King County
Department of Development
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900 Oakesdale Avenue Southwest
Renton, WA 98055-1219

DDES

May 19, 1998

TO: Mason Bowles, Don Finney, Priscilla Kaufmann, Mark Mitchell, Kate Stenberg

FM: Barbara Questad *Barbara*

RE: Lakepointe Independent Analysis of Fisheries Resources by CH2M Hill

CH2M Hill just delivered the Lakepointe Development SEIS -- Major Issues: Fisheries Resources -- Independent Analysis. The analysis is marked "DRAFT", but we are not asking you to comment on the document at this time. What we would like you to do is review the document and become familiar with the contents and conclusions so that when you receive the Preliminary Final EIS for review on (or about) June 12th, you will be "up to speed" and be able to review and comment on the Preliminary in a very short turn-around time.

When you receive the Preliminary, we will give you only about ten calendar days maximum and ask that you provide me with exactly-worded edits that can be inserted by a typist. We will have only one shot at making corrections, and neither I nor Huckell/ Weinman will have time to respond to general comments. The Final EIS must be published before the Council can take action on any proposed Road Improvement District and before DDES can issue any permits. The "drop dead" date for publication is the end of July.

Let me know if you have questions.

Attachment

cc: Marilyn E. Cox, Supervisor, SEPA & Site Plan Review Section

EXHIBIT G-37

# DRAFT

## Lakepointe Development SEIS
## Major Issues:
## Fisheries Resources

# Independent Analysis



Prepared By
CH2M HILL

For
King County
Department of Development and Environmental Services

May 1998

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# Introduction

This technical report represents an independent review of the fisheries issues associated with the Lakepointe Development in support of the Supplemental Environmental Impact Statement (SEIS). It is understood that this project has been under review for some time and that regulatory staff are familiar with the project and with previously submitted materials regarding fisheries issues. Information provided in the EIS and the *Final Lakepointe Technical Report on Natural Resources* (Beak Consultants 1998) is referenced when describing existing conditions and to support conclusions.

The purpose of this document is to describe existing fisheries resources and to analyze the probable impacts of the Lakepointe Development on those resources. Direction was given to:

- Use only appropriate references
- Qualify and describe uncertainty
- Use fish numbers in terms of density rather than absolute numbers
- Discuss all stocks involved
- Provide a specific species-by-species discussion
- Evaluate total predation if possible
- Consider offsite predation
- Include a discussion of Endangered Species Act (ESA) considerations

The major issues concerning the development-related effects on juvenile salmonids include the following:

- Loss of habitat
- Potential for increased predation
- Potential attraction of predators and creation of predator habitat
- Potential increased production of predators for subsequent dispersal
- Potential increased foraging efficiency of predators
- Water quality impacts

It is appropriate to note the limitations of existing literature and data able to be used in the assessment. For a large lake in a metropolitan area, Lake Washington is surprisingly understudied. That status is currently being rectified with the 3-year-old program now in progress to study the "sockeye problem." In the 1970s there was a flurry of research activity that generated a number of masters theses and doctoral dissertations that form the bulk of fish ecology information available for use today. Unfortunately, none of these studies really answered the questions that are being asked relative to the Lakepointe Development. Most of the research was (and is) directed at sockeye, because they are the largest salmonid resource in the basin.

Another confounding factor in using some of the past literature is that the trophic nature and shoreline character of the lake have changed significantly since the 1970s. The lake has changed from eutrophic to mesotrophic bordering oligotrophic as a result of the elimination of wastewater discharges to the lake. The invasion of eurasian milfoil (*Myriofillum spicatum*) has transformed shoreline areas from sparse cover (except for docks) to densely covered with macrophyte growth. In addition, there have been changes in the planktonic community that changed fish population structure and foraging dynamics.

# Affected Environment

## Fish Use

### Salmonid Fish

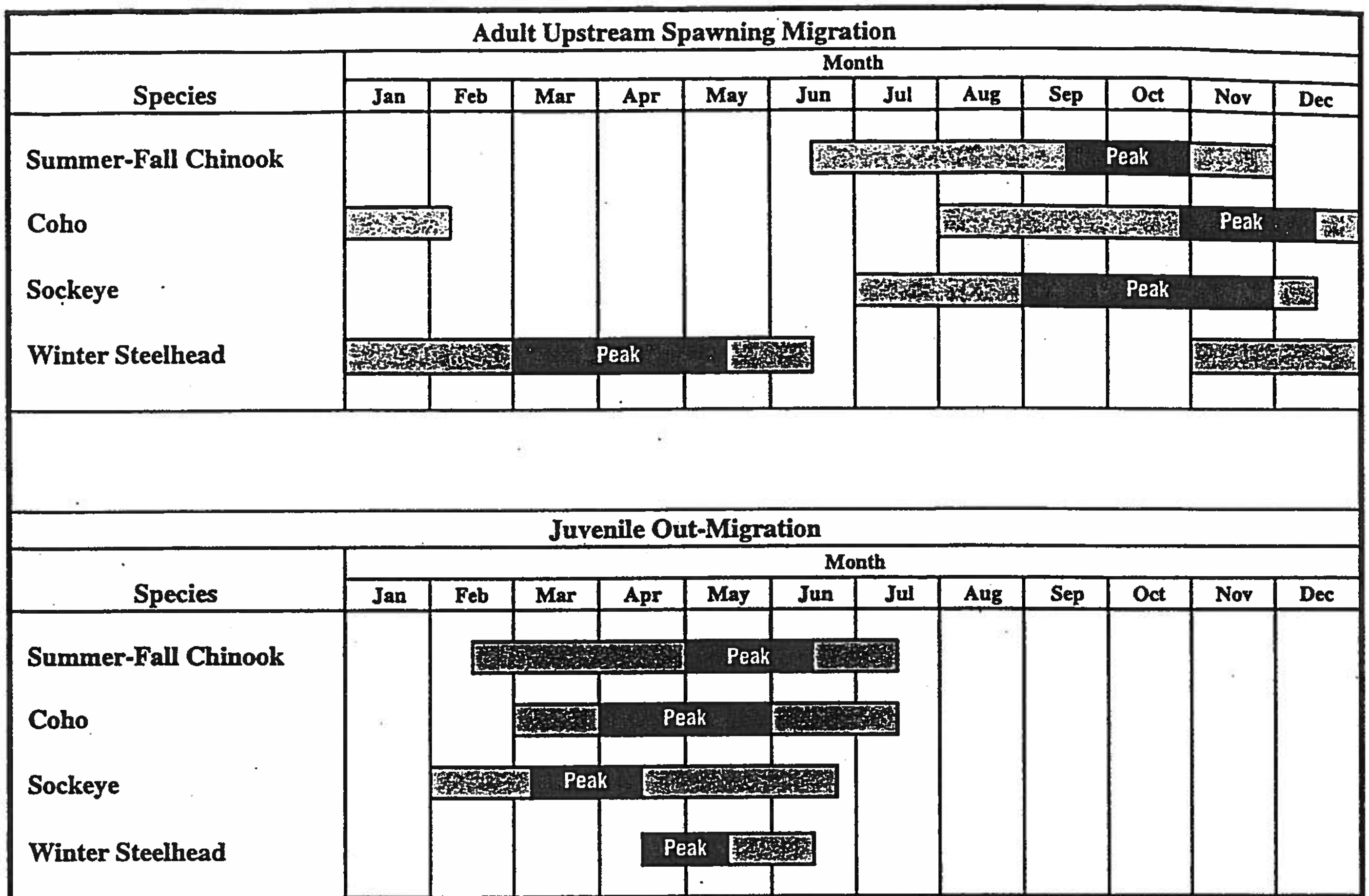
**Timing and Distribution.** The Sammamish River basin supports a variety of anadromous salmonids, including chinook (*Onchorhynchus tshawytscha*), coho (*O. kisutch*), and sockeye salmon (*O. nerka*), and steelhead (*O. mykiss*) and cutthroat trout (*O. clarki*) (Williams et al. 1975; Washington Department of Fish and Wildlife et al. 1994). The Sammamish River system also supports runs of nonanadromous kokanee (*O. nerka*) salmon and adfluvial cutthroat trout (King County 1993). The mouth of the Sammamish River provides rearing habitat for salmonids and is a migration corridor for adult and juvenile salmon.

The majority of the spawning and rearing activity of salmon and trout migrating past the Lakepointe site occurs in tributaries to the Sammamish River and Lake Sammamish, including Issaquah, North, Swamp, Big Bear, Little Bear, and Cottage Lake Creeks. Both natural and artificial production occurs in Issaquah Creek. Timing of the various life history stages of each species is shown in Figure 1 and described below.

Anadromous juveniles produced in this system emigrate through the Sammamish River, passing by the Kenmore Pre-mix property, before reaching Lake Washington (see Beak [1998] for site maps and project description). Washington Department of Fish and Wildlife (WDFW) personnel suspect that outmigrating juvenile salmonids may temporarily hold in the shallow beach area at the western edge of the Kenmore Pre-Mix Property before migrating through Lake Washington (Fisher, WDFW, pers. comm., 1996). The migratory habits of juvenile salmonid outmigrants have never been studied at the mouth of the Sammamish River, so it is not known whether sockeye fry or other salmon smolts have a migratory preference. Chinook and coho are known to have a strong shoreline preference and thus would be expected to turn north or south at the river mouth. Sockeye are known to move relatively quickly offshore upon reaching a lake, but some have been found to use shoreline areas for their first month of residence (Martz et al. 1996) in Lake Washington.

Adult fall chinook salmon begin entering Lake Washington in early July. River entry and upstream spawning occurs from mid-September through October (Williams et al. 1975). Juvenile chinook generally rear in tributaries for 3 months before migrating to sea (Williams et al. 1975), but some juveniles in the Lake Washington system might remain in freshwater for longer periods given the rearing environment provided by the lake (Wydoski and Whitney 1979). Seaward migration occurs from early March to early July (Williams et al. 1975; Martz. et al. 1996).

Adult coho salmon enter Lake Washington as early as August. River entry and spawning in north Lake Washington tributaries occurs from late October to mid-December (Williams et al. 1975). Coho juveniles rear throughout the year in streams and rivers, with very few thought to use Lake Washington for rearing (B. Tweit, WDFW, pers. comm. 1998). Coho smolts migrate to sea between early March and early July as yearlings (Williams et al. 1975).




**SOURCE:** Adapted from Williams et al, 1975.

Figure 1

**Salmon and Steelhead Migration Timing in Lake Washington System**

145173.B1.ZZ • Salmon and Steelhead Migration • 5/12/98 • LW

Adult sockeye enter Lake Washington in mid-June. River entry and spawning in Lake Washington/Sammamish tributaries takes place from early September through November (Williams et al. 1975; Wydoski and Whitney 1979). Lake Washington shoreline spawning occurs between November and mid-January (Wydoski and Whitney 1979). Sockeye fry produced in the Sammamish Basin migrate to Lake Washington from mid-January through April, with the peak of outmigration occurring from early March to mid-April (Seiler and Kishimoto 1997). Sockeye juveniles rear in the lake for 1 or 2 years before migrating to the sea. Peak smolt migration occurs from late April to mid-May (Martz et al. 1996a).

Adult steelhead begin entering Lake Washington in mid-December. Spawning in lake tributaries takes place from early March to early June. Steelhead juveniles typically rear in streams for 1 to 3 years. Seaward migration of smolts occurs from April through June, with the peak of outmigration taking place in mid-April (Wydoski and Whitney 1979). Resident rainbow trout live throughout the year in Lake Washington, spawning in tributary streams about the same time as steelhead.

Three forms of cutthroat trout exist in the Lake Washington basin: anadromous, adfluvial, and fluvial (King County 1993). The fluvial form spend their entire lives in the same stream. The adfluvial form grows to maturity in Lake Washington or Lake Sammamish and return to their natal streams to spawn. The sea-run, or anadromous form, spawns in tributary streams, rear for 2 to 5 years, then migrate to sea where they mature. Sea-run cutthroat spawn from late December to February, whereas resident cutthroat typically spawn from April to early May. Seaward migration of smolts occurs from January through June, but the majority migrate from April through June (Wydoski and Whitney 1979).

The size at migration of juvenile salmonids varies among species and among stocks within a population. Fry typically enter the lower Sammamish River and Lake Washington at a relatively small size. The salmon fry are weak swimmers compared to larger yearling outmigrants and are particularly susceptible to predation. Sockeye migrate into Lake Washington as fry, chinook as subyearling smolts, coho as yearling smolts, and steelhead as 1- and 2-year old smolts.

**Salmon Stock Inventory.** WDFW and western Washington treaty tribes jointly assembled specific information for the Lake Washington basin in developing a Washington State Salmon and Steelhead Stock Inventory (SASSI). The current status of salmon and steelhead stocks in the basin was evaluated as of 1992 (Washington Department of Fish and Wildlife et al. 1993). This is information summarized in Table 1 and described below.

***Chinook Salmon.*** Three stocks of summer-fall run chinook salmon have been identified by state and tribal biologists in the Lake Washington System (Washington Department of Fish and Wildlife et al. 1993): the Issaquah Creek, the Cedar River, and the North Lake Washington tributary chinook stocks. The status of the Issaquah Creek stock is healthy, and this stock is supported by hatchery production. An average of 2,000 fish are used as broodstock at the hatchery. Excess escapement and hatchery fish that spawn in Issaquah Creek below the hatchery form a naturalized group; i.e., they spawn and rear naturally but have hatchery/non-native genetic disposition. The status of the two native stocks is unknown

**TABLE 1**
Summary of SASSI Information for Anadromous Stocks of Salmonid Fish Stocks in Lake Washington, with Updated Escapement Numbers as Indicated

| Species | Stock | Stock Status | Stock Origin | Escapement Range | Escapement Average | Notes |
|---|---|---|---|---|---|---|
| Summer/fall chinook | Issaquah Creek | Healthy | Non-native | 500 - 5,000 | 2,000 | Hatchery production Natural production |
| Summer/fall chinook | North Lake Washington tributaries | Unknown | Native | 716 - 3082<br>34 - 524 | 1,731[a]<br>221[a] | Wild production<br>Natural[b] |
| Summer/fall chinook | Cedar River | Unknown | Native | 600 - 4,300 | 1,900 | Wild production |
| Coho | Lake Washington/ Sammamish River tributaries | Depressed | Mixed | Unknown[c] | Unknown[c] | Hatchery and wild production |
| Coho | Cedar River | Healthy | Mixed | Unknown | Unknown | Wild production with some hatchery plants |
| Sockeye | Lake Washington/ Sammamish River tributaries | Depressed | Unknown[d] | 3,601 - 29,713 | | Wild production |
| Sockeye | Lake Washington Beach spawning | Depressed | Unknown | 54 - 103 | | Wild production |
| Sockeye | Cedar River | Depressed | Non-native | 76,000 - 365,000 | | Wild and hatchery production |
| Winter Steelhead | Lake Washington | Depressed | Native | 474 - 1,816 | | |

[a] 5-year average. Source: C. Smith, WDFW.
[b] Natural: hatchery fish spawning in Issaquah Creek.
[c] Presumed to be very low (B. Tweit, WDFW).
[d] Now thought to be native origin based on electrophoresis (J. Ames, WDFW).

due to insufficient information. Excluding the naturalized hatchery population in Issaquah Creek chinook spawning escapement to the Sammamish River system ranges from 34 to 524 fish, averaging 221 (C. Smith, WDFW, pers. comm. 1998). The Issaquah Creek naturalized stock averages about 1,700 fish. Hatchery production and naturalized production dominate smolt production in the Sammamish system, with a combined total of roughly 2 million outmigrants (Table 2). Wild smolt production has been calculated to be about 22,000 fish, based on escapement (C. Smith, WDFW, pers. comm. 1998).

**TABLE 2**
Estimated Fry and Smolt Production of Anadromous Salmonids in Sammamish River System

| Species | Fry/Smolt Production (recent average) | | | |
|---|---|---|---|---|
| | Wild | Natural[a] | Hatchery[b] | Total |
| Chinook | 22,100[c] | 173,000[c] | 1,943,000 | 2,138,100 |
| Coho | 13,398[d] | Unknown | 1,862,000 | 1,875,400 |
| Sockeye | 1,395,000[e] | N/A | N/A | 1,395,000 |
| Steelhead | <1,000[f] | N/A | 13,500[f] | 14,000 |
| Total | 1,431,498 | 173,000[e] | 3,818,000 | 5,422,500 |

[a]Natural spawning refers to hatchery fish spawning and rearing naturally. This occurs extensively in Issaquah Creek, upstream not downstream from the hatchery. Some wild fish might be mixed in with this group.

[b]Average of 1996 and 1997 data only (Beak 1998).

[c]Based on escapement estimates, calculated survival (see Appendix A).

[d]Based on the total Lake Washington outmigrant estimate and apportioned by watershed size (B. Tweit, WDFW, pers. Comm. 5/98).

[e]Average of 1997 and 1998 outmigrant estimates in Sammamish River (D. Seiler, WDFW, pers. Comm. 1998).

[f]Wild production estimate is an optimistic estimate. Hatchery production is the number being reared at Issaquah Hatchery at present for release next spring (S. Foley, WDFW, pers. comm. 1998).

***Coho Salmon.*** There are two stocks of coho salmon identified in the Lake Washington system: one is supported by the Lake Washington/Sammamish tributaries stock and the other by the Cedar River (Washington Department of Fish and Wildlife et al. 1993). The status of the Lake Washington/Sammamish tributaries stock is considered depressed, while the Cedar River stock is considered to be healthy. Both of these stocks are of mixed native and non-native production. Escapement and production of wild coho in the Sammamish system is unknown but is thought to be quite low due to urban-related impacts (B.Tweit, WDFW, pers. comm. 1998). Egg-to-fry survival has been estimated to be near zero in some years in some streams. Smolt production from the entire Lake Washington system was estimated to be about 77,000 fish for 1997 (B. Tweit pers. comm. 1998). Based on the proportion of watersheds draining into the lake, the production of natural coho smolts from the Sammamish system would be about 13,400 fish (Table 2). Hatchery production dominates coho production in the Sammamish system, with about 1.9 million fish produced in recent years.

***Sockeye Salmon.*** There are three stocks of sockeye salmon identified in the Lake Washington basin: the Cedar River, Lake Washington/Sammamish tributaries, and Lake Washington beach spawners. Sockeye were introduced into Lake Washington in 1935 from the Baker River stock, and planting of sockeye in the lake continued until the early 1960s. There is evidence that the beach spawners and northern tributary spawners (primarily Bear Creek) might be native in origin, but they are classified as unknown at this time.

The Lake Washington sockeye run size estimates have varied substantially over the years, ranging between 98,000 and 621,000 fish. The best production years can produce an order of magnitude more returning fish than poor years. There are many factors thought to be involved with this variability in survival, including redd scour from floods, river and lake predation, changes in the plankton community, and competition for forage. Egg-to-fry survival can vary by an order of magnitude or more between years (J. Ames, D. Seiler, WDFW, pers. comm. 1998).

Approximately 70 percent of the Lake Washington system sockeye spawn in the Cedar River. The remainder spawn primarily in Bear Creek and Issaquah Creek in the Sammamish system, with small numbers scattered in small tributaries. The escapement goal of 350,000 sockeye was met in 1988 and again in recent years. However, all three stocks are considered depressed based on declining escapements. In four of five recent years, run sizes were below 100,000 fish. Fry production from the Sammamish system was estimated to be about 930,000 from about 60,000 spawners in 1996. The 1997 brood year produced about 2,000,000 fry from about 10,000 spawners (D. Seiler, WDFW, pers. comm. 1998). Sockeye from the Sammamish system mostly move into Lake Washington as fry in early spring to rear (Figure 1). The number rearing to the smolt stage in Lake Sammamish is unknown.

***Steelhead Trout.*** Winter steelhead are managed as a single unit in the Lake Washington basin. This stock is considered a distinct wild winter native steelhead run, although hatchery smolts were also stocked in the system between 1982 and 1992. Wild winter steelhead escapement has ranged from 474 to 1,816 fish since 1983. An escapement goal of 1,600 wild winter steelhead was set for the Lake Washington system in 1985. Escapement since 1985 has averaged 868 fish and only exceeded the goal one time. The status of the stock is considered depressed. At present, escapement is on the rebound, with about 650 spawners observed in the Cedar River in 1997/1998. Escapement to other tributaries is very low in the Sammamish system, with estimated numbers on the order of 2 or 3 fish per stream for tributaries such as Issaquah Creek, Bear Creek, North Creek, and Cottage Creek (S. Foley, WDFW, pers. comm. 1998). Wild smolt production is probably less than 1,000 fish currently (S. Foley, WDFW, pers. comm. 1998).

**Site-Specific Surveys.** Beak Consultants performed a series of fish surveys at the Kenmore Pre-mix/Lakepointe site in 1996 and 1997. Methods included electrofishing, gillnetting, snorkeling, and beach seining. Refer to *Final Lakepointe Technical Report on Natural Resources*, Section 3, Fisheries (Beak, 1998), for details on methodology and results.

It is our judgment that the methods used by Beak for assessing fish use at the Kenmore Pre-mix/Lakepointe site are useful only to document presence or absence of fish and to make relative comparisons among sampling sites. These methods cannot quantitatively assess fish use with any degree of reliability, for a number of reasons. The beach seining deployed from shore tends to scare off many fish before they can be caught, and shoreline obstructions required lifting of the net at times. Gillnets are problematic for quantitative estimates because of deployment in consistency and high variability in capture rates for different species. Of all of the methods used, nighttime electrofishing was probably the most effective, but it was conducted either too infrequently or with the wrong equipment. In 1996, a backpack shocker was used from shore for 4 minutes per site on six occasions. A backpack shocker does not have much sampling range and is typically used effectively only in small streams. In 1997, a boat shocker was used in the inner harbor on three occasions, fishing the entire shoreline. Theoretically, this should have worked well, although three sampling periods during the entire outmigration must be viewed as sparse coverage.

In a crude attempt to use the electrofishing data quantitatively to estimate salmon use in the project area, we expanded the 1996 data based on distance and time sampled. Because the fish were moving through the area on their way out to the lake, we assumed that the fish were traveling at a cruising speed of 0.325 foot per second. This analysis suggests that salmon use in the inner harbor was 6,847 fish during the period between the first and last sampling dates in 1996 (Table 3). Estimates for the Sammamish River shoreline and lakeshore were 17,514 and 20,032 fish, respectively.

These estimates of shoreline fish use in the project area are a very small proportion of the estimated 5 million juvenile salmonids migrating out of the Sammamish system each year. This large difference suggests that either a very large proportion of the fish travel offshore or that there was significant avoidance of the electrofishing gear by fish along the shoreline.

The conclusion of this estimating exercise is that, at the very least, several thousand out-migrant salmonids use the inner harbor each year. The sampling data suggest that fewer salmonids use the inner harbor compared to the adjacent river shoreline and lakeshore. This is plausible due to the shallowness of the shoreline at the mouth of the inner harbor. Many fish might simply pass across the mouth of the harbor on their way to the lake.

**TABLE 3**
Estimate of Nearshore Juvenile Salmonid Use in Lakepointe Project Area Using Beak (1998) Electrofishing Data, 1996 Season

| Site | Total Salmonids Collected | Salmonids Caught per Foot (mean) | Length of Shoreline Sampled (feet per day) | Length of Shoreline (feet) | Estimate of Total Salmonid Use | Ratio Compared to River Catch Data (expected) |
|---|---|---|---|---|---|---|
| Sammamish River Shoreline | 28 | 0.0133 | 350 | 2,182 | 17,514 | 1.0 |
| Lakeshore | 41 | 0.0152 | 450 | 727 | 20,032 | 1.14 (0.5) |
| Inner Harbor | 11 | 0.0048 | 50 | 2,000 | 6,847 | 0.39 (0.5) |

## Other Fish Species

Lake Washington contains a wide variety of nonsalmonid fish species, some of which are considered "warm water" species. Easy access to the Sammamish River from Lake Washington makes it likely that many of these lake species occasionally journey into the river. Fish inhabiting Lake Washington and the Sammamish River are both native and non-native in origin (Table 4).

The most abundant fish in Lake Washington in terms of biomass are sculpins. Of fish susceptible to oneida tap capture, yellow perch are most abundant, comprising 42 percent by number (Pfeifer and Weinheimer 1992).

**TABLE 4**
Lake Washington Fish

| Common Name | Scientific Name | Origin |
|---|---|---|
| Sockeye salmon and kokanee | *Oncorhynchus nerka* | Introduced |
| Chinook salmon | *O. tshawytscha* | Native |
| Coho salmon | *O. kisutch* | Native |
| Cutthroat trout | *O. clarki* | Native |
| Steelhead trout and rainbow trout | *O. mykiss* | Native |
| Squawfish | *Ptychocheilus oregonensis* | Native |
| Rocky Mountain whitefish | *Prosopium williamsoni* | Native |
| Peamouth chub | *Mylocheilus caurinus* | Native |
| Large-scale sucker | *Catostomus macrocheilus* | Native |
| Coastrange sculpin[a] | *Cottus aleuticus* | Native |
| Prickly sculpin | *Cottus asper* | Native |
| Riffle sculpin | *Cottus gulosus* | Native |
| Three-spined stickleback | *Gasterosteus aculeatus* | Native |
| Longfin smelt | *Spirinchus thaleichthys* | Native |
| Pacific lamprey | *Entosphenus tridentatus* | Native |
| Brook lamprey | *Lampetra planeria* | Native |
| River lamprey | *Lampetra fluviatilis* | Native |
| Redside shiner | *Richardsonius balteatus* | Native |
| Large mouthed bass[b] | *Micropterus salmoides* | Introduced |
| Small mouthed bass[b] | *Micropterus dolomeiui* | Introduced |
| Yellow perch[b] | *Perca flavescens* | Introduced |
| Common carp[b] | *Cyprinus carpio* | Introduced |
| Brown bullhead[b] | *Ictalurus nebulosus* | Introduced |
| Black crappie[b] | *Pomoxis nigromaculatus* | Introduced |
| White crappie[b] | *Pomoxis annularis* | Introduced |
| Bluegill[b] | *Lepomis macrocheilus* | Introduced |
| Tench[b] | *Tinca tinca* | Introduced |
| Atlantic salmon[b] | *Salmo salar* | Introduced |
| Goldfish[b] | *Carassius auratus* | Introduced |
| Pumpkinseed sunfish[b] | *Lepomis gibbosus* | Introduced |

[a]The pelagic sculpin frequently found in association with sockeye salmon and long-fin smelt has not been officially identified but might be a subspecies of the coast range sculpin (Wydoski and Whitney 1979).

[b]Introduced species.

Source: Wydoski and Whitney 1979.

In the Pfeifer and Weinheimer study, largemouth bass, squawfish and smallmouth bass represented 9.65, 1.26, and 0.22 percent of the total (Table 5). Clear differences in capture efficiency were apparent in their data among oneida trap, electrofishing, and gillnetting techniques.

**TABLE 5**
Species, Number, and Relative Abundance of the Aggregate Sample of Warmwater Fish from Lake Washington, 1982

| Species | Number | Percent |
|---|---|---|
| Yellow perch | 1,688 | 41.57 |
| Brown bullhead | 547 | 13.47 |
| Peamouth chub | 491 | 12.09 |
| Black crappie | 479 | 11.80 |
| Largemouth bass | 392 | 9.65 |
| Pumpkinseed | 79 | 1.95 |
| Largescale sucker | 71 | 1.75 |
| Stickleback | 52 | 1.28 |
| Squawfish | 51 | 1.26 |
| Carp | 48 | 1.18 |
| Tench | 44 | 1.08 |
| Sculpin | 43 | 1.06 |
| Rainbow trout | 35 | 0.86 |
| Sockeye salmon | 10 | 0.25 |
| Coho salmon | 10 | 0.25 |
| Longfin smelt | 9 | 0.22 |
| Smallmouth bass | 9 | 0.22 |
| Chinook salmon | 3 | 0.07 |
| Total | 4,061 | 100.00 |

Source: Pfeifer and Weinheimer 1992.

The best method for assessing bass populations is through the use of mark and recapture methods (Pfeifer pers.comm.1998). Two such studies have been done in Lake Washington. Fayram (1996) estimated smallmouth and largemouth bass populations to be 1,001 and 145 in Lake Washington, respectively. Stein calculated a population size for largemouth bass of 2,100. No population estimates have been made for squawfish, but they are known to be very abundant throughout the lake.

At the Kenmore Pre-mix/Lakepointe inner harbor site, methods used by Beak for capturing nonsalmonids included electrofishing and gillnetting. In 1996, the most abundant were prickly sculpin (134), three-spine stickleback (181), and squawfish (53) (Beak Consultants 1998). Four largemouth bass and no smallmouth bass were caught. In 1997, very few fish were caught.

## Threatened and Endangered Species

There are at present no fish species in the Lake Washington/Sammamish River system listed as threatened or endangered under the federal Endangered Species Act (ESA) or under the Washington Administrative Code (WAC 232-12-297). Several Pacific salmon species are currently under review for listing including coho, and chinook salmon (Table 6). Puget Sound fall chinook were formally proposed for listing as a threatened species in February 1998 by National Marine Fisheries Service (NMFS). It is possible that they will be listed by 1999. This would include fall chinook in the Lake Washington system.

**TABLE 6**
Federal ESA Listing Status for Aquatic Species of Concern in Lake Washington System

| Species | Federal ESA Status |
|---|---|
| Chinook salmon | Under review for listing; proposed threatened |
| Coho salmon | Under review for listing |
| Sockeye | Not proposed for listing |
| Pacific lamprey | Species of concern |
| River lamprey | Species of concern |
| Bull trout | Species of concern |

Source: Beak Consultants 1998.

WDWF publishes a state Species of Special Concern (SSC) list that includes native Washington species listed as State Endangered, State Threatened, State Sensitive, or State Candidate as established by Washington Administrative Code (WAC 232-12-297), as well as species listed or proposed for listing under the federal ESA (discussed in the previous section). Currently, there are no additional Lake Washington fish species on the state SSC list that are not included in the federal list.

# Potential Impacts of Proposed Project

## Introduction

Features of the proposed Lakepointe Development specific to shoreline areas surrounding the Kenmore Pre-mix property include: 1) a public shoreline park along the north bank of the Sammamish River; 2) a fixed moorage pier; 3) public plazas and viewpoints along the northeastern shore of the inner harbor (Beak 1998); and 4) floating moorage slips in the eastern half of the Inner Harbor. The design specifications of the Lakepointe project have evolved through the EIS process, making impact analysis somewhat difficult. To clarify the scope of the current project as it pertains to this analysis, shoreline features are quantified in Table 7.

The concern by regulatory agency and tribal biologists over this project stems primarily from the proximity of the site to the Sammamish River mouth and from the status of the salmon runs regionally and in the Lake Washington watershed. About 5 million salmon fry and smolts travel down the Sammamish River on their way to Lake Washington and ultimately to the ocean. They become very concentrated at this point and are particularly vulnerable to predation during this migration. Coho and chinook salmon as well as steelhead trout populations are at historically low numbers. Development-related activities in the watersheds are considered a primary cause for their decline. The proposed listing of fall chinook salmon in Puget Sound as threatened under ESA has alerted the entire region that changes need to be made to reverse these declines.

The following discussion addresses the major issues related to fisheries as indicated by the comment letters received on the Final Lakepointe Report on Natural Resources report dated May 30, 1997, prepared by Beak Consultants.

**TABLE 7**
Summary of Shoreline Treatments and Water Structures Under Existing Conditions, Proposed Marina Described in Draft SEIS, and Revised Proposed Marina

| | Existing Conditions | | Proposed Marina | | |
|---|---|---|---|---|---|
| | Draft SEIS | Revised | Draft SEIS | Revised | Change from Revised Existing Conditions |
| Area of Surface Water Overhang (sq. ft.) | 7,642 | 8,938[a] | 32,488 | 9,504 | +566 |
| Area of Floating Material | | | | | |
| Floats | 7,795 | 7,795 | 12,700 | 9,340 | +1,545 |
| Boats | 25,800 | 29,648[b] | 14,632 | 26,045 | –3,603 |
| Total Shaded Area | 41,237 | 46,381 | 59,820 | 44,889 | -1,492 |
| Lineal Feet of Bulkhead | 1,131 | 1,131 | 1,016 | 1,016 | -115 |
| Number of In-Water Pilings | 365 | 395 | 449 | 255 | -140 |

Source: Beak Consultants 1998.

[a]Surface water overhang and number of pilings increased due to inclusion of an existing private covered moorage dock that is located within the site. These structures were assumed to be offsite in the Draft SEIS.

[b]The amount of floating boat surface area increased to include tug berthing areas, commercial vessel berthing, and other miscellaneous boat moorages shown in photographic documentation of the inner harbor during spring 1996. These areas were not incorporated into previous estimates of boat surface water coverage in the Draft SEIS.

## Water Quality

Water quality associated with the proposed project appears to be adequately addressed in meeting National Pollutant Discharge Elimination System (NPDES) requirements. Stormwater detention and treatment are stated to conform with King County Surface Water Management Standards and thus comply with best management practices (BMPs) for surface water. This is adequate for meeting National and State Environmental Policy Act (NEPA and SEPA) requirements. Water quality was not identified as a major issue.

## Habitat Quality

### Shallow Water Habitat

The existing habitat quality along the entire perimeter of the Kenmore Pre-Mix site is degraded to varying degrees. The inner harbor area is seriously degraded with bulkheads, piers, docks, floats, construction debris, abandoned structures, major vessel moorage, and industrial activity. The channel is periodically dredged.

The protected nature of the harbor reduces wave action and allows temperatures to rise above that found on adjacent shorelines. This probably attracts bass and other warm water fish that are known to prey on juvenile salmonids.

The proposed project would do little to alter the shorelines along the Sammamish River and the lakefront area. A few trees would be removed and others planted. The southern exposure of the river shoreline precludes these trees from creating any shade at present. The inner harbor would be cleared of wood debris, construction debris, abandoned piers, major vessels, and house boats. The overall amount of shading from overhead structures and boats would be reduced. A bulkhead would be removed and replaced with shallow semi-natural shoreline for a length of 115 linear feet. Since tug traffic would cease, turbidity will probably be reduced, although the increased small boat traffic might create the same problem in shallow water. Overall, it would appear that rearing habitat for salmonids will not be degraded from its present condition. This was not identified as a major issue.

### Dredging

With commercial barge traffic eliminated, the need for dredging would presumably be eliminated or drastically reduced. This would reduce the periodic disturbance and would result in gradual burying of the mildly contaminated sediments found there. This benefit, however, might be offset by contaminants originating from the new vessels at the new marina. Dredging was not identified as a major issue.

## Predation

Predation has been identified as the primary concern of the state, county, and tribal biologists. The greatest predation rates on juvenile salmonids in Lake Washington are likely from other adult and pre-smolt salmonids fishes, primarily resident cutthroat and rainbow trout (Beauchamp et al. 1992; Beauchamp 1994, Tabor and Chan 1996b). However, some warm water species might also occasionally prey on juvenile salmonids. These species include northern squawfish, largemouth and smallmouth bass, pumpkinseed, black crappie, catfish, prickly scuplin, brown bullhead, and yellow perch. Of these piscivores, the squawfish, bass, and sculpin are thought to offer the greatest potential to occasionally prey on small salmonid outmigrants in Lake Washington ( Forester 1968; Stein 1970; Bartoo 1972; Olney 1975; Eggers 1978; Eggers et al. 1978; Tabor and Chan 1996b; Martz et al 1996a,b; Fayram 1996).

The inner harbor is a backwater area that provides spawning and rearing habitat for squawfish, largemouth bass, and perhaps smallmouth bass. The exact number of these species using the inner harbor is not known. However, survey results from three of the above studies showed at least some use by these species, except smallmouth bass. Extensive use by these species in the harbor is probable for several reasons. Lake Washington does not have abundant shallow backwater areas that warm up sufficiently in May and June to support successful spawning for either species of bass. Areas that do warm up above 13.0 degrees C in May would be sought out. The abundance of in-water structure would tend to attract ambush predators such as bass throughout the year. Squawfish spawn on rocky substrates, but little is present in the project area. However, they do tend to concentrate in bays during the spring and summer (Olney 1975).

Juvenile salmonids are present and migrating through the project area at the same time that bass would be present (May and early June). The majority of sockeye fry might pass by the site before bass arrive but the occurrence of chinook and coho smolts is coincident with the expected arrival and metabolic activation of smallmouth and largemouth bass.

### Structures

Several different types of structures are planned for addition, deletion, or modification as a part of the Lakepointe Development. These include bulkheads, floating docks, fixed pier structures, and boats. Bulkheads currently present will remain with the exception of 115 feet of bulkhead at the very end of the harbor that will be removed and replaced with a semi-natural shoreline. There will be a decrease in over-water structure (Table 7). This, in association with a net loss of pilings, should be a beneficial impact. It is well known that ambush predators such as large- and smallmouth bass associate with structures such as these (Pflug 1981), although other studies have found minimal association (e.g., White 1975).

The behavioral characteristics of juvenile salmon around piers, docks, bulkheads, and floats are not well understood. The bulk of information comes, with a few exceptions, in the form of anecdotal visual observations of fish behavior from experienced fisheries biologists. Ratte (1985) observed that pink salmon fry would swim along the shoreline under a pier rather than travel along the perimeter. This author, however, has observed the opposite behavior in chinook salmon and chum salmon smolts in Port Gardner and in Elliot Bay. In those studies (Parametrix, 1984a, 1984b, 1985a, 1985b), chinook and chum smolts traversed the perimeter of the piers and would not venture underneath even if startled. A fish passage study at the Manchester fuel pier (Dames and Moore 1993) found that chum salmon smolts confronted with a relatively high, narrow pier (with good light penetration under it) would pass under or go around it in approximately equal proportions. The configuration of the Manchester fuel pier probably represents the transition point in terms of lighting for salmonid under-pier migration, at least for chum salmon. There is no reason to believe that salmon smolt migratory behavior around pier structures is different in the estuarine environment during the first week of marine residence from their behavior in fresh water. In both situations, the fish are active migrants.

The limited behavioral observations of salmon around piers suggest that the perimeter of over-water structure rather than surface area would be a better parameter to assess potential impacts of predation. Therefore, the perimeter of over-water structures was measured for the existing configuration of the inner harbor and compared with the proposed configuration. Some of the over-water structures or objects were deleted from consideration as ambush cover because they were too far from shore. These included moored barges for the existing condition and the entire detached pier structure in the proposed design. It was assumed that 10 feet was the maximum striking distance for a bass foraging foray. Since the existing configuration of structures in the inner harbor is for large objects, the surface area is large in comparison to the perimeter. The numerous finger piers of the proposed configuration create a greater perimeter. The perimeter comparison is:

| | |
|---|---|
| Existing structure perimeter: | 1,820 feet |
| Proposed structure perimeter: | 2,675 feet |
| Proposed perimeter along ends of finger piers | 1,150 feet |

If out-migrant salmonid smolts or fry (in the case of sockeye) traverse the perimeter in the shoreline, they would traverse 855 feet additional feet of structure with the proposed project. There is no way of knowing how many predators might inhabit 855 feet or how many juvenile salmonids they might eat in the course of the outmigration. Based on the low bass population density in the lake, the number might not be more than a few fish. If the migrating salmon traverse the ends of the finger piers, which is a real possibility due to the occupancy of slips with boats, effective perimeter length would be less with the proposed project (1,150 feet) and the potential predation on salmon would be less than under existing conditions.

### Species-by-Species Analysis

In order to give a more comprehensive perspective on the issue of predation, a species-by-species discussion is offered in the following subsections.

**Cutthroat Trout.** Cutthroat trout are important predators of sockeye fry as well as coho and chinook salmon smolts. They are viewed as an important salmonid predator in Lake Washington (Martz et al. 1997; Tabor and Chan 1996) as well as in other sockeye lakes (Beauchamp et al. 1995). They are effective predators for a number of reasons, including compatible temporal and spatial distribution, and a high degree of mobility and abundance. Although cutthroat trout population estimates for Lake Washington and Lake Sammamish have not been made, they are considered fairly abundant (Foley, WDFW, pers. comm. 1998). The niche of cutthroat trout in waters with anadromous forms is well known to include congener piscivory in the larger fish. This relationship is a co-evolved one and well established. Cutthroat trout are cruising predators, at least in lakes, as opposed to sessile or ambush predators. For this reason, the presence or absence of docks, floats, piers offers little habitat value. The diversion of fry and smolts away from the refuge of shallow shorelines might increase predation effectiveness by cutthroat trout, however. Cutthroat trout were collected in the inner harbor and can be assumed to be there post-project.

The uncertainty about the migrational characteristics around the finger piers and the uncertainty as to the relative increase in vulnerability from shoreline diversion precludes judgment as to whether there is a net gain or loss of smolt vulnerability to these predators. Since cutthroat trout are not attracted to warm water and since there are hundreds of docks along the shoreline of Lake Washington, the incremental increase in predation from this project by cutthroat trout is likely to be negligible.

**Rainbow Trout.** Resident rainbow trout, like cutthroat trout, behave as congener and conspecific predators. The degree of piscivory in rainbow trout varies with stock. In Lake Washington, rainbow trout were found to exhibit a relatively high degree of piscivory, especially for a hatchery stock (Beauchamp 1990). About 250,000 trout juveniles are planted every year in Lake Washington. The analysis for rainbow trout parallels that given for cutthroat trout.

**Northern Squawfish.** Northern squawfish are known to be predators of juvenile salmonids and are abundant in Lake Washington. As with cutthroat and rainbow trout, they co-evolved with salmon and thus can be expected to be spatially and temporally in tune with salmonid smolt migratory behavior. Squawfish are opportunistic feeders showing a high degree of adaptability depending on food availability. When littoral resources are ebbing, they feed on longfin smelt and sockeye pelagically (Eggers et al. 1978). When littoral resources are abundant, they exploit those. It is not surprising that Prickly sculpin, the most abundant fish in Lake Washington in terms of biomass, is extensively exploited by squawfish (Eggers 1978; Martz at al. 1997). Squawfish are known to concentrate and exploit seasonal concentrations of juvenile salmonid out-migrants in situations where the opportunity presents itself. Such is the case in the Columbia River, where squawfish congregate in the tailraces of hydroelectric projects and upper sections of reservoirs to prey on smolts (Beamesderfer et al. 1987; Poe et al. ___). In Lake Washington, squawfish prey heavily on sockeye fry at the mouth of the Cedar River and along the southern end of the lake in spring and early summer. These are bottleneck situations that are energetically profitable to exploit. The same situation would be expected to exist at the mouth of the Sammamish River and adjacent shorelines. Squawfish were found in moderate numbers in the Kenmore inner harbor.

Squawfish are not ambush-type predators, and in-water or over-water structures would not be expected to increase their habitat. However, the displacement of migration juvenile salmonids into deeper water along the pier faces might increase their vulnerability as with trout. As stated previously, this effect, if any, depends on the behavior of out-migrants in response to the proposed marina design.

Assuming that squawfish are attracted to the inner harbor and that the increased structure perimeter increases smolt vulnerability to predation to some degree, it is likely that a small but unmeasurable loss of salmon outmigrants would occur seasonally due to squawfish. Since the project will not create conditions more suitable for squawfish spawning or juvenile rearing, reproduction and dispersal concerns are not warranted for this species.

While the project may increase rearing habitat for largemouth bass to a small degree, it is unknown whether spawning habitat will increase. Largemouth bass spawn in shallow water. In Lake Sammamish, Pflug (1981) found nest sites at depths ranging between 2 and 5 feet in the presence of aquatic vegetation. It would seem as though there might be conflict between the use of shallow depth and the considerable human activity the marina would generate. The activity might discourage spawning. There is little reason to believe that the project would increase largemouth bass spawning success in the inner harbor. Thus, it is improbable that reproductive augmentation and subsequent dispersal concerns are warranted.

**Largemouth Bass.** Largemouth bass are not abundant in Lake Washington (Fayram 1997) but are concentrated in quiet, weedy, silt-bottomed shorelines (Pflug 1981). They are ambush-type predators and thus associate with cover such as vegetation, woody debris, or docks and pilings. In Lake Sammamish, largemouth bass were found to be spatially separated from smallmouth bass for the most part (Pflug 1981). Largemouth bass move into warmer sheltered areas of the lake to spawn in spring. The Kenmore inner harbor qualifies as a sheltered and warm area of the lake and thus constitutes bass habitat. The Beak surveys found juvenile largemouth bass but no adults. The use of the inner harbor by bass and salmonids overlaps during the months of May and June. This puts largemouth bass in contact with some of the sockeye and most of the coho and chinook out-migration.

Largemouth bass are opportunistic feeders. They might not target salmonids but will prey on them when they are available and abundant (Pflug 1981).

The in-water and over-water structures in the inner harbor can be expected to be used by bass as habitat. An increase in structure perimeter can be expected to increase habitat for ambush predators like largemouth bass. The amount of increased usage of 855 feet of added perimeter is unknown but probably small. Increased predation to some small but unquantifiable amount might occur in the absence of mitigation.

**Smallmouth Bass.** According to the work of Stein (1970), Fayram (1997), Pfeifer and Weinheimer (1992) and judging from trends in bass tournament catches, it appears that the smallmouth bass population is expanding at the expense of largemouth bass in Lake Washington (Pfeifer, WDFW, pers. comm. 1998). Even so, they cannot be considered abundant. Surveys by Beak in 1996 and 1997 did not find any smallmouth bass in the inner harbor, the lakefront area, or at the river mouth. The one night survey by the Muckleshoot Tribe (MIT 1997) in the vicinity likewise did not catch smallmouth (but did catch largemouth). Pfeifer and Weinheimer (1992) surveys in the Kenmore area were in agreement. Largemouth bass do not generally live in sympatry with smallmouth bass (Pfeifer and Weinheimer 1992), both have distinct habitat preferences (Pflug 1981; Pflug and Pauly 1984), and smallmouth bass were not found while largemouth bass were. These facts suggest that smallmouth bass might not use the Kenmore inner harbor. Their preference for rocky or gravel substrate and dropoffs also suggests that they might not use this area.

**Prickly Sculpin.** Large sculpin are capable of capturing sockeye fry and are known to use this resource at least in the vicinity of the Cedar River (Tabor and Chan 1997). This probably occurs at the mouth of and in the Sammamish River seasonally. Even though their predation rate is not high and limited to the larger individuals, their abundance makes their predation on sockeye significant. Life history and habitat requirements of prickly sculpin in Lake Washington has not been studied to date. Their abundance, wide distribution, and ability to exploit many types of food resources suggests an ability to use a variety of habitats. In the Kenmore inner harbor, prickly sculpins were captured in numbers second only to sticklebacks. Based on their small size and generalized behavior, it is doubtful that prickly sculpins benefit from the presence of floating docks. If such an assumption can be made, the increase in dock perimeter and reduction in dock surface area would not result in a change in predation by sculpins.

### Lighting

Largemouth bass and other predators can be expected to use artificial lighting to some degree to extend feeding opportunities on juvenile salmon. The amount of lighting that currently exists at the Kenmore Pre-Mix plant is sufficient to augment predation. However, the post-development lighting is not expected to be greater than what currently exists.

## Impact Summary

The major fisheries concern associated with the Lakepointe Development is the potential for project features in the inner harbor to attract resident fish, such as bass, which in turn could prey on the numerous juvenile salmon that pass through the project area each spring. In response to this concern, the develop has reconfigured the inner harbor features. The result is to produce a net reduction in the surface area of over-water structures (docks, boats overhang), fewer lineal feet of bulkhead, and fewer in-water pilings, compared to existing conditions. All of these modifications should reduce the potential to attract predator fish.

The modified dock configuration also would increase the perimeter of over-water structure in the inner harbor. Because juvenile salmon tend to go around rather than under docks, it is possible that the increased dock perimeter would increase the exposure of juvenile salmonids to ambush predators residing under the docks. However, if boats are moored in the slips between docks, it is likely that the juvenile salmonids would travel along the periphery of the docks, thus being exposed to less predation.

### Recommendations

The new configuration of the project features in the inner harbor should eliminate potential new impacts associated with salmonid predation. However, there is some degree of uncertainty with this conclusi9on because of our reliance on assumptions regarding fish behavior. Therefore, to provide additional certainty of nonimpact, we recommend that a minor reconfiguration of the floating dock area be considered. We suggest that the floating docks be detached from the shoreline by about 5 to 10 feet. Human access to the docks would be via above-water walkways. This modification would produce an open water area along the shoreline where juvenile salmonids could pass without being directly exposed to predators around the dock perimeter.

## References

(To Come)

APPENDIX A

# Calculations

## Assumptions for Estimates of Chinook Production

1. Fecundity: 4,000 eggs/female
2. Sex ratio: 1 to 1
3. Egg to fry survival: 10 percent (actual range 0 to 20 percent)
4. Fry to smolt survival: 50 percent
5. All migrants are subyearling smolts

Wild:

$$221 \text{ adults } x \frac{4{,}000 \text{ eggs}}{\text{pair (2)}} x\ 0.1\ x\ 0.5 = 22{,}100$$

Naturalized:

$$1{,}731 \text{ adults } x \frac{4{,}000 \text{ eggs}}{\text{pair}} x\ 0.1\ x\ 0.5 = 173{,}100$$

## Estimate of Nearshore Juvenile Salmon Use at Kenmore Pre-Mix/Lakepointe Site

### Assumptions

1. Sampling season (March 29 through June 24) spanned entire outmigratory period.
2. Electrofishing methods were 100 percent effective and covered area offshore.
3. Sampling days were representative.
4. Cruising speed of the average smolt or fry equals 0.325 fps (cruising speed of sockeye fry; Bell 1978).
5. Sampling efficiency was equal at each sampling station.
6. All migration is at night (average = 13 hr).
7. All sockeye fry migrants stay inshore for first day of lake residence.
8. One-half of the migrants turn north at river mouth and one-half turn south.
9. 1.5 million sockeye fry migrants.

## Calculations

$$\frac{\text{No. fish}}{1} \times \frac{\text{days / season}}{\text{days / sampled}} \times \frac{\text{Ln tot}}{\text{Ln sampled}} \times \frac{\text{passage turnover}}{\text{rate (PTR)}} = \frac{\text{No. fish passage}}{\text{season}}$$

$$\text{PTR} = \frac{\text{0.325 feet}}{\text{sec}} \times \frac{\text{46,800 sec}}{\text{13 hr / 1 night}} \times \frac{1}{\text{shoreline Ln (feet)}} = \frac{\text{fish groups / night}}{\text{passed by a given location}}$$