Bandon Marsh National Wildlife Refuge
Interim Monitoring

Fall 2010 – Spring 2011

Brook P. Silver, J. Michael Hudson, Sam Lohr, and Timothy A. Whitesel

U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office
Vancouver, WA

March 2012

Introduction

The loss of tidal wetlands, primarily through dike construction and draining, has been identified as a major factor contributing to the decline of fish populations and overall productivity of estuaries (Simenstad et al. 1982, 1992; Myers et al. 1998; Bottom et al. 2004). Bandon Marsh National Wildlife Refuge (BMNWR) is in the process of conducting a large-scale tidal marsh restoration project on the Ni-les'tun Unit (Unit), within the Coquille River estuary (Figure 1). This project is designed to restore approximately 418 acres of important tidal wetlands. When construction is completed in fall 2011, it will constitute the largest tidal marsh restoration project in Oregon's history (USFWS and FHA 2009).

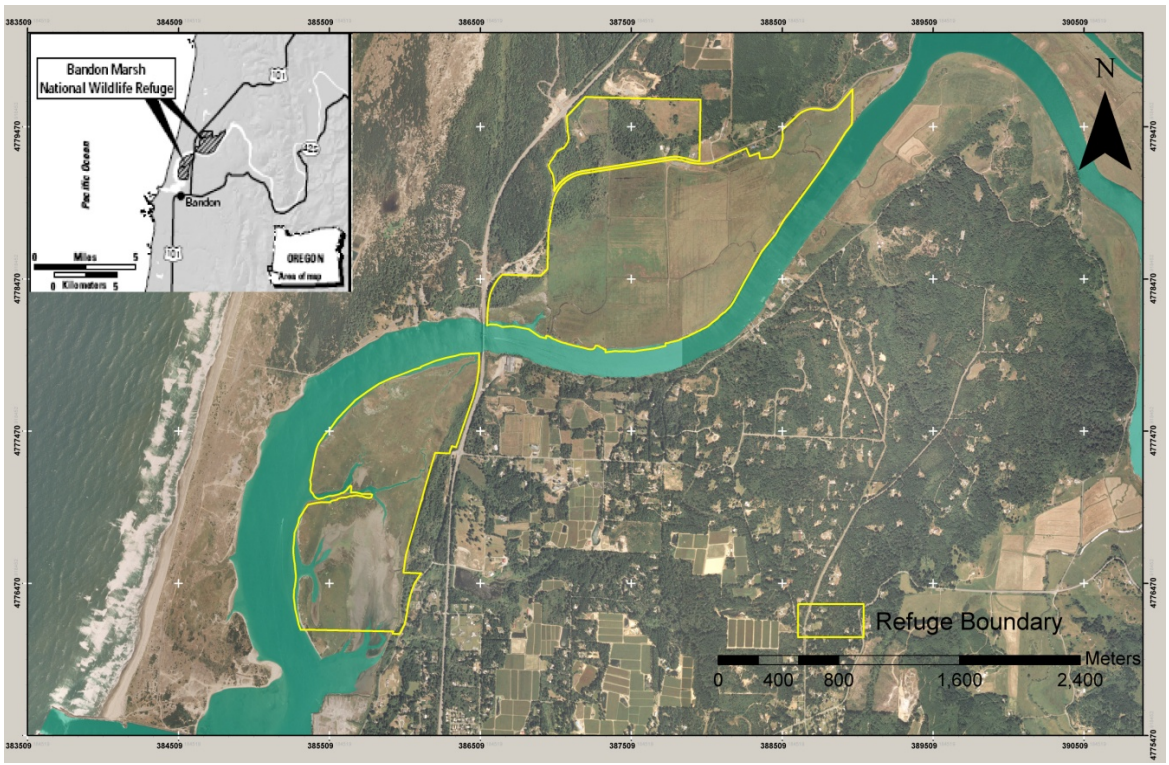


Figure 1. Bandon Marsh National Wildlife Refuge area of study

Restoration actions include dike and tide gate removals, culvert replacements, channel and wetland construction. Utility and infrastructure portions of the restoration include the undergrounding of a powerline that crosses the Unit and raising of a county road (North Bank Lane) that will be effected by the restoration. Phase one of the construction began in 2009, with phase two implemented in 2010, and the final phase will be completed in 2011. The complete restoration and associated tasks has an estimated budget of over $9.5 million, and includes more than 35 partners over a ten year period. Similar restoration efforts occurred in 2007 within the Nestucca Bay NWR where 0.7-miles of dike along the Little Nestucca River were removed restoring 3,965 linear feet of historic tidal channels (USFWS *unpublished data*, Little Nestucca River Restoration, NFWF Project #2006-0175-003).

The short-term goals of the restoration project are to restore tidal wetlands by creating physical conditions allowing unrestricted tidal inundation and fish access to the Unit (USFWS and FHA 2009). The long-term goals are to improve overall quantity and quality of tidal wetlands and estuarine conditions in the lower Coquille River watershed, which provide foraging and rearing habitats for a variety of aquatic species, including native trout and other salmonids (USFWS and FHA 2009). Since greater than 97% of the tidal marshes and swamps in the Coquille River estuary were estimated to have been lost between 1870-1970 (i.e., 14,350 v. 380 acres), the restoration project could provide a substantial contribution to habitat restoration in the basin (Coquille Watershed Association 2003).

The Unit consists of floodplain lowlands encompassing portions of three drainages, Fahys, Overlook, and Redd creeks. Prior to the restoration project, about 25 km of drainage ditches were constructed by past landowners and over 2.5 km of dikes and three tide gates impeded connectivity of the Unit with the estuary (USFWS and FHA 2009). A tide gate designed to provide better fish passage was installed on the Fahys Creek outlet in 2003. Recent restoration actions eliminated the drainage ditches and dikes, providing a dendritic network of tidal channels for fish and wildlife.

The monitoring project is focused on changes in the aquatic species community before and after the restoration construction occurring in 2010 and 2011. For the purposes of this report, construction is referred to as a specific action being implemented to achieve restoration of the tidal marsh, which has an unknown timeframe. Objectives of the monitoring project are as follows: 1. Describe and compare fish species community within and among restoration areas and reference areas before and after construction; 2. Describe and compare fish species distribution within and among restoration areas and reference areas before and after construction; 3. Describe and compare fish species relative abundance within and among restoration areas and reference areas before and after construction; 4. Collect invertebrates to archive from restoration areas and reference areas before and after construction.

Methods

Construction Schedule

This sampling period represents the interim period of construction in the Bandon Marsh restoration project. Pre-construction monitoring occurred 2007-2010 (Hudson et al. 2010). Construction to restore the tidal marsh to a more natural flood regime began in summer 2010. It will be completed in summer 2011. The interim period of construction is between these two summers.

Fish Sampling

Fahys Creek

Stream sections within Fahys Creek were determined based on habitat characteristics before restoration began (Hudson et al. 2010). All sections within Fahys Creek are located within the previously diked areas of the refuge (Figure 2). For Sections F1-F4, we used a system of two hoop nets, placed cod end to cod end with wings, providing the ability to block a channel during a sampling period (methods described in Hudson et al. 2010). Random sample sites were identified across the four lower sections (Hudson et al. 2010). Four sites (F2-15, F3-24, F3-27, and F4-29) were repositioned to accommodate the restored channel (Figure 2).

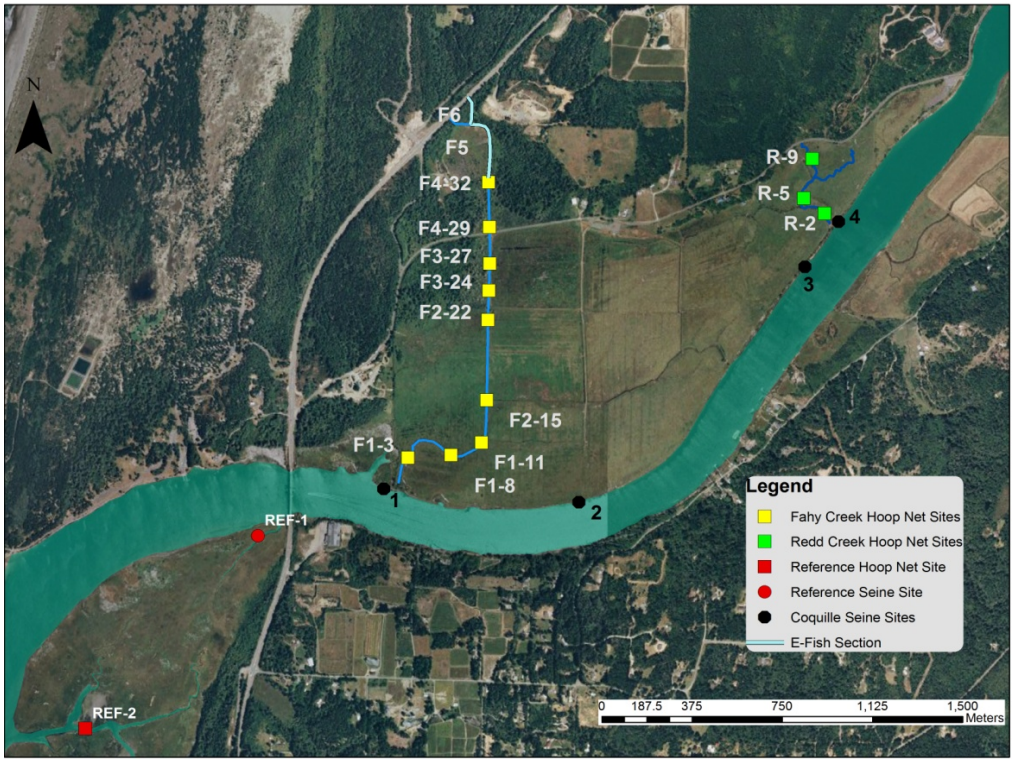
Fishing occurred overnight for at least eighteen hours. Net sizes used were as follows: 0.76 m diameter, with 4 hoops, and wing size 0.61 m x 1.83 m, and 0.91 m diameter, with 5 hoops, and wing size 0.91 m x 3.05 m. All nets were 6.35 mm mesh. Net sizes deployed at each site were selected to fit the channel size and fish the water depth at the site. The time of deployment and removal of the nets were recorded as well as the size of the net used. Water temperature, conductivity, and salinity measurements were taken at each site. Each individual net at a site was named by the site number and location relative to its partner net, such as North or South.

Table 1. Interim restoration sample dates.

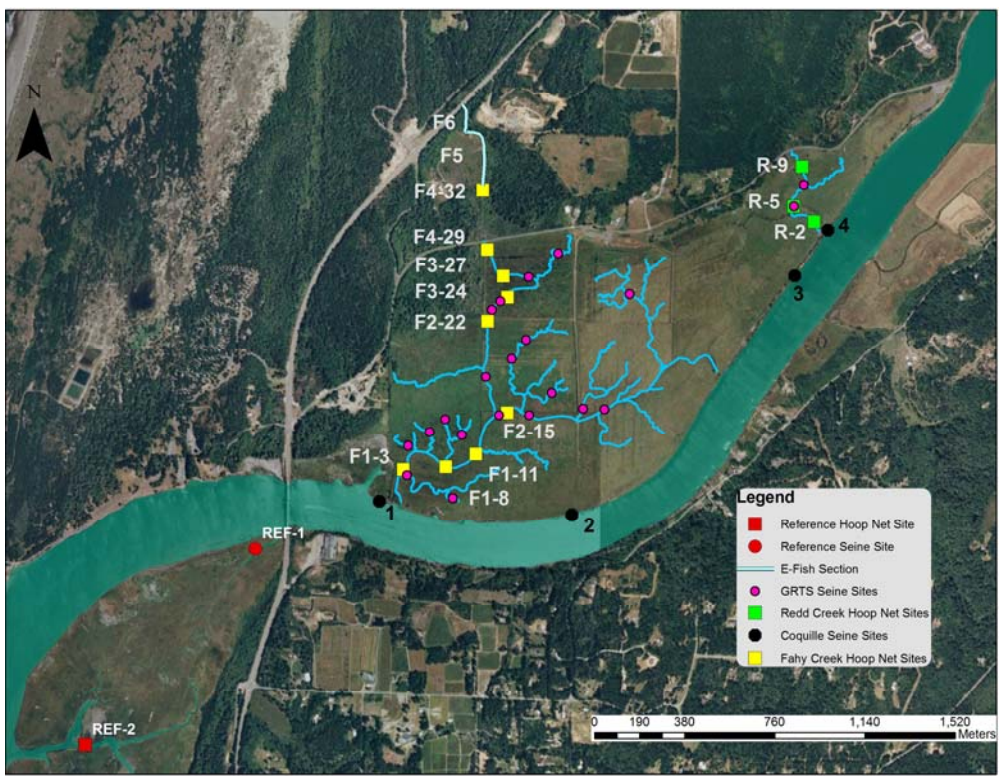
Year	Season	Sample Dates	
2010	Fall	October	18-21
2011	Winter	March	7-9
	Spring	May	1-5
	Summer	June	27-30

Sampling occurred once a season from fall 2010 through summer 2011 (Table 1). Fish captured in each net were visually identified and measured for fork length (mm). Weight (g) was collected on all salmonid species. Measurements were only taken from the first 20 individuals of a species pulled from the bucket containing the net sample. Length-frequency was evaluated for salmonids to document size structure of the measured fish. Start and stop times of net deployment were recorded each day. All fish were released at the site of capture immediately following workup.

Electrofishing was conducted in sections F5 and F6 of Fahys Creek. Electrofishing was completed with a Smith Root LR-24 electrofisher. Sampling was conducted moving upstream involving two netters working with one electrofisher. Electrofisher settings, determined for the environmental conditions (i.e., depth, conductivity, temperature), were 24 Hz, 15 % Duty Cycle, and 350 Volts. Electrofishing was completed once in the fall and once in the spring. Information collected from captured fish followed that previously described for fish captured in hoop nets.



a)



b)

Figure 2. Bandon Refuge hoop net, seine, and electrofishing sample sites a) pre-construction, b) post-construction. Tide gates are located at the outlets of Fahys (western drainage) and Redd (eastern drainage) creeks. North Bank Lane is the road that runs along northern perimeter of the marsh, just to the north of sites F4-29 and R-9 in Figure 2b. Hwy 101 is road with bridge over Coquille River (the large stream flowing from east to west).

Redd Creek

Redd Creek sampling occurred between the tide gate and below North Bank Lane (Figure 2). Random sample sites were identified (methods described in Hudson et al. 2010). Site R-9 was moved to accommodate the new channel (Figure 2). As described for Fahys Creek, hoop nets were the only sample approach applied to Redd Creek. Sampling occurred on the same schedule as Fahys Creek and data collected from captured fish followed that previously described.

Reference Areas

Two reference areas were sampled in the Bandon Marsh Unit, a separate, non-diked tidal marsh with functioning natural channels on the west side of the refuge. One random sample site, representing a 50 m reach, was identified per reference area. Reference-1 (REF-1) is located west of Hwy 101 south of the Coquille River, and Reference-2 (REF-2) is located southwest of REF-1 (Figure 2). An unbagged, 15.2 m long, 1.8 m deep, 0.6 cm mesh seine with float and lead lines was used to collect fish at REF-1. One end of the net was held at shore while the other was pulled out in a wide arc and towed back to the bank, the drag lines were then pulled to shore simultaneously. Area sampled was estimated by distance from the water's edge and distance along the water's edge the net was pulled through. The same hoop net methodology described for Fahys Creek was used for REF-2. Hoop net and seine sampling took place at the same schedule as Fahys Creek and data collected from captured fish followed that previously described.

Mainstem Coquille

To gather information on fish community in the Coquille River, four beach seine sites were sampled on the mainstem, adjacent to BMNWR (Figure 2). Four sample sites were chosen on the north bank of the Coquille River (Hudson et al. 2010). Seining was conducted as described for the reference areas. Sampling occurred on the same schedule as Fahys Creek.

GRTS Sites

To analyze the fish community in newly restored channels throughout the refuge, sample sites were determined using a random, spatially-balanced design (Generalized Random-Tesselation Stratified, GRTS, design; Stevens and Olsen 2004). This design identifies a spatially well-distributed probability sample of sites that are randomly ordered. Each site represents a 50 m reach in this case. The first 8 ordered reaches (i.e., 1-8) were sampled beginning in fall 2010. To account for seasonal variation within and among sites while maintaining the spatially-balanced design, the last four ordered reaches from the previous trip (e.g., 5-8 in the example above) and the next four ordered reaches (e.g., 9-12) were sampled on each subsequent trip. This approach was maintained except for the final trip, when one of the previous trip's reaches was not sampled (dry), and five new reaches were sampled (Table 2). Eight reaches were identified for sampling each trip to provide a well-distributed sample throughout the study area while accounting for logistical challenges of completing the sampling. A total of 21 different reaches were sampled over the four trips conducted.

Due to the highly tidal and ephemeral nature of the channels, to prevent fish stranding, we seined using a 0.06 cm mesh, 5 m bagged seine (as opposed to hoop nets). A block net was set 25 m upstream of each site. The seine was pulled upstream to the block net where all fish collected in the bag were sampled. Sampling occurred on the same schedule as Fahys Creek.

Table 2. Ordered GRTS reaches sampled during interim monitoring.

Sample Trip	Ordered Reaches Sampled
Fall 2010	2, 3, 6, 7, 8, 9, 10, 11
Winter 2011	8, 9, 10, 11, 12, 13, 14, 15
Spring 2011	12, 13, 14, 15, 16, 17, 18, 19
Summer 2011	16, 18, 19, 20, 21, 22, 24, 28

Biodiversity

All species encountered within the Unit restoration area through the period of monitoring were ecologically classified according to average relative species abundance and percent frequency of occurrence (González-Acosta 1998, González-Acosta et al. 2005). This method of classification is based on Olmstead-Tukey's test (Sokal and Rohlf 1969) and allows an ecological and quantitative classification of the species in each area (González-Acosta et al. 2005). The analysis results in the division of species present into four ecological categories (dominant, common, occasional, and rare) represented by quadrants of a scatter plot that is divided by two axes identifying the mean frequency of occurrence and mean relative abundance for a specific area. Ecological classification was conducted for six distinct areas of the study area: Upper Fahys, Lower Fahys, Redd, Reference Areas, Mainstem Coquille, and GRTS sites.

Biodiversity was quantified and reported in terms of alpha diversity. Alpha diversity (Simpson Diversity Index) is an index of species richness, or number of species within an area or season. Alpha diversity was compared using ANOVA within a section (Fahys Sections 1-6, Redd, Reference, Mainstem, and GRTS Sites) among seasons. Biodiversity analyses were conducted on data collected by electrofishing (Upper Fahys), hoop net (Lower Fahys, Redd, and Reference Site), and seine (Mainstem Coquille, Reference Site, and GRTS Sites). Capture efficiency for a given species can vary depending on method of capture and habitat and influence this analysis. However, methods were selected for respective habitats to maximize capture efficiency, and facilitate comparison of changes in alpha diversity among areas. Lapointe et al. (2006) found that seines produced significantly higher richness and diversity than hoop nets and electrofishing in shallow offshore waters of large rivers (i.e., Mainstem Coquille). Clark et al. (2007) found that fyke nets produced significantly higher richness and diversity than seines when sampling littoral fish communities in floodplain lakes (i.e., Lower Fahys, Redd, and the Reference Site). In addition, Lapointe et al. (2006) also found that samples obtained by hoop nets and electrofishing were not significantly different in richness and diversity. If the fish community consists of species with similar catch vulnerabilities, a seine is suitable to measure the population (Parsely 1989). These finding suggest the methods we selected provide useful measures for comparison of frequency of occurrence (ecological classification) and species richness (alpha diversity). We recognize that potential differences in capture efficiency among methods also affect abundance data (i.e., ecological classification). However, capture methods were selected to maximize capture efficiency in each habitat.

Macro-invertebrate Sampling

Fahys Creek

Invertebrate sampling reaches were located on either end and between each of the hoop net sites for Sections F1-F4. Sections F5 and F6 were combined to represent one reach. There were a total of 11 reaches sampled. Collection of water column and surface invertebrates was conducted using a drift net design as described in Hudson et al. 2010. Set net sites were

deployed for 30 minute periods. Because flow was too low to gather readings on the mechanical flow meter, an orange and stopwatch were used to calculate approximate flow (Orth 1983). Sampling depth of the net depended on the water depth at the site. Attempts were made to capture as much of the water column near the surface as possible while trying to avoid scraping or disturbing any of the substrate along the bottom.

Collected invertebrate specimens were transferred and stored in 500 ml bottles filled with isopropyl alcohol. All samples were preserved. Invertebrate sampling occurred during the spring of 2011.

Results

Fish Sampling

Fahys Creek

Native fish species captured within Fahys Creek using hoop nets included: CCT, CHN, COHO, three-spined stickleback (*Gasterostreus aculeatus*) (SKB), and sculpin species (*Cottidae*) (SCP) (Appendix I). Non-native fish species found included brown bullhead (*Ameiurus nebulosus*) (BBH), and mosquito fish (*Gambusia affinis*) (MQF). Amphibian species found included rough skinned newts (*Taricha granulose*) (RSN), red-legged frogs (*Rana aurora*) (RLF), bull frogs (*Rana catesbeiana*) (BF), and northwestern salamanders (*Ambystoma gracile*) (NWS).

Electrofishing effort totaled 1,319 seconds (sec) during fall 2010 and 1,821 sec during spring 2011. Native fish species captured in reaches F5 and F6 included CCT, COHO, SKB, and SCP (Table 3). SCP, SKB, and amphibian species were not targeted. No non-native species were captured

Length distributions indicated multiple size classes of CCT, COHO and CHN, in Fahys Creek (Figures 3 and 4). Larger CCT were found in reaches F1-F4 while reaches F5-F6 supported relatively small fish. Conversely, smaller COHO were found only in reaches F1-F4.

Table 3. Electrofishing capture results: CCT (coastal cutthroat trout), coho salmon, and trout fry.

Date	Section	CCT	COHO	TF
10/18/2010	F5	5	4	0
	F6	20	0	2
5/1/2011	F5	19	1	1
	F6	9	0	0

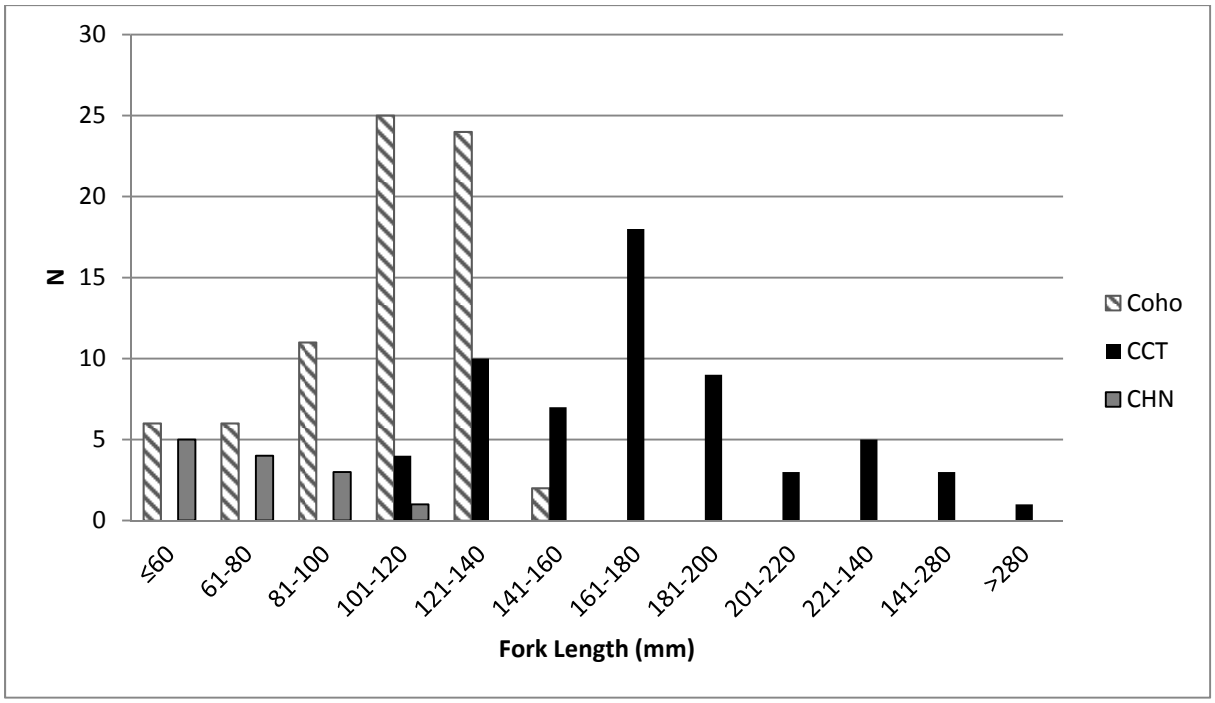


Figure 3. Length distribution of salmonid species captured across all hoop-netting efforts in sections F1-F4 in Fahys Creek.

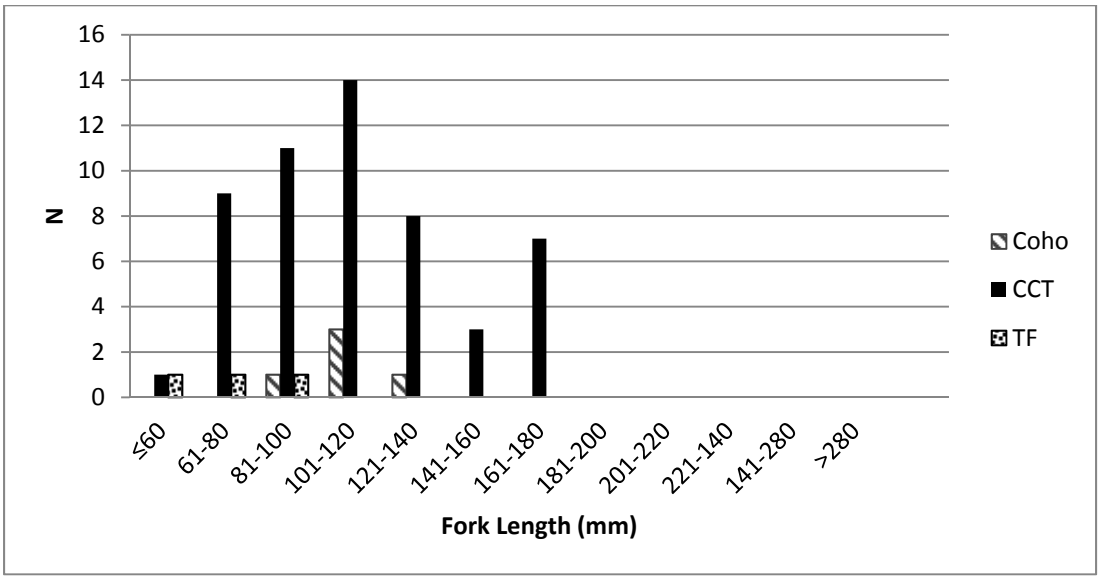


Figure 4. Length distribution of salmonid species captured across all electrofishing efforts in sections F5-F6 of Fahys Creek.

Redd Creek

Native fish species captured on Redd Creek using hoop nets included: CCT, CHN, COHO, SKB, and SCP (Appendix I). Non-native fish species found included BBH and MQF. Amphibian species found included RLF and RSN. Coho salmon and CCT exhibited a similar length distributions in Redd Creek as they did in Fahys Creek (Figure 5), with a relatively high proportion of COHO in the ≤ 60 mm size range. Only CHN shorter than 60 mm were captured in Redd Creek.

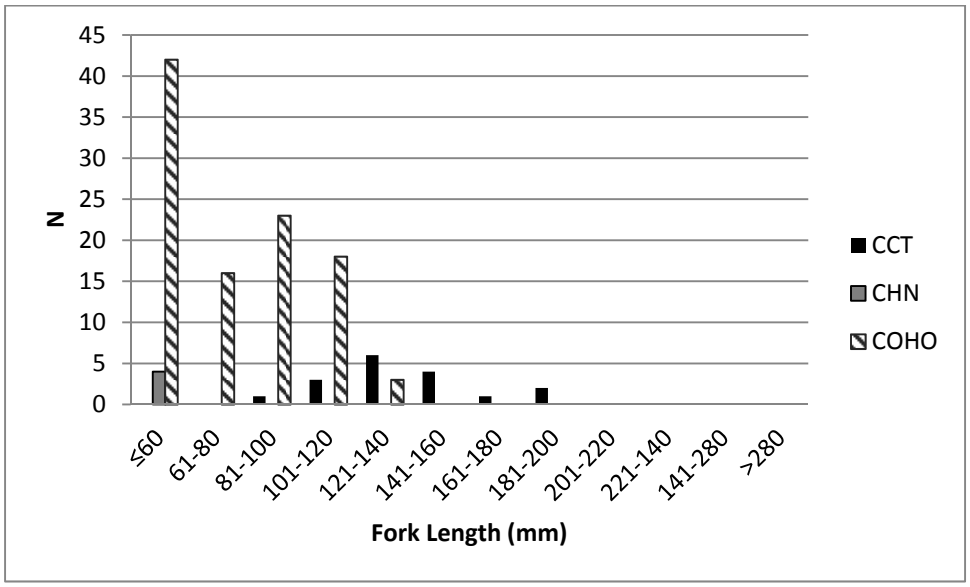


Figure 5. Length distribution of salmonid species captured across all hoop netting efforts in Redd Creek.

Reference Areas

Four native species have been captured while seining at REF-1: CHN, SCP, SKB, and shiner perch (*Cymatogaster aggregata*) (SP). Native species captured in REF-2 using hoop nets included: CHN, COHO, SCP, and SKB (Appendix I, II). Catch rates were high enough to look at length distribution for only COHO captured in the REF-2 hoop net site, which was similar to Redd Creek COHO size structure (Figure 6).

Species catch rates varied for each sampling trip (Appendix I, II). No non-native species have been captured thus far. Shrimp, crabs (of at least two different species), and jellyfish were captured at both REF-1 and REF-2.

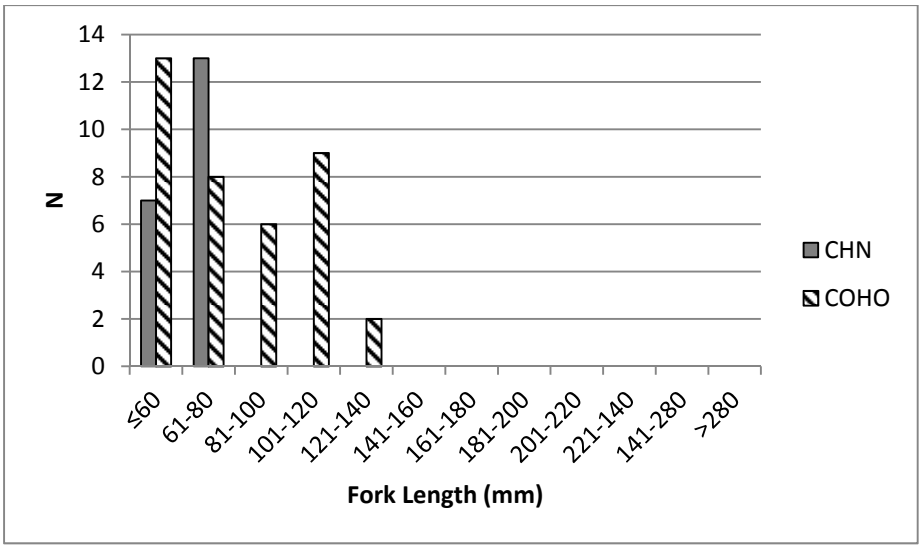


Figure 6. Length/frequencies of salmonid species captured across all sample efforts in Reference Site 2.

Mainstem Coquille

Native species captured include: CHN, COHO, SCP, SP, gunnel fish (*Pholidae*) (GUN), surf smelt (*Hypomesus pretlosus*) (SS), and starry flounder (*Platichthys stellatus*) (STF). No non-native species have been captured (Appendix II). Shrimp, jellyfish, and crabs were also captured in the mainstem Coquille River.

Catch rates were high enough to look at length distribution for only COHO and CHN. COHO exhibited a similarly shaped size structure as Redd Creek, CHN were similarly structured as COHO but at a higher relative catch rate (Figure 7).

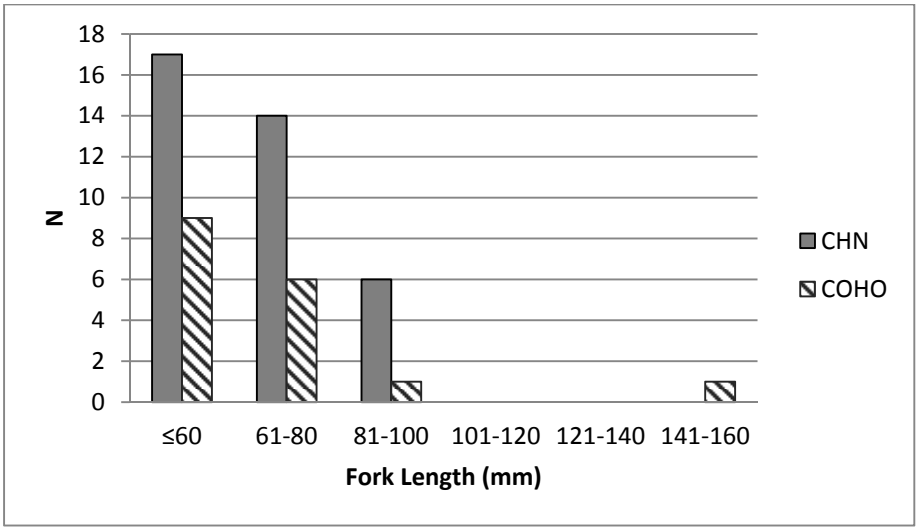


Figure 7. Length/frequencies of salmonid species captured across all seine efforts in the mainstem Coquille River.

GRTS Sites

Native fish species captured throughout the refuge using a seine included CCT, COHO, SKB, and SCP. Non-native fish species found included MQF. Amphibian species found included RLF, RSN, and BF (Appendix II). Catch rates were only high enough to conduct length distribution on COHO, which exhibited a similarly shaped size structure as Redd Creek (Figure 8).

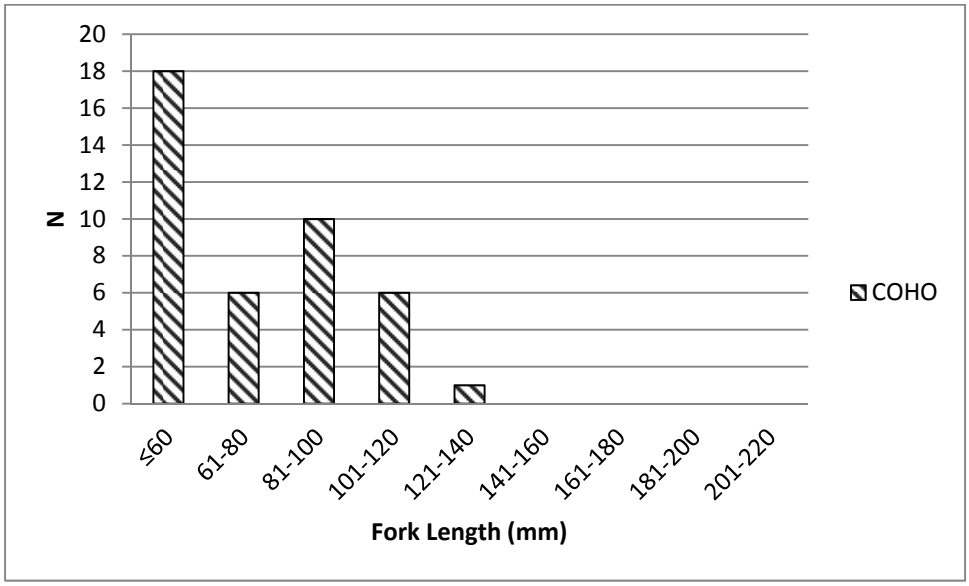


Figure 8. Length/frequencies of salmonid species captured across all GRTS seine efforts in the refuge.

Biodiversity

Ecological classification indicated differences in occurrence and relative abundance among the five distinct areas of the study area (Figure 9). SKB and SCP were most frequently classified dominant across the areas. One exception was Upper Fahys Creek where CCT were dominant. This part of the stream is above tidal influence during most times of the year. Therefore, we did not expect to see as many SKB and SCP. CCT and COHO were classified common in both Upper and Lower Fahys Creek and dominant in Redd Creek. CCT were classified as rare in the GRTS sites whereas they were common in Lower Fahys Creek and Redd Creek. COHO were common in the GRTS Sites.

CCT were not present in the two remaining areas (Reference Areas and Mainstem Coquille River). Shiner perch were classified rare in Mainstem Coquille River and Reference Areas and not present in Upper Fahys, Lower Fahys, Redd creek, or GRTS sites. Nonnative species (BBH and MQF) were rare and only present behind the dike in Fahys and Redd creeks.

Alpha diversity (Simpson Diversity Index) is documented for all sections and seasons on an index of 0 to1, where 0 represents a truly homogenous community and 1 represents a truly heterogeneous community. Alpha diversity ranged from 0.000 to 0.833 (Table 4). There were no significant differences in alpha diversity within a section among seasons since 2007 (Figure 10; Hudson et al. 2010). Patterns in diversity among seasons included: The highest alpha diversity levels were in Fahys Creek in the spring and fall; alpha diversity was generally higher in Fahys and Redd creeks than in the reference areas or the GRTS sites; the lowest overall alpha diversity levels were in the fall and winter.

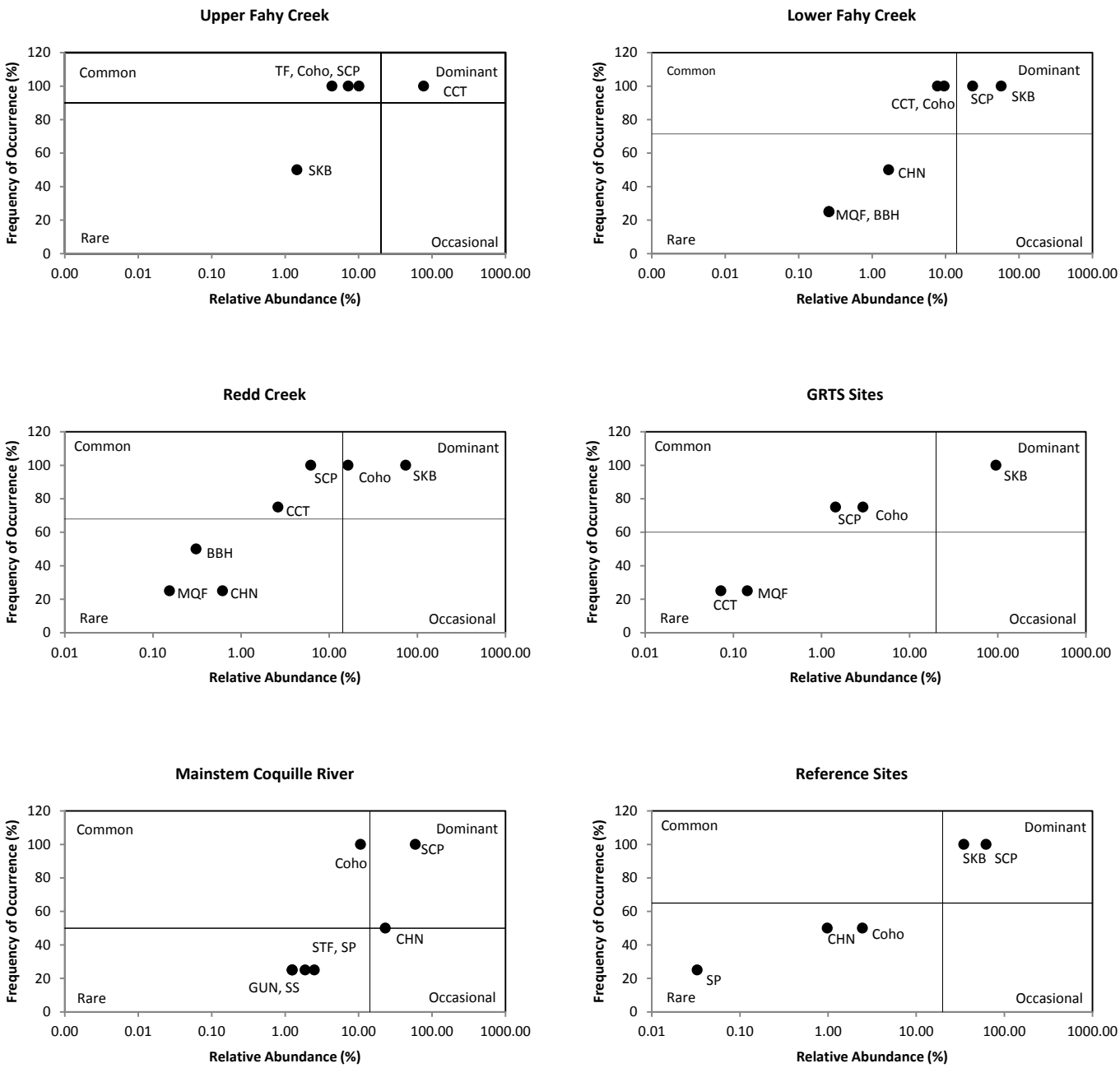
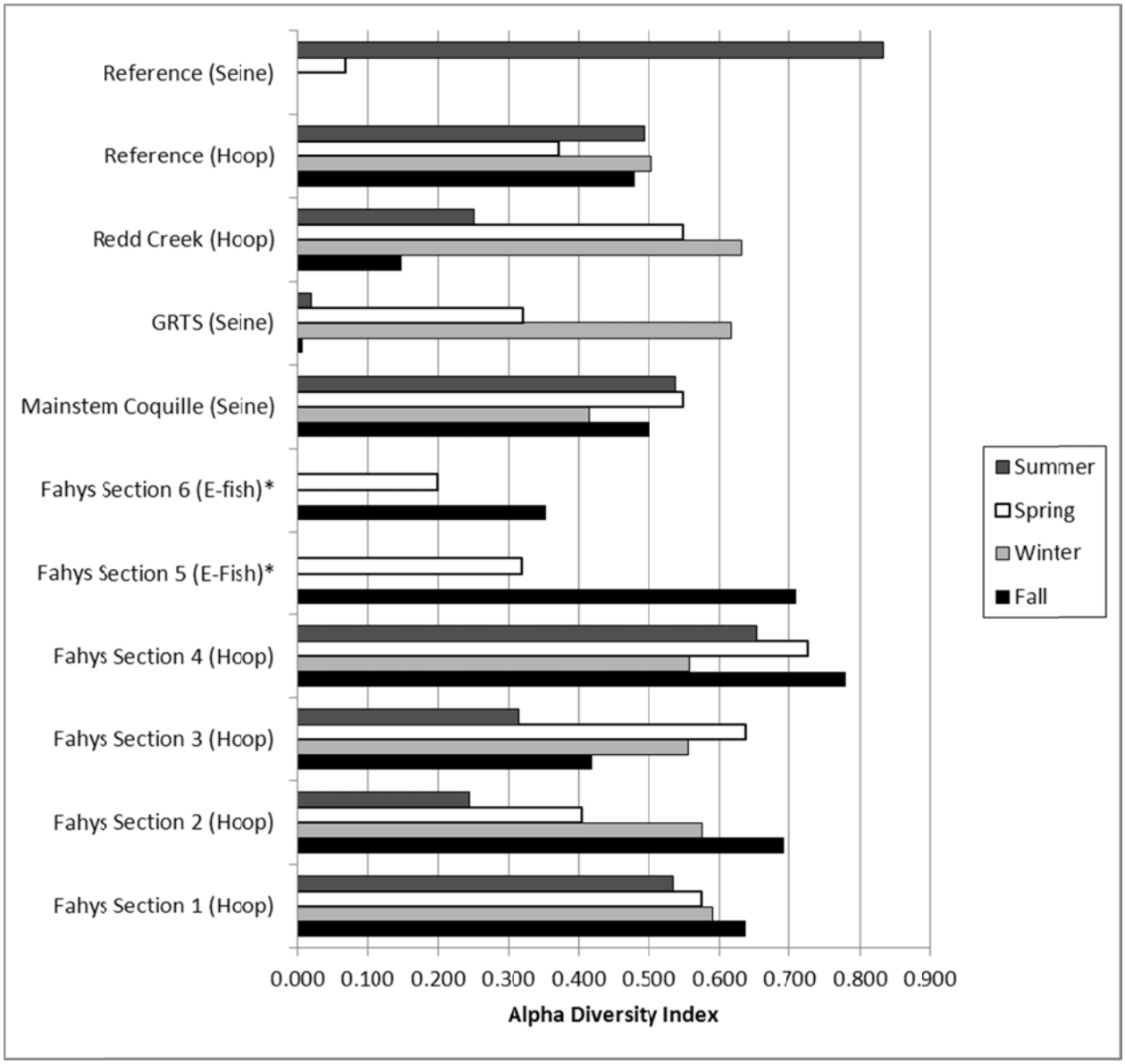


Figure 9. Ecological classification of taxon encountered throughout restoration area during the period of monitoring. Taxon are classified to Dominant, Common, Occasional, or Rare.

Table 4. Seasonal alpha diversity (Simpson Diversity Index) across sampling areas of the tidal marsh.

Season	*Sample Date*	*Section 1*	*Section 2*	*Section 3*	*Section 4*	*Section 5*	*Section 6*	*Redd Creek*	*GRTS*	*Reference*	*Reference*	*Mainstem Coquille*
Method		Hoop	Hoop	Hoop	Hoop	E-Fish	E-Fish	Hoop	Seine	Hoop	Seine	Seine
Fall	Oct-10	0.636	0.690	0.419	0.780	0.709	0.353	0.149	0.008	0.479	0.000	0.500
Winter	Mar-11	0.590	0.576	0.556	0.557	--	--	0.632	0.616	0.505	0.000	0.416
Spring	May-11	0.575	0.403	0.636	0.727	0.320	0.200	0.549	0.321	0.372	0.067	0.549
Summer	Jun-11	0.535	0.244	0.316	0.652	--	--	0.250	0.020	0.493	0.833	0.538

"--"represents no sampling conducted



*Not sampled in winter or summer

Figure 10. Seasonal variations of alpha diversity across sample areas and sample methods.

Invertebrate Sampling

Invertebrate samples (n=30) were collected across 11 reaches on Fahys Creek in 2011. These samples are archived at USFWS-CRFPO, Vancouver, Washington.

Interim Year Findings

- Salmonids were found in all areas (Fahys Cr., Redd Cr., Reference, and Mainstem Coquille) sampled.

- Coastal cutthroat trout were only found in areas behind existing dike structure (Fahys and Redd creeks). Both of these areas have freshwater sources independent of the mainstem Coquille River.

- Nonnative species were only found in areas behind existing dike structure. Both of these areas have freshwater sources independent of the mainstem Coquille River.

- Multiple size classes of CCT and larger COHO than any other area sampled were captured in Fahys Creek.

- Ecological classification indicates CCT and COHO as common/dominant species (in absence of SKB and SCP) in Fahys Creek and Redd Creek.

- Ecological classifications of taxon encountered during this interim period of construction are similar to that determined during pre-construction monitoring.

- GRTS sampling shows similar size composition of COHO to Fahys, Redd, reference areas, and the mainstem Coquille.

- Patterns in diversity among seasons included:
  - The highest alpha diversity levels were in Fahys Creek in the spring and fall. This is consistent with pre-construction data (Hudson et al. 2010).
  - Alpha diversity was generally higher in Fahys and Redd creeks than in the reference areas or the GRTS sites.
  - The lowest overall Alpha diversity levels were in the fall and winter.

References

Bottom, D. L., C. A. Simenstad, A. M. Baptista, D. A. Jay, J. Burke, K. K. Jones, E. Casillas, and M. H. Schiewe. 2004. Salmon at River's End: The Role of the Estuary in the Decline and Recovery of Columbia River Salmon. U.S. National Marine Fisheries Service, Seattle, WA. 263 pp.

Clark, S.J., J.R. Jackson, and S.E. Lochmann. 2007. A comparison of shoreline seines with fyke nets for sampling littoral fish communities in floodplain lakes. North American Journal of Fisheries Management 27:676-680.

Coquille Watershed Association. 2003. Coquille Watershed Action Plan. http://www.coquillewatershed.org/Action_Plan.html.

González-Acosta, A.F. 1998. Ecología de la comunidad de peces asociada al manglar del estero El Conchalito, Ensendada de la Paz, Baja California Sur, México. Tesis de Maestría en Ciencias con Especialidad en Manejo de Recursos Marinos. Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, México, 126 pp.

González-Acosta, A.F., G. de la Cruz Agüero, J. de la Cruz Agüero, and G.R. Campos. 2005. Seasonal pattern of the fish assemblage of el Cohchalito mangrove swamp, La Paz Bay, Baja California Sur, Mexico. Hidrobiológica 15:205-214.

Hudson, J.M., S.M. Castle, J.R. Cook, B.P. Silver, S. Lohr, and T.A. Whitesel. 2010. Pre-restoration Monitoring at Bandon Marsh National Wildlife Refuge 2007-2010. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Lapointe, N.W.R., L.D. Corkum, and N.E. Mandrak. 2006. A comparison of methods for sampling fish diversity in shallow offshore waters of large rivers. North American Journal of Fisheries Management 26:503-513.

Myers, J., G. Bryant, and J. Lynch. 1998. Factors contributing to the decline of chinook salmon: An Adendum to the 1996 West Coast Steelhead Factors for Decline Report. David Moskowitz (ed.), National Marine Fisheries Service, Protected Resources Division. Portland, OR. 74p.

Orth, D. J. 1983. Aquatic habitat measurements. Pages 61–84 *in* L. A. Nielsen and D. L. Johnson, editors. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Parsley, M. J., Palmer, D. E. and Burkhardt, R. W. 1989. Variation in capture efficiency of a beach seine for small fishes. North American Journal of Fisheries Management, 9: 239–244. [Taylor & Francis Online], [CSA]

Simenstad, C. A., K. L. Fresh, and E. O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of pacific salmon: An unappreciated function. *In* V.S. Kennedy (ed.), Estuarine Comparisons. Academic Press, Toronto, Canada. pp. 343-364.

Simenstad, C. A., D. A. Jay, and C. A. Sherwood. 1992. Impacts of watershed management on land-margin ecosystems: The Columbia River estuary. *In* R. J. Naiman (ed.), Watershed Management: Balancing sustainability and environmental change. pp. 266-306.

Sokal, R.R., & F.J. Rohlf. 1969. Biometry. W.H. Freeman & Co., San Francisco, CA 776 pp.

Stevens, D.L., and A.R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262-278.

USFWS (US Fish and Wildlife Service) and FHA (Federal Highway Administration, Western Federal Lands Division). 2009. Environmental assessment for the Ni-les'tun Unit of the Bandon Marsh National Wildlife Refuge restoration and North Bank Lane improvement project. 83 pp.

Appendix I: Catch table for all hoop net samples.

		Species											
Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Fall 2010	F1-11-N	--	6	--	--	--	--	2	--	--	--	--	--
	F1-11-S	--	--	--	--	--	--	--	2	--	--	--	--
	F1-3-N	--	--	--	--	--	--	1	--	--	--	--	--
	F1-3-S	--	2	--	--	--	--	13	15	--	--	--	--
	F1-8-N	--	--	--	--	--	--	--	--	--	--	--	--
	F1-8-S	--	3	--	--	--	--	12	8	--	--	--	--
	F2-15-N	--	3	--	--	--	--	3	3	--	--	--	--
	F2-15-S	--	2	--	--	--	1	2	8	--	--	--	--
	F2-22-N	--	--	--	--	--	--	1	2	--	--	--	--
	F2-22-S	--	5	--	--	--	--	4	2	--	--	--	--
	F3-24-N	--	--	--	--	--	--	--	12	--	--	--	--
	F3-24-S	--	2	--	--	--	--	1	3	--	--	--	--
	F3-27-N	--	--	--	--	--	--	--	1	--	--	--	--
	F3-27-S	--	--	--	--	--	1	1	--	--	--	--	--
	F4-29-N	--	2	--	--	--	--	--	1	--	--	--	--
	F4-29-S	--	--	--	--	--	--	1	--	--	--	--	--
	F4-32-N	--	--	--	2	--	--	4	2	--	--	--	--
	F4-32-S	--	2	--	--	--	--	--	--	--	--	--	--
	R-2-N	--	--	--	--	--	--	--	1	--	--	--	--
	R-2-S	--	--	--	--	--	--	1	1	--	--	--	--
	R-5-N	--	--	--	1	--	1	--	58	--	--	--	--
	R-5-S	--	--	--	3	--	--	1	34	--	--	--	--
	R-9-N	--	--	--	--	--	--	2	4	--	--	--	--
	R-9-S	--	--	--	--	--	--	--	8	--	--	--	--
	REF-2-N	--	--	--	--	--	--	36	34	--	--	--	--
	REF-2-S	--	--	--	--	--	--	261	418	--	--	--	--
	Total	--	27	--	6	--	3	346	617	--	--	--	--

"--" represents no fish captured

Appendix I: Catch table for all hoop net samples. *(cont.)*

Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Winter 2011	F1-11-N	--	--	--	--	--	--	1	--	--	--	--	--
	F1-11-S	--	--	--	--	--	--	--	2	--	--	--	--
	F1-3-N	--	--	--	--	--	--	1	--	--	--	--	--
	F1-3-S	--	--	--	--	--	--	--	--	--	--	--	--
	F1-8-N	--	--	--	--	--	--	4	--	--	--	--	--
	F1-8-S	--	1	--	--	--	--	2	4	--	--	--	--
	F2-15-N	--	--	--	3	--	--	1	5	--	--	--	--
	F2-15-S	--	--	--	--	--	--	--	7	--	--	--	--
	F2-22-N	--	1	--	2	--	--	1	1	--	--	--	--
	F2-22-S	--	--	--	--	--	--	--	--	--	--	--	--
	F3-24-N	--	--	--	1	--	--	--	--	--	--	--	--
	F3-24-S	--	--	--	--	--	--	--	--	--	--	--	--
	F3-27-N	--	2	--	5	--	--	--	--	--	--	--	--
	F3-27-S	--	--	--	--	--	--	--	1	--	--	--	--
	F4-29-N	--	--	--	2	--	--	--	--	--	--	--	--
	F4-29-S	--	--	--	--	--	--	--	1	--	--	--	--
	F4-32-N	--	--	--	--	--	--	--	--	--	--	--	--
	F4-32-S	--	7	--	12	--	--	1	--	--	--	--	--
	R-2-N	--	--	--	--	--	--	3	--	--	--	--	--
	R-2-S	--	--	--	10	--	--	3	2	--	--	--	--
	R-5-N	--	--	--	5	--	--	--	4	--	--	--	--
	R-5-S	--	1	--	9	--	--	--	7	--	--	--	--
	R-9-N	--	--	--	2	--	--	--	5	--	--	--	--
	R-9-S	1	--	--	2	--	--	1	5	--	--	--	--
	REF-2-N	--	--	--	--	--	--	27	41	--	--	--	--
	REF-2-S	--	--	--	6	--	--	169	98	--	--	--	--
	Total	1	12	--	59	--	--	214	183	--	--	--	--

"--" represents no fish captured

Appendix I: Catch table for all hoop net samples. *(cont.)*

		Species											
Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Spring 2011	F1-11-N	1	--	--	--		--	2	1	--	--	--	--
	F1-11-S	--	--	--	--	--	--	--	1	--	--	--	--
	F1-3-N	--	--	2	1	--	--	20	13	--	--	--	--
	F1-3-S	--	--	5	1	--	--	7	2	--	--	--	--
	F1-8-N	--	--	--	2	--	--	21	5	--	--	--	--
	F1-8-S	--	--	--	--	--	--	--	--	--	--	--	--
	F2-15-N	--	--	--	9	--	--	8	65	--	--	--	--
	F2-15-S	--	3	--	9	--	--	9	67	--	--	--	--
	F2-22-N	--	3	--	--	--	--	--	--	--	--	--	--
	F2-22-S	1	--	--	--	--	--	--	1	--	--	--	--
	F3-24-N	--	--	--	--	--	--	--	--	--	--	--	--
	F3-24-S	--	--	--	2	--	--	--	--	--	--	--	--
	F3-27-N	--	--	--	1	--	--	--	--	--	--	--	--
	F3-27-S	--	3	1	4	--	--	1	--	--	--	--	--
	F4-29-N	--	--	--	2	--	--	4	8	--	--	--	--
	F4-29-S	--	4	--	14	--	--	--	--	--	--	--	--
	F4-32-N	--	--	--	--	--	--	2	--	--	--	--	--
	F4-32-S	--	1	--	--	--	--	2	4	--	--	--	--
	R-2-N	--	--	--	--	--	--	--	1	--	--	--	--
	R-2-S	--	--	1	9	--	--	6	2	--	--	--	--
	R-5-N	--	1	2	6	--	--	1	34	--	--	--	--
	R-5-S	--	3	1	6	--	--	7	36	--	--	--	--
	R-9-N	--	5	--	17	--	--	2	37	--	--	--	--
	R-9-S	1	--	--	24	--	--	--	38	--	--	--	--
	REF-2-N	--	--	24	57	--	--	68	30	--	--	--	--
	REF-2-S	--	--	4	12	--	--	1076	205	--	--	--	--
	Total	3	23	40	176	--	--	1236	550	--	--	--	--

"--" represents no fish captured

Appendix I: Catch table for all hoop net samples. *(cont.)*

		Species											
Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Summer 2011	F1-11-N	--	--	1	--	--	--	4	10	--	--	--	--
	F1-11-S	--	1	--	--	--	--	3	4	--	--	--	--
	F1-3-N	--	--	2	--	--	--	9	7	--	--	--	--
	F1-3-S	--	--	--	--	--	--	--	1	--	--	--	--
	F1-8-N	--	--	2	--	--	--	6	14	--	--	--	--
	F1-8-S	--	1	--	--	--	--	5	17	--	--	--	--
	F2-15-N	--	--	--	--	--	--	8	67	--	--	--	--
	F2-15-S	--	--	--	--	--	--	--	6	--	--	--	--
	F2-22-N	--	--	--	--	--	--	--	1	--	--	--	--
	F2-22-S	--	2	--	--	--	--	3	8	--	--	--	--
	F3-24-N	--	--	--	--	--	--	1	14	--	--	--	--
	F3-24-S	--	2	--	1	--	--	2	38	--	--	--	--
	F3-27-N	--	--	--	--	--	--	--	--	--	--	--	--
	F3-27-S	--	--	--	--	--	--	6	2	--	--	--	--
	F4-29-N	--	--	--	--	--	--	--	2	--	--	--	--
	F4-29-S	--	1	--	1	--	--	--	3	--	--	--	--
	F4-32-N	--	--	--	--	--	--	--	1	--	--	--	--
	F4-32-S	--	1	--	--	--	--	2	1	--	--	--	--
	R-2-N	--	1	--	--	--	--	--	20	--	--	--	--
	R-2-S	--	--	--	1	--	--	1	4	--	--	--	--
	R-5-N	--	2	--	6	--	--	11	59	--	--	--	--
	R-5-S	--	--	--	--	--	--	--	7	--	--	--	--
	R-9-N	--	2	--	--	--	--	--	10	--	--	--	--
	R-9-S	--	2	--	5	--	--	1	101	--	--	--	--
	REF-2-N	--	--	--	--	--	--	29	33	--	--	--	--
	REF-2-S	--	--	--	--	--	--	152	200	--	--	--	--
	Total	--	15	5	14	--	--	243	630	--	--	--	--

"--" represents no fish captured

Appendix II: Catch table for all seine samples.

		Species											
Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Fall 2010	GRTS02	--	--	--	--	--	--	1	--	1	--	--	--
	GRTS03	--	--	--	--	--	--	1	--	--	--	--	--
	GRTS06	--	--	--	--	--	--	--	--	11	--	--	--
	GRTS07	--	--	--	--	--	--	--	--	1	--	--	--
	GRTS08	--	--	--	--	--	--	--	--	8	--	--	--
	GRTS09	--	--	--	--	--	1	--	--	379	--	--	--
	GRTS10	--	--	--	--	--	--	--	--	26	--	--	--
	GRTS11	--	--	--	--	--	1	--	--	64	--	--	--
	REF-1	--	--	--	--	--	--	--	2	--	--	--	--
	SEINE-1	--	--	--	--	--	--	--	--	--	--	--	--
	SEINE-2	--	--	--	--	--	--	1	--	--	--	--	--
	SEINE-3	--	--	--	1	--	--	--	5	--	2	--	--
	SEINE-4	--	--	--	--	--	--	--	4	--	1	--	--
	Total	--	--	--	1	--	2	3	11	490	3	--	--

"--" represents no fish captured

Appendix II: Catch table for all seine samples. *(cont.)*

		Species											
Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Winter 2011	GRTS08	--	--	--	--	--	--	1	--	--	--	--	--
	GRTS09	--	--	--	1	--	--	--	1	--	--	--	--
	GRTS10	--	--	--	--	--	--	--	5	--	--	--	--
	GRTS11	--	--	--	1	--	--	--	--	--	--	--	--
	GRTS12	--	--	--	--	--	--	1	--	--	--	--	--
	GRTS13	--	--	--	--	--	--	--	--	4	--	--	--
	GRTS14	--	--	--	--	--	--	1	--	--	--	--	--
	GRTS15	--	--	--	14	--	--	--	--	3	--	--	--
	REF-1	--	--	--	--	--	--	--	18	--	--	--	--
	SEINE-1	--	--	--	3	--	--	--	3	--	--	--	--
	SEINE-2	--	--	--	--	--	--	1	--	--	--	--	--
	SEINE-3	--	--	--	--	--	--	--	11	--	--	--	--
	SEINE-4	--	--	--	3	--	--	--	2	--	--	--	--
		--	--	--	22	--	--	4	40	7	--	--	--

"--" represents no fish captured

Appendix II: Catch table for all seine samples. *(cont.)*

		Species											
Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Spring 2011	GRTS12	--	--	--	2	--	--	--	--	--	--	--	--
	GRTS13	--	--	--	--	--	--	--	--	3	--	--	--
	GRTS14	--	--	--	1	--	--	--	--	1	--	--	--
	GRTS15	--	--	--	--	--	--	--	--	41	--	--	--
	GRTS16	--	1	--	14	--	--	--	1	79	--	--	--
	GRTS17	--	--	--	2	--	--	--	3	9	--	--	--
	GRTS18	--	--	--	--	--	--	--	--	8	--	--	--
	GRTS19	--	--	--	--	--	--	--	9	4	--	--	--
	REF-1	--	--	1	--	--	--	--	57	1	--	--	--
	SEINE-1	--	--	6	--	--	--	--	6	--	--	--	--
	SEINE-2	--	--	--	1	--	--	--	3	--	--	--	--
	SEINE-3	--	--	--	--	--	--	--	1	--	--	--	--
	SEINE-4	--	--	14	2	--	--	--	--	--	--	--	--
	Total	--	1	21	22	--	--	--	80	146	--	--	--

"--" represents no fish captured

Appendix II: Catch table for all seine samples. *(cont.)*

		Species											
Season	Site	BBH	CCT	CHN	COHO	GUN	MQF	SCP	SKB	SP	SS	STF	TF
Summer 2011	GRTS16	--	--	--	1	--	--	--	--	140	--	--	--
	GRTS18	--	--	--	--	--	--	1	--	--	--	--	--
	GRTS19	--	--	--	--	--	--	--	--	21	--	--	--
	GRTS20	--	--	--	--	--	--	--	--	23	--	--	--
	GRTS21	--	--	--	--	--	--	--	--	142	--	--	--
	GRTS22	--	--	--	--	--	--	--	--	31	--	--	--
	GRTS24	--	--	--	--	--	--	--	--	16	--	--	--
	GRTS28	--	--	--	5	--	--	--	1	309	--	--	--
	REF-1	--	--	1	--	--	--	--	2	--	1	--	--
	SEINE-1	--	--	16	7	--	--	--	5	--	1	2	1
	SEINE-2	--	--	1	--	2	--	--	5	--	--	--	--
	SEINE-3	--	--	--	--	--	--	--	25	--	--	--	1
	SEINE-4	--	--	--	--	--	--	--	25	--	--	--	1
		--	--	18	13	2	--	1	63	682	2	2	3

"--" represents no fish captured