Maritimes Region Inshore Scallop Assessment Survey: Detailed Technical Description

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by

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ABSTRACT

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Inshore scallop assessment surveys are conducted annually in the Bay of Fundy and approaches on commercial scallop draggers. These surveys are used to provide advice on stock status to DFO Fisheries Management and industry stakeholders. The survey methodology and design is continually changing as new information and technology is developed and incorporated into the protocols. This Technical Report details the current (2016) protocols for survey design, survey gear, fishing activities, biological sampling, and data handling used to conduct these surveys.

RÉSUMÉ

Chaque année, des relevés d'évaluation de la pêche côtière du pétoncle sont effectués dans la baie de Fundy et ses environs sur des dragueurs commerciaux à pétoncles. Ces relevés sont utilisés pour fournir un avis sur l'état du stock à la Gestion des pêches du MPO et aux intervenants de l'industrie. Les méthodes et la conception des relevés changent continuellement à mesure que de nouveaux renseignements et de nouvelles technologies sont élaborés et intégrés dans les protocoles. Le présent rapport technique décrit les protocoles actuels (2016) pour la conception des relevés, les engins de relevés, les activités de pêche, l'échantillonnage biologique et le traitement des données utilisés pour effectuer ces relevés.

INTRODUCTION

Annual surveys of the sea scallop (*Placopecten magellanicus*) in the Bay of Fundy and approaches have been conducted since 1981, on both Canadian Coast Guard vessels and commercial fishing vessels. The survey is used to assess the biomass in Scallop Production Areas (SPAs) and provide information to DFO Resource Management for setting the Total Allowable Catch (TAC) for each area. Throughout the history of the survey there have been changes to the vessel, fishing gear, and survey design. This report captures the current technical details, methodology, and equipment used to conduct the inshore scallop assessment surveys. The surveys are conducted onboard a commercial fishing vessel, by DFO Science staff working in collaboration with the captain and crew to implement all established sampling protocols. The Captain and crew are an essential to the success of the surveys as they have expertise in fishing methods and gear handling. The crew also pick and sort the scallop and bycatch caught in each tow along with DFO Science Staff, and when required assist in processing the scallop catch, bycatch, and biological sampling.

DFO Scientific Staff consists of the Chief Scientist (CS) and one field technician. The CS is responsible for and directs all survey activities to ensure the survey protocols are implemented consistently and accurately to produce a high quality data product. The CS is required to monitor the condition of the gear and direct repairs as necessary. They also monitor all data collection and recording and identify and remedy any breech in the established protocols when required. The field technician is responsible for assisting the CS in all aspects of the data collection and management.

The inshore scallop assessment survey is conducted under a scientific fishing licence (pursuant to section 52 of the General Fisheries Regulations of Canada) issued by the Minister of Fisheries to the Regional Director of Science Branch (RDS) to the Maritimes Region. A Fisheries Research Notice (FRN) is created and distributed under the authority of the RDS to provide specific fishing operations to various parties of interest such as DFO Resource Management and DFO Conservation and Protection (Enforcement), See Appendix 1.

HISTORY

Annual inshore scallop stock assessment surveys in the Bay of Fundy began in 1981 and were limited to the local area around Digby, Nova Scotia. Surveys conducted between 1981 and 1988 took place on commercial scallop draggers using 7 gang Digby gear. From 1989 to 2004 the Bay of Fundy scallop assessment surveys were conducted by the CCGS J.L. Hart with 4 gang Miracle gear. When the CCGS J.L. Hart was decommissioned there was not another vessel within the Coast Guard available to conduct the surveys. A tendering process was established and the Fishing Vessel (FV) Royal Fundy conducted the Bay of Fundy surveys from 2005 to 2011 with 4 gang Miracle gear (Smith et al., 2013). In 2012, the FV Brittany & Madison III was awarded the survey charter and began to conduct the survey with 9 gang miracle gear. Comparative survey work was conducted in 2012 to compare the Digby and Miracle gears and the results are documented in Smith et al. (2013).

Scallop Fishing Area 29 West (SFA29W) surveys began opportunistically in 2000 when Scallop Production Area (SPA) 3 survey sampling was completed early and the remaining sea time was used to conduct exploratory tows (Smith et al., 2014). The SFA29W survey series began in 2001, aboard the FV Julie Ann Joan, with the survey design evolving as more information on the area became available (Smith et al. 2014).

SURVEY DESIGN

The inshore scallop fishing areas (SFA29 and SPAs) are shown in Figure 1, they encompass the Bay of Fundy and approaches. Currently SPA 1A, 1B, 3, 4, 5, 6 and SFA29 A, B, C, D, E are surveyed on an annual basis (Nasmith et al., 2016). Each SFA is subdivided into survey strata (Figure 2). The R scripts used to implement the survey design for each survey strata are contained in Appendix 2. SPA 1A consists of survey stratum 6, 7, 11-20, and Mid Bay South. The stations are allocated randomly over the entire area for stratum 6-7, 12, 18 and Mid Bay South. In stratum 11, 13-17, 19-20 the stations are allocated randomly but use the variance from the previous year's commercial size scallop (>=80mm) to determine the number of stations to be allocated in the stratum for the current year.

SPA 1B consists of 8 survey strata: Cape Spencer, Mid Bay North, Upper Bay 28C, 28D Outer, Advocate, Spencer's Island, 28D Inner, Scot's Bay (Figure 2). The stations are allocated randomly in Cape Spencer, Spencer's Island, 28D Inner, and Scot's Bay. In Mid Bay North, Upper Bay 28C, 28D Outer, and Advocate the allocation uses a sampling with partial replacement design where approximately 25% of the stations are randomly selected repeats from the previous year's stations.

SPA 3 consists of Brier Island, Lurcher Shoals, and St Mary's Bay (Figure 1), stratified by vessel monitoring system (VMS) polygon area which create strata referred to as inside VMS and outside VMS areas (Figure 3). These polygon areas were created from the fishing effort from 2002 to 2010 (Smith et al. 2012). Within this design, sampling with partial replacement is used where 25% of the stations are randomly selected stations from the previous year's survey.

SPA 4 consists of survey strata 1-5, 8-10 (Figure 2). The stations are allocated randomly and use the variance from the previous year's commercial size scallop (>=80mm) to determine the number of stations to be allocated within a stratum for the current year.

In 2015, there was implementation of a new survey design for SPA 6 that uses two polygons, inside VMS (624.63 km^2) and outside VMS (377.68 km^2) (Figure 4). These were created using fishing effort from 2002 to 2014 to delineate the areas within SPA6 that are traditionally fished (Nasmith et al. 2016). The total tow allocation is proportional to VMS polygon area, 62% of tows inside the VMS area, and 38% in the outside area. Of that allocation, 25% of the stations are randomly selected repeats from the previous year's survey.

SPA 5 is contained in Annapolis Basin (stratum 21). There are 5 random stations conducted within a survey polygon based on fished area (18.5055 km^2, Figure 5) designated from cumulative effort from 2012-2014 (Nasmith et al. 2016).

The survey design for SFA 29W has changed numerous times over the years and these changes are documented in Smith et al. (2015). The current design started in 2015 and is based on scallop habitat suitability maps (Smith et al., 2017). The survey area is classified as High, Medium, or Low suitability habitat for scallop (Figure 6). The current allocation for each area and stratum is listed in Table 4. Habitat suitability data is not available for SFA 29E and this subarea was not routinely covered by the survey until 2012. Coverage in 2012 and 2013 consisted of exploratory stations with tows chosen in locations where vms indicated fishing had occurred in the associated year. Since 2014, regular random survey tows have been conducted which are allocated randomly within a fished area polygon (Sameoto et al. 2015). This polygon was designed using fishing information from 2002 to 2013.

SURVEY GEAR/EQUIPMENT

Since 2012, for SPA 1A, 1B, 3, 4 and 5, and 2013 for SPA 6 the annual inshore scallop assessment survey is conducted with 9 gang toothed miracle scallop gear (Figure 7). Each drag (gang) has a 2 foot by 1 foot bridle with each side having five 2 inch teeth with 3.5 inch spaces between (Figures 8 and 9). A bag consists of 8 3 ¼" rings with steel washers along the front and back, 3 3 ¼" rings with rubber washers along the sides and 7 3 ¼" rings deep (22 around, 7 deep) and 2 rows of 4 rubber tire chaffers on the front (Figure 8). The bag is attached to a tail pole with 18 (3x6) offshore steel rings welded together (Figure 13). The survey uses 2 drags lined with 38 mm polypropylene mesh (Table 2, Figure 11), and 7 unlined drags (Table 2, Figure 10). Each liner is made with a piece of netting that is 50 mesh wide by 6 feet. It is folded once to a 3 foot length and the open sides are sewn and knotted in each mesh, leaving just the 50 mesh wide top open. The liners are secured in the drag by running rope through the top row of mesh and alternately through the top shackles that attach the ring bag to the bridle. An additional rope is secured through the middle of the bottom of the liner and attached through the tail pole (Figure 11) that the ring bag is attached to. The third and seventh drags are lined and drags 1, 2, 4-6, 8, and 9 are unlined. In the case that it is necessary to subsample a survey tow, only 1 lined drag (#7) and 2 unlined drags (#2 and #4) are picked and counted (Table 2). On the dumping table, the catch from each drag is kept separate with dividers attached to the dump table. The crew ensures that the drags are lined up with the associated divider when the drags are being dumped (Figure 7 and 12). Throughout the survey season repair and maintenance are required on the survey gear, including fixing holes in the ring bags, mending and replacing liners. The SFA 29 West the survey has always used 9 gang toothed miracle gear. Until 2015, only the two end drags (1 and 9) were picked and counted, with one being lined and the other unlined. In 2016 the same survey sampling protocols used in the other scallop production areas was adopted for SFA 29W.

Since 2016, a motion compensating Marel scale (M2200) is used to process biological samples at sea. The resolution is set to 0.1 grams and is used to weigh scallop adductor muscles (meats) and gonads. The scale is calibrated at the start of every sample using the 100 gram reference weight, tested, and re-calibrated if required throughout the weighing process.

A Vemco Minilog II temperature recorder is attached to the gear (Figure 14) and set to record temperature every 30 seconds. This provides bottom temperature data for every tow location on the survey. The temperature recorder stores the data until it is downloaded to the Vemco Field Reader at

the end of each day. Upon the completion of each survey the data is downloaded from the Vemco field reader to the database. Appendix 3 contains the initialization settings required to start the Minilog II recording temperature.

REFERENCE MATERIALS

Bycatch ID guides:

A guide to the species caught during the Scotian Shelf Snow Crab survey. Zisserson and Cameron. (Internal DFO)

Commercial fishery species guide. A photo guide to commercially encountered Marine Fishes of the Northwest Atlantic (NOAA NFSCR Doc 12-10)

Key characteristics for distinguishing between some marine fish and Invertebrates (Internal DFO)

Selected invertebrates collected during Scotian Shelf trawl surveys: Identification guide and sampling protocols 2nd edition. Day and Tremblay 2000. (Internal DFO)

Skate species identification guide (NOAA)

Marel manual M2200 PO2 & MO2 Scale Non-automatic & automatic weighing Version 2.00

Olex User Manual Version 7.31 (www.olex.no)

Vemco Field Reader and LoggerVUE Software User Guide (4762-04)

SURVEY PROTOCOLS

Wheelhouse

The Chief Scientist work station is located in the wheelhouse. They work directly with the Captain to direct the fishing and sampling activities of the survey. The workstation consists of a laptop with OLEX navigational software linked to the vessel GPS. Both the science and the vessels navigation computers have a feed from the same GPS. All survey tows are entered into both OLEX systems as waypoints for ease of operations. Communication and cooperation between the CS and Captain is essential to the successful completion of each tow

The Captain directs all navigation and aims to pass as close to the tow location as possible, and if conducting a repeat tow, to follow the previous year's tow track as closely as possible. During deployment of the gear the CS is in the wheelhouse with the Captain, ready to start tracking the tow with OLEX and record the start location, time, depth, bearing, tide cycle, strata, if the tow is a repeat, amount of warp used, as soon as proper amount of warp is deployed (2.5-3 x the depth plus 10 fathoms) and the brake is locked on the winch. This is the true start of the tow, when the gear starts fishing. At each tow location an 800 meter tow (approx. 8 minute) is conducted at a speed of 2.5-3.5 knots, towing in the direction of the tide cycle. When the tow is complete and the warp starts to be hauled in, the CS stops the OLEX tow track and records end location, time, and distance coefficient (meters). The

waypoint is assigned a tow number and the symbol is changed to indicate the tow is complete. The bottom type and volume of scallop catch (in baskets) is recorded after processing the tow (Appendix 4).

Deck Work

The Crew is responsible for deploying and retrieving the survey gear, and properly emptying the drags in associated bins on the dump table (Figure 12). After the gear is emptied, the crew and DFO Science Staff pick through the entire catch by bin to separate scallop catch and bycatch into scallop baskets, keeping the lined and unlined catch separate. Total scallop catch in baskets and bottom type (assigned by visual inspection of the catch) are recorded at this time.

Deck Workstation

Before starting operations each day the Vemco Minilog II temperature recorders are installed on the gear (Figure 14) and the deck workstation is set up with all required supplies. On deck there is a catch processing workstation consisting of a scallop measuring board (Figure 15), fish measuring board, clip board with deck sheets (Appendix 5), and calipers. There is one waterproof deck data sheet for each tow where the scallop height frequency for lined and unlined drags, biological sample data, and bycatch is recorded. The workstation is located near the shucking box for ease of processing biological samples. The scallops from the unlined gear are measured and counted first followed by the scallops from the lined drags. The scallop measuring board has a plate divided into 5mm increments and a corresponding counter to tally the individual scallop shell heights (Figure 16). For scallops over 65 mm the bottom side of the plate is used to tally the scallops. When all scallops over this size are counted the numbers are recorded on the waterproof paper deck data sheet, and the counters reset. The scallops less than 65mm are measured on the top side of the plate in the same manner, then recorded on the data sheet and counters reset. For scallops over the maximum size (135 mm) of the scallop measuring board, calipers are used to measure the shell height and tally individually on the data sheet in the proper 5mm bin. The same process is followed for the scallop catch from the lined gear but recorded separately on the waterproof paper deck data sheet (Appendix 5).

When a biological sample is required (determined by CS), 3 scallops from each 5mm bin are retained in bins for scallops 50mm and over. The scallop is opened (shucked) with all soft parts and gonad discarded and the meat retained. The meat is placed on a paper towel in a sample box which has been labelled with the tow number, and the exact shell height is measured using calipers and recorded with an associated shell number. This is done for all scallops retained for the sample. If time allows, the meats are weighed and recorded on the deck data sheet in real time on the motion compensating Marel Marine scale instead of being placed in the sample box. Otherwise, the meats are put in the sample box and placed on ice to weigh when time allows, usually after the completion of fishing activities for the day. Some projects require that the associated gonad be retained with the weight, sex, and stage of maturity recorded. The gonads are handled the same as the individual meats but stored in a separate sample box.

Bycatch processing consists of recording lobster carapace length and sex, identification and fish length of commercial species, length and sex of skates, and identification and mantle length of octopus, squid and cuttlefish (Table 2). However it is important to note that not all bycatch species have been recorded over the full time period of the survey. Requests for additional sampling for other groups within DFO and other Government Agencies are reviewed and if it is deemed logistically possible, the additional

protocol is incorporated into the sampling routine. The Scallop Unit requires protocols for additional data collection so they can be reviewed before the start the scallop assessment survey season.

When the wheelhouse tow metadata is recorded, and all scallops, bycatch and the biological sample are processed, the tow is considered complete.

DATA MANAGEMENT

At the end of the day, the data from the Vemco Minilog recorder is downloaded to the Vemco field reader. At the end of the trip the temperature data is downloaded from the field reader to LoggerVue software to view and converted to a .csv file. There is a time delay for the temperature to drop in the data recorder, but in the temperature profile it is apparent when the temperature reaches a minimum and remains consistent for approximately the last 5 minutes of the tow. This is the temperature that is used for bottom temperature for each tow. The bottom temperature for each tow is recorded in the wheelhouse log book.

In 2001, the DFO Data Management Group constructed an inshore scallop survey database (scallsur) to house the annual survey data. All data collected on the survey is validated and loaded into this database. There are data entry templates for the cruise, tow data, height frequency, bycatch, biological samples, and repeated tows. This information and the edit/validation information are in the Bay of Fundy Scallop System data dictionary 2013, and Bay of Fundy Scallop System data entry and loader user guide 2013. There have been updates and modifications to this database since its development to allow for additional information on changing strata and survey design to be captured.

ACKNOWLEDGEMENTS

Many thanks to Captain Carmen Burnie, Captain Leo Hamm and the crew of the FV Brittany & Madison III and FV Brittany & Madison V for their hard work, fishing expertise and dedication to the successful completion of the survey; The DFO staff who participate in the at-sea data collection, and Kohila Thana for trouble shooting and continual support in the management of the survey data and survey database.

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Nasmith, L., Sameoto, J., and Glass, A. 2016. Scallop Production Areas in the Bay of Fundy: Stock Status for 2015 and Forecast for 2016. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/021. vi + 140 p.

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Smith, S.J., Glass, A., Sameoto. J., Hubley, B., Reeves, A., and Nasmith, L. 2013. Comparative survey between Digby and Miracle drag gear for scallop surveys in the Bay of Fundy. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/161. iv + 20 p.

Smith, S.J., Nasmith, L., Glass, A., Hubley, B., and Sameoto, J.A. 2015. Framework assessment for SFA 29 West scallop fishery. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/110. v + 69 p.

Smith, S.J., Hubley, B., Nasmith, L., Sameoto, J., Bourdages, H., and Glass, A. 2012. Scallop Production Areas in the Bay of Fundy: Stock Status for 2011 and Forecast for 2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/009: vii + 123 p.

TABLES

Table 1: Location of lined and unlined drags in the 9 gang miracle gear. Asterisks indicate the drags that are picked and counted for a subsample.

1	2	3	4	5	6	7	8	9
	*	Lined	*			Lined*		

Table 2: Species encountered to date on the inshore scallop survey and associated species codes. Refer to Bay of Fundy Scallop System Data Dictionary for complete list of species codes.

SPECCD_ID	COMMON	SPECCD_ID	COMMON
10	COD(ATLANTIC)	142	FOURSPOT FLOUNDER
11	HADDOCK	143	BRILL/WINDOWPANE
12	WHITE HAKE	201	THORNY SKATE
13	SQUIRREL OR RED HAKE	202	SMOOTH SKATE
14	SILVER HAKE	203	LITTLE SKATE
15	CUSK	204	WINTER SKATE
18	HAKE UNID.	1191	WINTER / LITTLE SKATE
20	REDFISH	220	SPINY DOGFISH
21	REDFISH, DEEP WATER	337	SMELTS,CAPELIN (NS)
30	HALIBUT(ATLANTIC)	400	MONKFISH,GOOSEFISH,ANGLER
40	AMERICAN PLAICE	441	KEY WORM EEL
41	WITCH FLOUNDER	501	LUMPFISH
42	YELLOWTAIL FLOUNDER	2550	AMERICAN LOBSTER
43	WINTER FLOUNDER	2552	SHORT LOBSTER
50	STRIPED ATLANTIC WOLFFISH	4500	CEPHALOPODA C.
60	HERRING	4511	SHORT-FIN SQUID
112	LONGFIN HAKE	4521	OCTOPUS
120	WHITE PERCH	4522	BOBTAIL SQUID
121	SOUTHERN SEA BASS	4524	BATHYPOLYPUS ARCTICUS
122	CUNNER	626	4-LINE SNAKE BLENNY
141	SUMMER FLOUNDER	845	EELPOUT (NS)

Table 3: Inshore scallop assessment survey station allocation.

SCALLOP PRODUCTION AREA	STRATA	RANDOM STATIONS	REPEAT STATIONS
1A	6, 7	11	-
1A	11-20	70	-
1A	Mid Bay South	42	-
1B	Cape Spencer	29	-
1B	Mid Bay North	34	10
1B	Upper Bay 28C	17	10
1B	28D Outer	8	3
1B	Advocate	4	4
1B	Spencer's Island	5	-
1B	28D Inner	-	-
1B	Scot's Bay	4	-
SPA 3	Inside VMS Area	56	19
SPA 3	Outside VMS Area	45	15
SPA 4	1-5, 8-10	70	-
SPA 5	21	5	-
SPA 6	Inside VMS Area	56	19
SPA 6	Outside VMS Area	33	12

Table 4: Scallop Fishing Area 29 West station allocation based on Habitat Suitability survey design.

AREA	**LOW SUITABILITY**	**MED SUITABILITY**	**HIGH SUITABILITY**
29A	-	7	7
29B	8	16	10
29C	7	16	10
29D	5	16	14
29E	8 Random stations in vms area, no habitat suitability		

FIGURES

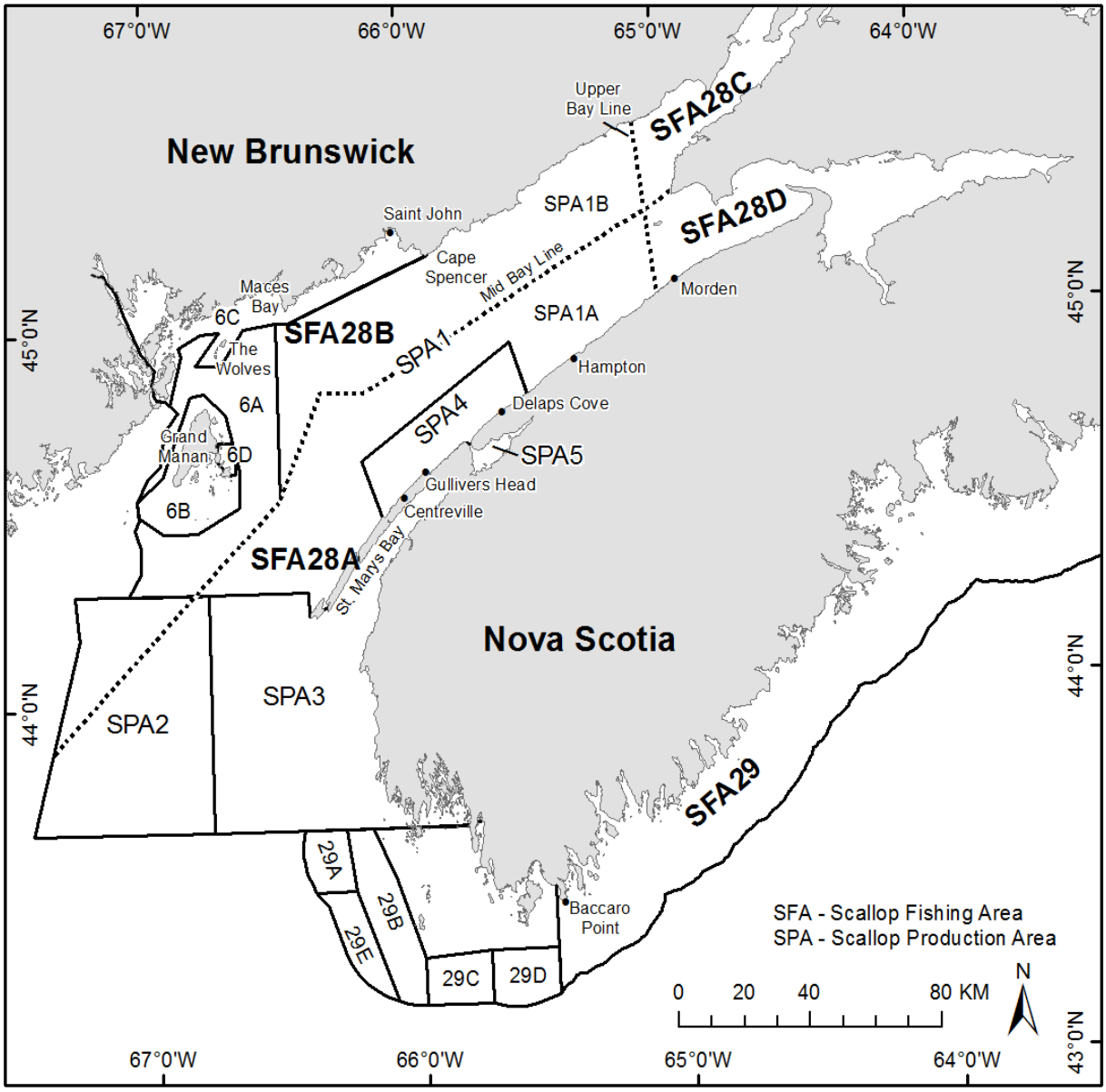


Figure 1: Inshore scallop fishing areas

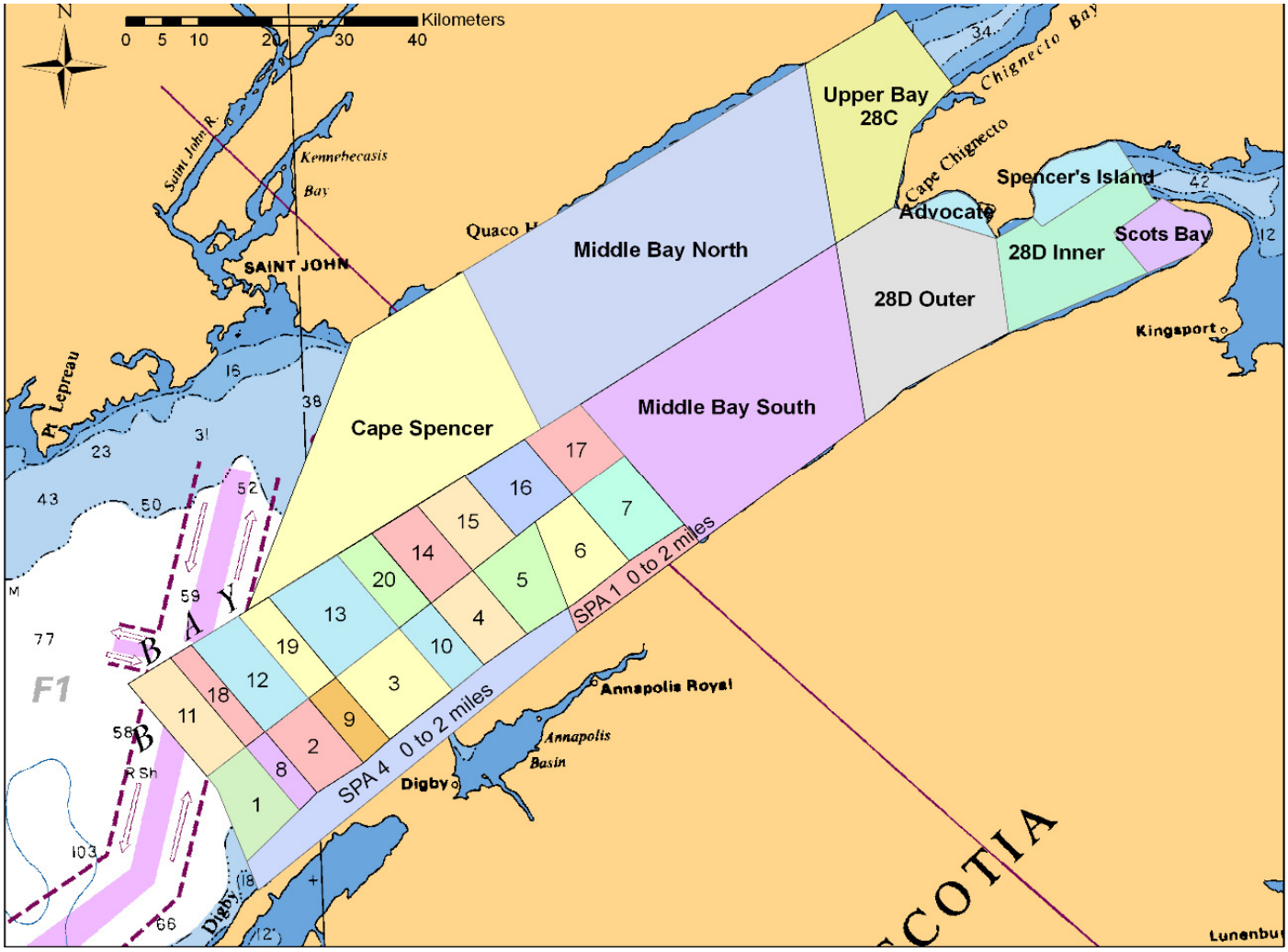


Figure 2: Inshore scallop survey strata for SPA 1A, 1B, and 4.

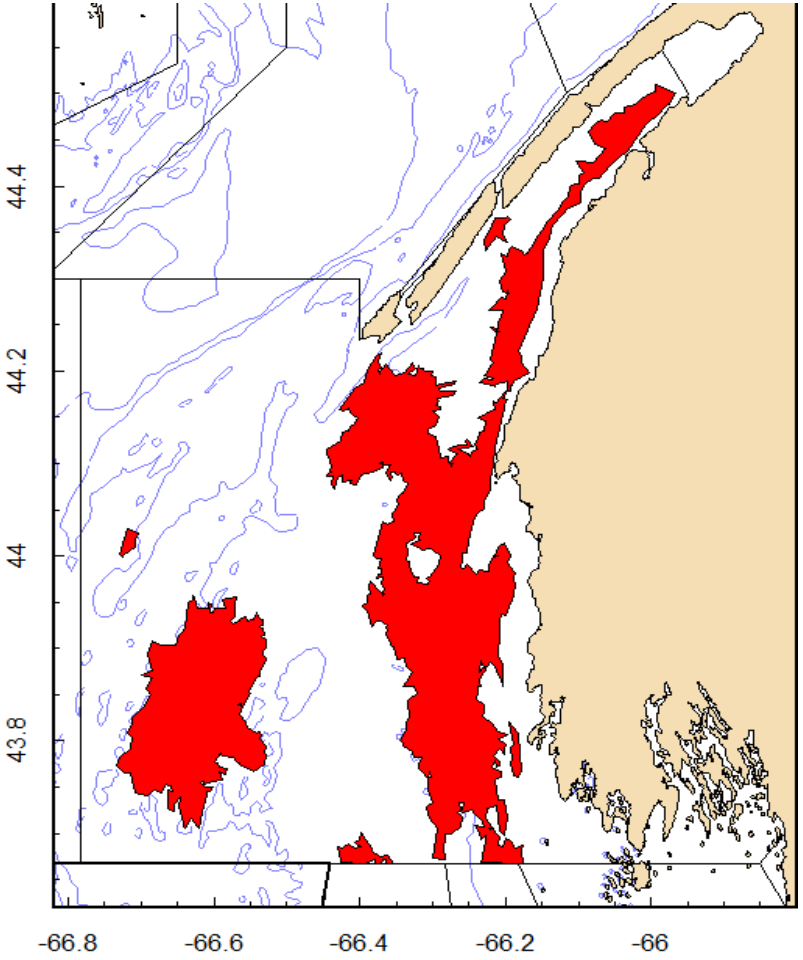


Figure 3: SPA 3 consisting of Brier, Lurcher and St. Marys Bay strata. The inside VMS polygon for SPA 3 is shown in red.

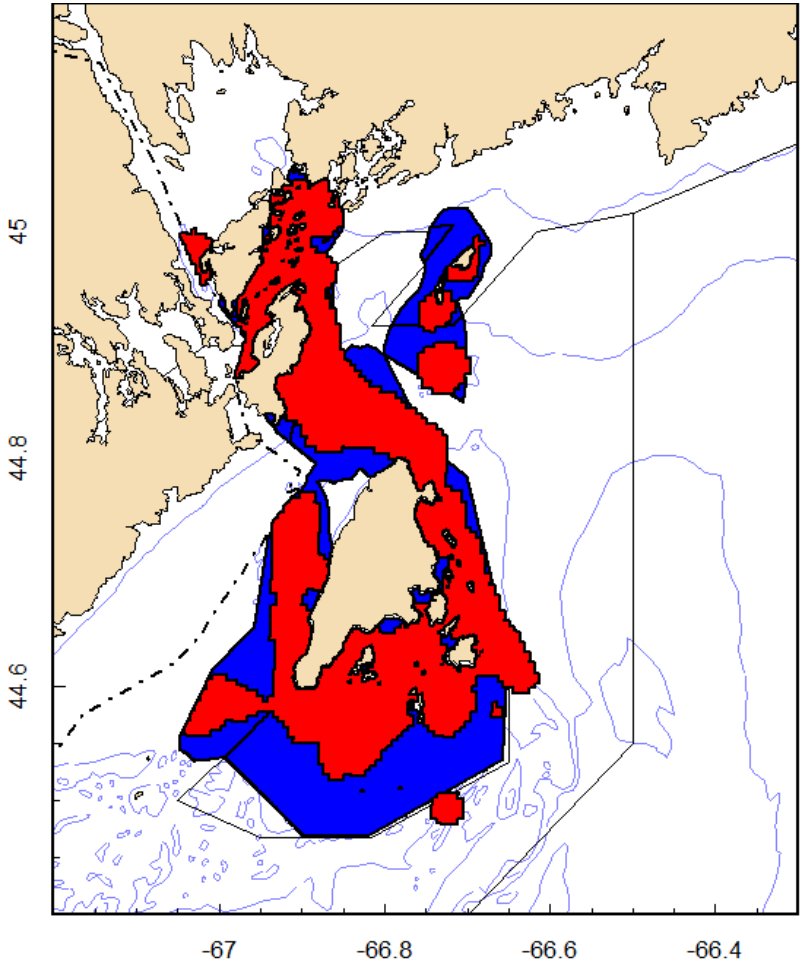


Figure 4: Survey polygon boundaries for SPA 6. Red indicated the VMS area, Blue indicates outside VMS area.

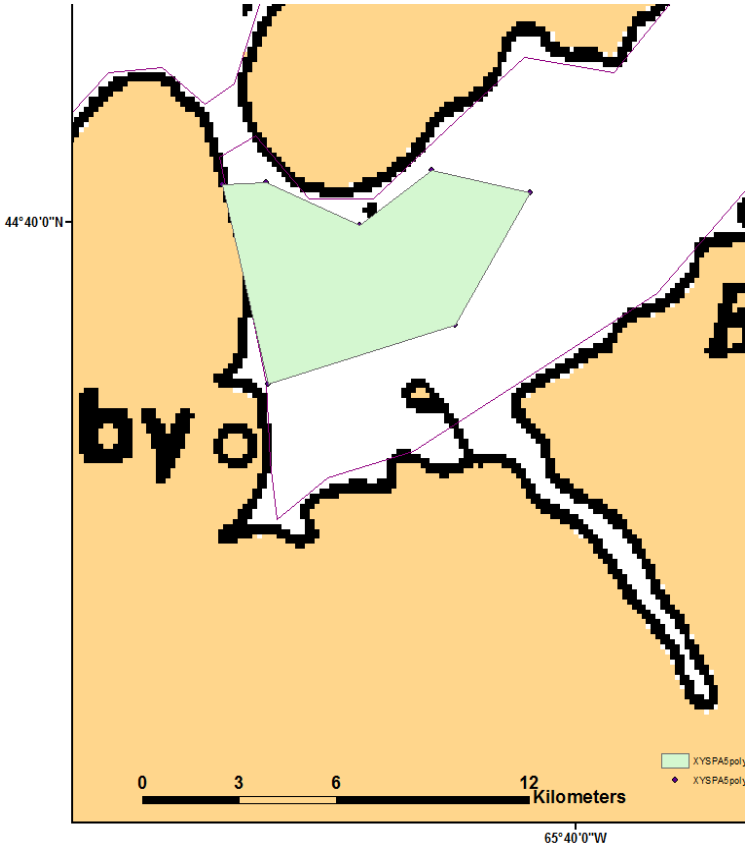


Figure 5: Survey polygon for SPA 5 within survey strata 21, Annapolis Basin.

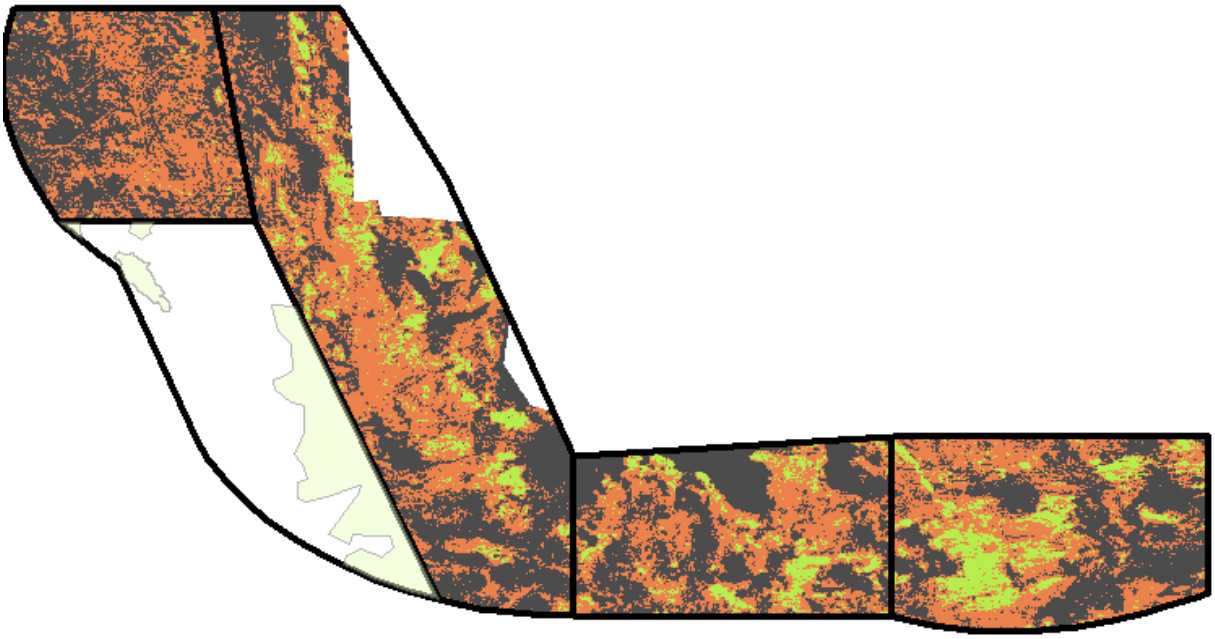


Figure 6: Survey strata for SFA 29W using the habitat suitability maps. Brown is low, orange is medium and yellow is high suitability. The survey polygon for SFA 29W subarea E is also shown.

Figure 7: 9 gang toothed miracle gear used to conduct the inshore scallop assessment survey. Drags 3 and 7 are lined with 38 mm mesh.

Figure 8: Individual inshore scallop drag showing the details of the survey specifications for the drag, teeth, ring bag and chaffers.

Figure 9: Individual inshore scallop drag showing the teeth on the drag and ring bag attachment to the drag.

Figure 10: Individual unlined inshore scallop drags used in the survey.

Figure 11: Individual lined inshore scallop drag used in the survey, showing liner installation in the drag

Figure 12: Inshore scallop survey gear, showing the dividers on the dump table to separate the catch from each individual drag.

Figure 13: Tail pole for the individual inshore scallop drag.

Figure 14: Pipe welded to the dump pole to house the Vemco Minilog II temperature recorder.

Figure 15: Scallop measuring board used to tally the total number of scallops at size in each tow.

Figure 16: Portion of the scallop measuring board showing a scallop that is between 115-120 mm in height.

APPENDICES

Appendix 1: Fisheries Research Notice (Example)

Fisheries and Oceans Canada / Pêches et Océans Canada — Canada

Maritimes Region | Région des Maritimes

Fisheries Research Notice

Number: M-16 - 04

Title: *Inshore Scallop Assessment Survey Areas SPA 1, 3, 4, 5, 6*

Duration (starting and ending dates): May 24, 2016 *(start)* — September 30, 2016 *(end)*

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

Vessel Name: FV Brittany & Madison IV

Officer In Charge (OIC): Amy Glass

Name of License Holder (if different from above): Captain Carmen Burnie

Scientific Staff: Amy Glass, Michele Covey, Ben Zisserson, Jeremy Broome, Leslie Nasmith, David Keith,Tricia Pearo-Drew

Fishing Gear used (size and mesh - describe): 9 gang Miracle gear with 90 mm inside diameter rings knitted together with rubber washers; Drag #1 is lined with 38 mm polypropylene stretch mesh

Expected Catch: Sea Scallops (Species) — 500 lbs (Amounts)

Will Fish be Retained? ☒ YES ☐ NO

If YES, how will the fish be disposed of after the project is complete? Approx. 500 lbs of scallops will be retained for biological analysis, all others will be returned to the sea

Area of Work: SPA 1, 3, 4, 5, and 6 (Bay of Fundy and Approaches)

Objectives:

To determine the distribution and relative abundance of the sea scallop Placopecten magellanicus in SPA 1, 3, 4, 5, 6.
To collect scallop shells for aging analysis.
To weigh scallop meats for yield analysis.
To record/measure bycatch of lobster, octopus, squid, and commercial groundfish species.

Responsible Officer: Amy Glass **Date :** April 18, 2016

Approval / Approbation: **Date:** APR 19 2016

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

August 2015

Appendix 2: R Scripts to generate stations according to survey design

```
#### SCRIPT TO GENERATE STATIONS FOR INSHORE SURVEY SPA 1 and 4
#run this so that it will plot the stations properly
#.First<-function(){
options(stringsAsFactors=F)
# }
# Import inshore survey data from oracle
### Manual RODBC connection
### GETS INSHORE DATA FROM ORACLE DATABASE
### currently standardized live shell height frequency

require(RODBC)


channel<-odbcConnect("bank", "username", "password")
     qu.hf <- "select * from SCALLSUR.SCLIVERES left join SCALLSUR.SCTOWS
on SCALLSUR.SCLIVERES.CRUISE = SCALLSUR.SCTOWS.CRUISE and
SCALLSUR.SCLIVERES.TOW_NO = SCALLSUR.SCTOWS.TOW_NO"
     surv.dat <- sqlQuery(channel, qu.hf)

     qu.strata <- "select * from SCALLSUR.SCSTRATAINFO"
     str.polys <- sqlQuery(channel, qu.strata)


     odbcCloseAll()
     rm(qu.hf)
     rm(qu.strata)

#####Convert tow location from DDM to DD#####

source("Y:/INSHORE SCALLOP/Survey/2010/r/fn/convert.dd.dddd.r")
surv.dat$lat<-convert.dd.dddd(surv.dat$START_LAT)
surv.dat$lon<-convert.dd.dddd(surv.dat$START_LONG)
surv.dat$year<-as.numeric(format(surv.dat$TOW_DATE, "%Y"))

###Shows structure of survey data and unique management areas in the survey
dataset###
str(surv.dat)
unique(surv.dat$MGT_AREA_ID)

####### Bay of Fundy  SPA 1 and 4

surv2014.dat<-subset(surv.dat,year==2014&MGT_AREA_ID%in%c("4","1"))

BOFtows14<-
subset(surv2014.dat,year==2014,c("TOW_NO","lon","lat","STRATA_ID"))


newAreaPolys<-read.csv("Y:/Maps/data/NewAreaDefsforISAREADEFS.csv")
```

```
source("Y:/INSHORE SCALLOP/Survey/2010/r/fn/ScallopMap.r")
ScallopMap('bof')

names(str.polys)<-c("PID","POS","X","Y","PName","Area")
str.polys<-str.polys[order(str.polys$PID),]
str.data<-subset(str.polys,POS==1,c("PID","PName","Area"))
str.polys<-subset(str.polys,!(PID%in%c(37,38,47,48,53)&POS==1))

BOFstr.data<-subset(str.data,PID%in%c(1:20,35:39,47:53))


ScallopMap('bof',plot.lines=F,poly.lst=list(str.polys,BOFstr.data))

surv2014.dat$tot<-rowSums(surv2014.dat[,27:50])       # this is 80mm and
above


#the next line is to remove strata 12 and 18 from the ramdom generated
stations proportion to variance in area 1
#because a portion of the area has  variance that is always high  so a
large portion
#of unnecessary tow get allocated to this area and then have to be removed.
SPA1str.data<-subset(BOFstr.data,PID%in%c(13:17,19:20))
S_h<-
with(subset(surv2014.dat,STRATA_ID%in%SPA1str.data$PID&year==2014),tapply(t
ot,STRATA_ID,sd))
N.SPA1<-58
#N.SPA1<-61 #    reduced number of tows in 2015 to allocate more to SPA6
alc1<-round(N.SPA1*((SPA1str.data$Area*S_h)/sum(SPA1str.data$Area*S_h)))
alc1[which(alc1==min(alc1))]<-alc1[which(alc1==min(alc1))]+N.SPA1-sum(alc1)
SPA1str.data$allocation<-alc1
SPA1str.data$repeats<-NA

 #In area 4 the variance from last years data is used to allocate stations
this year
SPA4str.data<-subset(BOFstr.data,PID%in%c(1:5,8:10))
S_h<-
with(subset(surv2014.dat,STRATA_ID%in%SPA4str.data$PID&year==2014),tapply(t
ot,STRATA_ID,sd))
N.SPA4<-79
alc4<-round(N.SPA4*((SPA4str.data$Area*S_h)/sum(SPA4str.data$Area*S_h)))
alc4[which(alc4==min(alc4))]<-alc4[which(alc4==min(alc4))]+N.SPA4-sum(alc4)
SPA4str.data$allocation<-alc4
SPA4str.data$repeats<-NA

#you must call in the allocation file, it provides the set allocation for
all of the other strata
BFalloc<-read.csv("Y:/INSHORE SCALLOP/Survey/2015/amyBOFalloc2015.csv")
BFstr.data<-subset(BOFstr.data,PID%in%c(6:7,35:39,49,51:53,12,18))
BFstr.data<-merge(BFstr.data,BFalloc,all=T)

BOFstr.data<-rbind(SPA4str.data,SPA1str.data,BFstr.data)
```

```
HSI.poly<-read.csv("Y:/INSHORE
SCALLOP/Survey/2010/r/BOFsurveyBoundingPoly.csv")

rep14.dat<-
subset(surv2014.dat,STRATA_ID%in%BFstr.data$PID[!is.na(BFstr.data$repeats)]
&year==2014,c("TOW_NO","lon","lat","STRATA_ID"))
BOFstr.data$PName<-as.character(BOFstr.data$PName)
source("Y:/INSHORE SCALLOP/Survey/2010/r/amyalloc.poly.r")
BFtows15<-
alloc.poly(list(str.polys,BOFstr.data),bounding.poly=HSI.poly,repeated.tows
=rep14.dat)


ScallopMap(ylim=c(44.5,45.6),xlim=c(-66.4,-
64.3),plot.lines=F,poly.lst=list(str.polys,BOFstr.data[,-4]))
points(Y~X,BFtows15$Tows$new.tows,cex=0.8,pch=21,bg='red')
points(Y~X,BFtows15$Tows$repeated.tows,cex=0.8,pch=24,bg='green')
legend('bottomright',c('new','repeated'),pch=c(21,24),pt.bg=c('red','green'
),inset=0.1,bty='n')

write.csv(BFtows15$Tows$new.tows,"Y:/Amy/2016 Survey
Prep/BF16newtows.csv",row.names=F)
write.csv(BFtows15$Tows$repeated.tows,"Y:/Amy/2016 Survey
Prep/BF16repeatedtows.csv",row.names=F)
```

```
#### SCRIPT TO GENERATE STATIONS FOR INSHORE SCALLOP SURVEY SPA 3 ####
#run this so that it will plot the stations properly
.First<-function(){
options(stringsAsFactors=F)
 }

require(RODBC)

channel<-odbcConnect("ptran", "username", "password")

      qu.hf <- "select * from SCALLSUR.SCLIVERES left join SCALLSUR.SCTOWS
on SCALLSUR.SCLIVERES.CRUISE = SCALLSUR.SCTOWS.CRUISE and
SCALLSUR.SCLIVERES.TOW_NO = SCALLSUR.SCTOWS.TOW_NO"
      surv.dat <- sqlQuery(channel, qu.hf)

      qu.strata <- "select * from SCALLSUR.SCSTRATAINFO"
      str.polys <- sqlQuery(channel, qu.strata)

      odbcCloseAll()
      rm(qu.hf)
      rm(qu.strata)

#####Convert tow location from DDM to DD#####

source("Y:/INSHORE SCALLOP/Survey/2010/r/fn/convert.dd.dddd.r")
surv.dat$lat<-convert.dd.dddd(surv.dat$START_LAT)
surv.dat$lon<-convert.dd.dddd(surv.dat$START_LONG)
surv.dat$year<-as.numeric(format(surv.dat$TOW_DATE, "%Y"))

###Shows structure of survey data and unique management areas in the survey
dataset###
str(surv.dat)
unique(surv.dat$MGT_AREA_ID)

###### SPA 3 #####
#select just the data from strata 3 and 7
SPA3surv.dat<-subset(surv.dat,MGT_AREA_ID%in%c("3","7"))

#to pull out just previous year's tows, so that repeats can be selected
SPA3tows14<-
subset(SPA3surv.dat,year==2014,c("TOW_NO","lon","lat","STRATA_ID"))


source("Y:/INSHORE SCALLOP/Survey/2010/r/fn/ScallopMap.r")
ScallopMap('spa3')
#plot last year's tows
points(lat~lon,SPA3tows14,col='blue')


Oldsurv.poly<-read.csv("Y:/INSHORE
SCALLOP/Survey/2010/r/SPA3surveyPoly.csv") #outer bounds of SPA3
VMS.poly<-read.csv("Y:/INSHORE SCALLOP/Survey/2011/SPA3/SPA3_VMSpoly.csv")
```

```
SMB.poly<-read.csv("Y:/INSHORE SCALLOP/Survey/2011/SPA3/SMBpoly.csv")

outerPoly<-joinPolys(Oldsurv.poly,VMS.poly,operation="DIFF")
outerPoly$PID=2

surv.poly <-rbind( VMS.poly,  outerPoly)

surv.poly <- as.PolySet(surv.poly, projection="LL")

attr(Oldsurv.poly,'projection')<-"LL"
attr(SMB.poly,'projection')<-"LL"
attr(VMS.poly,'projection')<-"LL"


addPolys(VMS.poly)
addPolys(SMB.poly)
addPolys (Oldsurv.poly)
addPolys(VMS.poly,polyProps=data.frame(PID=1:2,col=4:5))


#this line is to set the random allocation for the two survey polygons and
set the number of repeats in each
 poly.info <-
data.frame(PID=1:2,PName=c("VMS","outer"),allocation=c(56,45),repeats=c(19,
15))

names(SPA3tows14)<-c("EID","X","Y","Poly.ID")

ref<-findPolys(SPA3tows14,surv.poly)
SPA3tows14$Poly.ID[SPA3tows14$EID%in%ref$EID[ref$PID==1]]<-1
SPA3tows14$Poly.ID[SPA3tows14$EID%in%ref$EID[ref$PID==2]]<-2

addPolys(VMS.poly,border='red',lwd=2)

#use this one to get red border for the survey area
addPolys(surv.poly,border='red',lwd=2)

# ALLOCATION by SIMPLE RANDOM SAMPLING
# option of repeated design

# ARGUMENTS
# ntows = number of stations
# bounding.poly = area to be surveyed in PBSmapping format i.e.
names=c("PID","POS","X","Y")
# area.plot = to plot or not to plot, options include 'sfa29', 'bof',
'upper', 'mid', 'outer' & 'spa6'
# repeated.tows = last year's tows in PBS mapping format i.e.
names=c("EID","X","Y") to select repeated tows from
# p.rep = proportion of ntows that should be repeated from last year
# mindist = minimum distance between stations in kms, default is 1

#install splancs and spatstat packages in R before running these next lines
source("Y:/INSHORE SCALLOP/Survey/2010/r/amyalloc.poly.r")
```

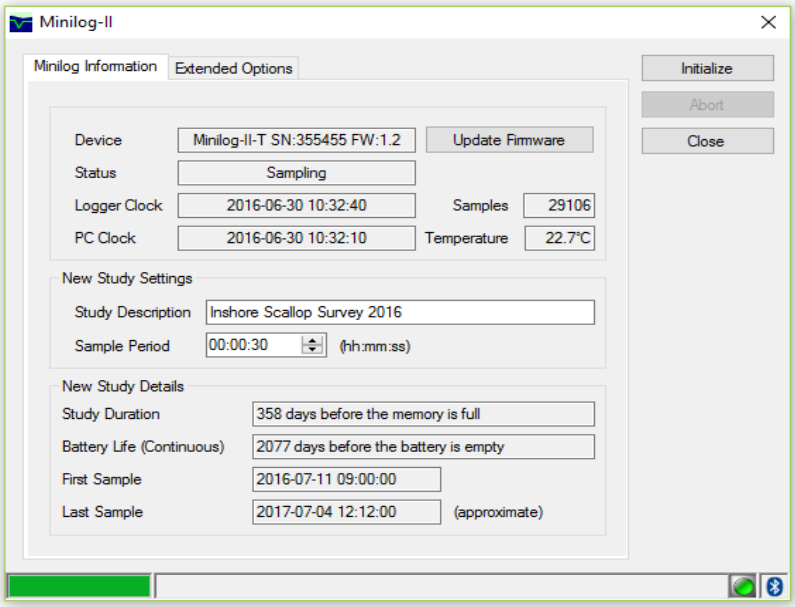
```
SPA3tows15<-alloc.poly(list(surv.poly,poly.info),ntows
=135,mindist=1,repeated.tows=SPA3tows14)
ScallopMap('spa3',poly.lst=list(surv.poly,poly.info))
addPoints(SPA3tows15[[1]][[1]])
addPoints(SPA3tows15[[1]][[2]],pch=3)
SPA3tows15.dat<-do.call("rbind",SPA3tows15[[1]])


write.csv(SPA3tows15.dat,"Y:/Amy/2015 Survey Prep/SPA3tows15vmsdesign.csv")
```

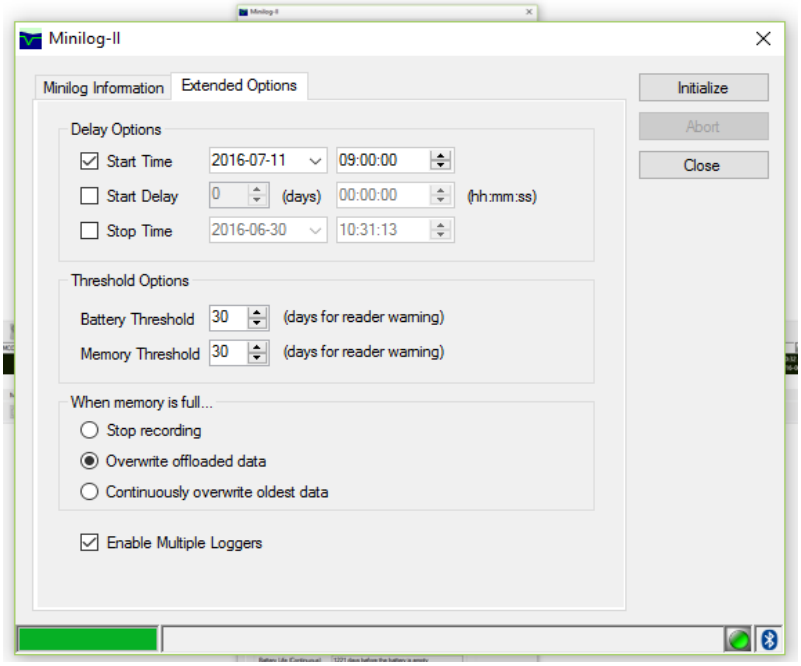
```
#### SCRIPT TO GENERATE STATIONS FOR INSHORE sCALLOP SURVEY SPA 6 ####
## new vms polygon and outside polygon for survey design##
#run this so that it will plot the stations properly
.First<-function(){
options(stringsAsFactors=F)
 }

require(RODBC)

channel<-odbcConnect("ptran", "username", "password")

      qu.hf <- "select * from SCALLSUR.SCLIVERES left join SCALLSUR.SCTOWS
on SCALLSUR.SCLIVERES.CRUISE = SCALLSUR.SCTOWS.CRUISE and
SCALLSUR.SCLIVERES.TOW_NO = SCALLSUR.SCTOWS.TOW_NO"
      surv.dat <- sqlQuery(channel, qu.hf)

      qu.strata <- "select * from SCALLSUR.SCSTRATAINFO"
      str.polys <- sqlQuery(channel, qu.strata)


      odbcCloseAll()
      rm(qu.hf)
      rm(qu.strata)

#####Convert tow location from DDM to DD#####

source("Y:/INSHORE SCALLOP/Survey/2010/r/fn/convert.dd.dddd.r")
surv.dat$lat<-convert.dd.dddd(surv.dat$START_LAT)
surv.dat$lon<-convert.dd.dddd(surv.dat$START_LONG)
surv.dat$year<-as.numeric(format(surv.dat$TOW_DATE, "%Y"))

###Shows structure of survey data and unique management areas in the survey
dataset###
str(surv.dat)
unique(surv.dat$MGT_AREA_ID)

###### SPA 6 #####
#select just area 6 data
SPA6surv.dat<-subset(surv.dat,MGT_AREA_ID%in%c("6C","6B","6A"))
#select just last years data
SPA6tows14<-
subset(SPA6surv.dat,year==2014,c("TOW_NO","lon","lat","STRATA_ID"))


#this will plot last year's survey tows
source("Y:/INSHORE SCALLOP/Survey/2010/r/fn/ScallopMap.r")
ScallopMap('gm')
points(lat~lon,SPA6tows15,col='blue')

names(SPA6tows14)<-c("EID","X","Y","Poly.ID")

## read in survey polygons
```

```
VMS.poly<-read.csv("Y:/INSHORE
SCALLOP/BoF/2015/SPA6/Survey/SPA6_VMS_IN_R_final_MOD.csv")

OUT.poly<-read.csv("Y:/INSHORE
SCALLOP/BoF/2015/SPA6/Survey/SPA6_VMS_OUT_R_final_MOD.csv")

#outerPoly<-joinPolys(OUT.poly,VMS.poly,operation="DIFF")
#outerPoly$PID=2

surv.poly <-rbind(VMS.poly,OUT.poly)

surv.poly <- as.PolySet(surv.poly, projection="LL")


attr(OUT.poly,'projection')<-"LL"
attr(VMS.poly,'projection')<-"LL"


addPolys(VMS.poly)
addPolys(VMS.poly,col='red',lwd=2)
addPolys(OUT.poly)
addPolys(OUT.poly,col='blue',lwd=2)
##addPolys(VMS.poly,polyProps=data.frame(PID=1:2,col=4:5))


#this line is to set the random allocation for the two survey polygons and
set the number of repeats in each
 poly.info <-
data.frame(PID=1:2,PName=c("VMS","OUT"),allocation=c(56,33),repeats=c(19,12
))

names(SPA6tows14)<-c("EID","X","Y","Poly.ID")

ref<-findPolys(SPA6tows14,surv.poly)
SPA6tows14$Poly.ID[SPA6tows15$EID%in%ref$EID[ref$PID==1]]<-1
SPA6tows14$Poly.ID[SPA6tows15$EID%in%ref$EID[ref$PID==2]]<-2

addPolys(VMS.poly,border='red',lwd=2)
addPolys(OUT.poly,border='blue',lwd=2)
#use this one to get red border for the survey area
##addPolys(surv.poly,border='red',lwd=2)

# ALLOCATION by SIMPLE RANDOM SAMPLING
# option of repeated design

# ARGUMENTS
# ntows = number of stations
# bounding.poly = area to be surveyed in PBSmapping format i.e.
names=c("PID","POS","X","Y")
# area.plot = to plot or not to plot, options include 'sfa29', 'bof',
'upper', 'mid', 'outer' & 'spa6'
# repeated.tows = last year's tows in PBS mapping format i.e.
names=c("EID","X","Y") to select repeated tows from
```

```
# p.rep = proportion of ntows that should be repeated from last year
# mindist = minimum distance between stations in kms, default is 1

#install splancs and spatstat packages in R before running these next lines
source("Y:/INSHORE SCALLOP/Survey/2010/r/amyalloc.poly.r")

SPA6tows15<-
alloc.poly(list(surv.poly,poly.info),ntows=120,mindist=1.5,repeated.tows=SP
A6tows14)
ScallopMap('gm',poly.lst=list(surv.poly,poly.info))
addPoints(SPA6tows15[[1]][[1]])
addPoints(SPA6tows15[[1]][[2]],pch=3)
SPA6tows15.dat<-do.call("rbind",SPA6tows15[[1]])



write.csv(SPA6tows15.dat,"Y:/Amy/2016 Survey Prep/SPA6tows15vmsdesign.csv")
```

Appendix 3: Vemco Inialization in LoggerVue software





Appendix 4: Wheelhouse log and deck data sheets

WHEELHOUSE LOG BOOK

DATE: _____

TOW _____ STN_____ DEPTH (Z)_____DIRECTION _____

START LAT._____ START TIME_____ TIDE CYCLE _____

START LONG._____ DISTANCE _____

END LAT._____ END TIME_____

END LONG._____

CATCH: _____ STRATA_____

BOTTOM TYPE_____ WARP LENGTH_____

NOTES_____ TOW TYPE_____

Appendix 5: Deck Data Sheet

DATE			TOW			BOTTOM TYPE					CATCH		
	LINED		UNLINED		Lobster Carapace	Sex	Shell #	Shell Ht	Meat Wt		Shell #	Shell Ht	Meat Wt
	A	D	A	D			1				37		
0-5							2				38		
5.-10							3				39		
10.-15							4				40		
15-20							5				41		
20-25							6				42		
25-30							7				43		
30-35							8				44		
35-40							9				45		
40-45							10				46		
45-50							11				47		
50-55							12				48		
55-60							13				49		
60-65							14				50		
65-70							15				51		
70-75					Octopus	Sex	16				52		
75-80							17				53		
80-85							18				54		
85-90							19				55		
90-95							20				56		
95-100							21				57		
100-105					Fish	Length	22				58		
105-110							23				59		
110-115							24				60		
115-120							25				61		
120-125							26				62		
125-130							27				63		
130-135							28				64		
135-140							29				65		
140-145							30				66		
145-150							31				67		
150-155							32				68		
155-160							33				69		
160-165							34				70		
165-170							35				71		
170-175							36				72		