DRAFT

Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the Northwest Fisheries Science Center

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Appendix A

NWFSC Research Gear and Vessel Descriptions

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1. Trawl nets

A trawl net is a funnel-shaped net towed behind a boat to capture fish. The codend, or 'bag,' is the fine-meshed portion of the net most distant from the towing vessel where fish and other organisms larger than the mesh size are retained. In contrast to commercial fishery operations, which generally use larger mesh to capture marketable fish, research trawls often use smaller mesh to enable estimates of the size and age distributions of fish in a particular area. The body of a trawl net is generally constructed of relatively coarse mesh that functions to gather schooling fish so they can be collected in the codend. The opening of the net, called the 'mouth, is extended horizontally by large panels of wide mesh called 'wings' (Figures A-1 and A-2). For many trawl nets, the mouth of the net is held open by hydrodynamic force exerted on the trawl doors attached to the wings of the net. As the net is towed through the water, the force of the water spreads the trawl doors horizontally apart. Typically, the mouth of a trawl net is held open vertically using floatation on the upper edge, or "headrope", and weights on the lower edge, or "footrope". For other types of trawls, the horizontal spread of the net is maintained by a beam (beam trawl; Figure A-3) or the distance between two towing vessels (pair trawl; Figure A-4).

The trawl net is usually deployed over the stern of the vessel, and attached with two cables, or 'warps,' to winches on the deck of the vessel. The cables are played out until the net reaches the fishing depth. The duration of the tow depends on the purpose of the trawl, the catch rate, and the target species. Commercial trawl vessels may travel at speeds between two and five knots while towing the net for up to several hours, whereas the majority of NWFSC trawl surveys involve tow speeds from 1.5 to 3.5 knots and tow durations from 10 to 30 minutes. For research purposes, the speed and duration of the tow and the characteristics of the net must be standardized to allow meaningful comparisons of data collected at different times and locations. Active acoustic devices incorporated into the research vessel and the trawl gear monitor the position and status of the net, speed of the tow, and other variables important to the research design. At the end of the tow, the net is retrieved and the contents of the codend are emptied onto the deck or sorting table.

Some NWFSC research surveys use "pelagic" trawls, which are designed to operate either near the surface or at various depths within the water column, and other surveys use "bottom" trawls (see Table 2.2-1 in the DPEA for survey protocol and net details). Examples of NWFSC trawl gear fished at the surface include the Nordic 264, Kodiak surface trawl, and paired surface trawls. Examples of NWFSC trawl gear fished lower in the water column include the Modified Cobb mid-water trawl and the Aleutian wing mid-water trawl. Pelagic trawl nets are not designed to contact the seafloor and do not have bobbins or roller gear on the footrope. Bottom trawl nets have footropes with rollers or other groundgear designed for particular sea floor conditions to maximize the capture of target species living close to the bottom and minimize damage to the gear while moving across uneven surfaces (Figure A-1). Examples of NWFSC bottom trawl nets include the modified Aberdeen trawl, Poly Nor'easter trawl, paired shrimp trawl, and beam trawls

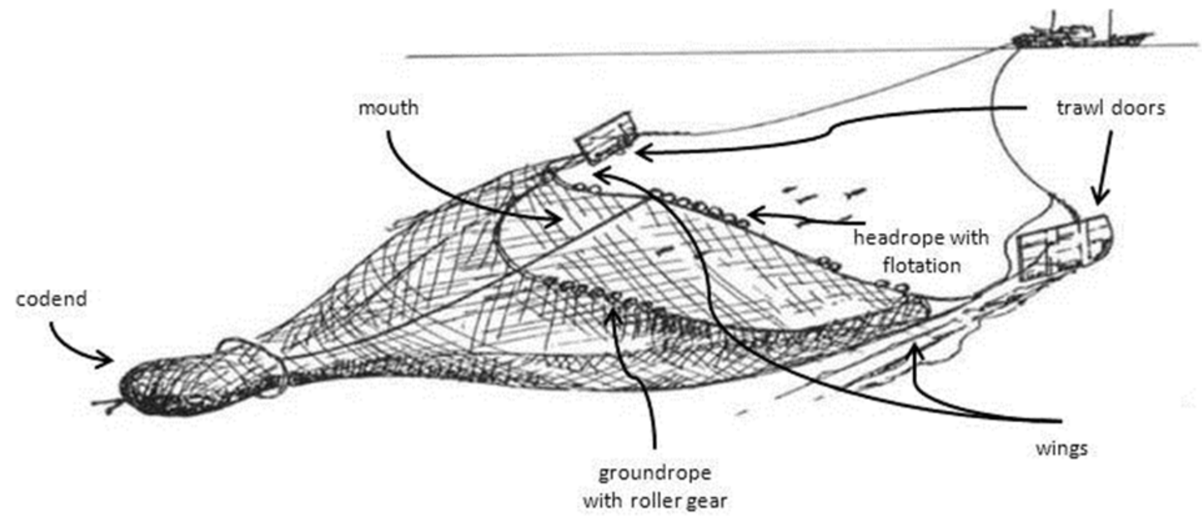


Figure A-1. Bottom trawl illustration

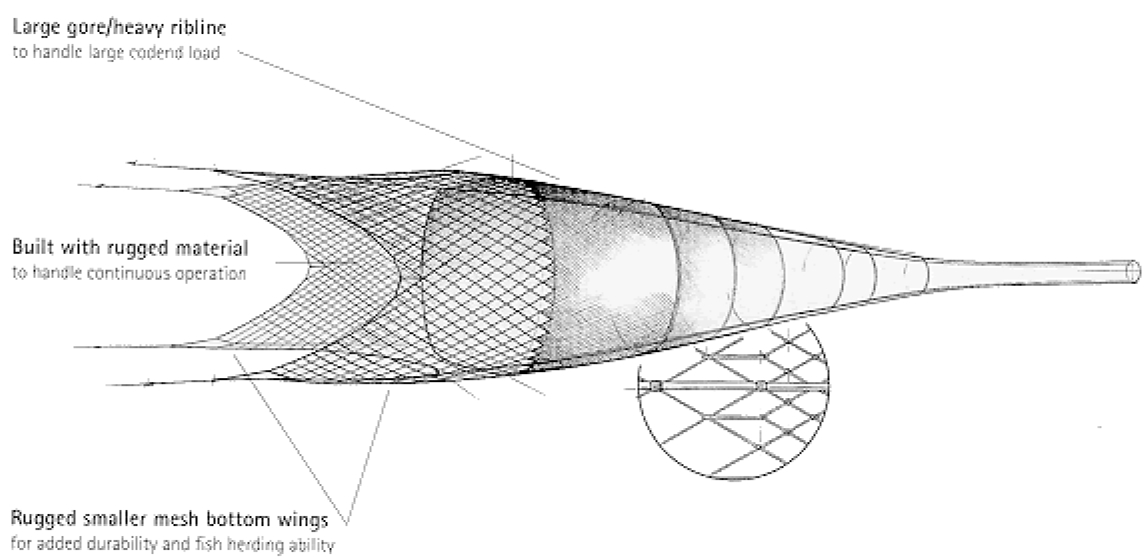


Figure A-2. Aleutian wing trawl illustration

Figure A-3. Beam trawl illustration

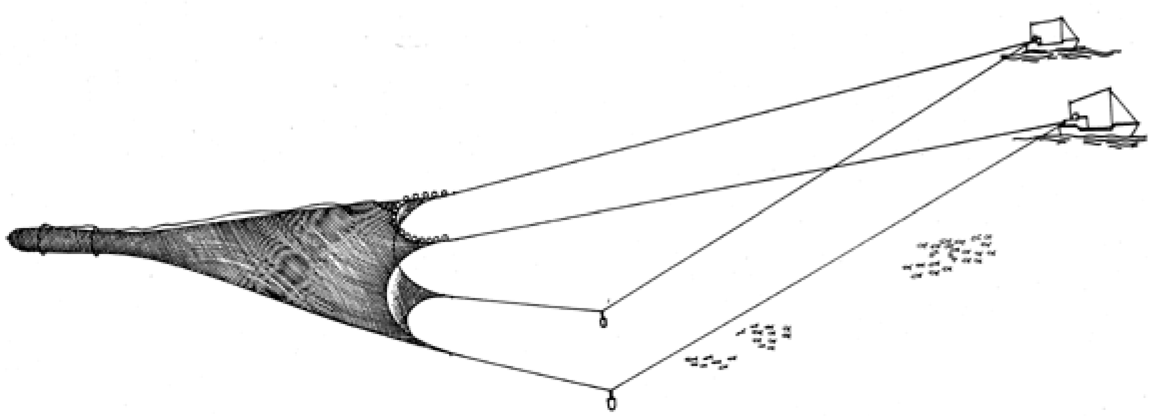


Figure A-4. Pair trawl illustration

Most NWFSC research trawlers employ a single trawl net to catch fish. The Bycatch Reduction Research Survey uses a double rigged trawl. In this method, the vessel tows two small trawl nets simultaneously rather than a single large one.

Marine mammals can become entangled by trawl gear with risks differing widely among species. Many species of marine mammals forage and swim at mid-water depths and all species come to the surface to breathe and rest, putting them at risk of being captured or entangled in pelagic trawls. Species that forage on or near the seafloor are at risk of being captured or entangled in bottom trawl netting or tow lines. There is also potential for marine mammals to interact with bottom trawl equipment near the surface of the water, as the gear is retrieved from fishing depth and brought aboard the vessel.

Recently, considerable effort has been made to develop excluder devices that allow marine mammals to escape from the net while allowing retention of the target species (e.g. Dotson et al. 2010). Marine mammal excluder devices (MMEDs) generally consist of a large rigid grate positioned in the intermediate portion of the net forward of the codend and above or below an "escape panel" constructed into the net panel (Figure A-5). The angled grate is intended to guide marine mammals through the escape panel and prevent them from being caught in the codend (Dotson et al. 2010). Different configurations of MMEDs are currently being tested on Nordic 264 nets used in the PNW Juvenile Salmon Survey.

Several NWFSC surveys use trawls with an open codend. These surveys have a reduced impact to marine organisms because they use equipment to detect or record target species and eliminate the need to capture organisms. The Pair Trawl Columbia River Juvenile Salmon Survey uses a surface pair trawl with an open codend equipped with a passive integrated transponder (PIT) detector array (discussed in detail in Section 12) to assess the passage of tagged juvenile salmon migrating from the Columbia River basin to the ocean. Another survey uses a 2-meter beam trawl with a digital video camera system (discussed further in Section 13). The trawl has an open codend and the video camera documents what goes into the net since there is no catch. A different survey also uses a 2-meter beam trawl with a video camera. In this survey, the beam trawl primarily has an open codend but a few tows are conducted with a closed codend to verify species composition identified in the video.

(Dotson et al. 2010)

Figure A-5 Marine Mammal Excluder Device installed in Nordic 264 pelagic trawl net.

2. Plankton nets

NWFSC research activities include the use of several plankton sampling nets which employ very fine mesh to sample plankton from various parts of the water column. NWFSC plankton nets employ mesh sizes from 20 to 500 micrometers. Plankton sampling nets usually consist of fine mesh attached to a rigid frame. The frame spreads the mouth of the net to cover a known surface area. Many plankton nets have a removable collection container at the codend where the sample is concentrated. When the net is retrieved, the collecting bucket can be detached and easily transported to a laboratory. Plankton nets may be towed through the water horizontally, vertically, or at an oblique angle. Often, plankton nets are equipped with instruments such as flow meters or pitch sensors to provide researchers with additional information about the tow or to ensure plankton nets are deployed consistently.

To capture plankton with vertical tows, the NWFSC uses ring nets. A ring net consists of a circular frame and a cone-shaped net with a collection jar at the codend. The net, attached to a labeled dropline, is lowered into the water while maintaining the net's vertical position. When the desired depth is reached, the net is pulled straight up through the water column to collect the sample.

A bongo net (Figure A-6) looks like two ring nets whose frames are yoked together and allows replicate samples to be collected concurrently. Bongo nets are towed through the water at an oblique angle to sample plankton over a range of depths. During each plankton tow, the bongo net is deployed to the desired depth and is then retrieved at a controlled rate so that the volume of water sampled is uniform across the range of depths. In shallow areas, sampling protocol is adjusted to prevent contact between the bongo nets and the seafloor. A collecting bucket, attached to the codend of the net, is used to contain the plankton sample. Some bongo nets can be opened and closed with remote control to enable the collection of samples from particular depth ranges. A group of depth-specific bongo net samples can be used to establish the vertical distribution of zooplankton species in the water column at a site.

Credit: Morgan Busby, Alaska Fisheries Science Center

Figure A-6. Bongo net

The Tucker net is a medium-sized single-warp trawl net used to capture plankton at different depths. The Tucker trawl usually consists of a series of nets that can be opened and closed sequentially without retrieving the net from the fishing depth.

Neuston nets are designed to capture members of the neuston, the collective term for the organisms that inhabit the water's surface. Neuston nets have a rectangular frame and are towed horizontally at the top of the water column.

3. Epibenthic tow sled

An epibenthic tow sled is an instrument that is designed to collect organisms that live on bottom sediments (Figure A-7). It consists of a fine mesh net attached to a rigid frame with runners to help it move along the substrate. The sled is towed along the bottom at the sediment-water interface, scooping up benthic organisms as it goes. NWFSC uses an epibenthic tow sled with a 1 meter by 1 meter opening and 1-millimeter mesh to collect epibenthic invertebrates in shallow eelgrass beds in Central Puget Sound.

Credit: University of South Carolina

Figure A-7. Epibenthic tow sled

4. Seine nets

A seine is a fishing net that generally hangs vertically in the water with its bottom edge held down by weights and its top edge buoyed by floats. NWFSC uses several types of seines including purse seines, beach seines, and pole seines. A purse seine is a large wall of netting deployed around an entire area or school of fish. A purse seine has rings along the bottom of the net through which a drawstring cable is threaded. Once a school of fish is located, the vessel encircles the school with the net. The cable is then pulled in, 'pursing' the net closed on the bottom, preventing fish from escaping by swimming downward (Figure A-8). The catch is harvested by either hauling the net aboard or bringing it alongside the vessel. Purse seines can reach more than 6,500 feet in length and 650 feet in depth, varying in size according to vessel, mesh size, and target species (NOAA Fisheries 2014). The purse seines employed by NWFSC are between 500 and 1,500 feet in length, between 30 and 90 feet in depth, and have mesh sizes ranging from 0.45 inches to 1.3 inches depending on the location in the net.

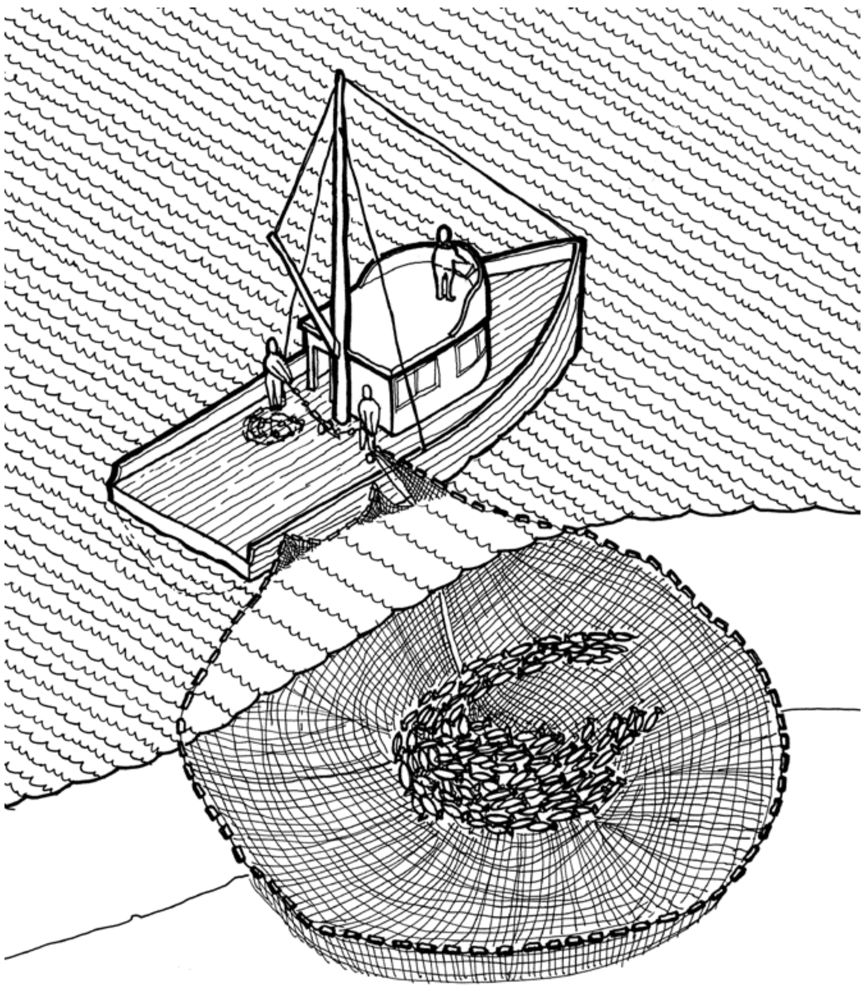


Figure A-8. Purse seine illustration

Beach seines are deployed from shore to surround all fish in a nearshore area. When setting the net, one end is fastened to the shore while the other end is set out in a wide arc and brought back to the beach. A beach seine can be deployed by hand or with the help of a small boat. When the net is set, each side is pulled in simultaneously, herding the fish toward the beach (Figure A-9). During the entire operation, the headrope with floats stays on the surface and the weighted footrope remains in contact with the bottom to prevent fish from escaping the area enclosed by the net. The beach seines used in NWFSC research are 6 to 8 feet in depth and 120 to 150 feet in length, with mesh sizes of less than 1 inch.

Credit: Paul Olsen, NOAA Fisheries

Figure A-9. A beach seine being pulled in

A pole seine is a rectangular net that has a pole on either end to keep the net rigid and act as a handle for pulling the net in (Figure A-10). The net is pulled along the bottom by hand as two or more people hold the poles and walk through the water. Fish and other organisms are captured by walking the net towards shore or tilting the poles backwards and lifting the net out of the water. The pole seine used by NWFSC is 40 feet long, 6 feet tall, and has mesh smaller than 1 inch.

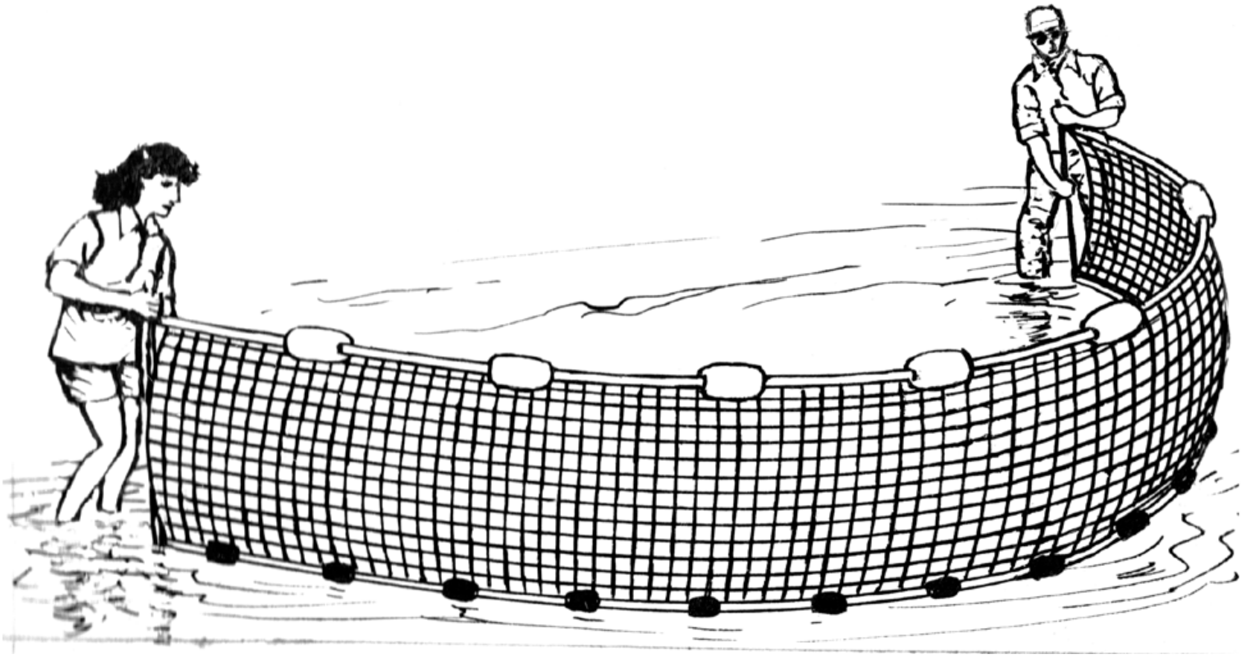


Figure A-10. Pole seine

5. Tangle net

Tangle nets are vertical panels of nylon netting and are normally set in a straight line (Figure A-11). The top of the net is buoyed with floats and the bottom of the net is weighted to maintain the net's vertical position. Tangle nets are designed for non-lethal capture of fish. The smaller mesh of a tangle net prevents fish from entering the net beyond the operculum (gill cover); instead, fish are caught by the nose or jaw. This allows fish to continue respiring and reduces their risk of injury. NWFSC uses a 600- by 40-foot tangle net with 4.25-inch mesh to catch adult salmon in the Columbia River Estuary.

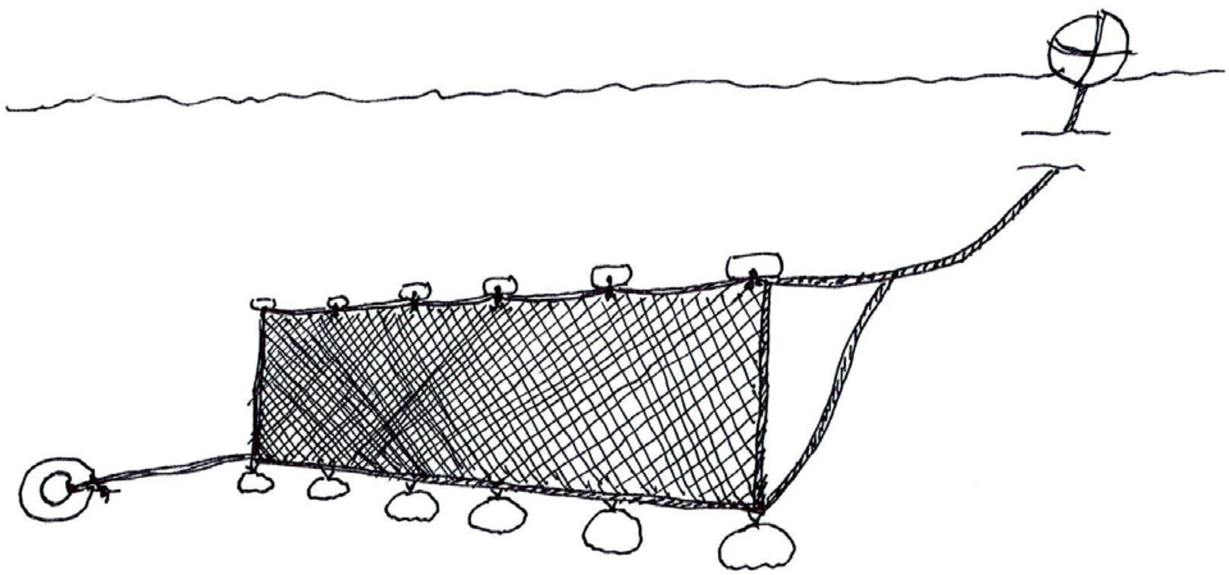


Figure A-11. Diagram of a tangle net, shown upright

6. Fish traps and pots

Fishing pots and traps are three-dimensional structures that permit fish and other organisms to enter the enclosure but make it difficult for them to escape. Traps and pots allow commercial fishers and researchers to capture live fish and can allow them to return bycatch to the water unharmed. Traps and pots also allow some control over species and sizes of fish that are caught. The trap entrance can be regulated to control the maximum size of fish that enter. The size of the mesh in the body of the trap can regulate the minimum size that is retained. In general, the fish species caught depend on the type and characteristics of the pot or trap used. Fishing traps and pots used by NWFSC include fyke traps and sablefish pots. A fyke trap consists of a trap or bag that can be conical, cylindrical, rectangular, or a floating box that are held open by frames or hoops (Figure A-12). Fyke traps are often outfitted with wings and/or leaders to guide fish towards the entrance of the actual trap. NWFSC sets fyke traps with 0.25-inch mesh for up to 6 hours in the Snohomish and Columbia river estuaries. Fyke nets are used in estuarine wetland types of habitats. The NWFSC traps channels that range in width from less than 3 ft to 15 ft. Fyke trap wings can be set up to form a barrier across a channel, trapping fish that attempt to proceed through the channel. As the tide ebbs, fish eventually seek to leave the wetland channel and are then trapped. A fyke trap is fixed on the bottom with anchors or stakes or sand bags. Usually the wings and mouth of the trap float or stick out of the water so fish cannot evade capture by swimming over the trap.

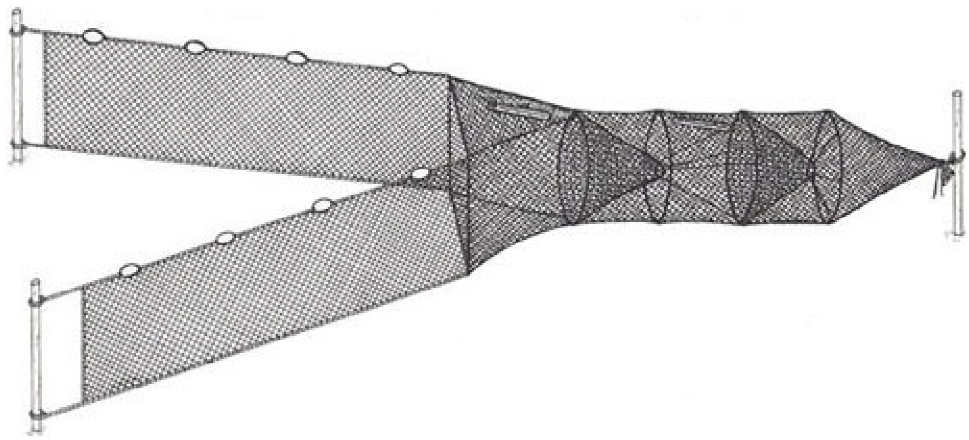


Figure A-12. Fyke trap

The NWFSC employs a limited number of conical sablefish pots (Figure A-13) to catch fish for broodstock. These pots consist of a conical-frustum-shaped frame covered in nylon netting with one or more funnel-shaped entrance tunnels. The sablefish pots used by NWFSC are 4 feet in diameter, have a soak time of 8 hours, and they are baited with squid and herring to lure fish into the pots. Sablefish pots rest on the seafloor and are often attached by a rope to a buoy at the water's surface. If a series of pots is set, a groundline may be used to connect the pots to each other to aid in pot deployment and retrieval. Modified sablefish pots are also used as predator exclusion cages for the Herring Egg Mortality Survey in Puget Sound.

Figure A-13. Illustration of a conical sablefish pot

7. Insect traps and benthic corers

As part of the Columbia River Estuary Tidal Habitats survey, NWFSC uses insect fallout traps, emergent insect cone traps, and benthic corers to sample invertebrate prey items potentially available to juvenile salmon. Insect fallout traps measure the quantity and diversity of wetland insects falling on the surface of the water. An insect fallout trap consists of a plastic box filled approximately halfway with soapy water. The containers used by NWFSC measure 50 by 35 by 14 centimeters and have a less than 10 percent dish soap solution. The containers are surrounded by four stakes to prevent the trap from floating away while allowing it to float vertically with the tides (Roegner et al. 2004).

Emergent insect cone traps are designed to capture insects as they metamorphose from aquatic nymph to terrestrial adult. The traps used by NWFSC look like inverted plastic funnels with a collection container attached to the top to contain the emerged insects (Figure A-14). Each trap is anchored in the water and collects all insects that emerge in the 0.6-m^2 area directly below the mouth of the funnel.

Benthic corers are used to collect sediment and associated benthic invertebrate samples (Figure A-14). A common type of benthic corer consists of a plastic cylinder that is pressed vertically into the sediment. Then the corer has been inserted far enough into the substrate, the top of the cylinder is capped and the corer along with the sediment sample can be pulled out far enough to cap the bottom of the tube. The corer used by NWFSC collects a sample with a 0.0024-m^2 surface area.

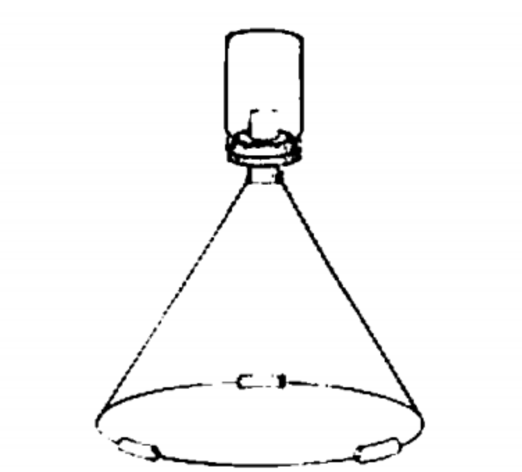



Figure A-14. An illustration of an emergent insect cone trap (left) and an example of a benthic corer with a sediment sample (right)

8. Hook-and-line Gear

Under the Status Quo, the NWFSC used rod and reel hook-and-line gear for the Southern California Groundfish Surveys that occurred within untrawlable areas. Under the Preferred Alternative, that project has been expanded to occur all along the West Coast and has been renamed, “Coastwide Groundfish Hook and Line Survey in Untrawlable Habitat”. Hook-and-line gear deployed from rod and reel was also used for fish movement studies in Puget Sound on sixgill shark, Chinook and Coho salmon as well as lingcod. Barbed or barbless circle hooks are used depending on the needs of the research to retain or release fish with minimal injury (Figure A-15).

Figure A-15. Barbed and barbless circle hooks

Longline fishing is a type of hook-and-line gear in which baited hooks attached to a mainline or 'groundline' are deployed from a vessel (Figure A-16). The length of the longline and the number of hooks depend on the species targeted, the size of the vessel used, and the purpose of the fishing activity. Commercial longlines can be over 100 kilometers long and can have thousands of hooks attached, however longlines used for research purposes are much shorter. The longline gear NWFSC uses for collection of fish for broodstock consists of 500 hooks attached to a mainline approximately 750-1000 fathoms in length. Hooks are attached to the longline by thinner lines called a 'gangions.' The length of the gangions and the distance between each gangion depends on the purpose of the research. For NWFSC broodstock collection, the gangions are less than one foot in length and are attached to the mainline at intervals of about 10 feet.

Longline research gear can be deployed either suspended in the water column with floats (pelagic gear) or anchored to the bottom (Figure A-16) with the hooks either resting on the bottom or floating just above the seafloor (demersal gear). The NWFSC uses pelagic gear in the CCRA and demersal gear in the PSRA. Demersal longline gear has weights to hold the mainline down and buoys to provide flotation and keep the baited hooks suspended in the water. Flag buoys (or 'high flyers') equipped with radar reflectors, radio transmitters, and/or light sources are often attached to each end of the mainline to enable the crew to find the longline gear for retrieval.

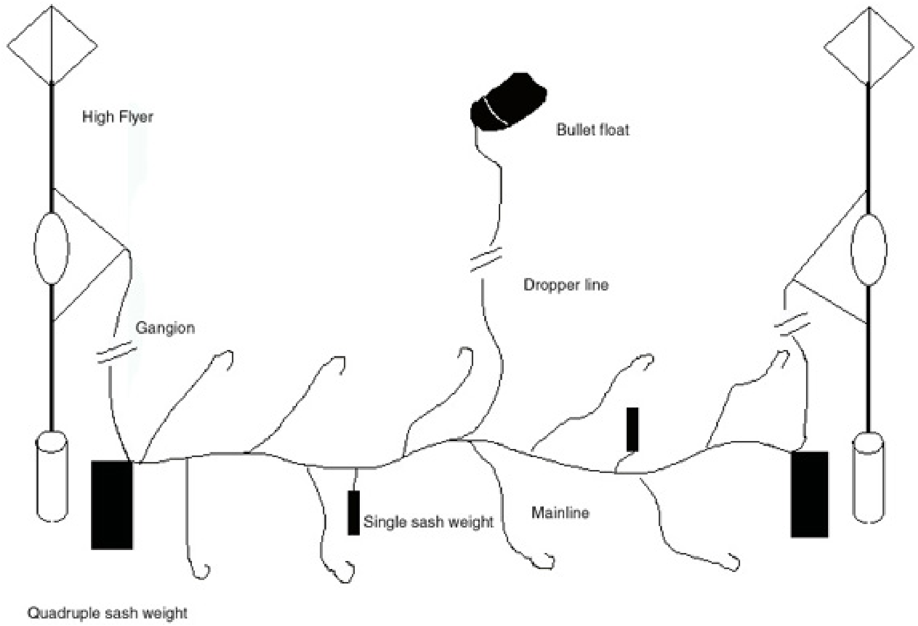


Figure A-16 Schematic example of bottom longline gear.

The time between deployment and retrieval of the longline gear is the 'soak time.' Soak time is an important parameter for calculating fishing effort and may be an important part of the research protocol. The optimal soak time maximizes the catch of target species while minimizing bycatch and minimizing damage to hooked target fish that may result from sharks or other predators. Soak time can also be an important factor for controlling longline interactions with protected species. Marine mammals, turtles, and other protected species may be attracted to bait, or to fish caught on the longline hooks. Protected species may become caught on longline hooks or entangled in the longline while attempting to feed on the catch before the longline is retrieved.

Birds may be attracted to the baited longline hooks, particularly while the longline gear is being deployed from the vessel. Birds may get caught on the hooks, or entangled in the gangions while trying to feed on the bait. Birds may also interact with longline gear as the gear is retrieved.

9. Electrofishing

Electrofishing is a common scientific survey method that uses electricity to momentarily stun fish or force them to involuntarily swim towards an electrical field to make them easier to capture. This method is used to sample fish populations to determine abundance, density, and species composition. NWFSC researchers use both backpack electrofishing units (Figure A-17) and boat-based electrofishing to collect fish. Both types of electrofishing use a power source to create electrical currents that flow from the positive electrode (anode) through the water to the negative electrode (cathode). When stunned fish are immobilized or move toward the anode, they are quickly captured with a dip net and placed in a bucket or holding tank. The fish can then be identified, measured, and released. Electrofishing does not result in permanent harm to the fish, which recover within a few minutes.

Credit: NOAA Fisheries West Coast Region

Figure A-17. A backpack electrofishing crew.

The person on the left is operating the backpack electroshocker and holding the anode in the water. The person on the right is using a dip net to collect stunned fish.

10. Active Acoustic Sources used in NWFSC Fisheries Surveys

A wide range of active acoustic sources are used in NWFSC fisheries surveys for remotely sensing bathymetric, oceanographic, and biological features of the environment, Most of these sources involve relatively high frequency, directional, and brief repeated signals tuned to provide sufficient focus and resolution on specific objects. Table A-1 shows important characteristics of these sources used on NOAA research vessels conducting NWFSC fisheries surveys, followed by descriptions of some of the primary general categories of sources, including all those for which acoustic takes of marine mammals are calculated in the LOA application.

Table A-1 Output Characteristics for Predominant NWFSC Acoustic Sources

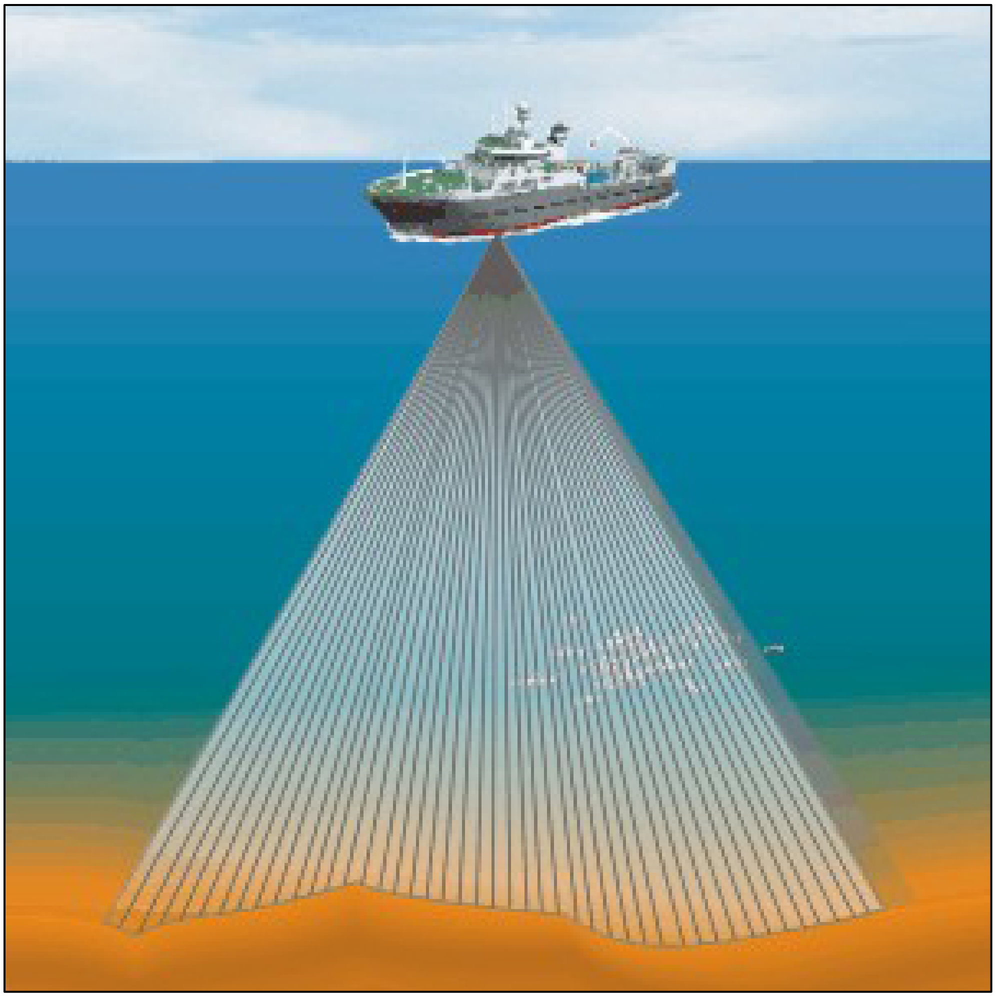
Abbreviations: kHz = kilohertz; dB re 1 µPa at 1 m = decibels referenced at one micro Pascal at one meter; ms = millisecond; Hz = hertz

Acoustic system	Operating frequencies (kHz)	Maximum source level (dB re 1 µPa at 1 m)	Single ping duration (ms) and repetition rate (Hz)	Orientation/ Directionality	Nominal beam width (degrees)
Simrad EK60 narrow beam echosounder	18, 38, 70, 120, 200 kHz	224	1 ms @ 1 Hz	Downward looking	11°
Simrad ME70 multibeam echosounder	70-120 kHz	205	2 ms @ 1 Hz	Downward looking	140°
RDI ADCP Ocean Surveyor	75 kHz	223.6	External trigger	Downward looking (30° tilt)	40° x 100°
Simrad ITI trawl monitoring system	27-33 kHz	<200	0.05-0.5 Hz	Downward looking	40° x 100°
Simrad FS70 trawl sonar	330 kHz	216	1 ms @ 120 kHz	Third wire trawl sonar for monitoring net opening and fishing conditions	5° x 20°
Simrad SX90 omni-directional multibeam sonar	70-120 kHz	206	2 ms @ 1 Hz	Downward omni-directional	0°-90° tilt angle from vertical (average)

Multibeam echosounder and sonar

Multibeam echosounders (Figure A-18) and sonars work by transmitting acoustic pulses into the water then measuring the time required for the pulses to reflect and return to the receiver and the angle of the reflected signal. The depth and position of the reflecting surface can be determined from this information, provided that the speed of sound in water can be accurately calculated for the entire signal path.

The use of multiple acoustic 'beams' allows coverage of a greater area compared to single beam sonar. The sensor arrays for multibeam echosounders and sonars are usually mounted on the keel of the vessel and have the ability to look horizontally in the water column as well as straight down. Multibeam echosounders and sonars are used for mapping seafloor bathymetry, estimating fish biomass, characterizing fish schools, and studying fish behavior. This gear generally emits frequencies from 38 to 200 kHz at less than 228 dB/1 µPa.



Credit: Simrad

Figure A-18. Conceptual image of a multibeam echosounder

Multi-frequency single-beam active acoustics

Similar to multibeam echosounders, multi-frequency split-beam sensors are deployed from NOAA survey vessels to acoustically map the distributions and estimate the abundances and biomasses of many types of fish; characterize their biotic and abiotic environments; investigate ecological linkages; and gather information about their schooling behavior, migration patterns, and avoidance reactions to the survey vessel. The use of multiple frequencies allows coverage of a broad range of marine acoustic survey activity, ranging from studies of small plankton to large fish schools in a variety of environments from shallow coastal waters to deep ocean basins. Simultaneous use of several discrete echosounder frequencies facilitates accurate estimates of the size of individual fish, and can be used for species identification based on differences in frequency-dependent acoustic backscattering between species. The NWFSC uses devices that transmit and receive at four frequencies ranging from 30 to 200 kHz.

ADCP

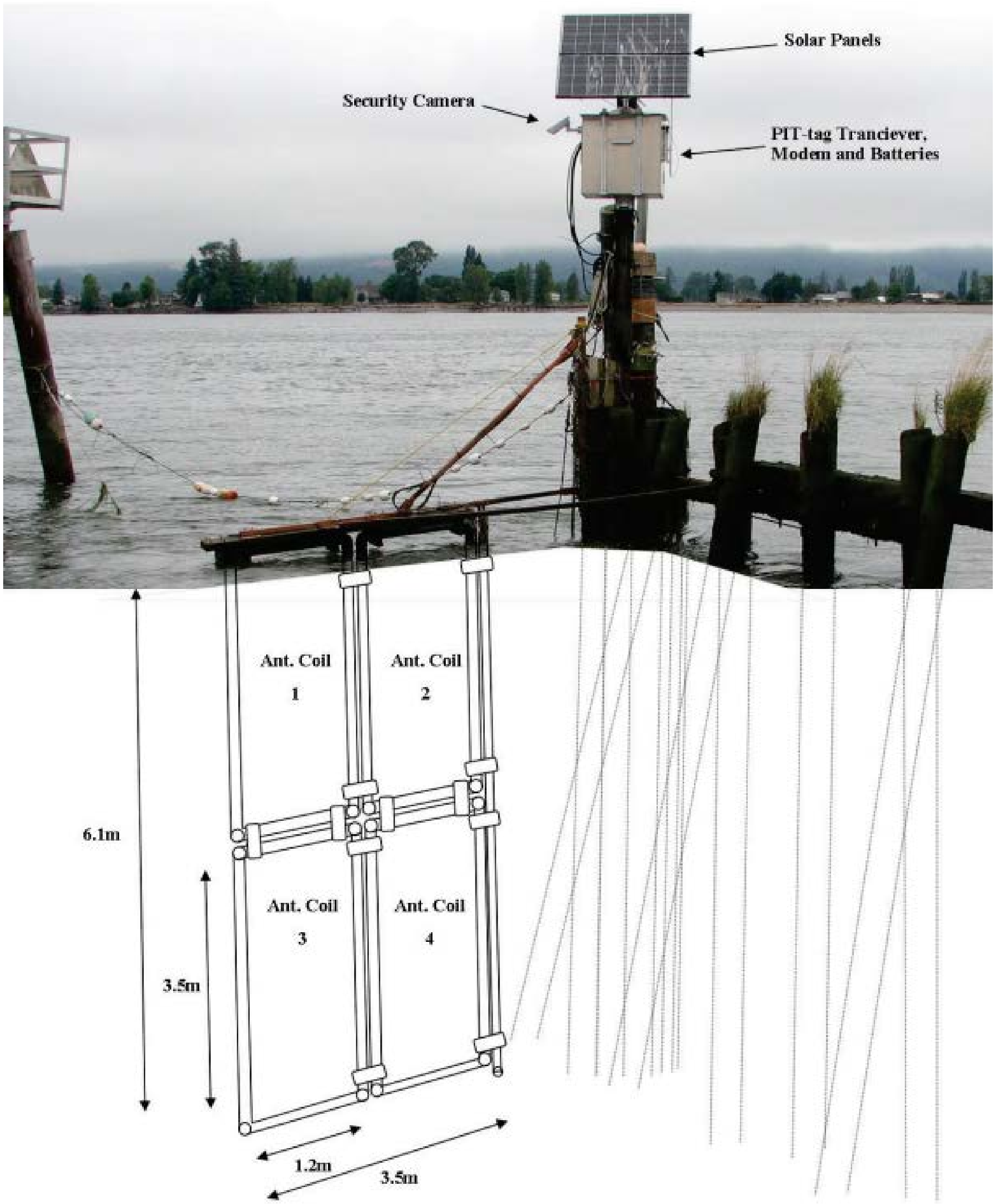
An Acoustic Doppler Current Profiler (ADCP) is a type of sonar used for measuring water current velocities simultaneously at a range of depths. An ADCP instrument can be mounted to a mooring or to the bottom of a boat. The ADCP works by transmitting "pings" of sound at a constant frequency into the water. As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument (WHOI 2011). Sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return and particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The instrument uses this shift to calculate how fast the particle and the water around it are moving. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by. By measuring the time it takes for the waves to return to the sensor, and the Doppler shift, the profiler can measure current speed at many different depths with each series of pings (WHOI 2011).

11. Acoustic telemetry

Acoustic telemetry for fisheries research employs acoustic tags which are small, sound-emitting devices allowing the detection of fish or aquatic invertebrates. An acoustic tag, or transmitter, is an electronic device usually implanted or externally attached to an aquatic organism. A tag transmits short ultrasonic signals (typically 69 kHz) either at regular intervals or as a series of several pings that contain a digital identifier code (which allows researchers to identify individual fish) and sometimes physical data (e.g., temperature). An acoustic receiver detects and decodes transmissions from acoustic tags. NWFSC uses Vemco VR2 receivers moored in fixed locations to detect the presence or absence of coded tags. For the Effects of Dredging on Crab Recruitment survey, NWFSC uses V9-2H transmitters to track Dungeness crab movements. These tags have a battery life of 100 to 280 days.

12. PIT tags and antennas

The passive integrated transponder (PIT) is a type of radio frequency identification used extensively in fisheries research. A PIT tag consists of an integrated circuit chip, capacitor, and antenna coil encased in glass. PIT tags vary in size and shape depending on the study animal. Generally, tags are cylindrical in shape, about 8-32 mm long, and 1-4 mm in diameter. PIT tags can be inserted in fish or other organisms via large-gauge hypodermic needles. Unlike acoustic tags (described in Section 13), PIT tags are dormant until activated and do not require an internal source of power. To activate the tag, a low-frequency radio signal is emitted by a scanning device that generates a close-range electromagnetic field. The tag then sends a unique alpha-numeric code back to the reader, allowing researchers to identify specific individuals (Smyth and Nebel 2013). NWFSC uses stationary PIT detection antennas in the Columbia River Estuary to detect migrating adult and juvenile salmon (Figure A-19). NWFSC also uses a PIT detector array attached to a surface pair trawl with an open codend (described in Section 1) which is towed at a depth of 5 meters for 8 to 15 hours at a speed of 1.5 knots in the Columbia River Estuary to assess the passage of migrating juvenile salmon.



Credit: NWFSC

Figure A-19. Configuration of antennas for a PIT tag detector on a pile dyke in the Columbia River Estuary

13. Video cameras

The NWFSC uses several apparatuses to collect underwater videos of benthic habitats and organisms. These include a CamPod, a video camera sled, video beam trawls, and a remotely operated vehicle

(ROV). Each apparatus includes a video camera system consisting of a digital video camera, lights, and a power source. The CamPod (Figure A-20) is a lightweight, three-legged platform equipped with a video system and adequate illumination. The frame holds a 35-millimeter stills camera system and two video cameras – one that provides a forward-looking oblique view and a high-resolution video camera that faces downward. Designed primarily for making images of the benthic environment, the configuration of the device focuses on minimizing its hydrodynamic presence in the field of view of the cameras. The CamPod is deployed vertically through the water column on a cable and is intended to view one point on the bottom.

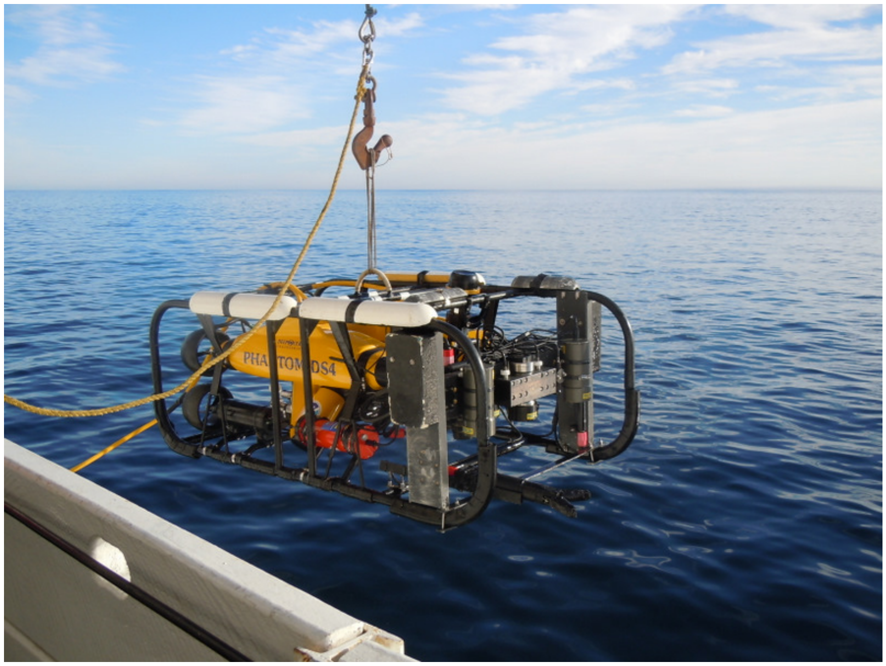
Credit: Northwest Atlantic Fisheries Organization

Figure A-20. A CamPod being deployed from a vessel

A video camera sled consists of a video camera system mounted on a metal frame with runners to allow it to move along the benthic substrate. A research vessel tows the sled along the seafloor, allowing the camera to capture video footage of the benthic environment.

The video beam trawls used by NWFSC are similar to video camera sleds. Video beam trawls consist of a video camera system attached to a beam trawl (described in Section 1) which is towed along the seafloor at speeds of 1 to 1.5 knots. NWFSC uses video beam trawls to assess the seasonal and interannual distribution of young of the year groundfishes as well as the potential effects of hypoxia on groundfish.

NWFSC uses a video ROV (Figure A-21) to capture underwater footage of the benthic environment. The ROV is controlled and powered from a surface vessel. Electrical power is supplied through an umbilical or tether which also has fiber optics which carry video and data signals between the operator and the ROV. This enables researchers on the vessel to control the ROV's position in the water with joysticks while they view the video feed on a monitor.



Credit: Southwest Fisheries Science Center

Figure A-21. A remotely operated vehicle (ROV) being deployed from a vessel

14. CTD profiler and rosette water sampler

'CTD' stands for conductivity, temperature, and depth. A CTD profiler measures these and other parameters, and is the primary research tool for determining chemical and physical properties of seawater. A shipboard CTD is made up of a set of small probes attached to a large (1 to 2 meters in diameter) metal rosette wheel (Figure A-22). The rosette is lowered through the water column on a cable, and CTD data are observed in real time via a conducting cable connecting the CTD to a computer on the vessel. The rosette also holds a series of sampling bottles that can be triggered to close at different depths in order to collect a suite of water samples that can be used to determine additional properties of the water over the depth of the CTD cast. The duration of a CTD cast varies depending on water depth. The data collected at different depths are often called a depth profile, and are plotted with the value of the variable of interest on the x-axis and the water depth on the y-axis. Depth profiles for different variables can be compared in order to glean information about physical, chemical, and biological processes occurring in the water column.

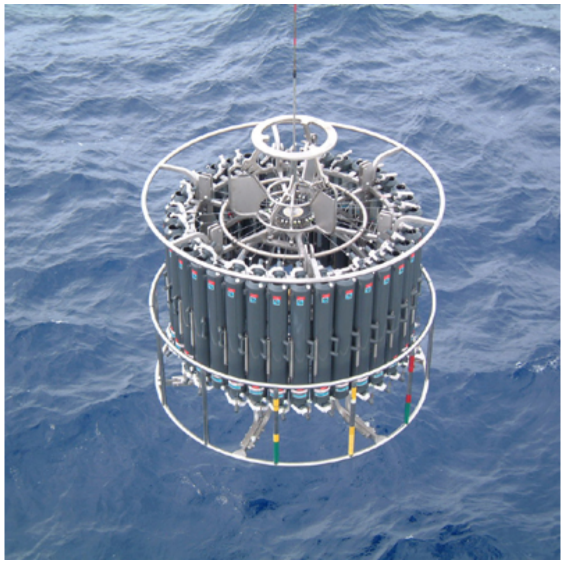


Figure A-22. Sea-Bird 911 plus CTD profiler (left) and CTD profiler deployment on a sampling rosette (right)

Conductivity is measured as a proxy for salinity, or the concentration of salts dissolved in seawater. Salinity is expressed in ‘practical salinity units’ which represent the sum of the concentrations of several different ions. Salinity is calculated from measurements of conductivity. Salinity influences the types of organisms that live in a body of water, as well as physical properties of the water. For instance, salinity influences the density and freezing point of seawater.

Temperature is generally measured using a high-sensitivity thermistor protected inside a thin walled stainless steel tube. The resistance across the thermistor is measured as the CTD profiler is lowered through the water column to give a continuous profile of the water temperature at all water depths.

The depth of the CTD sensor array is continuously monitored using a very sensitive electronic pressure sensor. Salinity, temperature, and depth data measured by the CTD instrument are essential for characterization of seawater properties. CTD profilers can be outfitted with instruments such as fluorometers, transmissometers, and dissolved oxygen sensors to measure additional water quality parameters. A fluorometer measures fluorescence and can be used to detect chlorophyll-a concentrations, an indicator of phytoplankton biomass. A transmissometer measures the transmission of light through water, which is essential to the productivity of oceans. Transmittance is reduced when light is scattered and absorbed by suspended particles, phytoplankton, bacteria, and dissolved organic matter. Dissolved oxygen sensors measure the amount of oxygen gas that is dissolved in seawater. Dissolved oxygen affects ocean chemistry and is essential for many marine organisms such as fish and invertebrates. Dissolved oxygen concentrations are impacted by environmental conditions such as temperature, salinity, turbidity, and plankton blooms.

15. Thermosalinograph and water pump, water level and temperature loggers

The CTD is not the only tool NWFSC uses to collect water quality parameters. Onboard the research vessel for the Juvenile Salmon Pacific Northwest Coastal Survey, NWFSC uses a continuous water pump with an SBE-45 MicroTSG thermosalinograph to measure sea surface conductivity and temperature. The pump continuously pumps seawater from a depth of 3 meters near the bow of the research vessel to the thermosalinograph which sends the temperature and conductivity data to a shipboard computer. The importance of conductivity and temperature measurements is described in Section 14.

To collect physical environmental data in riverine and estuarine habitats, NWFSC uses water level and temperature loggers. These devices are placed underwater at fixed locations where they continuously record data. NWFSC uses a 3 by 4 centimeter device called a TidbiT to measure and record water temperatures. To log water levels, NWFSC uses a Hobo U-model water level data logger. These devices record measurements at user defined intervals and generally have the memory and battery power to record thousands of measurements over several years.

16. NWFSC Vessels used for Survey Activities

NMFS employs NOAA-operated research vessels, chartered vessels, and vessels operated by cooperating agencies and institutions to conduct research, depending on the survey and type of research.

Figure A-23. R/V *Bell M. Shimada*

New to NOAA in 2010, the R/V *Bell M. Shimada* (Figure A-23) is one of the most technologically advanced fisheries vessels in the world. Many of the advances are focused on making the boat quieter and reducing disturbance to marine life. The vessel is fourth in the series of new fisheries survey vessels built for NOAA by VT Halter Marine, Inc. R/V *Bell M. Shimada* is home ported in Newport, OR and is shared by the SWFSC and the NWFSC. The vessel is 209 feet in length with a diesel electric drive system with two 1,508-horsepower propulsion motors and one 14.1-foot propeller. The deck has an oceanographic winch, two stern trawl winches, and two A-Frame winches. The ship can cruise at 12 knots. The R/V *Bell M. Shimada* can accommodate 39 crewmembers, including 15 scientists. The technologies on the boat offer scientists the ability to monitor fish populations without altering their behavior, allowing accurate data collection.

Figure A-24. **R/V *Pelican***

The R/V *Pelican* (Figure A-24) is a 39-foot aluminum pontoon boat owned by NWFSC and is specifically designed for purse seining. It has a pilothouse, a flat back deck, and mast and boom for purse seining. There are no rails on the starboard side to facilitate deployment of the purse seine. The vessel is propelled by an inboard gas engine and has a separate gas engine, surface mounted on the aft port side, to run the water system as well as the hydraulics for the purse seine winch. R/V *Pelican* and accompanying skiff, R/V *Tule*, are used exclusively for studying salmon habitat-use in the Lower Columbia River estuary.

Credit: NOAA

Figure A-25. R/V *Noctiluca*

The R/V *Noctiluca* is a 26-foot NMFS vessel with a center console (Figure A-25). This aluminum skiff, made by Pacific Boats, has a draft of 2 feet and a beam of 8.5 feet. The vessel is propelled by a 225-horsepower Honda outboard engine and has a 9.9-horsepower Honda kicker motor.

Credit: NWFSC

Figure A-26. **R/V *Minnow***

The R/V *Minnow* is a 21-foot NMFS vessel made by Workskiff (Figure A-26). The vessel has a 2.5-foot draft, an 8-foot beam, an aluminum hull, and a T-top center console. It is propelled by a 135-horsepower Honda outboard engine and has an 8-horsepower Honda kicker motor.

Figure A-27. R/V *Tule*

The R/V *Tule* is a 19-foot Magnum-brand aluminum skiff with a 90-horsepower Honda outboard engine (Figure A-27). It has a center console and a hefty towing post in the back for pulling in a purse seine. The skiff accompanies the purse seiner R/V *Pelican*. Both vessels are used exclusively for studying salmon habitat-use in the Lower Columbia River estuary.

Credit: David Fox, Oregon Department of Fish & Wildlife

Figure A-28. R/V *Elakha*

The R/V *Elakha* is a 54-foot, aluminum-hulled vessel owned by Oregon State University (Figure A-28). The vessel was built by Rozema Boat Works in Mount Vernon, WA and is propelled by a Caterpillar 3176B 6-cylinder diesel engine, capable of up to 600 horsepower. The R/V *Elakha* is home ported in Newport, OR and has a draft of 5 feet and a beam of 16.5 feet. It is outfitted with an A-frame, a winch, a transducer well, and other scientific equipment.

Figure A-29. M/V *Forerunner*

The M/V *Forerunner* is a 50-foot, steel-hulled vessel owned by Clatsop Community College (CCC) in Astoria, Oregon (Figure A-29). Originally launched as a commercial fishing vessel in 1969, CCC acquired M/V *Forerunner* in 1974. The vessel underwent a major overhaul in 2010. M/V *Forerunner* has a draft of 6.5 feet and is propelled by a 335-horsepower engine (CCC 2013).

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Appendix B

Spatial and Temporal Distribution of NWFSC Fisheries Research Effort

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Spatial and Temporal Distribution of NWFSC Fisheries Research Effort by Gear Type

This appendix provides a brief synopsis of NWFSC fisheries research effort under the Status Quo Alternative by gear type and by season for trawling, seining, miscellaneous fish nets, and longline fishing. Complete descriptions of the research efforts in the NWFSC research area are provided in Table 2.2-1.This appendix provides information about the spatio-temporal distribution of research effort in the NWFSC Research Area to complement the information provided in Table 2.2-1.

Table B-1 NWFSC Research Effort by Gear Type and Season in the CCRA

Gear type	Surveys	Gear Description	Sampling Events	Effort
California Current Research Area (CCRA)				
Spring (March-May)				
Bottom trawling	Bycatch reduction research	Commercial bottom trawls of various net sizes	40 bottom trawls/year (yr)	Up to 4 hour duration tows at 1.5-3.5 knots (kts) at depths of 50-1000 meters (m)
	Bycatch reduction research	Double rigged shrimp trawl of various net sizes	Up to 60 trawls/yr	30-80 minute duration tows at 1.5-3.5 kts and fished at depths of 50-1000 m
	Cameral trawl research	Poly Nor'easter Bottom Trawl (PNE)	Various	2.8-3.5 knot tows at variable depths and duration depending on time it takes to verify acoustic signal
	Groundfish bottom trawl survey	Modified Aberdeen bottom trawl of net size 5 x 15 m	737-773 trawls/yr	15 minute duration tows at 2.2 kts at depths of 55-1280 m
Midwater trawling	Bycatch reduction research	Commercial pelagic trawls of various net sizes	Up to 60 trawls/yr	Up to 8 hour duration tows at 1.5-3.5 kts and 500-1000 m depth
	Hake Acoustic Survey	AWT	150 trawls/yr	Variable duration tows at 2.8-3.5 kts at variable depths
	Camera trawl research (associated with hake acoustic survey)	Aleutian Wing Midwater Trawl (AWT)	40 trawls/yr	2.8-3.5 knot tows at depths down to 500 m
	Northern juvenile rockfish survey	Modified Cobb trawl with 9.5 mm codend and net size of 12 x 12 m	100 trawls/yr	15 minute duration tows at 2.7 kts at depths of 30-40 m
	PNW ichthyoplankton survey	Nordic 264 surface trawl of net size 30 x 20 m	40 trawls/yr	30 minute duration tows at 3 kts at depths of 30-50 m
Surface trawling	Juvenile salmon PNW coastal survey, PNW ichthyoplankton survey, PNW piscine predator and forage fish survey	Nordic 264 surface trawl of net size 30 x 20 m	88-180 trawls/yr	30 minute tows at 3-4 kts at depths down to 30 m

Gear type	Surveys	Gear Description	Sampling Events	Effort
Purse seine	Near coastal ocean purse seining	Purse seines with net size of 750 x 60ft or 1000 x 40ft and mesh size of 0.625 inches	75 sets/yr	1 hour duration sets
Longline	Aquaculture and physiology broodstock collection	750-1000 fathom mainline set at a depth of 700-3000 feet (ft)	30 sets/yr	3 hour soak time
Hook and line gear	Aquaculture and physiology broodstock collection	Rod and reel, barbed circle hooks	6 hours of fishing/day	90 hours total fishing time
Pot gear	Aquaculture and physiology broodstock collection	Sablefish pots	1 set/yr	Variable
Summer (June-August)				
Bottom trawling	Bycatch reduction research	Commercial bottom trawls of various net sizes fished at depths of 50-1000 m	40 bottom trawls/yr	Up to 4 hour duration tows at 1.5-3.5 kts
	Bycatch reduction research	Double rigged shrimp trawl of various net sizes fished at depths of 50-1000 m	Up to 60 trawls/yr	30-80 minute duration tows at 1.5-3.5 kts
	Groundfish bottom trawl survey	Modified Aberdeen bottom trawl of net size 5 x 15 m	737-773 trawls/yr	15 minute duration tows at 2.2 kts at depths of 55-1280 m
	Hake acoustic survey	PNE	150 trawls/yr	Variable duration tows at 2.8-3.5 kts at variable depths
Midwater trawling	Bycatch reduction research	Commercial pelagic trawls of various net sizes	Up to 60 trawls/yr	Up to 8 hour duration tows at 1.5-3.5 kts and 500-1000 m depth
	Hake acoustic survey	AWT	150 trawls/yr	Variable duration tows at 2.8-3.5 kts at variable depths
	Camera Trawl Research (associated with hake acoustic survey)	AWT	40 trawls/yr	Variable duration tows at 2.8-3.5 kts at depths down to 500 m
	Northern juvenile rockfish survey	Modified Cobb trawl with 9.5 mm codend and net size of 12 x	100 trawls/yr	15 minute duration tows at 2.7 kts at depths of 30-40 m

Gear type	Surveys	Gear Description	Sampling Events	Effort
		12 m		
	PNW ichthyoplankton survey	Nordic 264 surface trawl of net size 30 x 20 m	40 trawls/yr	30 minute duration tows at 3 kts at depths of 30-50 m
Surface trawling	Juvenile salmon PNW coastal survey, PNW ichthyoplankton survey, PNW piscine predator and forage fish survey	Nordic 264 surface trawl of net size 30 x 20 m	88 to 180 trawls/yr	30 minute tows at 3-4 kts at depths down to 30 m
Purse seine	Near coastal ocean purse seining	Purse seines with net size of 750 x 60ft or 1000 x 40ft and mesh size of 0.625 inches	75 sets/yr	1 hour duration sets
Longline	Aquaculture and physiology broodstock collection	750-1000 fathom mainline set at a depth of 700-3000 ft	30 sets/yr	3 hour soak time
Hook and line gear	Aquaculture and physiology broodstock collection	Rod and reel, barbed circle hooks	6 hours of fishing/day	90 hours total fishing time
Pot gear	Aquaculture and physiology broodstock collection	Sablefish pots	1 set/yr	Variable
Fall (September-November)				
Bottom trawling	Bycatch reduction research	Commercial bottom trawls of various net sizes fished at depths of 50-1000 m	40 bottom trawls/yr	Up to 4 hour duration tows at 1.5-3.5 kts
	Bycatch reduction research	Double rigged shrimp trawl of various net sizes fished at depths of 50-1000 m	Up to 60 trawls/yr	30-80 minute duration tows at 1.5-3.5 kts
	Cameral trawl research	Poly Nor'easter Bottom Trawl (PNE)	Various	2.8-3.5 knot tows at variable depths and duration depending on time it takes to verify acoustic signal
	Groundfish bottom trawl survey	Modified Aberdeen bottom	737-773 trawls/yr	15 minute duration tows at 2.2 kts at

Gear type	Surveys	Gear Description	Sampling Events	Effort
		trawl of net size 5 x 15 m		depths of 55-1280 m
	Hake acoustic survey	PNE	150 trawls/yr	Variable duration tows at 2.8-3.5 kts and fished at variable depths
Midwater trawling	Bycatch reduction research	Commercial pelagic trawls of various net sizes	Up to 60 trawls/yr	Up to 8 hour duration tows at 1.5-3.5 kts and 500-1000 m depth
	Hake acoustic survey	AWT	150 trawls/yr	Variable duration tows at 2.8-3.5 kts at variable depths
	Camera Trawl Research (associated with hake acoustic survey)	AWT	40 trawls/yr	Variable duration tows at 2.8-3.5 kts at depths down to 500 m
	PNW ichthyoplankton survey	Nordic 264 surface trawl of net size 30 x 20 m	40 trawls/yr	30 minute duration tows at 3 kts at depths of 30-50 m
Surface trawling	Juvenile salmon PNW coastal survey, PNW ichthyoplankton survey	Nordic 264 surface trawl of net size 30 x 20 m	180 trawls/yr, 88 trawls/yr	30 minute tows at 3-4 kts at depths down to 30 m
Purse seine	Near coastal ocean purse seining,	Purse seines with net size of 750 x 60ft or 1000 x 40ft and mesh size of 0.625 inches	75 sets/yr	1 hour duration sets
Longline	Aquaculture and physiology broodstock collection	750-1000 fathom mainline set at a depth of 700-3000 feet (ft)	30 sets/yr	3 hour soak time
Hook and line gear	Aquaculture and physiology broodstock collection	Rod and reel, barbed circle hooks	6 hours of fishing/day	90 hours total fishing time
	Southern California Groundfish hook and line survey	Rod and reel, 5 hooks per line	275 sites	5 sets per angler per site with a 5 minute maximum soak time at depths of 37-229 m
Pot gear	Aquaculture and physiology broodstock collection	Sablefish pots	1 set/yr	Variable
Winter (December-February)				
Hake acoustic survey	AWT	150 trawls/yr	Variable duration tows at 2.8-3.5 kts at variable depths	Hake acoustic survey

Gear type	Surveys	Gear Description	Sampling Events	Effort
Midwater trawling	Camera Trawl Research (associated with hake acoustic survey)	AWT	75 trawls/yr	Variable duration tows at 2.8-3.5 kts at depths down to 500 m
Longline	Aquaculture and physiology broodstock collection	750-1000 fathom mainline set at a depth of 700-3000 ft	30 sets/yr	3 hour soak time
Hook and line gear	Aquaculture and physiology broodstock collection	Rod and reel, barbed circle hooks	6 hours of fishing/day	90 hours total fishing time
Pot gear	Aquaculture and physiology broodstock collection	Sablefish pots	1 set/yr	Variable

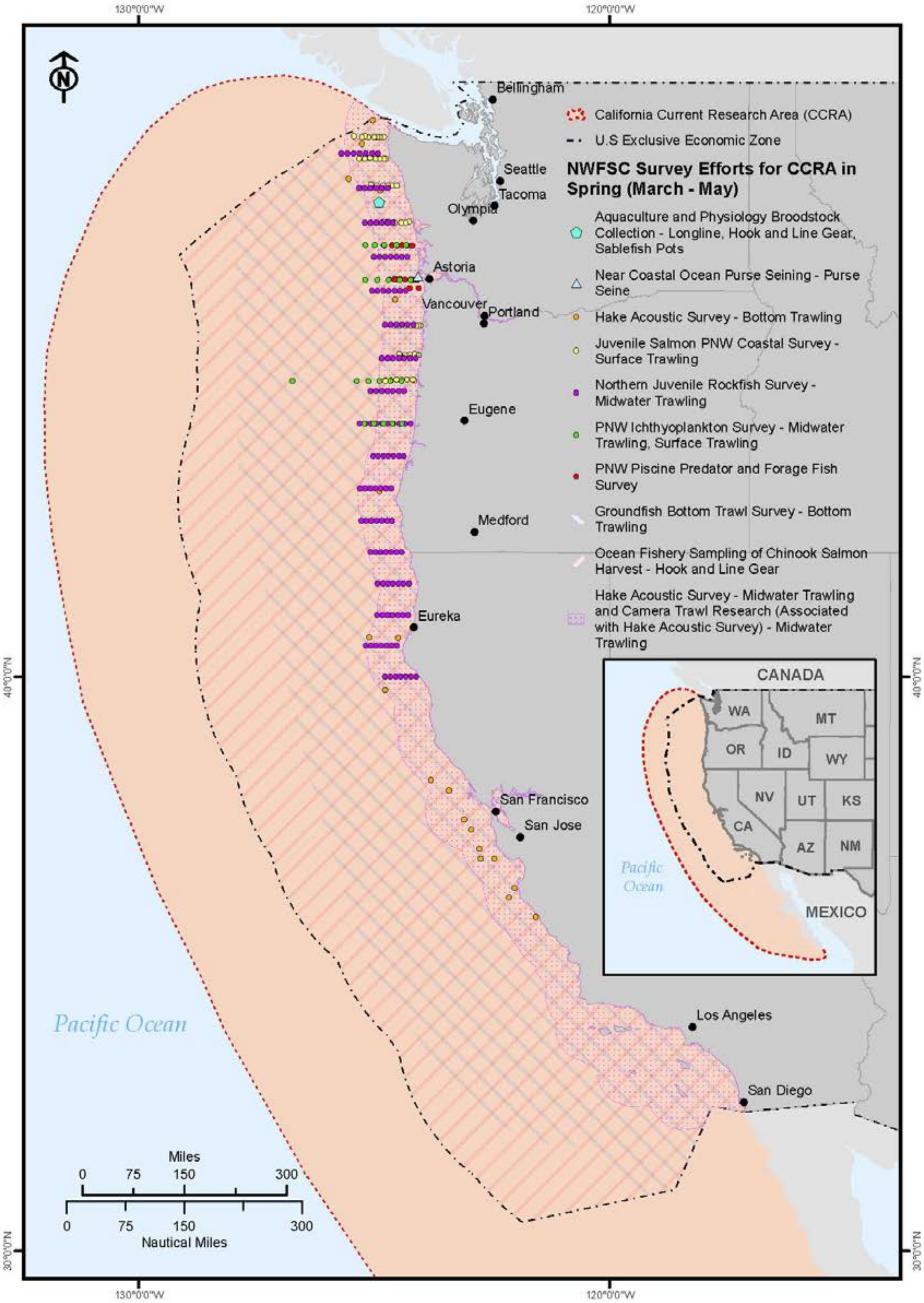

Figure B-1 Distribution of NWFSC research effort in the CCRA in spring

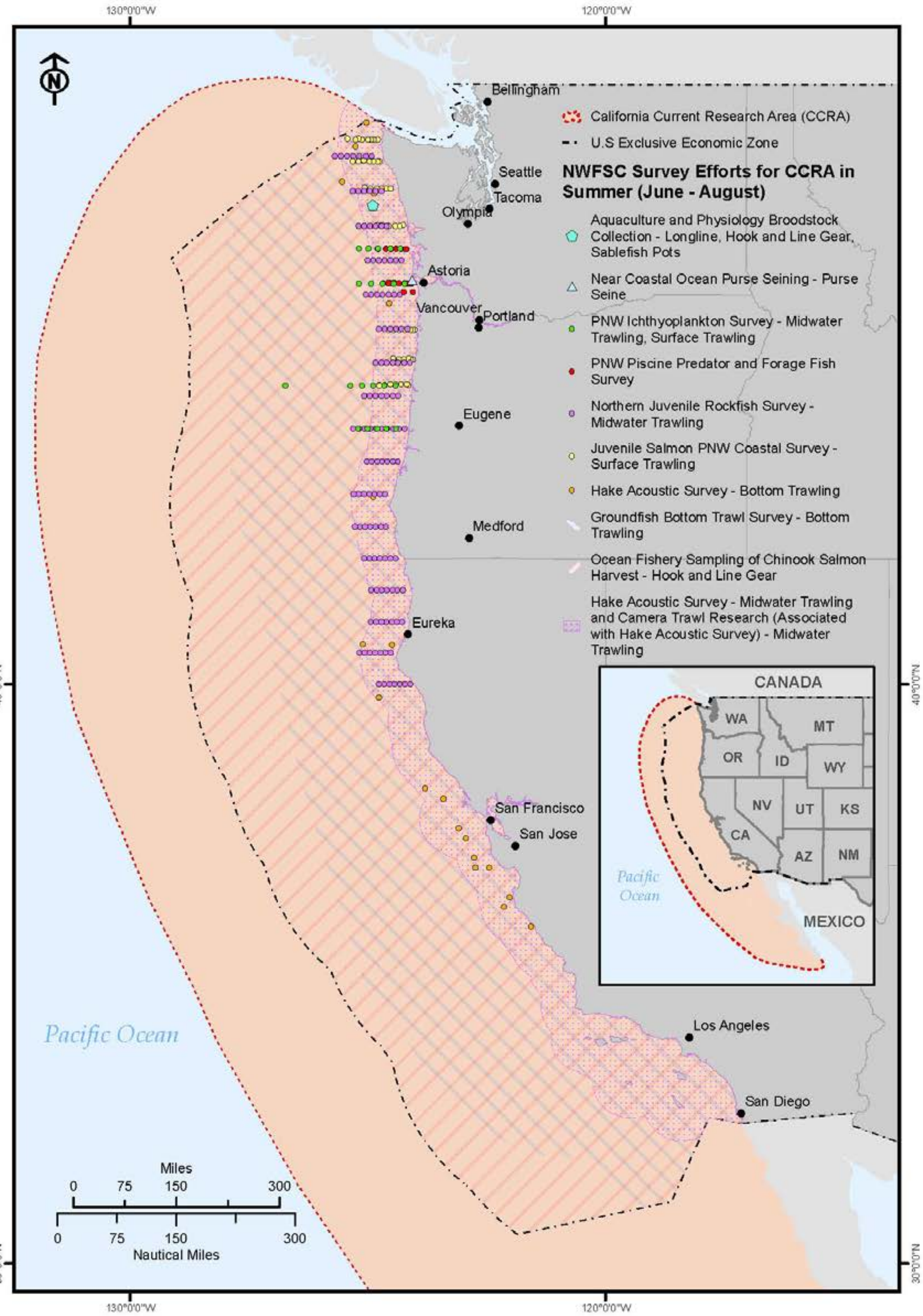

Figure B-2 Distribution of NWFSC research effort in the CCRA in summer

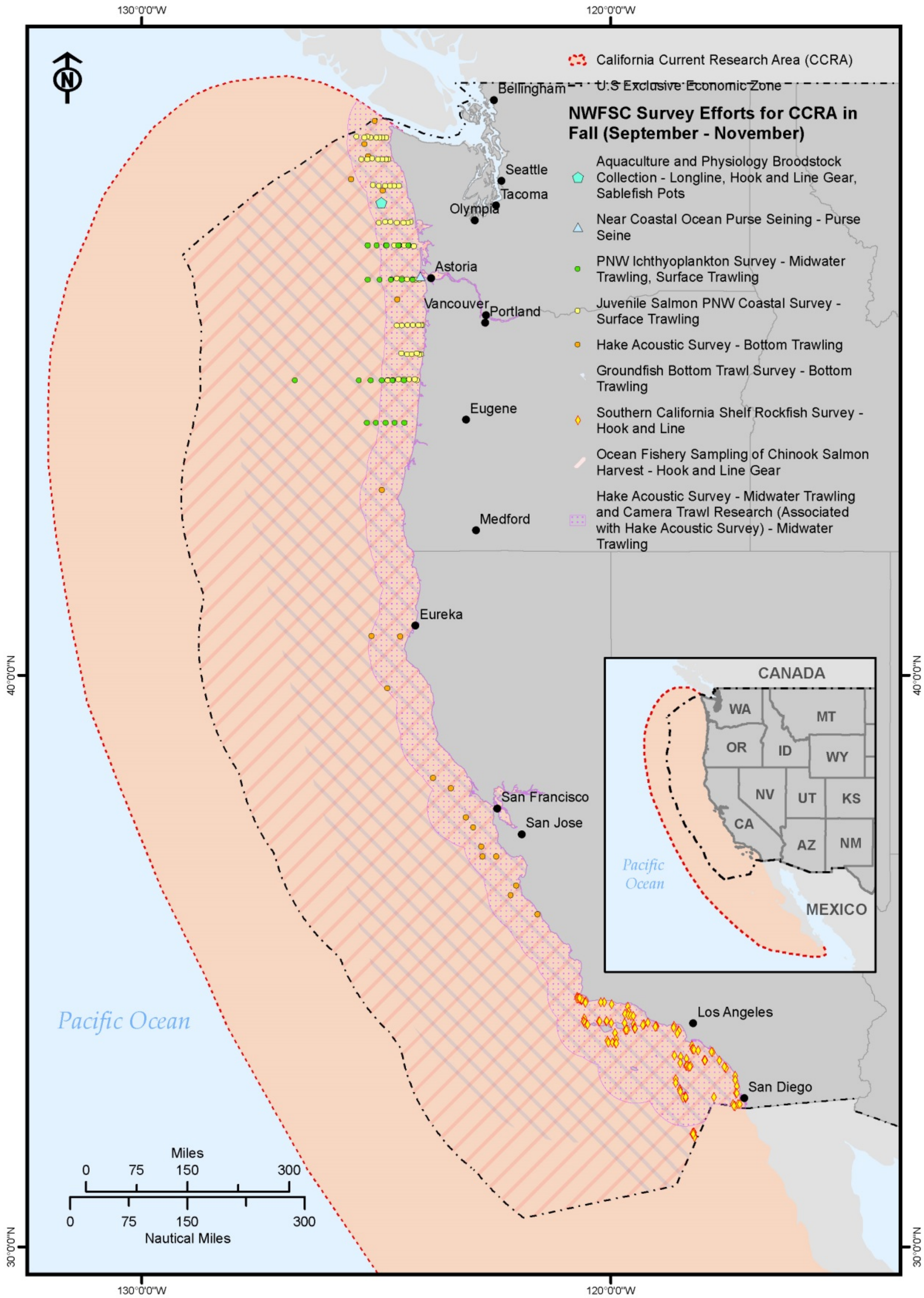

Figure B-3 **Distribution of NWFSC research effort in the CCRA in fall**

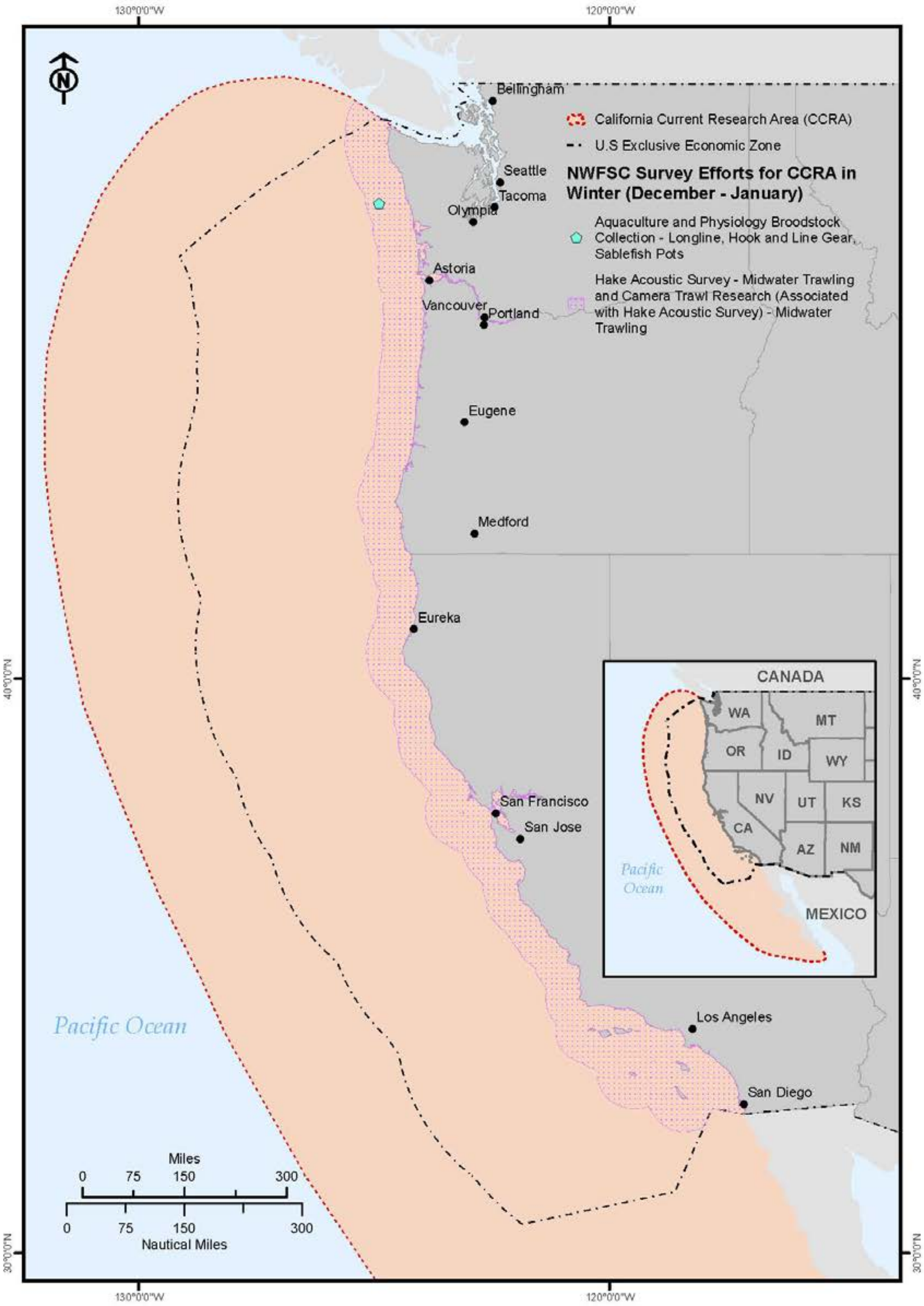

Figure B-4 **Distribution of NWFSC research effort in the CCRA in winter**

Table B-2 NWFSC Research Effort by Gear Type and Season in the LCRRA

Gear type	Surveys	Gear Description	Sampling Events	Effort
Lower Columbia River Research Area (LCRRA)				
Spring (March-May)				
Surface trawling	Pair trawl Columbia River juvenile salmon survey	Surface trawl modified with open cod end with wing size of 92 x 92 m	800-1200 hours/yr	8-15 hour duration tows at 1.5 kts from surface to 5 m depth
Purse and beach seine	Lower Columbia River estuary purse seining	Purse seines with net size of 500 x 30ft and mesh size of 0.34 inches	90 sets/yr	1 hour duration sets
	Columbia River estuary tidal habitats	Beach seine with 150 x 6 ft net size and 1.0 inch mesh size	< 100 sets/yr per survey	< 10 minute duration
Tangle nets	Migratory behavior of adult salmon	600 x 40 ft tangle nets with mesh size of 4.25 inches	Up to 75 sets/yr	25-45 minute duration sets
Fyke Trap	Columbia River estuary tidal habitats	Barrier trap with variable net sizes and <0.25 inch mesh	< 50 sets/yr	Up to 6 hour duration
Guidance net	Pike dike PIT tag detection system	Small guidance net anchored in place leading to an 8 x 20 ft opening; 36 inch square mesh	Continuous	continuous
Summer (June-August)				
Surface trawling	Pair trawl Columbia River juvenile salmon survey	Surface trawl modified with open cod end with wing size of 92 x 92 m	800-1200 hours/yr	8-15 hour duration tows at 1.5 kts from surface to 5 m depth
Purse and beach seine	Lower Columbia River estuary purse seining	Purse seines with net size of 500 x 30ft and mesh size of 0.34 inches	90 sets/yr	1 hour duration sets

Gear type	Surveys	Gear Description	Sampling Events	Effort
	Columbia River estuary tidal habitats	Beach seine with 150 x 6 ft net size and 1.0 inch mesh size	< 100 sets/yr per survey	< 10 minute duration
Tangle Nets	Migratory behavior of adult salmon	600 x 40 ft tangle nets with mesh size of 4.25 inches	Up to 75 sets/yr	25-45 minute duration sets
Fyke Trap	Columbia River estuary tidal habitats	Barrier trap with variable net sizes and <0.25 inch mesh	< 50 sets/yr	Up to 6 hour duration
Guidance net	Pike dike PIT tag detection system	Small guidance net anchored in place leading to an 8 x 20 ft opening; 36 inch square mesh	Continuous	continuous
Fall (September-November)				
Surface trawling	Pair trawl Columbia River juvenile salmon survey	Surface trawl modified with open cod end with wing size of 92 x 92 m	800-1200 hours/yr	8-15 hour duration tows at 1.5 kts from surface to 5 m depth
Purse and beach seine	Lower Columbia River estuary purse seining	Purse seines with net size of 500 x 30ft and mesh size of 0.34 inches	90 sets/yr	1 hour duration sets
	Columbia River estuary tidal habitats	Beach seine with 150 x 6 ft net size and 1.0 inch mesh size	< 100 sets/yr per survey	< 10 minute duration
Tangle Nets	Migratory behavior of adult salmon	600 x 40 ft tangle nets with mesh size of 4.25 inches	Up to 75 sets/yr	25-45 minute duration sets
Guidance net	Pike dike PIT tag detection system	Small guidance net anchored in place leading to an 8 x 20 ft opening; 36 inch square mesh	Continuous	continuous
Winter (December-February)				
Purse and Beach Seine	Columbia River estuary tidal habitats	Beach seine with 150 x 6 ft net size and 1.0 inch mesh size	< 100 sets/yr per survey	< 10 minute duration
Fyke Trap	Columbia River estuary tidal habitats	Barrier trap with variable net sizes and <0.25 inch mesh	< 50 sets/yr	Up to 6 hour duration

Gear type	Surveys	Gear Description	Sampling Events	Effort
Guidance net	Pike dike PIT tag detection system	Small guidance net anchored in place leading to an 8 x 20 ft opening; 36 inch square mesh	Continuous	continuous

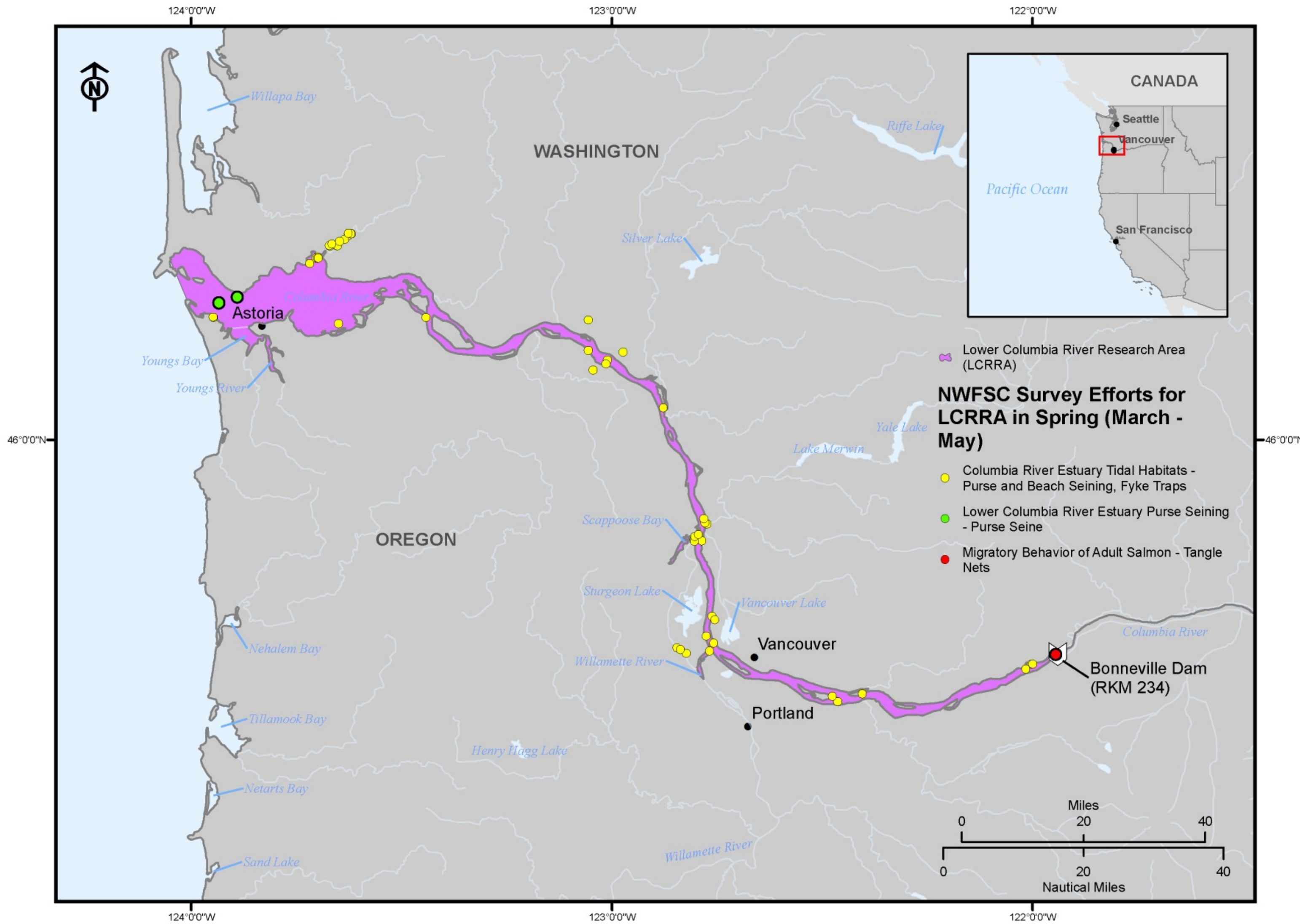

Figure B-5 Distribution of NWFSC research effort in the LCRRA in spring

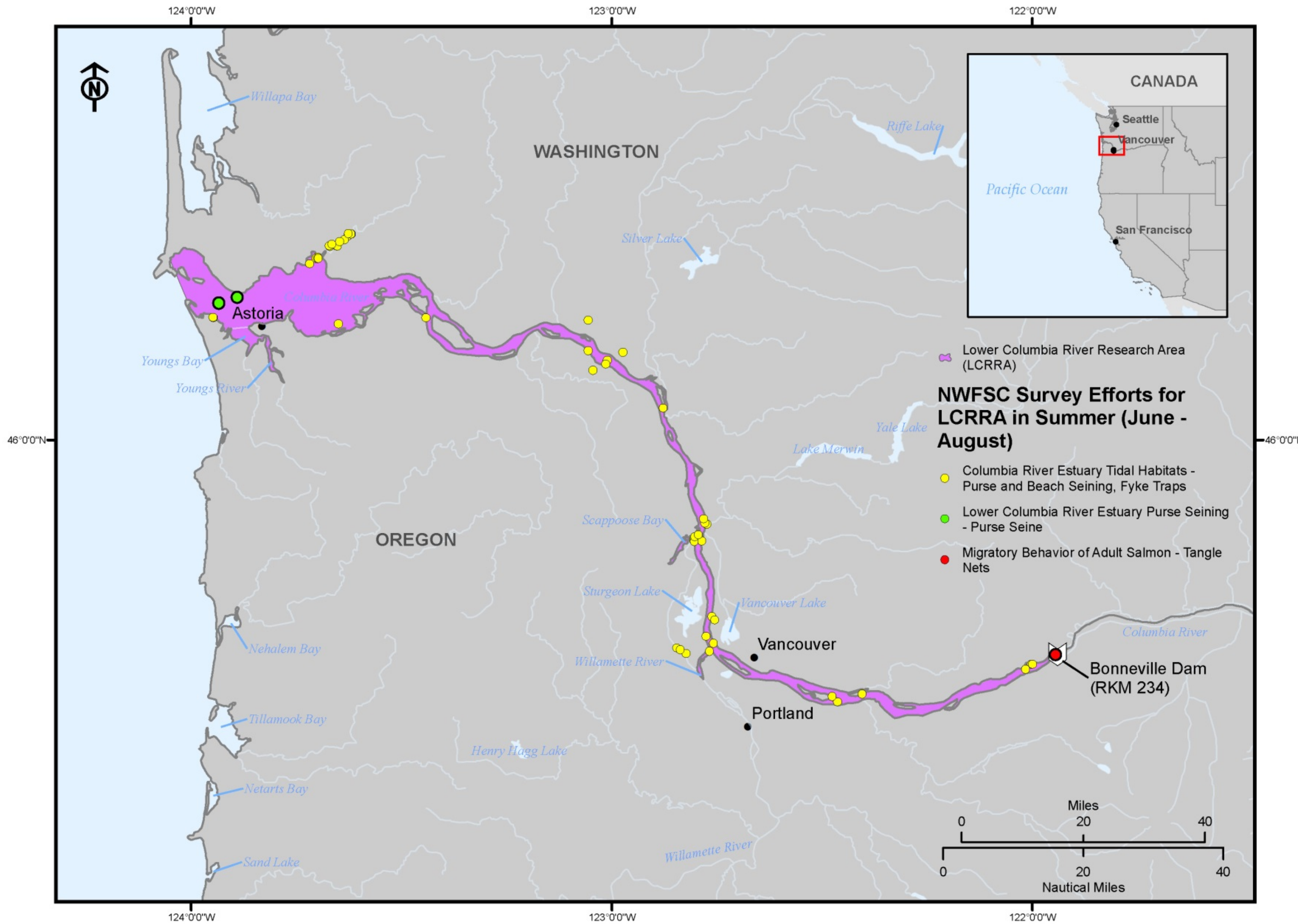

Figure B-6 Distribution of NWFSC research effort in the LCRRA in summer

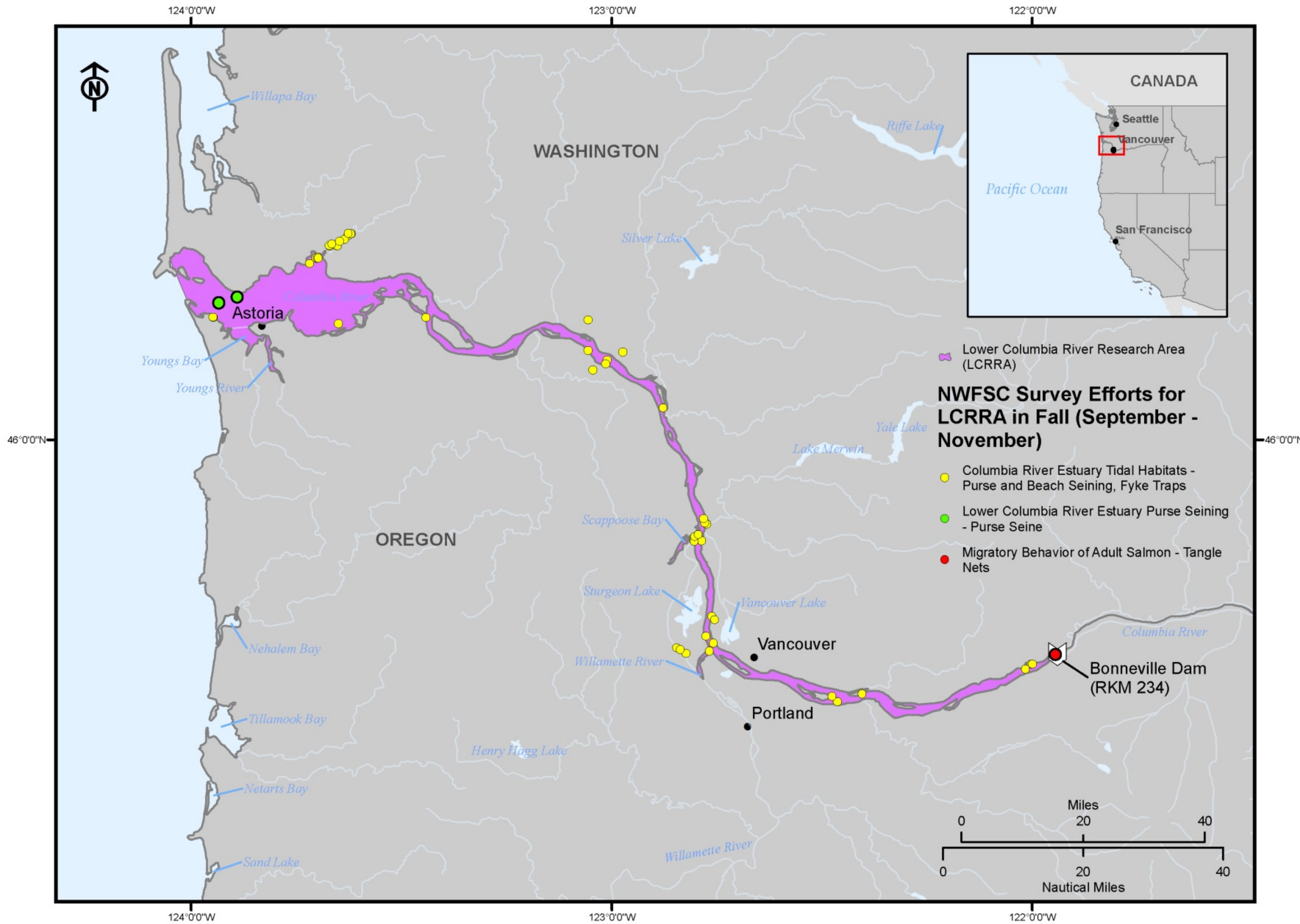

Figure B-7 **Distribution of NWFSC research effort in the LCRRA in fall**

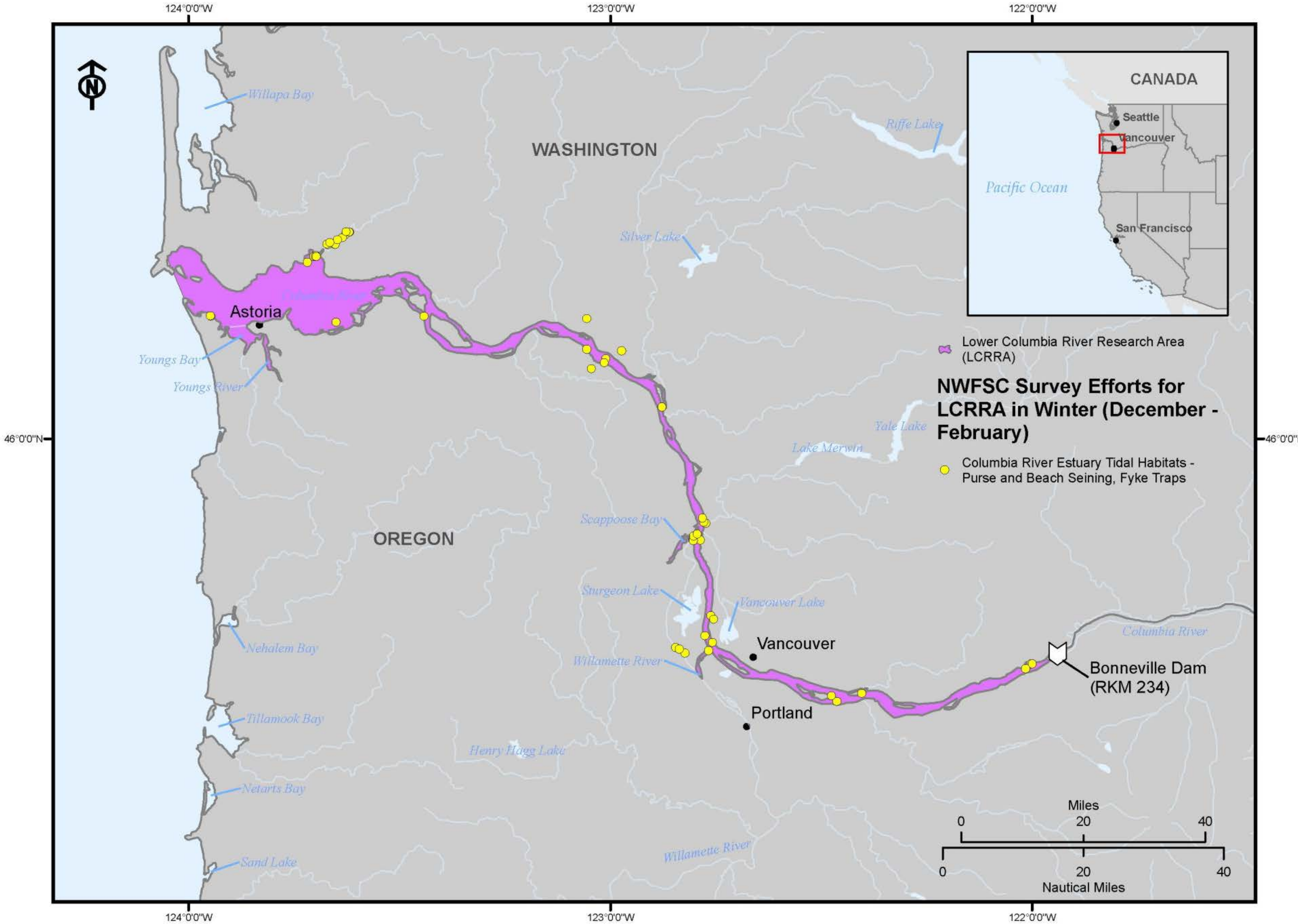

Figure B-8 Distribution of NWFSC research effort in the LCRRA in winter

Table B-3 NWFSC Research Effort by Gear Type and Season in the PSRA

Gear type	Surveys	Gear Description	Sampling Events	Effort
Puget Sound Research Area (PSRA)				
Spring (March-May)				
Bottom trawling	Movement studies of Puget Sound species	Commercial bottom trawls of various net sizes	12 trawls/yr	10 minute duration tows at 3.5 kts at > 10 m depths
	Puget Sound marine pelagic food web, Skagit Bay juvenile salmon survey	Kodiak surface trawl with net size of 3.1 x 6.1 m	250-500 trawls/yr	10 minute duration tows at 1.8-2.2 kts at depths <10 m
Beach and purse seine	Movement studies of Puget Sound species	Herring seine with net size of 1500 x 90 ft with variable mesh size	12 sets/yr	< 1 hour duration sets at < 50 m depths
	Elwha Dam removal, Snohomish juvenile salmon studies,	Beach seine with 140 x 6 ft net size and 0.25-1.0 inch mesh size	Up to 200 sets/yr per survey	< 10 minute duration
Pole Seine	Snohomish juvenile salmon studies Puget Sound marine biodiversity studies	Pole seine with 140 x 6 ft net size and < 1 inch mesh; benthic settling plates	80 sets/yr	< 5 minute duration
Fyke Trap	Snohomish juvenile salmon studies	Barrier trap with variable net sizes and <0.25 inch mesh	Up to 100 sets/yr	Up to 6 hour duration
Hook and line gear	Movement studies of Puget Sound species	Rod and reel, barbless hooks	10 trips/yr	Various
Summer (June-August)				
Bottom trawling	Movement studies of Puget Sound species	Commercial bottom trawls of various net sizes	12 trawls/yr	10 minute duration tows at 3.5 kts at > 10 m depths
Surface trawling	Puget Sound marine pelagic food web, Skagit Bay juvenile salmon survey	Kodiak surface trawl with net size of 3.1 x 6.1 m	250-500 trawls/yr	10 minute duration tows at 1.8-2.2 kts at depths <10 m
Purse and beach seine	Movement studies of Puget Sound species	Herring seine with net size of 1500 x 90 ft with variable mesh size	12 sets/yr	< 1 hour duration sets at < 50 m depths

Gear type	Surveys	Gear Description	Sampling Events	Effort
	Elwha Dam removal, Snohomish juvenile salmon studies	Beach seine with 140 x 6 ft net size and 0.25-1.0 inch mesh size	Up to 200 sets/yr per survey	< 10 minute duration
Pole Seine	Snohomish juvenile salmon studies Puget Sound marine biodiversity studies	Pole seine with 140 x 6 ft net size and < 1 inch mesh; settling plates	80 sets/yr	< 5 minute duration
Fyke Trap	Snohomish juvenile salmon studies	Barrier trap with variable net sizes and <0.25 inch mesh	Up to 100 sets/yr	Up to 6 hour duration
Hook and line gear	Movement studies of Puget Sound species	Rod and reel, barbless hooks	10 trips/yr	Various
Fall (September-November)				
Bottom trawling	Movement studies of Puget Sound species	Commercial bottom trawls of various net sizes	12 trawls/yr	10 minute duration tows at 3.5 kts at > 10 m depths
Midwater trawling	Puget Sound marine pelagic food web, Skagit Bay juvenile salmon survey	Kodiak surface trawl with net size of 3.1 x 6.1 m	250-500 trawls/yr	10 minute duration tows at 1.8-2.2 kts at depths <10 m
Purse and beach seine	Movement studies of Puget Sound species	Herring seine with net size of 1500 x 90 ft with variable mesh size	12 sets/yr	< 1 hour duration sets at < 50 m depths
	Elwha Dam removal, Snohomish juvenile salmon studies	Beach seine with 140 x 6 ft net size and 0.25-1.0 inch mesh size	Up to 200 sets/yr per survey	< 10 minute duration
Pole Seine	Snohomish juvenile salmon studies Puget Sound marine biodiversity studies	Pole seine with 140 x 6 ft net size and < 1 inch mesh; benthic settling plates	80 sets/yr	< 5 minute duration
Fyke Trap	Snohomish juvenile salmon studies	Barrier trap with variable net sizes and <0.25 inch mesh	Up to 100 sets/yr	Up to 6 hour duration
Hook and line gear	Movement studies of Puget Sound species	Rod and reel, barbless hooks	10 trips/yr	Various

Gear type	Surveys	Gear Description	Sampling Events	Effort
Winter (December-February)				
Bottom Trawling	Movement studies of Puget Sound species	Commercial bottom trawls of various net sizes	12 trawls/yr	10 minute duration tows at 3.5 kts at > 10 m depths
Purse and beach seine	Movement studies of Puget Sound species	Herring seine with net size of 1500 x 90 ft with variable mesh size	12 sets/yr	< 1 hour duration sets at < 50 m depths
Pole Seine	Snohomish juvenile salmon studies	Pole seine with 140 x 6 ft net size and < 1 inch mesh	80 sets/yr	< 5 minute duration
Fyke Trap	Snohomish juvenile salmon studies	Barrier trap with variable net sizes and <0.25 inch mesh	Up to 100 sets/yr	Up to 6 hour duration
Hook and line gear	Movement studies of Puget Sound species	Rod and reel, barbless hooks	10 trips/yr	Various

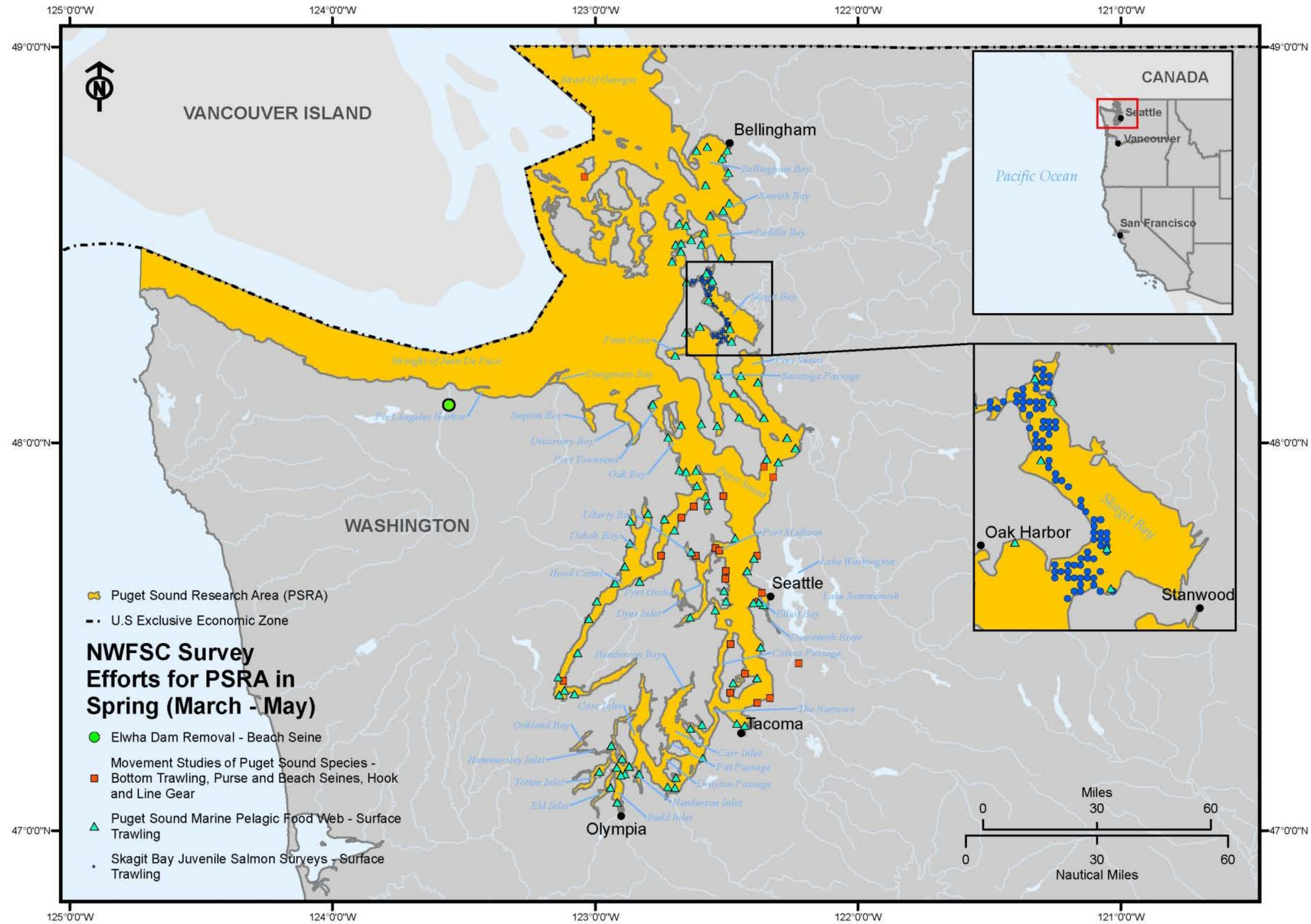

Figure B-9 **Distribution of NWFSC research effort in the PSRA in spring**

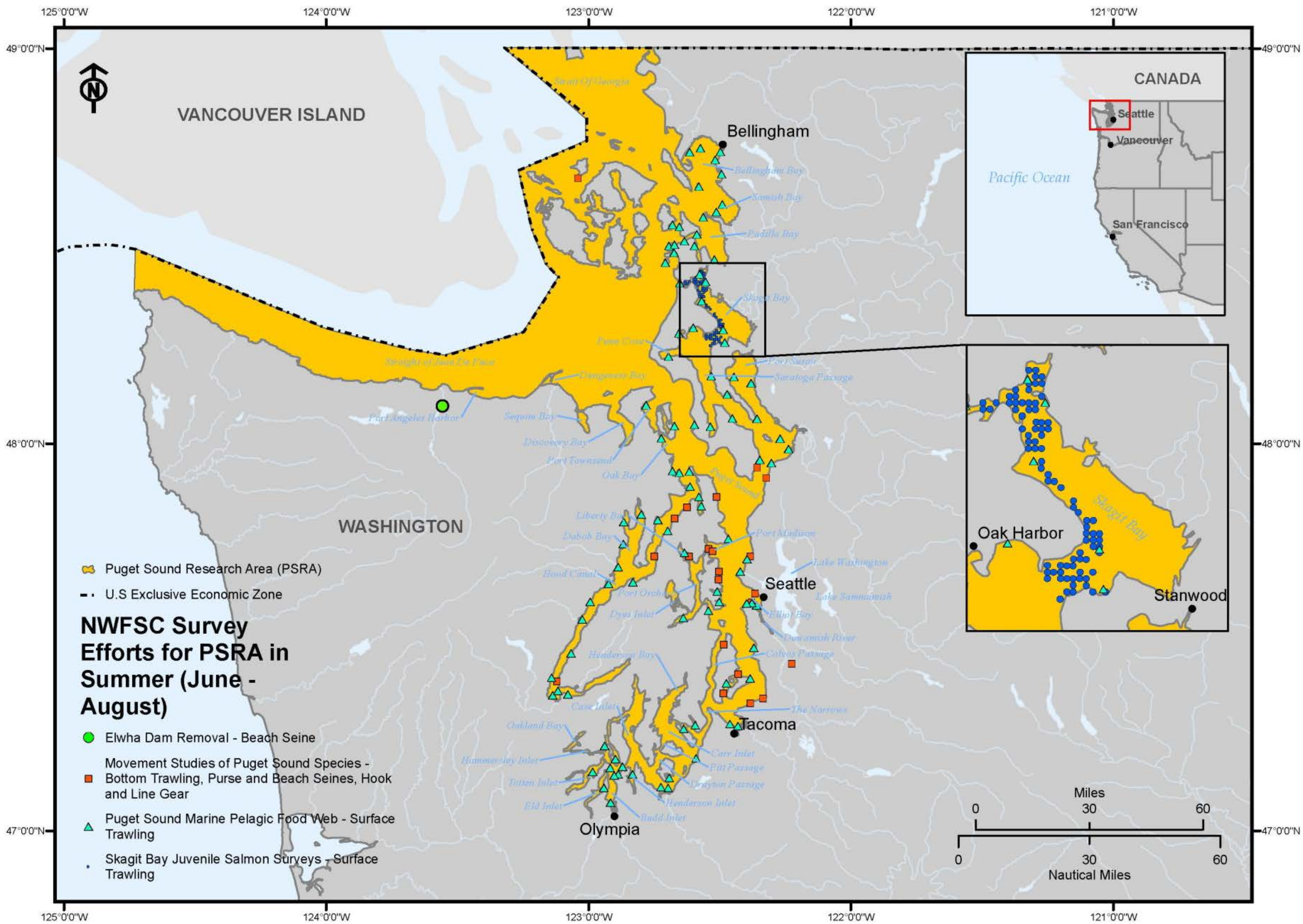

Figure B-10 Distribution of NWFSC research effort in the PSRA in summer

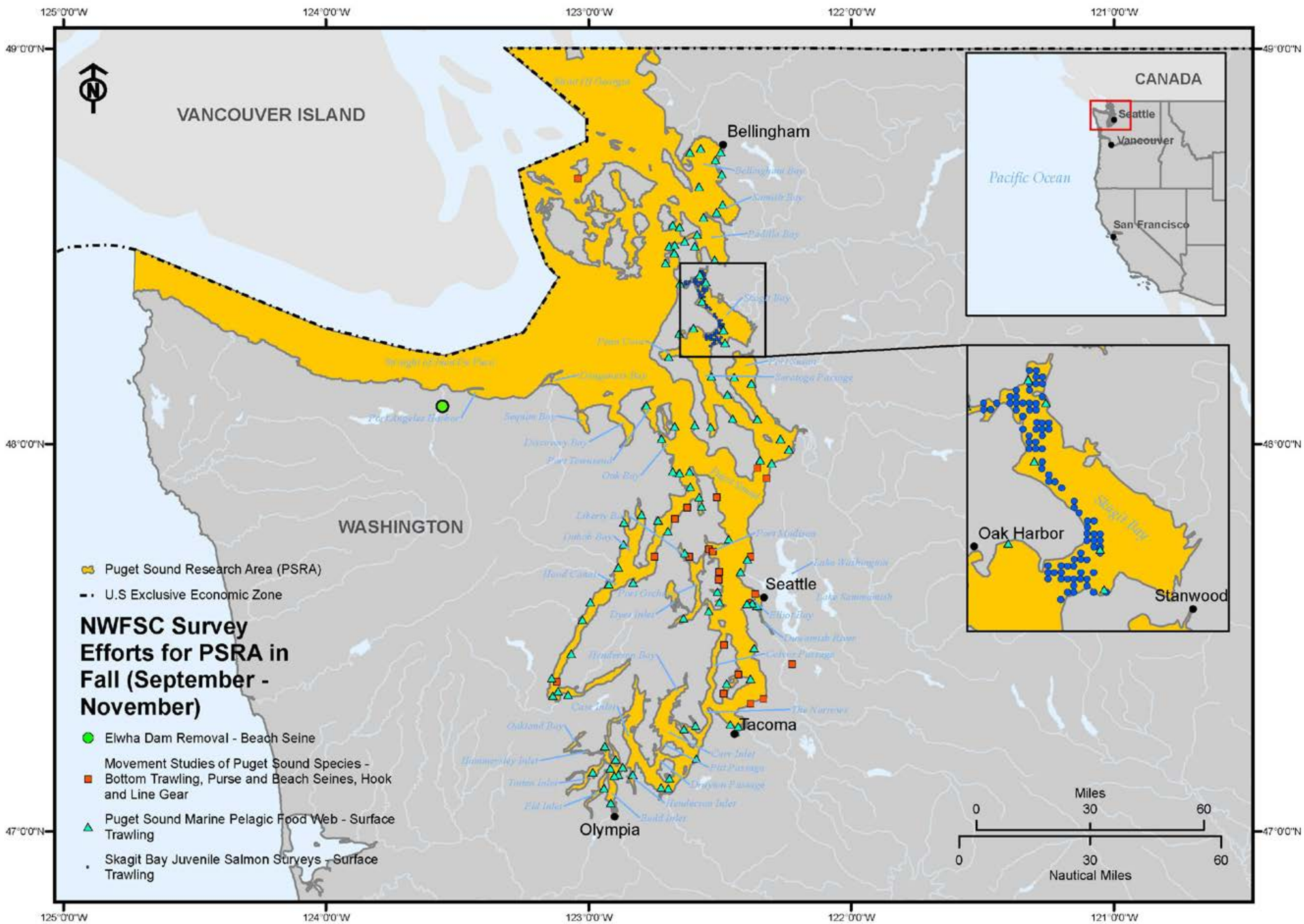

Figure B-11 Distribution of NWFSC research effort in the PSRA in fall

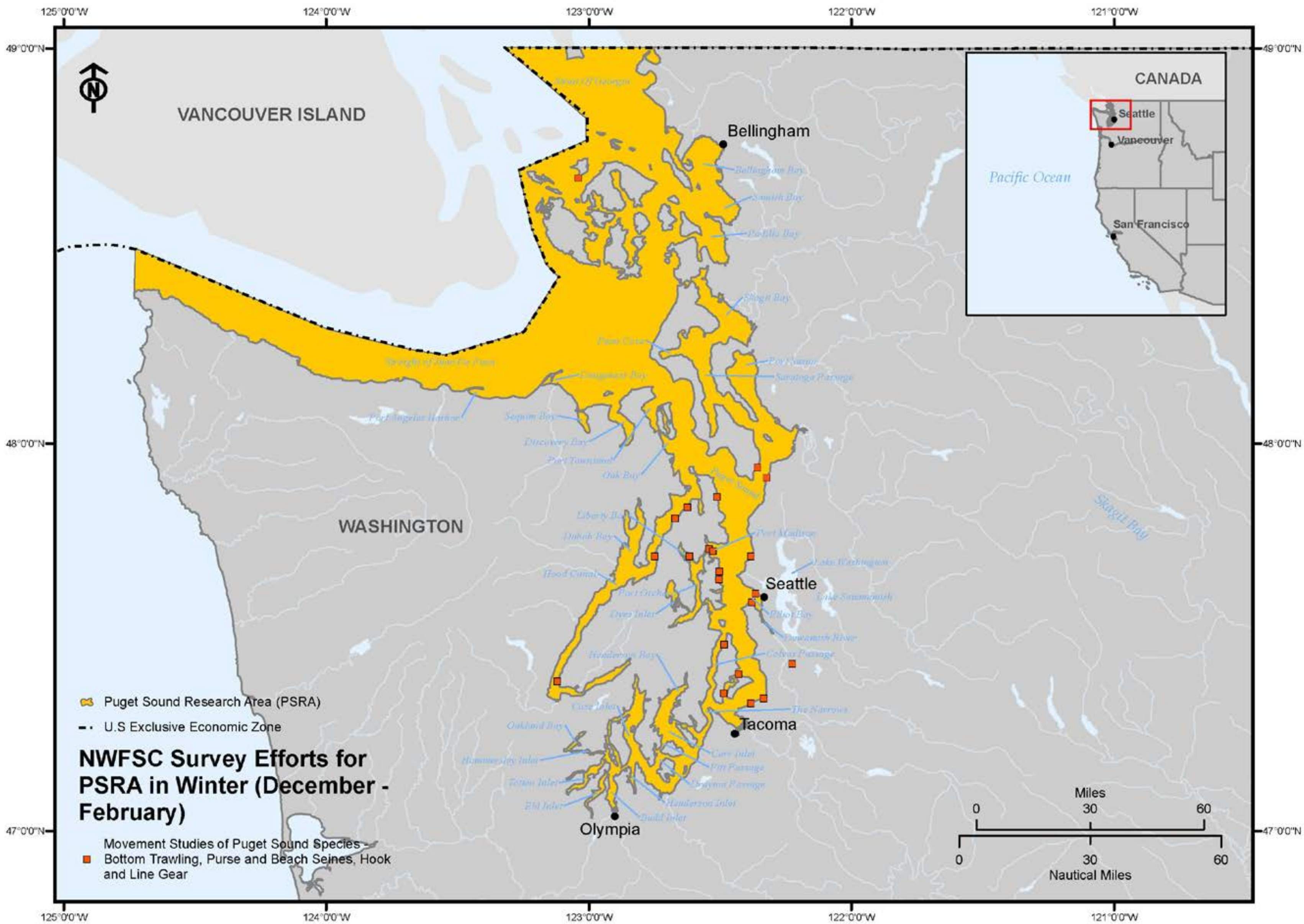

Figure B-12 **Distribution of NWFSC research effort in the PSRA in winter**

DRAFT
Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the Northwest Fisheries Science Center

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Appendix D

Protected Species Handling Procedures for NWFSC Fisheries Research Vessels

Prepared for the National Marine Fisheries Service by:

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Contents

1. Marine Mammal Handling Guidelines and Data Collection

The following describes handling procedures for incidentally caught marine mammals including data collection on captured animals. Specific data collection requirements may vary somewhat by survey, but have been developed to be responsive to all relevant permits and legislation (e.g., Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), and Magnuson-Stevens Act (MSA)). Animals that are captured may be alive, seriously injured or dead. A priority is to return a marine mammal that is still alive to the water as soon as possible. Of paramount importance is the safety of the scientists and crew. Any actions taken to record data, collect samples, etc., on captured marine mammals should all be performed only after an evaluation of the risks involved to personal safety Unacceptable human risk is not authorized in assisting marine mammals (e.g., observers are prohibited from entering the water to aid a marine mammal).A marine mammal may come aboard looking dead when it is in fact in shock and can suddenly wake up. This presents a serious safety risk to any science or vessel crew. Marine mammals can also carry microbes creating the risk off potential disease transmission and care should be taken if handling a marine mammal.

No collection of tissue samples or carcasses will be conducted unless authorized under the MMPA.

Marine Mammal Sampling Protocol for Incidental Takes during NWFSC Research Cruises

Marine Mammals that Are Living When Brought Aboard. If a marine mammal is brought aboard that is alive (even if injured), the goal should be to return the animals to the water as rapidly as possible. Once the risks and safety issues have been properly assessed and managed, identify the animal to species if possible, assess the condition (noting any injuries), take pictures from different angles, and then release the animal (see data sheet).

Marine Mammals that are Dead When Brought Aboard. If a marine mammal is brought aboard that is dead, the following is recommended for data collection on the animal. If possible, the easiest way to obtain detailed information on incidentally killed marine mammals is to simply put the carcass in a freezer and allow NWFSC marine mammal staff to process the animal after arrival of the ship into port. This is preferable to being worked up while at sea because:

1. Information/samples collected from untrained individuals makes the data highly suspect.
2. Collection of information/samples is time consuming. Necropsy of a marine mammal can be a messy/bloody procedure, potentially exposing untrained individuals to zoonotic pathogens.
3. Necropsy of a marine mammal requires sharp knives to be used on a moving platform, which can be a safety issue.
4. The most information can be gained through a full necropsy by a trained marine mammal biologist on land.

For retained carcasses, **assign a field id**, i.e. BMS20110731.01 (ship, date. carcass number for that day). In this example the specimen was collected aboard the Bell M Shimada on July 31, 2011 and is the first animal collected on that day. Attach a tag with a zip tie around the flukes or flipper (on pinnipeds).

However, if there is absolutely no space in the freezer to place the animal (or no freezer available), the following minimum information should be collected (cetaceans, #1-8, for pinnipeds, #1-6) and recorded on the accompanying data sheet:

1. **Assign a field id** as described above and label all samples with this id.
2. **Photos.** (lateral body, head, genital region)

3. **Species ID.**
4. **Total Standard Length** from tip of upper jaw to fluke notch (cetaceans) or tip of nose to tip of tail (pinnipeds), see diagram on following page. Straight length is preferable to curvilinear. It is assumed length is straight. Please note if it is curvilinear.
5. **Girth.** Maximum girth is collected for cetaceans and axillary girth is collected for pinnipeds. See diagrams on the following pages. If there is no dorsal fin on a cetacean (e.g. northern right whale dolphins) take axillary girth.
6. **Sex**. Take photos of genital region. (In cetaceans, anus and genital slit are almost continuous in females, but are clearly separate in males. In pinnipeds, two openings in between the rear flippers indicates female, one in between rear flippers and one on belly indicates male. See photos on following page).
7. **Skin Sample.** (3 x 0.5 cm is sufficient), frozen in whirlpack or vial. In pinnipeds, skin (not fur) is available at the end of the flippers.
8. **Blubber Sample.** With thin layer of muscle attached, 4 x 4 in, wrapped in foil, frozen. For cetaceans, this is collected from left lateral side just anterior of dorsal fin (where max. girth is taken).
9. **Head Sample.** The head should simply disarticulate once you cut through the blubber, muscle and esophagus. Start cutting one fist length posterior to the blowhole. You do not need to cut through any bone to get the head off.

Measuring standard total length = tip of upper jaw to fluke notch

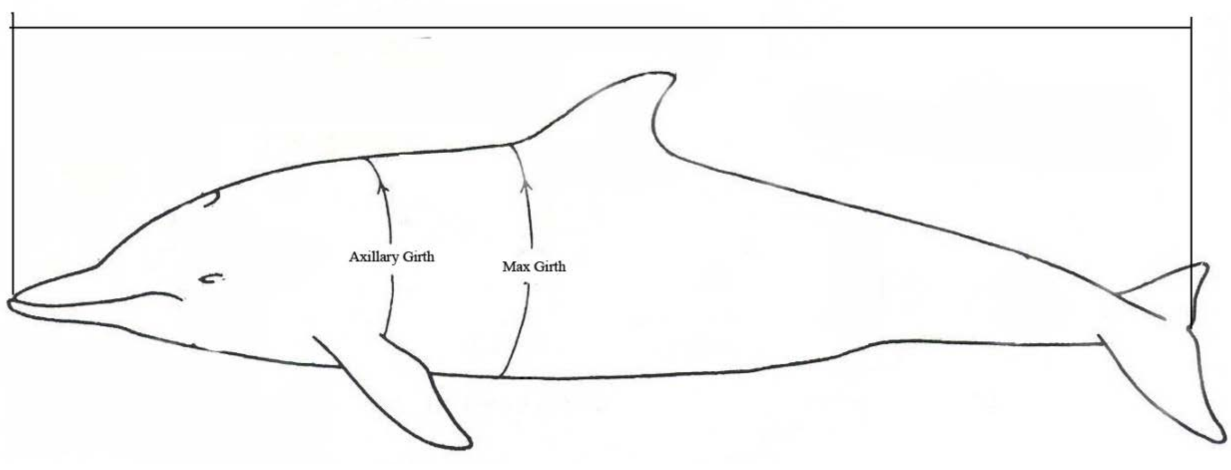


Figure 4-7. Female delphinid

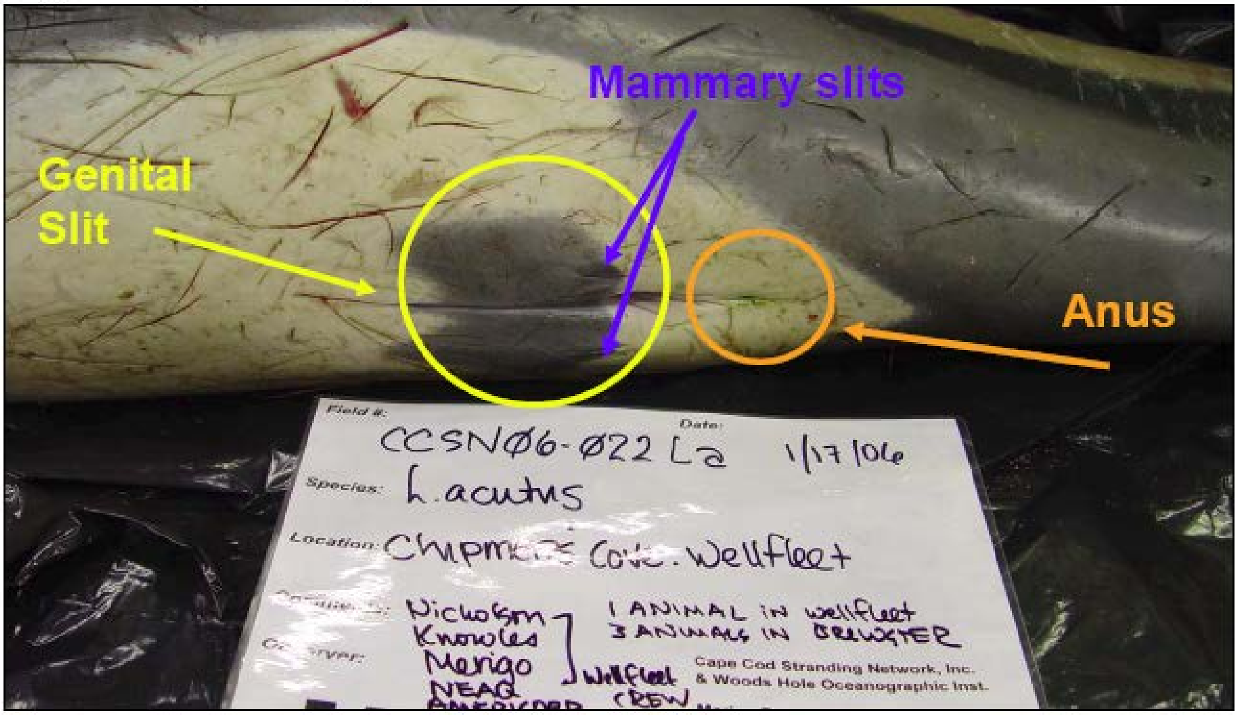
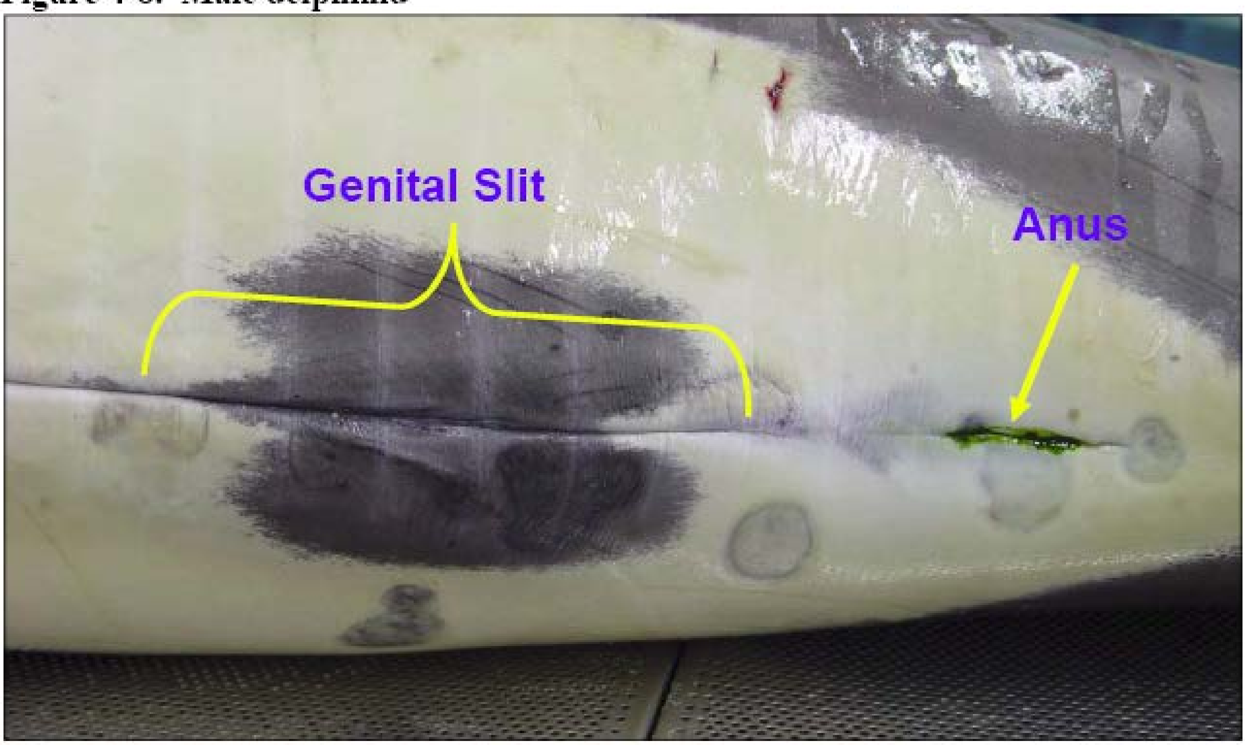


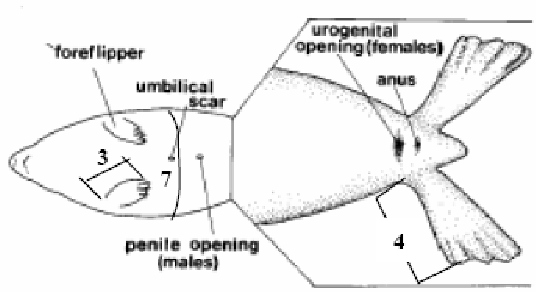
Figure 4-8. Male delphinid



Standard straight length: tip of nose to tip of tail

Curvilinear length: tip of nose to tip of tail (only use if straight length not possible)

Girth measurement



Strandings and Disentanglement

The National Marine Mammal Health and Stranding Response Program (MMHSRP) has developed protocols and guidance on responding to marine mammals that are stranded or in distress (including entangled animals), release protocols, and requirements for training. If an entangled animal is encountered, the appropriate NMFS Regional Marine Mammal Stranding Coordinator should be contacted as soon as possible. The list of Regional Stranding Coordinators is provided in Appendix 1. In some cases, vessel captains may be required by law to attempt disentanglement; it is the responsibility of a vessel captain to understand and carry out any legal requirements. If disentanglement is attempted, standard procedures on mitigating the risks to the animal and persons aboard the vessel should be followed. Such protocols are outside the scope of this document, but further information and copies of related materials can be obtained from:

Marine Mammal Health and Stranding Response Program
National Marine Fisheries Service Office of Protected Resources
Marine Mammal and Sea Turtle Conservation Division, F/PR21315 East-West Highway
Silver Spring, MD 20910
http://www.nmfs.noaa.gov/pr/health/
Phone: (301) 713-2322
Fax: (301) 427-2522

Stranding response resources and publications can be obtained from:
http://www.nmfs.noaa.gov/pr/health/publications.htm

NMFS Regional Strandings Coordinators

Northwest (WA, OR)
Brent Norberg, Stranding Coordinator
National Marine Fisheries Service
7600 Sand Point Way NE
Seattle, WA 98115
Phone: (206) 526-6550; Fax: (206) 526-6736

Lynne Barre, Assistant Stranding Coordinator
7600 Sand Point Way NE
Seattle, WA 98115
Phone: (206) 526-4745; Fax: (206) 526-6736

Southwest (CA)
Joseph Cordaro, Stranding Coordinator
Sarah Wilkin, Stranding Coordinator
National Marine Fisheries Service
501 West Ocean Boulevard, Suite 4200
Long Beach, CA 90802-4213
Phone: (562) 980-4017; Fax: (562) 980-4027
Large Whale Entanglement Hotline: 1-877-SOS-WHALE (1-877-767-9425)

Figure 1. Data sheet for recording information about a marine mammal take (one sheet per animal).

MARINE MAMMAL SPECIMEN DATA
INCIDENTAL RESEARCH TAKES ONLY

Collection Date:
Collector:
Vessel and Survey Name:
Net Type:
Field ID (ship initials-yymmdd.xx where xx is specimen number):
Species:
Locality:
Lat/Long of Capture:
Site Description (e.g., Station Name)
Sex☹ Male/Female/Unknown)
Length (cm) (see pictures above appropriate length measurements):
Girth (cm):

Brief History of Take:
Date of Death:
Time of Death:
Location of Take:

ADDITIONAL DATA COLLECTED: Yes No
Photographs:
Carcass:
Head:
Skin:
Blubber:

EXTERNAL EXAMINATION: Provide as much detail as possible
General condition (lesions, deformities, appearance, color):
Parasites:
Mouth / Teeth:
Eyes:
Blowhole / Nostrils:
Anus and Urogenital openings:
Mammary slits / glands:
Fins / Flukes / Flippers:

2. Seabird Handling Procedures and Data Collection

Seabirds may be incidentally caught in most gears. While it is highly likely birds will be dead in nets, especially those that are towed, it is possible that living birds maybe caught in a net as well as in some other gear types, especially hook and line gears. Again, as with marine mammals, there may be safety issues processing a captured seabird. This includes bites and scratches from a live bird and potential diseases on both living and dead birds.

The NWFSC has a salvage permit from the U.S. Fish and Wildlife Service for birds incidentally caught during NWFSC fisheries research activities (Number MB40092B-0).

Seabird that is Brought Aboard Alive (processing should consider safety issues). If a live bird is captured by any research gear, then first disentangle or unhook the bird if hook and line. If the bird is **not** listed under the Endangered Species Act, then use the following procedure:

1. Identify the bird if possible to species and sex.
2. Photograph the bird. If possible take the following pictures- overall dorsal, overall ventral, close up of head/beak, bands or tags, and any wounds, marks, damage.
3. Describe condition of bird including any damage (wounds, scars).
4. Check for presence of bands or tags and note number and location of any.
5. Comment on response of bird after release (did it fly immediately, for example).

Seabird that is Brought Aboard Dead.

1. Identify the bird if possible to species and sex.
2. Photograph the bird. If possible take the following pictures- overall dorsal, overall ventral, close up of head/beak, bands or tags, and any wounds, marks, damage.
3. Describe condition of bird including any damage (wounds, scars).
4. Check for presence of bands or tags and note number and location of any.
5. Retain bird, assuming it is fresh- (i.e. caught by the survey and not dead for other reasons). Prepare a label with bird species, vessel name, and id number (date followed by ship initials-yymmdd.xx) and place bird and label in large bag.

If a live bird is brought aboard that is federally protected under ESA (e.g., short -tailed albatross or marbled murrelet), then use the following protocol.

Immediately try to contact National Marine Fisheries Service, U.S. Coast Guard, or U.S. Fish and Wildlife Service. They will contact an expert to give you advice in the handling and release of the bird.

National Marine Fisheries Service (NMFS)
(808) 944-2200

U.S. Coast Guard (USCG)
08240.0 KHz (Daytime ITU Channel 816)
12242.0 KHz (Daytime ITU Channel 1205)
04134.0 KHz (Nightime ITU Channel 424)
06200.0 KHz (Nightime ITU Channel 601)

1. If caught in hook and line, stop vessel to reduce tension on the line and bring bird aboard using a dip net.

2. Wrap the bird's wings and feet with a clean towel to protect its feathers from oils or damage.
3. Remove any entangled lines from the bird and determine if the bird is dead or alive. If dead, follow procedure for processing dead birds. If alive, place bird in a safe, enclosed place and immediately contact NMFS, USCG or USFWS. If unable to make contact for 24-48 hours, determine if the bird is lightly, moderately, or deeply hooked (see description below).
4. If bird is deeply hooked, keep bird in a safe, enclosed place until further instructed. Do NOT release the bird.
5. If bird is lightly or moderately hooked, remove hook by cutting the barb and backing hook out.
6. Allow bird to dry for 1/2 hour to 4 hours in a safe, enclosed place. Refer to Release Guidelines.
7. Record information in the short-tailed albatross recovery data form.

Bird Condition:
Lightly Hooked: Hook is clearly visible on bill, leg or wing.
Moderately Hooked: Hooked in the mouth or throat with hook visible.
Deeply Hooked: Hook has been swallowed and is located inside the bird's body below the neck.

The bird is ready for release if it meets ALL of the following criteria:

- Stands on both feet with toes pointed forward
- Holds its head erect and responds to sound and motion
- Breathes without making noise
- Flaps and retracts wings to normal folding position
- Feathers are dry

If any of these conditions are not met, the bird cannot be released.

Figure 2. Data sheet for recording information about a seabird take (one sheet per animal).

SEABIRD SPECIMEN DATA
INCIDENTAL RESEARCH TAKES ONLY

Collection Date:
Collector:
Vessel and Survey Name:
Net Type:
Field ID (bag label) (ship initials-yymmdd.xx):
Species:
Locality:
Lat/Long of Capture:
Site Description (e.g., Station Name):
Sex☹ Male/Female/Unknown)
Length (cm) (longest length, bill to feet)

Brief History of Take:
    Date of Take
    Time of Take:
    Location of Take:
    Comments

ADDITIONAL DATA COLLECTED:
Photographs:
Carcass Obtained:
Head:
Skin:

EXTERNAL EXAMINATION: Provide as much detail as possible
General condition (lesions, deformities, appearance, color):
Tags/Bands/Marks:
Parasites:
External Marks:

3. ESA-listed Fish Handling Guidelines and Data Collection

Handling procedures for fish will only focus on incidental take of ESA-listed species. Protocols should be in place to process and handle directed take of listed species as part of Section 10 permits. There are a number of listed species that could be caught by NWFSC gears. Some of these can be challenging to differentiate, even for experts.

Sturgeon

Green sturgeon are listed under the ESA while white sturgeon are not. If a green sturgeon is brought aboard as an incidental take, first identify the fish to species if possible and determine if is alive or dead. If dead, record data using the data sheet in Figure 3 such as capture date and time, survey, vessel and so on. Take photographs of the specimen from several angles. Freeze the entire specimen if possible. If the specimen cannot be frozen, take a fin clip off the dorsal fin or tail (size of a dime) and preserve in alcohol. If the specimen is alive, record fork length, take photographs, and release the fish as quickly as possible.

Salmonids

Incidentally caught salmon can range in size from several inches to over a meter and include six different species. Given that most incidental takes of salmonids will be with gear that are not effective for catching salmon, numbers should be low. In general, juvenile and subadults will be dead or severely injured after being caught in a trawl. Conversely, most salmonids caught on hook and line should be alive. Fish identification sheets will be provided all surveys along with a measuring board and vials for fin clips. Some populations of Chinook, Coho, sockeye and steelhead are listed under ESA. We assume that incidental take of salmonids will be low (< 5 per haul) and thus the following guidelines are appropriate. The following are handling and data recording procedures for salmonids:

1. Adults of any species (>450 mm tail fork length [FL]) – identify the specimen, measure fork length, record if adipose is missing, take a fin clip (dorsal or caudal) and put in labeled vial, and release as quickly as possible.
2. Juveniles and sub adults (<450 mm FL) – Assuming there is a freezer or some sort of cold storage available, identify the specimen, kill it humanely and put in individually labelled bag. If the specimen cannot be retained, identify the specimen, record capture information, measure fork length, take fin clip, and release.

Rockfish

In Puget Sound, several species of rockfish are listed under ESA: Boccaccio, yelloweye rockfish, and canary rockfish. Because these fish typically live at considerable depths, they are likely to be dead or seriously injured when brought onto the boat. Thus, we recommend that unless the fish is clearly alive, that the fish be killed and then frozen whole with a label (see Figure 3 for data to be recorded).

Smelt

The southern population segment of eulachon are listed under ESA as threatened. Therefore, any eulachon caught incidentally should be assumed to be listed. While small catches of eulachon are possible, it is also possible that a survey may catch 100's to 1000's in individual hauls. If logistically possible (e.g., there is freezer space), small catches of eulachon (<20) should be frozen whole in a labeled bag (see Figure 4). In the event of a large catch (>20) and freezing fish is possible, put 20 individual eulachon into a labeled bag and freeze. Either count and release the rest of the fish or estimate total numbers using some subsampling procedure and then release the fish. If preserving specimens is not possible, then count or estimate numbers in the haul, record fork length of up to 20 eulachon in a haul and release them.

Figure 3. Data sheet for incidental takes of sturgeon, salmonids, and rockfish.

Survey	Date	Time	Location	Fish ID	Length	Species	Clipped Yes/No	Disposition

Figure 4. Data sheet for eulachon (one for any haul with eulachon).

Collection Date	Collector	Vessel and Survey Name	Net Type	Field ID	Locality	Lat/Long of Capture	Site Description (e.g., Station Name)	Total Catch of Eulachon	Method used to Estimate Total Catch	Disposition of Fish (released, frozen):

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Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the

Northwest Fisheries Science Center

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Appendix E

Additional Information on Hook and Line Survey in Channel Islands National Marine Sanctuary

Prepared for the National Marine Fisheries Service by:

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Part I. Survey Overview

The Southern California Shelf Rockfish Hook and Line Survey's (hereafter, hook and line survey) primary objective is to provide an annual index of relative abundance and a time series of biological data for several key species of shelf rockfish (genus *Sebastes*) in the Southern California Bight (SCB). These indices and associated biological data provide key information for the development of stock assessments for several important species including bocaccio (*S. paucispinis*), vermilion rockfish (*S. miniatus*), sunset rockfish (*S. crocotulus*), greenspotted rockfish (*S. chlorostictus*) and cowcod (*S. levis*). These species are targeted largely by the recreational fishing community and are not well-sampled by trawl gear due to the complex bathymetry and hard-bottom habitats of the SCB they inhabit. The hook and line survey complements existing research conducted by NOAA Fisheries' Northwest Fisheries Science Center (NWFSC), including its annual coastwide bottom trawl survey and the acoustic survey for hake, as part of a suite of fishery-independent programs aimed at monitoring long-term trends in distribution and abundance of west coast groundfish.

The hook and line survey is a collaborative project among the NWFSC, Pacific States Marine Fisheries Commission, and the commercial passenger fishing vessel industry. The survey is conducted each fall aboard chartered sportfishing vessels and uses hook and line gear to sample untrawlable habitat throughout the SCB. Each year, 121 fixed sites are sampled, covering a depth range of 37–229 m. The sampling area is bounded by Point Arguello in the north (lat 34°30′N) and the border of the U.S.-Mexican exclusive economic zone in the south (lat 32°00′N). The sites are stratified by 20 different geographic areas to ensure sampling coverage throughout the SCB (Figure 1). In 2014, 42 new fixed sites were added to the sampling frame to provide preliminary survey coverage inside the two Cowcod Conservation Areas (CCAs). An additional 40 new sites are scheduled to be added in 2015 to provide synoptic coverage of the CCAs.

Figure 1. Location of 121 fixed sites (red triangles) within 20 subareas (white borders) sampled annually by the Hook and Line Survey

The survey is conducted using a fixed-point sampling design with specific locations defined by global positioning system (GPS) coordinates. Survey staff experimented with a random design during a 2003 pilot cruise; however, the distribution of suitable hard-bottom seafloor in the region is not sufficiently defined by habitat maps to support a stratified-random or reduced-random survey design without a significant increase in the amount of days at sea necessary to accommodate searching for appropriate target habitat. The fixed sites chosen for the sampling frame were compiled mainly from consultation with local sport and commercial fishermen and augmented with locations provided by California Department of Fish and Wildlife from historical monitoring programs and sites opportunistically sampled during previous hook and line cruises. Industry members provided input on a variety of historical fishing grounds throughout the region and gave their observations of the habitat types present and whether the productivity at these areas has changed over time. Using this information, a sampling frame was developed that included sites at a variety of depths, spatial areas, hard-bottom habitat types, and depletion levels.

Nineteen of the 20 sampling areas (Figure 1) contain between four and 13 sites based on the hypothesized (and later, observed) amount of target habitat in the area. The one exception is the Point Hueneme area, which currently contains only one site; other sites in this area were removed due to inappropriate habitat, and no others were added due to difficulty in locating replacements. Sites area assigned to the vessels such that over time, each site is sampled by each vessel approximately the same number of times. No formalized attempt was made to select sites according to depth stratification, although it was a consideration to include sites representing a variety of depths.

Sites are specific locations on the seafloor defined by GPS coordinates. A 100-yard radius around a site is provided to allow vessel captains flexibility in targeting the site given year-to-year changes in prevailing wind and ocean conditions. Sampling consists of three deckhands using rod and reel gear to make five coordinated drops of a vertically-arranged 5-hook sampling gangion, providing for a maximum possible catch of 75 fish per site. To assist in catch per unit effort analyses and modeling, deckhands use stopwatches to keep track of the soak time for each drop. The sampling rig consists of 5 shrimp flies on size 5/0 hooks baited with squid strips at 16-inch intervals and affixed to a 60 lb monofilament leader and gangion (Figure 2). The gangion is attached via a barrel swivel to an 80 lb Spectra mainline. Sinkers in one-pound intervals from 1 through 5 pounds are used as directed by the vessel captain based upon site depth and the prevailing wind and ocean conditions.

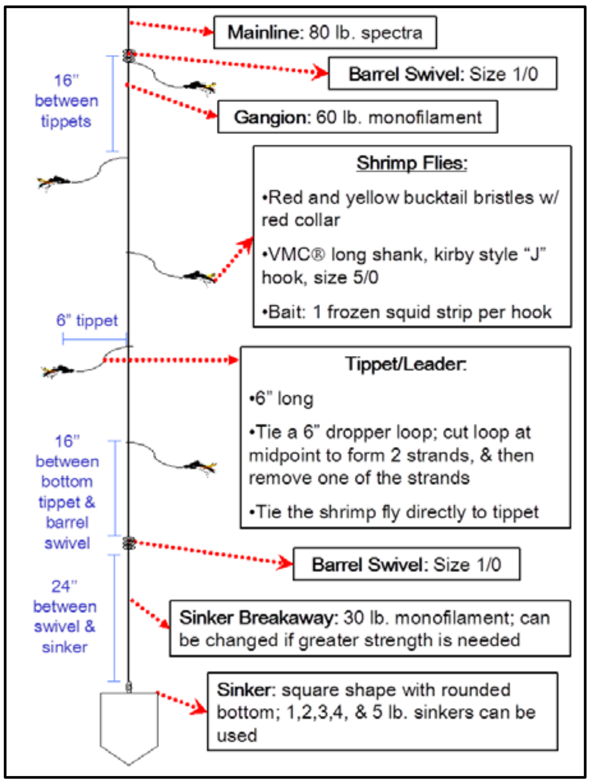


Figure 2. Schematic of the sampling gangion usied during the hook and line survey

CPUE data and basic biological information are collected from all captured specimens. Rockfish species are sacrificed, and length, weight, sex, age (via otolith extraction), and genetic (via fin clip) information is collected. The DNA analyses focus on confirming species identification, determining stock structure, and separating cryptic species including vermilion and sunset rockfishes (e.g., Hyde et al. 2008). Additional organ and tissue samples are collected on an opportunistic basis to facilitate research on into the maturity, diet, and trophic ecology of demersal rockfish species. Most non-rockfish species captured by the survey lack physoclistous swim bladders and are less prone to barotrauma; hence they are generally returned alive to the sea at the surface after basic biological data are collected. Quantitative and qualitative information on oceanographic and weather conditions is also collected by sensor deployment and observation.

Through 2014, the survey has compiled an 11-year annual time series of catch per unit effort (CPUE) and biological data for groundfish species in the SCB region. Since 2004, 53 different species of fish have been caught by the survey, including 37 species of rockfish (Table 1).

Table 1. All species encountered during the hook and line survey, 2004-2014.

Common Name	Scientific Name
Bank Rockfish	*Sebastes rufus*
Barred Sand Bass	*Paralabrax nebulifer*
Blackgill Rockfish	*Sebastes melanostomus*
Blue Rockfish	*Sebastes mystinus*
Bocaccio	*Sebastes paucispinis*
Bonito (Eastern Pacific)	*Sarda chiliensis chiliensis*
Bronzespotted Rockfish	*Sebastes gilli*
Brown Rockfish	*Sebastes auriculatus*
Brown Smoothhound	*Mustelus henlei*
Calico Rockfish	*Sebastes dalli*
California Lizardfish	*Synodus lucioceps*
California Scorpionfish	*Scorpaena guttata*
California Sheephead	*Semicossyphus pulcher*
Canary Rockfish	*Sebastes pinniger*
Chilipepper	*Sebastes goodei*
Copper Rockfish	*Sebastes caurinus*
Cowcod	*Sebastes levis*
Flag Rockfish	*Sebastes rubrivinctus*
Freckled Rockfish	*Sebastes lentiginosus*
Gopher Rockfish	*Sebastes carnatus*
Gray Smoothhound	*Mustelus californicus*
Greenblotched Rockfish	*Sebastes rosenblatti*
Greenspotted Rockfish	*Sebastes chlorostictus*
Greenstriped Rockfish	*Sebastes elongatus*
Halfbanded Rockfish	*Sebastes semicinctus*
Honeycomb Rockfish	*Sebastes umbrosus*
Lingcod	*Ophiodon elongatus*
Mexican Rockfish	*Sebastes macdonaldi*
Ocean Whitefish	*Caulolatilus princeps*
Olive Rockfish	*Sebastes serranoides*
Pacific Jack Mackerel	*Trachurus symmetricus*
Pacific Chub Mackerel	*Scomber japonicus*

Common Name	Scientific Name
Pacific Sanddab	*Citharichthys sordidus*
Petrale Sole	*Eopsetta jordani*
Pink Rockfish	*Sebastes eos*
Pinkrose Rockfish	*Sebastes simulator*
Rosethorn Rockfish	*Sebastes helvomaculatus*
Rosy Rockfish	*Sebastes rosaceus*
Sharpchin Rockfish	*Sebastes zacentrus*
Silvergray Rockfish	*Sebastes brevispinis*
Southern Rock Sole	*Lepidopsetta bilineata*
Speckled Rockfish	*Sebastes ovalis*
Spiny Dogfish	*Squalus suckleyi*
Squarespot Rockfish	*Sebastes hopkinsi*
Starry Rockfish	*Sebastes constellatus*
Swordspine Rockfish	*Sebastes ensifer*
Treefish	*Sebastes serriceps*
Vermilion Rockfish	*Sebastes miniatus*
White Croaker	*Genyonemus lineatus*
Widow Rockfish	*Sebastes entomelas*
Yelloweye Rockfish	*Sebastes ruberrimus*
Yellowtail Rockfish	*Sebastes flavidus*

A towed underwater video system is also used during portions of the cruises to gather visual footage of the seafloor habitat as well as any demersal fish and invertebrates present. These visual observations are used to improve our knowledge of the various bottom types at each sampling site, identify locations of important invertebrate colonies, and help develop and test hypotheses about fish and habitat interactions.

Part II. Impacts on Channel Island National Marine Sanctuary Resources

Identification of sanctuary resources and values that may be affected

All sampling on the hook and line survey is conducted within the SCB, ranging from Point Arguello in the north (34º 35’ N) to 60 Mile Bank in the south (32º 00’ N), in waters from 20 fathoms (37 m) to 125 fathoms (229 m) and includes the two Cowcod Conservation Areas (CCAs) (Harms et al. 2008). All sampling activities occur within the U.S. Exclusive Economic Zone. Six of the survey’s original 121 fixed stations (sites 180, 184, 048, 228, 229, and 413) occur within the Channel Islands National Marine Sanctuary (CINMS) Marine Protected Areas (MPAs) – 2 within the Richardson Rock Federal MPA (sites 180 and 184, Figure 3a) and 4 within the Footprint Federal Reserve (sites 048, 228, 229, and 413, Figure 3b). All research catch at all stations is accounted for in the Pacific Fishery Management Council’s (PFMC) Total Allowable Catch limits for each species established as per the Magnuson-Stevens Sustainable Fisheries Act.

a)

b)

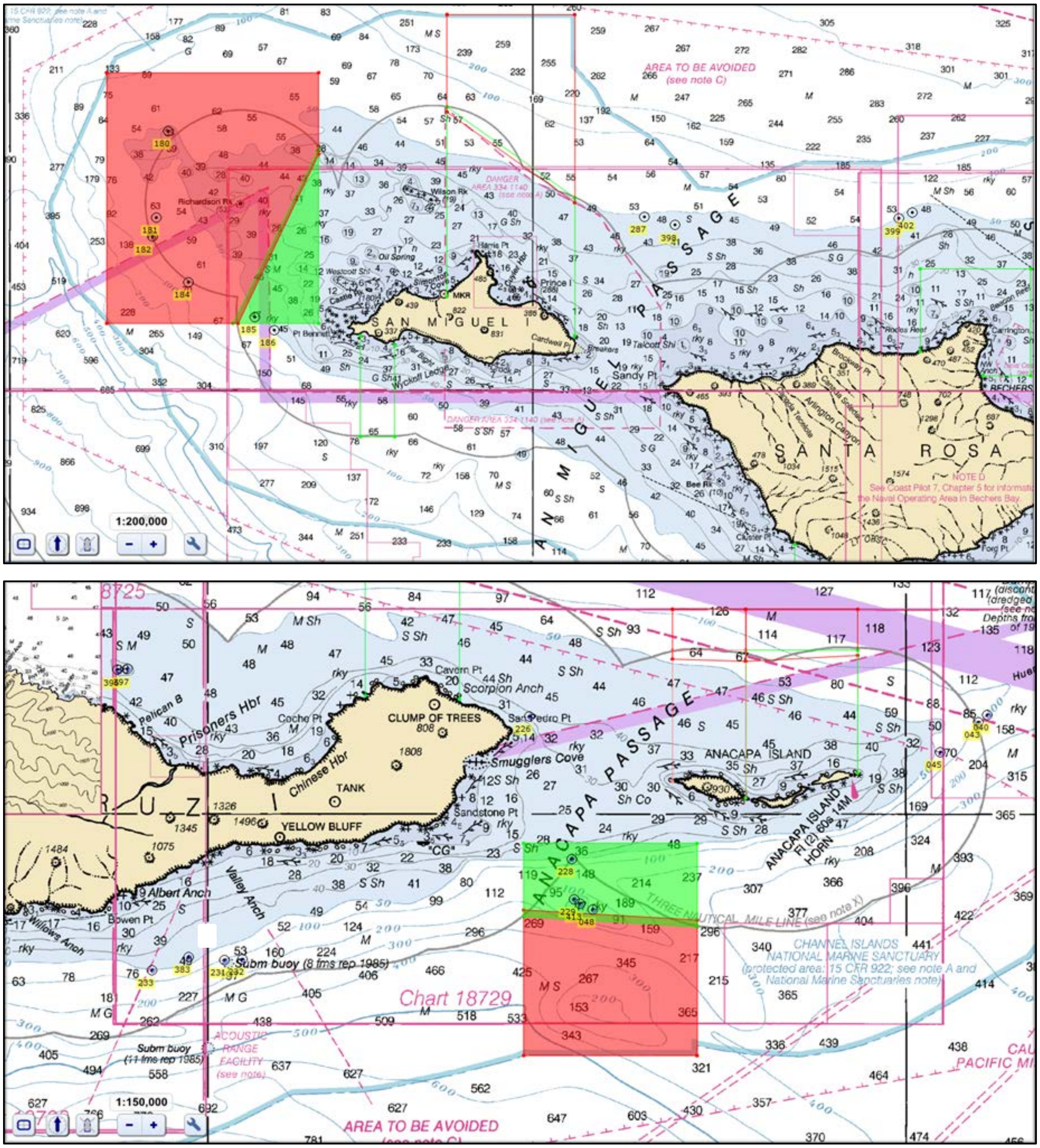


Figure 3. Hook and Line stations within the a) Richardson Rock Federal MPA (stations 180, and 184) and b) the Footprint Federal MPA (stations 048, 228, 229, and 413)
Although the green and red colors represent the corner coordinates used to demarcate the state and federal reserves, all sites within the Footprint MPA (1b) are actually in federal waters.

The hook and line survey's time series at stations inside both the Richardson Rock and Footprint MPAs began in 2004, prior to the implementation of the federal reserves in 2007 and 2008. The two Richardson Rock sites have been sampled 9 – 10 times from 2004 to 2014 and each of the four Footprint sites have been sampled 8 to 11 times over the same 11 year period. Sites have been missed primarily due to weather. Table 2 shows the location and number of times throughout the survey period (2004 – 2014) that the sites within the federal MPAs have been sampled.

Table 2. Hook and line survey sites within federal MPAs in the CINMS: latitude, longitude and total number of visits to each site 2004–2014

Site	Latitude	Longitude	Times sampled
180	34° 08.5'	120° 33.9'	10
184	34° 03.5'	120° 33.2'	9
48	33° 57.7'	119° 29.0'	11
228	33° 58.9'	119° 29.6'	8
229	33° 57.9'	119° 29.5'	10
413	33° 57.8'	119° 29.3'	8

The hook and line survey has encountered 24 fish species within the two CINMS MPAs during the period 2004-2014 which includes the cryptic species pair vermilion rockfish (*Sebastes miniatus*) and sunset rockfish (*S. crocotulus*) (Hyde et al., 2008). Virtually indistinguishable in the field, the vermilion rockfish complex is an integral component of the region's sportfishing sector and, collectively, is the state of California's 2nd most commonly landed species of groundfish among recreational anglers (RecFIN extracted 27 February 2014). Vermilion and sunset rockfish are separately identified based on DNA analysis at the conclusion of each annual survey. The hook and line survey is currently the only means of tracking the abundance of the complex's two constituent species.

Table 3 provides information on all species encountered at the 6 MPA sites within the CINMS during the period 2004-2014 including whether the species is primarily pelagic or demersal in habitat association. Also shown in the table are the total catch (summed across the 6 sites and 11 years of the survey) and the average annual catch for each species, adjusted for years when a site may have been missed due to weather. The final column in the Table 3 is, therefore, the species-specific, expected annual impact of continuing the hook and line survey within the MPAs at the Richardson Rock and Footprint sites. The expected annual impact ranges from a removal of 0.09 to 48.88 fish yr^{-1}, depending on species, or an average total catch of approximately 163 fish of all species for the 6 MPA sites. This is equivalent to the take of approximately 27 fish per year at each of the 6 MPA sites.

Table 3. Common and scientific names, habitat, total catch (individuals) and expected average catch per year (average yr^{-1} adjusted for years where not all sites were sampled) over the survey period (2004-2014) for species encountered in CINMS federal MPAs

Common Name	Scientific Name	Habitat	Total (n)	Expected avg yr^{1}(n)
Vermilion Complex	*Sebastes miniatus spp.*	demersal	445	48.88
Bocaccio	*Sebastes paucispinis*	demersal	440	48.17
Greenspotted Rockfish	*Sebastes chlorostictus*	demersal	95	9.82
Blue Rockfish	*Sebastes mystinus*	demersal	82	8.20
Speckled Rockfish	*Sebastes ovalis*	demersal	63	6.85
Lingcod	*Ophiodon elongatus*	demersal	66	6.55
Yellowtail Rockfish	*Sebastes flavidus*	demersal	49	5.40

Common Name	Scientific Name	Habitat	Total (n)	Expected avg yr^1(n)
Starry Rockfish	*Sebastes constellatus*	demersal	49	5.15
Pacific Mackerel	*Scomber japonicus*	pelagic	41	5.13
Chilipepper	*Sebastes goodei*	demersal	34	3.78
Olive Rockfish	*Sebastes serranoides*	demersal	36	3.60
Rosy Rockfish	*Sebastes rosaceus*	demersal	25	2.90
Swordspine Rockfish	*Sebastes ensifer*	demersal	16	1.58
Copper Rockfish	*Sebastes caurinus*	demersal	11	1.23
Flag Rockfish	*Sebastes rubrivinctus*	demersal	10	1.20
Widow Rockfish	*Sebastes entomelas*	demersal	10	1.04
Halfbanded Rockfish	*Sebastes semicinctus*	demersal	10	1.00
Sanddab unidentified	*Citharichthys spp.*	demersal	7	0.78
Squarespot Rockfish	*Sebastes hopkinsi*	demersal	6	0.63
Yelloweye Rockfish	*Sebastes ruberrimus*	demersal	5	0.50
Canary Rockfish	*Sebastes pinniger*	demersal	3	0.33
Bonito	*Sarda chiliensis*	pelagic	1	0.13
Greenstriped Rockfish	*Sebastes elongatus*	demersal	1	0.09

The actual number of fish sampled at each MPA site varies by location and year (Table 4). In general, more fish are encountered within the Richardson Rock MPA (average catch 35 – 45 fish yr^{-1}) than the Footprint MPA (average catch 12 – 18 fish yr^{-1}) with the range within MPAs varying from 1 – 70 fish yr^{-1} across years (Table 4).

Table 4. Total catch of all species within each of the 6 CINMS MPAs by year (2004-2014).

The minimum, maximum, and average catch within the study period are also shown. "NS" indicates a site was not sampled in a particular year.

	Site (reserve)					
Year	**180 (RR)**	**184 (RR)**	**48 (F)**	**228 (F)**	**229 (F)**	**413 (F)**
2004	24	NS	21	4	NS	NS
2005	44	66	40	NS	12	NS
2006	NS	NS	11	NS	7	3
2007	53	56	5	NS	1	1
2008	55	70	4	18	12	11
2009	42	60	12	10	10	7
2010	41	55	5	23	16	2
2011	56	66	21	33	20	46
2012	42	55	4	8	21	28

	Site (reserve)					
Year	**180 (RR)**	**184 (RR)**	**48 (F)**	**228 (F)**	**229 (F)**	**413 (F)**
2013	11	25	9	51	13	NS
2014	19	39	26	55	20	36
Minimum	11	25	4	4	1	1
Maximum	56	70	40	55	21	46
Avg catch	38.7	54.7	14.4	25.3	13.2	16.8

Assessment of the nature and likelihood of direct and cumulative effects.

To better understand the effects of survey-induced mortality on the resources within the Richardson Rock and Footprint federal reserves, we used observed survey catch rates to estimate total abundance first within the two MPAs, and then again at the larger CINMS level. We then examined the relative impact of survey take inside the MPAs compared to estimated overall abundance within the entire CINMS.

To estimate the total abundance of each species encountered by the survey within the two federal reserves, we used observed survey CPUE (n $site^{-1}$) at the 6 reserve sites for the taxa listed in Table 3 (22 species and one species complex). We then calculated the area sampled at each site (radius = 91.4 m; site area = 26,267.9 m^2 or 0.026268 km^2 per site or 0.15761 km^2 for all 6 sites in the reserves). The CPUE data were then converted to species-specific density estimates for each site (n km^2). Because the species targeted and captured by the hook and line survey are generally associated with hard bottom, we needed to estimate the proportion of hard bottom within the CINMS. The most recent Essential Fish Habitat Review (EFH) (PFMC, 2012) estimated approximately 6% of the seafloor area within the CINMS contains hard substrate, and another 14% of the seafloor area was designated as either unknown or a mix of hard and soft bottom habitats. Because of the uncertainty around the relative mix of hard, soft, and unknown bottom habitats, we assumed 50% of the ambiguously-classified habitat is actually hard substrate, bringing the estimated proportion of hard bottom habitat within the CINMS to 13%. This is likely a conservative estimate based upon preliminary analysis comparing visual observations from NWFSC camera sled deployments in the SCB with EFH maps (Chappell, A.C., 2014, unpublished research). We then used the rate of change of observed catch rates by drop at all 26 sites within the CINMS to estimate a catchability coefficient (q) of 0.12. Finally, we assumed a constant size selectivity of 1.0 (e.g., all individuals of all species are 100% vulnerable to the survey gear regardless of their size) which is a conservative assumption. Using these parameters, estimated total abundances aggregated for both the Richardson Rock and Footprint MPAs are presented in Table 5. The lowest abundances calculated are 47 for greenstriped rockfish and 65 for bonito. The estimates for greenstriped rockfish (often associated with soft substrate) and bonito (a generally pelagic species) are likely to be significant underestimates of true abundance within the reserves due to the survey's emphasis on sampling hard bottom habitats. Estimated abundances are significantly higher for key target species which are primarily associated with hard substrates such as the vermilion rockfish complex (n=25,300) and bocaccio (n=24,932). Expected annual catch of bocaccio at the 6 MPA sites relative to its estimated combined abundance in the Richardson Rock and Footprint MPAs as well as annual expected natural mortality due to predation and senescence (M_{inst}=0.15 converted to an annual value for M of approximately 0.139) is shown in Figure 4.

Table 5. Expected annual catch, estimated total abundances, and relative impacts of hook and line survey catch within the CINMS and its MPAs

Species	Expected avg annual catch in RR and Footprint MPAs (n yr^{-1})	Estimated total abundance in RR and Footprint MPAs (n)	Estimated total abundance in CINMS (n)	Relative impact: ratio of annual survey take in MPAs relative to total abundance in CINMS	
				Ratio	%
Blue Rockfish	8.20	4,244	160,698	5.10E-05	0.0051%
Bocaccio	48.17	24,932	919,869	5.24E-05	0.0052%
Bonito	0.13	65	755	1.66E-04	0.0166%
Canary Rockfish	0.33	173	11,960	2.79E-05	0.0028%
Chilipepper	3.78	1,955	50,207	7.52E-05	0.0075%
Copper Rockfish	1.23	634	217,985	5.62E-06	0.0006%
Flag Rockfish	1.20	621	15,027	7.99E-05	0.0080%
Greenspotted Rockfish	9.82	5,082	428,418	2.29E-05	0.0023%
Greenstriped Rockfish	0.09	47	10,042	9.05E-06	0.0009%
Halfbanded Rockfish	1.00	518	20,477	4.88E-05	0.0049%
Lingcod	6.55	3,392	137,874	4.75E-05	0.0048%
Olive Rockfish	3.60	1,863	68,903	5.22E-05	0.0052%
Pacific Mackerel	5.13	2,653	34,901	1.47E-04	0.0147%
Rosy Rockfish	2.90	1,501	47,549	6.10E-05	0.0061%
Sanddab Unidentified	0.78	401	49,062	1.58E-05	0.0016%
Speckled Rockfish	6.85	3,546	119,474	5.74E-05	0.0057%
Squarespot Rockfish	0.63	323	23,542	2.65E-05	0.0027%
Starry Rockfish	5.15	2,668	82,415	6.25E-05	0.0063%
Swordspine Rockfish	1.58	819	22,961	6.89E-05	0.0069%
Vermilion Complex	48.88	25,300	1,829,628	2.67E-05	0.0027%
Widow Rockfish	1.04	539	78,505	1.33E-05	0.0013%
Yelloweye Rockfish	0.50	259	5,380	9.29E-05	0.0093%
Yellowtail Rockfish	5.40	2,795	167,632	3.22E-05	0.0032%

We then used observed catch rates at all 26 sites in the CINMS (Figure 5) and employed the same methodology to estimate absolute abundance for the same 23 taxa in the CINMS as a whole (3,807 km^2). The last column in Table 5 provides an annual, species-specific relative impact of survey take by calculating the ratio of the average expected annual catch to the total estimated abundance within the entire CINMS. This information is also shown in Figure 6 sorted by decreasing relative impact and indicates that catch of bonito (a pelagic species captured only in the MPAs and not elsewhere in the CINMS and unlikely to be a permanent resident of the MPAs) is expected to have the greatest impact on CINMS resources with .0166% of the individuals in the region removed. Catch of the most abundant taxon within the CINMS (vermilion rockfish complex) is expected to have a much lower relative impact, with .0027% of the individuals in the region removed by the hook and line survey. The lowest relative impact was estimated for copper rockfish with .0006%) of the individuals taken in the CINMS removed from the 6 MPA sites. We believe any adverse effects on Sanctuary resources resulting from these low levels of mortality to be generally negligible at both the MPA and CINMS scales.

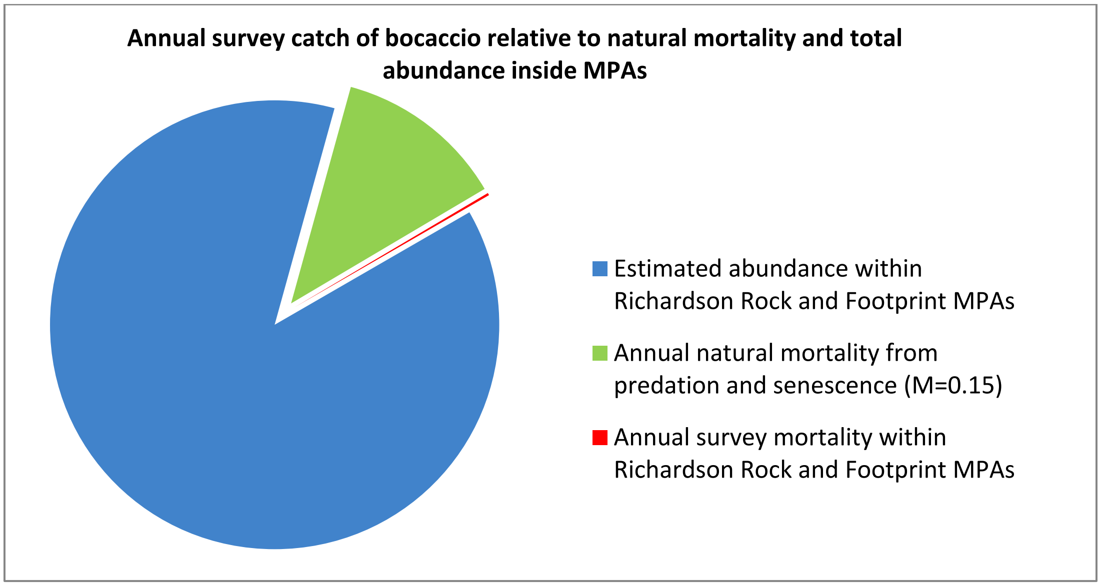


Figure 4. Ratio of expected average annual catch of bocaccio at the 6 federal MPA sites (red slice) relative to estimated removals due to natural mortality (calculated from M_{inst}=0.15; green slice) and estimated total abundance of bocaccio within the Richardson Rock and Footprint reserves (blue slice).

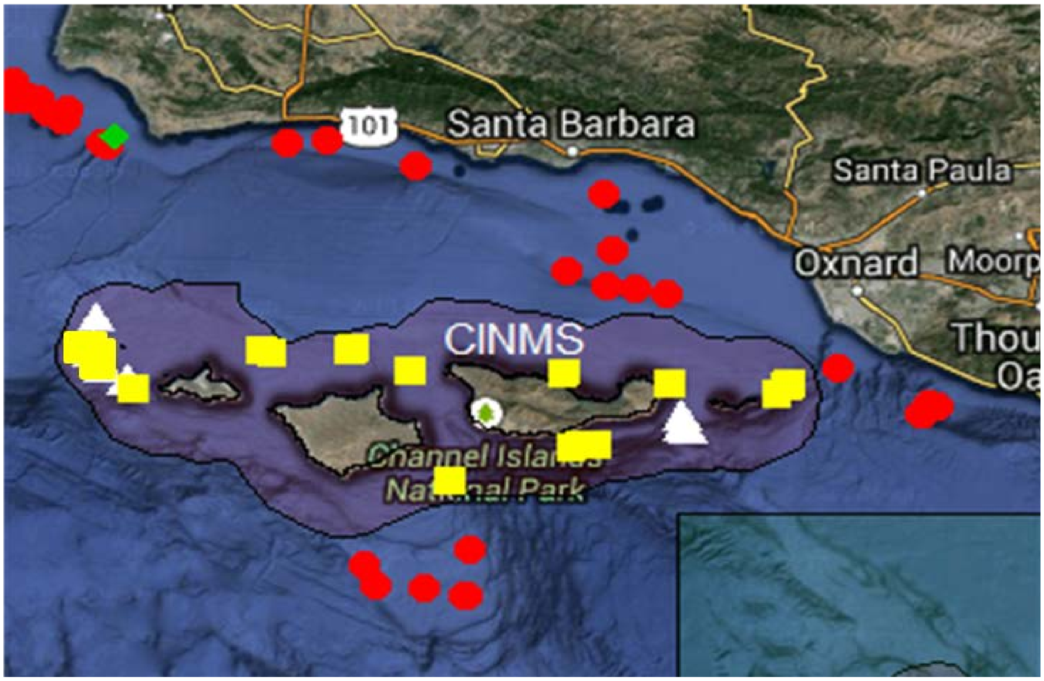


Figure 5. Location of all 26 hook and line survey sites within the CINMS.
White triangles are within federal MPAs, and yellow squares are within the CINMS but outside federal MPAs. Red circles are adjacent stations located outside of the CINMS.

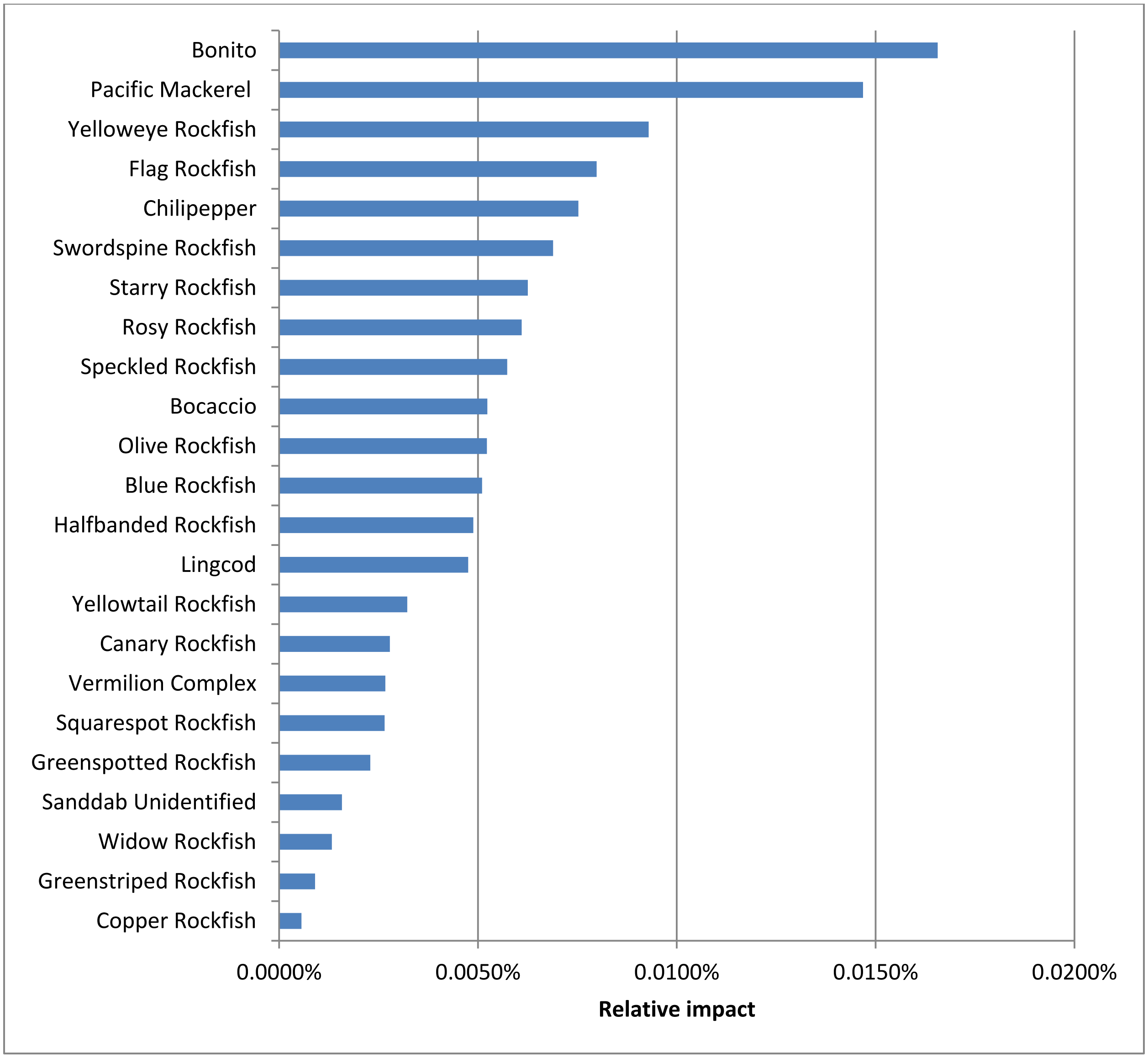


Figure 6. Relative impact of the hook and line survey on CINMS resources (i.e. ratio of average expected annual catch in the Richardson Rock and Footprint MPAs as a ratio of total abundance within the entire CINMS).

To investigate whether the hook and line survey might be causing localized depletion within MPAs, we compared the trend over time for catch of 23 taxa within the federal MPAs to the catch of the same species outside the federal MPAs from 2004-2014 (Figure 7). No discernible trend in abundance is readily apparent from within the MPA sites, but the data are not suggestive of survey-induced depletion. Catches at sites inside the CINMS but outside the federal reserves do suggest a slight decreasing trend over time which may be influenced by different population dynamics elsewhere in the CINMS, continued legal access to these areas by sport and commercial fishermen, or other factors.

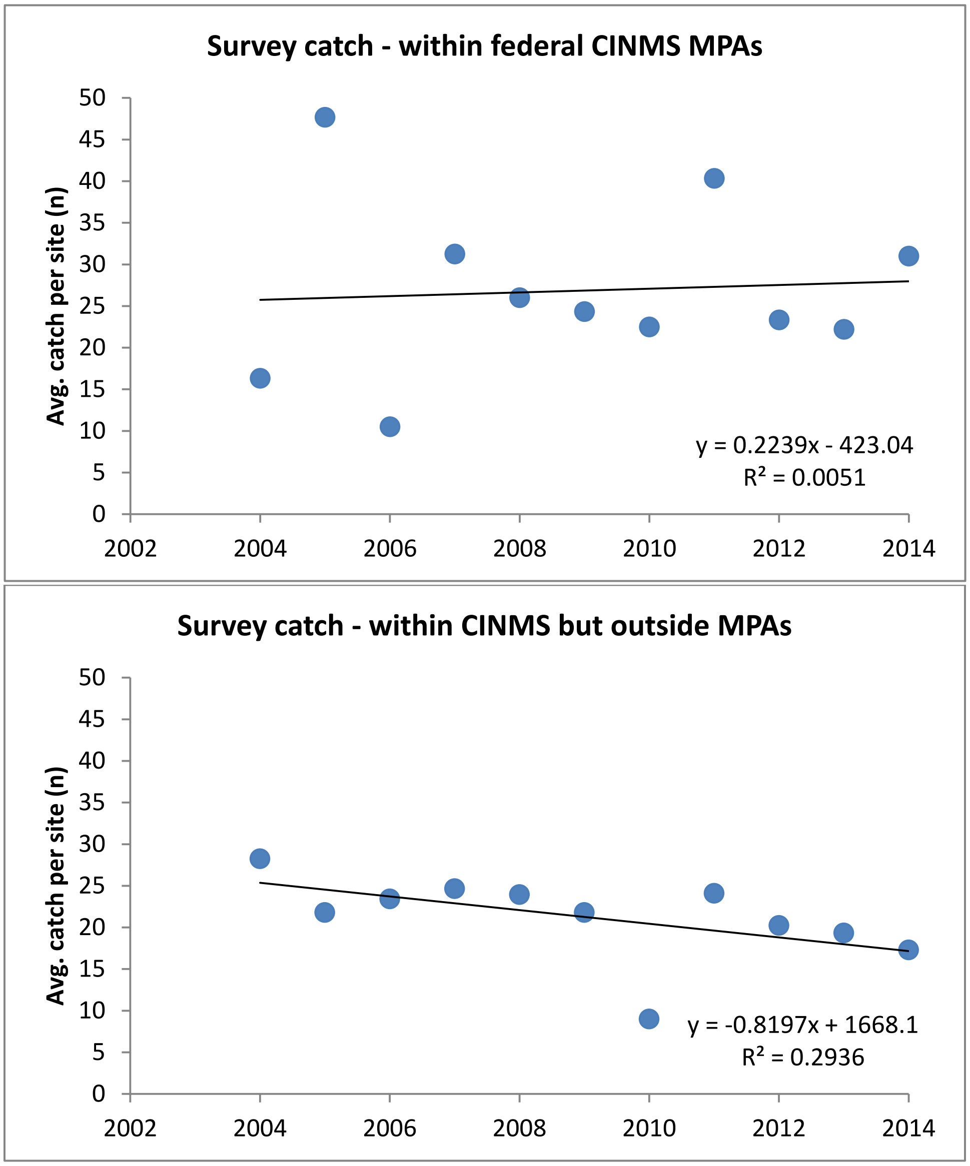


Figure 7. Average combined catch per site of 23 fish taxa by year during the hook and line survey within CINMS federal MPAs (upper panel) and inside the CINMS but outside federal MPAs (lower panel).

Assessment of the nature and likelihood of indirect effects

The potential direct effects were described above based on the known catch within the MPAs over the history of the hook and line survey. One indirect effect that is of potential concern is survey-induced mortality of older, larger fish. To investigate this, we compared the size (length, cm) of two abundant taxa (vermilion rockfish complex and bocaccio) within and outside the CINMS reserves. The boxplots in Figure 8 show the length distribution for the two species. For both species, the mean (asterisk) and median (bolded line) are larger within the reserves than at non-reserve sites within the CINMS. The data also indicate a larger spread of sizes at the non-reserve sites, as well as a lack of smaller fish inside the reserves suggesting the reserves may be serving as a repository for larger, older fish and are not being disproportionately removed via survey mortality. This is consistent with findings from other studies that indicate an association between protected areas and an increase in the average size of fish (Harmelin et al. 1995; Piet and Rijnsdrop, 1998; Tetreaut and Ambrose, 2007; Jaworski et al., 2010; Keller et al., 2014).

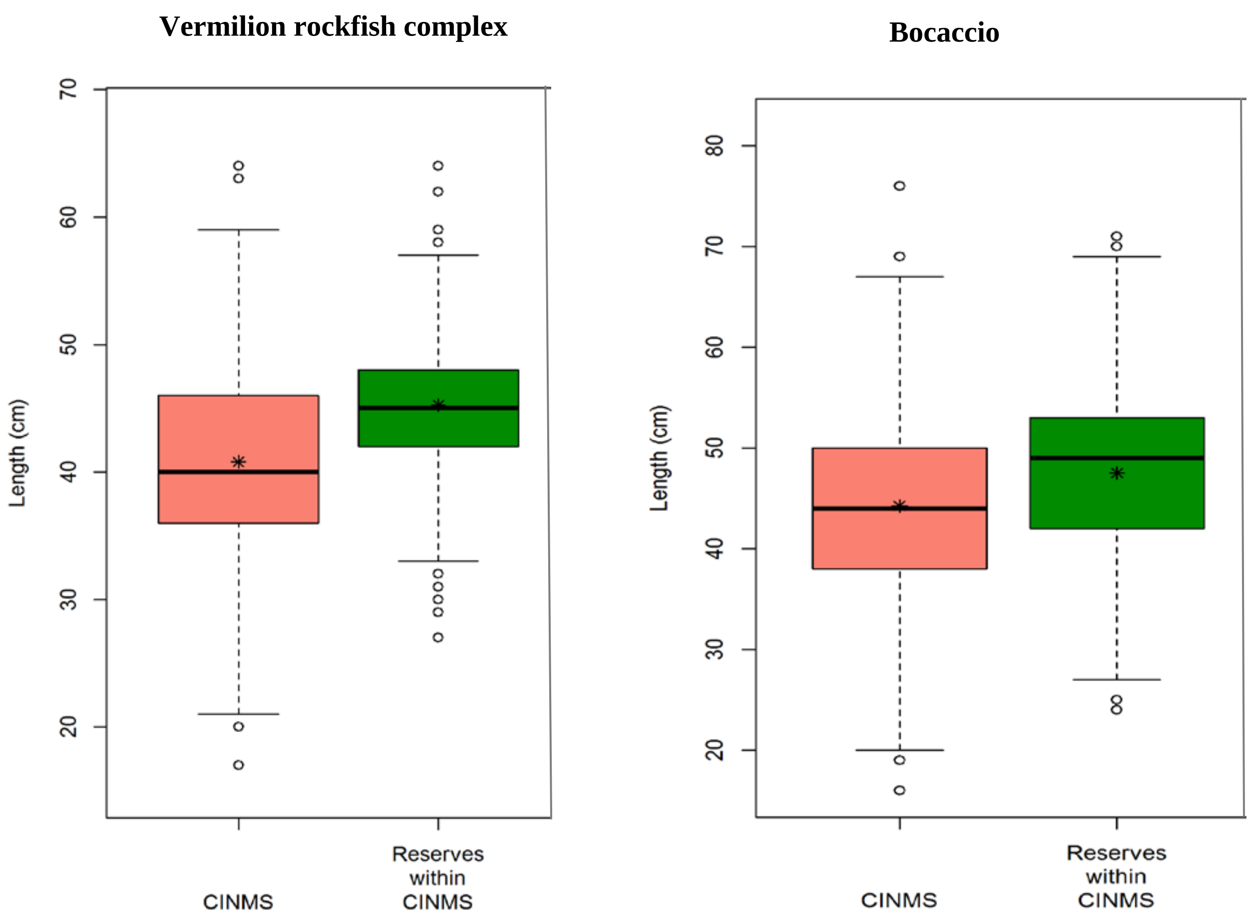
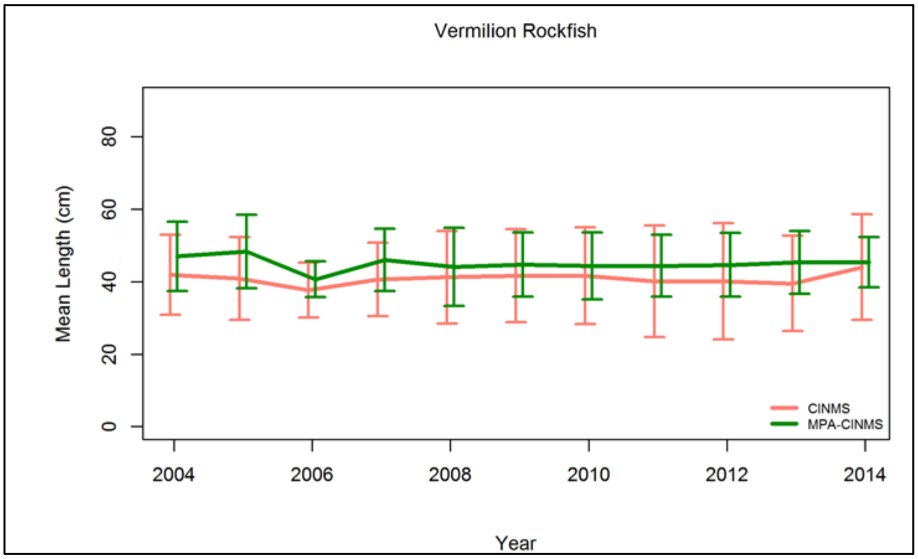


Figure 8. Boxplots of length (cm) for vermilion complex and bocaccio from sites within and outside the CINMS MPAs.
Asterisks indicate mean length and the bold horizontal lines indicate median length.

To determine whether mean length might be decreasing over time inside the reserves, we next compared mean length (cm) within and outside the CINMS MPAs by year for the same two species (Figure 9). Although there is a large amount of variability in the data, there is no readily apparent trend over time, and the mean length for both species is consistently higher inside the reserves than out. These analyses suggest the survey is not measurably reducing the amount of larger, older fish from sites inside or outside of the reserves, and that any adverse effect is short-term in duration.



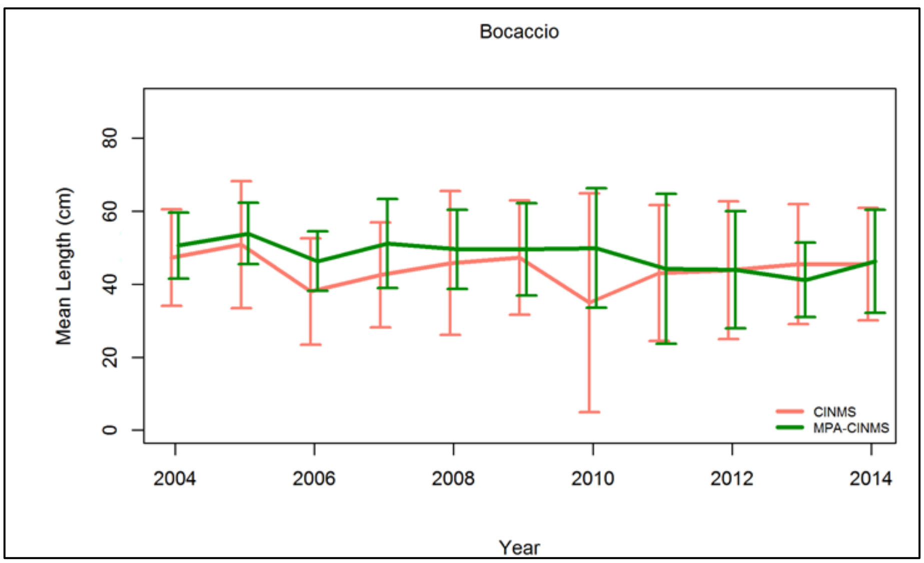


Figure 9. Mean length (cm) by year for vermilion rockfish and bocaccio within and outside the CINMS MPAs.
Error bars represent +2 standard deviations of observed lengths on each side of the mean length.

To examine the statistical impact of removing the federal and state MPAs from the suite of survey sites used to generate abundance indices for stock assessments, we developed standardized indices of abundance for three species with high catch rates inside the CINMS: bocaccio, vermilion rockfish complex, and yellowtail rockfish both with and without the MPA sites included in the models (Harms et al. 2010). Removing the federal MPA sites from the bocaccio analysis resulted in an average increase of 9.6% in the size of the 95% confidence intervals and an 18.6% increase when both the federal and state MPAs are removed from the analysis (Figure 10). For the vermilion rockfish complex, removing the federal MPA sites from that analysis resulted in an average increase of 0.7% in the size of the 95% confidence intervals and a 2.5% increase when both the federal and state MPA's are removed (Figure 11). More striking, for yellowtail rockfish, removing the federal MPA sites from that analysis resulted in an average increase of 126.8% in the size of the 95% confidence intervals and an 886.2% increase when both the federal and state MPA's are removed (Figure 12). Note that for the scenario of removing only the federal MPA sites for yellowtail rockfish, the large confidence intervals only appear for 2013-14 survey years. This corresponds to years where three vessels were used for the survey as compared to two vessels in the other years; hence it suggests that the model is responding with increased uncertainty to the relatively small number of yellowtail rockfish observations within some strata for those years. When both federal and state MPAs are removed from the analysis, this holds true for all years.

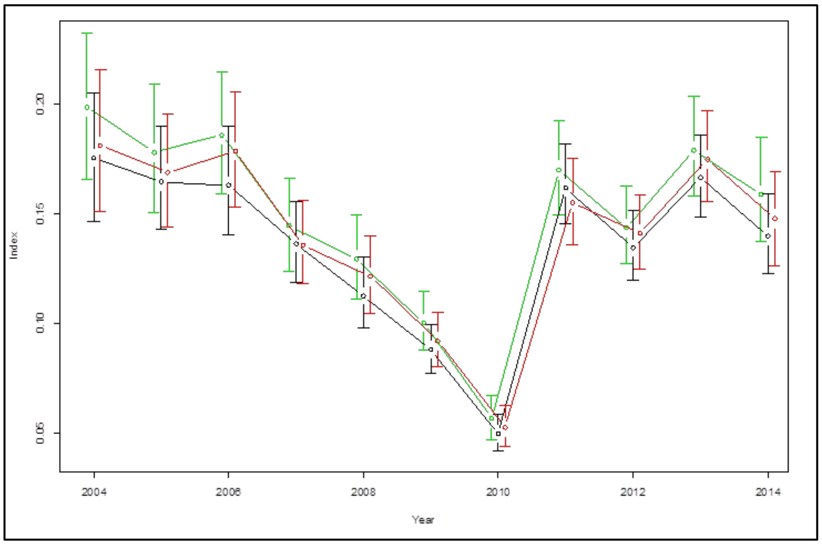


Figure 10. Bocaccio model index (black line) with 95% confidence limits.
The final model without the federal MPA sites in the CINMS is shown in red, and the final model without the federal and state MPA sites is shown in green.

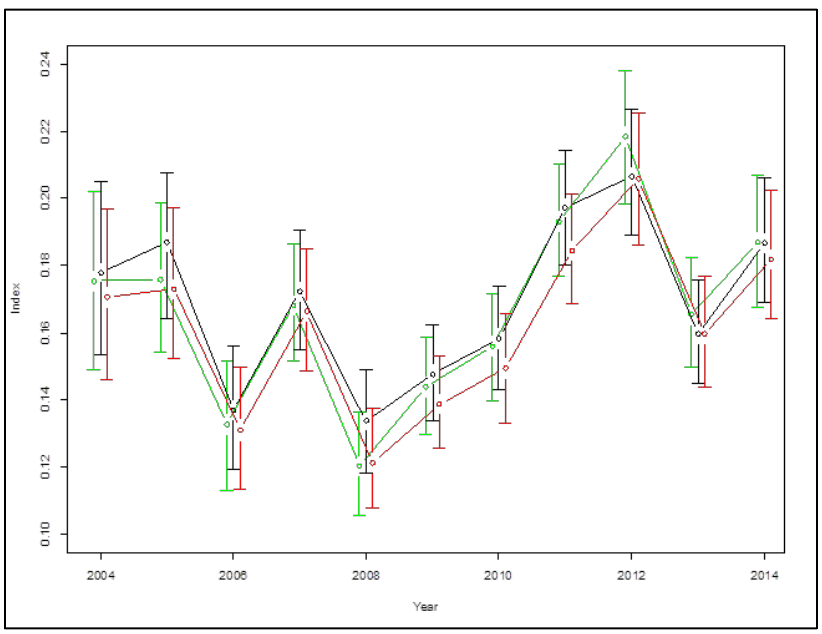


Figure 11. Vermillion rockfish complex model index (black line) with 95% confidence limits.
The final model without the federal MPA sites in the CINMS is shown in red, and the final model without the federal and state MPA sites is shown in green.

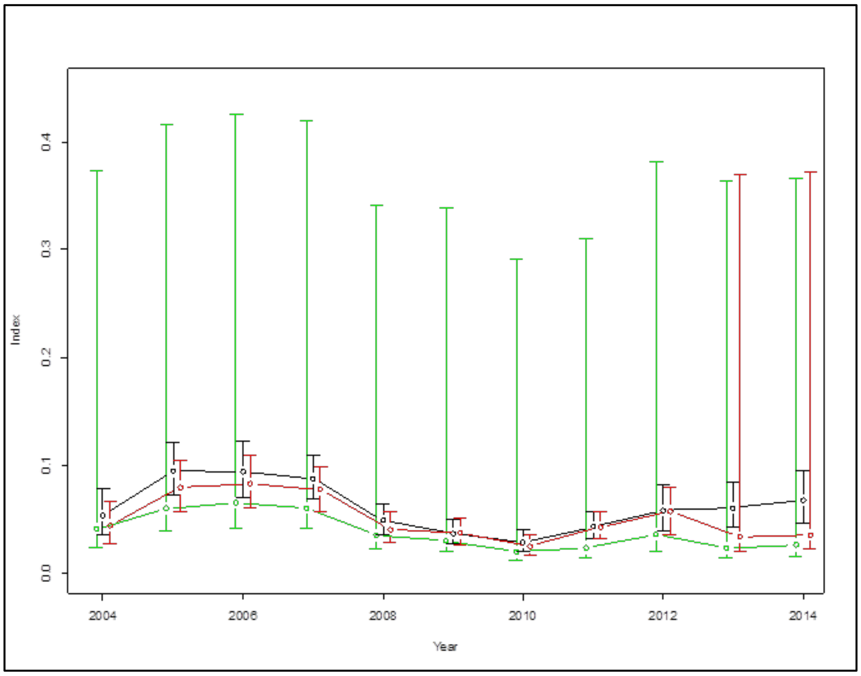


Figure 12. Yellowtail rockfish model index (black line) with 95% confidence limits.
The final model without the federal MPA sites in the CINMS is shown in red, and the final model without the federal and state MPA sites is shown in green.

The indices suggest that using a reduced number of sites, in all cases, resulted in more variable indices both within year and across years. However, different trends are observed for the different sets of data, suggesting that the species are utilizing various areas within the CINMS and its reserves differently, and it is important to monitor all sites when an index of the entire stock is desired. Reducing the uncertainty surrounding the population dynamics inside of areas closed to fishing was the underlying rationale cited by the PFMC and assessment authors for recommending the initiation of hook and line survey sampling within the two Cowcod Conservation Area reserves which had been closed to both fishing and fishery-independent surveys since 2000 (PFMC, 2013).

Documentation and permitting

Complete survey data are available upon request from the NWFSC. For the 2015 hook and line survey scheduled to begin in September 2015, we have obtained CDFW Scientific Collecting Permit (no. SC-11678) and are in the processing of obtaining a federal Scientific Research Permit (SRP-01b). In addition, all research catch is accounted for in the PFMC's Total Allowable Catch limits established as per the Magnuson-Stevens Sustainable Fisheries Act.

Part III. Mitigation Plan

The NWFSC is working in collaboration with the CINMS to minimize impacts at survey sites that occur within marine reserves. These measures include evaluating the impacts and feasibility of removing or re-locating existing survey sites currently inside reserves, short-term, immediate reductions in mortality, and using barotrauma-reduction descending devices to return captured fish alive to the seafloor.

Removal of site(s), and transition to site(s) outside the MPA

The NWFSC is interested in exploring whether one or more existing survey sites may be removed from the reserves through a calibration process with a new, paired site. Site 180 is located just inside the Richardson Rock MPA boundary. We propose establishing a paired site just outside the MPA that is similar in habitat, depth, and related features to site 180. We will then sample the two sites in parallel for a 10-year period to facilitate a calibration analysis. If both the CINMS and NFWSC deem the calibration suggests that the new site yields data that is sufficiently consistent with the data from site 180, the latter site will be removed from the sampling frame. To support this effort, we propose the following steps:

- Summer 2015 – Work with sanctuary staff and industry partners to identify one or more sites outside the Richardson Rock MPA that is similar to site 180 in habitat, depth, and related features.
- Fall 2015 – Begin sampling new site(s).
- 2016-2024 (annually) – The two sites will be sampled in parallel during the annual hook and line survey. The CINMS and NWFSC will statistically evaluate the suitability of incorporating the new site(s) into the time series. Jointly, NWFSC and CINMS will determine whether the new site is a suitable replacement for site 180.
- 2025 – Final decision for inclusion/exclusion of site 180, if it has not been made earlier.

Immediate reductions in survey mortality within federal MPAs

The NWFSC understands the immediate need to minimize survey impacts in marine reserves. Hence we propose for the 2015 survey a reduction in the number of drops from 5 to 3 at sites 180, 184, 048, 228, 229 and 413 providing an immediate 40% reduction in effort (and consequently, mortality) within the Footprint and Richardson Rock federal MPAs. In addition to reducing survey take within MPAs, this approach allows for the continuation of the survey's established and standardized sampling protocols and maintains the viability of the survey's historical time series at these sites until additional mitigation measures are implemented (see below). One caveat with this approach is that the reduction in survey effort will be accompanied by a proportional decrease in our ability to detect changes in abundance, species composition, and other quantities of interest. For this effort, we propose the following steps:

- Fall 2015 – reduce sampling in all 6 federal MPA sites from 5 drops to 3
- Annually thereafter – present mortality data inside and outside CINMS reserves to CINMS staff. The NWFSC and CINMS will jointly determine whether changes in sampling effort are appropriate for each subsequent year.

Use of descending devices

We will research and deploy descending devices in a manner that will ensure not only reduced survey mortality at reserve sites, but also provide useful data beyond what is collected during the course of regular survey operations. It is important to note that the release of live specimens will preclude the collection of biological data on age, diet and maturity. The CINMS and NWFSC will collaborate to determine the impact of the loss of these data on applications including stock assessments, life history research, and the ability to monitor the population dynamics within the reserves.

Survey vessels are currently required to carry fish descending devices, and survey staff used them on an experimental basis during the 2014 survey. Our experience suggests that the descending devices that are currently available are: 1) labor intensive, requiring an additional dedicated biologist or deckhand per descending device in use; and, 2) designed primarily for use during passenger fishing trips (where anglers typically use single or 2-hook gangions and capture smaller fish in waters generally shallower than those sampled on the survey). Consequently, they are not suitable for descending fish of the size and at the rate and depths they are caught on the survey. Given these conditions, the likely result from their expanded use during the survey is that many, if not most, descended fish will have little chance of survival.

A more suitable approach would be to develop a system that allows for the continued collection of basic biological data (e.g., species, length, weight, sex, etc.) and maximizes the likelihood of survival for captured specimens. We propose developing and building a custom device that can temporarily hold fish at the surface after basic biological data is collected from each fish captured during a sampling drop (up to 15 adult fish) and then descend all specimens to depth *en masse*. This approach not only supports the historical consistency of established sampling protocols, it also facilitates the collection of additional data useful to both the CINMS and NWFSC such as the integration of a mark-recapture study and evaluating the short-term mortality of descended fish by affixing an underwater video camera within the descending cage to capture visual observations of the descending process. Upon mutual determination that this approach adequately mitigates survey mortality within the reserves, survey effort will return to historical protocols of 5 sampling drops per site. We propose the following timeline for implementing descending devices:

- Summer 2015 – June 2016: Research, design, and construct a multi-fish descending device and all equipment necessary for its deployment including the *in-situ* holding cage, a winch or other means to deploy and retrieve the device, and a video system to monitor evaluate the behavior of the descended fish. In addition, staff will research the most appropriate protocols and design for the integrated tagging study. These steps will include an extensive literature review and consultation with industry and other fisheries scientists for effective approaches.
- Fall 2015: If possible, test components of the novel device on board chartered survey vessels. Continue experimentation with traditional descending devices; tag and descend 1-3 individuals at MPA sites when possible.
- Winter - Spring 2016: Develop a comprehensive plan that incorporates the new descending device and the mark-recapture project. Work with CINMS staff and the local sportfishing industry to develop an outreach plan to the recreational fishing community to maximize tag return.
- Spring 2016: NWFSC will report on progress and results to date to CINMS. If appropriate, CINMS and NWFSC will work together to apply for funding for further development and testing of devices, and discuss opportunities for increased (joint) staffing to allow devices to be deployed efficiently.
- Summer 2016: Test the newly developed system, adjust as appropriate. Report results to CINMS.
- Fall 2016: Deploy the newly designed descending device capable of handling 15 fish at a time (the maximum potential catch per drop) in CINMS reserves.
- If deployment of the new descending device is delayed for any reason, CINMS and NWFSC staff will consult on appropriate mitigation actions until issues can be resolved.

Part IV. Developing Additional Scientific Information for Fisheries and Sanctuary Use

Annual check-ins

The NWFSC is committed to an ongoing partnership with CINMS on research issues of mutual interest. We believe sampling associated with the hook and line survey represents an exciting opportunity to help understand the particular dynamics of the CINMS and its marine reserves while improving the stock assessments that are used to manage important species of groundfish. Further, we believe the survey represents only a starting point, rather than ending point for potential research collaboration and look forward to exploring many other interesting ideas for studying this unique area in the near future. To help ensure direct lines of communication remain open, the NWFSC proposes an annual, in-person meeting with CINMS to present the results of the survey and of relevant research and discuss areas of concern. This meeting may include the following:

- Presentation and discussion of analysis and metrics that can be used to assist the CINMS in monitoring MPAs (e.g., catch at reserve sites, catch at all CINMS sites, catch outside CINMS, length frequency analysis of indicator species inside and outside reserve sites, etc.).
- Discussion of potential changes in survey plans based on results of previous year's research.
- Discussion of future joint research (see also below).
- Presentation and discussion of subsequent year's work plan.
- Identification of potential funding sources to support additional research, vessel charter time, and project development
- Other topics as determined jointly two months before the meeting (allowing adequate preparation time).

Identification of potential new research areas

The NWFSC's hook and line survey offers many opportunities for the NWFSC and the CINMS to improve our understanding of the sanctuary itself as well as the living marine resources that use its waters. We propose that CINMS and the NWFSC staff work together to prioritize the following potential areas of work:

- Using hook and line survey data and specimens to understand the ecological impacts of these marine reserves in particular, as well as general attributes of marine reserves. This could include comprehensive analysis of existing data as well as new projects.
- Sanctuary-driven research projects that would include CINMS staff as research partners and survey participants.
- Improving the quality of habitat maps available for CINMS waters. The NWFSC's camera sled provides real-time video footage of the seafloor which can be used to ground-truth multibeam mapping data and improve the algorithms used to determine habitat type from backscatter. Improved habitat maps will in turn better inform abundance estimates calculated using survey CPUE data.
- Developing novel non-lethal survey methods within reserves.
- Using mark-recapture data and potentially stable isotope analysis to study the ontogenetic movement of key groundfish species at the scales of the individual reserve, entire CINMS, and the SCB as a region. This can shed light on what habitat types are most important to different life history stages and improve our understanding of population dynamics in the region.
- Using the suite of oceanographic data (e.g., temperature, salinity, dissolved oxygen, turbidity, and chlorophyll) collected during each survey site visit to improve our understanding of the role these parameters play in presence/absence of key species, relative abundance, and how populations respond to short- and medium-term changes in oceanography including short-lived algae blooms, El Nino events, and seasonal oceanographic anomalies.

- Integrating all of this into a more holistic analysis of how habitat, oceanography, abundance, and basic demographic data interact to drive the population dynamics within the CINMS and SCB.

After priorities have been established, the CINMS, NWFSC, and appropriate partners will develop a work plan to review and implement key studies. Some studies, such as those evaluating the impact of marine reserves, are likely to require a workshop and/or independent review to develop appropriate and statistically robust methodologies and approaches. In addition, due to limited resources, CINMS and NWFSC staff most likely will need to submit proposals to augment available funding to support this work.

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