**Salmon in the Nearshore: What do we know and where do we go?'**

A synthesis discussion from the all day special session entitled 'Salmon in the Nearshore' session of the 2004 Pacific Estuarine Research Society (PERS). Compiled by session chair Anne Shaffer, Washington Department of Fish and Wildlife. 332.E. 5th Street Port Angeles, Wa. 98362. 260.457.2634/417.2154fax shaffjas@dfw.wa.gov

The 2004 Pacific Estuarine Research Society (PERS) meeting was held on 17-18 April 2004 at Ford Worden Conference center in Port Townsend, Washington. The all day session included 16 presentations (presenter list with abstracts and contact information provided below) and a half hour overview discussion. Approximately 100 people participated in the dialogue. This summary provides an overview of session findings and recommendations from group dialog.

The all day session focused on salmon in the nearshore and included work by researchers from the University of Washington, Tribes, local/state/federal agencies, and private consulting firms (abstracts are available on the PERS website). Collectively the work covers a large geographic area including Puget Sound, North Puget Sound, Hood Canal, and the Strait of Juan de Fuca. The presentations focused on physical processes that define habitat function and use, seasonal and temporal variation in habitat use, geographic extent of nearshore habitat use, and details on how specific nearshore habitats function for feeding, refuge, and migration for Chinook, coho, and chum salmon, both hatchery and wild, and forage fish.

Some general common findings follow. First, use of the nearshore is very complex, and dependant on a number of variables including the species, size of fish, geographic area, and time of year. In fact, nearshore use may be density dependant and a limiting factor for wild stock survival. A number of studies revealed that once in the nearshore outmigrating juvenile salmon are not restricted to using the habitats in close proximity to their natal streams and may disperse widely throughout the marine environment.. This is strong evidence that proximity to natal streams is not the single deciding factor in nearshore habitat function for juvenile salmon, especially with life history types that have long nearshore residency periods. Many authors reported finding extensive juvenile salmon use along the estuarine and nearshore landscape, as well as strong evidence from coded-wire tag data of cross-Sound migration. Fish from north Puget Sound areas are found in central and south Puget Sound studies, and vice versa. These cross-Sound migration results are compelling, and gaining a clearer understanding of juvenile salmon movement and migration pathways within Puget Sound is a high priority for future research.

Significant revelations from work presented in this session include debunking the following fallacies (in italic):

1) *The existence of a uniform outmigration 'window' for Puget Sound salmon.* Juvenile salmon use the nearshore most of the year, and peaks in abundance extend well past the June 15 end point used by managers for decades;
2) *Coho don't use the nearshore.* Findings presented in this session indicate that in some areas coho are present in the estuarine nearshore for over a month;
3) *When leaving natal streams, juvenile salmon enter Puget Sound, head north, and then out through the Strait of Juan de Fuca to the Pacific Ocean.* Work in this session clearly reveals that salmon use the Puget Sound basin widely, and migrate back and forth within it, heavily;
4) *Foraging salmon don't feed on terrestrial insect assemblages.* Work from a number of these presentations clearly indicates otherwise. Several authors showed that for chinook, in particular, terrestrial insects can be the dominant prey (based on numeric, gravimetric, or IRI) found in gut contents at certain times of the year;
5) *Most mortality of salmon occurs in the ocean, and thus freshwater and marine life history stages are less important in determining survival to spawning age.* Research presented in this session suggests the opposite is true—the early life history stages are the most important in determining ultimate survival;
6) *Hatchery practices don't affect salmon life history diversity, or survival*. Several authors provided evidence that one legacy of past hatchery practices is dramatic loss of life history diversity, and detailed the likelihood of negative competitive interations between hatchery and wild fish, especially for chinook salmon.

The top data gap is basic life history information on salmonid use in the nearshore. Participants agreed on the pressing need for a long-term monitoring effort of an appropriate spatial and temporal scale to answer life history questions. The monitoring should focus on agreed upon metrics and use standard techniques including (but not exclusively limited to) beach seining and tow netting. The long-term monitoring should not focus just on salmon, but should also include relevant trophic resource and survival studies. A large-scale framework is needed to put in context potential sources of variation in salmon use of nearshore habitats caused by variation in population sizes, life history types, habitat (type, productivity, connectivity) and prey resources. A long-term framework is needed to understand the causes of annual and seasonal variation. If the framework for such a monitoring effort is developed, then local groups, for example Marine Resource Committees (MRC's), local citizens groups, and local non-profit businesses, such as the Menzies project, can help to implement the work. We know that our effort to understand nearshore issues locally will also contribute to the bigger picture – a better understanding of Puget Sound. The development of a collaboration framework, including technical guidance, is needed first.

The following additional data needs were discussed and agreed upon:

1) The role of marine riparian areas and the functional linkages to salmon including: a) a prey resource base; b) contribution to plankton and neuston available for prey

(i.e. organic inputs for detritus-based food webs), and; c) contributions to habitat structure (i.e. LWD), water quality, and other functions;

2) The role different kelp species play as habitat for juvenile salmon and forage fish;
3) Sediment quality and toxicity in the nearshore and relationship with salmonid resource. Commencement Bay is a key candidate for this work;
4) Hatchery monitoring, and the compelling need for consistent marking (i.e., coded-wire tag and fin clipping), and;
5) Additional impact assessments of anthropogenic modifications of marine nearshore habitats.

Finally, the group agreed that historical data sets are an invaluable resource for long-term assessment of population trends in the nearshore. Participants voiced a strong concern that, as researchers from past decades retire, these data sets will be lost. Critical data sets to be archived include the MESA studies, the long term data sets from Bruce Miller and the UW fisheries classes, and data from the Golden Gardens study. Finding, preserving, and disseminating these data sets (not just the reports) are a high priority.

The discussion concluded with the suggestion that PERS consider a position statement on priorities raised in discussion. PERS officers will consider taking the recommendation forward to the governing board for action. There is much work to be done, and time is of the essence. If researchers, co-managers, and local citizen stewards work together as a team at both the cross-region and site scale, we have a strong potential for achieving our goals of understanding and better managing nearshore habitats and salmon. But we need to begin now. For more information on *Salmon in the Nearshore* session or dialog on proceeding with the session recommendations, contact Anne Shaffer, 360.457.2634/shaffjas@dfw.wa.gov. For information on PERS contact Ted Dewitt, President, PERS, at dewitt.ted@epamail.epa.gov

Salmon in the nearshore presenters and presentation titles

Anne Shaffer, Session chair

**Beamer, E.**; R. Henderson; Kim Larsen: THE IMPORTANCE OF SKAGIT ESTUARINE DELTA HABITAT TO WILD OCEAN-TYPE CHINOOK SALMON.

**McBride, A.**; and E. Beamer: GEOMORPHIC CLASSIFICATION FOR ESTUARIES AND SHORELINES WITHIN WHIDBEY BASIN.

**Rice, C.**; C. Greene; E. Beamer; K. Fresh; D. Lomax; R. Henderson; and R. Reisenbichler: SPATIAL AND TEMPORAL DISTRIBUTION OF MARKED AND UNMARKED JUVENILE CHINOOK SALMON IN NEARSHORE SURFACE WATERS OF PUGET SOUND: PRELIMINARY RESULTS.

**Greene, C.M**.; D.W. Jensen; E. Beamer; G.R. Pess; and E.A. Steel: EFFECTS OF ENVIRONMENTAL CONDITIONS DURING STREAM, ESTUARY, AND OCEAN RESIDENCY ON CHINOOK SALMON RETURN RATES IN THE SKAGIT RIVER, WASHINGTON.

**Heatwole, D.**; and C. Simenstad: INFLUENCE OF HABITAT ON ARTHROPOD ASSEMBLAGES IN TIDALLY RESTRICTED AND NATURAL PUGET SOUND SALT MARSHES.

**Koehler, M.**; and B. Miller: RESIDENCE TIME AND MOVEMENT PATTERNS OF COHO SALMON SMOLTS IN THE SOUTH SLOUGH ESTUARY, CHARLESTON, OREGON.

**Lott, M.A**.; C.A. Simenstad; and D.L. Bottom: THE ESTUARINE BUFFET: HABITAT SPECIFIC SALMON FORAGING IN THE COLUMBIA RIVER ESTUARY.
**Young, C.D.**; C. Simenstad; J. Parish; J. Cordell; and K. Fresh: THE RESPONSE OF JUVENILE CHUM SALMON SCHOOLING AND MIGRATORY BEHAVIOR TO EELGRASS LANDSCAPE PATTERNS IN HOOD CANAL, WASHINGTON.
**Brennan, J.**; and K. Higgins: JUVENILE SALMON TIMING, DISTRIBUTION, AND DIET IN MARINE NEARSHORE WATERS OF CENTRAL PUGET SOUND.
**Shannon, J.**; and W. Taylor: OBSERVATIONS OF CODED WIRE TAGGED JUVENILE CHINOOK SALMON CAPTURED IN THE DUWAMISH RIVER ESTUARY AND ELLIOTT BAY, WASHINGTON.
**Gardiner, J.**: FORAGING SUCCESS OF JUVENILE PACIFIC SALMON: A COMPARISON AMONG SMALL, MEDIUM, AND LARGE ESTUARINE TIDAL CHANNELS.
**Von Saunder, A.**: JUVENILE SALMONID FORAGING ASSOCIATED WITH REHABILITATED HABITATS IN TWO HIGHLY INDUSTRIALIZED NORTHWEST ESTUARIES.
**Toft, J.**; C. Simenstad; J. Cordell; and L. Stamatiou: FISH DISTRIBUTION, ABUNDANCE, AND BEHAVIOR AT NEARSHORE HABITAT TYPES IN PUGET SOUND, WITH AN EMPHASIS ON JUVENILE SALMONIDS.
**Bahls, P.**: FISH DISTRIBUTION AND ABUNDANCE IN SHALLOW INTERTIDAL HABITATS OF TARBOO AND NORTH DABOB BAYS.
**Taylor, W.**; B. Rummel; N. Casper; and J. Shannon: SAMPLING TIDAL FLUX OF INVERTEBRATE PREY ORGANISMS FROM A CONSTRUCTED ESTUARINE HABITAT RESTORATION SITE TO ASSESS DESIGN PERFORMANCE.
**Shaffer, J.A.**: PREFERENTIAL USE OF NEARSHORE KELP HABITATS BY JUVENILE SALMON AND FORAGE FISH.

OPEN DISCUSSION ON SALMON IN THE NEARSHORE--'BIG PICTURE-WHAT DO WE SEE AND WHAT DO WE NEED?'J.A. SHAFFER, MODERATOR.

## PERS SPECIAL SESSION ‘SALMON IN THE NEARSHORE’ ABSTRACTS

***PRESENTER CONTACT INFORMATION**

### The Importance of Skagit Estuarine Delta Habitat to Wild Ocean-type Chinook Salmon

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A recently completed modeling study suggests survival of wild Skagit chinook in the nearshore lifestage is low and sensitive to climate induced environmental variation. Skagit River field study results indicate that the relationship between freshwater wild juvenile chinook population size and wild juvenile chinook abundance in estuarine river delta habitat is density dependent thus supporting the idea that delta habitat conditions are limiting the capacity of delta-rearing chinook. Conversely, the proportion of the total wild juvenile chinook population in Skagit Bay that bypasses rearing in delta habitats and migrates directly into Skagit Bay increases with wild smolt outmigration levels above 2,500,000. This finding indicates that at least some of the density dependence occurring in the delta results in the displacement of juvenile chinook out of rearing habitats in the delta where they end up in Skagit Bay. Otolith-based research on juvenile Skagit chinook shows that an extended delta-rearing period improves growth of chinook after they reach Skagit Bay. Therefore, the conditions occurring in the delta-rearing lifestage not only exert a limitation to fish in the delta, but also have a later effect. Present day delta conditions may be contributing to low survival of juvenile chinook in nearshore habitat.

### Geomorphic Classification for Estuaries and Shorelines Within Whidbey Basin

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We have developed a classification model for estuaries and shoreline habitats within the Whidbey Basin, Puget Sound. The model is used to analyze habitat utilization by estuarine fishes, estimate pre-anthropogenic conditions, and predict post-restoration outcomes. The classification is geomorphically and process-based, applicable at different spatial scales, and mechanistic rather than descriptive. The model was developed using field mapping and existing data for erosion potential, longshore drift, geology, and topography. The resulting geomorphic units fit within a nested hierarchy, ranging from the large-scale Puget Sound fjord estuary, to mid-scale river estuaries and littoral drift cells within Puget Sound, to small-scale shoreline segments (our geomorphic units) including pocket estuaries between the larger river estuaries within Puget Sound. Each unit ranges from 102-103 meters in length, a scale relevant to sampling estuarine fishes by common methods such as beach seine. We have begun testing biological response to habitat conditions. Our initial results have demonstrated that fry migrant chinook salmon prefer pocket estuaries over other shoreline types. We have used the model to remotely identify the locations of current and historic pocket estuaries. Subsequent field investigation has supported the former existence of pocket estuary habitat at all modeled sites checked thus far.

**Spatial and Temporal Distribution of Marked and Unmarked Juvenile Chinook Salmon in Nearshore Surface Waters of Puget Sound: Preliminary Results**

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In 2001 and 2002, we conducted pilot surface trawl (townet) studies to identify and characterize juvenile Chinook salmon (*Oncorhychus tshawytscha*) life history types present in Skagit Bay, Puget Sound, Washington, and to compare spatial and temporal distributions of hatchery and wild juvenile chinook in nearshore environments. In 2003, sampling was expanded to include five additional river mouth estuaries and several marine areas in between them. This expanded sampling will improve our landscape-scale understanding of the estuarine ecology of juvenile chinook, including evaluation of effects of different oceanographic characteristics and degrees of human influence. To date, 52 sites have been sampled between the Nooksack River estuary in the north, and the Nisqually River estuary in the south. Over 1000 10-minute tows have been successfully completed, and over 6500 juvenile chinook captured. Adipose fin clip and coded wire tag marking of hatchery chinook in the Skagit River system has been close to 100% since 1995. This provides unique opportunities for comparing wild and hatchery fish throughout the system, including the relatively understudied estuarine and marine environments. We found that unmarked chinook were more widely distributed than marked (adipose fin clipped or coded wire tagged) chinook with respect to time, space, and individual size. This suggests that wild chinook use estuarine habitats more extensively than do hatchery fish. In addition, areas in the southern, more urbanized, or hatchery-dominated systems showed higher peak chinook catches but more rapid seasonal declines in chinook abundance. Incomplete and inconsistent marking of hatchery fish complicates interpretation of these results. Future work will include detailed analysis of chinook otoliths, scales, and diet samples, and associated fish assemblage composition.

**Effects of Environmental Conditions During Stream, Estuary, and Ocean Residency on Chinook Salmon Return Rates in the Skagit River, Washington**

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We determined the relative effects of freshwater, estuarine, and ocean environmental variation by modeling 17 brood years of return rates (spawners per spawner) of wild Skagit River chinook salmon as a function of environmental conditions experienced during residency in freshwater, tidal delta, bay, and ocean habitats.

Our model also included density dependence (based on egg production) across life stages. The best predictors of return rate included magnitude of floods experienced during incubation, a principal components factor describing environmental conditions during bay residency, a similar factor describing conditions experienced during the third ocean year, and egg production. Our model explained 89% of the variation in return rate. Most of this variation was explained by flood recurrence interval and environmental conditions experienced in Skagit Bay; density dependence and conditions experienced during ocean residency each explained only about 5% of the variation. Our model successfully predicted the return rates of five brood years following the data used to construct the model. Our results suggest that returns of wild salmon can be predicted with high precision by incorporating habitat residency, and that freshwater and nearshore environmental conditions more strongly influence survival of Skagit River chinook salmon than ocean conditions.

**Influence of Habitat on Arthropod Assemblages in Tidally Restricted and Natural Puget Sound Salt Marshes**

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To promote Pacific salmon (*Oncorhynchus* spp.) recovery, intensive efforts are underway to preserve remaining coastal wetlands and to restore degraded ecosystems. However, the scientific and restoration communities have largely overlooked barrier salt marshes, found throughout the island archipelago of northern Puget Sound. This project investigates arthropod assemblages in one tidally restricted and five natural salt marshes in Island County, Washington. Using aerial fallout traps, we characterize arthropod abundance and composition at each marsh. Associated vegetation composition and physicochemical factors were documented at multiple space and time scales, to help explain arthropod assemblage patterns. Similar arthropod taxa inhabit all marshes: flies (esp. ceratopogonids, chironomids, and dolichopodids), chalcidoid wasps, hemiptera (esp. saldids, cicadellids, and scale insects), lathridiid beetles, and mites and ticks are particularly common. However, the assemblage of taxa varies widely among marshes. Stepwise regression revealed that a large portion of arthropod variation is explained by tidal flooding and habitat diversity differences. Identification of these underlying factors provides an initial step towards understanding arthropod assemblages in barrier salt marshes. Further research is needed to evaluate the ecological role of barrier salt marshes within the coastal ecosystem, particularly the benefits they provide for juvenile Pacific salmon.

**Residence Time and Movement Patterns of Coho Salmon Smolts in the South Slough Estuary, Charleston, OR**

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An increasing loss of estuarine wetlands, a decline of coho salmon (*Oncorhynchus kisutch*) populations along the Oregon Coast and a hypothesized link between rearing habitat and ocean survival make understanding coho use of estuarine habitats critical. We used hydroacoustic telemetry to determine estuarine residence time and movement patterns of coho smolts in the South Slough Estuary, Charleston, Oregon. Uniquely coded acoustic transmitters were implanted into nineteen smolts. Twelve receivers were placed from the low salinity, tidally influenced stream/estuary ecotone to the variable salinity, tidally influenced main estuary. Side channel, eelgrass and oyster culture habitats were also targeted by receiver placement. On average, coho smolts spent 18 days in the South Slough estuary. The fish reared in the stream/estuary ecotone for an average of 12 days and in the main estuary for an average of six days. The fish exhibited three different patterns of movement throughout the estuary which may be attributed to fish size.

**The Estuarine Buffet: Habitat Specific Salmon Foraging in the Columbia River Estuary**

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Many studies document the importance of shallow water estuarine habitats occupied by juvenile salmon, especially ocean-type chinook (*Oncorhynchus tshawytscha*), in which they serve as a migration corridor and "nursery," but there is little information available on the role of these specific habitats in the Columbia River estuary. An overall loss of 66% percent of marshes and 77% of forested wetlands in the Columbia River estuary coupled with a dramatic decline in wild salmon populations, has prompted us to take a closer look at the role of estuaries in the lives of wild-type juvenile salmon. This study will evaluate the response of juvenile chinook salmon in emergent marsh, scrub-shrub and forested wetland habitats by comparing the composition and relative abundance of prey within each habitat to the diet composition, selectivity and relative consumption rate of juvenile salmon. Characterization of trophic interactions within different wetland habitat types may provide us with a better understanding of how juvenile salmon utilize specific estuarine habitats and how historical changes within the estuary have affected the capacity of the estuary to support sub-yearling juvenile salmon. The information gained from this study will allow us to strategically design restoration projects based on habitat needs across the estuary.

**The Response of Juvenile Chum Salmon Schooling and Migratory Behavior to Eelgrass Landscape Patterns in Hood Canal, Washington**

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Juvenile chum salmon (*Oncorhynchus keta*) are model subjects to study how eelgrass (*Zostera marina*) landscape patterns affect migratory behavior of schooling fish in shallow estuarine waters. After leaving their natal streams in late winter/early spring, juvenile chum (< 5-6 cm FL) migrate in schools in shallow water. As they migrate, they encounter varying patch and corridor distributions of eelgrass within various shallow-water habitats. Observation suggests they utilize these habitats differently for foraging and predator avoidance. For instance, studies have demonstrated that juvenile chum ~ 5 cm FL preferentially prey on only a few taxa of epibenthic harpacticoid copepods despite the availability of many other taxa. These epibenthic crustaceans are distributed disproportionately throughout the landscape with the highest abundances being found in eelgrass beds. Thus, differences in landscapes structure may significantly alter juvenile chum salmon schooling and migratory behavior because predation risk and foraging are the two most important factors influencing such behavior. We are testing the null hypothesis of no fish individual or school response to variations in eelgrass landscape patterns. We are using systematic observations, both direct and video, to measure relative abundance, size, polarity, and compactness of the juvenile salmon schools in Hood Canal, Washington.

**Juvenile Salmon Timing, Distribution, and Diet in Marine Nearshore Waters of Central Puget Sound**

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The lack of knowledge regarding early marine residency is one of the most pressing issues facing salmon management. While a number of studies provide the basis of our understanding of juvenile salmonid life history characteristics in marine nearshore waters, few studies have been conducted outside of river-mouth estuaries, along open shorelines of Puget Sound. The purpose of this study was to fill data gaps in our knowledge of the composition, timing, distribution, and diet of juvenile salmonids in central Puget Sound. Beach seine surveys were conducted between May and October in 2001 and 2002, with a total of 591 sets made at 28 different sites. Nine salmonid species were captured during this study (chum, pink, chinook, coho, steelhead, sockeye, cutthroat trout, char, and Atlantic salmon). Chum and chinook were the most numerous salmonids captured, with chinook being the most persistent. The peak abundance between species was somewhat variable, but generally occurred between May and July for all species. Hatchery chinook captured in our study area originated from 22 different hatcheries and 13 WRIAs and greatly outnumbered "wild" chinook. Chinook diets consisted of prey from both aquatic and terrestrial origin with a high component of insects. Relationships between prey, fish size, and seasonality were apparent.

**Observations of Coded Wire Tagged Juvenile Chinook Salmon Captured in the Duwamish River Estuary and Elliott Bay, Washington**

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In 2002 and 2003 beach seining was conducted in the Duwamish River estuary and Elliott Bay to determine the migration timing of juvenile salmonids. As a result of these efforts, coded-wire-tagged (CWT) juvenile chinook salmon were captured and retained to determine hatchery origin, migration distance and migration speed. Captured CWT juvenile chinook salmon were from Duwamish River hatcheries as well as hatcheries of other river systems. The list of hatcheries includes Soos Creek, University of Washington (Portage Bay), Issaquah Creek, Gorst Creek, Grovers Creek, Minter Creek, White River, Puyallup River, Tulalip, and Wallace River hatcheries. CWT juvenile chinook salmon from as far away as 65 miles traveled at speeds of 8 miles a day to reach Elliott Bay. CWT juvenile chinook salmon did not simply migrate north to the Pacific Ocean but traveled south from their natal systems. Examining catches of CWT juvenile chinook salmon allows us to better understand their use of estuarine and nearshore habitats in the Duwamish River estuary and Elliott Bay. The next step is to determine if all juvenile salmonids species, hatchery and wild, exhibit the same migration complexity before heading to the Pacific Ocean.

**Foraging Success of Juvenile Pacific Salmon: A Comparison Among Small, Medium, and Large Estuarine Tidal Channels**

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Hydraulic-geometry relationships have been used to size tidal channel excavations in recovering marshes; however, the size of estuarine channels required to provide functional habitat for juvenile salmonids is poorly understood. This study examined if juvenile salmon feeding success is affected by estuarine channel size, and related channel size to diet composition and available prey resources. In the Snohomish River estuary in Washington State, channel trap nets were used in three different sized tidal channels, small, medium, and large, to capture juvenile Pacific salmon. Juvenile chum salmon (*Oncorhynchus keta*) and juvenile coho salmon (*O. kisutch*) were captured in the large and medium tidal channels. No juvenile salmon were captured in the small channel. Stomach fullness, a direct measure of feeding success, was compared for juvenile chum salmon captured in the large and medium tidal channels. No statistically significant difference in mean stomach fullness of juvenile chum was observed between the two different sized tidal channels. Aquatic insects and benthic crustaceans were the primary prey organisms for juvenile chum in both the large and medium channels. However, the diet composition of the juvenile chum, as indicated by the index of relative importance (IRI), differed between the two channels.

**Juvenile Salmonid Foraging Associated With Rehabilitated habitats in Two Highly Industrialized Northwest Estuaries**

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Pacific Northwest estuarine wetlands have been greatly degraded in the last century, likely contributing to the region's decline of anadromous salmon populations. However, in the highly industrialized Duwamish River estuary (Washington, USA), juvenile salmonids use available intertidal habitat, whether degraded or natural. Millions of dollars have been spent in the last decade in the Pacific Northwest on habitat restoration projects in an attempt to reestablish wetland habitat and accompanying biological functions eliminated by urbanization. In the Duwamish River, threatened Puget Sound chinook salmon (*Oncorhyncus tschawytscha*) can serve as indicators of the ecological health of the system. Because these salmon use shallow estuarine habitats, it is important to resource managers to understand whether habitat rehabilitation in the Duwamish estuary can help to recover biological function. Both direct and indirect measures of fish use of recovering habitats can help in determining the attainment of restoration goals. My research will examine indirect measures of biological function for juvenile salmon at three recently restored intertidal sites in the Duwamish estuary. The research will test if enhanced sites provide the same species composition and prey abundance as more natural sites, by comparing prey consumption and types of prey produced in these sites to reference sites in the estuary.

**Fish Distribution, Abundance, and Behavior at Nearshore Habitat Types in Puget Sound, with an Emphasis on Juvenile Salmonids**

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Shoreline modifications have altered many of the natural habitats in nearshore areas of Puget Sound. The main goal of our study was to quantify the abundance and behavior of juvenile salmonids and other fishes along various modified and undeveloped habitat types. We utilized enclosure nets and snorkel surveys to sample fishes during high tides directly along shore at five main habitat types: cobble beach, sand beach, rip-rap that only extends into the upper intertidal, deep rip-rap that extends into the subtidal, and overwater structures. Bottom-dwelling fishes exhibited the only significant density differences between cobble beach, sand beach, and rip-rap that only extended into the upper intertidal. Effects on pelagic fish were more evident when shoreline modifications extended into shallow subtidal waters. We typically found higher densities of total fish and juvenile salmonids along these modified shorelines. Behavior patterns and fish diets were altered as well, as we found larger salmonid school sizes and less input of terrestrial insect prey resources. Juvenile salmonids avoided swimming beneath overwater structures. Overall, our results indicate that shoreline modifications have the greatest effect on nearshore fish assemblages when the alterations extend from the supratidal through the subtidal zone.

**Fish Distribution and Abundance in Shallow Intertidal Habitats of Tarboo and North Dabob Bays**

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This study provides the first comprehensive documentation of the use of Tarboo-Dabob Bay by a diversity of marine and anadromous fish species. The purpose of this study was to better understand fish use, distribution, and abundance in one of the largest estuarine bays in Hood Canal during the spring and early summer seasons when salmonids were expected to be present. We used field procedures developed by the Skagit System Cooperative Research Department using an 80-foot long beach seine deployed from shore. We accessed sampling sites with a small skiff and outboard motor. Sampling was conducted once a month for a one to three day period from February 2003 through July 2003, and again in January 2004. Twenty-five sites were sampled in a diversity of shallow intertidal habitats over the survey period, with the same seven "standard" sites sampled every month. The presence and abundance of fish species changed dramatically over the survey season. Juvenile chum salmon were found along the shorelines at almost all sites as early as January and February. This early timing and the size of the chum indicate that they were probably Hood Canal summer chum salmon. Smaller fall chum were found in abundance in March and April. Most coho smolts were caught in May. Low numbers of chinook salmon juveniles were also found in Tarboo Bay from March through June. These chinook may have originated in Tarboo Creek, where small numbers of chinook spawners have been documented annually since the early 1990s. A variety of other fish species was captured, with staghorn sculpin being the most ubiquitous. The survey results document that Tarboo Bay, with its extensive and diverse saltmarsh, mudflat, coastal spit, and beach habitats, is important nursery habitat for juvenile salmon and a diversity of marine fish. Furthermore, if the identification of summer chum is correct, the results indicate that summer chum may out-migrate from their natal streams and adjacent estuarine habitat within a matter of days or weeks and spend up to three months in non-natal rearing areas. High quality non-natal estuaries like Tarboo-Dabob Bay may provide more critical habitat for summer chum survival than their smaller or impacted natal estuaries.

**Sampling Tidal Flux of Invertebrate Prey Organisms From a Constructed Estuarine Habitat Restoration Site to Assess Design Performance**

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Production of juvenile salmonid prey organisms and availability of those prey to juvenile salmon during their downstream migration are common goals for estuarine restoration site designs but are difficult to measure. This project presents the development of a flow-weighted composite sampling approach and technology to monitor juvenile salmonid prey organism numbers and composition in tidal waters flooding into and ebbing out of an urban habitat restoration site. The difference in prey numbers and composition between sequential flood and ebb tides can be used as an indication of prey production goals for the site. Results from the first year's sampling showed a narrow range in potential prey organisms and a seasonal change in potential prey between spring and summer samples. Juvenile salmon fish gut content samples also showed few prey organisms selected, but many of the individual fish stomachs were nonetheless gorged with those few organisms. The second year of sampling has commenced and some new results will be presented. Use of this sampling technique to assess prey production and availability could be applied to multiple restoration sites, with the contrasting results used to pose hypotheses about specific site designs that better support prey production and availability to migrating juvenile salmon.

**Preferential Use of Nearshore Kelp Habitats by Juvenile Salmon and Forage Fish***

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This study was conducted to quantify, for the first time, some basic parameters of juvenile salmon and forage fish use of kelp bed habitats. Findings include: Juvenile salmon and surf smelt appear to preferentially use kelp bed habitats over unvegetated habitats; Juvenile salmon appear to prefer the middle of the kelp surface canopy while surf smelt show no habitat use partitioning within the kelp bed; While prevalent in the nearshore, juvenile sand lance show no preference for kelp over unvegetated habitats; Juvenile salmon prefer shallow waters, but distance from shore and creek mouth do not appear to be factors for selecting habitats; Water depth, distance from shore, and distance from creek mouth are not selecting factors for juvenile surf smelt; Sand lance appear to select for deeper water. Together, these results indicate that juvenile salmon, surf smelt, and sand lance exhibit complex habitat partitioning within the nearshore. Further defining and understanding these habitat preferences is critical for future wise management of these species and the nearshore habitats that support them. **Presented at Puget Sound Research 2002.*