**OREGON PLAN for SALMON and WATERSHEDS**

**COASTAL COHO ASSESSMENT**

# INTRODUCED FISHES IMPACTS

**(PECE Policy Format)**

## Oregon Department of Fish and Wildlife

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# PECE (Policy for Evaluation of Conservation Efforts) Policy

**Certainty that the conservation effort will be implemented.**

1. Describe the staffing, funding level, funding source, and other resources necessary (and available) to implement the conservation effort or regulatory program.
Monitoring and management of introduced fishes are currently accomplished primarily through ODFW Fish District staff, and their activities funded through the agency's base budget. Funding of District management activities is typically through Other Funds (License and Tag fees) and Federal matching funds (Sport Fish Restoration, e.g.). While there is no current Western Oregon Warmwater Fish Biologist position within ODFW, the Eastern Oregon Warmwater Biologist has provided coastal Districts with assistance through population modeling, project review, and technical advice/expertise.

2. Describe the legal authority to implement and the commitment to proceed with the conservation effort or regulatory program.
ODFW has the legal authority granted to the agency by State statute for management of fish and wildlife populations, namely the Wildlife Policy—ORS 496.012. This includes a policy and commitment to "…prevent the serious depletion of any indigenous species…", which would apply to management of introduced fish species and their impacts on coho salmon.

3. Describe the legal procedural requirements (e.g. environmental review), if any exist, necessary to implement the effort or regulatory program.
Management objectives and actions for some populations of introduced fish are established through Basin Fish Management Plans, adopted by the Oregon Fish and Wildlife Commission. More general objectives for introduced species are outlined in ODFW's Warmwater Fish Management Plan. Development or amendment of these plans has concomitant public review processes. Other management of introduced fishes is guided or constrained by Oregon Administrative Rules or Oregon Revised Statutes that direct ODFW operations.

4. Describe the authorizations (e.g., permits, landowner permission), if applicable, necessary to implement the conservation effort or regulatory program. Describe the level of certainty that these authorizations will be obtained.
Under the Federal ESA rules, Section 4(d) Research authorization is required in order for ODFW employees and other entities to conduct research and monitoring activities that may impact listed species. Such activities pertaining to monitoring/management of introduced species would include trapping or netting fish for tagging, for example. ESA Section 10 permits are required to conduct boat electrofishing; however no ODFW Fish Districts within the Coastal Coho ESU currently hold such a permit to conduct this activity. Landowner permission would be required primarily for land access to water bodies where management or monitoring activities take place. For water bodies inhabited by introduced fishes, public access is typically available without the need for private permission.

If private water bodies are determined to hold introduced fishes for which management actions are necessary, landowner permission must be acquired to conduct such actions.

5. Describe the type and level of voluntary participation necessary to implement the conservation effort or regulatory program. Describe the level of certainty that this level of voluntary participation will be achieved.

The management and monitoring of introduced fishes does not require voluntary participation. However, volunteers under ODFW's Salmon and Trout Enhancement Program (STEP) often assist the agency with significant effort toward fish management, monitoring, and habitat improvement work.

6. Are necessary regulatory mechanisms (e.g., laws, regulations, ordinances) to implement the conservation effort or regulatory program in place?

As stated in #2 above, the Wildlife Policy mandates the protection of indigenous species. Other statutes and administrative rules guide and direct the management of native and introduced fishes.

7. Is there a high level of certainty that Oregon will obtain the funding necessary to implement the conservation effort or regulatory program?

As described above, monitoring and management of introduced fishes are conducted primarily through ODFW's base program. There is a high level of certainty that the agency's base budget will continue in the future.

8. Is an implementation schedule (including incremental completion dates) for the conservation effort established? If so, provide the schedule.

Monitoring of Oregon Coast ESU coho salmon is ongoing. The monitoring and management of introduced fishes are also ongoing as regular District management activities, however no specific schedule exists. (See ***Management*** and ***Monitoring*** sections of attached report.)

**Certainty that the conservation effort will be effective.**

1. Describe the nature and extent of threats (factors for decline) being addressed by the conservation effort or regulatory program and explain how the conservation effort or regulatory program reduces the threats.

On an ESU scale, introduced fishes are not widespread in their overlap with listed coho salmon. Abundance and prevalence of introduced species is greater in the southern end of the ESU, as opposed to the northern end. Conversely, the southern part of the ESU has exhibited healthier, more stable populations of coho salmon as compared to the northern part. For this and other reasons, the impacts of introduced fishes do not appear to be threatening the sustainability of the Oregon Coast coho ESU.

2. Describe explicit incremental objectives for the conservation effort or regulatory program and dates for achieving them.

Not applicable. No specific dates, but management and monitoring of native and introduced species are ongoing. (See ***Management*** and ***Monitoring*** sections of attached report.)

3. Describe the steps necessary to implement the conservation effort in detail.

Not applicable. Specific steps are not identified at this time. Management and monitoring of introduced fishes are ongoing. (See ***Management*** and ***Monitoring*** sections of attached report.)

4. Describe quantifiable, scientifically valid parameters that will demonstrate achievement of objectives, and standards for these parameters by which progress will be measured.

The status and health of Oregon Coast ESU coho salmon is intensive monitored by the ODFW's Oregon Plan Coastal Monitoring Program. Through ODFW's Native Fish Conservation Policy (NFCP), interim criteria have been established for abundance, distribution, life history, and other parameters to assess the status and risk to coho populations. Introduced fish species will continue to be evaluated as a potential risk factor in Conservation Plans developed under the NFCP.

5. Describe provisions for monitoring and reporting progress on implementation (based on compliance with the implementation schedule) and effectiveness (based on evaluation of quantifiable parameters) of the conservation effort or regulatory program.

Progress and effectiveness will be reported through the Oregon Plan Coastal Monitoring Program and through required periodic updates of stock status in the implementation of the NFCP.

6. Describe how principles of adaptive management are incorporated.

ODFW's current assessment of the impacts of introduced fishes does not implicate this factor as preventing the sustainability of Oregon Coast ESU coho salmon (see Results, below). If new information arises and the assessment changes, the agency will evaluate such information and adapt its management of introduced fishes accordingly. One such example of this occurred with the discontinuation of striped bass stocking in the Coos Basin, due primarily to concerns for listed, native coho salmon. (See ***Introduced Fishes Impacts at the Coho Population Scale—Coos***, below.)

October 12, 2004

**OREGON PLAN COASTAL COHO ASSESSMENT**
# ODFW INTRODUCED FISHES IMPACTS REPORT—(PECE Format)
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## Introduction

Many human activities reduce or negatively affect native fish, even causing direct mortality. Practices such as agriculture, grazing, logging, hydropower development, irrigation, navigation, and flood control are often cited as major factors contributing to the decline of native fish stocks. Additional factors of decline include urban development, habitat alterations, industrial and urban pollution, overharvest, hatchery fish management practices, and the introduction of non-native species.

The purpose of this report is to present the results of an assessment of interactions with introduced fishes as a factor for decline of Oregon Coast ESU coho salmon. This report also describes management and/or regulatory programs related to this decline factor.

Introduced fishes within the Oregon Coast Coho ESU (Figure 1) include largemouth bass, smallmouth bass, striped bass, hybrid bass (white bass x striped bass), bluegill, pumpkinseed, black crappie, white crappie, brown bullhead, yellow bullhead, yellow perch, American shad (shad, hereafter), brook trout, brown trout, kokanee salmon (native to Oregon, but introduced to the ESU), green sunfish, common carp, grass carp, and mosquitofish. (See Table 1 for a species list with scientific names.)

Impacts of non-native fish on coho salmon in the Oregon Coast ESU fall primarily in the categories of predation and competition. Largemouth, smallmouth, and striped basses, black crappie, and yellow perch are piscivorous and their diets include juvenile salmonids where the opportunity exists. Direct competition for food and rearing space may occur between juvenile coho and non-native fish species such as bluegill, shad, mosquitofish, brown bullhead, and juveniles of the predacious species named above. Interbreeding, often cited as a factor in a native/non-native interaction such as that of bull trout and brook trout, is not identified as a factor of decline for coastal coho. No disease-related impacts to coho salmon were identified from introduced fish sources (Amandi, 2004).

Introductions occurred during a period in history (1870-1930; Table 2) when there were few restrictions on the transport of new species into the State. These species were introduced to Oregon by individuals or agencies that envisioned commercial or recreational benefits to the populace. Eventually, many of these species were transported throughout the State, and into waters within the Oregon Coast ESU.

Brook trout were distributed widely throughout Oregon in the early to mid-1900's, but are not currently identified as inhabiting areas within the Oregon Coast ESU. Remnant populations were identified in coastal basins (e.g. Millicoma Basin, Matson Creek) as late as the 1980's (ODFW 1990), but have not been recently observed.

Introduced fishes support some of Oregon's most important recreational fisheries, such as the largemouth bass fishery in Tenmile Lakes and Brownlee Reservoir's crappie and channel catfish fisheries. Striped bass and shad supported commercial fisheries in coastal estuaries until the 1970's, and continue to provide recreational fisheries today.

**Description of Regulatory and Volunteer Measures—ODFW Management of Introduced Fishes**

Management of introduced fishes in Oregon is primarily addressed through four mechanisms: angling regulations, stocking, transport permits and restrictions, and habitat enhancement.

Within the ESU, angling regulations on introduced fish are generally aligned with the "Statewide" regulations for these species. In general, bag limits are five largemouth or smallmouth bass per day, with no more than three fish over 15 inches in length. Regulations for smallmouth bass in the Umpqua Basin are a more liberal, 10-fish bag limit with no size restrictions. A regulation is scheduled to take effect January 1, 2005, to prohibit harvest of largemouth bass 15 inches and over from the Tenmile Lakes. Under the Statewide regulations, there are no bag or size limits for bluegill, crappie, yellow perch, or brown bullhead. Striped bass are managed coast-wide with a two fish bag limit per 24-hour period, and a 30-inch minimum size. No bag or size limits pertain to angling for shad or common carp. Angling for brown trout in the North Umpqua system is catch-and-release only. Remnant numbers of hybrid bass remain in the Tenmile Lakes; no bag or size limits restrict their harvest. Kokanee in Triangle Lake are considered "trout" and fall under a five fish per day, eight-inch minimum length regulation. Presently, grass carp may not be harvested from Devils Lake.

Introduced fishes are not stocked regularly into water bodies in the ESU at the present time. Most populations of introduced fishes in the ESU are presently self-sustaining, with little or no assistance by ODFW. As previously discussed, stocking of striped bass into the Coos Basin was discontinued after the year 2000, although it remains as an approved action in the ODFW Coos River Basin Fish Management Plan (ODFW 1990). The stocking of hybrid bass into the Tenmile Lakes was discontinued in 1988, and angling bag and length restrictions were removed to expedite their removal from the lakes. *Gambusia* are commonly transported and released into private ponds and other water bodies for mosquito control. Vector control districts distribute *Gambusia* as one method of insect control; by statute, vector control plans must be submitted to ODFW for approval, and transport permits are required. ODFW is presently encouraging the use of native fishes for mosquito control, as opposed to further distribution of *Gambusia*.

General restrictions in the Oregon Sport Fishing Regulations (adopted as Oregon Administrative Rules) prohibit the transport of live fish or live eggs from one waterbody to another, or into the State, without a permit from ODFW. The Oregon Wildlife and Commercial Fishing Codes (Oregon Revised Statutes, Chapter 498) also prohibit non-permitted transport and importation of fish. ODFW policies and guidelines limit the distribution of introduced fish within the State, and restrict the introduction of new fish species into the State.

Few habitat enhancement efforts have been undertaken to enhance populations of warmwater fish where they exist in this portion of the State. Projects to increase angler access have been implemented to improve warmwater angling opportunity.

**Scope of Decline Factors Assessment**

The impacts of introduced fishes on coho salmon were considered on three scales: (1) coho salmon Population; (2) the Oregon Plan Monitoring Areas; and (3) the Evolutionarily Significant Unit (ESU), as defined by NOAA Fisheries (formerly NMFS).

There are four Monitoring Areas within the Oregon Coast ESU (Figure 1), and an additional one for the South Coast, outside the ESU. There are 19 groups of coho salmon identified as Independent or Potentially Independent Populations within the Oregon Coast ESU (Figure 2). The Oregon Coast Coho ESU is delineated as coho populations south of the Columbia River and north of Cape Blanco.

**Monitoring of Introduced Fishes**

ODFW Fish Districts conduct periodic sampling of warmwater populations in coastal lake systems through gillnetting and electrofishing. These sampling efforts typically gather information on fish species composition, average size, and population trend. In addition, the identification of illegal or unintentional introductions can be documented through these sampling efforts. The frequency and intensity of such monitoring has declined greatly with the loss of the Western Oregon Warmwater Fish Biologist position from ODFW. That biologist position was also responsible for undertaking specific studies to identify impacts of interactions between warmwater populations and native species. None of these studies have been initiated since 2001 in Western Oregon.

Under the Federal ESA, a Section 10 permit is needed to conduct boat electrofishing in lakes containing listed coho salmon or other listed fish. There is no current Section 10 permit held by ODFW Districts to allow boat electrofishing in lakes of the ESU.

Bass tournament data is provided to ODFW following the larger, permitted events (having 25 boats or more). This data provides information on average sizes and catch rates of quality-size and larger largemouth and smallmouth bass entered in the tournament, but has limited value in population monitoring since anglers may only weigh-in a limited number of the fish they catch in a day.

The effects of grass carp introductions into Devils Lake have been monitored by multiple entities, including ODFW and Portland State University. Such effects monitoring includes aquatic macrophyte reduction, changes in algal communities, changes to fish species composition, and ongoing monitoring of salmonid production in the basin.

The Coos Bay Salinity Intrusion Study (Moore, et al. 2000) was undertaken in 1996-2000 to investigate changes in the salinity of Coos Bay, partially due to navigational dredging of the shipping channel. The study was funded by the U.S. Army Corps of Engineers. Although results were not conclusive, they suggest that the altered salinity of Coos Bay does not favor the natural production of striped bass. During the study years, salinities in the upper tidewater area where spawning and egg/larval drift occurred were higher than the threshold lethal to developing eggs and larvae. Annual estuary seining in the upper tidewater by ODFW has not captured a juvenile striped bass in recent years. Juvenile shad are annually collected during this seine sampling, and a long-term trend for CPUE exists back to 1978.

Periodic estuary seining is conducted by ODFW Fish Districts in the Yaquina, Alsea, Siuslaw, Siletz, Beaver, Yachats, Umpqua, Coquille, and Tillamook estuaries.

Currently, no intensive studies are being undertaken to evaluate the impacts of introduced fishes on coho salmon. Studies have occurred in the past, such as Oregon Fish Commission and ODFW striped bass and shad monitoring in coastal river basins. These studies occurred during the 1950's, 60's, and 70's.

**Data Sources**

The primary sources of data and information for this assessment were ODFW District Fish Biologists and their District files (See **References**). Much of the assessment was made based on District fish management data (unpublished) and professional observation. Published reports and study results were cited where available. Information regarding coho salmon status was derived from Oregon Plan Salmonid Monitoring reports (Rodgers, 2000; Jacobs, 2002; Jacobs, et al. 2002) and an ODFW staff report (Zhou, 2000).

**Analytical Methods**

The analysis leading to these assessments consisted of conducting interviews with ODFW District Fish Biologists and other biological staff, compiling their pertinent data/reports/observations, and developing professional judgments as to the risk or impacts of introduced fishes on coho salmon. Study results, where available, were combined with District information to make assessments at the three scales of potential risk or known impacts on coho salmon by introduced fishes.

**Results—Introduced Fishes Impacts at the ESU Scale**

The following assessments of impacts at the Coho Population and Monitoring Area scales identify localized risks from introduced fishes. Because the individual introduced species are not distributed uniformly across the ESU, certain coho populations encounter impacts from single or various introduced species, while other populations have little to no exposure to impacts. Although predation and competition from introduced species may exert a source of mortality on localized stocks/populations of coho, evidence does not support that these impacts reduce the sustainability of coho on the ESU scale. Naturally-produced coho performed poorly in the late 1990's on the North Coast, where exposure to introduced species is minimal. During the same time period, the healthiest, most stable coho runs were found along the Mid/South Coast, where striped bass occur and the lake systems have an abundance of largemouth bass and other warmwater species. These situations indicate that introduced species are not preventing the sustainability of naturally-produced coho. Historic evidence does indicate that production of coho in the ESU could be greater in the absence of introduced fishes, especially with regard to warmwater fish impacts in the "Lakes Complex". However, other limiting factors (e.g. water temperatures and water quality) may be playing an equal or greater role in limiting coho natural production as compared to historic levels.

## Introduced Fishes Impacts at the Monitoring Area Scale

### North Coast Monitoring Area (Necanicum to Nestucca)

Very little overlap in habitat occurs between introduced fishes and coho salmon in this Monitoring Area. Predation and competition from non-natives present a very low risk to coho sustainability. Flooding, cold water, and saltwater limit the ability for the warmwater non-natives (e.g. largemouth bass and crappie) to survive escape from lowland lakes, and reproductive potential for these non-native escapees is low. Other introduced species of primary concern within the ESU (e.g. striped bass and shad) are present in numbers low enough to exert only minimal impacts to coho at the Monitoring Area scale. Coho returns in this Monitoring Area exhibited a substantial upturn in 2002 and 2003.

### Mid-Coast Monitoring Area (Salmon to Siuslaw)

Predatory/competitive species are found in greater overlap with coho salmon as compared to the North Coast Monitoring Area; however the abundance of each introduced species is relatively low. Predation and competition from non-natives present a low risk to coho sustainability at the Monitoring Area scale. Only the Siuslaw River has a recognized run of striped bass, but this is the northernmost "fringe" population of that species, observed in low abundance. Shad are also found in low abundance in this Area. Four lakes/reservoirs (Mercer, Sutton, Triangle, and Hult) have abundant warmwater species; however the coho production from these overlap areas represents a minor component of the overall production of the Monitoring Area. The Devils Lake warmwater population has been nearly eliminated through the introduction of grass carp and subsequent elimination of aquatic macrophytes, however there has not been a disproportionate increase in adult coho returns that can be attributed to the grass carp effects (see Fig. 3). Coho returns elsewhere in this Monitoring Area also exhibited a substantial upturn in 2002 and 2003.

### Umpqua Monitoring Area (Umpqua Basin)

Predation and competition from non-natives present an increased level of impact to coho populations within this Monitoring Area, relative to the North Coast and Mid-Coast Areas. Although these impacts undoubtedly occur, evidence indicates that introduced fishes are not preventing sustainability of coho in this Monitoring Area (Loomis, 2003). Predatory/competitive species are found in much higher abundance than in the North Coast and Mid-Coast Monitoring Areas, but similar to those found in the Mid-South Coast Monitoring Area. Primary species of concern, present in moderate to high abundance, are smallmouth bass, striped bass, and brown trout. Exposure of coho juveniles to predation and competition from non-natives occurs primarily during smolt outmigration. Biological and environmental conditions (i.e. water temperatures, turbidity, prey size selection, etc.) appear to mitigate the impacts to coho in this Monitoring Area.

### Mid-South Coast Monitoring Area (Siltcoos to Sixes)

Predation and competition from non-natives present an elevated level of impact to coho populations within this Monitoring Area relative to the North Coast and Mid-Coast Areas. Predatory/competitive species are found in much higher abundance than in the North Coast and Mid-Coast Monitoring Areas, but similar

to those found in the Umpqua Monitoring Area. The major exposures to predation and competition are from striped bass in the Coos and Coquille rivers, and from largemouth bass and other warmwater species in the Lakes Complex. Numbers of striped bass in this area are greatly reduced from historic abundance estimates. According to a recent Oregon Plan status assessment of anadromous salmonids, the Coos, Tenmile Lakes, and Siltcoos Lake basins have been the most productive coho basins in the Monitoring Area (Jacobs, et al. 2002). Of the four Monitoring Areas, the Mid-South Area has consistently had the highest adult coho spawner abundance in recent years. Although impacts undoubtedly occur, evidence indicates that, as a single factor, introduced fishes are not preventing the sustainability of coho in this Monitoring Area.

## Introduced Fishes Impacts at the Coho Population Scale

### Necanicum

Introduced fishes are not known to occur in this Coho Population Area in waters accessible to anadromous fish (Braun, 2003). No impacts to coho salmon are identified.

### Nehalem

Introduced fishes are not known to be distributed throughout this area in waters accessible to anadromous fish; however they may be present in small numbers in areas of the upper mainstem (Braun, 2003).

The middle to upper mainstem Nehalem (above rm 45) has areas of low gradient slack water in summer that may support small populations of introduced fishes. If present, any impacts on coho are likely minimal. Winter conditions of high flow and low temperature are unfavorable for warmwater species. During the years of poor coho abundance in basins of the North Coast, the upper Nehalem was consistently a strong producer with relatively stable coho abundance (Braun, 2003).

Another location with potential interactions of coho salmon and warmwater game fish is Fishhawk Lake (Buckman, 2003). The dam at Fishhawk Lake has a fish ladder, allowing coho to ascend above the lake. Non-native fish species in the lake are bluegill and black crappie. These fish were not abundant in the late 1980's, but proliferated in the mid-1990's. During recent years of poor coho production and ocean survival, the Fishhawk Lake component of the Nehalem Population was a "stronghold" for coho. As seen in the lake systems of the Mid-South Coast Monitoring Area, coho populations having a lake component to their life history have an apparent advantage in times of poor environmental conditions. Although not documented, it is believed that the warmwater species in Fishhawk Lake may exert predation and competition on coho juveniles.

Impacts of introduced fishes to the overall Nehalem Coho Population are considered to be low.

### Tillamook

Lakes of the Tillamook Coho Population Area contain yellow perch, bluegill, largemouth bass, and brown bullhead (Braun, 2003). However, the outfall of

these lakes are direct ocean entry or into Tillamook Bay, and these lake systems do not provide coho habitat. District sampling has not documented the presence of introduced warmwater fish or other non-native species in sloughs of the bay or lower rivers. Saltwater intrusion and annual floods reduce the potential for escape from lowland lakes and survival by these introduced species in riverine areas inhabited by coho.

Juvenile shad were documented in the Tillamook River tidewater area for several years in the mid-1990's, however no adults were ever observed (Braun, 2003). With no recent adult or juvenile observations, it is assumed that any population of shad is very small, and marginally self-sustaining, at best. Shad and other introduced fishes are not believed to have a detrimental impact to coho salmon at the population level.

**Nestucca**

Town Lake in the Nestucca Coho Population Area contains yellow perch, bluegill, and largemouth bass (Braun, 2003). The dam for Town Lake has no fish passage, and habitat above the lake is unsuitable for coho spawning. Below the lake is approximately one-quarter mile of marginal coho spawning and rearing habitat before reaching tidewater. There is no evidence of escaped warmwater fish below Town Lake. No impacts of introduced fishes to coho salmon are identified in this Population Area.

**Salmon**

With the exception of the Devils Lake system, introduced fishes are not known to occur in this Coho Population Area in waters accessible to anadromous fish Buckman, 2003). No impacts of introduced fishes to coho salmon are identified in this Population Area, except in Devils Lake.

The Devils Lake basin has a distinct group of coho, having a later spawning time (January peak) than adjacent coho groups (Buckman, 2003). Devils Lake once contained an abundant, assorted "warmwater mix" of largemouth bass, bluegill, black crappie, brown bullhead, and yellow perch. Grass carp were introduced in 1986 and restocked in 1987 and 1993, to reduce heavy macrophyte growth in the lake. Aquatic weeds were ruining the recreational and aesthetic values for lakeshore residents and lake users, and the introduction of grass carp was implemented to reduce weed growth and restore those values. Following the three carp stocking efforts, aquatic macrophytes (both native and non-native) were nearly eliminated by 1994, with the exception of canals separate from the main body of the lake. The Devils Lake warmwater population has been severely reduced through the introduction of grass carp and subsequent elimination of aquatic macrophytes. Bluegill, yellow perch, and crappie have nearly disappeared, while only the largest bass remain. Young-of-the-year bass are observed in the fall, but further sampling has not revealed their overwinter survival to age 1 (Buckman and Daily, 1999). The weed reduction has resulted in extremely decreased warmwater fish populations, but coho adult returns to the Devils Lake system have not increased at rates greater than nearby river basins (Buckman, 2003; Figure 3). Rearing conditions for salmonids in the lake may have improved, as indicated by good survival and growth of stocked rainbow.

Future management of grass carp and aquatic weeds, and the performance of warmwater fish, will remain as management considerations potentially affecting the production of Devils Lake coho. Without further grass carp stocking, the expected natural progression of lake conditions is a diminishing carp population, re-growth of aquatic macrophytes, and the eventual re-establishment of warmwater fish populations.

**Siletz**

Introduced fishes are not known to occur in this Coho Population Area in waters accessible to anadromous fish (Buckman, 2003). No impacts of introduced fishes to coho salmon are identified for this Population Area.

**Yaquina**

Shad are the primary introduced fish known to inhabit the Yaquina Coho Population Area (Buckman, 2003). The competitive impact on juvenile coho is unknown, but believed to be minimal due to the typically low numbers of shad that enter the system, and low shad juvenile recruitment. Largemouth bass, bluegill, and brown bullhead have been observed in low abundance in sloughs of the lower Yaquina system. Although very uncommon, a few observations of striped bass have been made in the Yaquina Basin. For all introduced species, the impact on this Coho Population is unknown but believed to be minimal due to low numbers of introduced fishes.

**Beaver**

Mosquitofish are the primary introduced fish known to inhabit the Beaver Coho Population Area (Buckman, 2003). The competitive impact on juvenile coho is unknown, however mosquitofish inhabit lower wetlands in this system and could be exerting competition for food and rearing space on juvenile coho in floodplain overwintering habitat. Coho juveniles are large enough to avoid falling prey to mosquitofish, and in fact the opposite may occur. Pre-migrational coho in floodplain wetlands may have the opportunity to prey on young mosquitofish. Mosquitofish tolerate water temperatures from 40° to 100°F, but do not persist where winter temperatures remain below 40° for prolonged periods (Wydoski and Whitney, 2003). Minimal impacts of introduced fishes to coho salmon are identified for this Coho Population Area.

**Alsea**

Shad are the primary introduced fish known to inhabit the Alsea Coho Population Area (Buckman, 2003). The competitive impact on juvenile coho is unknown, but believed to be minimal due to the typically low numbers of shad that enter the system, and low shad juvenile recruitment. Minimal impacts of introduced fishes to coho salmon are identified for this Coho Population Area.

**Siuslaw**

Shad and striped bass are the primary introduced fishes known to inhabit the Siuslaw Coho Population Area (Buckman, 2003). The degree of competitive impact by shad and predation by striped bass on juvenile coho are unknown. This is a minor "fringe" of the coastal striped bass distribution, as opposed to greater abundance in the Umpqua, Coos, and Coquille systems. The Siuslaw River is the

northernmost establishment of a striped bass population that ensued from the releases in California in the late 1800's. Minimal impacts of introduced fishes to coho salmon are identified for this Coho Population Area.

There are greater shad runs in the Siuslaw system as compared to coastal basins to the north, but still relatively low adult returns. Shad numbers in the Siuslaw support a small recreational fishery (Buckman, 2003).

Triangle Lake in the Lake Creek subbasin contains a "warmwater mix" of largemouth bass, pumpkinseed, bluegill, brown bullhead, and yellow perch. Kokanee were introduced and stocked from 1968 to 1976, and now comprise a large, self-sustaining population (Buckman, 2003). Triangle is a deep lake, and not believed to present a high predation impact on coho by warmwater fish, having limited shallows. The potential competitive impact from kokanee is substantial, however, due to their effects on zooplankton in the lake. In abundance, yellow perch can also have effects on zooplankton density and size (Shrader, 2004). Coho were introduced above Triangle Lake with the installation of a fish ladder at the lake outlet, where no anadromous passage existed historically.

Hult Reservoir in the upper Lake Creek subbasin also contains a "warmwater mix" of largemouth bass, bluegill, brown bullhead, and black crappie. This ladder also introduced coho to upstream areas without historic anadromous fish passage. It is suspected that negative interactions between coho and non-native species occur, however the Triangle Lake/Hult Reservoir/Upper Lake Creek coho production is a "minor" component of the overall Siuslaw Coho natural production (Buckman, 2003).

Mercer and Sutton Lakes, just north of the Siuslaw River mouth have a direct ocean outlet. They contain largemouth bass, bluegill, yellow perch, and white crappie. Native coho spawning occurs in streams above the lakes. These are relatively deep lakes, and unlike shallower lakes such as Tenmile, Siltcoos, Tahkenitch, and Devils, the risk to summer rearing coho juveniles may be less in Mercer and Sutton.

**Siltcoos, Tahkenitch, and Tenmile—"The Lakes Complex"**

These basins represent three separate Coho Population Areas. Introduced fish species and coho production scenarios are similar, thus combined here.

Siltcoos and Tahkenitch lakes hold an assorted "warmwater mix" of largemouth bass, bluegill, yellow perch, brown bullhead, and black crappie, introduced by the Oregon Game Commission in the 1920's and 30's (Saltzman, 1963; Saltzman, 1966). Many of these introductions took place following overflow pond salvage operations that occurred on Sauvie Island. There have been major habitat alterations of these lakes. Dam developments raised lake levels by several feet and stabilized water levels through the summer. Logging has occurred in the watersheds above the lakes. However, the introduction of warmwater species is likely the greatest impact on coho production in these systems. Artificially raised

and stabilized lake levels, in the absence of warmwater fish, could be beneficial to rearing juvenile coho (Buckman, 2003).

The history of fish introductions in the Tenmile Lakes began with illegal stocking of brown bullhead and yellow perch in the 1930's (ODFW 1991). These species were soon overpopulated and stunted. Contract commercial fishing in the 1950's did not substantially reduce their numbers. Bluegill were illegally introduced around 1964. Their numbers skyrocketed, so fish managers looked for ways to eliminate warmwater fish and rebuild coho runs. In 1967-68, wild coho were salvaged and reared in hatcheries, while the lakes were treated with rotenone. Coho numbers climbed immediately following the treatment, but within a few years, bluegill numbers were back. In 1971, largemouth bass were approved for stocking, to control bluegill numbers and provide a recreational fishery. Hybrid bass were introduced into North Tenmile Lake in 1982, again in an attempt to add a large predator on bluegill while providing for a unique recreational fishery. Due to habitat segregation, however, hybrids were not expected to control bluegill numbers. Brown bullhead eventually re-appeared after the rotenone treatment, and yellow perch were illegally re-introduced around 1986. Black crappie were illegally introduced around 1987.

Largemouth bass, as well as the larger size classes of black crappie, brown bullhead, and yellow perch are predators on juvenile coho migrating through or attempting to rear in these lakes. Significant habitat overlap occurs in the shallow littoral zones, where predatory fish utilize cover from vegetation and large wood to ambush prey. Non-predatory sized largemouth and other non-native species compete with juvenile coho for forage.

The hybrid bass stocking program ended in 1988, when it was determined that unacceptable straying was taking place. Hybrid bass were captured in the Coos, Umpqua, and Willamette rivers, and in Siltcoos Lake. Today, fifteen years after the last stocking of hybrid bass into the Tenmile Lakes, they continue to be caught. A specimen of 700 mm TL was captured in a gillnet in October of 2003 by ODFW Fish District personnel. Abundance of hybrid bass remaining in the lakes is assumed to be low, based on the rare frequency of observations. No evidence of successful reproduction of hybrid bass has been observed for Tenmile Lakes, although successful reproduction has been documented elsewhere. Gestring (1991) looked at stomach contents of hybrid bass, and the importance of various prey items in the diet. Mysid shrimp were the dominant food item, followed by bluegill. Coho fry and smolts were found in the diet, but made up a minor portion of samples collected from 1984 to 1988.

Summer rearing of juvenile coho in these lakes is severely reduced. Juvenile salmonids that are displaced due to high juvenile densities, or flushed into the lakes by freshets, are at a high risk of predation. They are also subjected to competition from abundant warmwater species and to habitat conditions that favor warmwater fish (e.g. warm water temperatures). The lower reaches of most streams that enter the lakes are pasture trenches, typically with little habitat complexity or riparian vegetative cover. In the late summer, temperatures in these reaches are favorable for warmwater fish. Other habitat alterations in the Tenmile

watershed have favored warmwater fish over salmonid production. These habitat impacts include sedimentation and shallowing of the lake arms, accelerated eutrophication, over-nutrification from septic tanks and yard fertilization, introduction of exotic macrophytes, and summer algal blooms.

The Tenmile system may have once been the largest natural coho production basin on the Oregon coast (Reimers 1989). Estimates run up to 75,000 adult spawners for peak years in the early 1900's. Nearly 73 million coho eggs were collected from 1935 to 1946, with a peak collection of almost 22 million in 1938.

In the past fifty years, adult coho population estimates for the Tenmile Basin range from a high of 41,500 in 1955, to a low of 630 in 1979 (ODFW Corvallis Research, ODFW Website). Zhou (2000) distinguishes between two distinct time periods with regard to coho abundance in the Tenmile system. Spawner estimates for the period 1955 to 1973 ranged from about 5,700 to 42,000, with a mean of 16,500. Escapement from 1974 to 1999 ranged from 777 to 7,581, with an average of only 3,453. There appears to be a strong time association between the introduction of largemouth bass (1971) and the decline of coho spawner abundance (ODFW 1991). There is an increasing trend in coho spawner abundance for recent years, however, with rounded estimates for run years 2000 to 2002 of 8,300; 11,000; and 13,900, respectively.

Despite the alteration of habitat and introduction of warmwater species, coho populations of the Lakes Complex (Siltcoos, Tahkenitch, and Tenmile) have remained healthy and stable, even through times of extremely low coho abundance in other areas of the ESU (Jacobs, et al. 2002). In summary for these Coho Population Areas, summer rearing of coho in the lakes has been eliminated or severely reduced, in part due to non-native fish introductions. Coho salmon rearing in streams above the lakes, or overwintering in the lakes prior to outmigration, are maintaining a stable population of coho in this area. Predation on overwintering coho is not as prevalent, due to a reduced feeding rate of warmwater species during this time of year.

**Lower Umpqua**

This section of the Umpqua Basin includes the mainstem and tributaries downstream from the confluence of the North and South forks (rm 111). Introduced fishes in this Coho Population Area include smallmouth bass, striped bass, shad, brown and yellow bullhead, largemouth bass, black crappie, and bluegill. Smallmouth bass were illegally introduced into the Umpqua River in the early 1970's. They inhabit primarily mainstem rivers, where juvenile coho are not rearing. Smallmouth bass and striped bass present the highest risk of impact to this population of coho salmon, however neither of these predatory species is considered to be preventing the sustainability or recovery of coho (Loomis 2003).

Daily (1992) asserts that habitat overlap does exist for salmonids and predatory-sized smallmouth bass in the Umpqua Basin, but that declines in salmonid populations have not been directly linked to predation. Due to size at emigration, wild spring chinook smolts were closest to the preferred prey size of smallmouth bass. He cites studies suggesting that juvenile salmonids larger than 85 mm are

less vulnerable to smallmouth predation than those from the size range of 35 to 85 mm. Based on smolt trapping data for 2001-03, wild coho smolts leaving the Smith River system ranged from 95 to 145 mm, with an average around 118 mm (Harris, 2004). Wild coho smolts trapped in Brush Creek, a tributary to Elk Creek near Elkton, ranged from 80 to 125 mm, with an average of 110 mm. The majority of these smolts are larger than the selected prey size for smallmouth bass suggested by Daily (1992) and others.

Stomach contents of smallmouth captured from the mainstem and South Umpqua rivers in May through September of 1988 were composed of crayfish, fish, and insects as the top three food items. Forty-five percent of the 47 non-empty stomachs contained fish, but only two fish were identified; one was a salmonid, and one was a pikeminnow. Daily (1992) also described temperature effects on bass feeding activity: smallmouth bass are lethargic and feed little at temperatures under 50°F, feed sparingly at temperatures under 60°F, and feed actively at temperatures over 60°F. Mean water temperature for the mainstem Umpqua near Elkton, pooled from 1986-90 data, reached 60°F near the first week of May. For 2001-03, wild coho smolts trapped in the Smith River peaked anywhere from April 23 to May 31 (Harris, 2004). Wild coho smolts trapped in Brush Creek, near Elkton, showed peak capture between April 23 and May 19. Water flow, temperature, and the timing of freshets likely influenced the peak timing of outmigration. Coho smolts emigrating through the lower mainstem prior to the river reaching 60°F would be less vulnerable to smallmouth predation than those migrating later.

Striped bass are found in the Umpqua Basin up to Sawyer's Rapids (rm 38), but major concentrations of striped bass are not typical in the mainstem Umpqua. Concentrations of striped bass have been observed in the upper tidal areas of the Smith River in April and May, likely attracted by releases of hatchery coho smolts (Loomis, 2003). Hatchery coho are no longer released in the Smith River subbasin. Wild smolts have an extended, staggered pattern of outmigration, and are believed to be at less risk of attracting predators.

For 2001, coho spawner estimates for the area upstream of Smith River Falls were 7,700 fish, derived from pooled mark-recapture recoveries, and 6,000 fish, derived from spawner survey EMAP protocol (Jacobs 2002). Spawner density ranged from 0 to 96 adults/mile for 30 randomly selected survey reaches; only nine of those reaches were under 20 adults per mile. The 2001 estimates were up significantly from estimates of around 2,000 and 4,000 fish in the years 1999 and 2000, respectively. Adult coho estimates continued to increase in 2002 and 2003. While spawner estimates have increased in the past four years, population estimates for striped bass are not available to compare predator numbers to coho performance in the Smith River system.

Largemouth bass are found in low numbers in the lower mainstem Umpqua and Smith Rivers. Brown and yellow bullhead are also known to be present in the lower mainstem Umpqua River. Their impacts to coho are unknown, but believed to be minimal (Loomis, 2003).

A tremendous biomass of juvenile shad can be found in the lower 50-60 miles of the Umpqua mainstem from June to September (Loomis, 2003). Competition for food from these shad could be great, however, few juvenile coho are in this reach at that time. The potential for competition from juvenile shad is likely greater on juvenile fall chinook, having a longer estuarine rearing period.

Plat I Reservoir, on Upper Sutherlin Creek, has anadromous fish passage and about two miles of spawning and rearing habitat for coho above the reservoir. The reservoir contains largemouth bass, black crappie, brown bullhead, and bluegill, likely exerting predation and competition on coho salmon. An old outmigrant trap (now defunct) counted juvenile coho entering the reservoir from upstream. Wild adults are counted each year passing above the dam, however this is not a major component of the overall Lower Umpqua Coho Production Area; (Loomis, 2003).

Cooper Creek Reservoir (Sutherlin Cr. Basin) has poor coho habitat below the dam and no anadromous fish passage. Coho below this reservoir have a low exposure to impacts from introduced fishes, and do not represent a major component of the overall Lower Umpqua Coho Production Area (Loomis, 2003).

**Upper Umpqua**

This Coho Population Area comprises the Umpqua River watershed upstream from the confluence of the North and South forks (rm 111). Smallmouth bass and brown trout present the highest risk of impact to this population of coho salmon, however these predatory species are not considered to be preventing the sustainability or recovery of coho (Loomis 2003).

Smallmouth bass inhabit the lower two miles of the North Umpqua, nearly 80 miles of the South Umpqua, and 33 miles of Cow Creek (Daily 1992). Minimal habitat overlap occurs between coho and smallmouth in this Coho Production Area, except when coho outmigration passes through reaches inhabited by smallmouth.

Brown trout are found in the upper North Umpqua, from the mouth of Steamboat Creek up to Boulder Creek; observations are rare below Steamboat Creek (Loomis, 2003). They pose some risk of predation to juvenile coho during smolt outmigration in April and May. Coho juveniles rear in the tributaries of the North Umpqua, with very little use of the mainstem until outmigration. This minimizes the overlap between coho and brown trout, and thus the level of impact is believed to be low.

Low numbers of largemouth bass are found in the North and South Umpqua Rivers. Their impacts to coho are unknown, but believed to be minimal (Loomis, 2003).

Channel catfish are found in a private pond that lies in the floodplain near the South Umpqua River. They have not been observed, to date, in the river. This species poses a potential problem in the future, if they become established in the river (Shrader, 2004). Green sunfish are also found in ponds, but have not been identified in the river system. Tui chub are now found in the North Umpqua

River below Diamond Lake, but their numbers are few and this riverine habitat does not favor the chub over salmonids (Loomis, 2003).

Galesville Reservoir, on upper Cow Creek, blocks about 28 miles of potential coho habitat, having no fish passage at the dam. The reservoir contains largemouth bass and a mix of other warmwater species. Cold water released from Galesville Reservoir creates a low risk of survival from non-native escapees (Loomis, 2003).

Ben Irving Reservoir (Olalla Cr.) contains a mix of warmwater species (Loomis, 2003). However, there is poor coho habitat below the dam and no anadromous fish passage. Coho below this reservoir have a low exposure to impacts from introduced fishes, and do not represent a major component of the overall Lower Umpqua Coho Production Area (Loomis, 2003).

**Coos**

Striped bass present the highest risk of impact in this Coho Population Area, however population estimates for this predatory species have been dropping rapidly since the 1970's. Shad are the only other introduced species present in significant numbers in the Coos Basin.

Striped bass were introduced to San Francisco Bay in 1879, and appeared in Coos Bay around 1914. Soon after, striped bass numbers supported major commercial fisheries that continued until the mid-1970's, when commercial harvest of striped bass was prohibited. Adult striped bass populations were estimated at an average of 25,000 for the period from 1930 to 1975 (ODFW Coos-Coquille-Tenmile Fish District files, Charleston). The peak estimate occurred around 1945 at 75,000 fish. Striped bass numbers have dropped significantly since 1970, and natural production is extremely low at present. Adult striped bass numbers are estimated to be below 1,000 fish at present. Navigational dredging that occurred in the 1950's and again in the mid-1970's is believed to have altered the salinity intrusion into Coos Bay, to the detriment of striped bass egg and larval survival (Moore, et al. 2000).

Striped bass were hatched and raised experimentally in the early 1980's, to test the feasibility of augmenting natural production (ODFW 1990). Later, fingerling and yearling striped bass were purchased from a vendor in California, for release into the Coos Estuary. This program was discontinued in 1988, due to the pending coho listing under the federal ESA. Only a small release of marked fingerling continued through the summer of 2000, to facilitate a mark-recapture estimate of natural striped bass production. The striped bass stocking program is currently suspended, due to ESA and funding issues, although it is still an approved action item of the Coos Basin Plan.

Although intensive study of striped bass occurred from the 1950's through the 1990's, no study has conclusively tied striped bass predation to limiting coho populations. Temple and Mirati (1986) found that coho spawning counts tracked with estimates of striped bass abundance did not produce consistent findings of impact or lack of impact. Stomach content sampling by ODFW Fish District

biologists documented the presence of juvenile coho and chinook in the diet of striped bass (Muck, 2004).

Hostick (1975) reported age 0+ shad to be the most abundant species captured in seining the upper Coos Estuary. A high biomass of juvenile shad in the lower mainstem and estuary may provide competition for forage to native fish species, although an earlier coho emigration timing and shorter duration of estuarine residence puts them at less risk of impact than for other salmonids (e.g. fall chinook). Shad and striped bass spawn in upper tidewater in May and June, the timing of which is highly dependent on water temperature. Eggs of these species have been found in the diet of coho smolts and juvenile chinook, and may therefore provide a net benefit to salmonids (memo from Reese Bender and Paul Reimers, ODFW District biologists, to Ray Temple, ODFW Fish Division staff, dated July 11, 1997). Most juvenile shad leave the estuary and enter the ocean in late summer and early fall, however some juvenile shad reside in upper tidewater until the following summer. Shad are not believed to have a detrimental impact to coho salmon at the population level.

The Coos Basin has produced one of the healthiest runs of adult coho salmon in recent years (Jacobs, et al. 2002). The combined Coos/Coquille spawner estimates have ranged from about 20 to 50 percent of the adult abundance of the entire Oregon Coast ESU from 1990 to 2002 (ODFW Website, Corvallis Research, Coastal Salmonid Inventories). With the current low striped bass population level due to a lack of natural production, and considering the recent performance of coho runs, the impacts of introduced fishes on this Coho Population are currently low. Increased impacts may occur with rebounding striped bass numbers, or restoration of the striped bass stocking program.

**Coquille**

Striped bass present the highest risk of impact in this Coho Population Area. The history of striped bass introduction to the Coquille is similar to that of the Coos and Umpqua rivers. Commercial harvest once occurred in the Coquille River, but now only a recreational fishery exists. No recent research or population estimate has been conducted for striped bass in the Coquille, however anecdotal information from angler reports suggests a growing population. Significant navigational dredging has not occurred in the Coquille River as it has in the Coos Estuary, so environmental conditions may still be favorable for natural production and survival of striped bass.

Hatchery coho smolts are released from acclimation sites low in the system. These sites are Sevenmile Creek (rm 6.5), and Bandon Hatchery/Ferry Creek (rm 1.0). Smolt releases are made on a volitional basis, in an attempt to minimize a predator-concentrating effect. Wild coho smolts coming from tributaries further upriver have an extended, staggered pattern of outmigration, and are believed to be at less risk of attracting predators.

Largemouth bass, yellow perch, mosquitofish, and brown bullhead are present in Johnson Mill Pond (rm 28). The pond is located within the floodplain of the Coquille River, and floodwaters overtop the dikes in this reach on the highest

winter floods. Sloughs of the upper tidal portion of the basin (e.g. Fat Elk Slough, Beaver Slough) contain largemouth bass, bluegill, and mosquitofish. These introduced fishes likely exert predation and competition on coho juveniles. The sloughs and backwaters of the Coquille Valley are remnants of a historically-expansive overwintering habitat outside the main river channel. Much of the loss of coho production in the Coquille Basin is attributed to loss of this overwintering habitat through the building of dikes.

Angler reports indicate that smallmouth bass may have been recently introduced into the Middle Fork Coquille River. These reports are unsubstantiated to date, however the distance from the upper Middle Fork Coquille to areas of Cow Creek in the Umpqua Basin known to hold smallmouth bass is only a matter of a few miles, thus illegal transport and release would be feasible. Recent reports of smallmouth bass in Fat Elk Slough are also unconfirmed at this time.

Shad runs in the Coquille once supported commercial harvest, and still provide for a popular recreational fishery. As discussed for the Coos Basin, shad are not believed to have a detrimental impact to coho salmon at the population level.

Estimates of wild coho spawner abundance in the Coquille Basin have ranged from 2,115 to 16,169 for the period 1990-2002 (ODFW Website, Corvallis Research, Coastal Salmonid Inventories). Adult coho abundance has not declined in recent years, despite evidence of increasing striped bass numbers. Predation impacts of introduced fishes in this Coho Population Area may be higher than for other nearby populations, however evidence does not indicate that such impacts are reducing coho sustainability.

**Floras**

This Coho Population Area includes the Floras Creek, New River, Fourmile Creek, and Twomile Creek basins. Similar to the Mid-South Coast, this area includes lakes that are accessible to anadromous fish and provide habitat for warmwater fish species (Floras, New, Croft, and Laurel lakes). Introduced species collected in gillnets in these lakes are largemouth bass, black crappie, bluegill, pumpkinseed, and brown bullhead (Confer, 2003). Mosquitofish are known to inhabit ponds in these basins, but have not been confirmed in waters accessible to anadromous fish.

Similar to the Tenmile Lakes, use of these lakes for summer rearing of juvenile coho is severely reduced. Juvenile salmonids that disperse or are flushed into the lakes by freshets are at high risk of predation. They are also subjected to competition from the mix of warmwater species. The lower reaches of streams that enter the lakes have been channelized through pastures, having little habitat complexity or riparian vegetative cover. In the summer, temperatures in these reaches are favorable for warmwater fish, reducing their availability for salmonids and increasing the risk of predation on salmonids by warmwater fish.

Other than species presence, data is limited on warmwater fish/native fish interactions for the Floras Coho Population. Data from a screw trap operated at the outlet of Floras Lake from March through May provides information on the outmigration of juvenile coho and other salmonids, but few warmwater species

are sampled leaving the lake. Juvenile coho winter rearing is observed in Floras Lake, and the risk of predation at this time of year is estimated to be low (Confer, 2003). The spawning escapement of coho salmon in these river basins has been observed at 20 to 40 fish per mile in recent years. In summary for this Coho Population Area, summer rearing of coho in the lakes has likely been eliminated or severely reduced, in part due to non-native fish introductions. Habitat degradation leading to temperature increases is also a factor in the loss of summer rearing for coho in the lakes. Coho salmon rearing in streams above the lakes, or overwintering in the lakes prior to outmigration, are maintaining a stable population of coho in this area.

**Sixes**

Introduced fishes are not known to occur in this basin in waters accessible to anadromous fish (Confer, 2003). No impacts of introduced fishes to coho salmon are identified in this Population Area.

**Discussion/Summary**

The impacts of introduced fishes are localized and risks are greater at the geographically smaller Coho Population scale. At the Monitoring Area scale, the highest impacts are in the Mid-South and Umpqua Areas, the areas also exhibiting the healthiest coho populations in the last decade. Exposures to introduced fishes are not widespread at the ESU scale, suggesting that other factors have greater impact on coho production than introduced species. It should be noted that much of the assessment of introduced fishes impacts on coho salmon is based on ODFW District management data and professional observation, rather than intensive research studies on predation, competition, or other effects.

Warmwater fish have been moved around the State, either intentionally or unwittingly. Disastrous effects can be the result (e.g. Diamond Lake Tui chub and Phillips Reservoir yellow perch), and the potential exists for harm to coastal coho populations if the wrong species is introduced into a critical location.

Density of both predator and prey plays a big role in predation rates. Most of the overlap of coho and introduced predatory fishes found in this assessment occurs when coho smolts migrate through an area inhabited by the predator. As such, the probability of encounter is increased as the density of either predator or prey is increased. If both are increased, the encounter rate is significantly raised. Other factors such as prey size selectivity, predator activity/feeding rate, or the availability of other prey species also factor into the risk of predation to coho salmon.

Measures that affect non-native fish populations, such as changes in sport fishing regulations, are available to fish managers where localized impacts are assessed to be unacceptable to coho recovery, sustainability, or management objectives. However, angling regulations alone are seldom an effective tool for eradication/control of a fish population. Complete control or eradication of introduced fish populations may be impossible in some cases, given the realities of feasibility, funding, and social/political influences. Methods such as chemical treatment are often socially unacceptable or meet with daunting regulatory requirements. Introduced fishes are currently self-sustaining in

the ESU, with little or no artificial supplementation. Angling regulations are generally aligned with Statewide regulations, with a few exceptions. Monitoring of introduced fishes has been significantly reduced in recent years due to position cuts within ODFW.

This report focused on the impacts to coho from introduced fishes. Other exotic organisms (e.g. zebra mussels, New Zealand mud snails, purple varnish clams) have become established in other regions, and some are beginning to appear along the Oregon coast. Exotic, non-fish organisms may become an increasing concern in coastal ecosystems.

Finally, the impacts of non-native fish introductions should also be considered collectively with other anthropogenic factors for coho decline (e.g. land and water use activities). Taken alone, each activity may not represent significant risk to coho, but the additive risk from multiple factors may, in fact, jeopardize coho sustainability. The effects of one factor for decline of coho (e.g. habitat degradation) may exacerbate the effects of another (impacts of introduced fishes).

## TABLES

### Table 1. List of Introduced Fish Species in Oregon Coast Coho ESU

| Common name(s)/Code | Scientific Name |
|---|---|
| Largemouth bass (LB) | *Micropterus salmoides* |
| Smallmouth bass (SB) | *Micropterus dolomieu* |
| Striped bass, stripers (StB) | *Morone saxatilis* |
| Hybrid bass (white bass x striped bass), wipers | *Morone chrysops* x *Morone saxatilis* |
| Bluegill (BG) | *Lepomis macrochirus* |
| Pumpkinseed (Pk) | *Lepomis gibbosus* |
| Green sunfish (GS) | *Lepomis cyanellus* |
| Black crappie (BC) | *Pomoxis nigromaculatus* |
| White crappie (WC) | *Pomoxis annularis* |
| Brown bullhead (BrB) | *Ameiurus nebulosus* |
| Yellow bullhead (YB) | *Ameiurus natalis* |
| Yellow perch (YP) | *Perca flavescens* |
| American shad (Sh) | *Alosa sapidissima* |
| Common carp (Cp) | *Cyprinus carpio* |
| Grass carp, white amur | *Ctenopharyngodon idella* |
| Mosquitofish, gambusia (Mf) | *Gambusia affinis* |
| Tui chub | *Gila bicolor* |
| Brook Trout (BT) | *Salvelinus fontinalis* |
| Brown trout (Br) | *Salmo trutta* |
| Kokanee salmon (K) | *Oncorhynchus nerka* |

**Source: Wydoski and Whitney, 2003**

**Table 2. First Introductions of Non-Native Fish Species into Oregon Waters (Lampman, 1949).**

| Species | Year | Location |
|---|---|---|
| American Shad | 1876 | Columbia River; migrated from 1871 plant in Sacramento River |
| Carp | 1880 | Willamette Valley in Lane County; Columbia River in 1881 |
| Brown Bullhead | 1880 | Willamette Valley in Lane and Yamhill Counties |
| Black Bullhead | 1880? | Willamette River |
| Largemouth Bass | 1888 | Willamette River near Salem and Oregon City |
| Green Sunfish | 1890's | Thought to have immigrated from Washington plantings |
| Black Crappie | 1893 | Willamette River near Salem |
| White Crappie | 1893 | Willamette River near Salem |
| Bluegill | 1893 | Willamette River near Salem |
| Pumpkinseed | 1893 | Willamette River near Salem |
| Warmouth | 1893 | Willamette River near Salem |
| Channel Catfish | 1893 | Willamette River near Salem |
| Yellow Perch | 1904 | Columbia River; from 1894 plant in Silver Lake, WA |
| Yellow Bullhead | 1905 | Willamette River at Portland |
| Striped Bass | 1914 | Coos Bay; migrated from 1879 introduction in San Francisco Bay |
| Smallmouth Bass | 1923 | Lake Oswego |
| White Catfish | 1930 | Willamette Valley |

## Table 3. Relative impacts or risk to Oregon Coast ESU coho salmon from introduced fishes.

| Coho Population Area | Major Introduced Species [a] | Minor Intro. Species [b] | Relative Overlap/Exposure [c] | Impact(s) [d] | Data/Information Source [e] |
|---|---|---|---|---|---|
| **Necanicum** | None identified | None identified | none | none | DB |
| **Nehalem** | None identified | BG, BC | low | c, p | DB |
| **Tillamook** | None identified | YP, BG, LB, BrB, Sh | low | c, p | DB |
| **Nestucca** | None identified | YP, BG, LB | low | c, p | DB |
| **Salmon** | None identified | YP, BG, LB, BrB, BC, Grass Carp | low--only Devils Lake | c, p | DB, Grass carp study |
| **Siletz** | None identified | None identified | none | none | DB |
| **Yaquina** | None identified | Sh, StB | low--low abundance of Intro. Fish | c, p | DB |
| **Beaver** | None identified | Mf | low | c | DB |
| **Alsea** | None identified | Sh | low--low abundance of Intro. Fish | c | DB |
| **Siuslaw** | None identified | Sh, StB, LB, BG, BrB, YP, K, Pk, BC, WC | low--low abundance of Intro. Fish and localized areas | c, p | DB |
| **Siltcoos** | LB | YP, BG, BC, BrB | high | P, c | DB, OSGC staff reports |
| **Tahkenitch** | LB | YP, BG, BC, BrB | high | P, c | DB, OSGC staff reports |
| **Lower Umpqua** | SB, StB | Sh, BrB, YB, LB, BC, BG | high | P, c | DB, Smallmouth study |
| **Upper Umpqua** | SB, Br, | LB, ChC, GS, Tui chub | high | P, c | DB, Smallmouth study, WW Bio. |
| **Tenmile** | LB | YP, BG, BC, BrB, Hybrid bass | high | P, c | DB, ODFW Basin Plan, ODFW Info. Repts. |
| **Coos** | StB | Sh | moderate--reduced numbers of striped bass from historic | P, c | DB, Salinity Study, ODFW Basin Plan, ODFW staff reports, OFC info. Rept. |
| **Coquille** | StB | LB, YP, BrB, BG, Mf Sh, SB (unconfirmed) | high | P, c | DB, OFC/ODFW staff reports |
| **Floras** | LB | BC, BG, Pk, BrB, Mf | moderate | P, c | DB |
| **Sixes** | None identified | None identified | none | none | DB |

Footnotes:

a) Major introduced species are those providing the greatest known impact or potential for risk. Species codes in Table 1.

b) Minor introduced species are those present, but providing lower known impact or potential for risk. Species codes in Table 1.

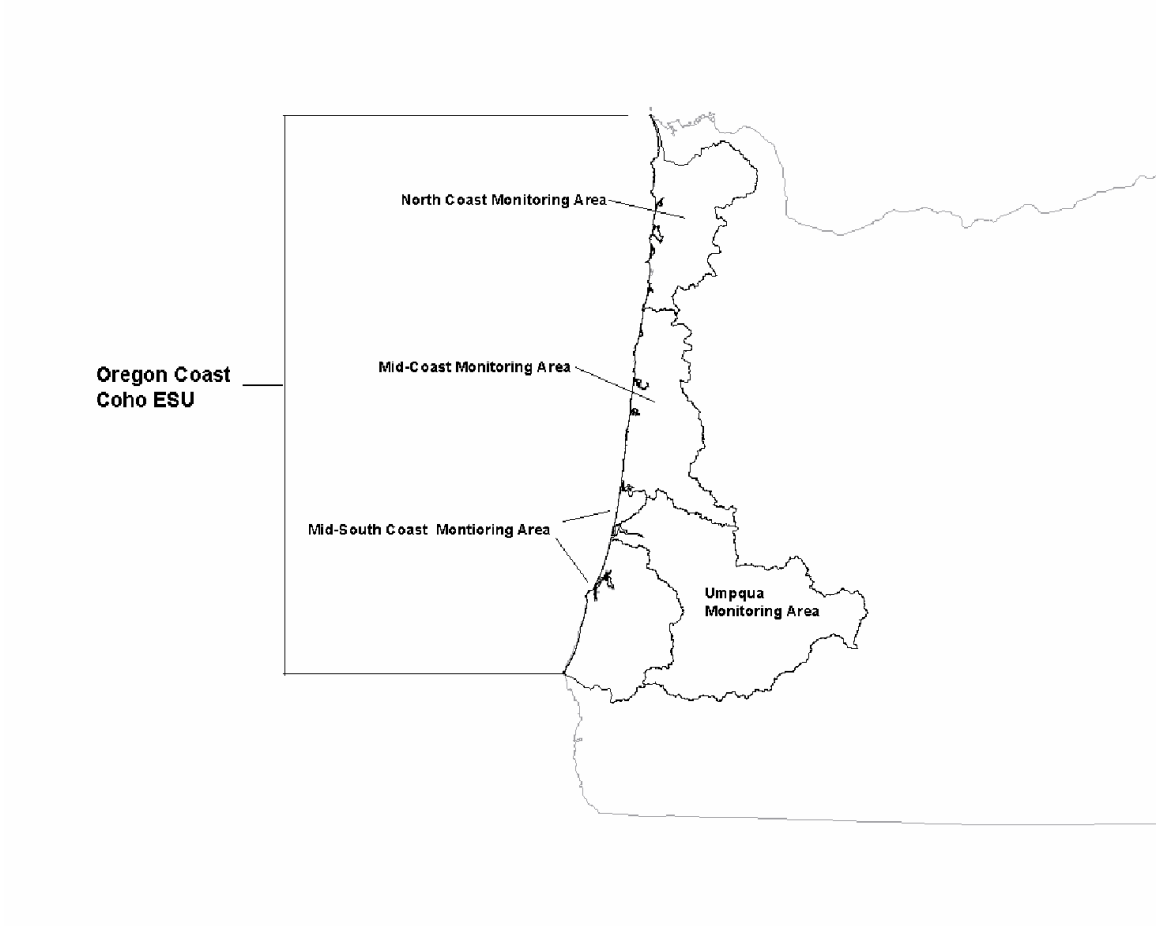
c) Relative overlap or exposure considers the overlap of coho salmon life history stages and amount of area within the coho population area. This rating is relative to the other population areas within the ESU.

d) Impacts are known or potential impacts from introduced fishes. Capitalized codes are greatest concern. P = predation; C = competition.

e) Data/Info are the sources used for this assessment. DB = District Biologist and/or District files; OSGC = Ore. State Game Commission; OFC = Ore. Fish Commission.

**FIGURES**

**Figure 1. Map of Oregon Coast ESU and Oregon Plan Monitoring Areas within the ESU.**



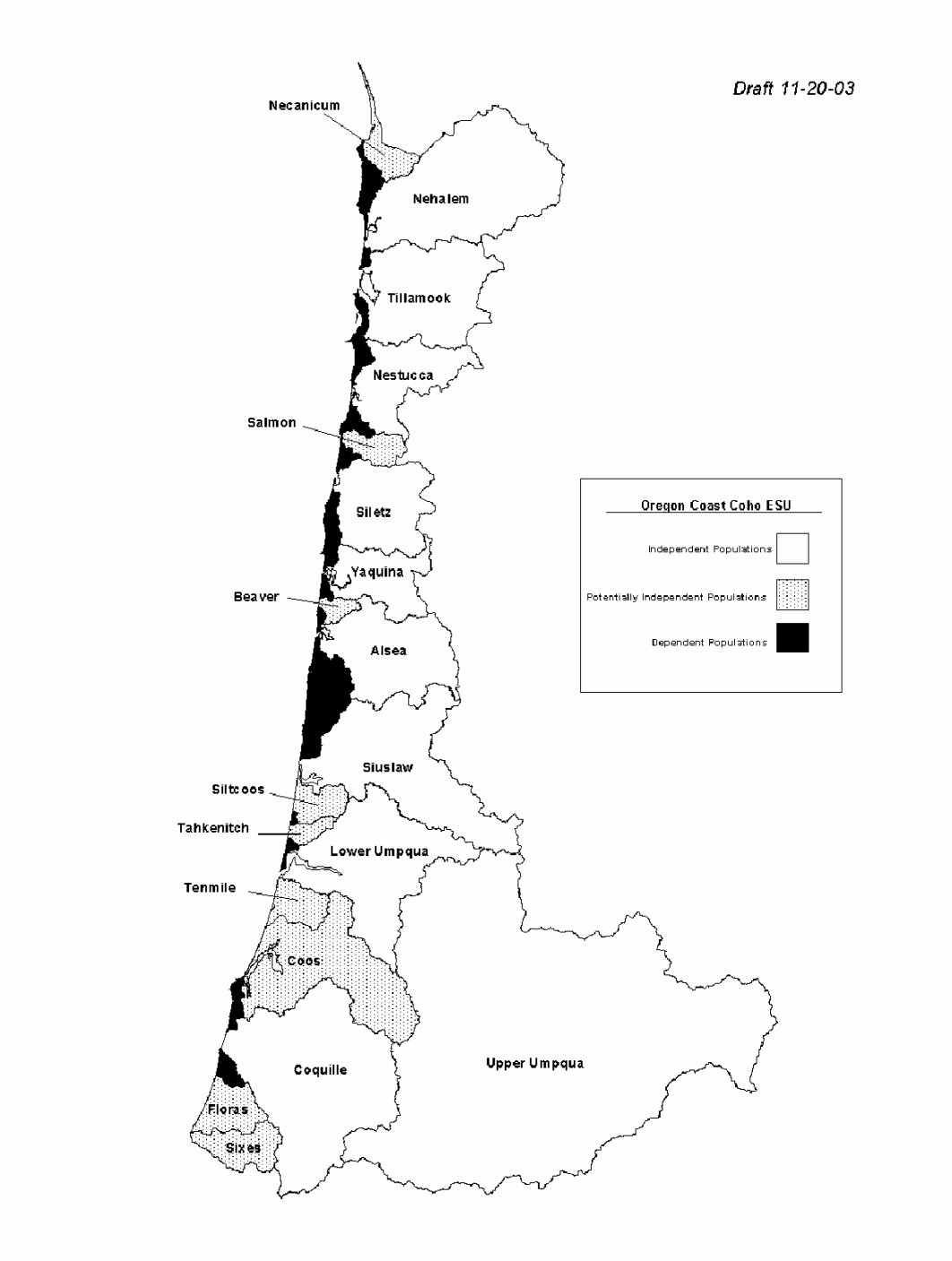
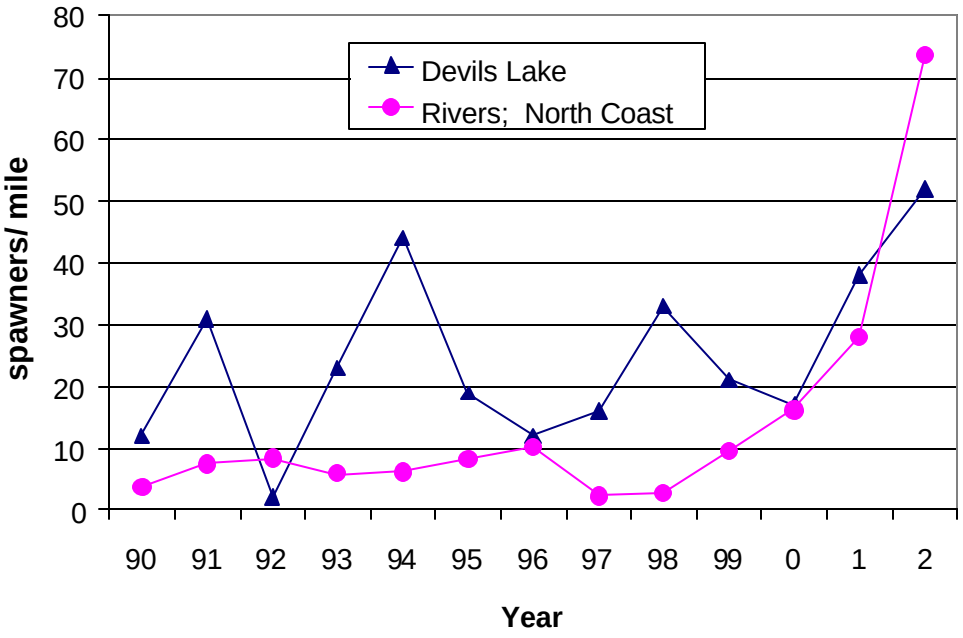



**Figure 2. Map of coho population areas within the Oregon Coast ESU.**

**Figure 3. Devils Lake Basin coho spawner abundance as compared to North Coast river basins.**



**References**

Amandi, A. 2004. Personal communication with Antonio Amandi, ODFW Fish Pathologist, Nash Hall, OSU, Corvallis, January 2004.

Braun, K. 2003. E-mail communication with Keith Braun, ODFW District Fish Biologist, Tillamook Field Office, North Coast Watershed District, 12/22/03.

Buckman, R. 2003. Personal communication with Robert Buckman, ODFW District Fish Biologist, Newport Field Office, North Coast Watershed District, 12/23/03.

Buckman, R. and K. Daily. 1999. Effects of grass carp on warmwater fish and coho salmon in Devils Lake, Oregon. *In* ODFW and NMFS. 1999. Management Implications of Co-occurring Native and Introduced Fishes: Proceedings of the Workshop. October 27-28, 1998, Portland, Oregon. 243 pp. Available from NMFS, Portland, Oregon.

Confer. T. 2003. Personal communication with Todd Confer, ODFW District Fish Biologist, Gold Beach Field Office, Rogue Watershed District, 12/22/03.

Daily, K. 1992. Smallmouth bass predation on indigenous fish species in the Umpqua, Rogue, and John Day river basins. Oregon Department of Fish and Wildlife.

Gestring, K.B. 1991. Stomach contents of striped bass x white bass hybrids in the Tenmile Lakes system. Information Report 91-1, Oregon Department of Fish and Wildlife, Portland.

Harris, D. 2004. Personal communication with David Harris, ODFW Assistant District Fish Biologist, Umpqua Watershed District, Roseburg, 1/27/04.

Hostick, G.A. 1975. Numbers of fish captured in beach seine hauls in Coos River Estuary, Oregon, June through September 1970. Information Report 74-11. Fish Commission of Oregon. Portland.

Jacobs, S. 2002. Calibration of estimates of coho spawner abundance in the Smith River basin, 2001. Monitoring Program Report Number OPSW-ODFW-2002-06, Oregon Department of Fish and Wildlife, Portland.

Jacobs, S., J. Firman, G. Susac, D. Stewart and J. Weybright. 2002. Status of Oregon coastal stocks of anadromous salmonids, 2000-2001 and 2001-2002. Monitoring Program Report Number OPSW-ODFW-2002-3, Oregon Department of Fish and Wildlife, Portland.

Lampman, B.H. 1949. The Coming of the Pond Fishes. Binfords and Mort, publishers. Portland, OR. 177 pp.

Loomis, D. 2003. Personal communication with David Loomis, ODFW Watershed District Manager, Umpqua Watershed District, Roseburg, 12/23/03.

Moore, J. W., K. D. Martin, and M. E. Gray. 2000. Coos Bay salinity intrusion study: the effects of deepening the shipping channel on striped bass and other fish populations. ODFW Final Report to U.S. Army Corps of Engineers. Contract no. W66QKZ01017672.

Muck, J. 2004. Personal communication with Jim Muck, ODFW District Fish Biologist, Roseburg Office, Umpqua Watershed District, 1/30/04.

ODFW. 1990. Coos River Basin Fish Management Plan. Oregon Department of Fish and Wildlife. Portland.

ODFW. 1991. Tenmile Basin Fish Management Plan. Oregon Department of Fish and Wildlife. Portland.

Reimers, P. E. 1989. Management of wild and hatchery coho salmon in the Tenmile Lakes system. Information Report #89-5. Oregon Department of Fish and Wildlife. Portland.

Rodgers, J.D. 2002. Abundance monitoring of juvenile salmonids in Oregon coastal streams, 2001. Monitoring Program Report Number OPSW-ODFW-2002-1, Oregon Department of Fish and Wildlife, Portland.

Saltzman, W. O. 1963. A compilation of data from Tahkenitch Lake, Douglas County, Oregon. Staff report. Oregon State Game Commission. Portland.

Saltzman, W. O. 1966. A review of fishery management at Siltcoos Lake. Progress Report for Fishery/Stream Flow Requirements, F-69-R-3. Oregon State Game Commission. Portland.

Shrader, T. and M. E. Gray. 1999. Biology and management of John Day River smallmouth bass. Information Report 99-1. Oregon Department of Fish and Wildlife, Portland.

Shrader, T. 2004. Personal communication with Terry Shrader, ODFW Warmwater Fish Biologist, Bend. 1/28/04

Temple, R. and A. Mirati. 1986. Striped bass and salmonid management issues in Coos Bay, Oregon—Section 1: Potential impacts of striped bass on salmonids. Staff report, Oregon Department of Fish and Wildlife. Portland.

Wydoski, R.S. and R. R. Whitney. 2003. Inland Fishes of Washington. 2nd ed. Univ. Washington Press, Seattle. 322 pp.

Zhou, S. 2000. Stock assessment and optimal escapement of coho salmon in three Oregon coastal lakes. Staff report, Oregon Department of Fish and Wildlife. Portland.

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