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ESTUARINE FISH SAMPLING METHODS  
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We sample estuarine habitat using three different methods (small net beach seine, large net beach seine, and fyke trap) depending on the habitat types.

Small net beach seine methods are used for sampling shallow intertidal shoreline areas of Skagit and Padilla Bays or distributary channel habitat in the Skagit tidal delta and Swinomish Channel. The areas seined are typically less than 4ft deep (1.2m) and have relatively homogeneous habitat features such as: water depth and velocity, substrate, and vegetation. Small net beach seine methodology uses an 80' (24.4m) by 6' (1.8m) by 1/8" (0.3cm) mesh knotless nylon net (Figure 1). The net is set in "round haul" fashion by fixing one end of the net on the beach while the other end is deployed by wading the net "upstream" against the water current using a floating tote, and then returning to the shoreline in a 1/2 circle. Both ends of the net are then retrieved yielding a catch. We typically conduct three sets per site.

Large net beach seine methods are used for sampling the intertidal-subtidal fringe of the Skagit and Padilla Bays. These areas are typically deeper than the areas seined by small net beach seine, ranging from 6-15ft (1.8-4.6m) requiring a longer and deeper net. Large net beach seine methodology uses a 120' (36.6m) by 12' (3.7m) by 1/8" (0.3cm) mesh knotless nylon net where one end of the net is fixed on the beach while the other end is set by boat across the current at an approximate distance of 60% of the net's length (Figure 2). After the set has been held open against the tidal current for a period of about 4 minutes, the boat end is brought to the shoreline edge and both ends are retrieved yielding a catch in the net's bunt section. We typically conduct three sets per site.

Fyke trap methods are used for sampling blind tidal channel habitat in the Skagit tidal delta, Swinomish Channel corridor, and southern Padilla Bay. Fyke trap methodology uses nets constructed of 1/8" (0.3cm) mesh knotless nylon with a 2' (0.6m) by 9' (2.7m) diameter cone sewn into the net to collect fish draining out of the blind channel site (Figure 3). Overall net dimensions (length and depth) are variable depending on the site's cross-sectional channel dimensions. All nets are sized to completely block fish access at high tide. The net is set across the blind channel site at high tide and "fished" through the ebb tide yielding a catch. The juvenile chinook catch is adjusted by a trap recovery efficiency (RE) estimate that is derived from mark-recapture experiments using a known number of marked fish released upstream of the trap at high tide. RE is usually related to

hydraulic characteristics unique to the site (e.g., change in water surface elevation during trapping, or water surface elevation at the end of trapping). Multiple RE tests (several times per season) at each site are used to develop a regression model to convert the “raw” juvenile chinook catch to an estimated population within the habitat upstream of the fyke trap on any sampling day.

Data collected for each beach seine set include:

- Time and date of set
- Tidal stage (ebb, flood, high tide slack, low tide slack)
- Water surface area seined
- Length of time the set is held open (large net only)
- Surface and bottom water temperature of area seined using YSI meter
- Surface and bottom salinity of area seined using YSI meter
- Maximum depth of area seined
- Average surface water velocity (small net only) using a flow meter
- Substrate of area seined following the definitions shown in Table 1 (small net only, unless substrate type is uniform for large net area)
- Vegetation of area seined following the definitions shown in Table 2 (small net only, unless vegetation type is uniform for large net area)
- Complete fish catch records by species following the coding shown in Table 3
- Sub-sample of individual juvenile chinook lengths and weights (following mark coding shown in Table 4)
- Sub-sample of individual lengths on all other fish species (following mark coding shown in Table 4)

Data collected for each fyke trap set include:

- Time at start and end of trapping
- Water surface elevation at start and end of trapping
- Surface and bottom water temperature at start and end of trapping
- Surface and bottom salinity at start and end of trapping
- Complete fish catch records by species following the coding shown in Table 3
- Sub-sample of individual juvenile chinook lengths and weights (following mark coding shown in Table 4)
- Sub-sample of individual lengths on all other fish species (following mark coding shown in Table 4)

## REFERENCES

Dethier, M. N.. 1990. A marine and estuarine habitat classification system for Washington State. Washington Natural Heritage Program, Washington Department of Natural Resources. Olympia WA. 56 pages.

Table 1. Definitions of substrate types modified from Dethier (1990).

<b>Substrate Type</b>	<b>Definition</b>
Bedrock	75% of the surface is covered by bedrock, commonly forming bluffs and headlands.
Boulder	75% of the surface is covered by boulders (>256mm).
Cobble	75% of the surface is covered by clasts 64 to 256mm in diameter.
Gravel	75% of the surface is covered by clasts 4 to 64mm in diameter.
Mixed Coarse	No one size comprises > 75% of surface area. Cobbles and boulders are > 6%.
Fines With Gravel	No one clast size comprises more than 75% of the surface area. Cobbles and boulders make up > 6% of the surface area; Coarse sediments combined make up < 55%. Rich with epibenthic fauna.
Sand	More than 75% of the surface area consists of sand 0.06 to 4 mm in diameter.
Mixed Fines	Fine sand, silt, and clay comprise 75% of the surface area, with no one size class being dominant. May contain gravel (<15%). Cobbles and boulders make up < 6%. Walkable.
Mud	Silt and clay comprise 75% of the surface area. Often anaerobic, with high organics content. Tends to pool water on the surface and be un-walkable.
Artificial	Anthropogenic structures replacing natural substrate within the intertidal zone, including boat ramps, jetties, fill, and pilings.

Table 2. Definitions of vegetation types from Dethier (1990).

<b>Vegetation Type</b>	<b>Definition</b>
Eelgrass	More than 75% of vegetative cover is <i>Zoster marina</i> , <i>Zoster japonica</i> , <i>Phyllospadix</i> spp., <i>Ruppia maratima</i> .
Brown Algae	More than 75% of vegetative cover is brown algae belonging to taxonomic group Division Phaeophyta.
Green Algae	More than 75% of the vegetative cover is algae belonging to the taxonomic group Division Chlorophyta.
Red Algae	More than 75% of the vegetative cover is algae belonging to the taxonomic group Division Rhodophyta.
Mixed Algae	Areas in which red, green or brown algae coexist, no single type occupies more than 75% of vegetated cover.
Kelp	More than 75% of the vegetative cover is large brown algae (Order Laminariales).
Salt Marsh	More than 75% of the vegetative cover is emergent wetland plants.
Spit-Berm	More than 75% of the vegetative cover is plants such as dune grass, gumweed, and yarrow, which generally occur above the highest tides, but still receive salt influence.
Unvegetated	More than 75% of the total surface area is unvegetated.

Table 3. Fish Species/age classes or groupings used to record catch data.

Fish Species or grouping	Species Abbreviation	Comments
Agonus acipenserinus	STUR POACHER	
Ammodytes hexapterus adult body form	LANCE a	Adult body form and color, > 60mm total length
Ammodytes hexapterus post larval	LANCE pl	Translucent, length < 60 mm total length
Artedius fenestralis	PADD SCULP	
Cancer magister <6.5"	DUNGI small	Only macro invert we count
Cancer magister >6.5"	DUNGI legal	Only macro invert we count
Catostomus sp.	SUCKER	
Clupea harangus adult body form	HERR a	Adult body form and color, > 40mm total length
Clupea harangus post larval	HERR pl	Translucent, length < 40 mm total length
Cottus aleuticus	COAST SCULP	
Cottus asper	PRICKLY SCULP	
Couesius plumbeus	L CHUB	
Cymatogaster aggregata	SHINER	
Embiotoca lateralis	STRIPED	
Enophrys bison	BUFF	
freshwater Cottid	FW SCULP	This group consists mostly of Coastrange and Prickly sculpins caught in tidal delta sites; they never include Staghorn, Great or Buffalo Sculpins
Gasterosteus aculeatus	3 STICK	
Hexagrammos sp.	O/U GREENLING	
Hypomesus pretiosus adult body form	SMELT a	Adult body form and color, > 60mm total length
Hypomesuspretiosus post larval	SMELT pl	Translucent, length < 60 mm total length
Lamprey	LAMP	
Lepomis gibbosus	PUMPKN	
Lepomis macrochirus	BLUEGILL	
Leptocottus armatus	STAG	
Microgadus proximus	TOMCOD	
Micropterus sp.	BASS	
Mylocheilus caurinus	PEAMTH	
Myoxocephalus polyacanthocephalus	GRT SCULP	
Oncorhynchus clarki adult	CT adult	**
Oncorhynchus clarki age 0+	CT 0+	**
Oncorhynchus clarki age 1+>	CT 1+>	**
Oncorhynchus gorbuscha 0+	PK 0+	**
Oncorhynchus keta age 0+	CH 0+	**
Oncorhynchus kisutch age 0+	CO 0+	**
Oncorhynchus kisutch age 1+ external mark	CO 1+ em	

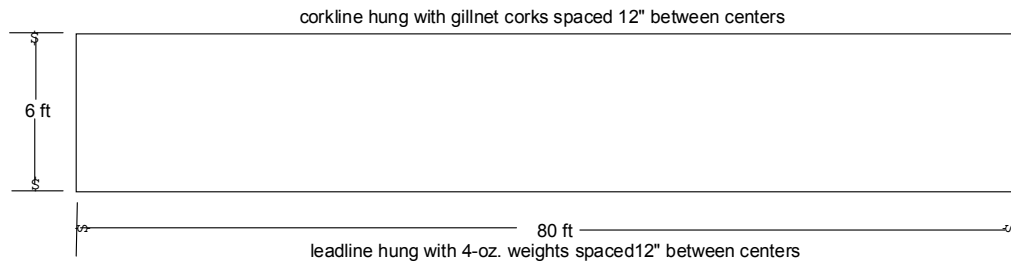
Oncorynchus kisutch age 1+ no external mark	CO 1+ nem	
Oncorynchus kisutch age 1+ cwt only	CO 1+ ucwt	
Oncorynchus mykiss 0+	RB 0+	**
Oncorynchus mykiss adult external mark	STHD em	
Oncorynchus mykiss adult no external mark	STHD nem	
Oncorynchus mykiss age 1+ or > external mark	RB 1+> em	
Oncorynchus mykiss age 1+ or > no external mark	RB 1+> nem	
Oncorynchus mykiss or clarki age 0+	TROUT 0+	**
Oncorynchus nerka age 0+	SOCK 0+	**
Oncorynchus nerka age 1+> external mark	SOCK 1+> em	
Oncorynchus nerka age 1+> no external mark	SOCK 1+> nem	
Oncorynchus tshawytscha age 0+ cwt only	CK 0+ ucwt	
Oncorynchus tshawytscha age 0+ external mark	CK 0+ em	
Oncorynchus tshawytscha age 0+ no external mark	CK 0+ nem	
Oncorynchus tshawytscha age 1+ cwt only	CK 1+ ucwt	
Oncorynchus tshawytscha age 1+ external mark	CK 1+ em	
Oncorynchus tshawytscha age 1+ no external mark	CK 1+ nem	
Ophiodon elongatus	LINGCOD	
Other or unknown Agonid	O/U POACHER	
Other or unknown Chub	O/U CHUB	
Other or unknown Cottid	O/U SCULP	
Other or unknown flatfish	O/U FLAT	
Other or unknown flatfish post larval	O/U FLAT pl	Metamorphosed flatfish < 40mm total length
Other or unknown gunnels and pricklebacks	GUNNL/PRICK	
Other or unknown Scorpaenids	ROCKFISH	
Pacific Spiny Lumpsucker	LUMP	
Parophrys vetulus	ENG SOLE	
Perca flavescens	Y PERCH	
Platichthys stellatus	STAR	
Prosopium williamsoni	WHITEFISH	
Racochilus vacca	PILE PERCH	
Rhinichthys sp.	DACE	
Salvelinus sp. (malma or confluentus) all ages	DV/BT	

\*\* We don't look for external marks on these species/age classes and assume they are all wild and unmarked. In the future we may need to treat these fish the same as chinook and coho.

Table 4. Mark codes used to record data about individual fish (e.g., length, weight, otolith vial number, etc). Mark Codes apply all chinook age classes, coho yearlings or older, steelhead smolts or older.

Mark Code	Definition
um	no external mark <u>and</u> no internal mark
adnb	adipose clipped, no coded wire tag present
adcw	adipose clipped with coded wire tag present
ucwt	no external mark, but coded wire tagged present
adsd	adipose clipped with stubbed dorsal fin (steelhead only)
ad	adipose fin clipped, but the fish was not tested for internal mark presence at the time of sampling (not wanted for coded wire tag detection) so we don't know whether the sample is "cw" or "nb"
Other	other external marks observed, but not accounted for in our sampling plan (e.g., paint injection, freeze brand)

## A - Small Net Beach Seine



B

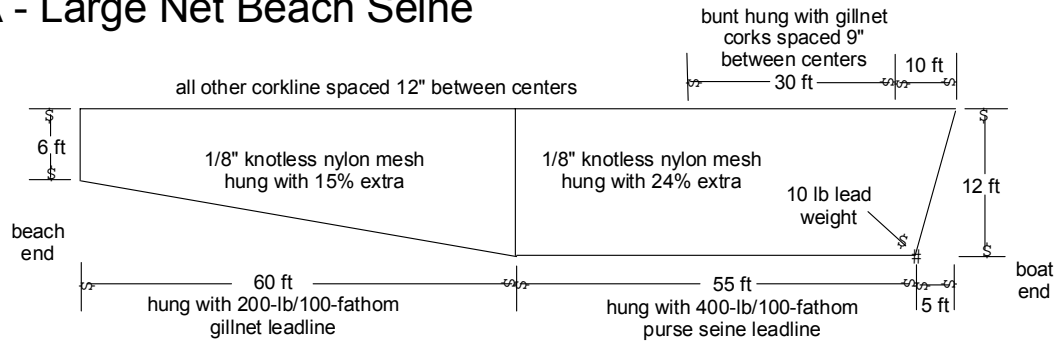


C



Figure 1. Small net beach seine methodology: A – design of net (not drawn to scale), B – setting net out of tote on shallow intertidal beach, C – beginning to haul net in distributary channel.

## A - Large Net Beach Seine



B



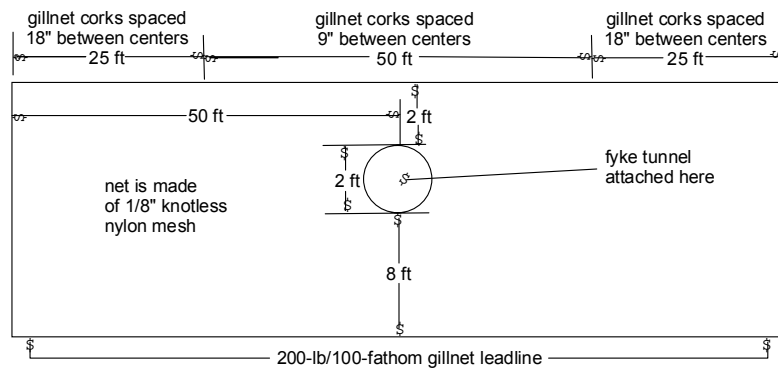
C



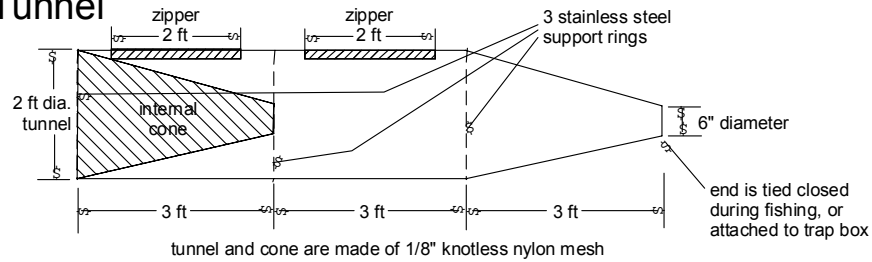
Figure 2. Large net beach seine methodology: A – design of net (not drawn to scale), B – towing on net, C – hauling net.



## A - Fyke Net



## B - Fyke Tunnel



C



D

Figure 3. Fyke trap methodology: A – design of net (not drawn to scale), B – design of tunnel (not drawn to scale), C – fishing during ebb tide, D – net at low tide (end of fishing).