Collecting Adult Coastal Pelagic Fish Using the Nordic 264 Rope Trawl: A Guide to Deployment and Sample Processing

INTRODUCTION

The Fisheries Resources Division (FRD), working jointly with California Department of Fish and Game, conducts stock assessments and recruitment research in support of management of Pacific sardine, chub mackerel, northern anchovy and market squid. These species are managed or monitored by the Pacific Fishery Management Council under the CPS (Coastal Pelagics) Fishery Management Plan (FMP). Other important coastal pelagic species, (bonito, yellowtail, barracuda, white seabass, etc.) occur in Southern California waters (U.S.) and Baja California (Mexico) waters. However, since they are not in a Federal plan, they are currently not the focus of FRD research. Annual assessments depend upon CalCOFI surveys to provide fishery independent measures of abundance. Cooperative work and sharing of data with Mexican scientists on CPS has been ongoing for over 50 years through the CalCOFI program.

In order to manage the fishery over its entire range, a more complete data set is needed which will lead to more complex and comprehensive assessment models. Questions which may arise in regards to the coast wide population could focus on the interactions between the northern and southern populations such as: What percentage of the northern stock is resident and what percentage undergo annual migration and what role does either have in the northern fisheries? What is the northern stock structure in terms of age and size and to what extent, if any, does fishery size selectivity play? The intent of this type of survey is to generate a coast-wide, synoptic measurement of the CPS biomass for Canada, Washington, Oregon, California and Baja California and to begin to answer these and other questions which will help us to understand and better manage this population.

In an attempt to conduct a baseline, PaCOOS (Pacific Coast Ocean Observation System) like survey, one of the core measurements necessary is that of fishery independent observations. Among the many critical observations necessary to understand these populations is the collection of the adult component using fishery independent methodology.

Since July of 2003, FRD has been using a Nordic 264 surface trawl with 3.0 m^2 XL-Lite foam-core alloy midwater doors to collect adult CPS, specifically the Pacific sardine. This net was suggested by the NWFSC Newport lab as a potential survey tool for our initial northwest sardine survey and it has proved to be a very useful and effective trawl. The following document describes the gear, technique and sample processing protocols in a relatively detailed nature in an effort to standardize methods and techniques for all vessels participating in the coast-wide survey.

GEAR

The Nordic 264 Rope Trawl

The trawl was built by NET Systems (Nor'Eastern Trawl) of Bainbridge Island, Washington. The trawl mesh is constructed of nylon cord and has an overall length of 93.45 meters plus an additional 8.5 meters for the sampling codend (refer to figs. 1 and 2). The working mouth opening has been measured as 600 m^2 at a towing speed of 3.5 knots. In order

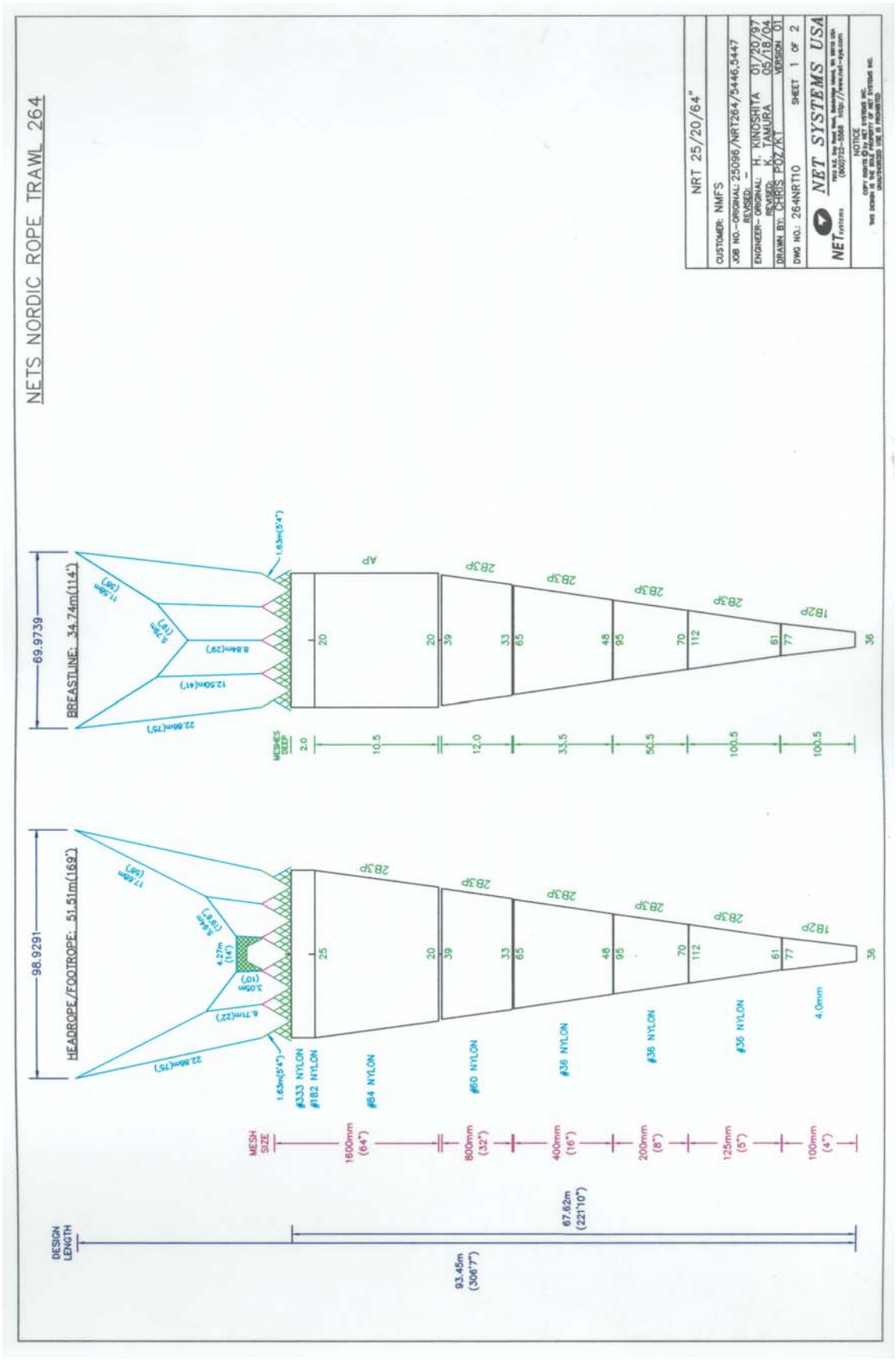

Figure 1. Details of the Nordic 264 trawl.

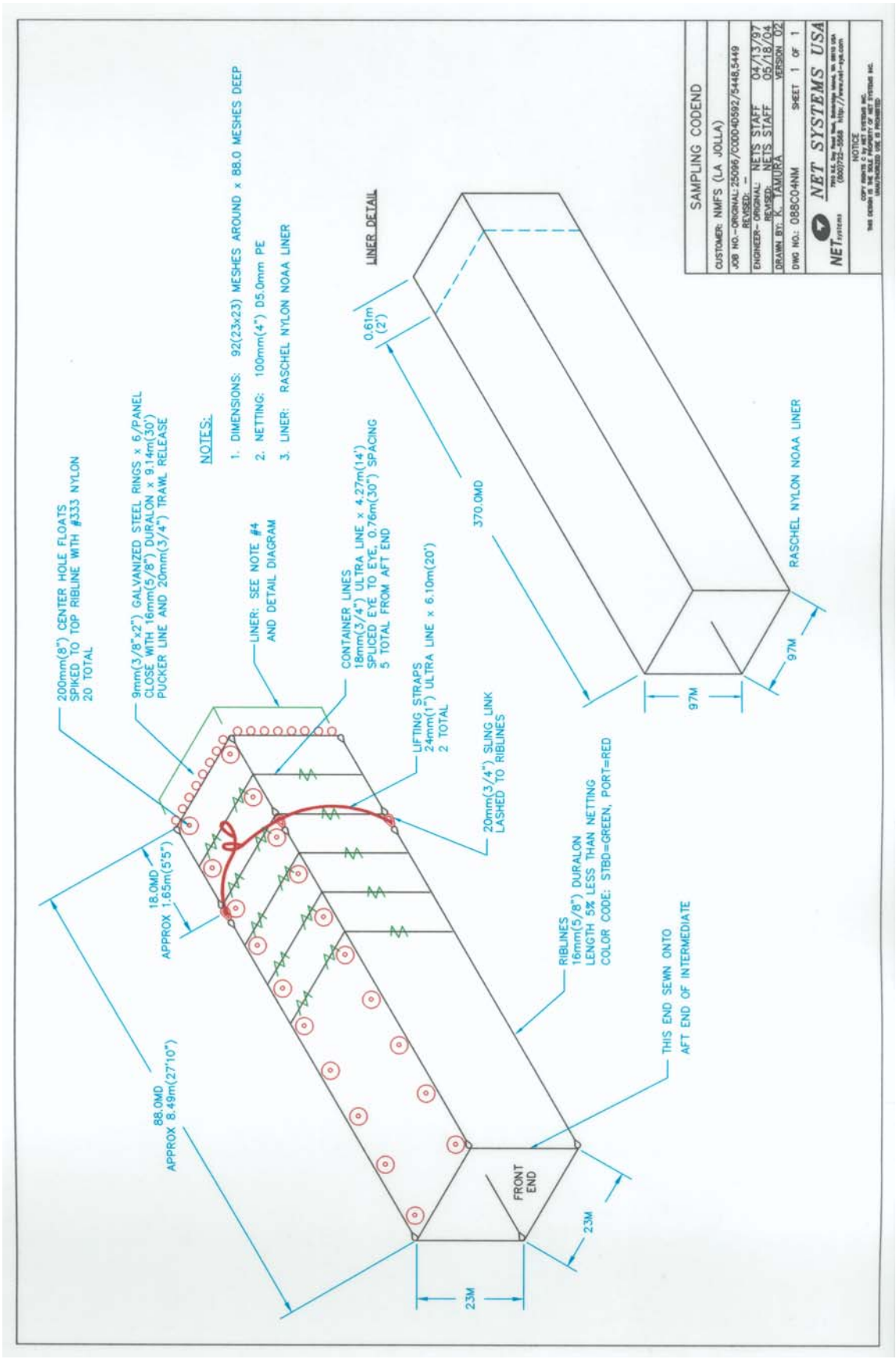

Figure 2. Details of the Nordic 264 codend.

to retain juveniles and in some cases, larval fish, a liner with a mesh size of 8 millimeters has been sewn into the codend (fig. 2).

The Nordic 264 Rope Trawl Rigging

The rigging for the Nordic 264 rope trawl is comprised of an upper and lower leg per side each 70 meters in length. When connected to the door legs, the entire bridle is almost 80 meters in length. The lower bridle has an additional chain set-back to optimize the efficiency of the trawl in regards to the projected towing depth. Removable clump weights of 91 kilograms are connected at the forward section of the set-back chain by means of a G-hook/flat-link connection, in order to maximize vertical spread of the trawl. The trawl doors (fig. 3) are 3.0 square meters in area and have a dry weight of 523 kilograms (1,150 lbs.). These hollow doors are filled with a non-compressible syntactic foam which gives them a weight in water of 135 kilograms (300 lbs.). They are a high aspect ratio design which gives maximum spreading power with less drag
than conventional trawl doors. These doors are rated for vessels having 300 - 500 horsepower which allows this system to be used on a wide variety of platforms. A detailed description is shown in figure 4. When fishing at the surface, net buoyancy is enhanced by attaching floats to four points on the trawl during deployment. The floats used are Polyform A4 buoys with 85 kilograms (187 lbs.) of buoyancy. The attachment to the trawl is as follows: Single floats are attached to the leading corners of the headrope's kite. Double floats are attached at the point where the wire bridles connect to the trawl's headrope. These double floats essentially counteract the negative buoyancy of the clump weights and enhance the trawl's vertical opening. These floats are connected during deployment and disconnected upon

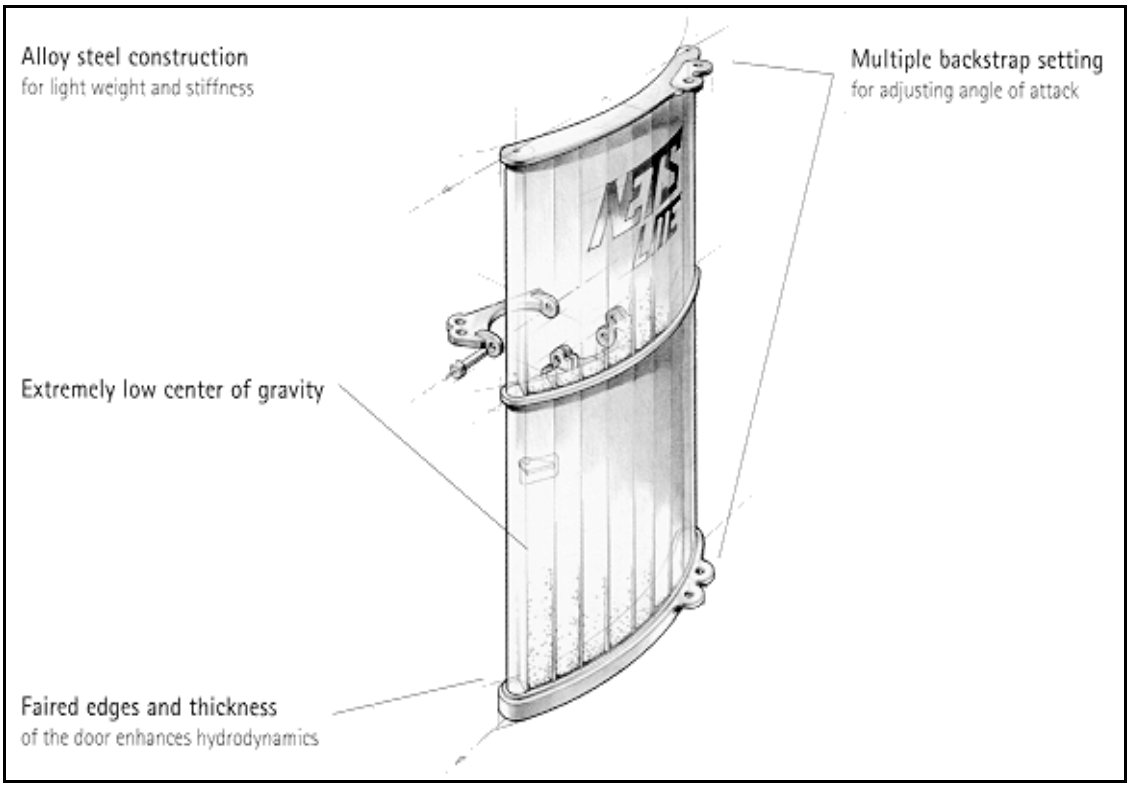

Figure 3. Illustration of the 3.0 m² XL-Lite door (taken from www.net-sys.com).

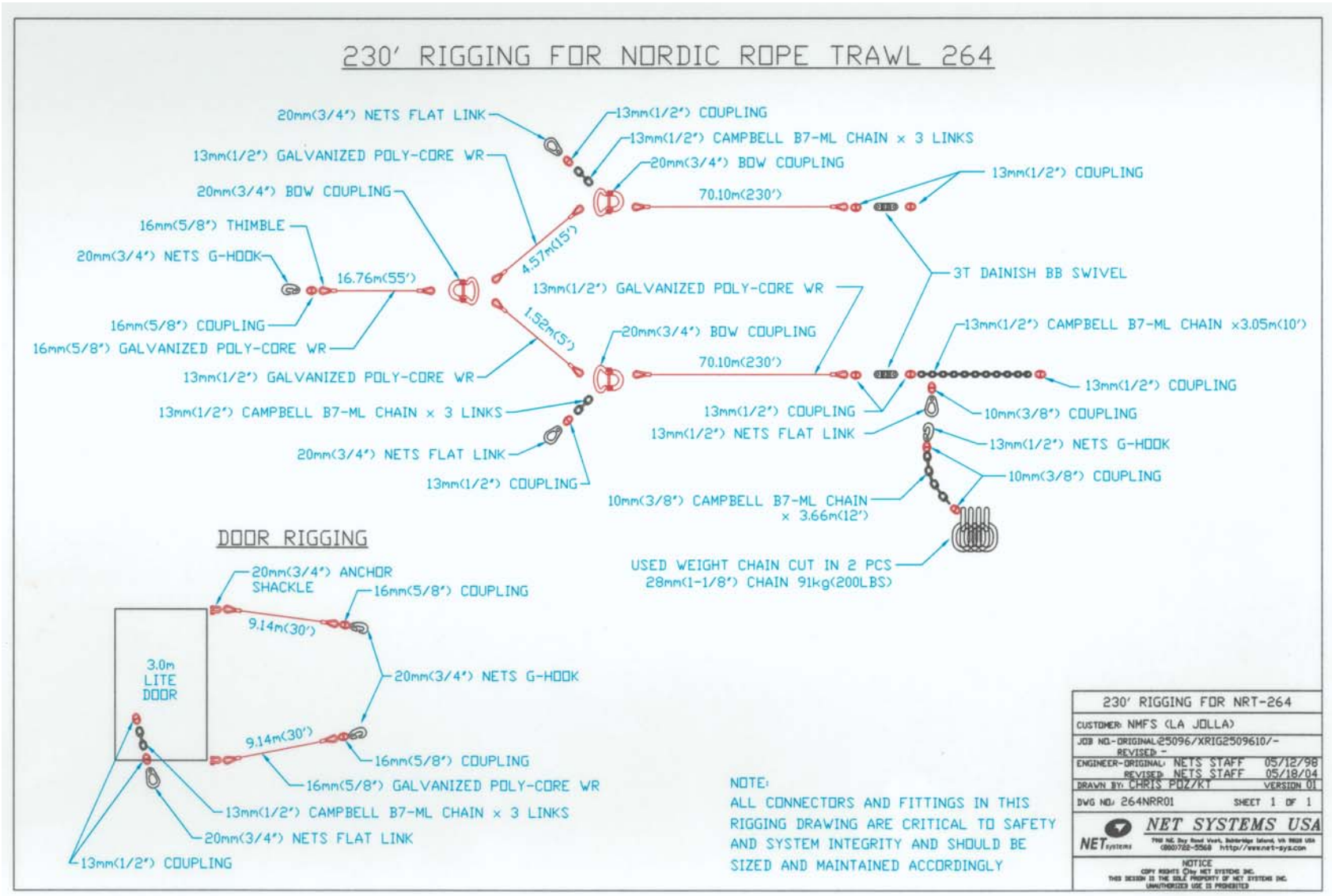

Figure 4. Details of the Nordic 264 rigging.

retrieval using quick release snap hooks.

DEPLOYMENT

The method in which the trawling site is chosen will vary from survey to survey. Whether or not the trawl site is pre-surveyed or fished blind will be determined by the protocols of the cruise. These variables will not be discussed in any detail. The protocols used for the coast-wide survey are basically blind trawling towing in a down swell direction.

Shooting the Trawl

Prior to deployment, the codend liner, which is longer than the codend, should be folded or rolled up and tied. The liner is then placed inside the codend and the pucker line is pursed and fastened with the cowbell. Once the vessel has been turned to the direction of the trawl line, the ship is brought to approximately 1.5 knots. The ship's speed must be slow enough that the trawl is not under too much tension that the front of the trawl lifts out of the water. The trawl will float at the surface if not under strain which will allow the floats to stay above the trawl and not become tangled with the trawl lines. Once the ship's speed is stable, place as much of the codend as possible in the water. Allow the ship's forward direction to begin to stream the trawl aft before beginning to spool the trawl from the net reel. Once tension is on the trawl, begin spooling the trawl from the net reel. When the headrope kite comes off of the net reel, stop spooling the trawl and connect a single Polyform float to each of the two leading corners of the kite. With the floats connected, continue to spool the trawl from the net reel. **Be sure that the lines of the trawl do not go over the top of the floats!** If they do, and you are not able to clear the lines, you will have to retrieve the net back on board in order to clear the lines. This is why it is so crucial to maintain a relatively slow deployment speed. If all lines are clear, continue to spool the trawl from the net reel until the attachment point of the clump weights is reached. At this point, stop spooling the trawl and attach the clump weights using a G-hook/flat-link connector. The point at which the double floats should be attached should just be coming off of the net reel at this time. You may need to allow the clump weights to slide down the trawl ramp partially in order to arrive at the attachment point for the double float connectors. Once the floats have been clipped on, continue spooling the trawl. Again, be careful not to allow any of the trawl lines to go over the top of the floats. It is not as critical at this point since the clump weights will pull the trawl's footrope down rapidly allowing less chance for entanglement to occur. At this point you will now spool off the 70 meters of bridle until you arrive at the attachment point of the headrope door leg (cable connected to the top of the trawl door). Stop the net reel and connect the top door leg to the headrope bridle. Continue to spool the trawl until the attachment point of the footrope door leg appears. Stop the net reel and connect the bottom door leg to the footrope bridle. At this point, all of the slack should be taken out of the trawl warps (towing cables) and the trawl doors lifted from their cradles. Continue to spool out the transfer cable until all of the tension from the net has been transferred to the trawl doors. The final step is to spool off the rest of the transfer cables, disconnect them from the net reel and reconnect them to the door couplings using the G-hook/flat-link connectors.

At this point the trawl is ready to be streamed out to a pre-determined length of trawl warp. Initially, the speed of the ship is increased gradually until the doors are approximately two to three meters below the surface. Depending on the ship and crew, the trawl warps can be stopped at this point and the stability and spread of the trawl doors can be observed. Other vessels and crew

continuously pay out the trawl warps without stopping at the surface. Either method works well. These trawl doors are very forgiving and stable and there does not appear to be any difference between the two types of deployment. Previously, a length of 100 fathoms of trawl cable (185 meters) has been deployed for standard surface trawls. This length can be adjusted at any time during the tow if necessary. At the moment in which a terminal length of trawl warp has been reached, the warps are stopped and the winch brakes are applied. This is the point at which you start timing your trawl. A more descriptive outline of recording the trawl data parameters will follow in the next section. It is critical to maintain visual contact with the trawl floats while the warps are being paid out to ensure that the floats do not wrap around each other. Visual contact is enhanced by using highly visible reflective tape applied to each float. It is more than likely that the tops of the trawl doors will be seen repeatedly breaking the surface during the tow. Again, these doors are quite stable and this does not appear to affect their efficiency. If it becomes extreme, the choice can be made to let out more trawl warp or slow the ship's speed slightly. Be aware that a very small change in the ship's speed will have an initial pronounced affect on the performance of the net.

At the completion of the specified time period, the ship is slowed to about 2 knots prior to beginning retrieval. Retrieval is achieved in essentially the reversed order of deployment. Once the doors break the surface of the water, they are brought back into their cradles but all of their weight and net tension remains solely on the trawl warps. The transfer cables are disconnected from the trawl doors and reconnected to the net reel. As the net reel retrieves the transfer cables, tension is transferred from the doors back to the net reel. At this point the doors are secured prior to releasing the tension from the trawl warps. As the net is reeled back on board, the door legs are disconnected from the doors and secured to the ship, the double floats and clump weights are removed, the single floats are removed from the kite and the remaining trawl is brought on board. As the kite comes on board, be certain that it is not twisted or tangled as it goes onto the net reel. Also spread it out as wide as possible when it goes on so as to ensure that it will come off in the same manner. Release the cowbell, untie the liner cord and deposit the catch for processing.

TOW DATA RECORDING

Specific information related to each tow conducted is as critical to the survey as the catch itself. It is important that the information recorded during each tow is accurate and complete enough that each tow can be virtually recreated, if necessary, back at the lab. Consistency between data recorders, surveys and vessels is also critical when collecting information pertaining to each tow. Figure 5 is the current version of the Haul-Position Form used by the SWFSC. This form was adapted from the RACE division of the Alaska Fisheries Science Center and some of the coding entries requested are residuals from their system. For consistency purposes, the form should be completed as follows:

COLLECTION #: the number which identifies the sample(s) collected during the tow specific to the HAUL #.

CRUISE: this is the cruise identifier. Usually the year and month such as 0504 for April of 2005.

VESSEL: the first two boxes are for a vessel code. If you know the code you can enter the two digit number otherwise leave blank.

HAUL #: this is the consecutive number of trawls performed.

ORDER OCC.: the order occupied is the number of stations completed. This may

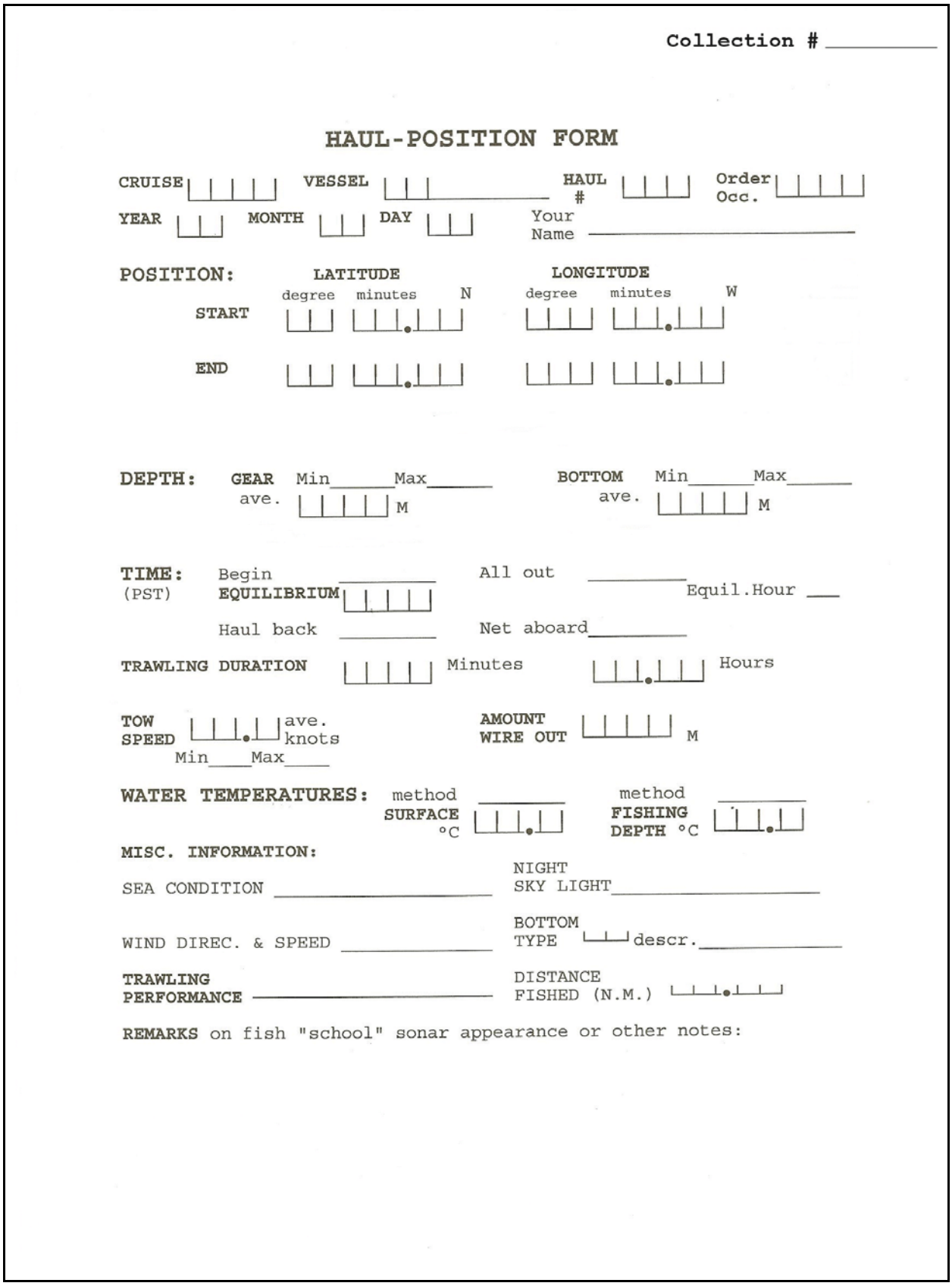

Figure 5. Current haul position data sheet.

differ from HAUL# if you are doing activities in addition to trawling. Basically, every time the vessel is stopped to perform an activity or a suite of activities, it is an ORDER OCC.

YEAR: last two digits of the current calendar year.

MONTH: two digit number for current month. If you are in a single digit month, precede it with a zero so there is no question as to what was recorded.

DAY: current local day. Again, fill in both spaces even if you are in a single digit day.

YOUR NAME: data recorders name.

POSITION:

Latitude/Longitude start: this position is recorded at the time of equilibrium, not when the net goes in the water.

Latitude/Longitude end: this position is recorded when the trawl winches begin to retrieve the net, i.e. haul back. The assumption being that the instant that the ship slows and the winches begin pulling in the warps, the net no longer fishes.

DEPTH:

Gear: the Min/Max depths are not critical for a surface tow. Becomes relatively important for bottom and mid-water trawls. Should be recorded in meters.

Bottom: bottom depths are not too critical for surface tows unless you are in fairly shallow depths. If the fathometer is indicating a bottom depth it should be recorded.

TIME:

Begin: record the time when the net goes in the water.

All out: record the time when the winches stop paying out the trawl warps.

Equilibrium: this time is recorded when the trawl depth is consistent. For a surface trawl, the **equilibrium** time is the same as the **All out** time.

Net aboard: this time is recorded when the codend is brought aboard. Note, all times should be recorded using a 24 hour clock. It must be decided prior to trawling whether to use GMT or local time.

Trawling duration: this is the time from equilibrium to haul back. It is recorded both in minutes and hours.

TOW SPEED: this is the speed maintained throughout the **trawling duration**. The Min/Max entries will give some indication of the consistency of the tow speed.

AMOUNT WIRE OUT: this is the length of wire paid out during fishing. If at any time this length is adjusted, note the adjustment and indicate what time the adjustment was made. All lengths are recorded in meters.

WATER TEMPERATURES:

Method (surface): this will be how the temperature for the surface temperature was obtained. Most often surface temperatures will be measured with a thermosalinometer or a bucket thermometer.

Surface °C: this is the value recorded by the above method in degrees Celsius.

Method (fishing depth): this will be how the temperature was measured at the net during the tow. This temperature will not always be obtainable if probes are not available. Some possibilities to measure temperatures at depth may be net mensuration gear or temperature-depth recorders. In the case of surface tows, the fishing depth temperature should equal the surface temperature.

MISC. INFORMATION:

Sea condition: this can be a descriptive term such as calm, rough or moderate.

Night Sky Light: since tows are conducted during darkness, it is important to know what light sources,

if any, are present during the tow. Possible sources could be moon (indicate the phase), pre-dawn or dusk light.

Wind Direc. & Speed: if ship instrumentation is available, use those values. If not, use best guess method. Direction is recorded as a compass reading in degrees, e.g. 270˚, from which the wind is coming from. Wind speed is recorded in knots.

Bottom type: Ignore the first two code boxes. This description is not too critical for surface and mid-water tows. Information usually can be retrieved from nautical charts.

Trawling performance: this is generally a descriptive term to characterize the overall tow. Such possibilities are good, poor (describe in remarks), lost float, etc.

Distance fished (N.M.): this can either be recorded using calculations from a GPS or simply by multiplying the trawling duration by the average tow speed. Units are in nautical miles.

Remarks: this section can become very important when trying to reconstruct the tow later. Be as detailed and descriptive as possible in regards to any aspect of the tow.

SAMPLE PROCESSING

For every haul, sorting and weighing of the catch will be performed regardless of catch size or composition. Use the Catch Form to enter catch data unless nothing is caught and write "water haul" in Note section of the Haul-Position Form. Information for Catch Form header should be recorded the same as that on Haul-Position Form (day=day at haul equilibrium which may be different than day sorting begins) for that haul. The catch is anything deposited/removed/dumped from the cod-end of the net as well as all individual fish or squid falling on the deck or pulled from the net during haul back (it is not necessary to ensure that all gelatinous invertebrates falling from the net are collected).

As the catch is deposited, immediately remove and estimate or measure individual fork length and body weight of any sunfish (*Mola mola*), shark, large coho or chinook salmon that are present in the catch. Record a value for each fish in the nonsubsampled basket weights column on the Catch Form by species and return each to the sea as quickly as possible. Sort the rest of the catch into fish baskets or any other containers suitable for the size of the catch. Fish will be identified and sorted by species except myctophids which will be combined with species composition noted if possible. Do not sort a species by size but try to keep it's basket(s) composition as random as possible.

As soon as all of the target fish species are sorted from the catch, two to three people should immediately begin subsampling and processing these targeted samples in the lab.

The following protocols were used during the coast-wide sardine survey in the spring of 2006. Since the Pacific sardine (*Sardinops sagax*) was the targeted species, the following description will use sardine as it's prime target.

Target Species Sampling

Subsample in a quasi-random manner (do not hand select by size) from different portions of the catch into a fish basket (50-200 fish). The first fifty sardines from the random basket or all sardines (if less than fifty sardines present in the haul) will be processed as the subsample. The remaining sardine baskets and any excess (greater than fifty fish) from the random basket will be weighed and recorded as nonsubsample basket weights on the Catch Form and kept (not discarded overboard, see exception for large catches) for additional random or selective individual

sampling as necessary. The random fish (fish sample numbers 1-50) individual data will be recorded on the Specimen Form. All fifty fish in the subsample will have otoliths, scales, eyeball, gill filament, and muscle tissue removed and saved. All females will have ovaries removed and preserved, and from an occasional haul, the remaining bodies of fish numbers 1-50 will be frozen for parasite analysis and more frozen for special studies. If there are not twenty five mature females present in the first fifty random fish, then the fish baskets will be processed for mature females random-selectively (fish number 51+) until twenty five mature females are obtained. Additional special selective sardine sampling will occur if time permits. Number by sex and total weight from the summary of fish numbered 1-50 (at top of the Specimen Form) will be recorded onto the Catch Form as subsample numbers and subsample basket weight. Length frequency will be generated from length of fish numbers 51-100 from the Specimen Form, they should have already been recorded as part of a nonsubsampled basket weight on the Catch Form.

Those persons not involved with biological sampling of Pacific sardine will finalize the sorting, weighing and sampling of the remainder of the catch which is as follows:

Invertebrates will be separated into three types: 1) market squid (*Loligo opalescens*), 2) other squid (if possible, note species), and 3) other combined invertebrates (note composition of each type). Enter total weight of each type in the nonsubsampled basket weight column on the Catch Form. For market squid, weigh and record a random thirty individuals from the nonsubsampled basket and record it to the subsampled weight column of the Catch Form.

All other fish species: obtain a random fifty fish subsample or all if less than fifty fish per species in catch (except myctophids), weigh the subsample and collect unsexed length frequencies for non-target species or process minor-target species as indicated. Weigh remaining containers of each species (including myctophids) and record them in the nonsubsampled basket weight column. All weights will be recorded on the Catch Form and later entered into the computer.

Minor-target Species Protocol

For the coast-wide sardine survey, minor -target species were identified as norther anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), Pacific or chub mackerel (*Scomber japonicus*), juvenile salmon (Onchorhynchus sp.) and market squid (*Loligo opalescens*). These species were processed in the following manner:

Engraulis mordax subsampling: obtain the random fifty fish subsampled, or all fish if less that fifty total and individually weigh, measure standard length, sex, assign a maturity code, collect otoliths and heads once the otoliths are removed. All of the above information should be entered onto the Specimen Form. Numbers by sex and total weight from the summary of fish numbers 1-50 will be recorded on the Catch Form as subsample numbers and subsample basket weight. Length frequency will be generated from fish lengths 1-50 later during computer data entry.

Scomber japonicus or ***Trachurus symmetricus*** subsampling: obtain the random fifty fish subsample or all if less than fifty fish present in haul for each species. Record the subsample basket weight and subsample number ($n \geq 50$ depending on the total number from the haul) on the Catch Form. Slit open, sex as a male, active female (contain yolking or hydrated oocytes in ovaries), inactive female or indeterminate. Measure each fish on a length frequency strip by sex/maturity category and record data to the LF Form or directly into the computer database.

Loligo opalescens subsampling: obtain a random subsample of thirty market squid or all if less than thirty total in haul and enter

number and weight in subsample column on Catch Form. Measure mantle length on length frequency (LF) strips by sex and record on LF Form or directly to computer database. Select up to twenty (if available) preovulatory mature females and record mantle length, weight, sex, and maturity code on Specimen Form. Remove and preserve guts in buffered formalin and take a punch sample of the mantle and along with the head place in freezer. Select thirty random juveniles ($\leq$80 mm) and record mantle length, weight and sex on Specimen Form and preserve by freezing.