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Science and Technology
Standards and Protocols for Surveys

NOAA FISHERIES PROTOCOLS FOR FIXED GEAR TRAP, POT AND CAMERA POD SURVEYS

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NOAA Fisheries Protocols:
Fixed gear Trap, Pot and Camera Pod Surveys

December 22, 2003

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Members of NOAA Fisheries Science Centers

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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Introduction

In a September 22, 2002 memorandum Bill Hogarth directed that in addition to the trawl survey protocols and calibration of warp measurements required by VADM Lautenbacher in his memo of September 16, 2002, the NOAA Fisheries Science Centers and the Office of Science and Technology would develop protocols for other survey methods. Specifically; "I have assigned F/ST the responsibility of coordinating a similar review and production of standards and protocols for each of our surveys in addition to the trawl surveys covered in the VADM's order". NOAA Fisheries has had and currently conducts surveys contributing to stock assessments using trap or pot fishing gear and a specially designed camera system.

The intent of this document for fixed trap, pot or camera pod gear is to identify areas for standardization of survey methodology and establish protocols to ensure these areas are addressed by the regionally specific sampling protocols for current or future surveys. The goal is to achieve consistency and repeatability of fixed trap, pot or camera pod gear by survey from station to station and year to year. Establishment of and adherence to protocols will document our attention to detail in gear handling to ensure consistency in sampling and data quality from our fixed gear surveys. These protocols will be applicable to any NOAA fisheries trap/pot/camera surveys that are used to generate CPUE data for managed fisheries.

Historical Overview of Trap, Pot and Camera Pod Surveys:

Fish traps and pots were among the earliest types of fishing gear used by ancient man and are currently used for many types of fish and shellfish fishing throughout the United States Exclusive Economic Zone (EEZ). Traps have the advantage of potentially capturing the prey alive and in many applications can be designed to reduce bycatch of unwanted species or undersized individuals. Traps and pots can be used for assessment surveys to sample in areas that cannot be easily sampled by traditional trawls or longlines due to rough bottom conditions, such as around reefs and rocky, broken bottom.

Traps have been used for many years by the Southeast Fisheries Science Center to sample reef fish on and adjacent to reef and hard bottom areas of the Gulf of Mexico and Caribbean. Early sampling used a single-funnel fish trap and in 1991 a camera was added to evaluate trap catch efficiency. The video camera replaced the fish trap as the index of reef fish abundance since it proved to be less selective than the trap. The fish trap/single camera gear was eventually replaced by a multiple-camera array designed to accommodate four cameras and a fifth down-looking camera. Fish are not retained by the camera array. Assessments are conducted by analysis of the video evidence from the stations. A chevron trap is also used to collect biological samples at the station.

The Hawaiian Islands have a commercial trap fishery for lobster, which harvests several species in the Northwestern Hawaiian Islands (NWHI). Lobster concentrations in the NWHI were documented by exploratory research cruises in 1976 and commercial trapping began in 1977. Regular surveys are conducted by the PIFSC to support ongoing research of the spatial and temporal variations in lobster abundance.

One of the largest U.S. finfish trap fisheries is for sablefish (*Anoplopoma fimbria*) or black cod on the west coast from southeast Alaska through California. In 1978 through 1981, research cruises to determine annual changes in sablefish abundance and size composition were conducted on the west coast. Commercial sablefish pots, fished in a string comprised of a groundline set with ten traps spaced fifty fathoms apart, were used for this survey. The NWFSC conducted cruises in 2002 and 2003 on charter vessels using commercial pots to determine depth distributions of sablefish and to compare pot catch data with trawl data collected by the West Coast Slope survey.

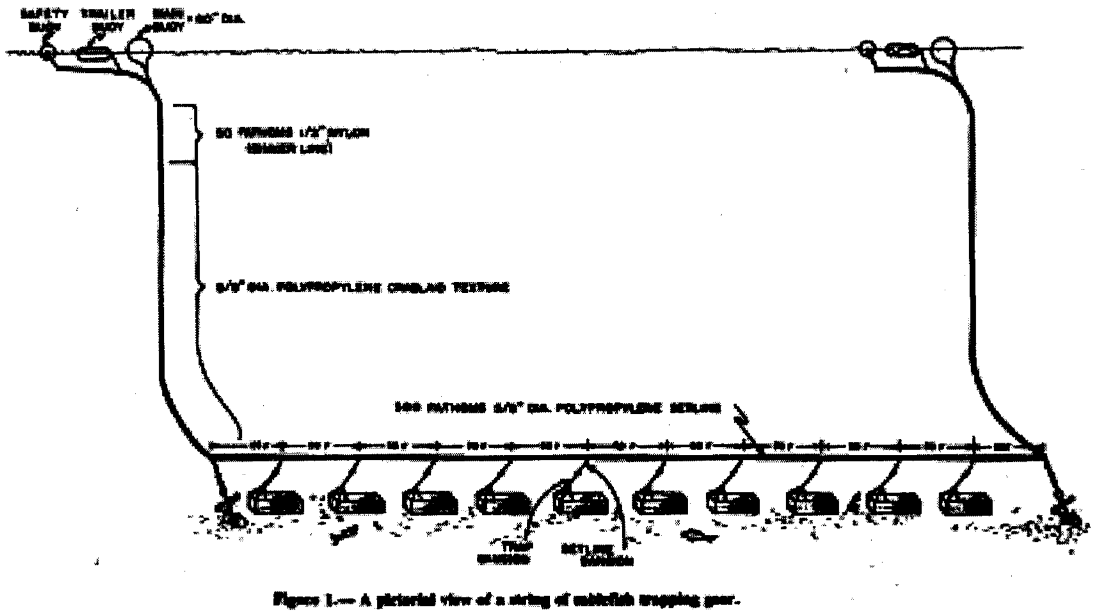


Illustration from NMFS Fishery Fact 7, A trapping system for harvesting sablefish, 1974

In 2001 the AFSC began to develop standardized pot fishing methods to research problems related to Pacific cod fisheries. There is a directed cod fishery in Alaska using pots that have been modified from a crab pot design. Where trawl methods smooth over area, pot methods smooth over time. AFSC is attempting to equip their pots with sensors that record time of capture and then marry that data to micro-scale observations of current, temperature, turbidity, light levels, and other aspects of physical oceanography. The sensors have been developed to a very functional state and are ready to be deployed on a regular basis rather than as part of prototype and development work. The next step is to develop methods to deploy instrument arrays among the gear as part of the research fishing conducted on a chartered commercial vessel.

Operational Protocols for Trap, Pot or Camera Pod surveys:

Standardize Trap/Pot/Camera Pod Gear by survey

Problem Statement:

Fishery independent data collected during NOAA Fisheries research surveys provide information for scientific analyses and assessments of the status of managed stocks. The configuration of gear employed to sample target species of fish and invertebrates must be standardized to maintain catchability among years and habitats. Any changes to the gear must be documented, and experiments conducted to determine any shifts in catchability.

Protocol 1: Standardize Trap/Pot/Camera Pod Gear by survey

The Field Party Chief (FPC) and ship bosun shall insure that all traps/pots/camera pod gear shall meet standards as outlined in the official description of the gear for that survey.
To ensure that comparable gear is used throughout the cruise, the FPC or designee and the ship's chief bosun or designee will inspect the sampling gear prior to, regularly during and at the conclusion of each survey. Any designee must be qualified to ensure the sampling gear meets the standard. A thorough description or diagram of gear construction will be provided to the FPC and ship's bosun for documentation. Examples of the types of information that should be in the description or diagram include mesh sizes, materials descriptions, acceptable mesh/twine/frame colors, frame dimensions, number of entrances, funnels or trigger types and whether the trap contains a biodegradable panel. Harnesses and connectors for the gear will be described with the gear diagrams including any specific materials or hardware. Harnesses, connectors and fittings will be inspected prior to, regularly during and at the conclusion of every survey with the overall gear inspections.

For the camera pod, the cameras are mounted with two bolts at fixed points on the array so that camera position and height above the bottom are consistent.

Sub-Protocol 1a: Damaged gear

If a trap is damaged during the survey, the FPC and Ship's bosun must determine if it can be repaired at sea to match the standard. If the gear is repaired, the FPC and Ship's bosun shall review the repair and determine if the trap continues to meet the standard before it is deployed again for the survey. If the gear cannot be repaired to meet the standard, it shall not be re-deployed in the survey.

Sub-protocol 1b: Gear calibration

If and when a survey needs to transition to a new gear style from the standard, a calibration must be conducted from the previous standard to new style gear. Regional programs will determine a methodology and document the methods used for comparison and results of any calibration between the different types of gear when transitioning to a new gear type standard for a survey.

Establish Guidelines for Appropriate Scope and Floatation for Buoy Line, and Standardize Buoy Line and Groundline Measurement by Specific Survey.

Problem Statement:
For consistency within a given survey, provisions must be made to ensure that there is sufficient scope for the trap/gear to settle on bottom without the buoy line affecting the performance of the gear. Scope ratio guidelines for buoy line will be specified for a survey and a mechanism to validate the line lengths will be established. Scope ratios should allow for current, tide and wave action to provide consistent catchability through all survey depths without impact to trap/pot/camera pod set. The optimum scope ratio of line length to depth range may vary through the depth ranges for optimal gear performance. More line may be required in a high sea state to avoid any bouncing or rocking of the gear on the bottom. However, excess buoy line can be counter-productive in heavy currents by increasing drag and potentially pulling the marker buoy under. Sufficient weight must be used to get gear on bottom and sufficient floatation must be used to keep the hy-flyer or pickup buoys from being pulled under.

If traps/pots are set as a string with multiple traps, the spacing of traps on the groundline should be consistent.

Protocol 2: Standardize Buoy Line Scope and Line Measurement
To ensure buoy line markings/measurement are correct so that sufficient scope can be deployed, techniques to confirm markings of buoy line prior to the survey and at deployment must be used. The buoy line for many surveys is in pre-measured sections in tubs or baskets. If known standard lengths of line are stored in multiple baskets, the lengths of the line sections should be confirmed prior to each survey and clearly marked on the line and tub. This is important if there is more than a single length of line and multiple tubs of line of varying fixed lengths being used on the same survey.

If the line is marked on a reel, a method will be specified to confirm these markings prior to the survey. If line on a reel is not marked, a standardized methodology will be described in the field operations guidelines for the measurement of the line to ensure sufficient scope.

Sufficient floatation will be used to insure that excessive buoy line scope is not required at a station and that the gear is not lost in heavy swells or currents. The appropriate amount of floatation will be defined in the field operations guidelines for a specific survey.

Sub-protocol 2a: Scope guidelines
Programs will establish buoy line scope guidelines by depth for their surveys. Ship's bosun and

bridge personnel will confirm the appropriate scope, from a table provided by the field party, to use on a set for the depth at the survey site. Consideration for bathymetry of the survey site will be included in the decision for scope to assist in avoiding lost gear on slopes. Current, tidal changes or other conditions at the survey site should be considered when determining appropriate scope, weight and marker buoy floatation for a sample site.

Sub-protocol 2b: Groundline trap spacing

If traps/gear are set in a string or "trawl" of multiple traps per set, the method employed to control the spacing of traps shall be standardized for the survey and defined by the program. For a given survey, the same number of traps will be set in a string at selected sites per the survey design throughout the survey. If anchors are used at the beginning or end of a string, the style and size of anchor will be described and the distance from the anchor to the first trap/pot will be defined.

Standardize Survey Operational Procedures

Problem Statement:

Standardization of station selection, gear deployment, operation and retrieval procedures are critical for maintaining consistency in survey catchability over time. Factors that can affect sampling of target species include selection of station, documenting gear time on bottom, sampling within day/night criteria and bait. Other issues addressed in previous protocols included gear standards and repairs. Written unambiguous protocols specifying these and other issues that may affect survey consistency provide a mechanism for communication between the scientific staff and the officers and crew of the research vessel, which in turn maintains continuity in procedures as personnel and vessels change over time.

Protocol 3: Standardize Survey Operational Procedures

If gear deployment and retrieval direction is important for consistency in the survey, the direction of the set into swells, into wind, along contour, speed of set or other variables shall be clearly outlined in the cruise instruction and discussed at a pre-cruise meeting. This requirement must be defined for each specific survey. If there is a requirement to deploy gear on or adjacent to a specific feature, such as a bottom depth, contour, patch reef etc., this must be clearly described in the cruise instruction or survey operational plan. To effectively set the gear on the target, vessel setting speed and sink rates for the gear by depth must be documented so that vessel personnel will know the appropriate time to shoot the gear to have it settle on the target. Clear communications from the bridge watch to the deck crew must be maintained to effectively set gear on small target sites.

Once the crew picks up gear and gets it safely on deck, the catch or cameras shall be delivered to the field party. The gear shall be inspected to insure that there has been no damage during the set and retrieval process. Once specimens, old bait, cameras etc. are removed, the gear shall be prepared for re-deployment at the next station following the guidelines for the specific survey and situation.

Guidelines for the selection of the actual gear deployment locations within the survey station site will be established and described in the cruise instruction or survey operational plan. Each survey will have station location procedures to assess conditions for site selection, which may include assessing bottom topography of the station to accomplish setting adjacent to relief or along a specific contour. An assessment should also be made of any potential slope or current at the station to avoid losing gear. In some cases an assessment of the depth contours for a desired station must be made to determine if the vessel can safely return to the sample site to retrieve the trap if the station is in an area near shoal water or navigational fairways. If for any reason the pre-selected site is not suitable, a provision for deleting the station or locating an alternate site, and identification of the amount of time that can be spent searching, should be documented in the operational plan for the specific survey.

Sub-protocol 3a: Bait standardization

To ensure that the gear maintains a comparable ability to attract target stocks over the course of the survey, the type of bait shall be standardized by survey. This should include the amount, type of bait (squid, mackerel, artificial, other), status (fresh, frozen, salted/preserved) and the container type. Provisions shall also be made to set criteria for when bait is determined to be unacceptable and must be replaced, such as if bait has been in the sun too long or dehydrates.

If a camera pod is used, the number, style, location and color of housings should be identified and consistent for the survey. If bait is attached to the pod, the amount, type and container style shall be identified. Probably the most significant aspects of the camera array pod, in terms of fish behavior, are its size (dimensions), shape, and the type and amount of bait.

Sub-protocol 3b: Standardize soak time

Soak time for the gear must be established by survey so that the gear is on bottom for at least the minimum acceptable soak time before it is retrieved. Ensure that soak time is accurately recorded and meets minimum for the survey design to retain comparability among sets and survey years. If daylight or darkness criteria for sampling are critical to a survey, these shall be clearly communicated to the ship. Day or night time criteria should be clearly defined so that gear is not set too close to sunrise or sunset to allow for the required sampling time in the correct day/night period.

If a device is used to close the trap after a specific period of soak time, the calibration or operation of the device shall be verified prior to the cruise and documented in the operational procedures.

Sub-protocol 3c: Success criteria

Establish criteria and guidelines for a successful set. Define what parameters must be met to constitute a successful set. Parameters such as: trap on bottom for sufficient time, period on bottom is within day/night criteria, trap not damaged, trap has not moved from the drop site and any other survey-specific requirement should specified.

If a set is judged to have been unacceptable by the watch leader or FPC, guidelines should be in place to define if the station should be repeated or deleted. Some reasons that a set may be judged not acceptable include: too short of a soak time, gear not set within acceptable distance from station, gear damaged/not in compliance with standard, gear lost, etc.

Sub-protocol 3d: Define responsibilities

The responsibilities of field party chief, field party and ship personnel for decisions on various aspects of the survey activities shall be clearly defined, discussed at a pre-cruise meeting, and whenever key personnel change. Each survey shall provide an operations plan to the science party, cruise participants and crew of the survey vessel that provides clear and unambiguous definitions of all procedures required to properly conduct the trap/pot/camera pod survey. This should include procedures and the party responsible for determining whether a sample site is acceptable, how long to spend searching for a suitable site within a survey station area before the station is deleted, and determining whether to attempt repeating an unsuccessfully sampled station.

Discussion:

All NOAA Fisheries surveys provide some form of a cruise instruction to their staff, cruise participants and crew of the survey vessel. However, some aspects of the operations necessary for a survey may be omitted or specified in insufficient detail to eliminate individual interpretation that may impact the survey while the survey is underway. By increasing the level of detail and formalizing the communication of procedures, operations should be consistent through time and among various staff in the field party and onboard the survey vessel. Implementation of the NMFS survey protocols will achieve the goal of consistency and repeatability of data collection from fixed trap, pot or camera pod gear by survey from station to station and year to year.

Regional Protocols

Because of the diversity among NOAA Fisheries fixed gear trap, pot and camera system surveys, these protocols are specified in general terms to allow each Science Center and survey flexibility in their approach to meeting the standardization criteria. In the following appendices the specific methodology used to implement the standardization requirements of the protocol by each NOAA Fisheries trap/pot/camera survey that is used to generate CPUE data for managed fisheries is described.

Appendix 1: Southeast Fisheries Science Center
Southeast Regional Protocol for Assessment and Monitoring Surveys for Reef Fish.

Appendix 1: Pacific islands Fisheries Science Center
Pacific Islands Regional Protocol for Lobster Trap Surveys.

Appendix 1

December 22, 2003

Southeast Regional Protocol for Assessment and Monitoring Surveys for Reef Fish

Prepared by Personnel from NOAA Fisheries Southeast Fisheries Science Center

Introduction

Reef fish habitat in the Gulf of Mexico (GOMEX) includes not only coral reefs found in the Florida Keys, but also banks, ridges and pinnacles found on the continental shelf, shelf edge and upper slope. The Southeast Assessment and Monitoring Program (SEAMAP) reef fish survey of shelf and shelf-edge banks in the Gulf of Mexico was initiated in 1992, with sampling conducted from late May to early August. The video survey evolved from a survey conducted with single-funnel fish traps that were baited with squid. The traps were highly selective and the catch rates of snappers and groupers were very low. In 1991, a single video camera was mounted outside of a single-funnel fish facing toward the trap to determine what role fish behavior had in producing the low catch of fish. We discovered that the traps were very selective and very inefficient, and we frequently observed the escapement of fish. The reef fish survey gear was switched to include video cameras in 1992, with the video camera aimed away from the trap. All camera sampling was conducted during daylight hours using single 8 mm video camera in an underwater housing. The video camera has been the primary gear since 1992, however, video camera gear has undergone changes as older camera models became unavailable and were replaced by newer models. In 1995, we switched to Hi8-mm video cameras and a switch to digital camcorders occurred in 2000.

Two types of gear have been used to deploy video cameras. We used a single-funnel fish trap (2.13 m long by 0.76 m square) with the camera mounted at a height of 25 cm above the bottom of the trap from 1992 to 1995. In 1995, we introduced a four-camera array with the four cameras mounted orthogonal to each other at a height of 25 cm above the bottom. The camera array was modified in 2001 to include a fifth downward-looking digital camera, and was also enclosed in aluminum diamond-mesh to protect the cameras. Since the camera survey evolved from a trap survey, all video camera gear has been baited with squid. Sample duration has varied, and was one hour for surveys conducted in 1992-1995. We conducted a resampling experiment of 26 one-hour videotapes in 1995 to determine the statistical cost of reducing time viewed. The estimated totals from twenty-minute viewing, when extrapolated to one hour were not significantly different than the total number of fish on the one-hour tapes. The number of taxa that were observed on a one-hour tape was reduced by 23%. However, the reduced time viewed decreased the person-hours required to view the tapes. As a result of the resampling experiment, the view time was reduced to twenty minutes in 1996. The camera gear since 1996 has soaked on the bottom for thirty minutes to ensure twenty minutes of view time. A chevron fish trap is still in use to collect biological samples. It is set at a randomly selected subset of the video stations with a sample size of approximately 12% of the total number video stations.

Standardize Trap/Pot/Camera Gear by Survey

Protocol 1: Standardize Trap/Pot/Camera Gear by Survey.
The SEAMAP reef fish survey currently employs Sony VX2000 DCR digital camcorders mounted in Gates PD150M underwater housings. The housings are rated to a maximum depth of 150 meters. Also in use is a Sony PC120 digital camcorder mounted in a Gates Diego housing. This camera is placed facing downward to obtain video images of the bottom. All Gates housings are fitted with a wide-angle lens with an approximate 74E field of view. All cameras are mounted in a camera pod. The Sony VX2000 camcorders are mounted orthogonally and a height of 30 cm above the bottom of the pod. The pod also includes a Seabird SBE25 sealogger CTD with pressure, temperature, salinity, turbidity and oxygen sensors. Each camera has at least two sets of lasers, one set mounted above the camera and another set mounted below the camera. Two lasers spaced 10 cm apart within each laser set are used to estimate fish lengths. The camera array is weighted with four, 9.07-kg lead weights attached to 24-hour magnesium releases. Four 12.25-cm plastic floats are attached at the top of the array. The array is negatively buoyant with only two weights. The floats and weights are designed to allow retrieval of gear if the line is cut.

A chevron (or arrow) fish trap with 1.5-inch vinyl-clad mesh is used to capture fish for biological samples. In its greatest dimensions, the trap is 1.76 m in length, 1.52 m in width and 0.61 m in depth. A 0.4 m by 0.29 m blow out panel is placed on one side and kept closed using 7-day magnesium releases. The magnesium releases are examined after each soak and replaced as needed. The trap is deployed at a randomly selected subset of video stations.

Sub-Protocol 1a: Damaged gear.
The condition of the fish trap is checked after each retrieval. Any dents or deformations are repaired. If repairs are not possible, a new trap is used.

Sub-Protocol 1b: Gear Calibration.
Any changes in chevron trap design, mesh size or bait will require experiments to compare trap designs or baits.

Standardize Buoy Line

Protocol 2: Standardize buoy line.
We employ 12-strand braided, 1/2-inch Spectra line, attached to the camera array with a stainless steel "D" shackle. At the surface, the Spectra line is attached to an aluminum, telescoping hy-flyer by another stainless steel shackle. The hy-flyer can extend to a height of 6.1 meters, has a radar reflector mounted at the top, and uses a 47-cm (18.5-inch) spar buoy. An inflatable buoy is attached to the Spectra line 1 to 2 meters before the hy-flyer. A mid-water float may be attached to the line at mid-depth to prevent tangles by keeping the line off of the bottom.

We use _-inch poly-Dacron line for the chevron trap. Both the camera array and fish trap are retrieved from the bottom using a hydraulic trap hauler. The hy-flyer is first retrieved, and the slack line pulled in by hand. The tension on the line is checked to determine if the gear is on the bottom. The amount of line used to set both gears is approximately twice the water depth. Line is stored in baskets on deck, and is coded by color for length segments of 10 fathoms (18.3 m), 20 fathoms (36.6 m), and 50 fathoms (91.4 m).

Standardize Survey Operational Procedures

Protocol 3: Standardize survey operational procedures.
If both a video camera array and a fish trap are deployed at the same site, the video gear is deployed first. After retrieval of the video gear, the chevron fish trap is deployed at the same site. The video camera array is dropped at selected sample sites from the stern of the vessel. If the vessel is a stern trawler, it can be shoved off of the stern ramp. If another vessel is used, the camera array is suspended off of the stern, and a forged snap shackle is used to drop the gear into the water. The chevron traps are dropped over the stern.

Sub-protocol 3a: Bait standardization.
Both the camera array and fish trap are baited with squid, and replaced after each soak. Frozen squid is thawed prior to placement in the camera array or fish trap. On the camera array, 4-5 large squid (*Loligo sp.*) are placed in a 10 cm by 10 cm square wire mesh cage. In the fish trap, six to ten squid are threaded on each of two lines, one line on each half of the trap.

Sub-protocol 3b: Standardize soak time.
The camera array soaks on the bottom for 30 minutes. The trap soaks on the bottom for one hour. The start time of the soak is set when the hy-flyer is released. The end time of the soak is set when the line is hauled back.

Sub-protocol 3c: Standardize processing of fish.
All fish captured in a fish trap are identified, measurements of total length, fork length and standard length taken, and each fish weighed. Otoliths or spines are taken for aging. Gonads, or other samples are taken upon request.

Sub-protocol 3d: Standardize video tape viewing procedures.
For each station, one tape is selected from out of the four. If all four tapes face reef fish habitat and are in focus, the viewed tape is selected randomly. Tape viewers examine 20 minutes of the selected videotape, identify and enumerate all species for the duration of the tape. Identifications are made to the lowest taxonomic level and the time when each fish enters and leaved the field of view is recorded. This is referred as a time in - time out procedure (TITO).

Tapes are viewed from the time when the view clears from any silt plume raised by the gear when it landed. Less than 20 minutes may be viewed if the duration when water is not clear enough to count fish is less than 20 minutes, or if the camera array is dragged. If a tape contains a large amount of fish, it is sub-sampled. There are four cases for sub-sampling: 1) when there is generally a large number of fish of a given species present throughout the tape so that following individual fish is difficult; 2) large number of fish occur in pulses periodically during the tape; 3) a single school of fish; and, 4) multiple schools of fish. Three estimators of relative abundance are available from the video data: 1) presence and absence; 2) maximum count (each fish of each taxon is counted each time it appears on the screen); and, 3) a minimum count (the greatest number of a taxon that appears on screen at one time). Presence and absence and minimum count estimators are advantageous because they avoid the potential of multiple counting of fish.

Sub-protocol 3e: Success Criteria
Video data success criteria depends on visibility, camera focus, and gear movement. Video gear sets in very turbid water (water transmissivity less than 50%) are not used. The cameras must be in focus to identify fish. The gear must not drag or bounce on the bottom. Fish trap sets are considered successful if they are not damaged during the set.

Sample Design

Protocol 4: Sample Design
The survey area is large; therefore a two-stage sampling design is used to minimize travel times between sample stations. The first stage or primary sampling units (PSUs) are blocks 10 minutes of latitude by 10 minutes of longitude (Figures 1 and 2). The ultimate sample units within each block are potential reef sites. The list potential reef site within each block was created from bathymetric charts. Ultimate sample units were approximately 100 m by 100 m. Currently, blocks are selected using a stratified random procedure. Sample sites within blocks are selected randomly by one of two procedures. For blocks that have been mapped, either from previous reef fish surveys or more recently using multibeam sonar, sites are randomly selected from a list of sites developed from the maps. For the second procedure, selected blocks that have not been mapped are surveyed at night with an echosounder. Acoustic transects are run systematically with a random start, and a list of reef sites developed using the echogram. Reef sites are then randomly selected from the list of reef sites determined from the echogram.

Appendix 2

December 29, 2003

Pacific Islands Regional Protocol for Lobster Trap Surveys

Prepared by Personnel from NOAA Fisheries
Pacific Islands Fisheries Science Center

Introduction

The Honolulu Laboratory conducts an annual lobster trapping survey in the Northwestern Hawaiian Islands (NWHI). Standardized trapping operations are conducted at pre-selected sites in the NWHI focusing at the two banks of greatest importance to the lobster fishery, Necker Island and Maro Reef. The resulting catch data is used to monitor trends in lobster and by-catch species stocks by providing a fishery independent index of abundance over time. Additional biological data is collected on the lobster catch to provide information on population structure and reproductive status.

The surveys started in 1985 and have used NOAA research vessels Townsend Cromwell (1985-2002) and Oscar Elton Sette (2003). Two trap types, each with minor variations, have been used over the years. Early in the surveys a two-chambered 2x4 inch wire mesh trap was the survey standard. In the late 1980s a shift in the industry standard and the lack of availability of the wire traps led to a change in the survey standard to a 1x2 inch mesh molded plastic trap.

Standardize Trap/Pot/Camera Pod Gear by survey

Protocol 1: Standardize Trap/Pot/Camera Pod Gear by survey

The trap used for our lobster monitoring surveys is the Fathoms Plus plastic shellfish trap. A photograph of the trap is found on the company web site at: http://www.fathomsplus.com/images/Picture_2_2.JPG. The trap consists of two identical halves. Lead or steel weights are added to each half, after which the two halves are joined with a plastic hinge pin resulting in traps weighing between 22 and 36 pounds depending on the weights available at the time. Studies have shown no significant difference in catch for either lead or steel weighting material or for total trap weights between 22 and 36 pounds. The traps come with the entry funnel blocked by a plastic plate that must be cut out. Escape vents, which are required to be cut out in the commercial fishery, are left blocked for our surveys in order to obtain a broader, more representative indication of lobster size structure. A 1/2-inch diameter polypropylene bridle is attached to one end of the trap to allow for attachment to the ground line. Prior to setting, one bait canister is inserted in each trap (each side has a bait canister insertion point, but only one side is used for our surveys).

Sub-protocol 1a: Damaged traps

All traps are examined by field party scientists prior to sailing and all damaged traps are replaced or repaired. Traps are reexamined for damage on each haul when removing old bait and catch from the traps. Broken traps are noted on the data form and either repaired or replaced prior to baiting and resetting. Mesh components of the Fathoms Plus trap are of varying strength. The weakest components are those that divide heavier 2x2 inch mesh in half and breakage of as many as 20 of these weaker components is not considered significant. Breakage of moderate or heavy mesh components resulting in potential openings of greater than 2x2 inches requires repair. Repair usually consists of wiring torn areas to approximate the 1x2 inch mesh of the original trap. Traps that cannot be adequately repaired must be replaced.

Sub-protocol 1b: Gear calibration

When traps are changed in any way, calibration studies must be conducted. As mentioned above, the survey standard trap in the mid 1980s was a two chambered, wire mesh trap that matched the industry and early research-trapping standard. When the industry standard shifted to the Fathoms Plus trap in the mid to late 1980s and the wire mesh trap became difficult to obtain, we shifted our survey standard trap to the Fathoms Plus trap. We conducted trap comparison studies with alternating trap type on otherwise typical multi-trap sets allowing estimation of relative fishing power of each trap type. We have also used various weight materials and conformations in our Fathoms Plus traps resulting in over all trap weights of 22-36 pounds. Studies with alternating weight materials and total trap weight on single strings of traps has shown no significant difference in trap catch for the various trap configurations studied. Similar studies will be conducted in the future as necessary with any changes in trap configuration or bait type.

Standardize Buoy Line Scope and Groundline Measurement

Protocol 2: Standardize Buoy Line Scope and Groundline Measurement
Lobster traps are set at depths ranging from 10 to 35 fathoms at our survey sites. All trap lines set within this range use a 50-fathom buoy line of _ inch polypropylene. All buoy lines are measured prior to the cruise and attached to appropriate ground line in bins prior to sailing. When buoy lines fray or are parted, they are repaired by cutting off weak sections and resplicing with new line. If more than 2 fathoms is removed from the buoy line, an additional section of line should be inserted, restoring the line to the 50-fathom standard.

Flotation is supplied by a single inflatable buoy and a trailing hard float with 2-3 fathoms of line to aid in retrieval. High fliers have not been used in our surveys for a number of years, but could be added in the future if desired without affecting catchability of the gear. On deeper sets in high current locales additional floatation is desirable. In these situations, doubling the inflatable buoys is suggested.

Sub-protocol 2a: Buoy line scope guidelines
When lobster traps are set at depths greater than 35 fathoms the buoy line length to depth ratio should target 1.5:1 (ranging between 1.25:1 and 2.0:1 depending on depth, current, and slope). It should be noted that these deeper sites are not part of our monitoring survey and are considered exploratory in nature. The standard lobster traps are considered heavy enough to hold gear on the bottom when used at our survey lobster trapping sites. No additional weights or anchors are necessary. As mentioned above, when fishing deep sites (> 100 fathoms) adding additional floatation is advisable. Furthermore, using the heavier traps (~35 pound) is suggested for these deeper sets. Alternatively, an anchor weight could be added to the ground line prior to the first trap.

Sub-protocol 2b: Multiple trap sets
On our monitoring surveys we use multiple trap sets for all of our sites. Certain sites call for eight traps to match pre-survey research trap sets, whereas other sites call for twenty traps allowing for greater time efficiency. The number of traps on a trawl is set for each site and does not change for that site from year to year. On each bank, catches from eight trap sets are compared with other eight trap sets between sites and years and twenty trap sets are compared with other twenty trap sets. Spacing between traps is set at 20 fathoms. Ground lines are examined and measured prior to sailing each year. Sections shorter than 19 fathoms are respliced to meet the 20-fathom standard. During the cruise, weak and frayed sections are removed and the line re-spliced. If more than 1 fathom is removed, a section of line must be inserted to maintain a 20-fathom separation. The 20 fathom sections are marked either by splicing in a shackle and swivel or a short gangion. Snaps on the trap bridles are used to attach the traps to the swivel or gangion.

When conducting exploratory trapping at depths deeper than 100 fathoms it is suggested that fewer traps be set on a trawl to prevent tangling of ground line and traps during decent.

Standardize Survey Operational Procedures

Protocol 3: Standardize Survey Operational Procedures
Survey dates and set sites are consistent between years. Monitoring surveys are conducted between mid-May and mid-July to ensure maximum comparability in catchability between years (catchability is known to decrease over the summer to lower levels by August/September). The survey sites are defined by 0.1 degree, girded quads. Necker quad 5-8 equates to 23.5° N 164.8° W, etc. The ship travels on the track described by the start and end positions and sets strings of traps, as they are made ready. Past depth ranges are listed for each site and sets should be within 2 fathoms of these ranges. The ship may have to veer off the track to maintain appropriate depth. Strings of eight traps are buoyed on only one end, whereas strings of twenty traps are buoyed on both ends. Traps are set in relation to the wind and seas to allow for an up wind retrieval. When wind and seas do not allow for appropriate setting with the ship following the required track line, individual strings may be set across the line along its length.

Upon retrieval, all organisms within each trap are identified to the lowest taxa possible with the number caught recorded on the catch data sheet. Additionally, lobsters of all species are sexed and measured (both carapace length and tail width). Females are examined for exterior ova. Any ova present are categorized by color as orange, brown, or white. Recently spent females are marked as such. The condition of sperm packets attached to the females is also recorded as white, gray, or black, and either rough or smooth. Lobsters are handled quickly and carefully. When processing is complete they are placed in a cage held in running seawater to await live release.

Sub-protocol 3a: Bait standardization
Frozen mackerel is used as the bait standard for our surveys. Bait is thawed and sliced prior to trapping. Slices are made in whole fish to make chunks weighing about _ to _ pound each. Each trap is baited with 1.5 to 2 pounds of bait. Baited traps are left on deck until setting later in that day. Baited traps left on deck for more than one day should be rebaited prior to setting.

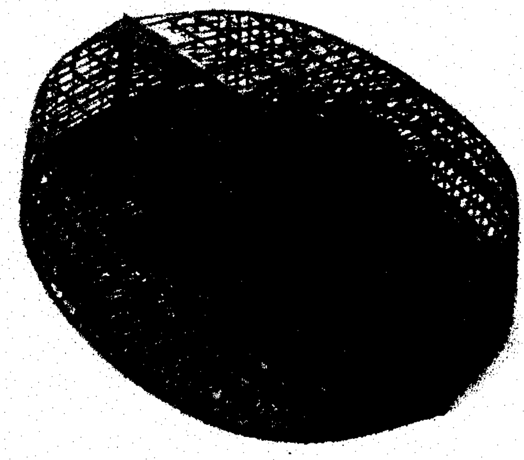
Sub-protocol 3b: Standardize soak time
Lobsters are active at night. The standard soak time for the lobster monitoring survey is one night. Gear is set in the afternoon or early evening and hauled starting the next morning. The gear must be in the water all night and only one night for the data to be comparable. Times of set and haul are recorded, but actual hours of soak are not considered important.

Sub-protocol 3c: Success criteria

Certain criteria must be met in order for a set to be considered successful. Traps must be in good repair at time of set and retrieval. They must be baited with an appropriate quantity of the standardized bait and must soak for one full night. Sets must be made at selected positions and depth ranges. Trap sets should not be made without reasonable expectation of meeting these success criteria. Occasionally traps are lost or come up damaged resulting in loss of data. Sets resulting in less than 30 successful trap hauls will be considered unsuccessful.

Sub-protocol 3d: Responsibilities

The Chief Scientist, with clearance from the Field Operations Officer, is responsible for determining what sites are set each day and their priority in case time is limiting. He can adjust the schedule as needed. The scientific party is responsible for getting the gear ready to set and for removing catch, etc. after haul. The ship's crew is responsible for physically setting and hauling the gear (with scientific party assistance).



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