Washington Contribution to the 2013 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

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Review of WDFW Groundfish/Forage Fish Research, Assessment, and Management Activities in 2012

A. Puget Sound Area Activities

Staff of the Puget Sound Marine Fish Science (MFS) Unit includes Dayv Lowry, Robert Pacunski, Larry LeClair, Kurt Stick, James Selleck, Adam Lindquist, Jim Beam, Erin Wright, Andrea Hennings, and Lisa Hillier. In addition, Courtney Adkins and Peter Sergeeff work as MFS employees during the spring bottom trawl survey. Unit tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. The main activities of the unit include the assessment of bottomfish and forage fish populations in Puget Sound, the evaluation of bottomfish in marine reserves, and the development of conservation plans for species of interest. Groundfish in Puget Sound are managed under the auspices of the Puget Sound Groundfish Management Plan (Palsson, et al. 1998).

1. Puget Sound Groundfish Monitoring, Research, and Assessment (*Contact: Theresa Tsou 360-902-2855, tien-shui.tsou@dfw.wa.gov; Dayv Lowry 360-902-2558, dayv.lowry@dfw.wa.gov)*

a. ESA-listed Rockfish Critical Habitat Designation

Working with NOAA staff at the Northwest Fisheries Science Center, MFS staff provided data to inform the designation of critical habitat for bocaccio, canary rockfish, and yelloweye rockfish, which were listed under the ESA in 2010. Data provided included occurrences of these three species in all historic and contemporary WDFW research and fishery datasets available. To the extent possible, characterization of the habitat associated with these occurrences was also provided. In the case of tethered drop camera (Visual Assessment Technique [VAT]) and remotely operated vehicle (ROV) recordings the nature of the benthic habitat could be explicitly detailed. The posting of critical habitat maps to the federal register for public review is expected within the next two months.

b. Participation in the Federal Rockfish Technical Recovery Team and Rockfish Working Group

In late 2012 Lowry and Pacunski were both appointed to NOAA's Rockfish Technical Recovery Team, which has been charged with developing a detailed recovery plan for the three ESA-listed species in Puget Sound and the Strait of Georgia. To date this group has met twice. The recovery plan is expected to be complete and ready for public review by the end of 2013.

Several members of the Rockfish Technical Recovery Team are also members of a less formal, regional Rockfish Working Group. This group contains members from state and federal government, academia, the aquarium trade, and fishery organization. They meet quarterly to discuss and coordinate regional research activities and share recent technology, research, and outreach developments. In 2013 this group will be formalized as an advisory technical workgroup under the auspices of the Puget Sound Partnership (PSP). In this incarnation, the workgroup will advise the PSP on issues relating to the monitoring and evaluation of rockfish in Puget Sound with the ultimate goal of "recovering" the Sound by 2020.

c. Update of Washington State's Priority Habitats and Species List

The Priority Habitats and Species List is a catalogue of habitats and species considered by the state of Washington to be of prime significance for conservation and management. At an interval of approximately every four years WDFW updates this list. In 2012, MFS staff participated in the update process and added the following marine species and habitats to the list: cabezon, Pacific halibut, sevengill sharks, sixgill sharks, giant Pacific octopus, Puget Sound king crab, deepwater marine biodiversity hotspots, and marine riparian forests. Representation on the list draws research and management interest and, often, increases options for fund sources as species/habitats become recognized as playing an important role in ecosystem health.

d. 2008 San Juan Archipelago ROV Survey Report: Habitat Stratified

The results of a rocky habitat-focused ROV survey conducted in the San Juan Islands in 2008 were finalized and published as a WDFW Technical Report. The report is available in pdf format at: http://wdfw.wa.gov/publications/01453/. This report is the first in a series of documents detailing recent ROV-based assessments of fish/habitat associations and distribution in the San Juan Islands and the entirety of Puget Sound.

e. 2010 San Juan Archipelago ROV Survey Report: Stereology

Based on the success of the habitat-stratified surveys conducted in 2008, WDFW returned to the San Juan Islands in 2010 to conduct a survey of all habitat types. The survey design was based on stereology, a technique borrowed from histology and forestry, which systematically surveys locations using a fixed grid with a random starting point. The advantage of this technique is that it allows estimates of fish abundance to be generated for the entirety of the survey area, rather than within a single habitat stratum. The survey grid included 168 stations and also allowed for adaptive stations to be occupied when ESA-listed rockfishes, or high densities of other rockfishes, were observed. A report comparing the results from the 2008, habitat-stratified survey and the 2010, stereology based survey was drafted in late 2012 and is currently under revision. A final report is planned for release by summer 2013.

f. 2012 Puget Sound-wide ROV Survey: Stereology

Building on the results of the 2008 and 2010 surveys in the San Juan Islands, WDFW embarked on a Sound-wide ROV survey based on a stereological design in April of 2012. A fixed grid of points separated by approximately 3 NM was overlaid on Puget Sound, generating 215 survey stations from the Canadian border to the Bonilla-Tatoosh line at the mouth of the Strait of Juan de Fuca, to South Sound. Transect time was increased from 15 or 30 minutes, as in past studies, to 60 minutes per site. The ability to complete a 60-min transect in shipping lanes was greatly enhanced by the addition of a Class II Automatic Information System (AIS) aboard the R/V MOLLUSCAN.

The 2012 Puget Sound Stereological ROV survey began on 15 March 2012 and concluded on 4 April 2013 with a total of 197 stations out of a planned 215 stations sampled. Several stations near Port Angeles and most stations near Point Roberts in the southern Gulf of Georgia were not sampled due to weather and logistical constraints. To control for possible diel fish behaviors, the survey was stratified into three time periods; 0000-0759 (morning), 0800-1559 (day), and 1600-2359 (evening). Our goal was to distribute sampling effort equally among periods, however, safety and logistical considerations combined with shorter tidal sequences in the morning and evening hours resulted in a greater proportion of daytime sampling. The final station breakdown by strata was 47 morning (24%), 110 day (56%), and 38 evening (20%).

Video review has been conducted concurrently with the survey and is ongoing, with approximately 35% of transect videos having been reviewed at least once thus far. Our current timeline for completion (including second reviews) is March/April 2014. Based on the 76 stations reviewed to date, sand and mud have been the dominant substrates encountered, accounting for 81% of the total number of habitat segments (30 seconds of video). In contrast, rock and boulder substrates represent less than 2% of the habitat segments. Excluding unidentified small fish, the dominant taxa encountered thus far have been unidentified eelpouts, unidentified flatfish, unidentified gadids, spotted ratfish, blackfish sculpin, and English sole. Few species typically associated with rock or high-relief substrates have been observed. Quillback rockfish are the most common rockfish species seen to date (n = 98), with this number split almost evenly between rock/cobble and sand/mud bottoms. The only other rockfishes seen thus far include seventeen Puget Sound rockfish, four copper rockfish, one greenstriped rockfish and one unidentified red rockfish. Hexagrammids observed include ninety-four kelp greenling, eleven lingcod, two whitespotted greenling and two unidentified hexagrammids.

g. Continued investigation of the 2006 Recruitment Event of Young-of-the-Year Rockfishes in Puget Sound

As noted in the 2010 report to the TSC, in 2006 an exceptional recruitment of juvenile rockfish was observed by MFS biologists throughout nearly all of Puget Sound. Based on the genetic analyses of post-settlement juveniles sampled in 2006, and length, density, and species composition data acquired from regularly surveyed index sites subsequent to 2006, the recruitment event appears to have been dominated by quillback-, copper-, and black rockfish. Marine Fish Science staff hypothesized that the unusually large numbers of sub-adult black rockfish observed in Puget Sound was the result of an influx of juveniles from coastal waters. As a partial test of the hypothesis, in 2012 MFS biologists sampled black rockfish from the outer coast, southern Puget Sound, Hood Canal, and the San Juan Islands to look for evidence of genetic differences between inland and coastal populations. The samples have been genotyped and a preliminary analysis of the data indicates that there are no detectable genetic differences between the two regions. Otolith ageing shows that nearly all of the black rockfish inland samples are from the 2006 cohort. Survey data from an ongoing long-term monitoring project at an artificial reef in central Puget Sound indicate that a significant shift in species composition is occurring at that location and may be the result of the 2006 recruitment event. Prior to 2006, rockfish fauna on the reef consisted almost entirely of brown rockfish, which were not believed to have been involved in the recruitment event. The reef is now dominated by copper rockfish and a prominent 2006 year-class spike (based on length) can be seen in the data. Due to shifting priorities and lack of available resources, juvenile rockfish index sites were not surveyed in 2012.

h. Bottom Trawl Surveys of Puget Sound

Since 1987, WDFW has conducted bottom trawl surveys in Puget Sound that have proven invaluable as a fisheries-independent indicator of population abundance for fishes living on unconsolidated habitats. These surveys have been conducted at irregular intervals and at different scales since 1987. Early surveys between 1987 and 1991 were synoptic surveys of the entire Puget Sound, later were stratified, random surveys focusing on individual sub-basins, and in 2008 became synoptic again with stations at fixed index sites.

From April 30th through June 1st, 2012, WDFW conducted a bottom trawl survey to assess the abundance of groundfishes in the Puget Sound. This survey was the fifth "Index" survey of Puget Sound, a departure from the stratified-random designs used prior to 2008. This new design is better for

assessing changes in the relative abundance of key groundfish species because reoccupying fixed stations will minimize variation in habitat and provide more powerful inter-annual comparisons. The complete "Index" survey design includes 51 stations partitioned among Puget Sound's eight oceanographic basins which include the Eastern and Western Strait of Juan de Fuca, San Juan Archipelago, Strait of Georgia, Whidbey Basin, Central Basin, South Puget Sound, and Hood Canal. Each basin was divided into two geographic subareas (north/south or east/west) except for Central Basin, which includes a third subarea (middle) to better represent this latitudinally elongate basin. We selected previously trawled stations within each subarea from pre-existing depth zones such that one station would be situated between depths of 30 to 120 feet, 120 to 240 feet, 240 to 360 feet, and greater than 360 feet. Depths less than 30 feet are excluded from the survey because they are too shallow for the trawl vessel to operate. Two replicate trawl samples were collected at each stations and were spaced several hundred meters apart to be close to each other but not directly overlapping. The specific objectives of the survey were to estimate the relative abundance, species composition, and biological characteristics of groundfish species at pre-selected, permanent index stations. Key species of interest include Pacific cod, walleye pollock, Pacific whiting, English sole, spiny dogfish, and skates, but all species of fishes and invertebrates will be identified and recorded.

The trawling procedure of the survey was similar to previous WDFW trawl surveys (Palsson et al. 2002, 2003). The 58-foot F/V CHASINA was the chartered sampling vessel, and it was equipped with an agency-owned 400-mesh Eastern bottom trawl fitted with a 1.25 inch codend liner. The net was towed at each station for a distance of 0.40 nautical miles at a speed of 1-3 knots, and the tows lasted approximately 12 minutes. Net openings ranged from 8 to 14 m depending upon depth and the amount of cable towing the net. The resulting catch was identified to the lowest taxonomic level, weighed and enumerated, and most of the catch was returned to the sea. The density of fish at each station was determined by dividing the catch numbers or weight by the area sampled by the net. Some of the catch was taken for biological samples that were sampled on deck or preserved for laboratory analysis.

During the 22 survey days we occupied 42 stations and conducted 84 bottom trawls (Figure 1). Due to concerns for endangered Chinook salmon in 2012, NOAA restricted the survey from operating in the shallowest depth zone (30-120 feet), eliminating nine stations (18 trawls) from the 2012 survey frame. An estimated 60,000 individual fish among 80 species/taxa weighing 11 mt were collected. By weight, spotted ratfish constituted 62% of the catch, followed by English sole at 12.5%. The next most abundant species were big skate, walleye pollock, Pacific whiting, Pacific sanddab, Pacific cod, spiny dogfish, blackbelly eelpout, starry flounder and longnose skate, which in aggregate accounted for 15% of the catch by weight (1% to 3% per species). Similar to 2011, Pacific cod remained as one of the most abundant species in the survey. Compared to the previous year, Pacific cod in 2012 were slightly larger, measuring between 25 and 70 cm and averaging 54 cm in total length, corresponding to a fish in its third to fourth year of life. Most of the cod were distributed in the western Strait of Juan de Fuca, the southern Strait of Georgia and the central basin of Puget Sound, with only a few cod captured in other basins. For the first time in the 26 year history of the trawl survey, a bocaccio rockfish was recorded in the catch. The specimen was captured at a station in the western Strait of Juan de Fuca several miles west of the DPS boundary established for endangered bocaccio in Puget Sound. The fish measured 20 cm in total length and a genetic sample (fish clip) was collected. After a short period of reacclimation in a live tank, the fish was returned alive to the ocean.

i. Marine Reserve Monitoring: Evaluation of No-Take Refuges for Rocky Habitat Fishes

Very little reserve monitoring has occurred since 2011 due to changes in program priorities and staffing limitations associated with the 2012 ROV survey of Puget Sound. The only activity to report in 2012 was the continuation of lingcod nest surveys at four sites in the San Juan Islands. Three of the four sites were sampled twice and one site was sampled once during February and March 2012. Overall, nest densities were much lower than previous years, but densities at reserve sites were much higher than at fished sites. With the exception of 2011, this survey has been conducted annually since 2000, and for the first time ever one of the fished site had no nests recorded on both dives.

j. Groundfish Surveys at U.S. Navy Facilities

In the interest of documenting the occurrence of various marine species in the waters within and immediately adjacent to U.S. Navy facilities on the Kitsap Peninsula, the Navy contracted with WDFW to conduct both ROV-based and hook-and-line sampling of these waters. The presence of specific species in Navy-controlled waters is of relevance to management of these species under the auspices of the Puget Sound Groundfish Management Plan, Endangered Species Act, and several other policy and management documents. It also has implications for future construction at Naval facilities, especially as it applies to Environmental Impact Statements.

Though details cannot be shared until final documents are approved for release by the Navy, three regions of the Naval Base Kitsap (NBK) Bremerton facility were surveyed with the ROV and a fourth is currently being surveyed using hook-and-line. In addition, three areas near the NBK Keyport facility were surveyed with the ROV. Funding is currently being negotiated to expand surveys to a second, complementary, season of sampling at NBK Bremerton and a series of surveys at NBK Bangor. The NBK Bangor survey could include other sampling methods, such as trawl, scuba, or beach seining.

k. ROV-based Surveys of the Nisqually Delta with the USGS

In August 2012 WDFW entered into a contract with the USGS to conduct an ROV survey of selected geologic features in south Puget Sound and the Nisqually delta. This survey follows a similar ROV survey conducted in central Puget Sound for the USGS in 2011. The purpose of these surveys was to collect video information to be used in classifying the seabed geology in support of ongoing USGS efforts to develop a seafloor habitat map of the Puget Sound basin. In 2012 we surveyed twenty-eight pre-selected and *ad hoc* sites over three days. Deployment sites ranged from 8 m to 170 m in depth but most sites were between 30 m and 70 m. Transects lasted from 15 to 61 minutes but most were 20 to 30 minutes in duration.

Most sites were characterized by soft bottom substrates, with a macro-invertebrate community dominated by sea pens, burrowing anemones, shrimp, seastars, and hydroids. Species composition varied based on habitat and provided clues about the underlying substrate that was often covered with silty sediments and sand. Small benthic fishes such as eelpout and flatfish were the most abundant species observed. Other fish observed included gadids, gobies, and quillback rockfish. The few rockfish we observed appeared to be smaller than 30 cm. All of the video imagery and tracking data from the ROV were supplied to the USGS with copies of the data held by WDFW for later analysis to examine fish-habitat relationships.

l. Participation in Conferences and Workshops

In 2012 staff of the Puget Sound MFS Unit presented at, and/or arranged symposia at, several regional scientific meetings, as indicated below.

Western Groundfish Conference, Feb 7-10. Presenters: Robert Pacunski, James Selleck, Andrea Hennings, Erin Wright, Henry Cheng (no longer with WDFW)

NOAA/WDFW Cooperative Research Symposium at Pt. Adams, Feb 23. Presenters: Dayv Lowry, Kurt Stick. Organizers: Dayv Lowry.

A Friday Harbor Labs Symposium: Biology and Management of Forage Fish in the Salish Sea, Sept 12-14. Presenters: Dayv Lowry, Jim West, Kurt Stick, Adam Lindquist, James Selleck. Organizer: Dayv Lowry

South Sound Science Symposium, Oct 30. Organizer: Dayv Lowry

Northwest Straits Commission Annual Meeting for Marine Resource Committees, Nov 2-3. Presenter: Dayv Lowry.

m. Other Activities

Dayv Lowry was appointed to the Northwest Association of Networked Ocean Observing Systems (NANOOS) Governing Board in 2012 and participated in three meetings in this role. The funding for NANOOS, and ocean observing systems in general, will likely increase in 2013 and the complexity, and utility, of this system for habitat monitoring is expected to increase as a result.

Bob Pacunski serves on the Nisqually Reach Aquatic Reserve Implementation Committee and participated in two meetings in 2012.

2. Forage Fish Stock Assessment and Research (*Contact: Dayv Lowry 360-95-2558, dayv.lowry@dfw.wa.gov; Kurt Stick (360) 466-4345 ext. 243, kurt.stick@dfw.wa.gov)*

a. Annual Herring Assessment in Puget Sound

Annual herring spawning biomass was estimated in Washington in 2012 using spawn deposition surveys. WDFW staff based in the Mill Creek, La Conner, and Point Whitney offices conduct these assessment surveys of all known herring stocks in Washington's inside waters annually. Stock assessment activities for the 2013 spawning season are in progress.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2012 is 8,517 tons (see table below). The cumulative total is a decrease from the 2011 total of 14,705 tons and considerably lower than the mean cumulative total for the previous ten-year (2002-2011) period of 13,376 tons. The combined spawning biomass of south/central Puget Sound (including Hood Canal) herring stocks in 2012 of 5,846 tons is a decrease from 2011, when the cumulative spawning biomass for this region was 11,189 tons. Spawning biomass for this region in 2012 was again dominated by the Quilcene Bay and Holmes Harbor stocks. Spawning abundance for these two stocks has been relatively very high in recent years, while many other stocks in the region are at low levels of abundance.

Cumulative biomass of north Puget Sound stocks, excluding the Cherry Point stock, in 2012 overall remained at a low level of abundance. The spawning biomass of the Cherry Point stock in 2012 was a decrease from 2011 and this stock, which is thought to be genetically distinct from other herring stocks in Puget Sound and British Columbia, continues to be at a critically low level of abundance. Estimated herring spawning activity for the Strait of Juan de Fuca region was similar to 2011, with an estimated spawning biomass of 148 tons.

PUGET SOUND HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 2003-2012

	YEAR									
	2012	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**
Squaxin Pass	589	565	750	817	1025	557	755	436	828	2201
Purdy	135	711	500	125	496					
Wollochet Bay	31	21	50	359	45	35	27	67	52	152
Quartermaster Harbor	108	96	143	843	491	441	987	756	727	930
Elliot Bay	290									
Port Orchard-Port Madison	217	123	350	1755	1186	1589	2112	1958	700	1085
South Hood Canal	264	156	150	156	223	70	244	210	176	207
Quilcene Bay	2626	4443	2012	3064	2531	2372	2530	1125	2342	916
Port Gamble	404	1464	433	1064	208	826	774	1372	1257	1064
Kilisut Harbor	0	0	0	0	0	24	54	170	184	448
Port Susan	61	138	152	251	345	643	321	157	429	450
Holmes Harbor	678	3003	673	1045	686	572	1297	498	673	678
Skagit Bay	443	469	500	1027	1342	1236	2826	1169	1245	2983
South-Central Puget Sound Total	5846	11189	5713	10506	8578	8365	11927	7918	8613	11114
Fidalgo Bay	89	119	103	15	156	159	323	231	339	569
Samish/Portage Bay	430	387	640	320	409	348	412	218	351	299
Int. San Juan Is.	5	0	17	0	60	33	285	41	67	72
N.W. San Juan Is.	0	0	0	0	0	0	0	0	0	13
Semiahmoo Bay	879	1605	1000	990	662	1124	1277	870	629	1087
Cherry Point	1120	1301	774	1341	1352	2169	2216	2010	1734	1611
North Puget Sound Total	2523	3412	2534	2666	2639	3833	4513	3370	3120	3651
Discovery Bay	105	0	26	205	248	42	1325	33	252	207
Dungeness/Sequim Bay	43	104	75	46	69	34	0	0	22	44
Strait of Juan de Fuca Total	148	104	101	251	317	76	1325	33	274	251
Puget Sound Total	8517	14705	8348	13423	11534	12274	17765	11321	12007	15016

b. Unique Herring Spawning and Pending Genetic Research

In late April a WDFW field technician (Roy Clark) on loan from another unit observe what appeared to be a herring spawning event in Elliot Bay, just offshore from Seattle. The location of this spawning event was unprecedented and the timing matched only one other known spawning population -- the high-profile Cherry Point Stock, which has been previously petitioned for ESA listing. Further investigation validated the presence of spawning and produced a spawning biomass estimate of 290 tons. Eggs collected during spawning surveys are being combined with genetic samples of three other herring stocks in Puget Sound to determine whether the Elliot Bay fish are more closely related to the nearest spawning stock (Port Orchard/Port Madison), a geographically proximate member of the genetically identified 'Other stocks' complex (Henderson Bay/Purdy Stock), or the Cherry Point Stock. Results are expected by August of 2013.

c. Recreational Surf Smelt Harvest Estimation

Fisheries for surf smelt in Washington State are currently managed under the assumption that recreational harvest is roughly comparable to commercial harvest on a Puget Sound-wide basis. This assumption may underestimate total fishing pressure and harvest, leading to localized or Sound-wide depletion and negative ecosystem impacts. Assessing recreational effort and harvest is complicated by the lack of a licensing requirement for fishers, the fact that fishing occurs throughout the year but tends to peak during locally specific time windows, and the ability of anglers to engage in the fishery from private shorelines in addition to public access points (e.g., boat ramps). In order to adequately estimate total recreational harvest a survey method must be developed that accounts for spatiotemporally diverse harvest patterns over the entirety of Puget Sound. In collaboration with the SeaDoc Society, WDFW utilized a hybrid access point/boat survey design to intercept recreational fishers dip-netting for smelt along the northern shores of Camano Island during the traditional fishing 'season.' In addition to

providing an estimate of harvest during this period in this location (4419 lbs), patterns of both fishing effort and catch were described through time, in association with tidal and other environmental variables, and compared between public access points and private beaches. Based on the site-specific estimate generated in the study, the capacity for Sound-wide recreational harvest to exceed the assumed 100,000 lbs exists and additional monitoring is warranted. By further optimizing sample size in both time and space a logistically feasible design can be developed that will allow estimation of recreational smelt harvest for the entirety of Puget Sound. Efforts are ongoing to identify funding and personnel to expand sampling in 2013 and beyond.

3. Puget Sound Ecosystem Monitoring Program (PSEMP) *(Contact: Jim West 360-902-2842, James.West@dfw.wa.gov)*

The Washington Department of Fish and Wildlife is a key partner of the Puget Sound Ecosystem Monitoring Program Project (PSEMP), a multi-agency effort to assess the health of Puget Sound. WDFW's "Toxics in Biota" group is staffed by Jim West, Jennifer Lanksbury, Laurie Niewolny, Stefanie Orlaineta, Andrea Carey, and Sandie O'Neill. This group conducts regular status and trends monitoring of toxic contaminants in a wide range of indicator species in Puget Sound, along with evaluations of biota health related to exposure to contaminants. This group has recently conducted additional focus studies on toxic contaminants in Dungeness crab (*Cancer magister*), spot prawn (*Pandalus platyceros*), blue mussels (*Mytilus* spp), as well as a field experiment testing the effects of chemicals leaching from creosote-treated wooden pilings on the health of developing Pacific herring (*Clupea pallasi*) embryos.

B. Coastal Area Activities

Staff of the Coastal Marine Fish Science (MFS - Coast) Unit includes Lorna Wargo, Brad Speidel, John Pahutski, Bob Le Goff, Brian Walker, Donna Downs, and Vicky Okimura. Seasonal and project staff include Michael Sinclair, Mariko Langness, Erin Dilworth, Colin Jones, Phillip Weyland and Kristen Hinton. Unit tasks are supported through a combination of state general and federal funds. Long-standing activities of the unit include the assessment of groundfish populations off Washington coast, the monitoring of groundfish commercial landings, and the rockfish tagging project. More recently, unit activity has expanded to include forage fish management and research. The unit is completing a ESA Section 6 funded project to evaluate eulachon smelt bycatch in the Washington pink shrimp trawl fishery and beginning in 2012 undertook a survey of outer coast beaches in an effort to document seasonal and spatial pattern of spawning in surf smelt, night smelt, and sand lance to inform marine spatial planning.

Activities Related to Pacific Fishery Management and North Pacific Fishery Management Councils

The Department contributes technical support for coastal groundfish and forage fish management via participation on the Groundfish Management Team (GMT), the Coastal Pelagics Management Team (CPSMT), the Scientific and Statistical Committee (SSC), and the Habitat Steering Group (HSG) of the Pacific Fishery Management Council (PFMC). The Department is also represented on the Scientific and Statistical Committee and Groundfish Plan Teams of the North Pacific Fishery Management Council.

Landings and fishery management descriptions for PFMC-managed groundfish are summarized annually by the GMT and the CPSMT in the Stock Assessment and Fishery Evaluation (SAFE) document.

1. Coastal Groundfish Management, Monitoring, Research, and Assessment (*Contact: Theresa Tsou 360-902-2855, tien-shui.tsou@dfw.wa.gov; Lorna Wargo (360) 249-1221 Lorna.Wargo@dfw.wa.gov*; *Corey Niles, 360-249-1223, Corey.Niles@dfw.wa.gov), Intergovernmental Resource Management)*

a. Coastal Rockfish Tagging Project

In Washington, the first black rockfish tagging project began in 1981. The early tagging work concentrated on gathering biological information, such as movement and growth. Over the intervening years, the project has undergone changes as study objectives were re-defined and improvements in tagging protocols were made. The overall objective of this program has been to produce estimates of black rockfish abundance, growth, survival, and mortality for incorporation into population assessment models. Beginning in 2010, this long-term project was expanded to address some crucial limitations identified by the PFMC stock assessment review panel for black rockfish in 2007 and in a scientific review of the study design conducted in 2008 by Department staff. The limitations included: 1) limited geographic coverage – sample stations were located mid-coast only, 2) tag recovery dependent on fisheries – only recreational charter catches landed at Westport, and 3) narrow focus – only black rockfish. In response, WDFW scientists designed an expanded project to evaluate and correct these limitations. The following objectives were identified:

1. Correct possible bias in current black rockfish tagging project.
2. Extend geographic coverage to include all areas accounted for in the current stock assessment boundaries.
3. Develop simple cost effective long-term fisheries-independent monitoring strategies for black rockfish and other nearshore species.
4. Develop two or more reliable longitudinal rockfish abundance indices.
5. Estimate the growth curve of black rockfish and other tagged fish species from multi-recapture data.
6. Better understand the spatial distribution of nearshore rockfish along the Washington coast.

The expanded project design incorporated numerous changes including broader coverage through capture (and recapture) of *all* rockfish species, not just black rockfish, at fixed locations distributed along the entire Washington coast (Figure 1). Historically, tagging has only been conducted in the spring (March-April); the expanded project added a fall tagging period (September-October). For each sampling period, the target was to capture a minimum of 400 rockfish or to fish a maximum of two days per index station, whichever came first. At each index station, PIT (Passive Integration Transponder) tags were inserted in all rockfish species. In total, the project was expected to tag and capture more than 8000 fish each year. When complete, the expanded survey will comprise three fall and three spring surveys. The first expanded survey was conducted fall, 2010 with the final scheduled for spring 2013 (Table 1).

Tagging trips depart from Westport, La Push and Neah Bay and are conducted onboard recreational charter vessels staffed by captains and deckhands with bottomfish fishing expertise specific to each area. For a typical tagging trip, 10 to 12 volunteer anglers are recruited and tasked with catching rockfish. Tagged fish are recovered as carcasses delivered to Westport from recreational bottomfish charter trips and through recapture during tagging trips.

Figure 1. Tagging Site Locations

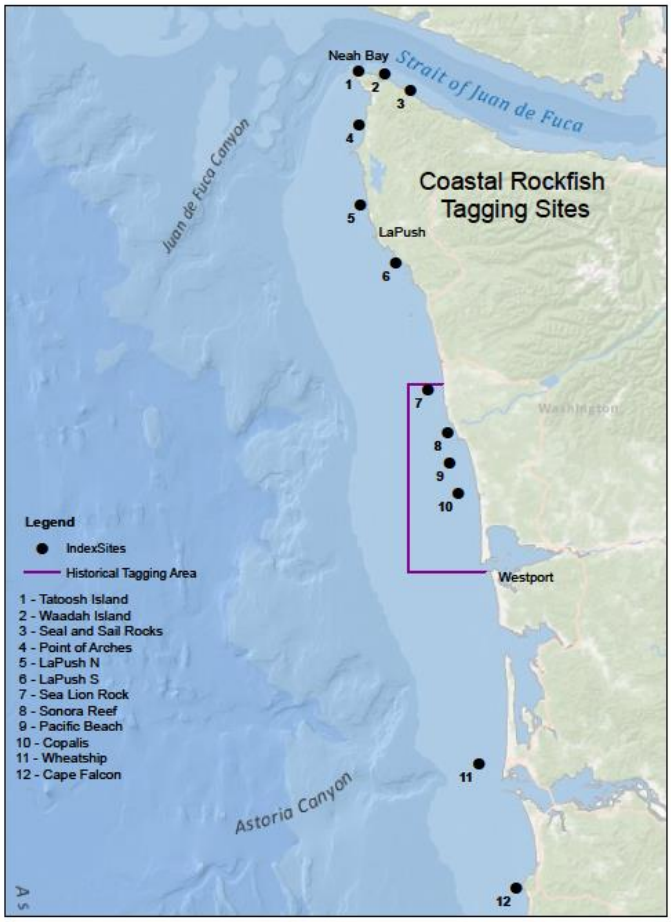

Table 1. Tagging Statistics

	2011		2012		
Season	Spring	Fall	Spring	Fall	**Totals**
Number of Trips	39	20	29	20	**108**
Total Fish Caught	6891	3227	8607	4052	**22777**
Total Fish Tagged	6320	3162	8297	4011	**21790**
Total Fish Released	6349	3196	8341	4039	**21925**
At Sea Tag Recoveries	29	34	44	28	**135**
Dockside Sampling					
	2011		2012		**Totals**
Fish Sampled Dockside	37741		40013		**77754**
Dockside Tag Recoveries	224		328		**552**

b. Rockfish Longline Survey

The Washington Department of Fish and Wildlife (WDFW) has been conducting longline surveys off the northern Washington coast to better understand seasonal changes in catch rates for rockfish that inhabit rocky habitat. Results from these research surveys will be used to improve future survey strategies to monitor and assess rockfish populations, evaluate the risk of localized depletion and survey effects, and to monitor the growth and movement of several important rockfish species.

Using IPHC survey design and data, WDFW has been refining survey strategies more specifically for rockfish that dwell in rocky habitat since 2006. The current survey design with 12 additional stations surrounding IPHC station 1082 (48^0 10' N and 125^0 23' W) in waters 50-100 fathoms in depth (Figure 1) was established in 2008. The R/V Pacific Surveyor has been chartered to complete the Yelloweye longline surveys. Due to their experience conducting summer IPHC surveys, the vessel and crew have maintained their gear and methods to IPHC survey standards for our research. Data collected include species composition, biological sampling, tag deployment, and CTD instrument deployment. WDFW biologists conduct 100 percent hook tally sampling for all stations. Biological data from non-rockfish species includes a LF sample of 20 percent of the catch. Catch from the first 20 hooks of each skate are measured. Retained rockfish are sampled for length, sex, weight, and age. Length, sex, tag numbers, and genetic samples are collected from Yelloweye rockfish. Non-rockfish species are released immediately unless they fall within the 20 percent Length Frequency (LF) sampling protocol. Rockfish, other than yelloweye, are retained on ice for biological sampling dockside and donated to a local food bank. Yelloweye rockfish are tagged with an external Floy tag and released at depth with a descending device.

In 2011, the Department began to explore potential seasonal effects on rockfish distributions around IPHC station 1082. Three surveys were completed between October 2011 and October 2012 with eleven, twelve, and nine stations covered respectively (Table 1). All sets deployed during these surveys were deemed to be successful sets. Station 1084 was not set in 2011 due to time constraints and its northernmost location. In October 2012, poor weather throughout the trip reduced fishing time to only three days and only stations 1082 and surrounding TRSS stations were set. A total of 227 yelloweye were successfully released with tags for all trips for an 86% tag rate of individuals encountered (Table 2). Most of the yelloweye encountered are consistently located on the southwest corner of the survey area (TRSS 1531). No tags have been recaptured at present. The total number of fish caught was 1768, 2101 and 1080 for fall 2011, spring 2012 and fall 2012, respectively (Tables 3, 4 and 5). Spiny dogfish comprised the majority of catch across all three surveys. The diversity of species encountered from the

fall 2011 survey increased 54% in spring 2012 with number of species caught increasing from 13 to 20. Rockfish species encountered doubled with three species encountered in 2011 and six species in 2012. Total number of fish caught increased 19% and total kilograms caught increased 132%. The percentage of hooks with catch was similar for these surveys with a difference of 4%. The fall 2012 survey saw declines in catch rates and species diversity. Percent of hooks with catch in the fall 2012 was 35.75%, a decrease of 18% and the number of species encountered fell to ten species.

No tags have been recovered from the three surveys conducted in 2011 and 2012. Depending on sufficient yelloweye research set-asides, WDFW anticipates conducting surveys, both spring and fall, over the next several years to tag additional rockfish and to provide the opportunity to encounter previously tagged fish. Initially, WDFW mimicked IPHC survey methods but focused on rockfish stations. In 2012 and going forward, survey methods will diverge somewhat as IPHC conducts bait tests while WDFW has and will continue to follow the original IPHC protocols for bait. To expand survey interception of smaller rockfish, WDFW intends to test sablefish hooks with squid during surveys in 2013. WDFW has also proposed that the summer IPHC survey include the rockfish stations around Station 1082 to improve seasonal comparisons. (The summer rockfish survey was canceled in 2010 and 2011 due to the low catch limits set by the PFMC and IPHC revising their survey design.)

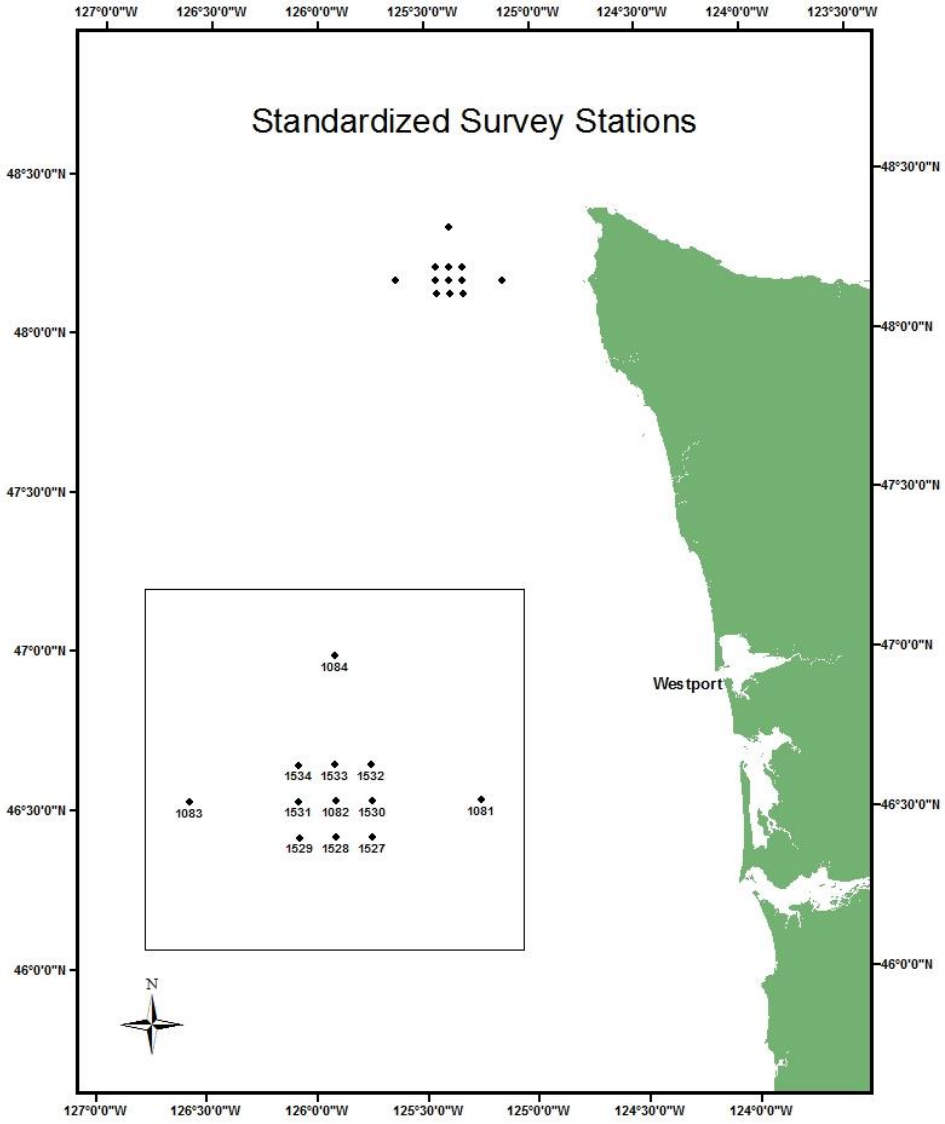

Figure 1. Standardized Survey Stations

Table 1. Trip Summary

Trip	Vessel	Survey	Days Fished	Number of Stations Set	Target Stations	Successful Sets
1	Pacific Surveyor	October 2011	4	11	12	100%
2	Pacific Surveyor	May 2012	4	12	12	100%
3	Pacific Surveyor	October 2012	3	9	12	100%
		Totals	**11**	**32**	**36**	

Table 2. Yelloweye Tagging Statistics

			Number Yelloweye Tagged by Station								
Trip	**Total YE Caught**	**YE Tagged and Released**	**1081**	**1082**	**1084**	**1528**	**1529**	**1530**	**1531**	**1533**	**1534**
1	97	65	1	8	0	12	4	9	14	12	5
2	110	108	13	9	3	30	2	0	43	4	4
3	56	54	0	14	0	9	1	0	26	3	1
Totals	**263**	**227**	**14**	**31**	**3**	**51**	**7**	**9**	**83**	**19**	**10**

Table 3. Fall 2011 Catch Statistics

						Number Caught by Station										
Species Name	**Total Caught**	**Average Weight (kg)**	**Total Weight (kg)**	**Percent of Catch by Weight**	**Percent of Catch by Number**	**1081**	**1082**	**1083**	**1527**	**1528**	**1529**	**1530**	**1531**	**1532**	**1533**	**1534**
Arrowtooth Flounder	3	1.00	3.00	0.07%	0.17%	1	0	0	0	0	0	2	0	0	0	0
Big Skate	2	5.00	10.00	0.22%	0.11%	1	1	0	0	0	0	0	0	0	0	0
Canary Rockfish	9	2.43	21.87	0.48%	0.51%	0	3	0	0	4	1	0	0	0	1	0
Lingcod	13	9.49	123.40	2.68%	0.74%	2	3	0	0	3	0	3	1	0	0	1
Longnose Skate	11	0.09	0.98	0.02%	0.62%	2	4	0	1	0	2	1	0	0	0	1
Pacific Halibut	77	7.91	609.08	13.24%	4.36%	19	16	0	0	8	5	7	3	2	15	2
Sablefish	5	5.00	25.00	0.54%	0.28%	2	0	2	0	1	0	0	0	0	0	0
Spiny Dogfish	1543	2.23	3443.88	74.88%	87.27%	201	237	188	125	134	119	100	109	119	92	119
Unidentified Sea Cucumber	1	0.10	0.10	0.00%	0.06%	0	0	0	0	0	0	1	0	0	0	0
Unidentified Sponge	1	0.10	0.10	0.00%	0.06%	0	0	0	0	0	0	0	0	0	1	0
Unidentified Starfish	5	0.10	0.50	0.01%	0.28%	1	0	0	1	0	2	1	0	0	0	0
Yelloweye Rockfish	97	3.72	360.49	7.84%	5.49%	1	11	0	0	21	4	10	23	0	16	11
Yellowtail Rockfish	1	1.00	1.00	0.02%	0.06%	0	0	0	0	1	0	0	0	0	0	0
Total Number Caught:	1768		4599.39	100.00%	100.00%	230	275	190	127	172	133	125	136	121	125	134
Number of Hooks:	4248															
Percent of Hooks with Catch:	41.62%															
Number of Sets:	11															
Number of Skates:	42															
Average Hooks per Skate:	101.143															

Table 4. Spring 2012 Catch Statistics

						Number Caught by Station											
Species Name	**Total Caught**	**Average Weight (kg)**	**Total Weight (kg)**	**Percent of Catch by Weight**	**Percent of Catch by Number**	**1081**	**1082**	**1083**	**1084**	**1527**	**1528**	**1529**	**1530**	**1531**	**1532**	**1533**	**1534**
Arrowtooth Flounder	1	1.00	1.00	0.01%	0.05%	0	0	0	0	0	0	0	1	0	0	0	0
Big Skate	7	20.00	140.00	1.31%	0.33%	2	2	0	2	0	0	0	0	1	0	0	0
Bocaccio	12	3.64	43.65	0.41%	0.57%	0	0	3	0	0	3	0	0	6	0	0	0
Canary Rockfish	8	2.30	18.39	0.17%	0.38%	0	2	0	0	0	2	0	0	4	0	0	0
Flathead Sole	1	1.00	1.00	0.01%	0.05%	0	1	0	0	0	0	0	0	0	0	0	0
Lingcod	25	7.91	197.83	1.86%	1.19%	5	3	1	0	1	5	5	0	4	0	1	0
Longnose Skate	64	5.38	344.44	3.23%	3.05%	34	6	3	4	7	0	3	1	4	0	0	2
Pacific Cod	1	1.00	1.00	0.01%	0.05%	1	0	0	0	0	0	0	0	0	0	0	0
Pacific Halibut	213	9.84	2096.79	19.69%	10.14%	40	39	36	15	14	3	15	2	25	0	8	16
Petrale Sole	1	1.00	1.00	0.01%	0.05%	0	0	1	0	0	0	0	0	0	0	0	0
Redbanded Rockfish	7	2.15	15.04	0.14%	0.33%	7	0	0	0	0	0	0	0	0	0	0	0
Sablefish	4	5.00	20.00	0.19%	0.19%	0	0	4	0	0	0	0	0	0	0	0	0
Silvergray Rockfish	1	3.32	3.32	0.03%	0.05%	0	0	0	0	0	0	0	0	1	0	0	0
Spiny Dogfish	1631	4.51	7353.09	69.04%	77.63%	64	196	175	233	143	148	108	159	44	174	111	76
Spotted Ratfish	3	1.00	3.00	0.03%	0.14%	3	0	0	0	0	0	0	0	0	0	0	0
Unidentified Idiotfish	3	1.21	3.63	0.03%	0.14%	3	0	0	0	0	0	0	0	0	0	0	0
Unidentified Sponge	1	0.10	0.10	0.00%	0.05%	0	0	0	0	0	0	0	0	1	0	0	0
Unidentified Starfish	4	0.10	0.40	0.00%	0.19%	1	1	0	0	1	0	0	1	0	0	0	0
Yelloweye Rockfish	110	3.61	397.48	3.73%	5.24%	13	9	0	3	0	31	2	0	43	0	4	5
Yellowtail Rockfish	4	2.32	9.30	0.09%	0.19%	0	0	0	0	0	3	0	1	0	0	0	0
Total Number Caught:	2101		10650.45	100.00%	100.00%	173	259	223	257	166	195	133	165	133	174	124	99
Number of Hooks:	4837																
Percent of Hooks with Catch:	43.44%																
Number of Sets:	12																
Number of Skates:	48																
Average Hooks per Skate:	100.77																

Table 5. Fall 2012 Catch Statistics

						Number Caught by Station								
Species Name	**Total Caught**	**Average Weight (kg)**	**Total Weight (kg)**	**Percent of Catch by Weight**	**Percent of Catch by Number**	**1082**	**1527**	**1528**	**1529**	**1530**	**1531**	**1532**	**1533**	**1534**
Canary Rockfish	11	2.38	26.15	0.81%	1.02%	7	0	0	2	0	2	0	0	0
Lingcod	6	8.28	49.66	1.53%	0.56%	2	0	1	0	0	3	0	0	0
Longnose Skate	1	1.00	1.00	0.03%	0.09%	0	0	1	0	0	0	0	0	0
Pacific Halibut	30	10.00	299.96	9.27%	2.78%	9	0	6	1	1	3	3	3	4
Rosethorn Rockfish	1	0.44	0.44	0.01%	0.09%	1	0	0	0	0	0	0	0	0
Sablefish	4	5.00	20.00	0.62%	0.37%	0	1	0	0	3	0	0	0	0
Silvergray Rockfish	1	3.99	3.99	0.12%	0.09%	1	0	0	0	0	0	0	0	0
Spiny Dogfish	969	2.70	2613.68	80.77%	89.72%	220	101	101	107	64	98	77	108	93
Spotted Ratfish	1	1.00	1.00	0.03%	0.09%	0	0	1	0	0	0	0	0	0
Yelloweye Rockfish	56	3.93	219.96	6.80%	5.19%	16	0	9	1	0	26	0	3	1
Total Number Caught:	1080		3235.83	100.00%	100.00%	256	102	119	111	68	132	80	114	98
Number of Hooks:	3021													
Percent of Hooks with Catch:	35.75%													
Number of Sets:	9													
Number of Skates:	30													
Average Hooks per Skate:	100.7													

c. Evaluation of Recreational Fisheries for Rockfish in Marine Catch Area 4B

In 2011, the MFS unit initiated a two-year research project at Neah Bay. The project's purpose is to evaluate conservation measures implemented in 2010 to protect rockfish specifically in Marine Catch Area "4B", an area that extends east from Tatoosh Island to the Sekiu River. New fishing regulations included a deep water (>120ft) closure for bottomfish fishing; no-retention of rockfishes other than black and blue; and a daily limit of six black and blue rockfish combined. Additionally, the aggregated daily limit for bottomfish was reduced from 15 to 10 in 2011.

A "test" fishery using recreational angling techniques and gears was conducted for rockfish in Area 4B to collect species composition, and temporal and spatial rockfish distribution. Data collected through established dockside sampling programs have been evaluated separately and in conjunction with test fishery data to assess the effectiveness of regulation changes in meeting the expected reductions in rockfish mortality in the sport fishery. In addition, a pilot effort is testing the use of a voluntary angler logbook as a cost-effective, long-term approach to monitoring the recreational bottomfish fishery. The logbook will be used to obtain detailed information about the chronology and catches from individual fishing trips throughout the whole year. A core group of sport anglers, enlisted in 2012, submit logbooks monthly.

d. Outreach and Education

In support of rockfish identification, and barotrauma and descending device outreach activities, coastal MFS staff expended considerable time and effort to obtain high quality photographs of rockfish, taking advantage of the access afforded through the tagging and 4B rockfish projects. Descending devices were also tested during both projects and photographed in use. These photographs now appear in agency produced barotrauma/descending device posters and brochures and in the 2013-2014 recreational fishery regulation pamphlet. Upgrades to the agency website are underway and these photographs are also being incorporated into the redesigned groundfish id webpage.

2. Forage Fish Management, Monitoring, Research, and Assessment (*Contact: Lorna Wargo (360) 249-1221 Lorna.Wargo@dfw.wa.gov; Dayv Lowry 360-95-2558, dayv.lowry@dfw.wa.gov)*

e. Washington – Outer Coast Smelt Spawning Beach Survey

Funded by proviso money from the Washington Legislature to inform marine spatial planning on the outer coast, WDFW staff undertook a 7-month survey, October 2012 to April 2013, of beaches in an effort to document seasonal and spatial patterns of spawning ground usage by surf smelt, night smelt, and sand lance. Substantial effort has been allocated in identifying forage fish spawning beaches in Puget Sound (over 30,000 surveys in over 30 years) and comparatively little effort on the outer coast (fewer than 100 surveys). Therefore, the distribution and timing of forage fish spawning on the Washington outer coast is incompletely known. This is the first comprehensive forage fish spawning survey of the Washington outer coast done in collaboration with the coastal tribes; Quinault, Hoh, Quileute, and Makah.

Sampling locations includes Washington outer coast (Columbia R. North Jetty to Cape Flattery) beaches identified as semi exposed cobble-mixed coarse and exposed sandy beaches based on DNR ShoreZone line feature GIS data. Based on the beach type criteria, there are 35 beaches, with each beach divided

into equal sampling segments as close to 1000' as possible. Based on our knowledge through extensive Puget Sound surveys, the chosen beach types have the potential to support spawning of surf smelt, night smelt, and sand lance, and 1000' has been the historic sampling resolution. 10% of potential beach segments are selected for sampling monthly (84 segments/month), without replacement, for each month from October 2012 – April 2013. The 7 month survey will produce an expected sample size of 70% (588 segments) of potential spawning beaches, and these data will be used in an occupancy model to extrapolate spatial temporal patterns to the remainder of the sampling universe.

This study uses a variant of the bulk sediment sampling procedure used for forage fish spawning surveys in Puget Sound. The protocol has been modified to sample perpendicular to the beach, from the entire upper third of the recent tidal range, allowing us to account for the lack of knowledge about the specific tidal height at which eggs are deposited on the outer coast. At each station, 3 bulk sediment subsamples are collected 100' apart. For each subsample, 4 evenly spaced scoops of sediment are collected within the estimated upper third of the tidal range. The sediment samples are run through a fixed set of sieves and the 0.5 mm sediment size fraction is "winnowed" to isolate the least dense elements. The remaining "light fraction" is examined under a microscope for egg presence and abundance. This study adopted the Puget Sound forage fish egg presence/absence laboratory protocol, with the WDFW standard for documenting a spawning site for a given species at 2+ eggs (live or dead) per single sample.

From the months of October 2012 – February 2013, we have sampled 330 of 420 (78.6%) planned sampling stations. Sampling loss is primarily due to limited site access and weather conditions. During these first 5 months of sampling, 329 stations were listed as "absent" of forage fish eggs, and 1 station "present" and documented as a spawning site. 1 of the 3 subsamples collected at this station had 2 smelt eggs (1 live, 1 dead/empty). The sample was collected by Hoh tribal technicians, mid-February, near the mouth of the Hoh River. March sample processing is currently incomplete; however, of the samples processed, 3 additional stations have been documented as spawning sites. All 3 stations are located in the Kalaloch region, between Kalaloch Creek and Steamboat Creek. Egg counts in 1 subsample ranged from 2 to 7 eggs and were all identified as smelt. All eggs found have been archived for future genetic testing to determine smelt species and to potentially identify demographically independent stocks of forage fish on the Washington outer coast.

The study initially planned a 7 month survey; however, it was hoped that sampling would continue through October 2013, for 1 full year of data, to fully assess the temporal patterns of coastal forage fish spawning. It is likely that sampling will continue for a full year, although it is currently pending confirmed funding from the Washington Legislature. Additionally, the Olympic National Park has expressed interest in funding the project through to a full year and the Department of Natural Resources has indicated a desire to continue funding, possibly for another 2 years of surveys during the months of February to October. At present, sampling is planned to continue past April and through to June 2013, in an effort to maximize data collection with currently secured funds. A report is currently expected to be submitted by summer 2013 unless sampling continues through fall, in which case the report will be submitted winter 2013 and later published as a WDFW Technical Report.

f. Washington Commercial Shrimp Trawl Observer Program – Eulachon Bycatch Study (*Contact: Lorna Wargo (360) 249-1221 Lorna.Wargo@dfw.wa.gov)*

The ocean pink shrimp (*Pandalus jordani*) trawl fishery is a vital component of Washington's coastal commercial fisheries, providing greater stability compared to other trawl fisheries. In 2010, eulachon were listed under the ESA as a threatened species. In that listing, the Pacific Northwest trawl fishery for ocean pink shrimp was deemed a moderate threat to eulachon recovery; the Eulachon Biological Review Team (BRT) ranked bycatch second among the severity of threats impacting recovery of eulachon stocks (Gustafson, et. al., 2010). The ocean pink shrimp fishery also encounters rockfish including "overfished" species, e.g. dark blotched rockfish *Sebastes crameri* and Pacific ocean perch *S. alutus* juveniles and yelloweye rockfish S. *ruberrimus*. Prior to 2010 very limited information about bycatch composition or rates existed for the Washington shrimp trawl fishery. To close this data gap, the Washington Department of Fish and Wildlife undertook two actions: 1) implemented regulations effective in 2010 to require participation of Washington licensed shrimp trawl fishers in the West Coast Groundfish Observer Program (WCGOP); and 2) sought and received a Species Recovery Grant to implement a state-based observer program (Studies of Eulachon Smelt in Oregon and Washington, NOAA Grant No.NA1ONMF4720038. This project concludes June 30, 2013; a final report is due December 31, 2013.

MFS-coastal unit staff conducted the state-based program, deploying observers on vessels during the 2011 and 2012 shrimp fishery seasons with simultaneous coverage by the WCGOP. In 2011, the WDFW observer program observed 819 tows (23.7%) across 50 trips (24.3%). Section 6 funding cuts reduced coverage in 2012 to 666 tows (15.9%) across 41 trips (16.1%). Sampling protocols largely followed the WCGOP and estimates of bycatch for eulachon smelt, plus other species or categories of fish will be reported. While the study had enumeration of bycatch and collection of eulachon biological data (including genetic sampling) as its primary objectives, formal and informal actions to reduce bycatch were also undertaken. Regulatory changes to allow only rigid panel excluders and to reduce the maximum bar spacing on excluder panels (or biological reduction device; BRDs) to ¾ inches were adopted and effective for the 2012 season. Staff encouraged voluntary gear and fishing practice changes by skippers to reduce bycatch, and deployed underwater camera equipment to collect video to further inform and guide these changes.

g. Participation in Conferences and Workshops

In 2012 staff of the Coastal MFS Unit presented at several regional scientific meetings, as indicated below.

Western Groundfish Conference, Feb 7-10. Presenter: Donna Downs, Poster: Lorna Wargo.
NOAA/WDFW Cooperative Research Symposium at Pt. Adams, Feb 23. Presenter: Lorna Wargo.
Friday Harbor Labs Symposium: Biology and Management of Forage Fish in the Salish Sea, Sept 12-14. Presenter: Lorna Wargo.