. In 1979, the estimated population for Oregon was about 16,000. The double-crested cormorant population of coastal regions in Oregon was estimated at 1700 birds. The pelagic cormorant was found to be in much smaller groups scattered along the coast and 6300 was the estimated population (Correspondence from USFWS).

TRIP RESULTS

From the Tillamook Bay area at the mouth of the Wilson, Tillamook, and Trask rivers, 24 Brandt's cormorants were collected on April 27, 1988. Of these 22 were adults and 2 were immature. At 7:00 AM, 7 incoming (heading upriver) cormorants were taken. Of these, 5 had no contents in their esophagus, 1 had 4 partially digested smolt, and 1 had 5. At 10:30 AM, 3 outgoing cormorants were collected with most fish in the esophagus: 1 had 6 steelhead smolt (all 7-8"), 1 had 16 salmon smolt, and 1 had 8 salmon smolt; and 7 incoming cormorants were collected with only partially digested smolt in the gizzard: 1 had no smolt, 3 had 2 smolt, 2 had 4 smolt, and 1 had 5 smolt. At 12:30 PM, 4 outgoing cormorants were collected with 4, 6, 7, and 9 smolt in the esophagus and gizzard and 3 incoming cormorants had 1, 3, and 3 smolt all partially digested. The information from these collected birds suggests that birds begin morning forays for food sometime around 7:00 AM. The number of fish consumed varied, but were greater for outgoing birds than incoming suggesting they were consuming fish from up in the rivers where the smolt were concentrated.

During the day, a flock of 250-300 birds was observed in the bay along with several others seen at the same time in other areas. A flock of 75 cormorants was hazed 0.5 miles upstream from the mouth of the Tillamook River around 1:00 PM. No effort, however, was made to determine cormorant numbers on the bay or in the area.

****

Appendix XII. Copy of original House Bill 3185, as introduced in March 1989 (see section 1-I-1).

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65th OREGON LEGISLATIVE ASSEMBLY--1989 Regular Session

House Bill 3185

Sponsored by Representatives HANNEMAN, HANLON, SOWA, Senators BRADBURY, BRENNEMAN (at the request of Jim Erickson, Nehalem)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure **as introduced.**

Directs State Fish and Wildlife Commission to issue only three permits per year, in calendar years 1989 and 1990, for hazing of cormorants on Oregon coastal rivers.

Declares emergency, effective on passage.

A BILL FOR AN ACT

Relating to cormorants; and declaring an emergency.

Be It Enacted by the People of the State of Oregon:

SECTION 1. Section 2 of this Act is added to and made a part of ORS chapter 498.

SECTION 2. The commission, by rule, shall issue not more than three permits in calendar year 1989 and not more than three permits in calendar year 1990 for the hazing of cormorants (Phalacrocoracidae) on Oregon coastal rivers. However, activities authorized by the permit shall not include the killing, trapping or other taking of cormorants.

SECTION 3. This Act being necessary for the immediate preservation of the public peace, health and safety, an emergency is declared to exist, and this Act takes effect on its passage.

****

Appendix XIII. Copy of amended House Bill 3185 that was passed by the Oregon House Agriculture, Forestry and Natural Resources Committee by a vote of 7-1 and that was also passed by the Oregon House by a vote of 56-4 (see section 1-I-3).

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65th OREGON LEGISLATIVE ASSEMBLY--1989 Regular Session

A-Engrossed

House Bill 3185

Ordered by the House April 26
Including House Amendments dated April 26

Sponsored by Representatives HANNEMAN, HANLON, SOWA, Senators BRADBURY, BRENNEMAN (at the request of Jim Erickson, Nehalem)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure.

Directs State Fish and Wildlife Commission to issue only three permits per year, in calendar years 1989 and 1990, for hazing of cormorants on certain Oregon coastal rivers. **Specifies time period for hazing. Requires monitoring of activities and report to Sixty-sixth Legislative Assembly.**

Declares emergency, effective on passage.

A BILL FOR AN ACT

Relating to cormorants; and declaring an emergency.

Be It Enacted by the People of the State of Oregon:

SECTION 1. Section 2 of this Act is added to and made a part of ORS chapter 498.

SECTION 2. The commission, by rule, shall issue not more than three permits in calendar year 1989 and not more than three permits in calendar year 1990 for the hazing of cormorants (Phalacrocoracidae) on certain Oregon coastal rivers. However, activities authorized by the permit shall not include the killing, trapping or other taking of cormorants. Hazing activities shall be conducted only on rivers that flow into Nehalem Bay or Tillamook Bay, during the period between release of hatchery smolts and June 30. Hazing activities shall be monitored by the department. A log of activities shall be kept and a report made to the Sixty-sixth Legislative Assembly.

SECTION 3. This Act being necessary for the immediate preservation of the public peace, health and safety, an emergency is declared to exist, and this Act takes effect on its passage.

****

Appendix XIV. Reprint of Erickson's (1989e) written petition to the Oregon Fish and Wildlife Commission. As a testifier and attendee at the House Agriculture, Forestry and Natural Resources Committee Hearing that Erickson refers to, I know, contra Erickson's assertion below, that "all sides" did **not** agree that hazing is necessary. Also note that both Erickson and Gallino are fishing guides (Anonymous 1988a). This is a public document.

****

April 24,1989

Randy Fisher
Director of O.D.F.&W.

We would like to submit this petition to the O.D.F.&W. Commission to issue Cormorant hazing permits for the Nehalem and Tillamook Bays.

The purpose of the hazing was well argued at the House Ag. committee meeting in Salem and all sides came to the agreement, hazing is necessary to protect the smolts if a carefully monitored program is carried out. Everybody except O.D.F.&W.

Wwould like to petition the commission for Cormorant harrassment permits as soon as possible. The reason being the smolts are coming down the river and are being eaten up by the Cormorants at an astounding rate.

We request at least 6 permits for the Nehalem and Tillamook Bays consisting of 2 master permits to J.R.Erickson and Sam Gallino with 4 sub-permits to be issued by Erickson and Gallino as they see fit when they need help. Erickson and Gallino will be respondsible for each sub-permitees actions.

We would also at that time present our plans for a study to determine what effort the Cormorants are having on the fish population.

APR 25 1989

Sincerely,

Jim Erickson
Rt.1 Box 268
Nehalem, Or.
97131

HOUSE AG & NATURAL RESOURCES
Bill No. HB 3185 Pages 3
Exhibit H Date 4/13/89
Presented by Jim Erickson

Appendix XV. Reprint of Erickson's (1989d) written testimony to Oregon House Agriculture, Forestry and Natural Resources Committee Hearing on 13 April 1989 about House Bill 3185. Also included with Erickson's written testimony was a photocopy of McAllister (1988), which is not reprinted here. This is a public document.

COMMITTEE OF H.B.3185

This is not a lengthy report of bird problems all over the world but very short to the point about the problems we face in our bays and estuarys in Oregon with bird predation, especially the Cormorants.

Each spring the hatcheries release the salmon and steelhead smolts by the thousands into the rivers either by truck or directly into the streams.

During the migration we observed these smolts held up in the bays and estuarys for some reason and for varying lengths of time; From one to six weeks before they leave for the ocean.

During this time the Cormorants can come into the bays and rivers and completely wipe out these smolts balls with absolutely no interference until 1988. During the hazing program in 1988 several things were found by Federal Fish and Wildlife people and ourselves.

1. Cormorants are eating smolts at an alarming rate. These cormorants are keyed in on the smolt migration and only come into the bays and rivers in large numbers during the smolts migration during April, May and June.

2. Hazing works very well with the cormorants as it does with other troublesome animals and birds with no noticable effect on other bird life in the immeidate area. This can be done with the standard cracker shells and screamer shells. Both these methods have proven to be both very effective and cost efficient in other hazing programs and also worked the the cormorants.

3. Hazing has already shown its value. More then 3x as many steelhead jacks returned to the North Fork Nehalem River hatchery this YEAR than any previous year(with or without the weir)so we have smolt survival, also if one sees large flocks

of cormorants eating large amounts of smolts and we can prevent this from happening with hazing. Hazing works. Seeing first hand the positive effects of hazing on other species of animals and birds to protect a resource it is hard to see why Oregon Deparment of Fish and Wildlife haven't adopted a hazing program on all the rivers that plant steelhead and salmon in the State of Oregon.

The conclusion is before the hazing program we saw thousands (or hundredsdepend who you want to listen to) cormorants eating smolts. After the hazing program was in operation we didn't see any cormorants eating any smolts,so therefore to be very simple, hazing works without killing any birds.

However we see a few problems with the number of permits issued and would like the bill to say,"at least 1 permit for Nehalem Bay and 2 permits for Tillamook Bay with provisions for 2 "helpers" on each bay."

Sincerely,

Jim Erickson

Jim Erickson
Rt.1 Box 268
Nehalem, Or
97131

Phone; 368-5365

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See Appendix I (p. 60) for alphabetized listing of common names with scientific names for animals mentioned.

Note that an indexed item may be cited more than once on each indexed page.

*=species is, or potentially, is a predator of juvenile coho or chinook.

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Cormorant/Fisherman Conflict

Trying to understand
this conflict is
an educational as well as
a philosophical experience.

This conflict is not limited
to Tillamook County
in 1988-1989;
it is an ancient conflict
that will probably continue
as long as there are
fishermen and cormorants.

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