Maritimes Region Snow Crab Trawl Survey: Detailed Technical Description

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by

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ABSTRACT

Zisserson, B. 2015. Maritimes Region Snow Crab Trawl Survey: Detailed Technical Description. Can. Tech. Rep. Fish. Aquat. Sci. 3128: v + 38 p.

An annual trawl survey is conducted on the Scotian Shelf to assess the snow crab stocks in the Maritimes Region. This survey uses a modified small mesh “Nephrops” trawl to capture snow crab across their size spectrum with constant monitoring and recording of trawl dimensions through a geo-referenced trawl monitoring / mensuration system. Water temperature at depth is also recorded for each tow. A suite of electronic equipment is used to facilitate the capture of all required data and two distinct personnel teams, vessel crew and scientific staff, cooperate to perform all required tasks. The trawl catch from each tow is separated, weighed and counted by species. All crab species are examined in more detail with morphometric measurements recorded for each animal. A detailed description of all tasks, standard operating procedures and materials used throughout the course of this survey are provided within this document.

RÉSUMÉ

Zisserson, B. 2015. Description technique du relevé au chalut sur le crabe des neiges pour la région des Maritimes. Rapp. Tech. can. Sci. halieut. Aquat. 3128: v + 38 p.

Un relevé au chalut est effectué annuellement sur le plateau néo-écossais afin de recenser les stocks du crabe des neiges dans la région des Maritimes. Ce relevé utilise un chalut de langoustine modifié avec petites mailles pour permettre la capture de crabes de différentes grandeurs. Le chalut est équipé d’un système d’enregistrement sonar pour mesurer en continue les dimensions de l’engin de pêche avec des données géo référencées. Une série d’équipements électroniques est utilisée pour faciliter la saisie des données requises et deux équipes de personnel, l'équipage du navire et le personnel scientifique, collaborent pour effectuer les tâches nécessaires. A chaque trait, les prises sont séparées par espèces, pesées puis comptées. Toutes les espèces de crabes, sont examinées en détail et des mesures morphométriques sont prises sur chaque animal. Une description détaillée des tâches, du matériel ainsi que les étapes d’opérations pour le relevé sont décrites dans le présent document.

INTRODUCTION

The snow crab (*Chionoecetes opilio*, Brachyura, Majidae, O. Fabricius) is a subarctic crustacean species found along the continental shelf of both the Pacific and Atlantic oceans. The Atlantic distribution now extends from the Gulf of Maine to the Barents Sea. On the Scotian Shelf (Figure 1), snow crab inhabit a wide range of depths (60 to 280m) and bottom types though soft, small substrate bottom types are generally preferred as are relatively cold (-1 to 6 ^{0}C) waters.

The snow crab fishery (Figure 1) is a large and economically important commercial fishery in the Maritimes Region of the Canadian Department of Fisheries and Oceans (DFO). After the wide spread collapse and subsequent closure of the groundfish fisheries in Atlantic Canada, the fishery for snow crab has become one of the highest value fisheries in the region (http://www.dfo-mpo.gc.ca/stats/stats-eng.htm). It is a trap-based fishery using large (6-7 foot base diameter) conical traps strung with mesh netting (≥3 inches).The fishing effort distribution and trap design (both shape and mesh size) selectively target large male crab, however to accurately assess the stock, a non-size selective fishing method is required. To accomplish this goal an annual trawl survey is conducted on the Scotian Shelf. This survey has largely been funded by snow crab industry members through partnership agreements with the Department of Fisheries and Oceans (DFO).

This survey is conducted under a scientific fishing license (pursuant to sections 52 and 56 of the General Fishery Regulations of Canada) issued by the Minister of Fisheries to the regional director of the science branch (RDS) of the Maritimes Region. A Fisheries Research Notice (FRN) is created and distributed under the authority of the RDS to provide specifics of the fishing operations to various parties of interest such as DFO Resource Management and DFO Conservation and Protection (Enforcement).This FRN (sample in Appendix 1) contains the following information:

- Name of project
- Start and end dates
- Port of departure and return
- Vessel name
- Officer in charge
- Name of license holder
- Scientific staff names
- Fishing gear used
- Expected catch
- Retention of fish if applicable
- Area of work
- Objectives
- Responsible officer
- Distribution list (not included in appendix for privacy purposes)

This technical report has been created to document the technical details of the snow crab trawl survey.

HISTORY

In the Maritimes (previously Scotia- Fundy) Region fisheries independent snow crab directed trawl surveys began in 1996 with intention of replacing catch and effort based abundance estimations for stock assessment. The stock assessment in the adjacent southern Gulf of St. Lawrence snow crab stock had been based on a fisheries independent trawl surveys since the 1980's which supported its potential viability as an assessment tool in this region.

The initial survey in 1996 was a very limited (station number and spatial extent) pre-season exploration in CFA 23. This first survey served as a "proof of concept" that led to the adoption of this approach and the creation of a much larger (then considered to be "comprehensive") survey the following year. The 1997 survey demonstrated the rugged nature of the seafloor on the Scotian Shelf as well as the existence of snow crab populations outside of traditional snow crab fishing grounds (particularly in S-ENS). The survey continued to expand in the following years in an adaptive manner attempting to reach the entire spatial extent of the snow crab distribution on the eastern Scotia Shelf. Added survey areas were subsequently removed if they proved to be unsuitable snow crab habitat. This created instability in the survey station count ranging from 150 (1997) to 317 (2000) and back to 234 (of the intended 269) in 2003. (Table 1)

These initial surveys (1996-2001) were conducted predominantly in the early spring and summer, preceding the commercial fishery. Since 2002, the snow crab survey has been a post-fishery survey conducted in the fall of the year.

In 2004, the mandate for snow crab assessment in Eastern Nova Scotia (ENS) was transferred from the Gulf Fisheries Center in Moncton, New Brunswick (also responsible for the snow crab assessment in the Southern Gulf of St. Lawrence) to the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. This transfer "passed the reigns" to a new survey and assessment team. With this new team and its ability to focus on a single region came an extended period of improvement, growth and eventual stability for the ENS snow crab trawl survey (Figure 2). Since 2004, the survey has spanned the extent of the snow crab distribution on the Scotian Shelf (N-ENS, S-ENS and CFA 4X at the westernmost end of the snow crab's distribution in the North Atlantic, Figure 1). Since 2004, there have been approximately 400 (369 – 414) stations annually sampled with some minor alterations between years in an attempt to rectify high inter-annual variability in some stations or localized areas. The same chief scientist and vessel captain supervised and conducted the survey since that time. A single vessel was used from 2004-2013 and was replaced only through necessity when it sunk while commercially fishing in December 2013. Previous to this vessel, five vessels were used from 1996-2003 with multiple captains and chief scientists (Table 1). This extended period of stability with vessel, captain and chief scientist benefitted the survey as growing personal experience of these individuals allowed for improvements in survey methods and efficiency.

STATION SELECTION / SURVEY DESIGN

The snow crab survey is a fixed station design. Initially, a minimum of one survey station occurred in 10 x 10 minute (latitude x longitude) area to facilitate geostatistical estimation techniques. Each grid was divided into 6 equally sized sub-areas, one of which was randomly chosen to contain the survey station. The exact station location within the chosen sub-area was selected based on physically locating trawlable bottom of sufficient size to accommodate the intended tow path. This required extensive vessel search time. Some 10 x 10 minute grids actually had more than one station located within them. This was due to an attempt to proportionally distribute stations within commercial fishing areas based on the relative financial contribution of that area's fishers at that time.

Since this initial distribution of stations, additional stations have been added for reasons including:

1. Expanding spatial extent of survey based on geographical expansion of commercial fishing activities (predominately in CFA 4X)
2. Expanding spatial extent of survey based on identification of potential snow crab habitat through increased knowledge of environmental conditions
3. Extreme variability between adjacent survey stations
4. High inter-annual variability with a station or group of stations

SURVEY TRAWL NET

This survey is conducted with a modified Bigouden Nephrops trawl net; a design originally used in the commercial Nephrops lobster fishery in Western Europe, specifically the Bigouden region of France. This net was designed to capture Nephrops lobster which bury into soft bottom sediment. Such a "digging" net design lends itself well to the capture of snow crab which can be found burrowed into soft bottom sediment. This net lacks the "rollers" or "rock hoppers" found on commercial fishing trawls on the Scotian Shelf which allows the net to capture small benthic invertebrates but also creates an inherent susceptibility to net damage due to rocks or other sea-floor features being swept into the trawl. The net blueprint and a more detailed description can be found in Appendix 2.

The trawl has a 1953 cm headline connected by 137 cm wing-lines to the 2788 cm fishing (or "bolsch") line. All these "net frame components" are constructed from 5/8" combination wire (steel wire rope with a polypropylene coating on individual strands). This trawl has a 2806 cm foot gear that is made of 9/16" steel wire rope threaded through 1 ¾" rubber disks. The footgear is attached every 30 centimeters by 2 links of 3/8" chain joined to the fishing line by a nylon twine "setting". The center 24 metres of the footgear is wrapped with 3/8" galvanized chain (1 wrap per ~30cm of foot gear). This chain wrapping weights to the bottom of the net to help ensure it digs consistently into the bottom sediment over the length of the net. The net itself consists of three sections, each using a different size braided nylon mesh: the wings (80 x 2.3mm mesh), the bellies (60 x 2.3mm) and the codend (46 x 2.3mm). The netting that attaches directly to the footgear is of the same size mesh as that section of the net (wings and bellies) but formed by nylon twine steam-compressed to 3mm. This compressed netting is more abrasion resistant to avoid tears in the net from repeated chafing along the seafloor.

This strip of heavier twine is referred to as the tear guard. The codend (terminal end of net) has a “chafer” on the top and bottom, each separately attached. These are made of a heavy (compressed to 4mm, top, and 6mm, bottom) double strand poly netting which is very slippery to avoid friction-related net wear on bottom features.

Throughout the history of the survey, trawl structure has remained consistent, although some net reinforcements have been made. These changes would not affect trawl catchability and include; the addition of a topside chafer, the tear guard, double roping float attachments and adding closed eye crimps to ends of footgear and wing-lines to reduce wire fraying at exposed terminations.

This trawl was initially tested in this region using wooden trawl doors as were used in the Gulf of St. Lawrence survey. These were subsequently replaced by steel doors which perform better at depth and are better equipped to withstand the punishment resulting from certain hard bottom types in our region. These doors are a #2 Bison™ (a UK manufacturer) trawl door constructed of 4mm steel. The most recent orders of these trawl doors have been galvanized to maximize their lifespan through reduced oxidation.

Every second year, these doors require maintenance / refurbishing. This often includes:

- Replacement of shoes (bottom edge of door)
- Replacement of washers adjusting tow point
- Reconstruction of attachment points and bushing as these become worn over time
- Replacement of all shackles and chains

ELECTRONIC EQUIPMENT

ELECTRONIC SCALES

Two Marel™ scales are used onboard the survey vessel. Both scales are motion compensated electronic scales to lower reading errors due to sea state. One scale is set to a resolution of 1 gram and is used to weigh individual crab. The other scale is set to a resolution of 0.01 kg and is used to weigh animals by species (basket weights). These scales are calibrated at the start of each trip and re-calibrated if the reference weights (2kg for small scale, 20 kg for big scale) are not accurately weighed when placed on the scale. The internal settings for these scales can be found in Appendix 3.

TRAWL MENSURATION SYSTEM

Three different trawl mensuration systems have been used over the course of the snow crab survey in the Maritimes region. Initially Scanmar™ sensors were used which were then changed to Netmind™. Netmind offered the advantage of local (Newfoundland-based) service and lower costs compared to Scanmar™. In 2009, eSonar™ sensors were purchased to replace failing Netmind™[company now defunct] sensors as they were completely cross-compatible unlike other potential trawl monitoring systems. Over the course of the next three years, a transition was made to a completely digital 28kHz eSonar system which includes sensors, dual hull-mounted hydrophones, a DBR digital receiver and software.

The trawl net has three sensors attached at all times which send signals to the vessel in real-time when the trawl is deployed. On the ends of the trawl wings, a master and a slave spread sensor are hung from the headline in a purpose-built aluminum protective housing on opposite ends of the trawl (wing-tips). The sensors are bolted into the housing and the housing is attached to the headline by 3/8" iron D-shackles. These sensors operate on 90 kHz frequency.

In the center of the headline a multipurpose sensor is placed in a mesh bag sewn to the top of the net adjacent to the headline. It is sewn into this mesh bag as well as being tethered directly to the headline with short lengths of nylon cord. This sensor provides two data streams, the height of the headline from the seafloor and the absolute depth of the trawl. The headline height is measured using 200 kHz acoustic pulses whereas the depth reading is determined by a 1000 meter range pressure sensor. Previous to the use of eSonar™, headline and depth were separate sensors.

Each of the main sensor systems used in the past (Netmind™ and eSonar™) have a software package designed to facilitate viewing and recording the net configuration in real time. The current eSonar "DBR" software does not include the ability to record the data but does so through the use of an add-on program ("DataLogger"). This is configured to record all desired net metrics each time a location is received from the GPS. This allows a precise "footprint" of the bottom trawled for each tow. It is important to note that the vessel position (GPS location) serves as a proxy for the net position. The DBR software is optimized to automatically capture the incoming signal from both the starboard and port transducers, allowing for post-processing of either or both data streams to maximize accuracy. Previously, one transducer was manually chosen through the software GUI interface.

Specific sensor and software settings can be found in Appendix 4.

TEMPERATURE / DEPTH RECORDER

A temperature and depth recorder (TDR) is mounted to the net for all tows. This sensor does not transmit data to the vessel in real time but stores it internally to be downloaded at the end of each day. This temperature and depth data collected is essential to the stock assessment. The depth is used to calculate the net's actual touchdown time (and corresponding location determined from the GPS log of the trawl mensuration data stream). This constrains the final footprint of the trawled bottom. The temperature forms an important basis of the habitat suitability measure used in the stock assessment model. The sampling interval of the TDR is 3 seconds.

Until 2013, a Vemco™ minilog was employed for the collection of temperature and depth data. In 2013 a Seabird™ SBE 39 became the chosen instrument for this purpose. The SBE 39 offers a substantially lower thermal time constant which improves accuracy of bottom temperatures for the relatively short (five minute) tow duration. The SBE 39 is substantially larger and more expensive than the minilogs which are no longer produced by Vemco™. The SBE 39 has a titanium body and is placed in acustom manufacturered stainless steel housing. The housing is attached to the net in a similar method to the multipurpose headline sensor. It is tied into a mesh bag sewn onto the top of the net just behind the headline and tethered directly to the headline by two short (~0.3m) lengths of braided nylon cord.

A temperature only minilog is still placed on the net so that is can be combined with the eSonar depth sensor data to recreate the TDR data if there was a failure of the stand-alone TDR sensor.

CAMERAS

A Canon™ water and shock proof digital camera is used to capture a still photograph of each catch after the trawl net is emptied in the sorting tank. This represents the unsorted catch including rocks, gravel, etc. An additional camera is kept on the working deck area to document any new species encountered or any other notable exceptions to the normal observations of crab or other species.

In the wheelhouse, a digital camera is used in lieu of a photocopier / scanner to keep a record of all deck sheets and paperwork. This ensures that there is a digital backup of all hard copy data.

COMPUTERS

A ruggedized laptop computer (Panasonic ™ Toughbook) is used in the wheelhouse to capture all data streams. A second monitor is attached to allow for easy viewing of multiple software interfaces. Unfortunately, most marine instruments still interface through RS232 (9 pin) serial cables whereas the adoption of USB interfaces have become the de facto interface for most computers. As such, most computers have no 9-pin serial now and require the use of serial adapters for many of our data streams. Using a docking station for the laptop does provide one serial port that captures the trawl mensuration data stream. An additional serial port is gained through a PC-card to serial adapter which ports the GPS data to the eSonar software. These data streams do not run reliably through USB to serial adapters. The Seabird is able to function properly through a USB to serial adapter and the minilog is downloaded via the Vemco™ field reader which interfaces through a proprietary Bluetooth™ / USB adapter. Each of these adapters requires specific drivers to operate. As such, multiple copies of all software and associated drivers are maintained at all times onboard the vessel. This computer is loaded with a Windows XP™ operating system as all software and drivers used for the survey are not compatible with later Windows™ versions.

A second identical computer, pre-loaded with all software and drivers, is onboard the vessel. This can be swapped out in a short time frame should problems arise with the primary computer.

At the end of each day, all data is backed up to a ruggedized external hard drive as well as the hard drive of the computer.

ANEMOMETER

An Airmar™ 150WX wind speed indicator is mounted on the vessel to ensure that the wind speed is within operating protocol (<25 knots) at all times. This sensor contains a solid state compass and a 10Hz GPS receiver that allows for calculation of true wind speed, not only apparent wind speed. In the past a Gill™ Windsonic anemometer was used. This unit is extremely accurate but is only able to show relative wind speed as opposed to true wind speed.

REFERENCE MATERIALS

SOFTWARE / HARDWARE

Manuals for various software and hardware are consulted as required. These include:

- Vemco Loggervue Software User’s Guide
- Seabird SBE 39 Manual
- Seabird SBE 39 Quick Guide
- Marel M1100 User’s Guide
- Marel M1100 Technical Guide
- eSonar User’s Manual
- eSonar Sensor Servicing Procedure
- Airmar Owner’s Guide and Installation Instructions- Weather Station Instrument

SPECIES IDENTIFICATION

The following reference materials are used to aid in species identification:

- Guide to Some Trawl Caught Marine Fishes from Maine to Cape Hatteras, North Carolina. NOAA Technical Report. Author- Donald Flescher
- A Practical Guide to the Marine Animals of Northeastern North America. Author- Leland Pollock
- A Field Guide to Atlantic Coast Fishes: North America- Peterson Field Guide
- A Guide to The Species Caught During The Scotian Shelf Snow Crab Survey
- Marine Species Identification Guide for the St. Lawrence. DFO, Insitut Maurice-Lamontagne

STANDARD OPERATING PROCEDURES

WHEELHOUSE

The wheelhouse is the primary work location for the chief scientist (CS) and the vessel captain. These two individuals work in conjunction to direct and control the fishing and sampling activities of the survey.

Chief Scientist

The chief scientist ("CS") directs all survey-related activities. Their primary focus must be the quality of the data produced by the survey by ensuring that fishing and sampling protocol is followed exactly. This quality assurance also includes closely monitoring that all electronic equipment is in perfect working order (calibrated, batteries checked, no physical damage, etc.) as is the fishing gear and other non-electronic equipment. If there is a breech in survey protocol or a problem with any required equipment, it is essential that the CS ceases survey operations until such a time that the problem(s) is remedied. Being able to recognize, identify and remedy such problems is an essential skill of a chief scientist.

A specific work station exists for the chief scientist that includes a computer, anemometer, Vemco™ field reader, Seabird™ interface cable, external hard drive and SD Card Reader. A separate computer contains the Linux- based OLEX™ navigation software and a display for the vessels acoustic sounder. The navigation software and sonar allows the CS to consult directly with the captain on questions of location or bottom suitability for trawling activities. In a fixed station survey design, this is only required in rare instances where a new tow is being added to the survey or a current tow needs to be relocated due to repeated inability to complete station due to net damage or if a physical barrier exists to completing station. These barriers might include other fishing gear or vessels (seismic, search and rescues, etc.) working in area that are unable to relocate.

The responsibilities of the chief scientist include:

- Ensuring that all scientific equipment is in proper working order
- Initializing and downloading Seabird™ and Vemco™ TDRs
- Confirming that the TDRs and trawl mensuration sensors are properly attached to the net
- Determining warp length for each tow and communicating this information to the captain
- Monitoring eSonar™ software displaying net metrics throughout the course of the net deployment
- Ensuring that net is taken to original (blueprint) specifications before each tow
- Taking photograph of each tow's catch
- Validating tow validity
- Supervising scientific staff
- Retaining and properly archiving all paperwork (see Data Streams Section) generated from each tow

The CS monitors the eSonar software throughout the course of the tow. The CS is able to see in real-time the shape of the net from the attached sensors. From this data, the CS determines when the net has commenced fishing and begins a five minute timer until the time that the winches are engaged and the net is retrieved from the ocean floor.

Tow Validation

The chief scientist is ultimately responsible for determining if each tow is deemed to be a good (of acceptable quality) tow. The tow may be denied for the following reasons:

- Hole(s) in the net which provided a reasonable chance that some catch was lost
- Insuffcent net sensor readings that calculating an accurate swept area would be impossible
- Doors crossed or fell (towed "on face")
- Aborted tow before five minutes bottom time
- A belief that the net did not fish properly. This decision may be based on environmental conditions (sea state, strong tides or currents) or simply on the experience of the chief scientist or vessel captain.

If a tow is not accepted for one or more of the above reasons, it is repeated in as close a location as possible. A minimum of three attempts are made to complete a tow at that station before abandoning that station for that survey year. This station will generally remain in the survey for the following season.

A detailed daily routine for the chief scientist can be found in Appendix 5.

Captain

The vessel captain is responsible for the operation of the vessel and the fishing gear in a safe and efficient manner. In the case of a marine emergency or any vessel-related safety considerations, the captain of the vessel retains absolute authority over all decision making and direction of all persons onboard, whether employed by the vessel contractor or DFO. The captain directs all navigation of the vessel and ensures that all survey tows are done in the proper location.

For each survey station, a start and end point is electronically charted. The captain attempts to place the net as close as possible to the exact location as past years. This helps ensure inter-annual continuity as well as reducing the risk of net damage as successful tows have been completed in past years in that exact location.

Operational Considerations

Extensive experience with this net has helped develop the following rules:

- If the bottom is sloped, tow the net down an incline as opposed to up it (this lowers the chance of net damage)
- When the CS believes that the net contains a substantial amount of debris (rocks, gravel, etc.), the vessel is to be placed in neutral and haul-back is conducted slower than normal (reduced winch speed). This pulls the vessel back to the net rather than dragging the net further along the seafloor and risking excessive net damage. Once the warp length is less than the water depth the net has been lifted vertically off the bottom. The vessel is then put in gear moving forward to shift the net behind the vessel and subsequently retrieved as normal.
- If the net becomes lodged in the bottom (“comes fast”), it is best to abort that tow immediately by placing the boat in neutral and slowly hauling net back. The tow will automatically need to be repeated but following this protocol avoids timely and costly net damage caused by attempting to pull the net free of the bottom while proceeding with the tow.
- If a section of the net has been repaired multiple times or appears to be thin due to repeated abrasion against the bottom, it is best to replace that entire section of the net or sew in a new piece of netting as required. This prevents fishing a net with inherent weak spots that will likely tear and require the tow to be repeated if any rocks or additional net strain are encountered.
- Wing spread sensors will occasionally produce inconsistent readings when towing on hard bottom substrate until the net accumulates catch, pulling it into shape.
- When fishing on very soft (i.e. silt) substrate, it is common to lose readings from the wing spread sensors after trawl touch down and wing spread stabilization. This is caused by interference of the substrate occurring between the master and slave sensor. This issue will generally correct itself after one to two minutes.
- If the wing spread sensors report consistent readings after the winches are stopped but cease as the net touches bottom and stabilizes, it is generally caused by sensor attachment to the net. Potential faulty attachments may include; netting mistakenly hooked in the attachment shackle, uneven placement of the sensors on the wing tips, sensors not centered between net floats on the wings, etc. It can also be caused by a net frame configuration issue that places

uneven tension on all frame components (headline, wing lines and fishing line). The uneven tension can be caused by improper attachment of the bridles to the net, a twist in one wing of the net, stretched or broken frame components or another related problem.

- If net fails to “jump out” (wings spread) when the doors and net touch bottom, there is possibly a problem with the trawl doors. This is often a result of the shoe of the door wearing, changing the angle of the door. Modifying (by raising or lowering) the attachment point of the warp to the door can often correct this problem. This lack of “jump out” often occurs gradually over successive tows as the door shoes are worn past a threshold. The door shoes are typically replaced every 1-2 years or as required.
- Sustained wind-speeds above 25 knots are deemed unfishable and survey operations cease until winds (and associated sea state) improve.

WORK DECK

Three members of the science team work on the main deck of the survey vessel, a lead technician and two samplers (generally two contracted at-sea fisheries observers). The lead technician focuses primarily on the sorting and weighing of bycatch by species. See appendix 6 for the species and family groups which non-crab species are divided and enumerated as well as deck identification sheet and groupings for certain common invertebrates. The samplers focus on counting, measuring and weighing crab species with more detailed analysis of snow crab. The science deck crew is assisted by the chief scientist and vessel crew as required. The work process on deck requires a number of steps as detailed below.

Deploying and Retrieving Net

The vessel crew is solely responsible for this step of the surveying process. The captain oversees all fishing activities. When the survey station is reached the net is prepared for deployment. The net is rolled off the net drum into the water. The vessel deck crew ensures that the net has no wraps or obstructions and that the headline and footgear separate properly when in the water. The trawl doors are then unchained and the net is transferred from the pennant attached to the net drum to the door legs (attachment chains from net to doors). The main winches slowly deploy the first 25 fathoms of warp (3/4” grease packed steel cable) until it is certain that the doors have spread properly to avoid fouling each other. The winches then pay out warp to a ratio of 3:1 (warp length: water depth). Vessel speed is generally 5-6 knots while deploying the trawl doors. The warps are deployed evenly (port and starboard) and the winches are paused at 100 and 300 fathoms to further ensure that the doors are spreading properly. This is particularly important when working in areas with strong tides or currents where the probability of crossing doors is increased. Once the warp length is reached, the winches are stopped; the winch brakes applied and the hydraulics are turned off. The net is allowed to settle to bottom and fishes for 5 minutes. In exceptional cases when the net becomes “fast” (stopped by a feature of the seafloor), the net is retrieved before the intended five minutes of bottom time.

After the net has been on bottom for four minutes, the crew is notified and assume their respective positions at the winches. At five minutes bottom time, hydraulics are turned on, winch brakes released and winches engaged to retrieve the net. The winches are run as fast as possible to quickly lift the net from the seafloor as soon as possible. In most cases, the vessel is left in gear and continues forward at 2-3 knots while the doors are retrieved. In exceptional cases when the captain and chief scientist believe there is a substantial amount of rocks or gravel in the net, the vessel is placed in neutral and the winches retrieve the doors slower. This procedure brings the vessel back to the net and then lifts the net vertically to the vessel. This lowers the chance of new or further net damage.

Once the doors reach the vessel, the winches are stopped, the winch brakes locked, the trawl doors secured and the net attachment is transferred from the trawl doors to the netdrum. The captain engages the netdrum and the net is slowly (for safety reasons) rolled on the drum and brought aboard. The science and vessel crews stand at the sides of the sorting tank on deck while the net is rolled onto the drum so the net passes immediately through the deck crew’s field of view. The net is visually inspected to ensure that all catch is removed and to assess any gear damage. If any holes are present, they are marked and repaired by the vessel crew before the next tow. If the damage cannot be fixed in a timely manner, another (identical) net is attached to the bridles and the damaged net is placed on deck to be repaired.

Once the net is completely on the drum, the codend is untied and the contents are dumped into the sorting tank. A digital photo is taken of the net contents. Any larger rocks (>~2 foot diameter) are then removed from the tank for safety reasons. The catch is removed from the path of these rocks and they are slid over the stern of the vessel by hand or a sling powered by the vessel’s hydraulic capstan. The vessel crew generally focus on repairing any net damage and retying the codend for the next tow. The science crew sorts and processes catch.

Sorting and Processing Catch

The catch is sorted into plastic (bushel) baskets in the sorting tank. The predominant species of the tow each get their own basket as does snow crab. The remaining (minor prevalence) species are generally sorted into two baskets- one for mixed invertebrates and one for mixed fish. All baskets of catch are removed from the tank and remaining debris (rocks, shells, etc.) is discarded overboard. All baskets of crab are moved to the wet lab on deck (aka the “doghouse”) and other species to the sorting/ weighing station behind the wet lab.

Non-crab species are sorted, counted and weighed. Generally each species is processed separately though in some cases species are grouped by family (i.e. sculpins). This grouping of certain species is not random and is repeated consistently between sets and across years. This ensures the comparability and consistency of bycatch data from the snow crab survey. All species (or species group) are individually weighed to 0.1 kilograms. When a large abundance (>200-300) of animals of an individual species is represented in the catch, the total species weight is determined with the digital scale and the count is determined by extrapolation of a counted and weighed subsample to accurately determine a #animal's /weight to be applied to the total species weight. The count and weight for all species is recorded on a waterproof catch summary sheet.

All non-snow crab species are counted and weighed by species. The carapace width of each animal is determined and the sex is recorded along with an individual weight (to the nearest gram). A more detailed examination is completed for snow crab. They are initially sorted by sex. The males are processed first by descending size and then females in the same order. A carapace condition is determined for each animal; a subjective measure of the relative time since the animal has last moulted. There is no subsampling routine for large catches of snow crab, all individuals are measured.

The following measurements are made for male snow crab:

- Carapace Width (CW)
- Chela (claw) height if CW>30mm
- Durometer if CW>60mm
- Weight

The following measurements / observations are made for female snow crab:

- Carapace width (CW)
- Abdomen (5^{th} segment) width if CW>30mm
- Presence / absence of eggs
- Egg colour (as per laminated colour match card)
- Percent of egg clutch (coded by 0%, 1-49%, 50-74%, 75-99% or 100%)
- Weight

This information is recorded on the waterproof crab morphology sheet. The proper location for measurements of snow crab morphology and carapace conditions can be found in Appendix 7.

DATA MANAGEMENT

NON-ELECTRONIC DATA

Appendix 8 contains master copies of all paper forms used on the survey. These are:

1. Tow Log- Completed by chief scientist throughout the course of the tow. One sheet per tow.

2. Captain Daily Log- Completed by the captain with detailed time, depth and location information for each tow. One sheet for the day.
3. Set Information- Completed by the chief scientist with information for all tows for that day (such as commercial fishing area, estimated total catch, tow quality, etc.). One sheet per day.
4. Set Profile- Completed by chief scientist with detailed time, depth and location information for all tows for that day. One sheet per day.
5. Catch Summary- Completed by the lead deck technician with a count and weight for all species (or species groups where applicable) in each tow. One per tow.
6. Crab Morphology- Completed by the sampling technicians with detailed morphological information for all crab species. Each crab species in an individual tow has a unique crab morphology sheet (or sheets if more than 40 animals of that species in the tow).

Each working day of the survey receives a unique “Trip Number” following the naming convention of “Sddmmyyyy” (i.e. September 30, 2013 would have a trip number of S30092013). Sets are numbered sequentially starting at #1 for each trip number (day). Individual crab (“Fish Number”) are numbered sequentially starting at the #1 for each set. These fish numbers are unique to each crab species by set. Once stored in the database this combination of trip, set and fish number becomes the unique identifier for each crab encountered on the snow crab survey. Stations are referred to by a unique three number string preceded with the letters “EP” (Eastern Position). The eSonar and photographs are named by the station number (i.e. eSonar file for station EP100 would be ep100.txt, photograph would be ep100.jpg). In the case where a tow needs to be repeated, the station is then named by the station number (epxxx) followed by R and the repetition number. For example, first repeat at station EP100 would be EP100R1, second repeat: EP100R2.

A record of all species (with associated count and weight) caught is recorded on the catch summary sheet. The more detailed information about crab species are captured on the crab morphology sheets. These sheets are collected after each tow, reviewed with any errors and stapled together with the chief scientist tow log. These are collected in a separate file folder for each day labeled with the trip number. Throughout the work day, the set information and set profile sheets are updated to reflect the days fishing activities. At the end of the day, the captain’s log is stapled to the set information and set profile sheet for that day and placed in that day’s folder.

Throughout the survey, all stored paperwork is visually edited for any errors and compiled for each trip / day. This is then passed to the contracted at-sea observer company for data entry and editing where their data analyst does a visual review of all paperwork to locate and correct any errors. This amounts to three visual edits for all paperwork before submission for data entry. Common errors corrected include: unclear handwriting; incorrect species codes, dates or set numbers and inappropriate morphometrics for crab sex (chela height for females or abdominal width for males, etc.).

The data entry for all paperwork is completed by a sub-contractor of the at-sea observer company who specializes in data entry. Once entered, the data is loaded into preliminary Oracle tables and reviewed electronically for any errors or data which appear extreme. The identified errors through the computer based data checks are edited manually when necessary. Once all edits have been made, the data is loaded to the ISDB, a DFO-specific Oracle™ database designed to capture such data. All further access to the data is accomplished through structured query language (SQL) used in conjunction with various software packages.

ELECTRONIC DATA

There are four distinct electronic data streams for this survey:

1. eSonar (net metrics)
2. Seabird (TDR)
3. Minilog (backup temperature data)
4. Digital photos of each catch

A unique electronic folder is created for each day (named with the date) with separate folders within it for each of the data streams. With the exception of the eSonar data, all data is downloaded to the folder at the end of each working day. The eSonar data is captured on a set by set basis. Each set is named by the station number for the eSonar data and the photograph. A single daily data file for Seabird and minilog is named with the trip number.

ACKNOWLEDGEMENTS

The author wishes to thank Captain John Baker for his dedication and expertise. Brent Cameron, DFO, has provided tireless efforts over many years to ensure that survey protocols and data collection are developed and held to the highest of standards. Bill McKeough and Charlie Ferguson and additional at-sea observers have been invaluable in the collection of quality data along with support from vessel crew members. This survey would never have developed and continued without financial and operational support from the snow crab industry.

REFERENCES

Biron, M., Savoie, L., Sabean, C., Wade, E., Hébert, M., Moriyasu, M. Historical review (1996-2002) and assessment of the 2003 snow crab (*Chionoecetes opilio*) fishery off eastern Nova Scotia (Areas 20 to 24). DFO Can. Sci. Advis. Sec. Res. Doc. 2004/034.

Choi, J.S., Zisserson, B.M. and Reeves, A.R. An assessment of the 2004 snow crab populations resident on the Scotian Shelf (CFAs 20 to 24). DFO Can. Sci. Advis. Sec. Res. Doc. 2005/028.

Cook, A. M., Zisserson, B.M., Cameron, B.J. and Choi, J.S. 2014. Assessment of Scotian Shelf Snow Crab in 2013. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/052. vi + 101 p.

TABLES

Table 1. Survey History Details

Year	Vessel	Station Count	Chief Scientist
1996	CCG Opilio	24	R. Campbell
1997	Glace Bay Lady, Marco Brittany	150	R. Campbell
1998	Marco Brittany	214	R. Campbell
1999	Marco Brittany	274	R. Campbell
2000	Marco Brittany	317	R. Campbell
2001	Den-C Martin, Marco Michel, Marco Brittany	303	R. Campbell
2002	Marco Michel	300	L. Savoie
2003	Marco Michel	258	L. Savoie
2004	Gentle Lady	379	B. Zisserson
2005	Gentle Lady	389	B. Zisserson
2006	Gentle Lady	374	B. Zisserson
2007	Gentle Lady	378	B. Zisserson
2008	Gentle Lady	405	B. Zisserson
2009	Gentle Lady	407	B. Zisserson
2010	Gentle Lady	407	B. Zisserson
2011	Gentle Lady	414	B. Zisserson
2012	Gentle Lady	407	B. Zisserson
2013	Gentle Lady	408	B. Zisserson
2014	Miss Jessie	369	B. Zisserson, B. Cameron

FIGURES

Figure 1- Scotian Shelf with snow crab fishing areas (CFA's)

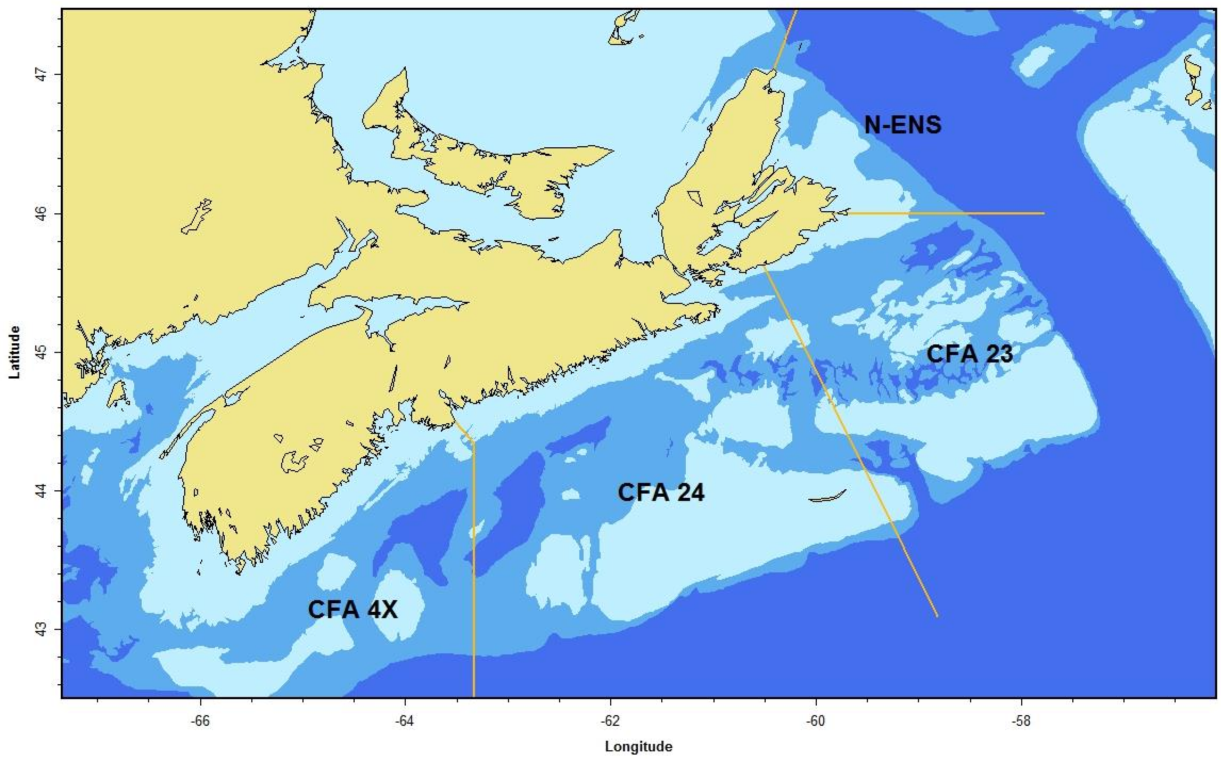
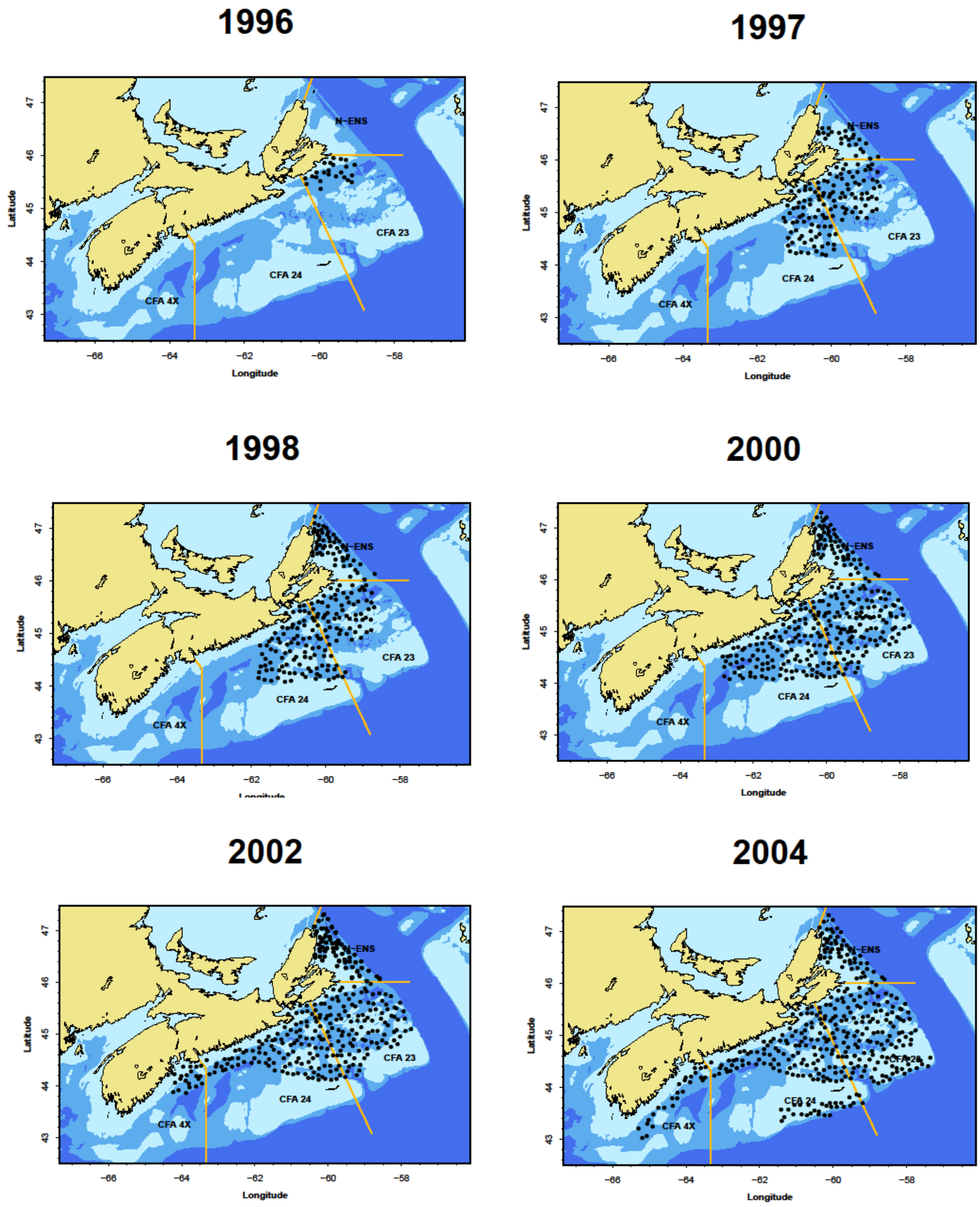


Figure 2. Snow crab survey development (stable since 2004)



APPENDICES

Appendix 1. Fisheries Research Notice (2014 example)

Maritimes Region
Région des Maritimes
Fisheries Research Notice

Fisheries and Oceans / Pêches et Océans

Number: *M-14* - 15

Title: Snow Crab Trawl Survey

Duration (starting and ending dates): August 15, 2014 *(start)* December 31, 2014 *(end)*

City of Departure and Return (Vessel or aircraft): Various Ports in Nova Scotia *(departure)* Various Ports in Nova Scotia *(return)*

Vessel Name: Miss Jessie

Officer In Charge (OIC): Ben Zisserson (DFO Science) / John Baker (Vessel Captain)

Name of License Holder (if different from above):

Scientific Staff: Ben Zisserson, Brent Cameron, Adam Cook, Alan Reeves + At-sea Observers

Fishing Gear used (size and mesh - describe): 20 meter Nephrops Trawl (80, 60, 40 mm mesh)

Expected Catch: Various (Species) Variable (Amounts)

Will Fish be Retained? ☐ YES ☒ NO (other than very limited samples for laboratory investigations)
If YES, how will the fish be disposed of after the project is complete?

Area of Work: Scotian Shelf (German Bank to St. Paul's Island)

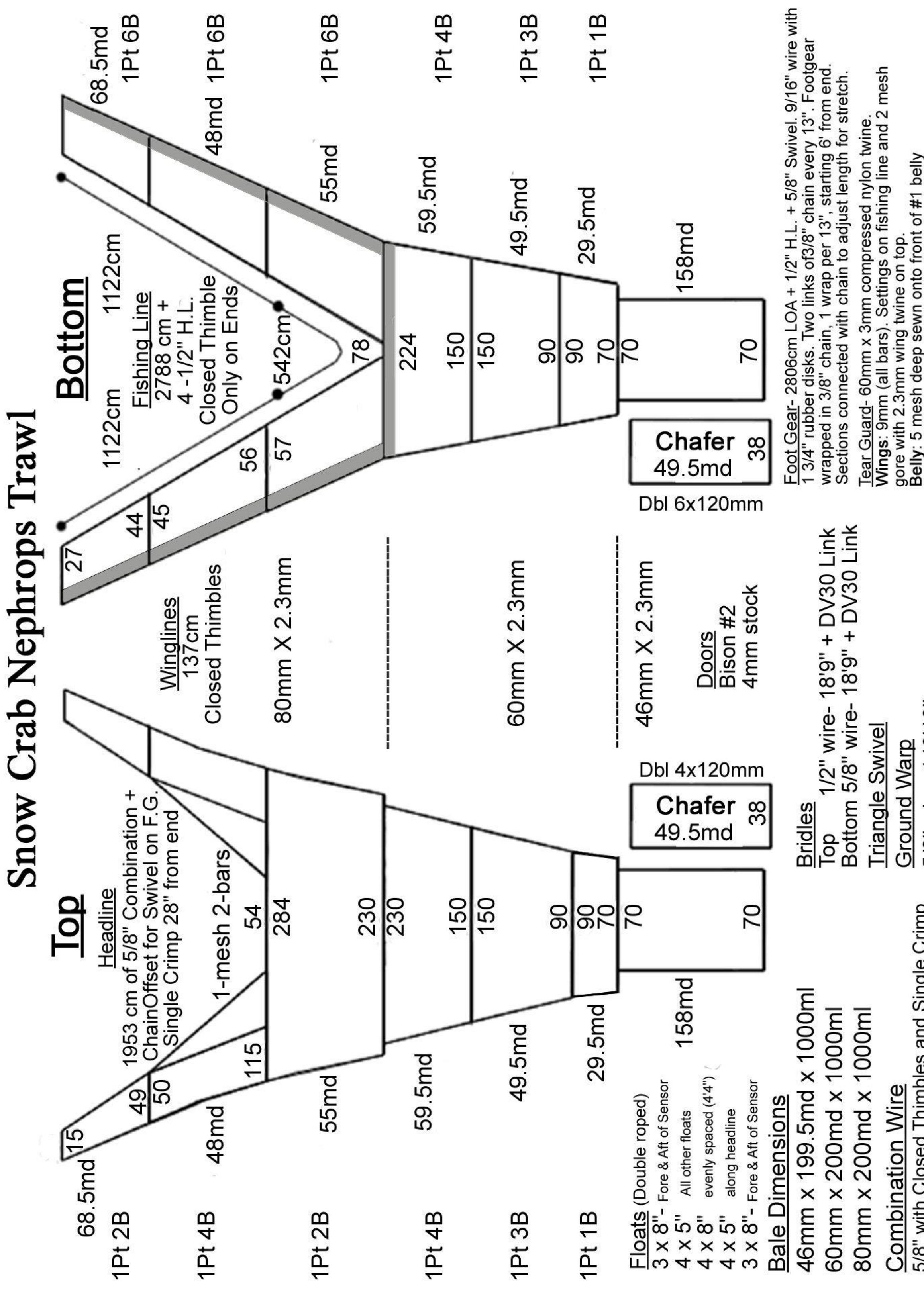
Objectives: A five minute tow will be completed at each station of a ~410 station survey for snow crab stock assessment purposes as well as additional ecosystem considerations / estimations.

Responsible Officer: Ben Zisserson Date : June 4, 2014

Approval / Approbation: Date: 4 June 2014

Name: Alain F. Vézina
Regional Director, Science
Science Branch
Maritimes Region

Appendix 2. Nephrops trawl blueprint



Appendix 3. Marel™ scale settings

Application (APP) Command Switch Settings

A01- Zero Tracking- **OFF**

A02- Automatic Tare- **OFF**

A03- Automatic Recording- **OFF**

A04- Reserved- **OFF**

A05- Response Time- **ON**

A06- Response Time- **ON**

A07- Optimized for Accuracy vs Speed- **ON**

A08- Reserved- **OFF**

A09- Packing Mode Extra Resolution- **OFF**

A10- Continuous Transmission- **OFF**

A11- Continuous Transmission- **OFF**

Appendix 4. eSonar™ trawl monitoring system settings

eSonar DBR Settings

*For eSonar or Netmind Wing Sensors and eSonar Headline with integrated depth

Sensor Setup

Sensor	Frequency (Hz)	Enabled
Headline	28640	✓
WingMaster	29120	
DoorMaster	28800	✓
Grid	29440	
Depth	29280	✓
Catch1	28960	
WingSlave	28480	
DoorSlave	28320	✓
Catch2	27840	
Catch3	27680	
Temperature	28160	
BottomContact	28000	

Close Window

Transducer Setup

Transducer	Type	Min Time	Max Time	Min Value	Max Value	Sensor	Assoc Tx	Log	Dimension
Primary	Standard	5.000	5.980	0.000	60.000	Headline	Primary	✓	Length
Secondary	Standard	6.000	6.980	2.100	31.200	Headline	Secondary		Length
FishCount	Standard	7.000	7.980	0.000	10.000	Headline	FishCount		None
Error	Standard	4.850	4.950	0.000	0.000	Headline	Secondary		None
DoorSpread	Standard	5.170	7.170	0.000	50.000	DoorMaster	DoorSpread	✓	Length
Error	Standard	5.020	5.120	0.000	0.000	DoorMaster	DoorSpread		None
WingSpread	Standard	12.000	14.000	0.000	150.000	WingMaster	WingSpread		Length
Error	Standard	11.850	11.950	0.000	0.000	WingMaster	WingSpread		None
Tilt	Standard	7.230	8.770	3.000	93.000	Grid	Tilt		Angle
Depth	Standard	6.000	8.000	0.000	1000.000	Depth	Depth	✓	WaterDepth
Catch1	Standard	30.000	31.000	0.000	1.000	Catch1	Catch1		None
DoorSymmetry	Differential	2.000	10.000	0.000	150.000	DoorSlave	DoorSymmetry		Length
WingSymmetry	Differential	8.000	16.000	-15.000	150.000	WingSlave	WingSpread		Length
Catch2	Standard	30.000	31.000	0.000	1.000	Catch2	Catch2		None
Catch3	Standard	30.000	31.000	0.000	1.000	Catch3	Catch3		None
Temperature	Standard	6.000	7.200	-5.000	35.000	Temperature	Temperature		Temperature
BottomContact	Standard	7.200	8.770	-45.000	45.000	BottomContact	BottomContact		Angle

Close Window

If using the Netmind depth sensor, change frequency to 29194 Hz. Min time=5.200, max time=6.800. Min Value=0.000, max value = 703.800.

In rare instances, the threshold settings in the DBR might need to be changed to improve the amount of reading being received. Follow these steps to do this:

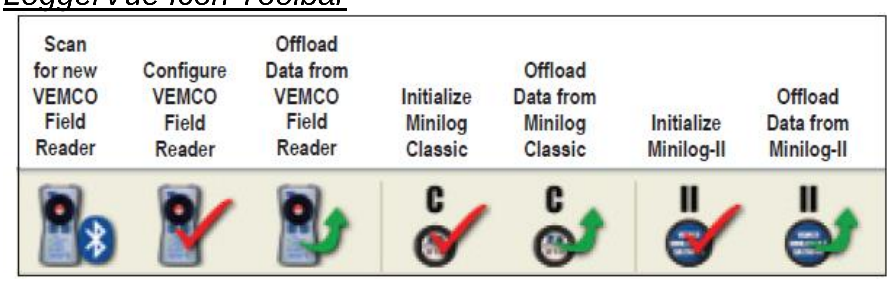
1. Close DBR
2. Right click on DBR shortcut-> properties-> Find Target
3. Open the .ini configuration file
4. ThresholddB can be changed from -5 (hard, rock bottom with increased echoing) to -12 for very deep soft bottom.
5. File-> Save-> File-> Exit
6. Re-open DBR

Appendix 5. Chief scientist daily routine

Start of Day

1. Make coffee and check supplies on deck (shop towels, durometers, etc)
2. Synchronise time between computers and GPS using the vessel's GPS as the standard.
3. Set-up master folder for the day. Name with the date. It must contain folders for Minilog, Netmind (eSonar), Seabird and Photos.
4. Seabird. Hit Connect , type "ds" to display status and confirm settings displayed (date, time, 3 second sampling, upload includes time, battery voltage, etc). Time will often need to be synced with the GPS through the "HHMMSS=" command. If battery is <7.9 Volts, change to other seabird or replace battery. Type "SampleNum=0" to reset memory. Type "StartNow" to begin sampling. The screen will echo back "start now" to confirm that sampling has commenced. **Refer to Seabird Command Summary Sheet for additional details if required.**
5. Open LoggerVue Minilog Software. Turn on Vemco field reader by holding the ON button until the wireless link light starts flashing to indicate its availability for a Bluetooth connection. The software will likely recognize and connect to field reader automatically. If not, hit button in bottom left Scan for new VEMCO Field Reader to connect to field reader. Once connection is established- hit Configure Field Reader button and sync reader and computer time (Set Clock) in top right of prompt box. Hit Apply and Close. Select Initialize Minilog II button. Confirm that sampling interval is 3 seconds and study name / ID is the trip number (Sxxxxxxxx). Hit Initialize and confirm that Minilog red LED is flashing once removed from the field reader.

LoggerVue Icon Toolbar



6. Open DBR Software. All settings will remain from previous session. **Refer to eSonar Reference Sheet for settings if required.**
7. Open DBR Logger. Set file path to the Netmind folder within the folder for that day. Set priority to GPS. Set file format to eSonar. Set file to epxxx. Set Ship number to epxxx, Trip to Sddmmyyyy(date) and tow number to 1. DBR Logger remembers no settings from the previous day.
8. Move eSonar Logger to cover minilog software window, allowing viewing of eSonar DBR software.

9. Attach the Minilog to Seabird and either place them in net or give to crew to place in net. Doing it yourself gives you a good chance to have a quick glance at sensors attachment, etc.

Each Tow

1. Start Protocol Sheet for each tow. Information required to complete will prompt chief scientist to ensure that protocol is being followed.
2. Start eSonar logger (as per step 6 above) with file and ship number named by station (EPXXX) and tow number to appropriate tow once doors are hooked up.
3. Check eSonar file to ensure that it is recording.
4. Call Touchdown . Relay depth and time information to captain.

Touchdown Indicators from DBR

- Doorspread jumps and remains above ~10 metres
- Headline Height drops to ~1.5m
- Depth stabilizes at ~ 2 X Depth shown on sounder

*Captain will often increase engine RPM's when net is in the process of touching down to maintain speed at 2 knots for duration of tow.

5. After 4 minutes, announce one minute remaining to crew via hailer.
6. After exactly 5 minutes, start hydraulics and tell depth to the captain.
7. Stop eSonar logger when doors are up. Move logger window across to block eSonar DBR window. This ensures that you won't forget to start logger as you cannot see the DBR window. Change Tow Number (previous tow + 1) and change file name and "ship number" to that of next station (EPXXX.txt)
8. Decide if tow is good upon inspection of the net and catch. Tow may be declared "bad" and repeated due to:
    - Any expectation that catch was lost (hole in net, codend not tied, etc)
    - NETMIND or Minilog did not work
    - Realistic assumption that net did not perform properly

It is important to be realistic in determining validity of tow. Captain can assist with this determination but it is ultimately the decision of the chief scientist.

9. If tow is good, take digital picture of the catch
10. Fill Out Logbook. In margin- start time of tow (touchdown), station ID, zone, location, estimated catch of snow crab in kg. Then complete body with good tow or not, count and weight of all bycatch, number and weight of snow crab with a detailed description of these snow crab (commercial, juvenile, multiparous, etc) and bottom type. Record start and end positions, start depth and a breakdown of male, female and total snow crab.
11. Review catch summary and morphology sheets to ensure data quality.
12. Fill out Set Information and Set Profile forms with required information. Notes in bottom margin to help with formatting data.

<u>Repeated tow ("redo")-</u> the first repeat an R (i.e. EPXXXR) is added to all references to station, then R2 (i.e. EPXXXR2) on a subsequent repeat of same station, R3,………

<u>Output for Each Good Tow</u>- protocol sheet, catch summary, crab morphology sheets, Minilog text file, Minilog ASCII file, eSonar file, photo of catch

End of Day

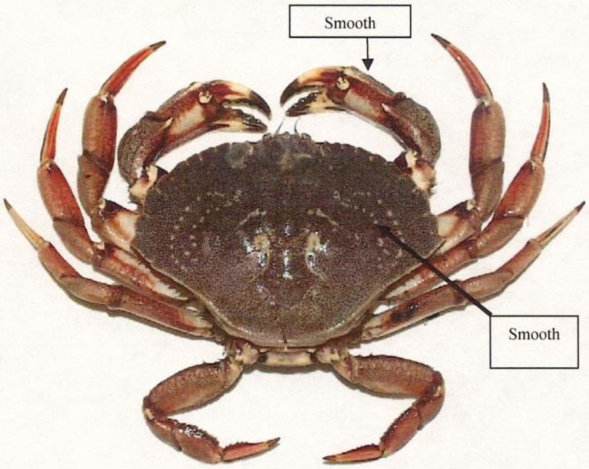
1. Download Seabird. Dry tip with air and connect plug. Hit Connect on Gui. Type “stop” and enter. Repeat five times. Hit STOP on Gui. Repeat five times. Type “stop” and enter. Repeat five times. Hit UPLOAD from Gui. Fill in header information as prompted and save the file with the trip number as the file name (Sddmmyyyy) in the Seabird folder for that day. Use Plot39 software to view that days seabird file to ensure everything looks okay. Once confirmed, type “SampleNum=0” to reset internal memory in Seabird.
2. Download minilog. Open LoggerVue Minilog Software. Turn on Vemco field reader by holding the ON button until the wireless link light starts flashing to indicate its availability for a Bluetooth connection. The software will likely recognize and connect to field reader automatically. If not, hit button in bottom left Scan for new VEMCO Field Reader to connect to field reader. Once connection is established- Hit Offload Data from Minilog II button in bottom right of software. Hit Stop Study then Offload. View the chart for the day’s data. In top of chart window, choose Chart then Export Data as…. And choose .csv. Name the file with trip number and save in the Minilog folder for that day.
3. Download photos on camera and rename each photo with the station number (EPXXX) then place all photos in the “Photo”
4. Move data folder to “*Completed*” folder and back-up (copy / paste) “*Completed*” folder to memory stick. Paste the completed folder to external hard drive in a new folder named with the date.

Appendix 6. Species codes used on snow crab survey

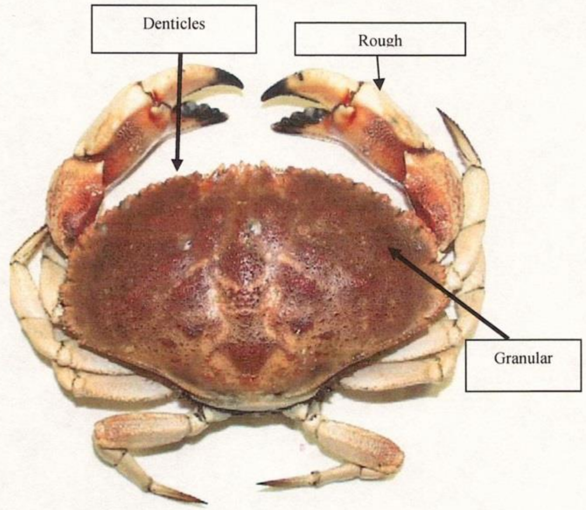
Invertebrates					
Anemones NS	8300	Scallop, Sea	4321	Tusk Shells	4110
Barnacles	2990	Sea Cucumbers	6600	Urchin, Green	6411
Clam, Northern Propeller	4312	Sea Mouse	3200	Urchin, Heart	6413
Clam, Arctic Surf	4355	Sea Peach	1827	Urchin, Purple	6412
Clams NS	4310	Sea Pen NS	8318	Whelks NS	4210
Clam, Razor NS	4315	Sea Potato	1823	Whelk Eggs, NS	1510
Cockles, NS	4340	Sea Slug	4400	Worm, Bristle	3100
Coral NS	8332	Sea Spider	5100	Worm, Catus	3451
Crab, Atlantic Rock	2513	Sea Squirts	1821	Worm, Segmented	3000
Crab, Deepsea Red	2532	Seaweeds NS	9300		
Crab, Hermit	2559	Shrimp, Mud	2413		
Crab, Jonah	2511	Shrimp, Northern	2211		
Crab, Lesser Toad	2521	Shrimp NS	2100		
Crab, Northern Stone	2523	Shrimp, Sand	2416		
Crab, Snow	2526	Shrimp, Striped	2212		
Crab, Toad	2527	Sponges NS	8600		
Eggs NS	1100	Squid, Bobtail	4522		
Jellyfish NS	8500	Squid, Shortfin	4511		
Lobster, American	2550	Star, Basket	6300		
Moonsnail, Northern	4221	Star, NS	6100		
Mussel NS	4330	Star, Brittle	6200		
Octopus	4521	Star, Horse	6117		
Quahog, Ocean	4304	Star, Mud (Mudstar)	6115		
Sand Dollar	6500	Sunstar, Purple	6121		
Scallop, Iceland	4322	Sunstar, Spiny	6123		

Fish					
Alewife	62	Hake, White	12	Skate, Winter	204
Alligatorfish	351	Halibut	30	Snailfish (Seasnail) Sp.	500
American Plaice	40	Herring	60	Snakeblenny	622
Argentine, Atlantic	64	Lanternfish NS	150	Snakeblenny, Fourline	626
Barracudina, White	712	Lumpfish	501	Spiny Lumpsucker	502
Beardfish	771	Mackerel	70	Turbot	31
Butterfish	701	Marlinspike Grenadier	410	Wolffish, Striped (Atlantic)	50
Capelin	64	Monkfish	400	Wolffish, Spotted	51
Cod, Atlantic	10	Poacher, Atlantic Sea	350	Wolffish, Northern (Jelly Cat)	52
Cod, Tom	17	Pollock	16	Wrymouth	630
Dory, Buckler	704	Pout, Ocen	640		
Eelpout NS	642	Redfish NS	23		
Flounder, Deepwater	385	Rockling, Fourbeard	114		
Flounder, Four-spot	142	Sand Lance NS	590		
Flounder, Gulfstream	44	Saury, Atlantic	720		
Flounder, Winter	43	Sculpin NS	311		
Flounder, Witch	41	Sculpin, Polar	307		
Flounder, Windowpane	143	Sea Raven	320		
Flounder, Yellowtail	42	Sea Robin	580		
Gunnel, Rock	621	Shad, American	61		
Haddock	11	Shanny, Daubed	623		
Hagfish, Northern	241	Skate, Barndoor	200		
Hake, Longfin	112	Skate, Little	203		
Hake, Red	13	Skate, Smooth	202		

Crab, Atlantic Rock 2513



Crab, Jonah 2511



Crab, Lesser Toad 2521

Crab, Toad 2527

Crab, Northern Stone 2523

Crab, Snow 2526

Star, Basket 6300

Star, Brittle 6200

Star, Horse 6117

Sunstar, Purple 6121

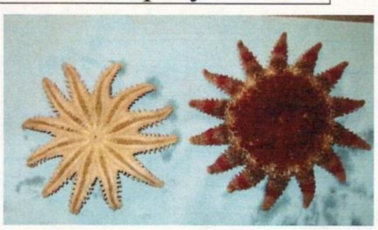
Star, Mud 6115

Star, NS 6100

Asteroidea Sp.

All starfish other than brittle stars, basket stars, mudstars, horse stars and sunstars

Sunstar, Spiny 6123



Clam, Northern Propeller 4312

Clam, Arctic Surf 4355

Clam, Razor NS 4315

Quahog, Ocean 4304

Clams NS 4310

Protobranchia, Heterodonta

All clams other than Northern Propeller, Quahaug, Razor and Arctic Surf

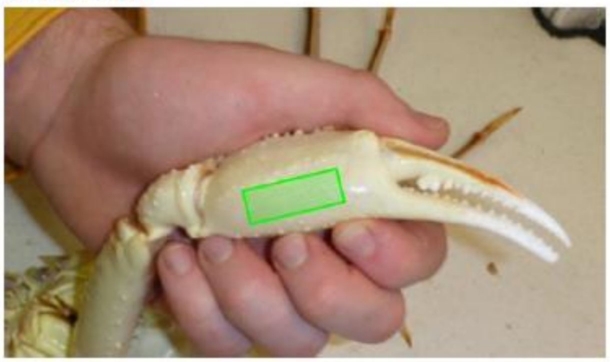
Cockles, NS 4340

Mussel NS 4330

Appendix 7- Measurement and carapace condition standards for snow crab

Carapace & Claw

Durometer



Shell Conditions

Appendix 8. Paper forms used onboard survey vessel (2014 Example)

Chief Scientist Tow Log

Fisheries and Oceans Canada　Pêches et Océans Canada

Snow Crab Survey Protocol

Date: ________/________/________ (dd / mm / yy)　Tow #: ____________

Station: ______________　Minilog ASCII File Name: ______________

Computer Time = + / - 1 second of GPS Unit: ____________　Technician: ____________

Mini Log Bin #: ________________　Bottom Temperature: __________ °C

Sensors

Distance: ______　Height: ______　Depth: ______　Touchdown: ______

Tow Characteristics

Start time NETMIND (24:00) : ________________

Touchdown Time (24:00:00): ____________　Retrieval Time (24:00:00): ______________

End time NETMIND (24:00) : ____________　Speed comments: __________________

Digital Photo: __________

Windspeed: ________ knots at _____ degrees

Tow Validation

Good: ________　Rejected: ________

Comments:

____

____

____

Captain's Log

Date- / /			
Tow #	**Tow #**	**Tow #**	**Tow #**
Start Time:	Start Time:	Start Time:	Start Time:
Start Depth:	Start Depth:	Start Depth:	Start Depth:
Start Position	**Start Position**	**Start Position**	**Start Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Position	**Finish Position**	**Finish Position**	**Finish Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Time:	Finish Time:	Finish Time:	Finish Time:
Finish Depth:	Finish Depth:	Finish Depth:	Finish Depth:
Warp	Warp	Warp	Warp
Tow #	**Tow #**	**Tow #**	**Tow #**
Start Time:	Start Time:	Start Time:	Start Time:
Start Depth:	Start Depth:	Start Depth:	Start Depth:
Start Position	**Start Position**	**Start Position**	**Start Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Position	**Finish Position**	**Finish Position**	**Finish Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Time:	Finish Time:	Finish Time:	Finish Time:
Finish Depth:	Finish Depth:	Finish Depth:	Finish Depth:
Warp	Warp	Warp	Warp
Tow #	**Tow #**	**Tow #**	**Tow #**
Start Time:	Start Time:	Start Time:	Start Time:
Start Depth:	Start Depth:	Start Depth:	Start Depth:
Start Position	**Start Position**	**Start Position**	**Start Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Position	**Finish Position**	**Finish Position**	**Finish Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Time:	Finish Time:	Finish Time:	Finish Time:
Finish Depth:	Finish Depth:	Finish Depth:	Finish Depth:
Warp	Warp	Warp	Warp
Tow #	**Tow #**	**Tow #**	**Tow #**
Start Time:	Start Time:	Start Time:	Start Time:
Start Depth:	Start Depth:	Start Depth:	Start Depth:
Start Position	**Start Position**	**Start Position**	**Start Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Position	**Finish Position**	**Finish Position**	**Finish Position**
Lat:	Lat:	Lat:	Lat:
Long:	Long:	Long:	Long:
Finish Time:	Finish Time:	Finish Time:	Finish Time:
Finish Depth:	Finish Depth:	Finish Depth:	Finish Depth:
Warp	Warp	Warp	Warp

Set Information

SET INFORMATION

TRIP NUMBER: S _ _ _ _ 2 0 1 (d d m m)

OBSERVER: ____________

VESSEL: Miss Jessie

SET NO.	GEAR #	OBS SET	SPECIES SOUGHT	ESTIMATED CATCH	COMMERCIAL AREA	200 MILE	NAFO ID	SET TYPE	HAUL COM.	WARP LENGTH	AMOUNT OF GEAR	STRATUM ID	STATION NO.
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					
	1	0	2526		C	1		4					

Haul Comments: 1 Good Tow; 4 Bad Tow

Estimated Catch: If no snow crab, 0.0000001 metric tonnes; If snow crab present, weight of snow crab in metric tonnes

Set Profile

SET PROFILE

TRIP NUMBER: S d d m m 2 0 1 OBSERVER: ____________ VESSEL: **Miss Jessie**

SET NO.	DATE DD/MM/YYYY	PT ID	LATITUDE START	LONGITUDE START	DEPTH START (m)	TIME START	SPEED	BOT. TYPE	PT ID	LATITUDE END	LONGITUDE END	DEPTH END (m)	TIME END
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:
	/ /	2	o .	o .		:	2 . 0		3	o .	o .		:

Depth: 1 Fathom = 1.83 metres

Catch Summary

CATCH SUMMARY

TRIP NUMBER: S _ _ _ _ 2 0 1 _ (d d m m)   OBSERVER: ______   VESSEL: **Miss Jessie**

SET ____

	SPECIES	KEPT WEIGHT	DISCARD WEIGHT	TOTAL NUMBER CAUGHT

SET ____

	SPECIES	KEPT WEIGHT	DISCARD WEIGHT	TOTAL NUMBER CAUGHT

Crab Morphology

CRAB MORPHOLOGIES

TRIP NUMBER: S 2 0 1 (d d m m y y y y) SET: ____ SPECIES: ____________

OBSERVER: ____________ VESSEL: **Miss Jessie**

				M		M		V			M		V		V		V		V
FISH NO.	SEX	Carapace Width (mm)	CODE	Claw Height	CODE	Abdomen Width	CODE	SHELL COND.	Weight (Grams)	CODE	Duro-meter	CODE	Clutch Egg %	CODE	Egg Color	CODE	Gonad Color	CODE	Bitter Crab
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	
			37		54		52			51		50		53		55		57	

Sex: 1 Male 2 Female

Shell Condition: 1 New Soft 2 New Hard 3 Hard Clean 4 Hard Light Moss 5 Old Heavy Moss

Clutch: 0 Absent 1 1-49% 2 50-74% 3 75-99% 4 100%

Egg Color: 1 Light Orange 2 Dark Orange 3 Black 4 White (Cocoon)

Gonad Color: 1 White 2 Beige 3 Orange

Bitter Crab: 0 Absent 1 Positive

Samplers: ____________

Basket Weights (kg):

________ ________ ________

________ ________ ________

________ ________ ________