U.S. Fish & Wildlife Service

Fishes of the Nisqually River, Estuary, and Reach

Western Washington Office
Aquatic Resources Division

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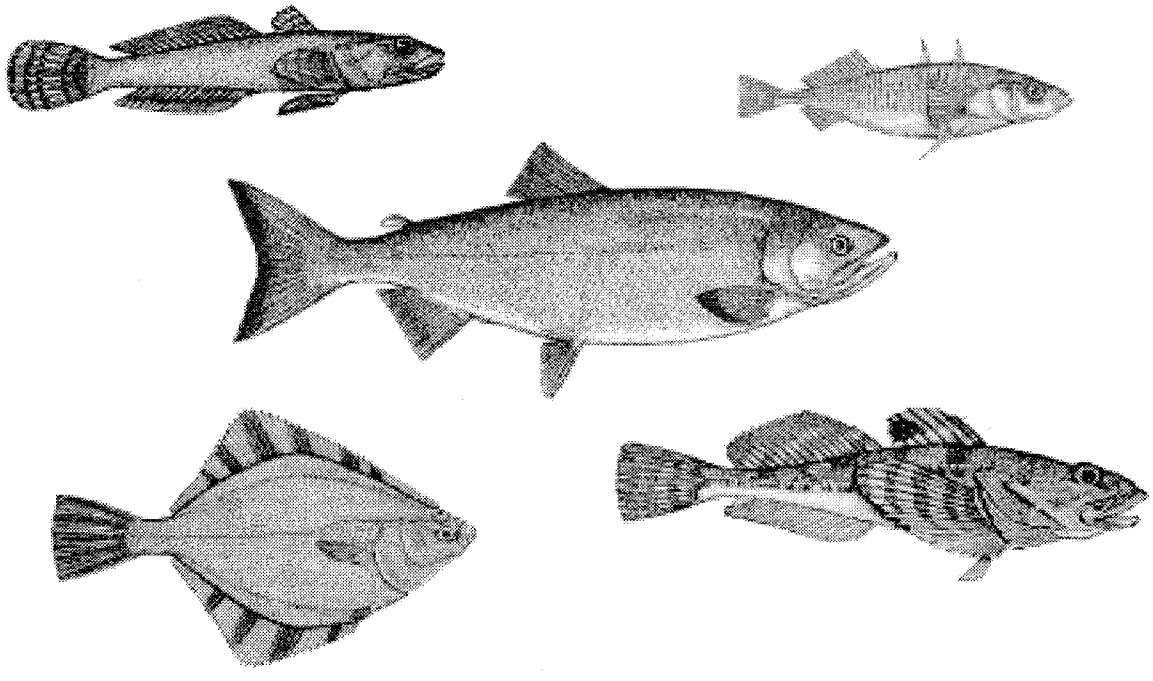

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Preface

The purpose of this report is to provide life history and stock status information on the fish species of the Nisqually basin and estuary. This report is to be used in describing the biological characterization of the Nisqually Wildlife Refuge's Comprehensive Conservation Plan. Emphasis was placed upon species included in the Washington Department of Fish and Wildlife's list of common or economically important fish and those species used as indicators of estuarine environmental health. Only fishes documented in the literature were included in this report. In this report, fishes are listed by family, scientific name, and accepted common name found in the most current American Fisheries Society's list of names. Due to the low number of fish investigations documented on the Nisqually, the total number of current or historically present species is undoubtably higher than what is described in this report.

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Introduction

Despite few fish investigations, the list of fish species that have been observed in the Nisqually basin, estuary, and reach is diverse (Appendix 1). The list is made up of 94 species of 30 different families, including lampreys, salmonids, herring, cods, sculpins, rockfish, surfperches, pricklebacks, gobies, and flatfishes. Life histories and current stock status, when available, of the various fish species are organized below by family.

Petromyzontidae, Lampreys

Lampreys are freshwater or anadromous fishes, parasitic or nonparasitic, and consist of 41 known species (Hart 1973; Nelson 1984). The young have a long larval period prior to metamorphosing into adults (Hart 1973). Most, if not all, lampreys die shortly after spawning. River and western brook lampreys have been captured in the Nisqually River and Pacific lampreys were found in the Nisqually Reach (Table 1). Western brook lampreys inhabit freshwater, while river and Pacific lampreys are anadromous.

Table 1. Lampreys reported to have been captured in the Nisqually River.

Common Name	**Latin Name**	**Habitat** [1] (*primary)		
River lamprey	Lampetra ayresi	F*	E	M*
Western brook lamprey	L. richardsoni	F*		
Pacific lamprey	L. tridentata	F*	E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

River lamprey ammocoetes were found to be very abundant during May and June in the lower reach of the Nisqually River (Harrington-Tweit and Svoboda 1980, 1982; Tierney and Svoboda 1983). River lamprey ammocoetes (larvae) are found on silty or sandy stream bottoms of backwater areas and feed on algae and microscopic organisms (Wydoski and Whitney 1979). River lampreys metamorphosize into adults at a length of 4.6 inches or more, migrate to the Pacific Ocean, and become parasitic on other fishes for an unknown period of time before returning to freshwater to spawn (Scott and Crossman 1973; Wydoski and Whitney 1979). No population estimate or information on distribution within the Nisqually basin are available for this species.

Western brook lamprey, primarily adults, have been captured in May and June in the lower reaches of the Nisqually River (Harrington-Tweit and Svoboda 1980, 1982; Tierney and Svoboda 1983). Western brook lamprey ammocoetes (larvae) are found on silty stream bottoms of backwater areas, while adults inhabit gravel beds suitable for spawning (Scott and Crossman 1973). This nonparasitic lamprey spawns in riffles from April to July on rocks, sand, or gravel (McIntyre 1969). The number of adhesive eggs deposited in the nests per female (sized 111-196 mm) ranges from 1100 to 3700 (Scott and Crossman 1973). Eggs hatch approximately 10-15

days later, and the ammocoetes then burrow into the silty bottoms of the stream margins (McIntyre 1969; Scott and Crossman 1973). The lifespan of the ammocoete stage is believed to be 3-5 years in length, with metamorphosis occurring from August to November (Scott and Crossman 1973). Brook lamprey ammocoetes are filter feeders, consuming microscopic diatoms, desmids, algae, detritus, and other plant and animal matter (Wydoski and Whitney 1979). Adults do not feed during their short lifespan of several months.

Pacific lampreys were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They are anadromous fishes, living in the ocean as adults for up to 3 or more years then returning to their natal streams to spawn (Love 1991). In the spring and summer, females lay an average of 34,000 eggs in bowl-shaped nests in gravel and course sand. The eggs hatch in approximately 24 weeks. The resulting larvae migrate downstream to bury in mud or sand at the bottom of pools and in backwater eddies. The lifespan of the larval stage is unknown, but may be up to 6 years (Wydoski and Whitney 1979). In July, the larvae begin metamorphosing into adults and migrating downstream to the ocean (Love 1991). The larvae are filter feeders, while juveniles and adults parasitize a variety of fishes.

Chimaeridae, ratfishes

The ratfish family consists of about 20 species, one of which, the spotted ratfish, inhabits the Pacific Ocean off of Washington (Nelson 1984). Spotted ratfish have been captured in the Nisqually Reach (Table 2). They are considered to be common or of economic importance in Puget Sound by the Washington Department of Fish and Wildlife (WDFW) (Palsson et al. 1997). Due to a lack of recent data, the recent stock trend and current status of South Sound spotted ratfish is unknown.

Table 2. Ratfish reported to have been captured in the Nisqually Reach.

Common Name	**Latin Name**	**Habitat** [1] (*primary)		
Spotted ratfish	*Hydrolagus colliei*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Spotted ratfish were captured in small numbers in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979). Spotted ratfish in Puget Sound occupy a wide variety of habitats and migrate inshore at night (Lamb and Edgell1986; Love 1991). Spawning is year round and sometimes in intertidal and subtidal waters. Females produce 2 eggs at a time and the embryos may remain in the egg cases for 1 year. Ratfish prey upon shrimp, clams, worms, fish and starfish and are eaten by sharks, halibut and pigeon guillemots.

Squalidae, dogfish sharks

There are about 71 known species of dogfish sharks (Nelson 1984). Only one of these species, the spiny dogfish, has been found in the Nisqually Reach (Table 3). Spiny dogfish are considered to be common or of economic importance by WDFW and the current stock status of South Sound spiny dogfish is "above average" (as defined as "the two year mean exceeded the long-term mean by more than 5%) (Palsson et al. 1997).

Table 3. Dogfish sharks reported to have been captured and observed in the Nisqually Estuary and Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
Spiny dogfish	*Squalus acanthias*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Spiny dogfish, a slow growing and late maturing shark, is common throughout South Sound (Palsson et al. 1997). Spiny dogfish often school and are found from the intertidal zone to1,000 ft deep (Love 1991). Female dogfish mature at 24 years of age on average, produce 1-20 young, and can live over 50 years. Young juveniles remain at the surface to feed, settling near the bottom as they grow older. Dogfish eat fish and a variety of other organisms, including krill, squid, octopi, crabs, sea cucumbers, and jellyfish. They are eaten by marine mammals, sharks, and lingcod.

Clupeidae, herrings

This family consists of about 190 known species of herrings, pilchards, and shad (Nelson 1984). These schooling species inhabit marine or fresh water, or they can be anadromous (Hart 1973). Most are plankton feeders. Herring species captured in the Nisqually River, estuary, and reach include American shad, a non-native species, and Pacific herring (Table 4). Pacific herring inhabit marine waters, while American shad are anadromous.

Table 4. Herrings reported to have been captured in the Nisqually River, Estuary, or Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
American shad	*Alosa sapidissima*	F*	E	M*
Pacific herring [2]	*Clupea harengus*		E*	M*

[1] F = Freshwater; E = Estuarine; M = Marine.
[2] Non-native.

American shad were captured in the lower reach of the Nisqually River in 1980 (Harrington-Tweit and Svoboda 1980). American shad, native to the Atlantic coast, were introduced in the Sacramento River in 1871 and the Columbia River in 1985-86 (Wydoski and Whitney 1979). American shad are anadromous and spawn in rivers when temperatures range between 60° to

65° F. Eggs are semibouyant, are laid in open water at night, and are carried downstream with the flow. The fry hatch after 7 to 12 days, remain in their natal streams over summer, and migrate to sea in late fall (Scott and Crossman 1973; Wydoski and Whitney 1979). American shad are plankton feeders, reach sexual maturity at 3 to 5 years of age, and can survive after spawning. They have been found to feed on copepods and related crustaceans and aquatic insects as juveniles in freshwater. Their marine diet consists primarily of copepods and mysids, with some planktonic crustaceans and small fishes (Scott and Crossman 1973). This species is considered an indicator of environmental stress because of its sensitivity to temperature (Emmett et al. 1991).

Pacific herring are a forage fish. Forage fish are a significant part of the prey base of finfish, marine mammals, and sea birds of Puget Sound, and are utilized for tribal subsistence and by recreational and commercial fishers (Lemberg et al. 1997). Most forage fish spawn within the intertidal to shallow subtidal range and these spawning locations, when documented, are protected from shoreline development in Washington state.

Pacific herring are also considered an indicator of environmental stress, having wide fluctuations in abundance believed to be related to environmental conditions (Emmett et al. 1991). There are 17 herring stocks and 18 spawning sites in Puget Sound. Pacific herring have been captured in the Nisqually Reach in 1977 and 1978, and in the estuary in 1979 and 1980 (Fresh et al. 1979; Pearce et al. 1982). The herring found utilizing the Nisqually Reach and estuary is the Squaxin Pass stock, the southernmost stock in Puget Sound. Prior to spawning, the ripening adults of this stock hold in the Nisqually Reach and once ready, spawn in south Puget Sound along Totten and Hammersley inlets and Squaxin Island from mid-January to mid-April (Figure 1) (Lemberg et al. 1997). Herring usually deposit transparent and adhesive eggs on intertidal and shallow subtidal eelgrass and marine algae, but because this spawning substrate is extremely sparse in this area of the Sound, spawning often occurs on rocks and gravel. Juveniles remain in nearshore shallow-water areas until fall, when most disperse to deeper off-shore waters (Emmett et al. 1991). Pacific herring are considered an indicator of environmental stress due to populations fluctuating with environmental conditions and sensitivity to oil-contaminated water. A sample of the Pacific herring caught in the Nisqually Reach at Tatsolo Point had consumed calanoid copepods, gammarid amphipods, ostracods, crab larvae, and fish larvae (Fresh et al. 1979). The Squaxin Pass herring stock status has been determined to be "moderately healthy" (defined as "a stock with recent two year mean abundance within 30% of the 20 year mean, and/or with high dependence on recruitment") with a "stable" recent trend in the 1996 Forage Fish Stock Status Report by the Washington Department of Fish and Wildlife (Lemberg et al. 1997). This southernmost stock has the slowest known growth rate of Washington stocks.

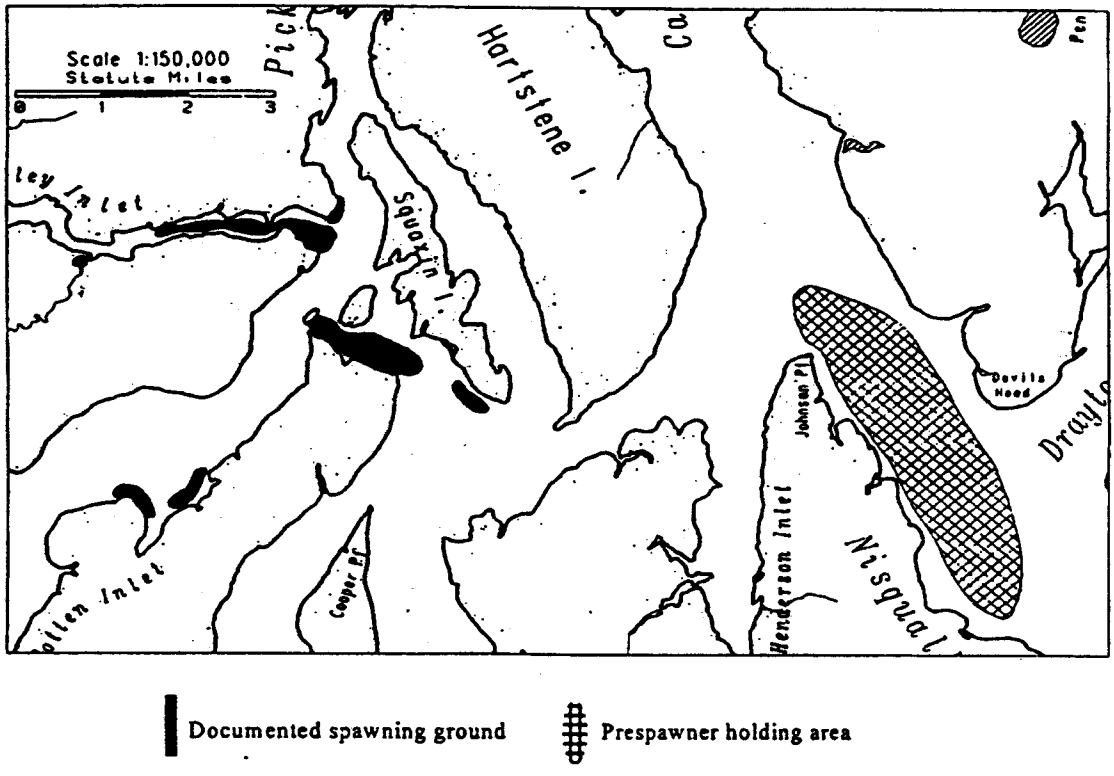

Figure 1. Squaxin Pass herring stock spawning grounds and prespawner holding area (Lemberg et al. 1997).

Cyprinidae, carps and minnows

The cyprinidae family, the largest family of fishes with over 2,000 species, consists of carps and minnows (Nelson 1984). They are primary freshwater species. The only cyprinid recorded to have existed in the Nisqually River is the longnose dace (Table 5).

Table 5. Minnows reported to have been captured in the Nisqually River.

Common Name	Latin Name	Habitat [1] (*primary)		
Longnose dace	*Rhinichythys cataractae*	F*		

[1] F = Freshwater; E = Estuarine; M = Marine.

Longnose dace have been found in the lower reach of the Nisqually River in 1980 and 1981 and in Muck Creek in 1980 (Harrington-Tweit and Svoboda 1980, 1982; Hiss et al. 1982; Tierney and Svoboda 1983). Longnose dace inhabit swift riffles and pools of rivers, spawning in the late spring or early summer on gravel bottoms of shallow riffles (Wydoski and Whitney 1979). The adhesive eggs hatch in 7 to 10 days (McPhail and Lindsey 1970). The fry remain pelagic for approximately 4 months, then become benthic. Longnose dace consume primarily aquatic insects and algae. These fish are thought to mature at 3 years of age (Wydoski and Whitney 1979).

Catostomidae, suckers

Catostomids are freshwater fishes, consisting of 61 known species, and are most often benthic feeders with a ventral mouth (Nelson 1984). The only catostomid found to have been present in the Nisqually River is the largescale sucker (Table 6).

Table 6. Suckers reported to have been captured in the Nisqually River.

Common Name	Latin Name	Habitat [1] (*primary)		
Largescale sucker	*Catostomus macrocheilus*	F*		

[1] F = Freshwater; E = Estuarine; M = Marine.

Largescale suckers were captured in the lower reach of the Nisqually River in 1980 and 1981 and in Muck Creek in 1980 (Harrington-Tweit and Svoboda 1980, 1982; Hiss et al. 1982). Largescale suckers inhabit the bottoms of both lakes and streams, spawning during April and May in shallow and deep water (Wydoski and Whitney 1979; R. Tabor, USFWS, personal communication). A female may lay more than 20,000 adhesive eggs along the bottom (McCart and Aspinwall 1970). The eggs hatch in approximately 2 weeks. The fry remain pelagic until summer, at which time they move to the bottom. Largescale sucker fry eat small zooplankton when pelagic, changing their diet to aquatic insect larvae, diatoms, and plant material after they become bottom dwellers (Carl 1936; Wydoski and Whitney 1979). Larger fish consume

crustaceans, aquatic insect larvae, earthworms, snails, and detritus. These fish are thought to mature at 3 to 5 years of age (Wydoski and Whitney 1979).

Ictaluridae, bullhead catfishes

Ictalurids are freshwater catfishes found primarily in eastern North America (Nelson 1984). This family consists of about 45 known species. The only ictalurid species recorded to have been captured in the Nisqually River is the brown bullhead, a non-native to western North America (Table 7).

Table 7. Bullhead reported to have been captured in the Nisqually River.

Common Name	**Latin Name**	**Habitat** [1] (*primary)		
Brown bullhead [2]	*Ameiurus nebulosus*	F*		

[1] F = Freshwater; E = Estuarine; M = Marine.
[2] Non-native.

Brown bullhead were captured in the lower reach of the Nisqually River in 1980 and 1981 and in Muck Creek in 1980 (Harrington-Tweit and Svoboda 1980, 1982; Hiss et al. 1982). Native to the fresh waters (and few brackish waters) of eastern and central North America, they were introduced to the west coast in the late 1800's and now inhabit warm-water lakes, ponds, sloughs, and slower moving water in streams (Scott and Crossman 1973; Wydoski and Whitney 1979). They are tolerant of a large range of temperature and oxygen levels, as well as pollution (Scott and Crossman 1973). Brown bullhead mature at 3 years of age and spawn in shallow water between April and June in a nest built along the bottom. Approximately 2,000 to 13,000 adhesive eggs are laid by the female in sand or mud bottoms, in vegetation, shade, or along objects, which are then guarded by the male or both parents until the eggs hatch and the fry reach approximately 2 inches in length (Scott and Crossman 1973; Wydoski and Whitney 1979). Eggs hatch in approximately 5-7 days, depending upon the temperature, and the resulting fry school and feed in the shallow water until the end of summer, at which time the fry disperse and move into deeper water. Brown bullheads are omnivorous bottom feeders, with the young feeding primarily on zooplankton and midge larvae, while shifting to midges, mayflies, worms and crustaceans as they grow (Raney and Webster 1940). The adults feed on a variety of organisms, including insect larvae, molluscs, worms, leeches, terrestrial insects, algae, other aquatic plants, fishes, and fish eggs (Imamura 1975). Few brown bullhead live past 5 years of age (Wydoski and Whitney 1979).

Osmeridae, smelts

Osmerids are marine, anadromous, or coastal freshwater fishes, consisting of 10 known species (Nelson 1984). Surf smelt is the only osmerid species listed to have been captured in the Nisqually Estuary and Reach (Table 8).

Table 8. Smelts reported to have been observed and captured in the Nisqually Estuary and Reach.

Common Name	**Latin Name**	**Habitat**[1] (*primary)		
Surf smelt	*Hypomesus pretiosus*		E*	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Surf smelt, considered forage fishes, were captured in the Nisqually Reach in 1977 and 1978, and in the estuary in 1979 and 1980 (Fresh et al. 1979; Pearce et al. 1982). All life stages of the surf smelt are found in the estuarine and marine waters. Surf smelt reach sexual maturity in their second year and spawn in 2.5-5.0 cm of water, depositing an average of 15,000-20,000 adhesive eggs that stick to sand (Emmett et al. 1991). The eggs hatch in 8 to 30 days . As of 1996, 195 miles of surf smelt spawning habitat has been documented, including the Nisqually estuary (Figure 2) (Lemberg et al. 1997). Due to their strict spawning habitat requirements, this species is considered an indicator of environmental health (Emmett et al. 1991). Surf smelt feed primarily on zooplankton, in particular, crustaceans. Those caught in the Nisqually Reach in 1978 had consumed primarily shrimp larvae (Fresh et al. 1979). Most surf smelt do not reach the age of 4 (Emmett et al. 1991).

Limited information regarding the surf smelt populations of Puget Sound is available. The Washington Department of Fish and Wildlife has recently begun to take a systematic approach to obtain data on this species (Lemberg et al. 1997). This initial work has focused primarily on the identification and documentation of spawning habitat to protect it from degradation. Spawning habitat occurs within the upper intertidal zone, which is very susceptible to development. The status of the surf smelt population has been determined to be "unknown" in the 1996 Forage Fish Stock Status Report by the Washington Department of Fish and Wildlife (Lemberg et al. 1997).

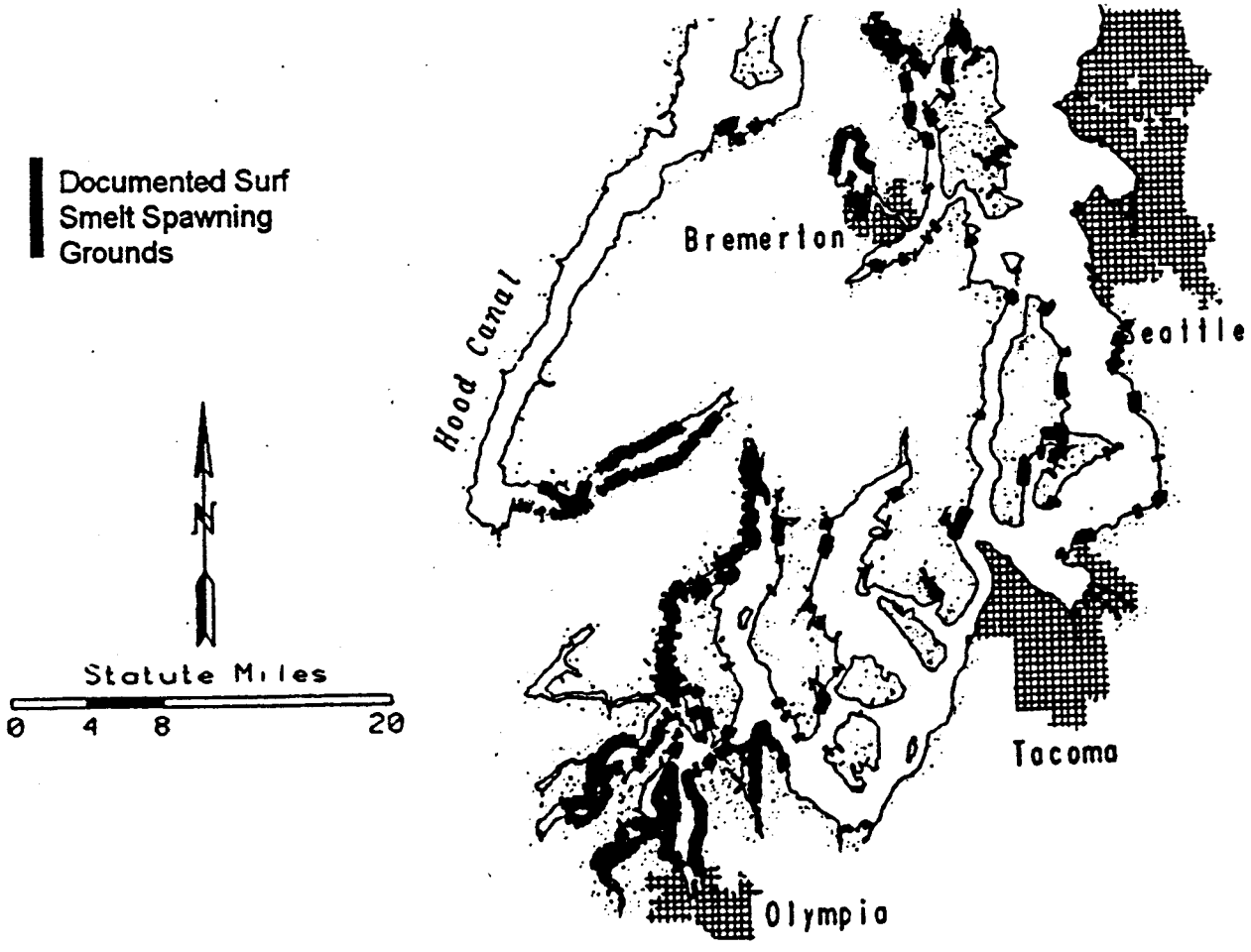

Figure 2. Documented surf smelt spawning grounds in South Puget Sound (Lemberg et al. 1997).

Salmonidae, trouts

The salmonid family consists of about 68 known species (Nelson 1984). They can be anadromous or live solely in freshwater. Salmonids are probably the most abundant fishes in the Nisqually River basin, with ten species having been found in the Nisqually River and Estuary, McAllister Creek, and independent tributaries (Table 9). Six of the salmonids observed in the Nisqually basin are Pacific salmon. The Pacific salmon runs present in the Nisqually River include summer/fall chinook, winter chum, coho, and pink salmon, cutthroat, and summer and winter steelhead. Chum salmon are the most abundant species, followed by coho salmon, pink salmon, steelhead, and chinook salmon. Hatchery production of most of these species has occurred since 1950, with the majority of releases consisting of fall chinook, coho, and chum salmon (Appendix B).

Table 9. Salmonids reported to have been observed or captured in the Nisqually River, Estuary, or Reach.

Common Name	**Latin Name**	**Habitat** [1] (*primary)		
Cutthroat trout	*Oncorhynchus clarki*	F*	E*	M
Pink salmon	*O. gorbuscha*	F*	E*	M*
Chum salmon	*O. keta*	F*	E*	M*
Coho salmon	*O. kisutch*	F*	E*	M*
Steelhead (rainbow trout) [2]	*O. mykiss*	F*	E	M*
Sockeye salmon [3]	*O. nerka*	F*	E	M*
Chinook salmon	*O. tshawytscha*	F*	E*	M*
Mountain whitefish	*Prosopium williamsoni*	F*		
Bull trout [4]	*Salvelinus confluentus*	F*	E	M
Dolly varden	*S. malma*	F*	E	M

[1] F = Freshwater; E = Estuarine; M = Marine.

[2] The term steelhead is applied to sea-run rainbow trout.

[3] One fish captured in the reach in 1977 (Fresh et al. 1979). There is doubt regarding the existence of a native run of anadromous sockeye salmon in the Nisqually River (Williams et al. 1975; NRTF and WDOE 1987). Landlocked sockeye salmon are reported to have released from hatcheries in the upper reaches of the Nisqually River system in 1994, 96, and 97 (Appendix B).

[4] Primarily historical accounts, with one fingerling captured in the early 1980's (Suckley and Cooper 1860; George Walters, Nisqually Indian Tribe, personal communication).

The generalized life history of Pacific salmon includes spawning, egg incubation, hatching, and emergence from redds in freshwater, migration through estuaries to the ocean, and subsequent maturation and migration back to freshwater for spawning. There is a high degree of variability in life-history traits exhibited by salmon, such as some males mature in freshwater, never migrating to the ocean, and juvenile rearing in freshwater may be minimal or take place over

years (Myers et al. 1998). Juveniles migrate from the river to the estuary primarily during spring and early-summer. The occurrence of juvenile salmon within different estuarine habitats has been found to vary by time, species and size, with species residing in estuaries from a few days to many months. Estuaries provide important habitat for foraging, predator avoidance, and for the physiological transition from fresh to salt water (Healey 1982; Simenstad et al. 1982; Iwata and Komatsu 1984; Aitkin 1998).

There are 136 miles of stream available to salmonids in the Nisqually River and 5 miles in McAllister Creek, with abundant spawning and rearing areas (Williams et al. 1975). Large pools are also available for adult holding prior to spawning, which are particularly important for chinook salmon and steelhead. Salmonids are considered to be indicator species of environmental stress within estuaries (Emmett et al. 1991).

Cutthroat trout were captured in the Nisqually estuary in 1979 and 1980 and in the lower reach of the river in 1982 (Pearce et al. 1982; Tierney and Svoboda 1983). Cutthroat trout can be anadromous or nonmigratory and may live after spawning (Wydoski and Whitney 1979). Spawning takes place between late fall and late winter with fecundity averaging 1,000 to 1,700 eggs per female (Scott and Crossman 1973). The anadromous form may spawn in small tributaries and the resulting fry remain there for approximately a year before moving into larger streams (Wydoski and Whitney 1979). The majority of Washington stocks migrate to sea at 3 years of age between April and June and return to the estuary of their natal stream between October and January. It is believed they stay close to their natal stream while in Puget Sound. Juvenile trout feed on insects, crustaceans, and some fish, while subadults and adults are highly piscivorus in the marine, estuarine, and fresh waters (Scott and Crossman 1973; Tabor and Chan 1996). No information is available on the stock status of cutthroat trout in the Nisqually River basin.

Pink salmon enter the spawning grounds from August through October in odd-numbered years only (Williams et al. 1975; WDFW et al. 1994). Spawning occurs from September to late October, primarily in the mainstem of the Nisqually River with additional spawning occurring in Ohop Creek, Yelm Creek, and Mashel River (Figure 3).

Pink salmon fry have been captured in the Nisqually Estuary and Reach between March and mid-June, peaking in March and mid-April (Fresh et al. 1979). Juvenile pink salmon prefer to feed primarily on planktonic organisms, primarily calanoid copepods, in early summer (Miller et al. 1977; Simenstad et al. 1977; Fresh et al. 1979). Fresh et al. (1979) found pink salmon fry to have consumed primarily harpacticoid and calanoid copepods, followed by gammarid amphipods, cumaceans, decapod larvae, and tanaids.

Nisqually pink salmon are considered to be genetically distinct from other Washington pink salmon stocks (WDFW et al. 1994). They are isolated from other pink salmon stocks by geographic separation of the spawning grounds. Three hatchery plants of pink salmon, totaling 350,060 fry, have been recorded for the Nisqually River (years 1917, 77, 83). It is believed that these plants unlikely had any influence on the native stock, therefor, Nisqually River pink salmon

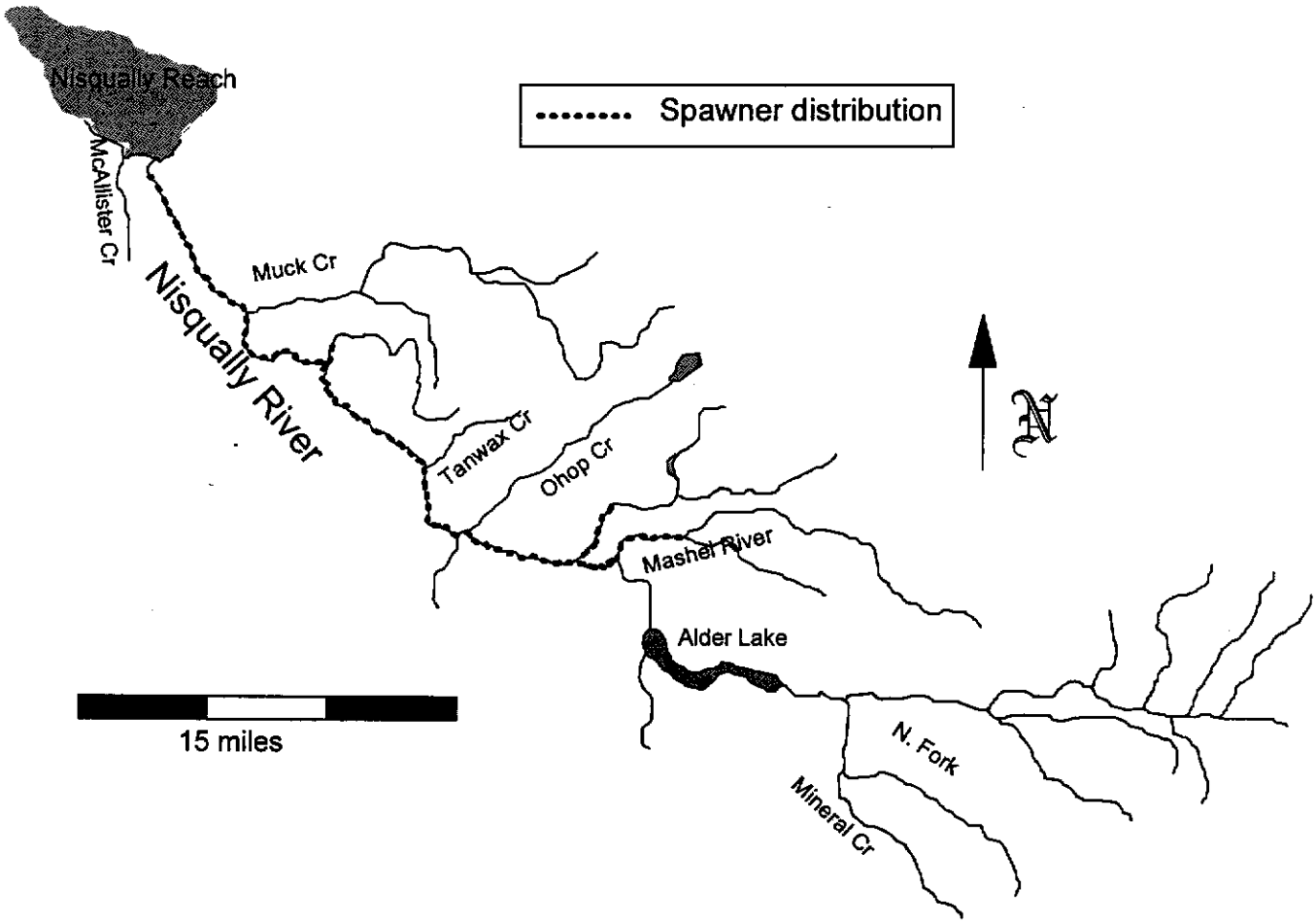

Figure 3. Nisqually River pink salmon spawner distribution (WDF et al. 1994).

are considered to be of native origin. Escapement estimates from 1967 to 1991 ranged from 500 to 12,300 fish, averaging approximately 5,000 fish annually (Figure 4). The Nisqually River pink salmon stock was determined to be "healthy" in SASSI (WDFW et al. 1994). Nisqually pink salmon are caught in the Strait of Juan de Fuca, in the Puget Sound fisheries, and Nisqually River (WDFW et al. 1994). Nisqually River pink salmon were included in the odd-year pink salmon evolutionary significant unit (ESU) determined by NMFS in their status review of pink salmon stocks of Washington, Oregon, and California (Weitkamp et al. 1995). It was determined that this ESU was not presently at risk of extinction, but concern was expressed over the decline of certain populations within this ESU, as well as a recent decline in body length of Washington odd-year pink salmon.

Winter chum salmon have been found to enter the Nisqually River between December and mid-February (WDFW et al. 1994). Chum salmon spawn from January to early-March primarily in the Nisqually River mainstem, the lower 5 miles of Muck Creek, and Mounts and McAllister Creeks (Figure 5) (WDFW et al. 1994). In 1997, a culvert that had blocked anadromous salmonids for 60 years on Red Salmon Creek was replaced and over two dozen adult chum salmon were observed in this creek in the fall of 1998 (Bruce Verhei, South Puget Sound Salmon Enhancement Group, email to USFWS). Adult chum salmon commonly return to their natal streams at ages 3-5, and occasionally at age 2. They typically spawn from the intertidal areas up to the lower 5 kilometers in Washington streams (Mason 1974) in water depths of < 1.3 m and in velocities of < 1 m/s (Caldwell and Caldwell 1987). It is suggested fall chum salmon favor the boundary between pools and riffles for spawning (Reiser and Bjornn 1979).

After emerging from the redd, chum fry move into swift currents and rapidly emigrate at night from freshwater to shallow nearshore marine habitats where food is plentiful (Hoar 1951; Neave 1955; Parker 1971; Healey 1979). Chum salmon fry have been captured in the lower reach of the Nisqually River from early March through early July (Harrington-Tweit and Svoboda 1980, 1982; Harrington-Tweit and Tierney 1985; Tierney and Svoboda 1983), and in the Nisqually estuary between April and August (Pearce et al. 1982).

Upon arrival in the marine environment, chum salmon fry require nearshore habitats and environmental conditions conducive to rapid growth (Parker 1971; Healey 1979) and immediately begin feeding in the marine environment (Simenstad and Salo 1980). Bax et al. (1978) determined the abundance of chum salmon fry was positively correlated with the size of shallow nearshore zones, and sublittoral eelgrass beds have been considered to be the principal habitat utilized by the smaller (< 60 mm) juvenile chum salmon in Hood Canal (Simenstad et al. 1980). During their early marine migration, the main prey of juvenile chum salmon captured in the Nisqually Reach with beach seines was found to be epibenthic and planktonic organisms (Fresh et al. 1979; Pearce et al. 1982). Chum salmon fry have been found to migrate offshore as they increase in size ($\geq$ 65mm) and density (Bax 1983) and with spring runoff (Schreiner 1977). This offshore movement allows the now larger juveniles to exploit the abundant, larger neritic zooplankton consisting of gammarid amphipods, calanoid copepods, other macroinvertebrates, and fish larvae. The diet of chum salmon in the Nisqually Reach and Estuary was observed to

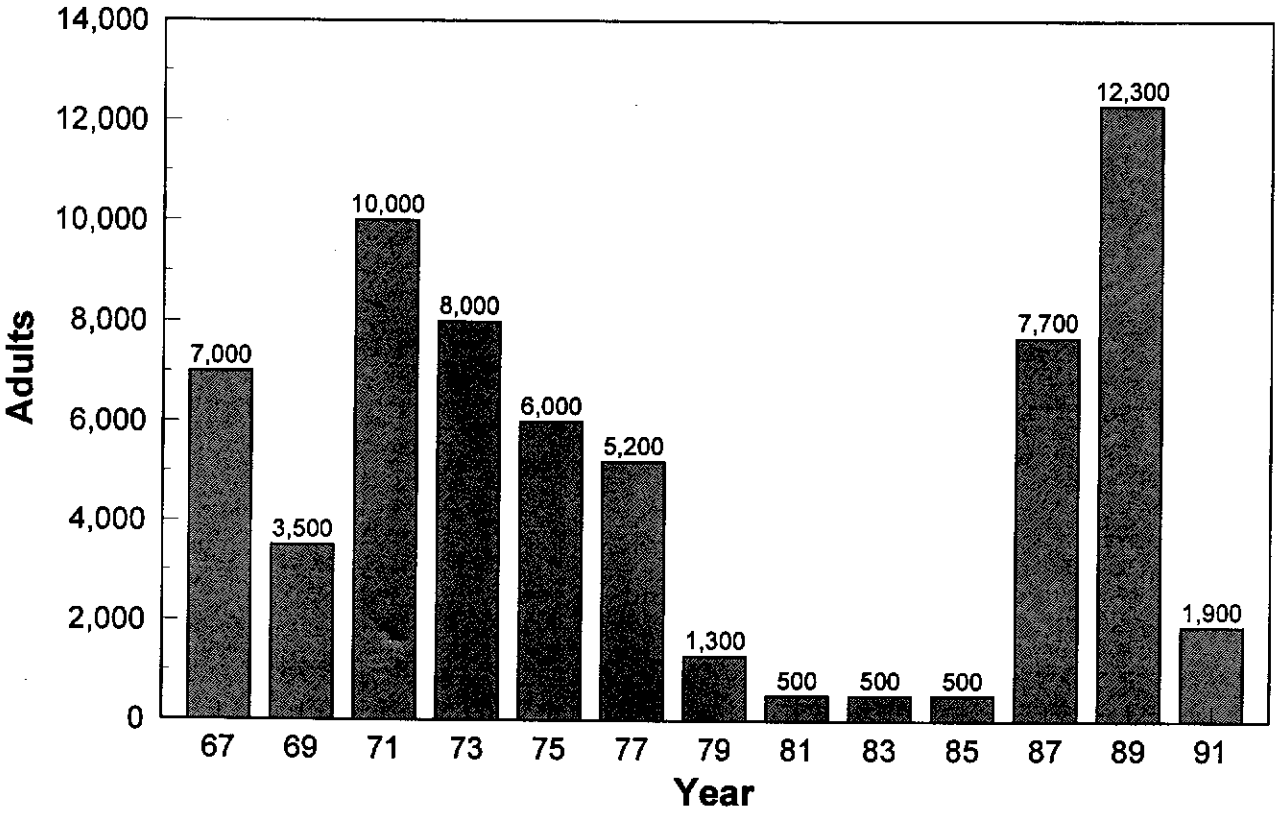

Figure 4. Nisqually River pink salmon escapement estimates from 1967 to 1991 (WDF et al. 1994).

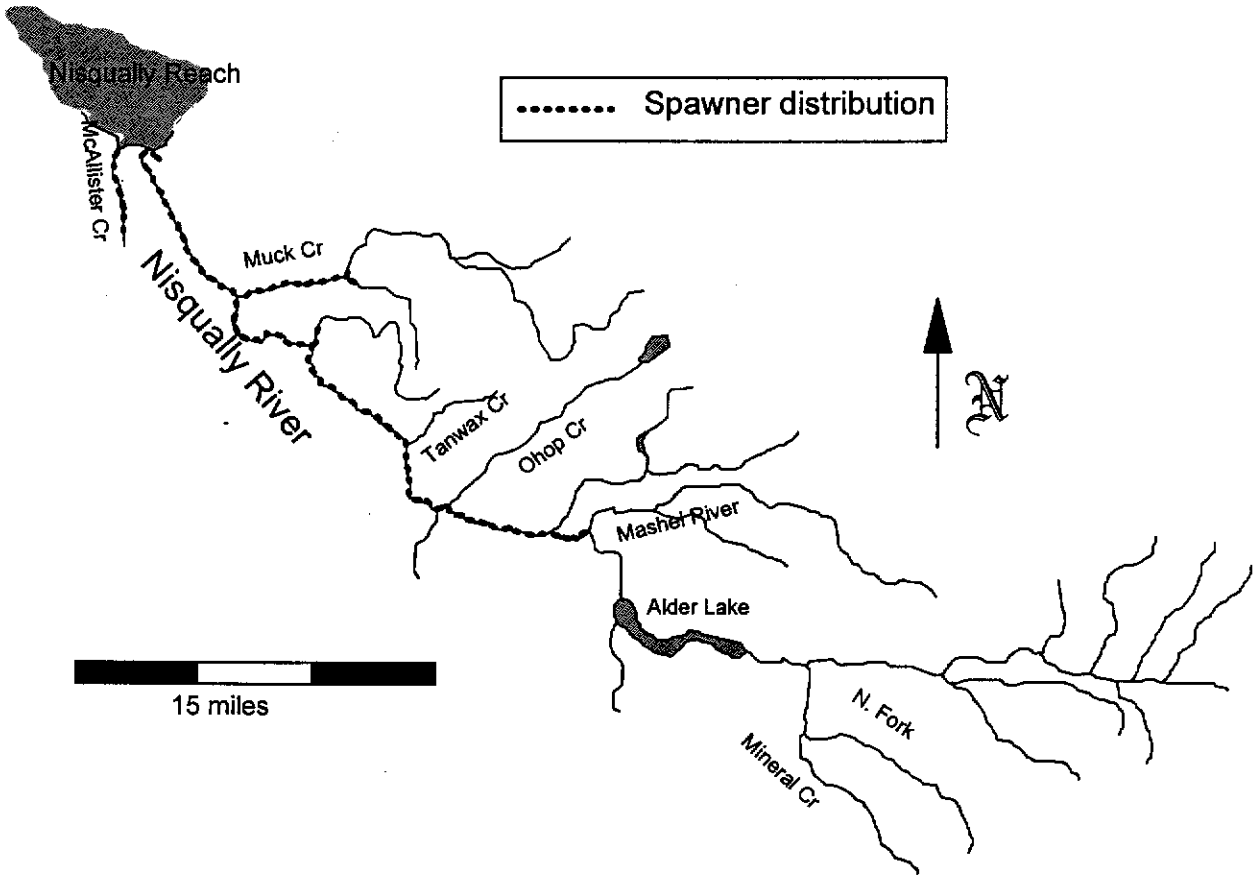

Figure 5. Nisqually River winter chum salmon spawner distribution (WDF et al. 1994).

shift over the period of outmigration from epibenthic prey, primarily harpacticoid copepods and gammarid amphipods, to neritic prey, such as calanoid copepods, crustacea larvae, and hyperiid amphipods (Fresh et al. 1979; Pearce et al. 1982). This shift occurred when chum reached lengths of 50 - 70 mm.

Nisqually River winter chum salmon were classified as native in origin and distinct from other Puget Sound chum salmon stocks in the SASSI based upon their geographic spawning distribution, temporal separation, and distinct genetic characteristics (WDFW et al. 1994). Winter chum salmon from the Nisqually River typically return later to spawn than other stocks. Estimates of adult wild chum salmon escapement to the Nisqually River Basin have ranged from 5,282 to 38,083 fish from 1967 to 1991, averaging 2,700 fish annually (WDFW et al. 1994) (Figure 6). On average, 558,000 chum salmon fry have been released yearly into the basin from 1960-93 (Appendix B). Current hatchery production goals include 500,000 eggs to be release into underescaped Nisqually River tributaries and 20,000 fry to be released into Yelm Creek (WDFW 1998). The Nisqually River winter chum salmon stock was determined to be "healthy" in SASSI (WDFW et al. 1994). Nisqually River chum salmon were included in the Puget Sound/Strait of Georgia evolutionary significant unit (ESU) determined by the National Marine Fisheries Service (NMFS) in their status review of chum salmon stocks of Washington, Oregon, and California (Johnson et al. 1997). This ESU was classified as presently not likely to become extinct or endangered in the foreseeable future.

Coho salmon have been found to enter the Nisqually River between mid-July and mid-October (Williams et al. 1975). Coho salmon spawn from mid-November to mid-January in nearly all accessible streams in the Nisqually basin, with the tributaries of the Nisqually River serving as the principal spawning grounds (Figure 7) (Williams et al. 1975; WDF et al. 1994). Upon emergence, juveniles remain in the system for more than a year, rearing in the accessible length and tributaries of the Nisqually River, the independent tributaries of the south shore of the Nisqually Reach, McAllister Creek, and the estuary (Williams et al. 1975). The majority of outmigration to saltwater occurs between late February and early June, with some coho smolts moving seaward year around. Coho salmon smolts have been captured in the lower reach of the Nisqually River from March through June (Harrington-Tweit and Svoboda 1980, 1982; Harrington-Tweit and Tierney 1985; Tierney and Svoboda 1983), and in the Nisqually estuary between April and July (Pearce et al. 1982). In a subsample of the chinook and coho smolts captured in 1981, the primary diet consisted of all life stages of midges and mayflies (Harrington-Tweit and Svoboda 1982). Fresh et al. (1979) found that juvenile coho salmon located in shallow sublittoral habitat in the Nisqually Reach, fed primarily upon epibenthic organisms, such as gammarid amphipods, harpacticoid copepods, cumaceans, isopods, and mysids, as well as surface drift insects. Pearce et al. (1982) found sand lance, harpacticoid copepods, and dipteran flies to be important to the diets of juvenile coho salmon in the Nisqually Estuary in 1980. In some areas, juvenile coho salmon consume large numbers of salmonid fry (Foerster 1968; Ruggerone and Rogers 1992).

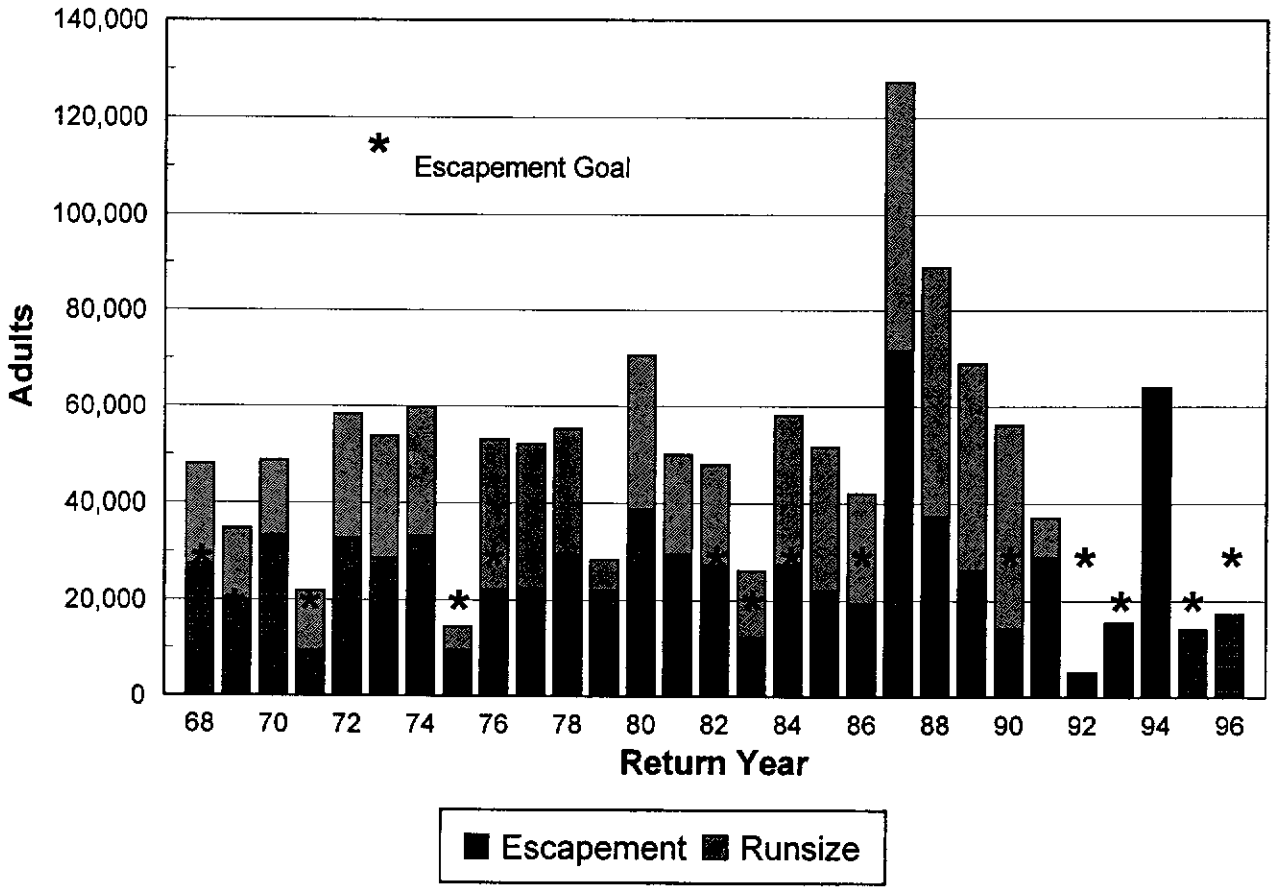

Figure 6. Nisqually River winter chum salmon runsize estimates from 1968 to 1996 (WDF et al. 1994).

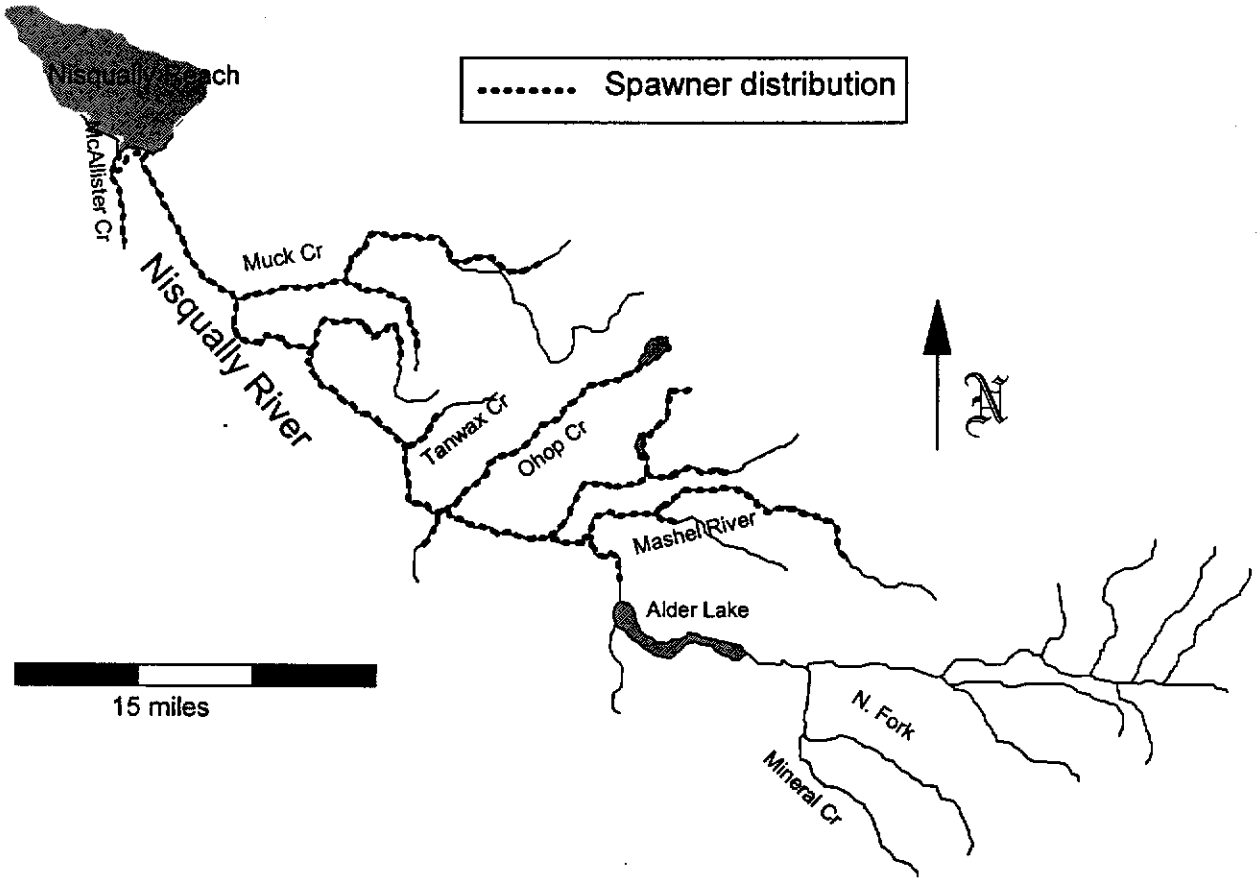

Figure 7. Nisqually River coho salmon spawner distribution (WDF et al. 1994).

Nisqually River coho salmon were classified as distinct from other Puget Sound coho salmon stocks in SASSI (WDFW et al. 1994) based upon their geographic spawning distribution. There have been extensive hatchery releases within the system of non-native stocks, primarily Green River, Skykomish River, and Puyallup River stocks. Due to these extensive hatchery releases, the stock is considered to be of mixed origin (native and non-native). The release goal of hatchery produced coho salmon is currently 1,416,500 fish for the Nisqually River and its tributaries (WDFW 1998). Estimates of adult wild coho salmon escapement to the Nisqually River have ranged widely from 600 to 13,000 fish from 1967 to 1991, averaging 3,080 fish annually (WDFW et al. 1994) (Figure 8). The Nisqually River coho salmon stock was determined to be "healthy" in SASSI (WDFW et al. 1994). This stock is primarily harvested in Canadian and Washington troll, net and sport fisheries (WDFW et al. 1994). Nisqually River coho salmon were included in the Puget Sound/Strait of Georgia evolutionary significant unit (ESU) determined by the National Marine Fisheries Service (NMFS) in their status review of coho salmon stocks of Washington, Oregon, and California (Weitkamp et al. 1995). This ESU was not classified likely to become extinct or endangered, but further consideration of this ESU was deemed warranted due to the continuing loss of habitat, high artificial production rates, extremely high harvest rates, and a severe recent decline in average size of spawners.

Steelhead exhibit complex life history traits (Busby et al. 1996). They can be anadromous (steelhead) or remain in freshwater (rainbow trout). This species also has the ability to spawn more than once, unlike all other salmon except cutthroat trout (Busby et al. 1996). Scientists have divided steelhead into two races: "stream-maturing", which enter fresh water in a sexually immature condition and requires several months to mature and spawn, and "ocean-maturing", which enter fresh water with well-developed gonads and spawns immediately (Busby et al. 1996). Nisqually River steelhead are ocean-maturing, spending 2 years (63% of the population) to 3 years (36% of the population) in the ocean before entering fresh water to spawn. Nisqually steelhead enter the spawning grounds from December through May. Spawning occurs from March to mid-June, peaking in April and May, primarily in the mainstem of the Nisqually River with additional spawning occurring in Ohop Creek, Muck Creek, Tanwax Creek, and Mashel River (Figure 9) (WDFW et al. 1994). Most female steelhead produce an average of 1,500-5,000 eggs (Bell 1984). Fry and parr reside in areas of the river that have cover and move to deeper water as they grow (Emmett et al. 1991). Primary food items in freshwater include gammarid amphipods, small crustaceans, insects, and small fishes (Moyle 1976; Wydoski and Whitney 1979; Loch 1982; Dawley et al. 1986). Nisqually River steelhead generally (80% of the population) reside in the river for two years before smolting (WDFW 1994b as cited *in* Busby et al. 1996). Steelhead outmigrants have been captured from March through June in the Nisqually River (Harrington-Tweit and Svoboda 1980, 1982; Hiss et al. 1982; Tierney and Svoboda 1983; Harrington-Tweit and Tierney 1985), and in the spring and early summer in the Nisqually Estuary (Pearce et al. 1982). Steelhead smolts, subadults, and adults migrate through estuaries, but generally do not spend much time rearing in estuaries (Dawley et al. 1986). Adult steelhead captured in the Nisqually Reach were found to have consumed Pacific herring, juvenile English sole, Pacific sand lance, salmon fry, and gammarid amphipods (Fresh et al. 1979).

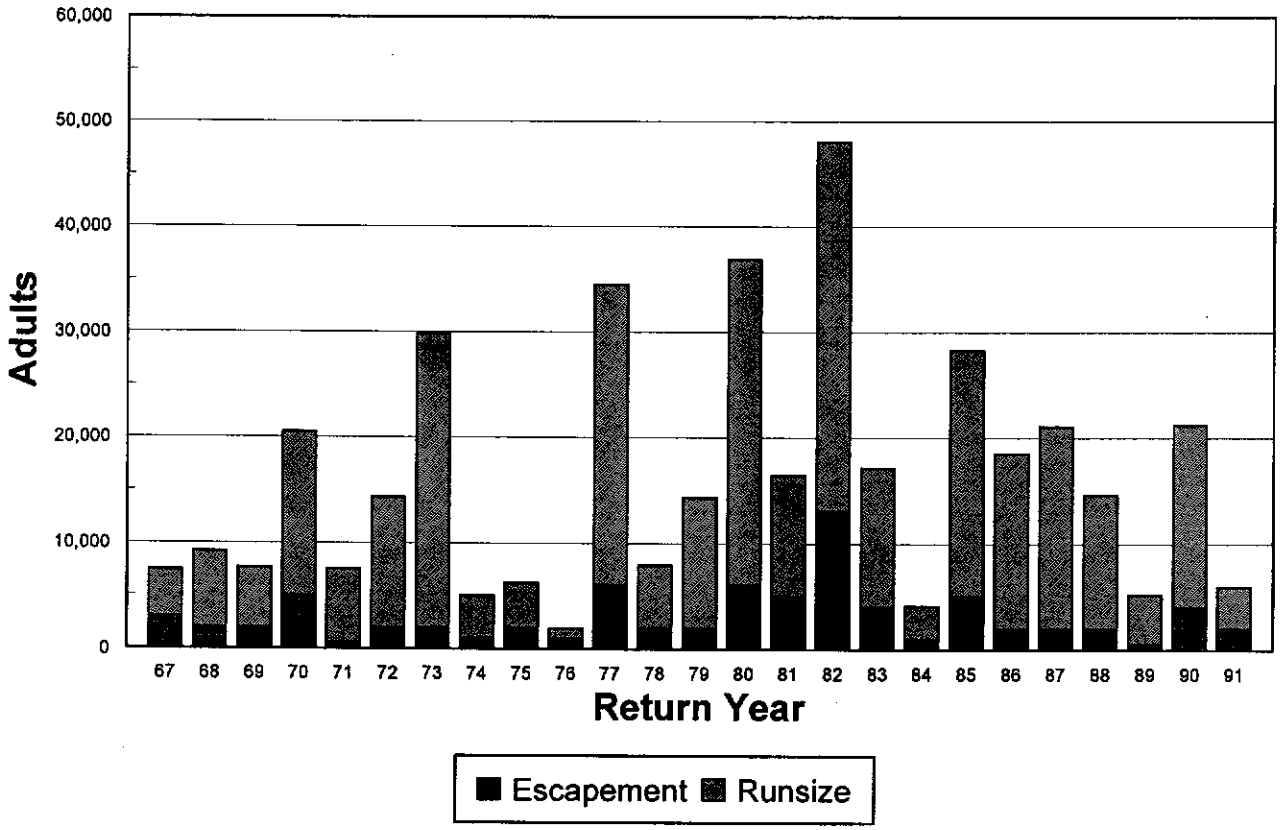

Figure 8. Nisqually River coho salmon escapement and runsize estimates from 1967 to 1991 (WDF et al. 1994).

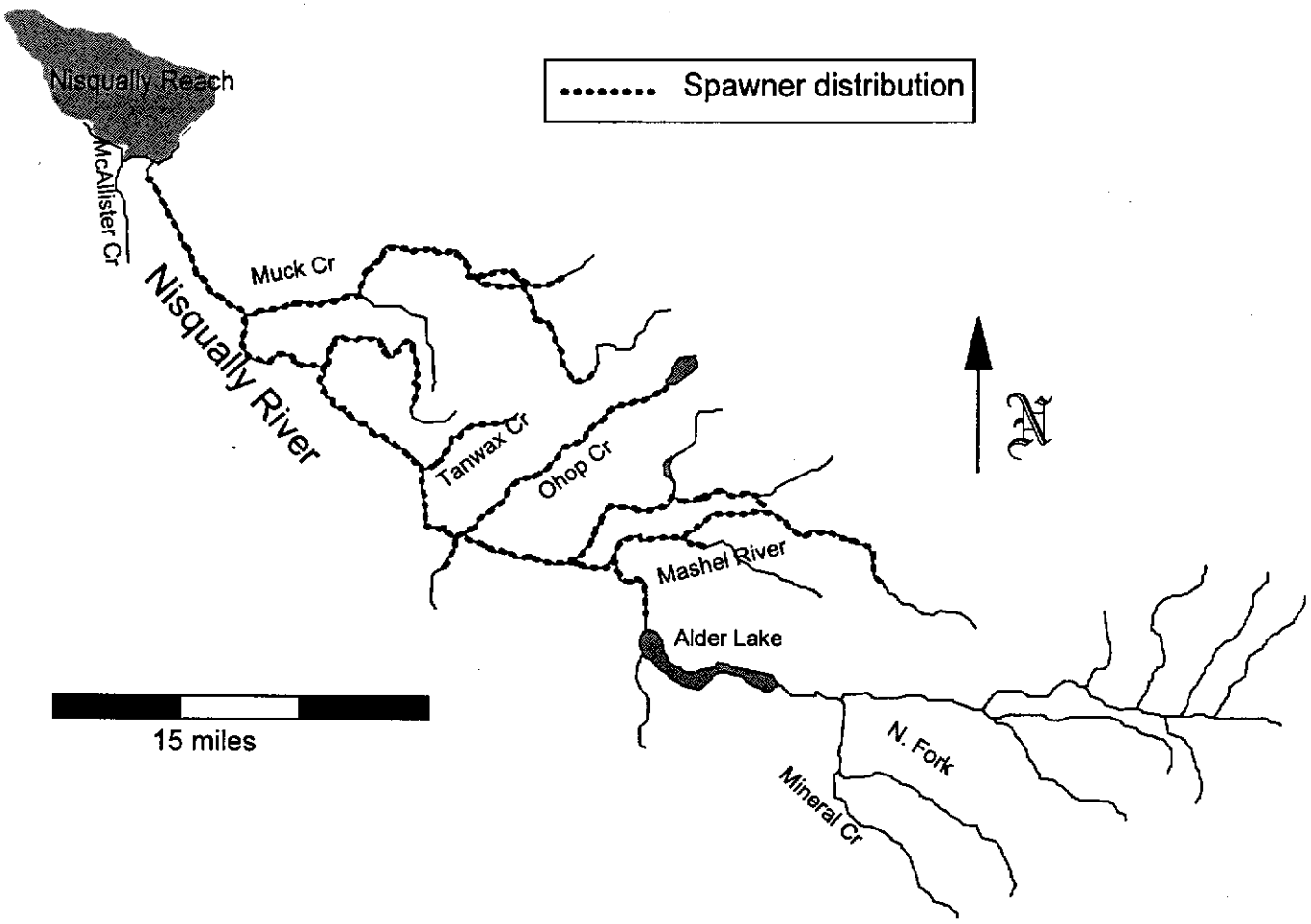

Figure 9. Nisqually River wild winter steelhead spawner distribution (WDF et al. 1994).

Nisqually steelhead are considered to be distinct from other Washington steelhead stocks (WDFW et al. 1994). They are isolated from other steelhead stocks by geographic separation of the spawning grounds and due to few hatchery produced releases of steelhead in the system (averaging 25,000 per year), the stock origin is considered to be native. Escapement estimates from 1979 to 1991 ranged from 642 to 3,817 fish, averaging approximately 2,100 fish annually (Figure 10). The Nisqually River winter steelhead stock was determined to be "healthy" in SASSI (WDFW et al. 1994). Nisqually River steelhead were included in the Puget Sound evolutionary significant unit (ESU) determined by the National Marine Fisheries Service (NMFS) in their status review of steelhead stocks of Washington, Idaho, Oregon, and California (Busby et al. 1996). This ESU was classified as presently not likely to become extinct or endangered.

Summer/Fall chinook salmon, also known as king, quinnat, or tyee salmon, is the largest of the Pacific Salmon (Netboy 1958). This species ranged historically from southern California to Alaska in North America (Healey 1991). Chinook salmon have the most diverse life history strategies of the Pacific salmon (Myers et al. 1998) and remain at sea commonly from 2 to 4 years, with some proportion remaining as little as 2 or 3 months or as long as 6 years (Gilbert 1912; Mullen et al. 1992). Based on coded-wire-tag (CWT) recoveries, Nisqually River chinook salmon migrate in marine waters to the north along the coast and are caught primarily in Canadian fisheries off Vancouver Island and in Washington Puget Sound fisheries (WDF et al. 1994). Chinook salmon freshwater migration into the Nisqually River begins in mid-July and is complete by mid-October (Williams et al. 1975; WDF et al. 1994). Upon return to freshwater, chinook salmon take advantage of resting pools that may maximize the success of the spawning migration by providing thermal refuge from high summer and fall temperatures, refuge from potential predators, and possibly reduce susceptibility to pathogens (Berman and Quinn 1991; Hockersmith et al. 1994). Spawning occurs in September, October, and early November along the lower mainstem of the Nisqually River to LaGrande Dam and in the lower regions of the Mashel River and Ohop, Yelm, and Muck Creeks (Figure 11) (Williams et al. 1975; WDF et al. 1994).

Scientists have divided chinook salmon into two races: "ocean-type", which, as juveniles, migrate to the ocean within their first year, and "stream-type", which reside longer in freshwater (Gilbert 1912; Healey 1983,1991). The Puget Sound chinook salmon stocks are predominantly ocean-type. Ocean-type fish have exhibited a faster growth rate than stream-type fish (Gilbert 1912; Carl and Healey 1984; Taylor 1990). Ocean-type juveniles have been found to enter saltwater at one of three phases: immediately after yolk absorption at 30-45 mm in length, 60-150 days post-hatching, and as fingerlings in the late summer or autumn of their first year. Nisqually River chinook salmon rear in the system for approximately three months before migrating to saltwater (Williams et al. 1975).

The majority of juvenile chinook out-migration to the estuary has been found to occur between mid-February and early June (Williams et al. 1975). Chinook salmon smolts have been captured in the lower reach of the Nisqually River from March through July (Harrington-Tweit and

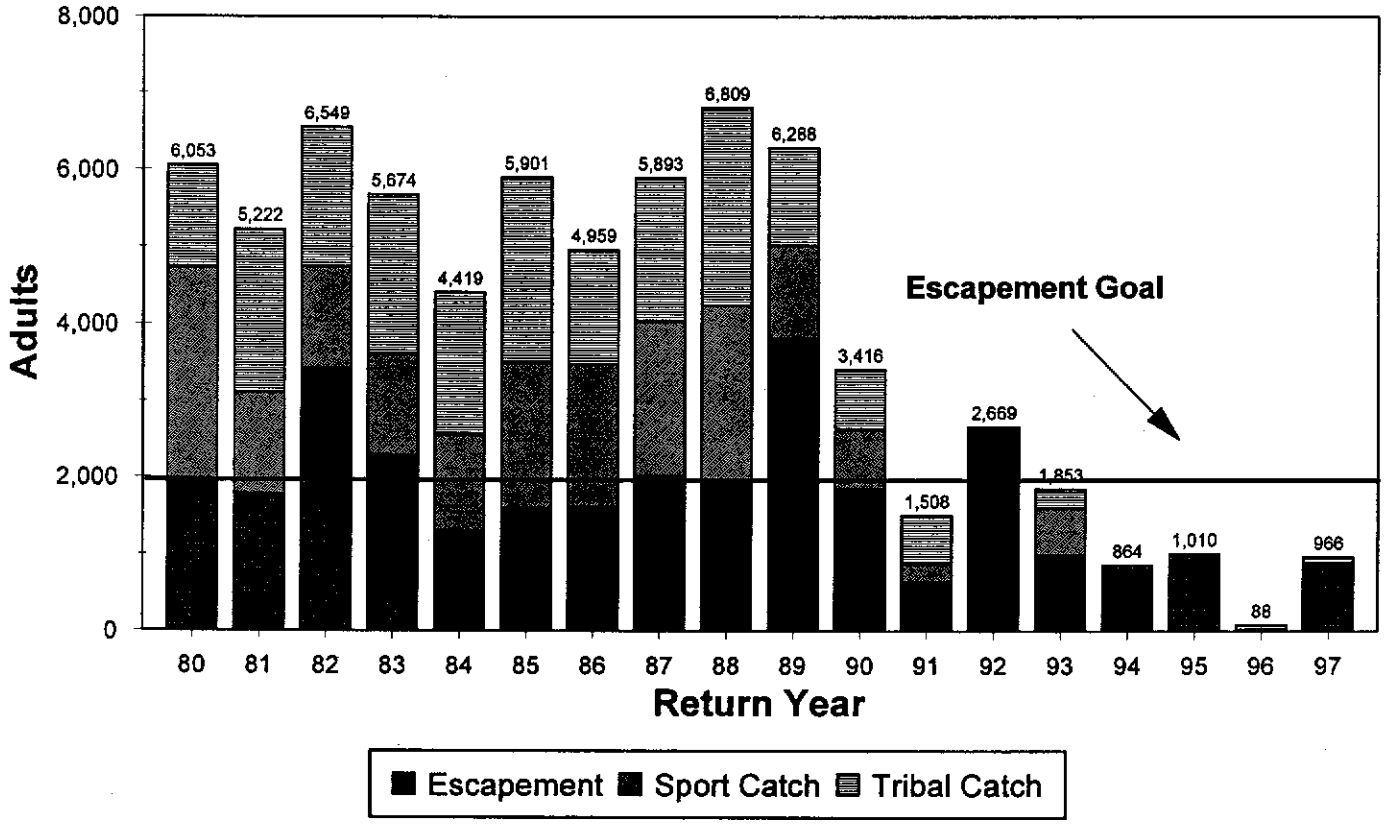

Figure10. Nisqually River wild winter steelhead runsize and escapement estimates from 1980 to 1997 (WDF et al. 1994).

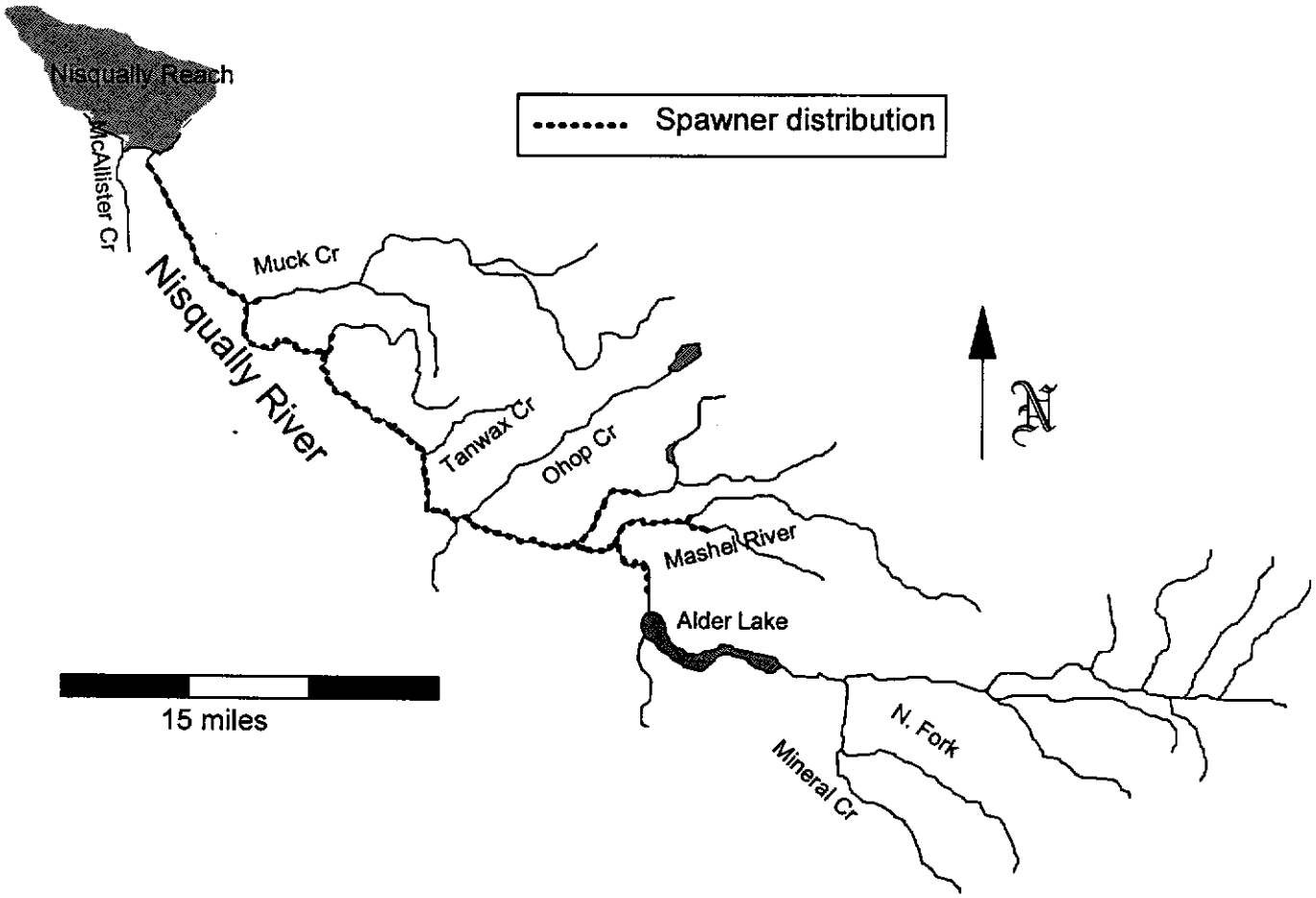

Figure 11. Nisqually River wild summer/fall chinook salmon spawner distribution (WDF et al. 1994).

Svoboda 1980, 1982; Harrington-Tweit and Tierney 1985; Tierney and Svoboda 1983) and in the Nisqually estuary between April and September (Pearce et al. 1982). The principal prey items eaten by the juvenile chinook in the estuary were insects, primarily dipteran flies, spiders, decapod zoea, harpacticoid copepods, amphipods, and fish (Pearce et al. 1982). Ocean-type chinook salmon tend to utilize estuaries and coastal areas more extensively for juvenile rearing than stream-type fish (Myers et al. 1998) and rivers with well-developed estuaries have been found to sustain larger ocean-type populations than those without (Levy and Northcote 1982). The number of fry migrants has also been found to be positively related to rivers with large estuary systems (Fraser et al. 1982).

Estimates of adult wild chinook salmon escapement to the Nisqually River have ranged from 85 to 2,332 fish from 1978 to 1990, averaging 830 fish annually (Figure 12). Nisqually River chinook salmon were classified as distinct from other Puget Sound chinook salmon stocks in the 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI) (WDFW et al. 1994) based upon their geographic distribution. There is doubt regarding this distinction as there have been extensive releases within the system of non-native stocks, primarily Green River and Deschutes River stocks. Due to the extensive hatchery releases, the stock is considered to be of mixed origin (native and non-native). Release goals of hatchery produced chinook salmon fry are currently 3,700,000 for Nisqually River tributaries and 250,000 for McAllister Creek (WDFW 1998). The Nisqually River chinook salmon stock was determined to be "healthy" in SASSI (WDF et al. 1994).

Nisqually River chinook salmon were included in the Puget Sound evolutionary significant unit (ESU) determined by the National Marine Fisheries Service (NMFS) in their status review of salmon stocks of Washington, Idaho, Oregon, and California (Myers et al. 1998). This ESU includes spring-, summer-, and fall-run chinook salmon of the coastal basins of the eastern part of the Strait of Juan de Fuca, Hood Canal and Puget Sound. These stocks tend to mature at ages 3 and 4 and are harvested primarily in the Puget Sound and Canadian fisheries (WDFW et al. 1994; Myers et al. 1998). NMFS determined this ESU to be at risk of becoming endangered within the foreseeable future, and decided to list this ESU as threatened under the Endangered Species Act (NMFS 1998; News Report via email, March, 1999). Even though the total abundance in this ESU is relatively high, much of this production is from hatcheries and the long-term and short-term trends in abundances are downward for many of the stocks.

Mountain whitefish have been found in the lower reach of the Nisqually River (Harrington-Tweit and Svoboda 1980, 1982). They prefer riffles in summer and large pools during winter (Wydoski and Whitney 1979). They reach sexual maturity at 3 to 4 years of age and spawn in gravel in late fall or early winter (Scott and Crossman 1973). A female may lay an average of 5000 eggs per pound of fish (Scott and Crossman 1973). The eggs hatch in late winter or early spring and the newly hatched fry inhabit the stream shallows for a few weeks before moving offshore (Brown 1952). Mountain whitefish have a variable diet, feeding primarily on bottom-dwelling aquatic insect larvae, as well as crayfish, fresh water shrimp, leeches, fish eggs, and occasionally small fish (Ellison 1980; Thompson and Davies 1976; Northcote and Ennis 1994).

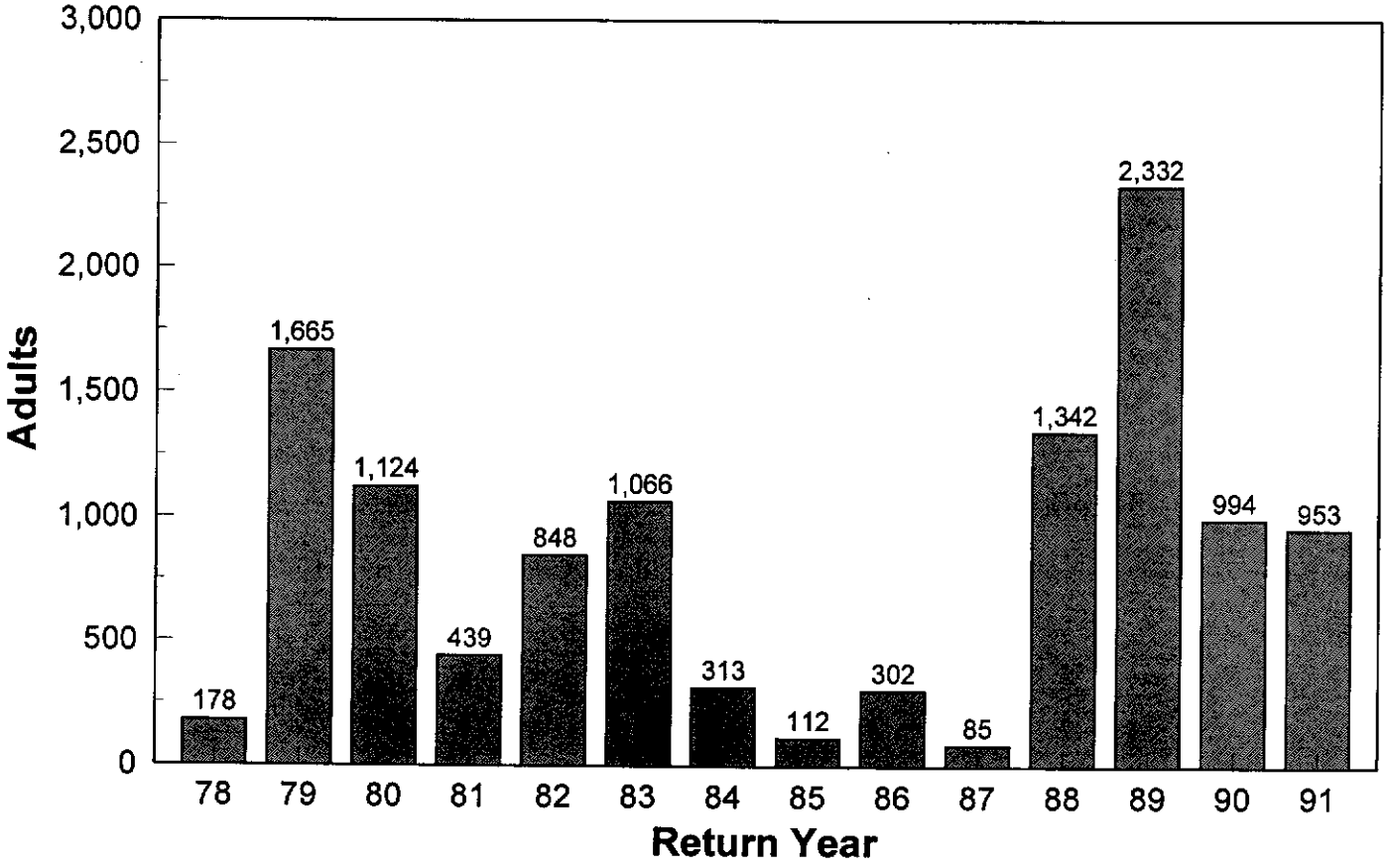

Figure 12. Nisqually River wild summer/fall chinook salmon escapement from 1978 to 1991 (WDF et al. 1994). This graph does not include McAllister Creek chinook salmon escapement, which is included in "miscellaneous South Sound tributaries production" by WDFW.

Bull trout were described as entering the Nisqually River in "vast numbers" in historical accounts (Suckley and Cooper 1860), but little is known about the current status of the population (WDFW 1997). One fingerling was captured in the early 1980's during a salmonid outmigration study (George Walters, Nisqually Indian Tribe, personal communication). Bull trout may migrate to salt water or reside solely in freshwater streams and lakes (USFWS 1998). They have been found to be associated with the coldest stream reaches in basins (Lee et al. 1997; Rieman and McIntyre 1993). Bull trout also associate with large, deep pools and high habitat complexity (Rieman and McIntyre 1993; Watson and Hillman 1997). Bull trout become sexually mature at 5 to 7 years of age (Rieman and McIntyre 1993). They generally spawn from August through November in small tributaries and headwater streams. Bull trout prefer loose, clean, gravel for spawning (Fraley and Shepard 1989). Hatching occurs in late winter or early spring (Rieman and McIntyre 1993). Juveniles inhabit side channels, stream margins, and other low-velocity areas, favoring cover, substrate, or undercut banks (Goetz 1991; Rieman and McIntyre 1993) Bull trout eat aquatic and terrestrial insects, macrozooplankton, mysids, and fish (Shepard et al. 1984). Large bull trout may feed almost exclusively on fish (Fraley and Shepard 1989; Shepard et al. 1984).

The U.S. Fish and Wildlife Service considers the Nisqually River bull trout to be a subpopulation which has been rated as "depressed" (Jeff Chan, USFWS, personal communication). This subpopulation is part of the Coastal-Puget Sound population segment that has been proposed as threatened in June of 1998 under the Endangered Species Act.

Gadidae, cods

Gadids consist of about 55 known species (Nelson 1984). All, but one, are marine fishes. Codfishes are known to form large schools along shallow coastal or deeper continental shelf habitats (Lamb and Edgell 1986). Four codfish species have been captured in small numbers from 1978 to 1980 in the Nisqually Estuary and Reach (Table 11). All of the codfish listed are considered to be common or of economic importance in Puget Sound by WDFW, except Pacific tomcod, which is considered an indicator species of estuarine health. WDFW has determined South Sound stocks of Pacific whiting, Pacific cod, and walleye pollock to have been over-utilized, are declining in abundance, and are at "critical" stock abundance levels (defined as "the two year mean was below the long-term mean by more than 76%, or the fishery or population was not detectable") (Palsson et al. 1997).

Table 11. Cod species reported to have been captured in the Nisqually Estuary or Reach.

Common Name	**Latin Name**	**Habitat**[1] (*primary)		
Pacific cod	*Gadus macrocephalus*		E	M*
Pacific hake	*Merluccius productus*		E	M*
Pacific tomcod	*Microgadus proximus*		E	M*
Walleye pollock	*Theregra chalcogrammus*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Pacific cod school, live near the bottom over soft or gravel substrate, and make substantial along-shore movements (Love 1991). They inhabit shallow waters in late spring and early summer to feed and move to deeper waters in autumn and winter to spawn. Pacific cod are cold-water species, preferring temperatures of less than 50°F. Most Pacific cod reach sexual maturity at 2 to 4 years of age and spawn in winter, with females producing as many as 3,350,000 eggs. Eggs hatch in 8-28 days and juveniles are found in shallower waters more often than adults. Pacific cod prey upon krill, shrimp, crabs, and fish (primarily sand lance and herring) and are preyed upon by marine mammals, sea birds and fish. Three juvenile Pacific cod captured in the Nisqually Reach in 1977 and 1978 had consumed calanoid and cyclopoid copepods, hippolytid shrimp, and hyperiid amphipods (Fresh et al. 1979).

Pacific hake reach sexual maturity at 3 to 4 years of age, can grow to a size of 3 ft in length, and live over 20 years (Love 1991). Most South Sound Pacific hake spawn in the winter in Port Susan (Palsson et al. 1997). They live in 35 to 3,000 ft depths, are omnivorous, nocturnal foragers. Juveniles consume krill, while adults eat krill, fish and shrimp (Love 1991). These fish are eaten by many other fish and marine mammals. The recovery of this stock may be hindered by high predation by marine mammals (Palsson et al. 1997).

Pacific tomcod are fast growing, may reach sexual maturity in two years, and spawn from late winter to spring in Washington in marine (euhaline) coastal waters (Emmett et al. 1991; Walters 1984). Larvae and small juveniles are pelagic, occurring in nearshore marine waters and estuaries, while adults and juveniles are demersal and are found in polyhaline to euhaline waters. The larvae are planktonic carnivores, while juveniles and adults are epibenthic, planktonic, and benthic carnivores (Emmett et al. 1991). Preferred prey items of larvae and juveniles include calanoid and harpacticoid copepods, mysids, juvenile crangonid shrimp, crab megalops, fish larvae, and polychaetes. Diet of the adults include fish. Pacific tomcod larvae are consumed by many fishes, while juveniles and adults are eaten by large fishes, harbor seals and other marine mammals (Emmett et al. 1991).

Walleye pollock are schooling, midwater and bottom dwelling, and live in subtidal to over 3,000 ft depths (Love 1991). South Sound walleye pollock are at their extreme southern end of their Pacific coast distribution (Palsson et al. 1997). Walleye pollock reach sexually mature at 2 to 3 years of age, reach 3 ft in length, and can live to be 14 years old. Spawning occurs in winter to summer, in 150 to 1,200 ft depths. Young walleye pollock school in inshore waters. Preferred prey items are planktonic animals, including krill, shrimp, and copepods, as well as other fish. They are consumed by marine mammals, sea birds and other fishes. Walleye pollock were the most commonly harvested bottomfish in Puget Sound recreational fisheries in the 1970's and 1980's, at which time the population sharply declined (Palsson et al. 1997).

Batrachoididae, toadfishes

The batrachoididae family are marine toadfishes consisting of about 64 known species (Nelson 1984). Most are benthic and inhabit coastal areas in tropical seas (Hart 1973). Only one toadfish, the plainfin midshipman, is recorded to have been found in the Nisqually Reach (Table 12).

Table 12. Toadfish reported to have been captured in the Nisqually Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
Plainfin midshipman	*Porichthys notatus*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Plainfin midshipman are a shallow marine water fish with numerous photophores (Nelson 1984). A small number of them were captured in the Nisqually Reach in 1978 (Fresh et al. 1979). Plainfin midshipman spawn in shallow water or in the intertidal zone in the spring (Hart 1973). Males protect the eggs after they are laid in a cavity scooped out in sand or under shells or rocks. The eggs hatch in 16 to 20 days. Young bury in the bottom sediments and venture out at night to feed on crustacean larvae. Adults prey on fishes and crustaceans. Plainfin midshipman can grow to a length of 15 inches and make a humming sound "oonk" that can be heard for 12 m.

Gobiesocidae, clingfishes

There are about 110 known species of clingfishes (Nelson 1984). Clingfishes are small fish with an adhesive disc used to cling to rocks, shells, eelgrass, and kelp (Hart 1973). Most inhabit shallow water or intertidal marine areas (Nelson 1984). Only one species of this family, the northern clingfish, is recorded to have been found in the Nisqually Reach (Table 13).

Table 13. Clingfish reported to have been captured in the Nisqually Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
Northern clingfish	*Gobiesox meandricus*		E*	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Northern clingfish have an adhesive disc used to cling to rocks in the intertidal zone and in tidal currents (Hart 1973). They can reach a length of 6 in and prey on small crustaceans and molluscs. A small number of northern clingfish were captured in the Nisqually Reach in 1977 (Fresh et al. 1979).

Gasterosteidae, sticklebacks

The family gasterosteidae consists of only seven known species of sticklebacks and two species of tube-snouts (Nelson 1984; Robins et al. 1991). Two of these species, tube-snout and threespine stickleback, are reported to have been found in the Nisqually River, Estuary and Reach (Table 14). Sticklebacks can inhabit marine, brackish, or freshwater areas (Nelson 1984). They can also be anadromous.

Table 14. Sticklebacks reported to have been captured in the Nisqually River, Estuary, or Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
Tube-snout	*Aulorhynchus flavidus*		E	M*
Threespine stickleback	*Gasterosteus aculeatus*	F*	E*	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Tube-snout are marine schooling fish that are small and very slender (Hart 1973). Tube-snouts were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Spawning has occurred in April off of British Columbia and in June in Friday Harbor (Hart 1973). Males protect nests of eggs deposited on kelp or algae. Hatching occurs in 2 to 3 weeks. The young reach a length of 5 cm in about 2 months and form small schools in shallow water. Tube-snouts can reach a length of 17 cm and usually remain near the surface. Prey items include small crustacean plankton including amphipods, mysids, and crab zoea, as well as fish larvae. A tube-snout captured in the Nisqually Reach in March of 1977 had consumed harpacticoid and cyclopoid copepods and a few juvenile euphasiids (fresh et al. 1979).

Threespine sticklebacks have been found in the Nisqually River, estuary, and reach (Fresh et al. 1979; Harrington-Tweit and Svoboda 1980, 1982; Hiss et al. 1982; Tierney and Svoboda 1983; Pearce et al. 1982). Threespine sticklebacks can inhabit fresh, estuarine, or marine waters. Freshwater threespine sticklebacks are usually found near the bottom of streams and often associated with aquatic vegetation (Wydoski and Whitney 1979). They are short-lived species, with approximately 90% of the fish in Washington living for only 1 year. Threespine sticklebacks spawn from May to August on algae and debris in nests built in vegetation and on the bottom. They feed upon aquatic insect larvae, snails, terrestrial insects, and small worms. Fish caught in the Nisqually Reach had consumed harpactocoid copepods, gammarid amphipods, decapod zoea, and shrimp zoea (Fresh et al. 1979). This species is considered an indicator species of environmental stress because it is easy to collect and hold in aquaria to test for water pollution (Emmett et al. 1991).

Syngnathidae, pipefishes

Syngnathids consist of about 230 known species of pipefishes and seahorses (Nelson 1984). They usually inhabit shallow marine or euryhaline waters, with most species occurring in warm

temperate to tropical waters. Only one syngnathid species, bay pipefish, has been found in the Nisqually Reach (Table 15).

Table 15. Pipefish reported to have been captured in the Nisqually Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
Bay pipefish	*Syngnathus leptorhynchus*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Bay pipefish are found in shallow water around eelgrass beds and wharves. Individuals of this species were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Bay pipefish have been found spawning among the San Juan Islands in late June (Moffett 1970). Males care for the fertilized eggs that are attached to them in a pouch. Prey items include small crustaceans, such as amphipods, copepods, and decapod larvae (Hart 1973). An adult bay pipefish, captured in the Nisqually Reach in March of 1977, had consumed crustacean eggs and gammarid amphipods (Fresh et al. 1979).

Scorpaenidae, scorpionfishes

Scorpanids are scorpionfishes, also known as rockfishes, that inhabit marine waters (Nelson 1984). There are about 310 known species of scorpaenids. Rockfish are long-lived, late-maturing, and bottom-dwelling fishes. Over 20 rockfish species are commonly caught in South Puget Sound, of these species, 3 have been captured in the Nisqually estuary and reach (Table 16) (Palsson et al. 1997). All species listed are considered to be common or of economic importance by WDFW. The current status of rockfish stocks in South Puget Sound is "below average" (defined as "the two year mean was below the long-term mean by 6% to 35%).

Table 16. Rockfishes reported to have been captured in the Nisqually Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
Brown rockfish	*Sebastes auriculatus*		E	M*
Copper rockfish	*S. caurinus*		E	M*
Quillback rockfish	*S. maliger*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Brown rockfish were observed in the Nisqually Reach in 1978 (Fresh et al. 1979). They inhabit shallow subtidal waters to 420 ft, with juveniles preferring more shallow water than adults (Love 1991). Half of the fish may reach maturity at five years of age and all are mature at 10 years of age. Brown rockfish spawn in spring and summer. They feed on fishes and crustaceans.

Copper rockfish are solitary bottom dwellers and live from 20 to 600 ft in depth (Love 1991). One individual was captured in the Nisqually Reach in 1977 (Fresh et al. 1979). Half of copper rockfish may reach maturity at five years of age and all are mature at 8 years of age. They spawn

in late winter and early spring. Juveniles live in more shallow water than adults (up to 20 ft in depth) and feed on plankton. Adult copper rockfish eat octopi, shrimps, crabs, and small fishes.

Quillback rockfish were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They are solitary bottom dwellers and most often live among rocks from 40 to 250 ft in depth (Love 1991). They may live over 30 years and do not make extensive migrations, preferring to remain on a reef for long periods. These rockfish spawn April through July. They eat primarily crustaceans.

Anoplopomatidae, sablefishes

Anoplopomatids are marine sablefishes consisting of two known species (Nelson 1984). One, *Anoplopoma fimbria*, has been found in the Nisqually Reach (Table 17). This species is considered to be common or of economic importance by WDFW (Palsson et al. 1997). Sablefish in South Sound have been declining in abundance since the 1980's and their current stock status is critical.

Table 17. Sablefish reported to have been captured in the Nisqually Reach.

Common Name	**Latin Name**	**Habitat** [1] (*primary)		
Sablefish	*Anoplopoma fimbria*		E	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Sablefish are schooling fish, inhabiting inshore waters to over 9,000 ft in depth (Love 1991). Juveniles prefer the more shallow waters, while adults are rarely found in depths of less than 600 ft. One sablefish was captured in the Nisqually reach from 1977 to 1978 (Fresh et al. 1979). The sablefish migrating through South Puget Sound are juveniles (Palsson et al. 1997). Half of all females mature by 6 years of age and spawning takes place from October to April in deep waters. Eggs and larvae remain in deep waters, while most young-of-the-year swim inshore and are pelagic. At about one year of age, juveniles move to the bottom and migrate slowly into deeper water as they mature. Sablefish eat small fish, squid, amphipods, krill, and octopi. They are eaten by sea birds, fish, and marine mammals. Sablefish can live over 50 years. The recent stock trend of sablefish in South Sound is declining and the current stock status is critical (Palsson et al. 1997).

Hexagrammidae, greenlings

The family Hexagrammidae consists of 9 known species of greenlings (Nelson 1984). Greenlings are marine fishes found in the North Pacific. They are common bottom fishes of shallow water (Hart 1973). Four species of greenlings have been found in the Nisqually Reach (Table 18). Kelp and whitespotted greenlings are considered to be common or of economic importance by WDFW. The recent stock trend of South Sound greenlings is declining and the current status of the stocks is below average (Palsson et al. 1997).

Table 18. Greenlings reported to have been observed or captured in the Nisqually Reach.

Common Name	Latin Name	Habitat [1] (*primary)		
Kelp greenling	*Hexagrammos decagrammus*		E	M*
Rock greenling	*H. lagocephalus*		E	M*
Whitespotted greenling	*H. stelleri*		E	M*
Painted greenling	*Oxylebius pictus*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Kelp greenling are solitary and territorial rocky reef fish, commonly found on the bottom from tide pools to 150 ft in depth (Love 1991). In Puget Sound, kelp greenlings are common in 10 to 35 ft of water. They were reported to have been observed in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Kelp greenling mature by age 5 and spawn in October and November (Hart 1973; Love 1991). Males guard the eggs which are laid in large masses. Prey items include worms, crustaceans, octopi, snails, and small fishes. They can reach a length of 21 inches. Young kelp greenlings are commonly found consumed by salmon and steelhead.

Rock greenling are rarely encountered in southern Puget Sound (Delacey, et al. 1972). One was captured in the Nisqually Reach in 1977 (Fresh et al. 1979). This fish had consumed hippolytid shrimp and a crab. They can grow to a length of 24 inches (Hart 1973).

Whitespotted greenling are a common species in southern Puget Sound (Delacey, et al. 1972). They inhabit depths from intertidal to 175 m and spawn in April (Hart 1973). Eight fish were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Whitespotted greenlings eat worms, crustaceans, and small fishes (Hart 1973). Fish captured in the Nisqually Reach had consumed fish, fish eggs, crabs, and shrimp.

Painted greenling inhabit tidal pools and subtidal rocky bottoms at depths of 15-70 ft (Frey 1971; Love 1991). Painted greenling were captured in the Nisqually Reach in 1977 and 1978 and were one of the most common species observed during SCUBA transect surveys made near the Dupont Dock (Fresh et al. 1979). Female painted greenlings mature at age 3, males at age 2, and spawning occurs in summer. Egg masses are laid on rocks, which the male then guards. Larvae remain nearshore and are generally pelagic (Wang 1986). They prey upon worms, crabs, shrimps, and amphipods (Love 1991). Two fish captured in the Nisqually Reach had consumed shrimp and caprellid amphipods (Fresh et al. 1979).

Cottidae, sculpins

Cottids consist of about 300 known species of sculpins, most of them marine (Nelson 1984). Sculpins are small to moderate-sized bottom dwelling fishes (Hart 1973). Over thirty species of sculpin live in the marine environment of South Puget Sound, mostly inhabiting shallow water,

though some may occur in moderately deep water (Palsson et al. 1997). Twenty-two freshwater, marine and estuarine species of sculpin have been observed or captured in the Nisqually River, Estuary, and Reach (Table 19).

Table 19. Sculpins reported to have been captured in the Nisqually River, Estuary, or Reach.

Common Name	**Latin Name**	**Habitat**[1] (*primary)		
Padded sculpin	*Artedius fenestralis*		E	M
Smoothhead sculpin	*A. lateralis*		E	M
Silverspotted sculpin	*Blepsias cirrhosus*			M
Roughback sculpin	*Chitonotus pugetensis*			M
Sharpnose sculpin	*Clinocottus acuticeps*			M
Calico sculpin	*C. embryum*			M
Coastrange sculpin	*Cottus aleuticus*	F*	E	
Prickly sculpin	*C. asper*	F*	E	
Shorthead sculpin[2]	*C. confusus*	F*		
Reticulate/riffle sculpin[2]	*C. perplexus/gulosus*	F*		
Torrent sculpin	*C. rhotheus*	F*		
Buffalo sculpin	*Enophrys bison*			M
Red Irish lord	*Hemilepidotus hemilepidotus*			M
Pacific staghorn sculpin	*Leptocottus armatus*		E*	M
Great sculpin	*Myoxocephalus polyacanthocephalus*			M
Sailfin sculpin	*Nautichthys oculofasciatus*			M
Tidepool sculpin	*Oligocottus maculosus*		E	M
Tadpole sculpin	*Psychrolutes paradoxus*			M
Soft sculpin	*P. sigalutes*			M
Grunt sculpin	*Rhamphocottus richardsoni*			M*
Cabezon	*Scorpaenichthys marmoratus*			M*
Manacled sculpin	*Synchirus gilli*			M*

[1] F = Freshwater; E = Estuarine; M = Marine.

[2] Not listed by species, but likely to have been included in "*cottus* sp". *in* Harrington-Tweit and Svoboda (1980, 1982), and Tierney and Svoboda (1983).

Of the species identified, cabezon are considered to be common or of economic importance by WDFW and the Pacific staghorn sculpin is considered to be an indicator species of environmental health. South Sound marine sculpin are believed to be increasing in abundance and their stock status is currently listed as above average (Palsson et al. 1997).

Padded sculpin, marine fish, were captured in the Nisqually Reach in 1978 (Fresh et al. 1979). Six of the fish caught had consumed hippolytid shrimp. Padded sculpin spawn from January to March and can reach a length of 14 cm (Hart 1973).

Smoothhead sculpin are common marine fish in tide pools and shallow water (Hart 1973). Smoothhead sculpin were captured in the Nisqually Reach in 1978 (Fresh et al. 1979). One fish sampled had eaten isopods, gammarid amphipods, and a tanaid. They spawn in spring and summer, depositing a mass of eggs in a protected location among rocks (Hart 1973). The eggs hatch in about 16 days. Smoothhead sculpin can reach a length of 12.7 cm.

Silverspotted sculpin are marine fish found in shallow bays to depths of 37 m (Hart 1973). One was captured in 1977 and others were observed in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Eggs of the silverspotted sculpin are attached to rocks in shallow water (Hart 1973). They can grow to 19 cm in length.

Roughback sculpin are marine fish found most commonly in depths of less than 73 m (Hart 1973). Large numbers of roughback sculpins were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They feed upon shrimps and other crustaceans and can reach a length of 23 cm (Hart 1973).

Sharpnose sculpin, a small marine species of fish, are generally found in shallow water (Hart 1973). Sharpnose sculpin was captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). A few of the fish sampled had consumed isopods, gammarid amphipods, and shrimp zoea. Sharpnose sculpin can grow to 5.1 cm in length (Hart 1973).

Calico sculpin are small marine fish that reach a maximum length of 7 cm (Hart 1973). A few were captured in the Nisqually Reach in 1977 (Fresh et al. 1979).

Coastrange sculpin are freshwater fish. They were captured in Muck Creek in 1980 and in Sequalitchew Creek in 1978 (Fresh et al. 1979; Hiss et al. 1982). These sculpin inhabit the bottom of medium to large streams with moderate to swift current (Wydoski and Whitney 1979). Coastrange sculpin spawn in spring when they reach 3 years of age. The male guards the adhesive eggs which are deposited under rocks (Scott and Crossman 1973). The larvae are planktivores, shifting to stoneflies and other aquatic insect larvae as they grow. Adults will also feed upon annelids, molluscs, salmon fry, and salmon eggs during the spawning season of salmon (McPhail and Lindsey 1970; Wydoski and Whitney 1979).

Prickly sculpin are found in fresh and brackish water along the Pacific slope of North America (Scott and Crossman 1973). A small number of prickly sculpin were captured in Sequalitchew Creek in 1978 and in the lower reach of the Nisqually River in March, 1999 (Fresh et al. 1979; R. Tabor, USFWS, personal communication). One individual captured in 1999 was 19.7 cm in length. Prickly sculpin avoid strong currents, grow to a maximum size of about 24 cm, and spawn in the spring (Scott and Crossman 1973; R. Tabor, USFWS, personal communication). The females deposits a cluster of adhesive eggs in a nest created by a male. Many females may spawn with the male in the nest. The eggs hatch in approximately 2 weeks, depending upon temperature. The resulting larvae are pelagic and may school. They metamorphose after 30 days or so and settle on the bottom. Young prickly sculpin eat primarily aquatic insect larvae and other bottom invertebrates, while some consume salmonid fry. Larger sculpins may also consume crayfish, fish and fish eggs (Tabor and Chan 1996).

Shorthead sculpin, a freshwater species, is believed to exist in the Nisqually River (Paul Mongillo, WDFW, personal communication). They live in cold, fast riffles with rubble or gravel bottom, occasionally inhabiting slower moving waters (Wydoski and Whitney 1979). They prefer cool summer water temperature (< 60° F), reach sexual maturity at ages 2 or 3, and spawn in the spring. Shorthead sculpin are probably most abundant in the headwaters of the Nisqually River and may be rare in the lower section of the river.

Reticulate/Riffle sculpin are two freshwater species that are believed to exist in the Nisqually River (Paul Mongillo, WDFW, personal communication). There is debate among biologists over whether or not reticulate sculpin exist in Puget Sound streams. Riffle sculpin and reticulate sculpin are often difficult to distinguish from each other and some biologists believe that riffle sculpins in the Puget Sound region have been misidentified as reticulate sculpins (Roger Tabor, USFWS, personal communication). Riffle sculpin live in pools and riffles, reach sexual maturity at 2 years of age, and spawn in the spring under rocks or other objects (Wydoski and Whitney 1979). They feed primarily on immature aquatic insects, such as mayflies and stoneflies. Other food items include midge, beetle, and caddisfly larvae, as well as other sculpins, salmon eggs and fry.

Torrent sculpin inhabit freshwater. They were captured in Muck Creek in 1980 (Hiss et al. 1982). Torrent sculpin usually inhabit swift currents (1.4 to 4.0 feet per second) with stable substrate (Wydoski and Whitney 1979). They become sexually mature at two years of age and spawn in late spring under substrate in swift currents (Northcote 1954). Torrent sculpin feed on a variety of organisms, including copepods and ostracods, mayfly and stonefly nymphs, caddisfly and Diptera larvae, molluscs, and fishes (Wydoski and Whitney 1979). Young torrent sculpins (to 55 mm) have been found to consume aquatic insect larvae, primarily midges and mayflies, and to a lesser degree, planktonic crustaceans (Scott and Crossman 1973). As the size of the sculpin increased, fish became more important in the diet, with minnows most frequently eaten (Northcote 1954). In the Cedar River, a tributary to Lake Washington, torrent sculpin are an important predator of salmonid fry (Tabor et al. 1998).

Buffalo sculpins, marine fishes, were captured in the Nisqually Reach in 1977 and 1978 and in the Nisqually Estuary in 1979 and 1980 (Fresh et al. 1979; Pearce et al. 1982). Buffalo sculpin spawn in February and March, depositing eggs in small clusters (Hart 1973). They prey upon shrimps, crabs, amphipods, mussels, and young fishes and can reach a length of 30.5 cm.

Red Irish lords were observed during SCUBA surveys of the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They have been found to spawn masses of eggs in shallow water or in the intertidal zone in March (Hart 1973). Adult red Irish lords eat crabs, barnacles, and mussels and can grow to 51 cm in length.

Pacific staghorn sculpin are usually found in shallow water (<50 m) in the sand or mud of bays and estuaries (Emmett et al. 1991; Love 1991). Large numbers of Pacific staghorn sculpin were captured in the Nisqually Reach in 1977 and 1978 and in the Nisqually Estuary in 1979 and 1980 (Fresh et al. 1979; Pearce et al. 1982). Pacific staghorn sculpin feed at high tide on mudflats and can bury themselves if stranded (Love 1991). They mature at a year old and spawn in bays during winter and spring. Recently hatched fish may migrate to reside in freshwater of streams, moving into brackish waters after 3 months or so. They can live up to 10 years in Washington (Wydoski and Whitney 1979). Juveniles prey upon benthic and epibenthic organisms, while adults consume fish and large crustaceans (Emmett et al. 1991; Armstrong et al. 1995). In some cases, staghorn sculpin may consume large numbers of salmonid fry (Mace 1983). They are eaten by large fishes, birds and mammals. This species is considered to be an indicator of environmental stress because it may live entirely within estuaries and is distributed throughout most Pacific coast estuaries (Emmett et al. 1991).

Great sculpin were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They are a marine fish that can grow to be over 76 cm in length (Hart 1973). Prey items include small fishes.

Sailfin sculpin is a nocturnal marine fish species (Hart 1973). A small number of sailfin sculpins were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). One fish captured had eaten polychaetes, gammarid amphipods, and a shrimp. Sailfin sculpin deposit eggs in late winter or spring (Hart 1973). They can reach a length of 20 cm and prey items include crustaceans.

Tidepool sculpin are marine fishes that are very abundant in tide pools around rocky shores (Hart 1973). A large number of tidepool sculpins were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Females mature at about one year of age (Hart 1973). They can grow to 8.9 cm in length. One fish captured in the Nisqually Reach in 1977 had eaten gammarid and caprellid amphipods, tanaids, flabelliferan isopods, and a polychaete.

Tadpole sculpin, a marine fish species, can grow to 5.8 cm in length (Hart 1973). A small number of tadpole sculpins were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979).

Soft sculpin, a marine fish species, can grow to 8.3 cm in length (Hart 1973). A few soft sculpins were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979).

Grunt sculpin, a marine fish species, is common in tide pools and shallow water (Hart 1973). They are usually found along rocky shores, but can also occur on sandy beaches. A small number of grunt sculpins were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They can grow to a length of 7.6 cm and tend to grunt when removed from the water (Hart 1973).

Cabezon are sedentary marine fish preferring hard bottoms associated with reefs, oil platforms, and wrecks (Love 1991). Cabezon were observed during SCUBA surveys of the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They commonly live from the intertidal zone to 90 ft in depth. Cabezon mature at 2-5 years of age and spawn from November to September, peaking in March and April. Egg nests are laid on rocks or sunken logs in the intertidal zone to 55 ft in depth. The male guards the mass of adhesive and toxic eggs until they hatch (Lamb and Edgell 1986). Cabezon feed on crustaceans, fishes, molluscs, and octopi (Hart 1973; Love 1991).

Manacled sculpin are marine fishes that can cling to barnacles on pilings and rocks (Hart 1973). A few manacled sculpins were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They feed on small crustaceans, mature at 5.1 cm in length, and can grow to 6.4 cm in length (Hart 1973).

Agonidae, poachers

The agonidae family consists of about 50 known species of poachers (Nelson 1984). These fish are small, bottom marine fishes most frequently found at moderate depths, with some species occasionally found in tide pools. Five of these species have been caught in the Nisqually Reach in 1977 and 1978 (Table 20) (Fresh et al. 1979). None of these species are considered to be common or of economic importance by WDFW, nor are they used as indicator species of estuarine health.

Table 20. Poachers reported to have been captured in the Nisqually Reach.

Common Name	**Latin Name**	**Habitat**[1] (*primary)		
Northern spearnose poacher	*Agonopsis vulsa*			M
Pygmy poacher	*Odontopyxis trispinosa*			M
Tubenose poacher	*Pallasina barbata*			M
Sturgeon poacher	*Podothecus acipenserinus*			M
Blacktip poacher	*Xeneretmus latifrons*			M

[1] F = Freshwater; E = Estuarine; M = Marine.

Northern spearnose poachers can grow to a length of 20 cm (Hart 1973). Six northern spearnose poachers were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979).

Pygmy poachers are most commonly found at depths between 18 and 373 m (Hart 1973). Two pygmy poachers were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Young pygmy poachers have been found to eat copepods, euphasiids, and decapod larvae (Hart 1973). They can grow to 8.1 cm in length.

Tubenose poachers can grow to a length of 13 cm (Hart 1973). A single tubenose poacher was captured in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979).

Sturgeon poachers have been found at depths of 18 m to 55 m along the coast of British Columbia (Hart 1973). Large numbers of sturgeon poachers were reported to have been captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). This species has been found to consume marine worms and crustaceans and can grow to a length of 30.5 cm (Hart 1973)

Blacktip poachers have been found at depths from 18 m to 400 m along the Pacific coast (Hart 1973). One blacktip poacher was captured in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979). They have been found to eat primarily mysids and they are in turn eaten by flatfishes, hake, and lancetfish (Hart 1973). Blacktip poachers may live to be over 6 years old and can grow to 19 cm in length.

Cyclopteridae, snailfishes

Cyclopterids are small and medium-sized marine fishes found most commonly in northern waters (Hart 1973). This family consists of about 177 known species of lumpfishes and snailfishes (Nelson 1984). Only one cyclopterid, the ringtail snailfish, has been found in the Nisqually Reach (Table 21).

Table 21. Snailfish reported to have been captured in the Nisqually Reach.

Common Name	**Latin Name**	**Habitat**[1] (*primary)		
Ringtail snailfish	*Liparis rutteri*		E	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Ringtail snailfish are believed to inhabit moderate depths (Hart 1973). Three snailfish were captured in the Nisqually Reach in 1977 (Fresh et al. 1979). Individuals of this species can grow to 11.4 cm in length (Hart 1973).

Centrarchidae, sunfishes

Centrarchids consist of about 30 known species of freshwater sunfishes found in North America (Nelson 1984). Sunfishes are considered to be prized sport fish and because of this, many

species have been introduced outside of their native range. Three sunfish species, which all are not native to the western North America, were found in the Nisqually River in 1980 and 1981 (Table 22). No recent catch information or population estimates are available on these non-native fishes listed below.

Table 22. Sunfishes reported to have been captured in the Nisqually River.

Common Name	Latin Name	Habitat [1] (*primary)		
Pumpkinseed [2]	*Lepomis gibbosus*	F*		
Largemouth bass [2]	*Micropterus salmoides*	F*		
Black crappie [2]	*Pomoxis nigromaculatus*	F*		

[1] F = Freshwater; E = Estuarine; M = Marine.
[2] Non-native.

Pumpkinseed, native east from the Midwest, were captured in the lower reach of the Nisqually River in 1980,1981, and 1982 and in Muck Creek in 1980 (Harrington-Tweit and Svoboda 1980, 1982; Hiss et al. 1982; Tierney and Svoboda 1983). Pumpkinseed inhabit clear, fresh waters in ponds, lakes, and slow-moving rivers (Wydoski and Whitney 1979). They prefer areas with dense aquatic vegetation and warm temperatures (above 70° F). They reach sexual maturity at 2 to 3 years of age and spawn in late spring or early summer when water temperatures reach approximately 68° F in shallow nests dug by the male. The number of eggs produced varies with the size of the female (600 to 2,923 eggs for 2 to 5 year old fish have been reported). The male defends the nest until the eggs hatch, which can be in as few as 3 days, and the fry leave the nest. Pumpkinseed primarily feed on aquatic insects, small molluscs, and crustaceans, with larger fish occasionally preying upon fishes. Most pumpkinseed do not live beyond 6 years.

Largemouth bass, native east from the Mississippi River system, were captured in the lower reach of the Nisqually River in 1980 and 1981, in Muck Creek in 1980, and in Sequalitchew Creek in 1978 (Harrington-Tweit and Svoboda 1980, 1982; Hiss et al. 1982; Scott and Crossman 1973). Largemouth bass were extensively introduced into Washington and Oregon in the late 1800's (Wydoski and Whitney 1979). They are long-lived, tolerant of warm water, and prefer to inhabit shallow areas of lakes with sandy or muddy bottoms associated with cover. They generally reach sexual maturity by 4-5 years of age and in Lake Washington, spawning occurs in a nest dug by the male in May and June. The number of the demersal and adhesive eggs deposited is variable (2,000 to 94,157 in Lake Washington), depending upon the size of the female (Scott and Crossman 1973; Wydoski and Whitney 1979). The eggs hatch in 3 to 7 days and the male guards the nest until the fry leave. The fry eat primarily crustaceans and insects until they reach 3 to 4 inches long, at which time their diet shifts to fishes, crayfish, frogs, worms, molluscs, and large insects. Largemouth bass can compete with trout for food and space (Wydoski and Whitney 1979). Few largemouth bass live longer than 10 years in Washington.

Black crappie, native to the fresh waters of eastern and central North America, were captured in the lower reach of the Nisqually River in 1980 and in Muck Creek in 1980 (Harrington-Tweit and Svoboda 1980; Hiss et al. 1982). Black crappie inhabit the clear water of large streams, reservoirs and medium-sized lakes (Wydoski and Whitney 1979). They reach sexual maturity when 2 to 3 years of age, prefer sandy, mucky bottoms with dense aquatic vegetation, and spawn in the spring in shallow nests built by the males. The number of the small, demersal, adhesive eggs deposited varies with the size of the female (11,000 to 188,000), and like the largemouth bass, the male guards the nest until the fry leave the area. The eggs hatch in 3 to 5 days (Scott and Crossman 1973). Crappie fry first feed primarily on zooplankton, shifting to aquatic insect larvae, then fishes (if available) as they grow (Wydoski and Whitney 1979). Most black crappie do not live beyond 5 years of age.

Percidae, perches

Percids are freshwater perches found in the northern hemisphere (Nelson 1984). Freshwater perches, like the centrarchids, are not native to western North America. This family consists of about 146 known species. Only one percid, the yellow perch, has been found in the Nisqually River (Table 23).

Table 23. Perch reported to have been captured in the Nisqually River.

Common Name	Latin Name	Habitat[1] (*primary)		
Yellow perch [2]	*Perca flavescens*	F*		

[1] F = Freshwater; E = Estuarine; M = Marine.
[2] Non-native.

Yellow perch, native to eastern and central North America, were captured in the lower reach of the Nisqually River in 1980 and 1982 and in Muck Creek in 1980 (Harrington-Tweit and Svoboda 1980; Hiss et al. 1982; Tierney and Svoboda 1983). Yellow perch were introduced throughout Washington in the 1890's (Wydoski and Whitney 1979). They are a schooling fish, prefer clear water with vegetation, and warm temperatures. Adults live near the bottom and move to shallow water in spring to spawn. Yellow perch reach sexual maturity at 1 to 4 years of age (Scott and Crossman 1973; Wydoski and Whitney 1979). Females deposit eggs in a gelatinous mass on the bottom or on vegetation. The number of eggs produced varies with the size of the female (18,354-139,565 for fish ranging in length from 6.6 to 14.8 inches in Lake Washington) averaging about 23,000 eggs (Scott and Crossman 1973; Nelson 1977). Eggs usually hatch in 8-10 days (Scott and Crossman 1973). Young inhabit shallow water, feeding on zooplankton, particularly copepods and cladocerans, shifting their diet to include immature insects as the fish grow (Wydoski and Whitney 1979; Costa 1979). Large yellow perch will feed on forage fish if they are available (Tabor and Chan 1996). Most yellow perch do not live more than 7 years.

Embiotocidae, surfperches

Embiotocids are coastal marine fish of the North Pacific, consisting of about 23 known species of surfperches (Nelson 1984). Most surfperches inhabit shallow intertidal locations along sandy or muddy shores (Lamb and Edgell 1986). Unlike most fish they bear large and fully developed young. Three surfperch species have been captured in the Nisqually estuary and reach (Table x). Shiner perch is considered an indicator species of environmental health and pile perch and striped seaperch are considered to be common or of economic importance in Puget Sound by WDFW.

Table 24. Surfperches reported to have been captured in the Nisqually Estuary or Reach.

Common Name	Latin Name	Habitat[1] (*primary)		
Shiner perch	*Cymatogaster aggregata*		E*	M
Striped seaperch	*Embiotoca lateralis*			M
Pile perch	*Rhacochilus vacca*			M

[1] F = Freshwater; E = Estuarine; M = Marine.

Shiner perch are commonly associated with docks and pilings and aquatic vegetation (eelgrass) in nearshore intertidal and subtidal areas with depths of less than 50 ft (Emmett et al. 1991; Love 1991). Very large numbers of shiner perch were captured in the Nisqually Reach and Estuary from 1977 to 1980 (Fresh et al. 1979; Pearce et al. 1982). Shiner perch move into shallow bays and estuaries in spring and summer, and offshore into deeper water in fall and winter (Emmett et al. 1991). Most males mature shortly after birth, while females mature sometime during their first year. Shiner perch mate in the summer in Washington and give birth to 5 to 36 young the following summer. Shiner perch can live to be 8 years old, but most live less than 6 years. Juveniles and adults feed primarily upon copepods, amphipods, fish eggs, and to a lesser extent, algae, barnacles, polychaetes, bivalves, crab larvae, cladocera, isopods, and mysids (Emmett et al. 1991; Love 1991). They are eaten by large marine fishes, marine mammals, and piscivorus birds.

Striped seaperch inhabit shallow areas near pilings and jetties or weed-covered rocks in less than 70 ft of water (Lamb and Edgell 1986; Love 1991). Striped seaperch were found in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Most striped seaperch mature in their third year, mate in spring and summer, and give birth to 100 to 92 young the following summer. Prey items include shrimp, crab, amphipods, worms and other small bottom-dwelling invertebrates (Love 1991). The recent stock trend and current status of Puget Sound striped sea perch is unknown (Palsson et al. 1997).

Pile perch is a schooling fish, inhabiting nearshore waters of less than 60 ft in depth (Love 1991; Palsson et al. 1997). Pile perch were found in the Nisqually Estuary and Reach from 1977 to 1980 (Fresh et al. 1979; Pearce et al. 1982). Female pile perch mature in their second year, mate in summer, and give birth to up to 50 young (Love 1991). Pile perch eat brittle stars, crabs,

mussels, clams, and snails. They are eaten by marine mammals. The current stock status of South Sound pile perch is below average (Palsson et al. 1997).

Stichaeidae, pricklebacks

Stichaeids are marine fishes found primarily in the North Pacific, consisting of about 60 known species of pricklebacks (Nelson 1984). Pricklebacks inhabit the bottom in primarily cool or frigid coastal waters (Lamb and Edgell 1986). Stichaeids that have been found in the Nisqually Reach are listed in Table 25. None of the species listed are considered to be common or of economic importance by WDFW, nor are they used as indicator species.

Table 25. Pricklebacks reported to have been captured in the Nisqually Reach.

Common Name	Latin Name	Habitat[1] (*primary)		
Slender cockscomb	*Anoplarchus insignis*		E	M*
High cockscomb	*A. purpurescens*		E	M*
Snake prickleback	*Lumpenus sagitta*		E	M*

[1] F = Freshwater; E = Estuarine; M = Marine.

Slender cockscombs inhabit waters up to 30 m deep and prefer rocky shorelines for refuge (Lamb and Edgell 1986). One was captured in the Nisqually Reach in 1977 (Fresh et al. 1979).

High cockscombs commonly live in water less than 3 m deep and, like slender cockscombs, prefer rocky shorelines for refuge (Lamb and Edgell 1986). One was captured in the Nisqually Reach in 1977 (Fresh et al. 1979).

Pacific snake pricklebacks prefer sandy or muddy bottoms and migrate into shallow coves and bays in summer and early fall (Lamb and Edgell 1986). Pacific snake pricklebacks were captured and observed in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979).

Pholidae, gunnels

Pholids are marine fishes which consist of about 13 known species of gunnels found in the North Atlantic and North Pacific (Nelson 1984). Gunnels live exclusively in shallow or intertidal areas (Lamb and Edgell 1986). They are bottom dwellers preferring sheltered areas with plants, rocky crevices, pilings, or logs. Four species of gunnels have been found in the Nisqually Reach (Table 26). None of these species are considered to be common or of economic importance by WDFW, nor are they used as indicator species.

Penpoint gunnels were observed and captured in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979). They feed on small crustaceans and molluscs and can reach a length of 46 cm (Hart 1973).

Table 26. Gunnels reported to have been observed and captured in the Nisqually Reach.

Common Name	Latin Name	Habitat[1] (*primary)		
Penpoint gunnel	*Apodichthys flavidus*		E	M
Rockweed gunnel	*A. fucorum*		E	M
Crescent gunnel	*Pholis laeta*		E	M
Saddleback gunnel	*P. ornata*		E*	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Rockweed gunnels eat small crustaceans and molluscs, can grow to a length of 23 cm, and are frequently found in rockweed masses. One was captured in the Nisqually Reach in 1977 (Fresh et al. 1979).

Crescent gunnels frequently inhabit tide pools or are found under rocks in the intertidal zone (Hart 1973). They can reach a length of 25 cm and are commonly found at depths down to 55 or 73 m. Crescent gunnels were observed and captured in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979).

Saddleback gunnels occur frequently on muddy bottoms at depths between 18 and 37 m near the outlets of streams (Hart 1973). Saddleback gunnels were captured and observed in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979). They feed on small crustaceans and molluscs and can reach a length of 30 cm (Hart 1973).

Ammodytidae, sand lances

Sand lances are marine fishes, with about 12 known species, found in the Atlantic, Indian, and Pacific Oceans (Nelson 1984). The Pacific sand lance is the only ammodytid that has been found in the Nisqually Estuary and Reach (Table 27).

Table 27. Sand lance reported to have been captured in the Nisqually Estuary and Reach.

Common Name	Latin Name	Habitat[1] (*primary)		
Pacific sand lance	*Ammodytes hexapterus*		E	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Pacific sand lance, considered forage fishes, were captured in very large numbers in the Nisqually Reach in 1977 and 1978, and in the estuary in 1979 and 1980 (Fresh et al. 1979; Pearce et al. 1982). Limited information regarding the sand lance populations of Puget Sound is available. The Washington Department of Fish and Wildlife has recently begun to take a systematic approach to obtain data on this species (Lemberg et al. 1997). This initial work has focused primarily on the identification and documentation of spawning habitat to protect it from degradation. Spawning habitat occurs within the upper intertidal zone, which is very susceptible

to development. The status of the South Sound sand lance population has been determined to be "unknown" in the 1996 Forage Fish Stock Status Report by the Washington Department of Fish and Wildlife (Lemberg et al. 1997).

Pacific sand lance juveniles and adults use unconsolidated sand to borrow into to avoid predators and rest. Sand lance are sexually mature after 1 to 3 years and spawn from November to mid-February (Emmett et al. 1991; Lemberg et al. 1997). Hatching occurs in about a month, depending upon temperature. As of 1996, 120 miles of sand lance spawning habitat has been documented, but either the Nisqually estuary has not been surveyed or no habitat was found (Lemberg et al. 1997). Sand lance feed primarily on plankton, primarily diatoms, dinoflagellates, copepod nauplii as larvae, and copepods and euphausiids as juveniles and adults (Emmett et al. 1991). They may live to be 8 years old. Sand lance can be an important component of sea birds and salmon prey bases, with reports of 19% to 53% of the diet of coho, sockeye, and chinook salmon consisting of sand lance (Beacham 1986; Manzer 1969; Pearce et al. 1982). Due to its importance as prey for many species of marine vertebrates and its sensitivity to oil-contaminated sediments, Pacific sand lance is considered to be an indicator species of environmental stress (Emmett et al. 1991).

Gobiidae, gobies

The family gobiidae is the largest family of marine fishes, consisting of at least 1500 species of gobies (Nelson 1984). Most species reside in tropical and subtropical marine and brackish waters and some species inhabit freshwater. Bay and Arrow gobies, both marine fish species, have been found in the Nisqually Estuary and Reach (Table 28). Most gobies live in shallow to moderately deep coastal waters and prefer sandy, silty bays and tidal flats (Lamb and Edgell 1986). Gobies are active bottom-dwelling and small-sized fish. The arrow goby is considered to be an indicator of environmental stress (Emmett et al. 1991).

Table 28. Gobies reported to have been captured in the Nisqually Estuary or Reach.

Common Name	**Latin Name**	**Habitat**[1] (*primary)		
Arrow goby	*Clevelandia ios*		E*	M
Bay goby	*Lepidogobius lepidus*		E*	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Arrow gobies were captured in the Nisqually Estuary and Reach from 1977 to 1980 (Fresh et al. 1979; Pearce et al. 1982). Most arrow gobies reach sexual maturity in one year and spawning occurs year-round on intertidal mud flats or sand flats of estuaries. Larvae are pelagic, while juvenile and adult arrow gobies are demersal and live freely or seek out existing burrows of worms or mud and ghost shrimps for shelter. Primary prey items of juveniles and adults include copepods, ostracods, nematodes, amphipods, and oligochaetes (Emmett et al. 1991). Arrow gobies are eaten by birds and other fish (Lamb and Edgell 1986). Most live one year, while few may live 2 to 3 years (Emmett et al. 1991). Arrow gobies are considered to be indicators of

environmental stress because they are estuary-dependent and are easily kept in aquaria (Emmett et al. 1991).

Bay gobies are shallow dwelling and typically live on muddy or silty, level bottom habitat (Lamb and Edgell 1986). One bay goby was captured in the Nisqually Reach in 1978 (Fresh et al. 1979). Juvenile and adult bay gobies are demersal and retreat in existing burrows of worms, geoduck, or mud shrimps for shelter (Lamb and Edgell 1986). They are eaten by staghorn sculpins and shore birds.

Bothidae, lefteye flounders

Bothids consist of about 212 known species of lefteye flounders that inhabit the Atlantic, Pacific, and Indian Oceans (Nelson 1984). Flounders are carnivorous. Their eggs and larvae are usually pelagic, while juveniles and adults are demersal. The Pacific sanddab and speckled sanddab have been found in the Nisqually Reach (Table 29). Pacific sanddab are considered to be common or of economic importance by WDFW, but the lack of recent bottom trawl fisheries in South Sound preclude the determination of the status of this stock (Palsson et al. 1997).

Table 29. Lefteye flounders reported to have been captured in the Nisqually Reach.

Common Name	**Latin Name**	**Habitat**[1] (*primary)		
Pacific sanddab	*Citharichthys sordidus*		E	M
Speckled sanddab	*C. stigmaeus*		E	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Pacific sanddabs are commonly in shallow water but can be found at depths down to 306 m (Hart 1973). Two were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). They can reach a length of 41 cm and spawn in February in Puget Sound (Alverson et al. 1964; Hart 1973).

Speckled sanddabs are small flatfishes which may grow to a maximum of about 15 cm in length (Hart 1973). They frequently inhabit sandy bottoms in shallow water. A couple hundred speckled sanddabs were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979).

Pleuronectidae, righteye flounders

About 99 species of pleuronectids are known to exist (Nelson 1984). Most righteye flounders are marine species that inhabit the Arctic, Atlantic and Pacific Oceans. Nine pleuronectids that have been found in the Nisqually Estuary and Reach are listed in Table 30. Of those species listed, Dover sole, rock sole, butter sole, English sole, and sand sole are considered to be common or of economic importance by WDFW, but the lack of recent bottom trawl fisheries in South Sound preclude the determination of the status of these stocks (Palsson et al. 1997). Starry flounder and English sole are also considered indicator species of estuarine health (Emmett et al. 1991).

Table 30. Righteye flounders reported to have been captured in the Nisqually Estuary or Reach.

Common Name	Latin Name	Habitat[1] (*primary)		
Rex sole	*Errex zachirus*		E	M
Flathead sole	*Hippoglossoides elassodon*		E	M
Dover sole	*Microstomus pacificus*			M
Starry flounder	*Platichthys stellatus*	F	E*	M
Rock sole	*Pleuronects bilineatus*			M
Butter sole	*P. isolepis*			M
English sole	*P. vetulus*		E*	M
C-O sole	*Pleuronichthys coenosus*			M
Sand sole	*Psettichthys melanostictus*		E*	M

[1] F = Freshwater; E = Estuarine; M = Marine.

Rex sole, slow-growing and long-lived, have been found from the surface to about 730 m in depth (Grinols 1965; Hart 1973). They can grow to a length of 59 cm and live at least 24 years. Small numbers of rex sole were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979).

Flathead sole occur primarily from the surface to 550 m deep (Grinols 1965). One was captured in the Nisqually Reach in 1978 (Fresh et al. 1979). Most females mature at age 3 in Puget Sound and spawn in March and April (Hart 1973). Flathead sole eat clams, worms, and crustaceans and can grow to a length of 46 cm (Smith 1936; Hart 1973).

Dover sole landings are the largest of the flatfishes on the Pacific coast (Emmett et al. 1991). Small numbers of Dover sole were captured in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). Juveniles inhabit relatively shallow water, while adults prefer deeper water (2,000 to 3,300 ft) (Love 1991). Dover sole can live to be over 50 years in age and females mature on average at 7 years of age. They spawn from September to April and prey items include small clams, worms, brittle stars, snails, and shrimp. The recent stock trend and current status of South Sound Dover sole is unknown (Palsson et al. 1997).

Starry flounders are often the most abundant flatfish in many North Pacific coast estuaries and are considered indicators of environmental stress, as they often accumulates contaminants (Emmett et al. 1991). Very large numbers (~ 10,000) of starry flounders were captured in the Nisqually Estuary and Reach from 1977 to 1980 (Fresh et al. 1979; Pearce et al. 1982). Most starry flounders are found in 5 to 150 ft of water and juveniles are freshwater tolerant (Love 1991). Adults do not migrate extensively, living offshore during summer and fall moving inshore during winter and spring. These fish grow to 3 ft in length and can live to be over 20 years in age. Most males reach sexual maturity at 2 years of age and females at 3. Puget Sound

stocks spawn between February and April near river mouths and sloughs in shallow water (Emmett et al. 1991). Eggs and larvae are pelagic, while juveniles and adults are demersal, preferring soft bottom habitats. Juveniles most commonly live in estuaries in shallow water and are also found in sandy, intertidal and freshwater areas. Larvae are planktivores, and prey of juveniles and adults include clams, brittle stars, fish and crabs (Love 1991). They are preyed upon by marine mammals and piscivorus birds (Emmett et al. 1991; Love 1991). Starry flounder once comprised 20 to 25% of the flatfish catch in South Sound in the bottom trawl fisheries (Palsson et al. 1997). The recent stock trend and current status is unknown.

Rock sole has been the second most common flatfish in South Sound (Palsson et al. 1997). Large numbers (~1,000) of rock sole were captured in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979). Rock sole prefer pebbly or semi-rocky bottoms at depths of under 300 ft (Love 1991). They spawn in February and March. Juveniles and adults eat worms, shrimps, clams, brittle stars, and infrequently, fish. The recent stock trend and current status of South Sound rock sole is unknown (Palsson et al. 1997).

Butter sole usually inhabit shallow water, but have been recorded at depths of 274-366 m (Hart 1973). Butter sole were captured in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979). They have been found to eat marine worms, young herring, shrimps, and sand dollars (Hart 1973). A butter sole may live over 10 years and can reach a length of 46 cm.

English sole is the most abundant flatfish species in Puget Sound (Emmett et al. 1991). Large numbers (> 2,500) of English sole were captured in the Nisqually Reach from 1977 to 1978 (Fresh et al. 1979). It is considered an indicator species of environmental stress, as it often accumulates contaminants and develops tumors and lesions. English sole in Puget Sound mature at 2 to 4 years of age and spawn from January to April over soft-bottom substrates at depths of 50-70 m (Emmett et al. 1991). Larvae are transported to nearshore nursery areas (primarily estuaries) by tidal currents, feed on plankton, and metamorphose into juveniles in spring and early summer. English sole slowly migrate into deeper water as they mature (Love 1991). Due to its reliance on estuaries for rearing, alterations and pollution of estuarine habitats adversely affects English sole (Gunderson et al. 1990). Juveniles and adults prefer fine sand and mud bottoms in shallow water (<12 m deep) and feed upon a large variety of benthic organisms (Becker 1984). English sole are eaten by larger fishes, marine mammals, and piscivorus birds. They were once the primary target of bottom trawl fisheries in South Sound, but the recent stock trend and current status is unknown (Palsson et al. 1997).

C-O sole are found primarily at depths of 18 to 350 m, with young commonly found in shallow water during the summer (Hart 1973). A few dozen C-O sole were captured or observed in the Nisqually Reach in 1977 and 1978 (Fresh et al. 1979). C-O sole can grow to a length of 36 cm.

Sand sole is an inshore species, living in depths of less than 300 ft (Love 1991). They spawn from January to July and most juveniles rear in estuaries. Preferred prey include fish, shrimp, worms, and clams. Over 100 of these fish were captured in the Nisqually Reach in 1977 and

1978 (Fresh et al. 1979). Sand sole once comprised approximately 5% of the flatfish catch in South Sound in the bottom trawl fisheries (Palsson et al. 1997). The recent stock trend and current status is unknown.

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Appendices

Appendix A. Fish species observed in the Nisqually River basin, estuary, and reach, and the location in which they were observed. *This species is used as an indicator of estuarine environmental stress.

Fish Species Observed and/or Captured in the Nisqually River, Estuary, and Reach			
Common Name	**Latin Name**	**River/ Estuary/Reach**	**Stock Status**
River lamprey	*Lampetra ayresi*	River[efgh]	
Western brook lamprey	*L. richardsoni*	River[efgh]	
Pacific lamprey	*L. tridentata*	Reach[c]	
Spotted ratfish	*Hydrolagus colliei*	Reach[c]	Unknown
Spiny dogfish	*Squalus acanthias*	Reach[c]	Above average
American shad *	*Alosa sapidissima*	River[e]	Non-native
Pacific herring *	*Clupea harengus*	Estuary[b], Reach[c]	Moderately healthy
Longnose dace	*Rhinichythys cataractae*	River[efgh]	
Largescale sucker	*Catostomus macrocheilus*	River[efh]	
Brown bullhead	*Ameiurus nebulosus*	River[efh]	Non-native
Surf smelt *	*Hypomesus pretiosus*	Estuary[b], Reach[c]	Unknown
Cutthroat trout *	*O. clarki*	River[bg], Estuary[b], Reach[c]	
Pink salmon *	*Oncorhynchus gorbuscha*	River[b], Estuary[b], Reach[c]	
Chum salmon *	*O. keta*	River[befg], Estuary[b], Reach[c]	
Coho salmon *	*O. kisutch*	River[befg], Estuary[b], Reach[c]	
Steelhead (Rainbow trout) *	*O. mykiss*	River[befgh], Estuary[b], Reach[c]	
Sockeye salmon *	*O. nerka*	Reach[c]	
Chinook salmon *	*O. tshawytscha*	River[befg], Estuary[b], Reach[c]	Federal listing proposed
Mountain whitefish	*Prosopium williamsoni*	River[efg]	
Bull trout	*Salvelinus confluentus*	River[d]	Federal listing proposed
Dolly varden	*S. malma*	Reach[c]	
Pacific cod	*Gadus macrocephalus*	Reach[c]	Critical
Pacific hake	*Merluccius productus*	Reach[c]	Critical

Fish Species Observed and/or Captured in the Nisqually River, Estuary, and Reach			
Common Name	**Latin Name**	**River/ Estuary/Reach**	**Stock Status**
Pacific tomcod *	*Microgadus proximus*	Reach[c]	
Walleye pollock	*Theregra chalcogrammus*	Estuary[b], Reach[c]	Critical
Plainfin midshipman	*Porichthys notatus*	Reach[c]	
Northern clingfish	*Gobiesox meandricus*	Reach[c]	
Tube-snout	*Aulorhynchus flavidus*	Reach[c]	
Three spine stickleback *	*Gasterosteus aculeatus*	River[cfgh], Estuary[b], Reach[c]	
Bay pipefish	*Syngnathus leptorhynchus*	Reach[c]	
Brown rockfish	*Sebastes auriculatus*	Reach[c]	Below average
Copper rockfish	*S. caurinus*	Reach[c]	Below average
Quillback rockfish	*S. maliger*	Reach[c]	Below average
Sablefish	*Anoplopoma fimbria*	Reach[c]	Critical
Kelp greenling	*Hexagrammos decagrammus*	Reach[c]	Below average
Rock greenling	*H. lagocephalus*	Reach[c]	Below average
Whitespotted greenling	*H. stelleri*	Reach[c]	Below average
Painted greenling	*Oxylebius pictus*	Reach[c]	Below average
Padded sculpin	*Artedius fenestralis*	Reach[c]	
Smoothhead sculpin	*A. lateralis*	Reach[c]	
Silverspotted sculpin	*Blepsias cirrhosus*	Reach[c]	
Roughback sculpin	*Chitonotus pugetensis*	Reach[c]	
Sharpnose sculpin	*Clinocottus acuticeps*	Reach[c]	
Calico sculpin	*C. embryum*	Reach[c]	
Coastrange sculpin	*Cottus aleuticus*	River[ch]	
Prickly sculpin	*C. asper*	River[ci]	
Shorthead sculpin	*C. confusus*	River[a]	
Reticulate/Riffle sculpin	*C. perplexus/gulosus*	River[a]	
Torrent sculpin	*C. rhotheus*	River[h]	
Buffalo sculpin	*Enophrys bison*	Estuary[b], Reach[c]	

Fish Species Observed and/or Captured in the Nisqually River, Estuary, and Reach			
Common Name	**Latin Name**	**River/ Estuary/Reach**	**Stock Status**
Red Irish lord	*Hemilepidotus hemilepidotus*	Reach[c]	
Pacific staghorn sculpin *	*Leptocottus armatus*	Estuary[b], Reach[c]	
Great sculpin	*Myoxocephalus polyacanthocephalus*	Reach[c]	
Sailfin sculpin	*Nautichthys oculofasciatus*	Reach[c]	
Tidepool sculpin	*Oligocottus maculosus*	Reach[c]	
Tadpole sculpin	*Psychrolutes paradoxus*	Reach[c]	
Soft sculpin	*P. sigalutes*	Reach[c]	
Grunt sculpin	*Rhamphocottus richardsoni*	Reach[c]	
Cabezon	*Scorpaenichthys marmoratus*	Reach[c]	Above average
Manacled sculpin	*Synchirus gilli*	Reach[c]	
Northern spearnose poacher	*Agonopsis vulsa*	Reach[c]	
Pygmy poacher	*Odontopyxis trispinosa*	Reach[c]	
Tubenose poacher	*Pallasina barbata*	Reach[c]	
Sturgeon poacher	*Agonus acipenserinus*	Reach[c]	
Blacktip poacher	*Xeneretmus latifrons*	Reach[c]	
Ringtail snailfish	*Liparis rutteri*	Reach[c]	
Pumpkinseed	*Lepomis gibbosus*	River[efgh]	Non-native
Largemouth bass	*Micropterus salmoides*	River[cefh]	Non-native
Black crappie	*Pomoxis nigromaculatus*	River[eh]	Non-native
Yellow perch	*Perca fluviatilis flavescens*	River[egh]	Non-native
Shiner perch *	*Cymatogaster aggregata*	Estuary[b], Reach[c]	
Striped seaperch	*Embiotoca lateralis*	Reach[c]	Unknown
Pile perch	*Rhacochilus vacca*	Estuary[b], Reach[c]	Below average
Slender cockscomb	*Anoplarchus insignis*	Reach[c]	
High cockscomb	*A. purpurescens*	Reach[c]	
Pacific snake prickleback	*Lumpenus sagitta*	Reach[c]	
Penpoint gunnel	*Apodichthys flavidus*	Reach[c]	

Fish Species Observed and/or Captured in the Nisqually River, Estuary, and Reach			
Common Name	**Latin Name**	**River/ Estuary/Reach**	**Stock Status**
Rockweed gunnel	*A. fucorum*	Reach[c]	
Crescent gunnel	*Pholis laeta*	Reach[c]	
Saddleback gunnel	*P. ornata*	Reach[c]	
Pacific sand lance *	*Ammodytes hexapterus*	Estuary[b], Reach[c]	Unknown
Arrow goby *	*Clevelandia ios*	Estuary[b], Reach[c]	
Bay goby	*Lepidogobius lepidus*	Reach[c]	
Pacific sanddab	*Citharichthys sordidus*	Reach[c]	
Speckled sanddab	*C. stigmaeus*	Reach[c]	
Rex sole	*Errex zachirus*	Reach[c]	
Flathead sole	*Hippoglossoides elassodon*	Reach[c]	
Dover sole	*Microstomus pacificus*	Reach[c]	Unknown
Starry flounder *	*Platichthys stellatus*	Estuary[b], Reach[c]	Unknown
Rock sole	*Pleuronectes bilineata*	Reach[c]	Unknown
Butter sole	*P. isolepis*	Reach[c]	
English sole *	*P. vetulus*	Reach[c]	Unknown
C-O sole	*Pleuronichthys coenosus*	Reach[c]	
Sand sole	*Psettichthys melanostictus*	Reach[c]	Unknown

[a]Paul Mongillo, WDFW, Personal communication.
[b]Pearce et al. 1982.
[c]Fresh et al. 1979.
[d]Suckley and Cooper 1860 as cited in USFWS 1998.
[e]Harrington-Tweit and Svoboda 1980.
[f]Harrington-Tweit and Svoboda 1982.
[g]Tierney and Svoboda 1983.
[h]Hiss et al. 1982.
[i]Roger Tabor, USFWS, Personal communication.

Appendix B. Reported releases of hatchery salmon and trout into the Nisqually Basin (Pacific States Marine Fisheries Commission, datapull, February 23, 1999).

Reported Hatchery Releases			
Species	**Brood Year**	**Release Site[1]**	**Total Released**
Fall Chinook Salmon	55	Nisqually River	500
	56	Nisqually River	150,000
	57	Nisqually River	249,800
	58	Nisqually River	282,132
	59	Nisqually River	823,821
	61	Nisqually River	499,380
	62	Nisqually River	726,160
	63	Nisqually River	933,006
	67	Nisqually River	150,142
	70	Nisqually River	1,266,888
	71	Nisqually River	2,076,304
	72	Nisqually River	1,463,760
	73	Nisqually River	865,000
	75	Nisqually River	1,000,000
	76	Nisqually River	439,000
	77	Nisqually River	901,381
	78	Nisqually River	491,011
	79	Nisqually River	2,254,310
	80	Nisqually River	1,716,689
	81	Nisqually River	1,765,611
		McAllister Creek	3,872,633
	82	Nisqually River	2,365,765
	83	Nisqually River	2,590,275
		McAllister Creek	3,246,100
	84	Nisqually River	4,244,644
		McAllister Creek	1,391,400
	85	Nisqually River	4,332,361
		McAllister Creek	1,286,300
	86	Nisqually River	4,230,027
		McAllister Creek	1,232,000

Reported Hatchery Releases			
Species	**Brood Year**	**Release Site[1]**	**Total Released**
Fall Chinook Salmon	87	Nisqually River	2,578,800
		McAllister Creek	1,648,300
	88	Nisqually River	1,782,300
		McAllister Creek	1,205,800
	89	Nisqually River	2,300,000
		McAllister Creek	1,257,200
	90	Nisqually River	2,952,000
		McAllister Creek	1,065,300
	91	Nisqually River	1,742,040
		McAllister Creek	1,339,800
	92	Nisqually River	1,063,000
	93	Nisqually River	1,796,514
		McAllister Creek	76,000
	94	Nisqually River	3,135,900
		McAllister Creek	1,320,984
	95	Nisqually River	2,859,499
		McAllister Creek	1,373,600
	96	Nisqually River	4,395,000
		McAllister Creek	1,321,000
	97	Nisqually River	3,257,000
		McAllister Creek	1,199,875
Winter Chinook Salmon	72	McAllister Creek	30,000
Coho Salmon	50	Nisqually River	64,853
	51	Nisqually River	239,504
	52	Nisqually River	1,149,680
	53	Nisqually River	166,565
	54	Nisqually River	80,880
	55	Nisqually River	208,331
	56	Nisqually River	287,241
	57	Nisqually River	176,656
	59	Nisqually River	149,356
	60	Nisqually River	560,153
	61	Nisqually River	178,413

Reported Hatchery Releases			
Species	**Brood Year**	**Release Site[1]**	**Total Released**
Coho Salmon	62	Nisqually River	143,312
	63	Nisqually River	133,114
	64	Nisqually River	369,045
	68	Nisqually River	359,660
	69	Nisqually River	675,360
	70	Nisqually River	1,292,421
	71	Nisqually River	302,198
	72	Nisqually River	216,904
	73	Nisqually River	236,018
	75	Nisqually River	389,106
	77	Nisqually River	1,393,345
	78	Nisqually River	780,012
	79	Nisqually River	637,591
	80	Nisqually River	1,633,604
	81	Nisqually River	1,752,064
	82	Nisqually River	1,114,800
	83	Nisqually River	1,348,300
	84	Nisqually River	2,052,952
	85	Nisqually River	2,083,924
	86	Nisqually River	1,845,100
	87	Nisqually River	2,103,700
	88	Nisqually River	2,664,415
	89	Nisqually River	1,651,885
	90	Nisqually River	1,836,900
	91	Nisqually River	2,520,550
	92	Nisqually River	1,262,088
	93	Nisqually River	1,360,775
	94	Nisqually River	1,604,444
	95	Nisqually River	1,039,100
	96	Nisqually River	1,569,178
Steelhead	81	Nisqually River	54,633
	82	Nisqually River	12,059
	83	Nisqually River	42,646

Reported Hatchery Releases			
Species	**Brood Year**	**Release Site[1]**	**Total Released**
Steelhead	84	Nisqually River	19,952
	85	Nisqually River	26,028
	87	Nisqually River	20,150
	89	Nisqually River	13,420
	91	Nisqually River	24,816
	92	Nisqually River	23,724
	93	Nisqually River	12,797
Landlocked Sockeye	94	Nisqually River	50,000
	96	Nisqually River	45,000
	97	Nisqually River	68,000
Winter Chum Salmon	60	Nisqually River	107,680
	61	Nisqually River	154,840
	76	Nisqually River	1,086,580
	77	Nisqually River	850,000
	78	Nisqually River	901,588
	79	Nisqually River	1,261,052
	80	Nisqually River	1,853,427
	81	Nisqually River	593,970
	82	Nisqually River	659,066
	83	Nisqually River	385,716
	84	Nisqually River	840,418
	85	Nisqually River	295,807
	86	Nisqually River	99,622
	87	Nisqually River	840,525
	88	Nisqually River	161,525
	89	Nisqually River	174,000
	90	Nisqually River	103,240
	91	Nisqually River	191,550
	93	Nisqually River	59,240
Pink Salmon	77	Nisqually River	106,480
	83	Nisqually River	19,580

[1] "Nisqually River" includes mainstem, tributaries, and lakes of the Nisqually River.