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An assessment of the Sea Cucumber (*Cucumaria frondosa*) resource on the St. Pierre Bank (NAFO Subdivision 3Ps) in 2016

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

The Sea Cucumber (*Cucumaria frondosa*) has been reported almost circumpolar in the northern hemisphere. Populations off Newfoundland and Labrador (NL) are normally found in waters down to 100 m, usually on hard bottom with a cobble-shell-boulder substrate composition.

In 2003, a Sea Cucumber drag fishery, under the umbrella of the New Emerging Fisheries Policy, was established on the St. Pierre Bank with eight participants sharing a total allocation of 454 t. As part of the emerging fishery, the same eight harvesters entered into a five year Joint Project Agreement (JPA) with Fisheries and Oceans Canada (DFO) to conduct a resource assessment survey and subsequent exploratory fishery which took place from 2004 to 2008. The Sea Cucumber emerging fishery formally transitioned to a commercial fishery in 2012. The allocation gradually increased to 2,242 t in 2013, where it has remained.

There are two Sea Cucumber fishing areas on the Canadian portion of the St. Pierre Bank, one northwest and one southeast of the French Economic Zone. The fishery has focused primarily on the northwest portion of the St. Pierre Bank, and in 2010, the southeast area was closed to fishing as a conservation measure to preserve the resource in this area until the effects of fishing on the northwest area could be evaluated.

A DFO Sea Cucumber survey on the St. Pierre Bank was carried out in September 2016, which covered the entire southeast area and 23% of the northwest area. Based on this research survey a Peer Review Process for the assessment of Sea Cucumber in the Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps took place in February 2017.

Sea Cucumber landings averaged approximately 1,200 t since 2010, the exception being 2015 with landings of 2,297 t. The catch per unit effort (CPUE) increased at the beginning of the fishery (2003) to 2008 and has since remained stable with a mean CPUE of 597 kg/tow. The biomass indices based on the emerging Sea Cucumber fishery surveys from 2004 to 2008 (excluding 2005) averaged 89 kt in the northwest area and 210 kt in the southeast area. The 2005 estimate was not considered reliable due to gear configuration issues. In 2016, the Sea Cucumber biomass index was 187 kt in the southeast area, and the survey in the northwest area was incomplete. The Sea Cucumber abundance index in 2016 in the southeast area was above the 2004-08 average. Sea Cucumber length, weight, and girth measurements from the 2016 survey indicate that Sea Cucumber in the northwest area are heavier and larger than in the southeast area. Sustainable exploitation rates and mortality are unknown and, given the uncertainties regarding this species on the St. Pierre Bank, provide no scientific basis for assessing the risk of any increase in harvest level.

Une évaluation de l'holothurie (*Cucumaria frondosa*) sur le banc de Saint-Pierre (sous-division 3Ps de l'OPANO) en 2016

RÉSUMÉ

L'aire de distribution de l'holothurie (Cucumaria frondosa) dans l'hémisphère Nord a été déclarée quasi circumpolaire. On trouve habituellement les populations au large de Terre-Neuve-et-Labrador à une profondeur pouvant atteindre 100 mètres, généralement sur le fond marin dur dont le substrat est composé de galets, de coquillages et de rochers.

En 2003, une pêche à la drague de l'holothurie a été menée sur le banc de Saint-Pierre, dans le cadre de la Politique sur les nouvelles pêches, au terme de laquelle huit participants se sont partagé une allocation totale de 454 tonnes. Les huit mêmes pêcheurs de cette nouvelle pêche ont conclu un accord de projet conjoint quinquennal avec Pêches et Océans Canada en vue de mener un relevé d'évaluation de la ressource et une pêche exploratoire subséquente; celle-ci a eu lieu de 2004 à 2008. En 2012, la nouvelle pêche de l'holothurie est officiellement devenue une pêche commerciale. L'allocation a graduellement augmenté à 2 242 tonnes, en 2013, et est demeurée telle quelle depuis.

On recense deux principales zones de pêche de l'holothurie dans la partie canadienne du banc de Saint-Pierre : l'une se trouve au nord-ouest de la zone économique exclusive française, tandis que l'autre se trouve au sud-est. La majorité des activités de pêche ont eu lieu dans la zone nord-ouest du banc de Saint Pierre, et en 2010, la zone sud-est a été fermée à la pêche en tant que mesure de conservation pour préserver les ressources dans cette zone jusqu'à ce que l'on puisse évaluer les effets de la pêche dans la zone nord-ouest.

En septembre 2016, Pêches et Océans Canada a mené un relevé de l'holothurie sur le banc de Saint-Pierre, et celui-ci couvrait la totalité de la zone sud-est et 23 % de la zone nord-ouest. En février 2017, en fonction de ce relevé de recherche, un examen par les pairs a été effectué pour l'évaluation de l'holothurie dans la sous-division 3Ps de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO).

Depuis 2010, la moyenne des débarquements d'holothuries s'élève à environ 1 200 tonnes par année, à l'exception de 2015, alors que 2 297 tonnes ont été débarquées. Les captures par unité d'effort (CPUE) ont augmenté entre le début de la pêche (2003) et 2008, et sont demeurées stables depuis, avec une moyenne de 597 kg/trait. En fonction des relevés de la nouvelle pêche de l'holothurie menés entre 2004 et 2008 (sauf 2005), les indices de biomasse atteignaient en moyenne 89 kt dans la zone nord-ouest et 210 kt dans la zone sud-est. L'estimation de 2005 n'était pas considérée comme fiable en raison de problèmes associés à la configuration des engins. En 2016, l'indice de biomasse de l'holothurie était de 187 kt dans la zone sud-est; les données pour la zone nord-ouest étaient cependant incomplètes. L'indice de l'abondance de l'holothurie dans la zone sud-est en 2016 était supérieur à la moyenne de 2004 à 2008. Les mesures de longueur, de poids et de circonférence de l'holothurie tirées du relevé de 2016 indiquent que les individus de la zone nord-ouest sont plus gros et plus lourds que ceux de la zone sud-est. Puisque les taux de mortalité et d'exploitation durable de l'espèce sont inconnus et qu'il existe de nombreuses incertitudes concernant cette espèce sur le banc de Saint-Pierre, il n'est pas possible d'évaluer scientifiquement le risque que poserait une augmentation du niveau de récolte.

INTRODUCTION

This document serves to assess the status of the Sea Cucumber (*Cucumaria frondosa*) resource on the St. Pierre Bank in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps. The information presented follows from a formal scientific assessment and regional peer review process conducted in February, 2017. The assessment focused on identifying the status of the stock to allow management to make informed decisions, and providing data that will be used to assist in the development of an Integrated Fisheries Management Plan (IFMP).

SPECIES BIOLOGY

Cucumaria frondosa, or the Orange Footed Sea Cucumber, is an echinoderm found in the North Atlantic and Arctic oceans. It is commonly distributed down to 100 m in Newfoundland and Labrador (NL) waters and prefers rocky bottoms or mixed substrates of gravels, stone, sand, and shells. It has five rows of tube feet which allow it to move and attach to substrates. Sea Cucumber feed on phytoplankton and zooplankton by spreading out their ten tentacles, which capture plankton suspended in the water column or organic matter on nearby substrate. The tentacles are covered with sticky mucus, which aids in food capture. Each tentacle is retracted individually into the Sea Cucumber's mouth, where the plankton is consumed (Singh et al. 1999). Adult Sea Cucumber are believed to exhibit low rates of movement (DFO 2009b). Sea Cucumber gather in aggregations known as "beds", which allows a certain level of reproductive success, as this species achieves external fertilization.

There is limited information on the life history of Sea Cucumber specific to the St. Pierre Bank. The majority of literature reported on this species in Eastern Canada was obtained from studies in the St. Lawrence Estuary and Gulf of St. Lawrence, as well as from tank experiments using Sea Cucumber collected from NL waters (Coady 1973, Hamel and Mercier 1995, Hamel and Mercier 1996a, Hamel and Mercier 1996b, Hamel and Mercier 1996c, Hamel and Mercier 1998, Singh et al. 1999, Singh et al. 2001). Sea Cucumber studies conducted on the St. Pierre Bank (Grant et al. 2006, So 2009), indicate spawning occurs from late March to early May. This is similar to the Bay of Fundy (April-May) and Maine (March-April), but is earlier than in the St. Lawrence Estuary (mid-June) (Hamel and Mercier 1996). It appears that the Sea Cucumber population on the St. Pierre Bank is comprised of several subpopulations that spawn at different times which results in a protracted spawning season (Grant et al. 2006). Post-spawning, energy reserves begin to accumulate in the body wall tissues (David and MacDonald 2002). The Sea Cucumber has separate sexes and is sexually dimorphic with a conspicuous, tube-shaped (female) or heart-shaped (male) gonopore located under the crown of oral tentacles (Hamel and Mercier 1996a). After massive spawning events, fertilized eggs occur in high densities in the water column, undergo pelagic lecithotrophic development, and settle out of the water column after approximately four to seven weeks. Size at sexual maturity for Sea Cucumber on the St. Pierre Bank is ~9-11 cm contracted length (Grant et al. 2006). Growth rates of juveniles and adults are slow with seasonal patterns correlated with food supply (So 2009). Laboratory and field observations indicate that feeding rate is related to food abundance as detected by the oral tentacles, which contain chemosensory and mechanosensory cells.

The key predators of Sea Cucumber include fishes, sea stars, and crustaceans, with sea stars being the dominant predators in North Atlantic waters. *Solaster endeca*, the Purple Sunstar, is the main predator of Sea Cucumber at all life stages. Injured Sea Cucumber can attract, and are more vulnerable to, scavengers and predators (So 2009).

FISHERY

A fishery for Sea Cucumber developed in eastern North America in the 1990s. In the early 2000s various dive and towed gear surveys were undertaken in Newfoundland and Labrador waters to determine potential fishing grounds, biomass levels, and appropriate fishing gear (Department of Fisheries and Aquaculture [DFA] 2002a; DFA 2002b). The landed value, habitat, and distribution of the resource deemed it uneconomical to harvest Sea Cucumber by dive harvest. A study comparing the bycatch from the modified sea urchin drag and commercial scallop gear found the modified sea urchin drag to be effective at minimizing bycatch of scallops, sea urchins, various species of crab, as well as quantities of rocks (DFA 2002a). In 2002, the modified sea urchin drag from Maine was adopted as the standardized fishing gear to be used in the Sea Cucumber fishery in NL.

In 2003, eight harvesters were given an allocation of 454 t to investigate potential commercial concentrations of Sea Cucumber on the St. Pierre Bank. This exploratory fishery occurred on a predetermined grid (Figure 1) of 52 strata created from historical Fisheries and Oceans Canada (DFO) and NL DFA surveys. During this exploratory fishery, commercial concentrations of Sea Cucumber were found and the 454 t allocation was easily caught. The majority of landings came from two of the strata (2 and 7). In 2004, a Sea Cucumber drag fishery, under the umbrella of DFO's New Emerging Fisheries Policy, was established on the St. Pierre Bank. The same eight harvesters entered into a five year Joint Project Agreement (JPA) with DFO, DFA, the Fish, Food and Allied Workers Union (FFAW), and the Fogo Island Co-operative Society Ltd., to conduct a resource assessment survey. As a condition of license, these harvesters were required to actively participate in the fishery for five years and submit detailed fishing logbooks. In an attempt to distribute effort and reduce localized depletion, license conditions required that no more than 25% of landings could come from the two most heavily fished strata identified in the 2003 exploratory fishery. In 2006, the license conditions were revised to state that no more than 30% of landings could come from any one strata. These conditions remained in place for the 2007 and 2008 fisheries.

There are two main Sea Cucumber fishing areas on the Canadian portion of the St. Pierre Bank, one northwest and one southeast of the French Economic Zone (Figure 1). The commercial fishery normally takes place between June and December following spawning and has focused primarily within the northern portion of the northwest area of the resource distribution. In 2010, as a result of consultation between DFO Science, DFO Management, and Industry, the southeast area was closed until the effects of exploitation in the northwest area could be evaluated.

The resource allocation on the St. Pierre Bank increased from 454 t in 2003 to 612 t in 2005, in an effort to compensate fishers for the fraction of landed weight consisting of water, debris, and volume of damaged or undersized Sea Cucumber. This volume was estimated at an average of 30% by the Dockside Monitoring Program (DMP). Gross landings (including water and debris) are the weights recorded against allocation. The allocation increased to 907 t in 2010 following an assessment upon completion of the emerging fishery and in 2013, due to the formal transition to a commercial fishery and the addition of ten new licenses, the allocation increased to 2,242 t.

METHODOLOGY

EMERGING AND COMMERCIAL FISHERY LOGBOOK DATA

Commercial catch data were obtained from purchase slips and vessel logbooks. Fishing effort (number of tows) data were also obtained from vessel logbooks. During the emerging fishery

process, the logbooks were forwarded to DFO Science from DFO Fisheries Management (2003-09). Starting in 2010, these data were compiled by the Statistics Division of DFO Policy and Economics Branch. This dataset is normally incomplete in the current year due to a time lag associated with compiling data from the most recent fishery, thus the most recent point estimate is considered preliminary.

Landings (t) and catch per unit effort (CPUE; kg/tow) were assessed by year and strata and CPUE was standardized to a 0.5 nm tow. The emerging fishery logbooks collected tow-by-tow information; however, the commercial fishing logbooks do not. Consequently, the CPUE after 2009 is unstandardized. Tow positions from the Sea Cucumber logbooks were also mapped to assess the annual distribution of effort.

EMERGING FISHERY SURVEY DATA

In 2003, a grid survey design was created for the St. Pierre Bank using historical data from previous DFO surveys (scallop and multispecies), as well as surveys initiated by the DFA to determine potential Sea Cucumber distribution. An initial 52 10' x 10' (latitude x longitude) strata that were further subdivided into 1' x 1' survey units were established as the survey area (Figure 1). The survey strata were defined by, but not limited to, the 100 m contour. This block system was fished, but not properly surveyed, in 2003 and thus not used for biomass estimates. The number of survey strata was reduced to 32 in 2004 based on bottom classification data and the distribution and depth preference of Sea Cucumber. Stations were randomly assigned within the strata. Eight vessels participated in the surveys from 2004 to 2006 and one vessel completed the survey from 2007 to 2008. The standard survey tow used a six foot modified sea urchin drag towed for 0.5 nm at 2.5 knots. As a condition of the emerging fishery license, it was mandatory to have an observer onboard each vessel during the survey to conduct sampling and record tow details. The 2005 biomass estimate is not considered reliable due to gear configuration issues. The number of survey strata was further reduced in 2006 to 23 strata by eliminating strata where no Sea Cucumber had been caught during 2004 and 2005. These 23 strata remained unchanged for the duration of the emerging fishery (Figure 2). Total weights and numbers of Sea Cucumber from each tow were derived by using the weights and numbers from a single tote (plastic box in which captured Sea Cucumber are stowed during fishing activities), applied to the total number of totes caught. These measures were collected by the observer. The protocol was not followed in 2008 and resulted in the recording of the total number of totes caught and a weight for either 50 or 100 Sea Cucumber, rather than the weight and number of Sea Cucumber from one tote. The mean weights and numbers per tote by strata from the 2007 survey (from the same vessel) were applied to the total totes caught by set and strata for the 2008 survey to generate catch estimates. Following completion of survey stations, participants were permitted to take the allotted Total Allowable Catch (TAC) outside the assigned survey stations, while adhering to all license conditions.

To determine biomass and abundance indices from 2003 to 2008, the survey data were analyzed using STRAP - Stratified Random Assessment Process (Smith and Somerton 1981) and Ogmap - Ogive Mapping Assessment Approach (Evans 2000). Both STRAP and Ogmap are spatial expansion methods for survey catch rate data used to estimate biomass and abundance indices. Ogmap has been introduced in this assessment due to a greater flexibility to extrapolate across poorly sampled areas and narrower confidence intervals; however, the method is preliminary for Sea Cucumber survey data. Both methods are presented to compare results; however, STRAP analysis results are reported within this document and used in determining advice.

DFO SEA CUCUMBER SURVEY DATA

A DFO Sea Cucumber survey was conducted in 2016 using the same standardized six foot modified sea urchin dredge used commercially by harvesters and in the emerging fishery surveys. The random-stratified survey was conducted using the same strata grid and tow protocols as the emerging fishery surveys. The survey proposed to sample nine strata in the southeast area and 13 strata in the northwest area. Due to multiple unforeseen circumstances, only three strata (13, 16 and 17) were sampled in the northwest area accounting for 23% sampling coverage in this area. All southeast strata sampling was completed. Tow speed was 2.5 knots, the warp ratio was three times the depth in metres (3:1), and the tow distance was 0.5 nm. For 50 Sea Cucumber in each set, length (tip to tip; mm) was measured using a fish measuring board, girth (mm) was measured using a tape measure, and whole weight (g) was recorded to the nearest 0.1 g. Individual weights were recorded for the remainder of the sample, up to a maximum of 150 Sea Cucumber. Sea Cucumber were measured and weighed as soon as possible after completion of the tow to reduce water (weight) loss. The total weight and number of Sea Cucumber per tow was also recorded. Length, weight, and girth data were analyzed using a linear model with log transformed data.

All survey data were standardized by swept area before final biomass and abundance estimates were generated using STRAP and Ogmap.

Bycatch species caught during the 2016 DFO Sea Cucumber survey were identified, weighed and in the case of commercial finfish, sea stars, and scallops, measured. The percentage of the total catch by weight (kg) was calculated to determine the most prominent bycatch species caught in the modified sea urchin drag during the 2016 DFO Sea Cucumber survey.

DFO SCALLOP AND MULTISPECIES SURVEY DATA

DFO Scallop surveys were conducted in 2010 and 2015 and DFO 3Ps spring multispecies surveys were conducted from 1996 to 2016. All Scallop survey strata and four of the strata used in the multispecies surveys overlap the Sea Cucumber areas of the St. Pierre Bank. The DFO Scallop surveys were randomly stratified based on three known Scallop fishing beds, with sets optimally allocated in proportion to stratum-specific area and variance of the catch rates from the previous survey. These surveys used an eight foot New Bedford dredge which was towed at a speed of 3.0 knots, with a warp ratio of three times the depth in metres (3:1), and a tow distance of 0.5 nm. The DFO multispecies surveys were randomly stratified by depth, with sets allocated proportionally by depth and area. These surveys used a Campelen 1800 shrimp trawl with a tow time of approximately 15 minutes (0.75 nm) on bottom and a speed of 3.0 knots. The capture efficiency for Sea Cucumber in these two types of gear is unknown. During the DFO Scallop and multispecies surveys, total Sea Cucumber weight was recorded and all Sea Cucumber were counted or a subsample of 25 were counted and weighed to estimate total number caught.

To determine biomass and abundance estimates for 2010 and 2015, the Scallop and multispecies survey data was analyzed using STRAP and Ogmap.

RESULTS AND DISCUSSION

FISHERY DATA

The Sea Cucumber landings averaged 460 t over the period from 2003 to 2006 and declined to 190 t in 2007 due to poor market conditions. The landings averaged approximately 1,200 t since 2010 with the exception of 2015 at 2,297 t, and preliminary 2016 landings were 1,600 t (Figure

3). The 2016 landings are preliminary because they are based on logbooks compiled up to February 2017. Since increasing to 2,242 t in 2013, the TAC has only been fully taken once (2015). Fishing effort focused on three strata from the northwest area (strata 2, 7 and 8) throughout the emerging fishery (Figure 4) and the following commercial fishery (Figure 5). Landings since the emerging fishery (2008) have come exclusively from these three strata, with most landings caught in strata 7 (Figure 6). Following recommendations from the 2009 Science Advisory Report on the assessment of the Sea Cucumber resource on the St. Pierre Bank (DFO 2009a), the southeast area was closed to fishing in 2010 to allow a comparison of a commercially exploited area to an unexploited area.

Commercial CPUE increased from 2004 to 2009 and has remained relatively stable since 2009 with a mean CPUE of 597 kg/tow (Figure 3). Over the course of the emerging fishery (2003-08), the fishing effort contracted and by the end of 2008 there was no fishing effort in the southeast area and very little in the southern portion of the northwest area (Figure 4). The distribution of fishing effort has been increasing in strata 7 since 2013, along with increasing CPUE (Figure 5; Figure 7). The CPUE and fishing effort in strata 8 declined from 2014 to 2015 and preliminary logbook data indicate there was no fishing effort in strata 8 in 2016 (Figure 5; Figure 7).

SURVEY DATA

Catch per Unit Effort

CPUE was calculated from the Sea Cucumber emerging fishery surveys (2004-08), the DFO Sea Cucumber survey (2016), the DFO Scallop surveys (2010 and 2015), and the DFO 3Ps spring multispecies surveys (2004-16). From 2004 to 2008, the CPUE was consistently high in the southeast area and strata 2 and 7 of the northwest area (Figure 8). Due to the difference in fishing gears and sampling effort, it is difficult to determine trends in survey CPUE from 2009 to 2015 (Figure 9).

Biomass and Abundance Indices

The biomass indices based on the emerging fishery surveys from 2004 to 2008 (excluding 2005) averaged 89 kt in the northwest area and 210 kt in the southeast area. The 2005 estimate is not considered reliable due to gear configuration issues. No Sea Cucumber surveys were completed in the 2009-15 period. In 2016, the DFO Sea Cucumber survey biomass index was 187 kt in the southeast area. The northwest portion of the survey was incomplete, covering approximately 23% of the area (strata 13, 16, and 17). The biomass index for those strata was 22.6 kt. The biomass index for the southeast area in 2016 was below the 2004-08 (excluding 2005) average, but within the confidence interval (Figure 10). A similar trend in biomass indices was seen using the Ogmap analysis (Figure 11).

The Sea Cucumber biomass index was calculated using DFO Scallop survey data for 2010 and 2015 which covered some of the strata in the northwest and southeast Sea Cucumber areas. The biomass index in 2010 was 37 kt in the northwest area and 46 kt in the southeast area; while in 2015 the biomass index was 56 kt in the northwest area and 31 kt in the southeast area (Figure 10). Biomass indices for Sea Cucumber were also determined from the 3Ps multispecies spring survey data from 1996 to 2016; however coverage was sparse and catchability is questionable resulting in no clear trend.

The abundance indices based on the emerging fishery surveys from 2004 to 2008 (excluding 2005) averaged 146 million Sea Cucumber in the northwest area and 557 million Sea Cucumber in the southeast area. In 2016, the DFO Sea Cucumber survey abundance index was 748 million Sea Cucumber in the southeast area. The northwest portion of the survey was

incomplete, but the abundance index for those strata surveyed was 65 million Sea Cucumber. The abundance index for the southeast area in 2016 was above the 2004-08 average (Figure 12). A similar trend in abundance indices was seen using the Ogmap analysis (Figure 13).

The Sea Cucumber abundance index was calculated using DFO Scallop survey data for 2010 and 2015 which covered some of the strata in the northwest and southeast Sea Cucumber areas. The abundance index in 2010 was 100 million Sea Cucumber in the northwest area and 129 million Sea Cucumber in the southeast area; while in 2015 the abundance index was 113 million Sea Cucumber in the northwest area and 80 million Sea Cucumber in the southeast area (Figure 12).

In the southeast area, the biomass index was lower than the 2004-08 average while the abundance index was higher than the 2004-08 average suggesting Sea Cucumber have decreased in size in this area. This trend is unclear for the northwest area due to the incomplete 2016 DFO Sea Cucumber survey.

Survey drag efficiency is unknown, but believed to be less than one; therefore biomass and abundance indices obtained from the DFO Sea Cucumber survey are considered minimal indices. The biomass index is calculated from fresh wet weight of the Sea Cucumber at time of capture with no adjustments for drainage or water absorption. The biomass and abundance indices are not absolute numbers and are intended as an indicator of trends. The multispecies and Scallop survey gear catch efficiency for Sea Cucumber as a target species is deemed questionable.

Biometric Measurements

During the DFO Sea Cucumber survey in September 2016, up to 50 representative samples of Sea Cucumber were collected and measured (length, weight, and girth) from each tow. Standard measuring procedures were employed; however, variability is inevitable as Sea Cucumber are comprised of 80-90% water and are able to expand and contract by absorbing and dispelling water. Based on the samples collected from both the southeast area and the surveyed portion of the northwest area, the northwest area is comprised of Sea Cucumber that are larger and heavier than those occurring in the southeast area (Figure 14; Table 1). Similar results were found in a 2004 study that divided the St. Pierre Bank into Western, Central, and Eastern regions where Sea Cucumber from the Central region were heavier than those from the Eastern region, and Sea Cucumber from the Western region were heavier than Sea Cucumber from both the Central and Eastern regions (Grant et al. 2006).

Bycatch

Based on the most recent DFO Sea Cucumber survey in 2016, an estimate of the percentage of bycatch was calculated, where the most prominent bycatch species by weight were Sea Urchin (*Strongylocentrotus droebachiensis)* and Sand Dollar (*Echinarachnius parma)* (Figure 15). Approximately 72% of the catch by weight was Sea Cucumber.

EXPLOITATION

The ratio of the annual landings to the most recent biomass index can be calculated to provide an index of exploitation rate. As the biomass index is not absolute, neither is the exploitation rate index. Since the DFO Sea Cucumber survey was not completed in the northwest area and consequently a biomass index could not be calculated, there is no exploitation rate index for this area. Additionally, there has been no exploitation in the southeast area since 2008, and was

closed to fishing in 2010, therefore there is no exploitation rate index for this area. Sustainable exploitation rates are unknown for Sea Cucumber on the St. Pierre Bank.

Several different exploitation rates were tested for a Giant Red Sea Cucumber dive fishery in British Columbia that found areas with 8% and 16% exploitation rates showed a reduction in the density of Sea Cucumber more so than natural fluctuations observed elsewhere. The study suggests that populations can sustain at least small exploitation levels, such as 2% or 4% which were tested (Hand et al. 2008). A more cautious approach to exploitation of the St. Pierre Bank Sea Cucumber may be required as the Giant Red Sea Cucumber is a faster growing species than the Sea Cucumber caught on the St. Pierre Bank, and is caught in a dive fishery as opposed to a more efficient drag fishery.

MORTALITY

The natural mortality rate for Sea Cucumber on the St. Pierre Bank is unknown and there is currently neither a measure of fishing induced mortality nor survival rate of Sea Cucumber returned to the water from directed nor incidental fisheries (e.g. scallop dredging).

CONCLUSION

There is currently no Integrated Fishery Management Plan (IFMP) for Sea Cucumber on the St. Pierre Bank. Additionally, there are no established reference points by which to determine stock status in relation to a Precautionary Approach Framework. Fishery data (landings and commercial CPUE) and survey data (CPUE, biomass and abundance indices, and biometric measures) are used as indicators of stock status; however, sustainable levels are unknown. In most cases, current estimates are compared to the mean estimate from the 2004 to 2008 emerging fishery (excluding 2005), which represents the pre-commercial fishery Sea Cucumber stock status on the St. Pierre Bank. The indicators of stock status should be interpreted in terms of trends over time, not absolute values.

Caution should be taken when interpreting stock status indicators for St. Pierre Bank Sea Cucumber due to sources of uncertainty. There is limited information on the life history of Sea Cucumber specific to the St. Pierre Bank; especially with respect to age at maturity, recruitment processes, reproductive rate, natural mortality, and the connectivity between the northwest and southeast areas. The consequences of the harvesting method and removals on ecosystem structure and function are unknown.

Interpretation of the trends in stock status indicators over time is limited due to large gaps in the time series. Since the completion of the emerging fishery surveys in 2008, the Sea Cucumber resource on the St. Pierre Bank has been surveyed once and this survey was not complete in the northwest area. Increased frequency of surveys is necessary to address this issue.

Given the uncertainties with this species on the St. Pierre Bank, there is no scientific basis for assessing the risk of any increase in harvest level. Sustainable exploitation rates are unknown, and exploitation rate indices for the northwest and southeast areas could not be determined. Due to the slow growth rate of Sea Cucumber on the St. Pierre Bank, sustaining a relatively low exploitation rate could help maintain the biomass available to the fishery over a longer period of time.

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APPENDIX I - FIGURES

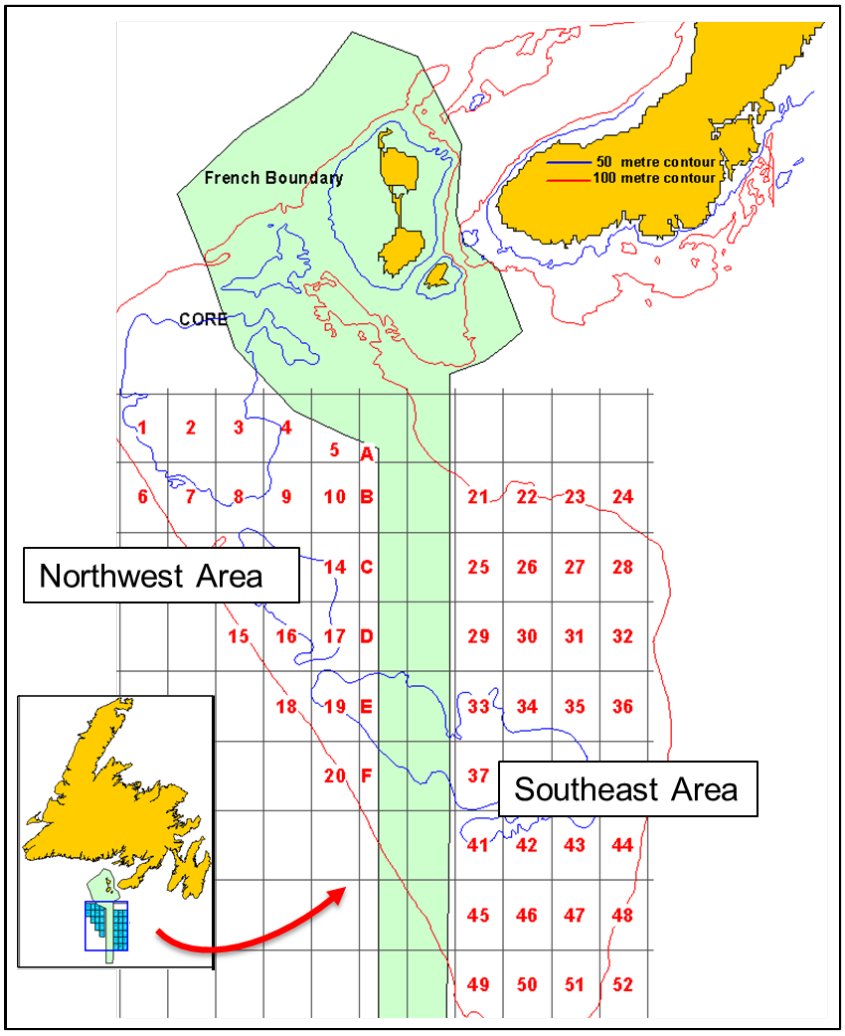

Figure 1. Map of the St. Pierre Bank including the northwest and southeast Sea Cucumber fishing areas and the original 52 strata from the Sea Cucumber emerging fishery surveys.

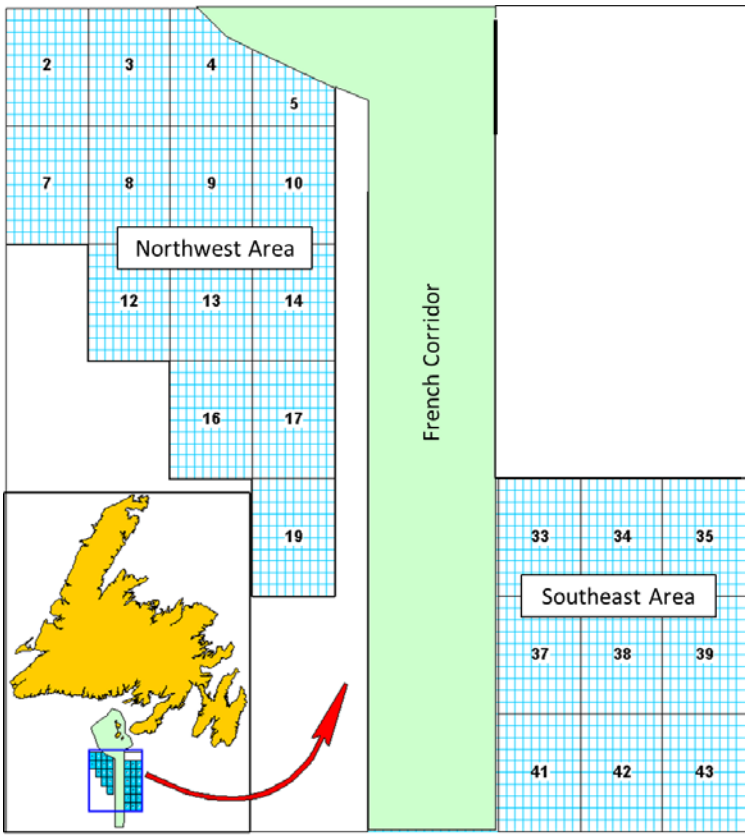

Figure 2. Final 23 strata used in the Sea Cucumber emerging fishery surveys from 2006 to 2008 and the 2016 DFO Sea Cucumber survey on the St. Pierre Bank.

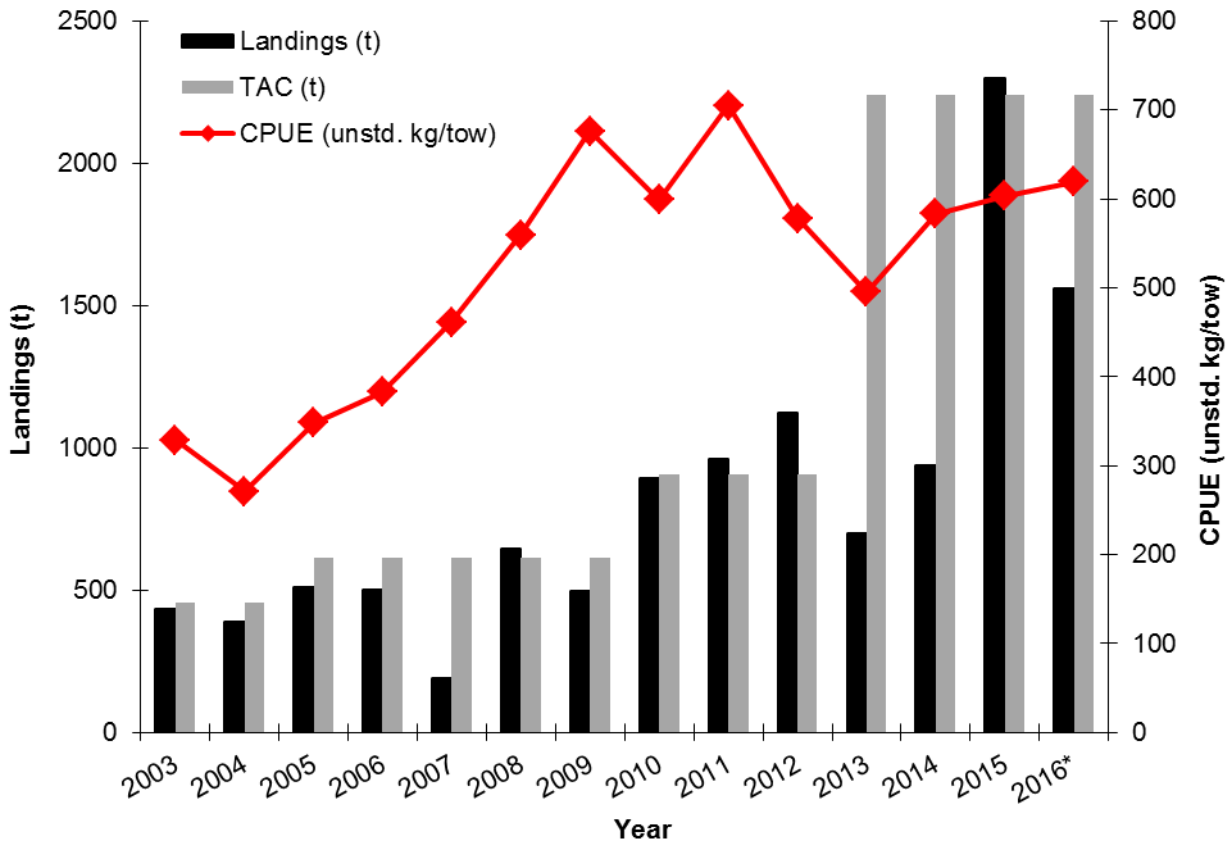

*Figure 3. Trends in St. Pierre Bank Sea Cucumber landings, TAC and commercial fishery CPUE from 2003 to 2016. Landings and TAC are from purchase slips and CPUE data are from commercial fishery logbooks. *The 2016 logbook data are preliminary as of February 2017. Fishing took place in both areas from 2003 to 2008, and only the northwest area from 2009 to 2016.*

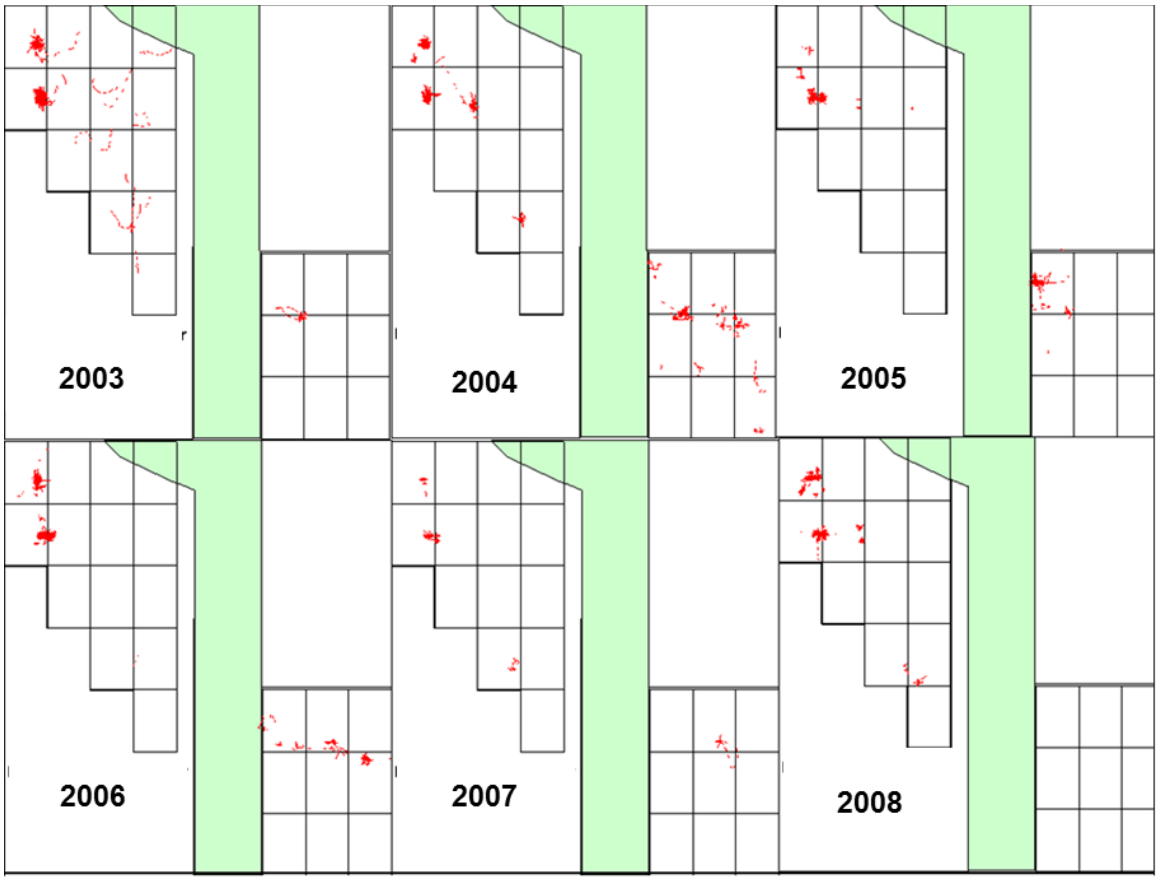

Figure 4. Distribution of fishing effort in the northwest and southeast areas of the St. Pierre Bank during the Sea Cucumber emerging fishery from 2003 to 2008 from emerging fishery logbook data.

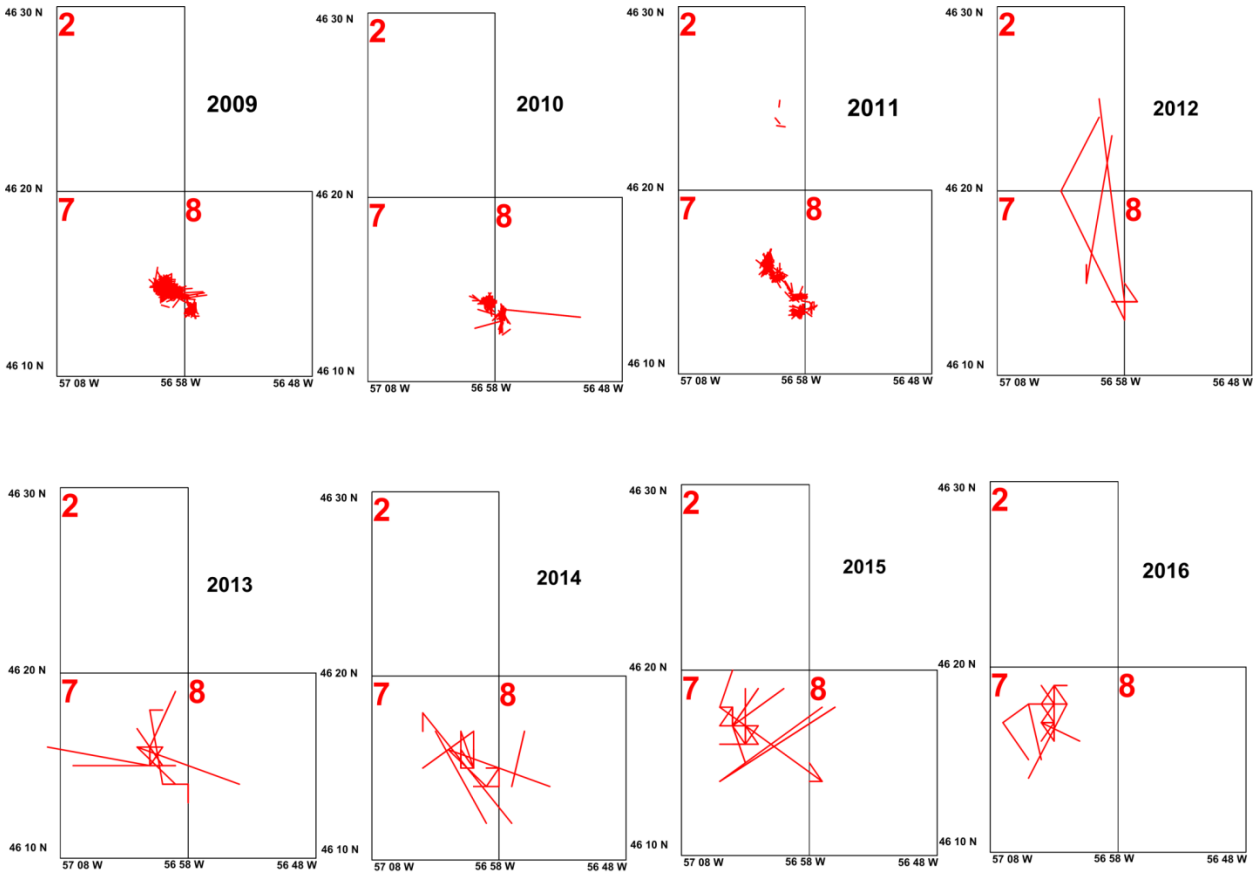

Figure 5. Distribution of fishing effort in strata 2, 7, and 8 in the northwest area from 2009 to 2016 from Sea Cucumber commercial fishery logbook data.

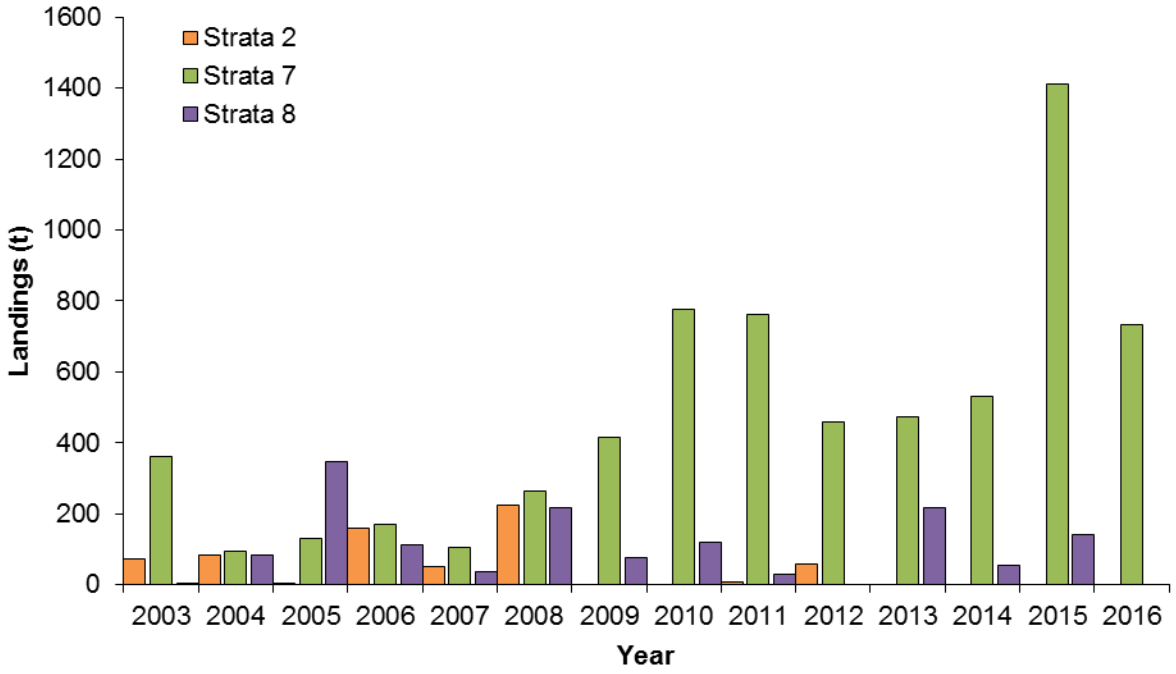

Figure 6. Trends in St. Pierre Bank Sea Cucumber landings in strata 2, 7 and 8 from 2003 to 2016 from emerging (2003-08) and commercial (2009-16) fishery logbook data. The 2016 landings are preliminary as of February 2017.

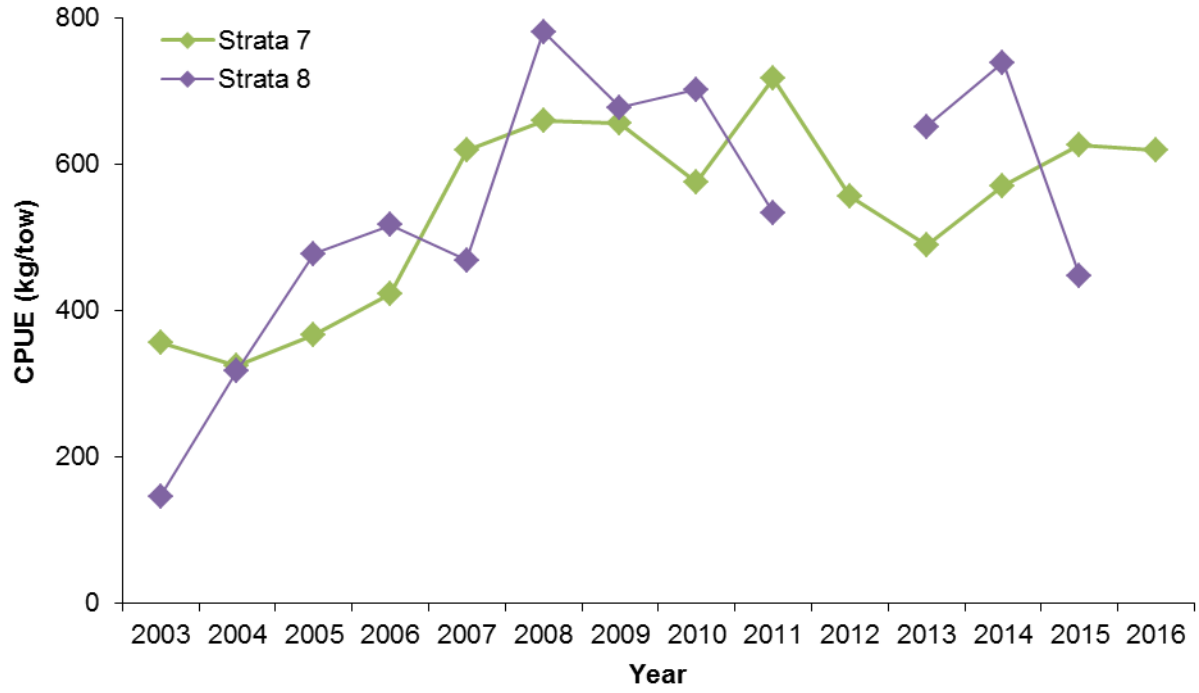

Figure 7. Commercial CPUE (kg/tow) from 2003 to 2016 in strata 7 and 8 in the northwest area on the St. Pierre Bank from emerging and commercial fishery logbook data. The 2016 logbook data are preliminary as of February 2017.

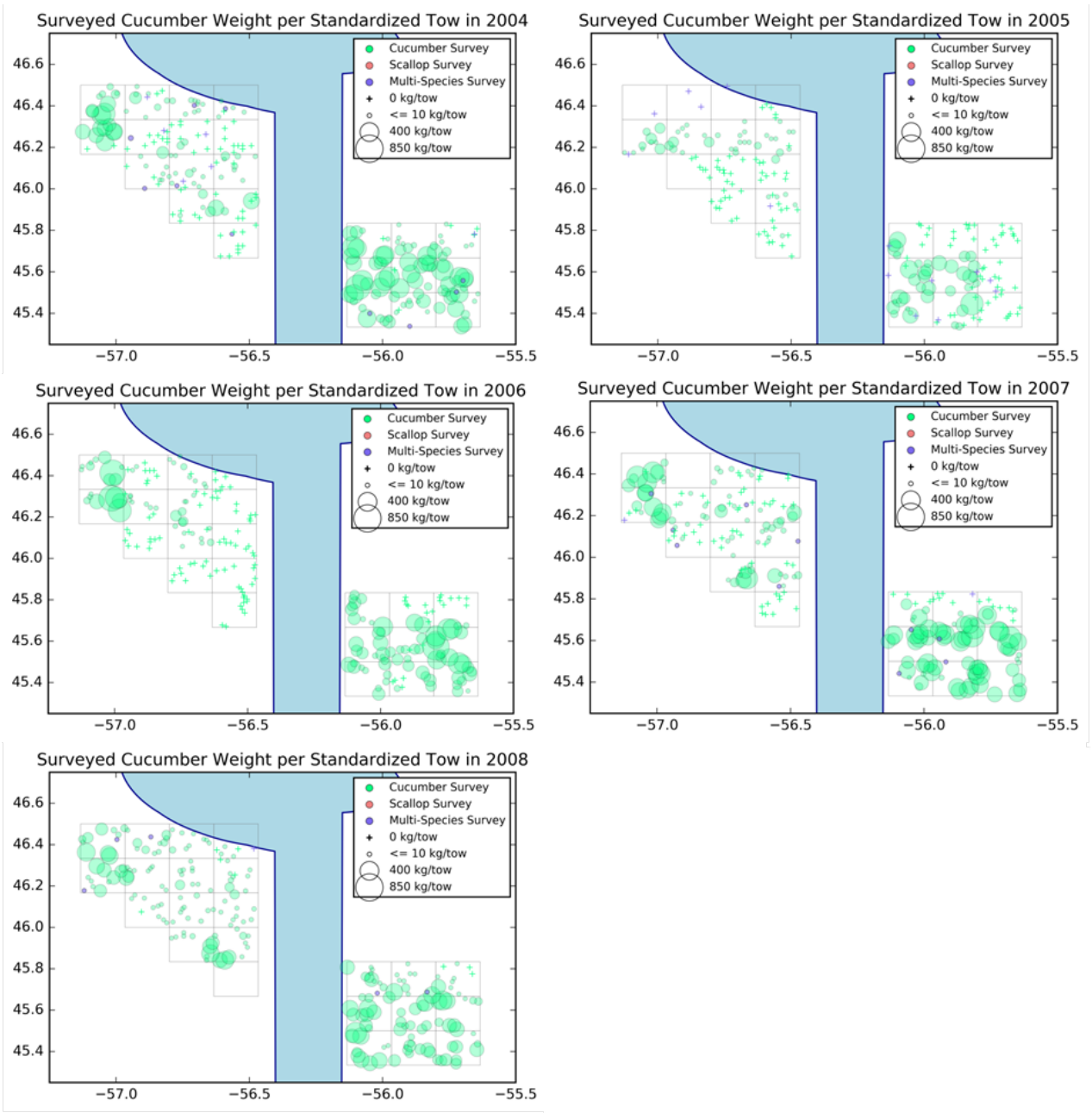

Figure 8. CPUE (kg/tow) of Sea Cucumber from the Cucumber surveys (emerging fishery surveys), DFO Scallop surveys and DFO 3Ps spring multispecies surveys from 2004 to 2008.There were no Scallop surveys between 2004 and 2008.

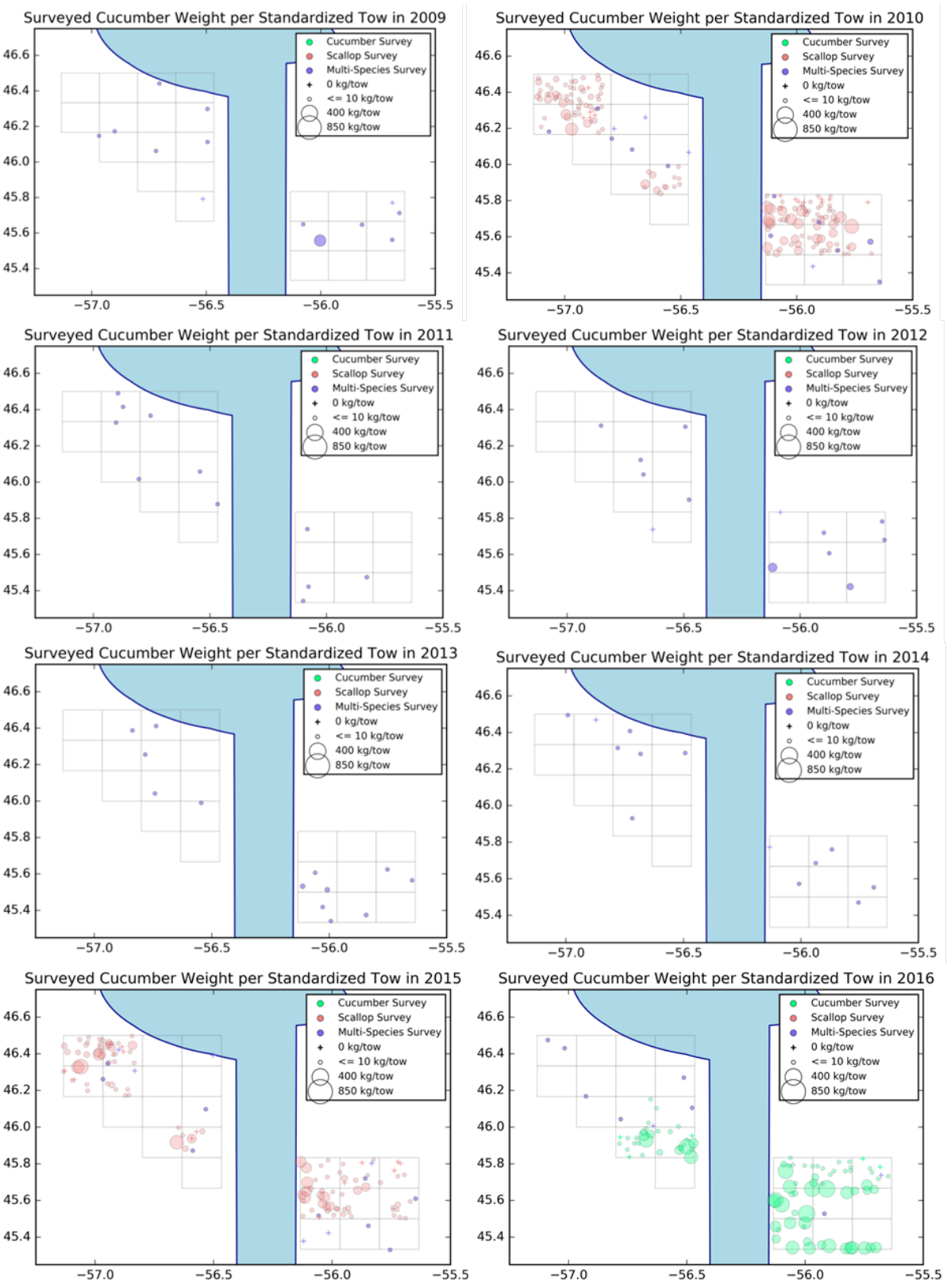

Figure 9. CPUE (kg/tow) of Sea Cucumber from the DFO Cucumber survey, DFO Scallop surveys and DFO 3Ps spring multispecies surveys from 2009 to 2016.

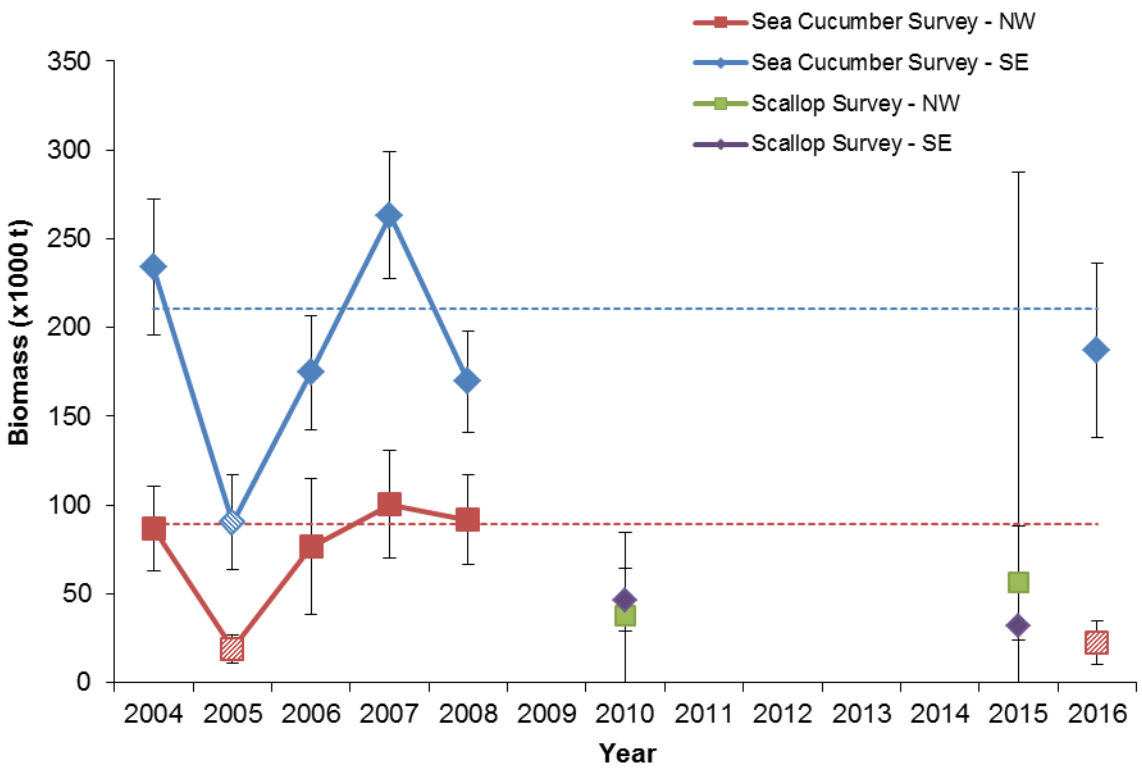

Figure 10. Annual biomass indices from 2004 to 2016 of Sea Cucumber in the northwest (NW) and southeast (SE) areas from emerging fishery surveys (2004-08), DFO Scallop surveys, and the DFO Sea Cucumber survey (2016) using STRAP analysis (error bars indicate 95% Confidence Intervals). The 2005 estimate is not considered reliable due to gear configuration issues. The dotted lines represent the 2004-08 average biomass indices (excluding 2005) for the northwest (red) and southeast (blue) areas.

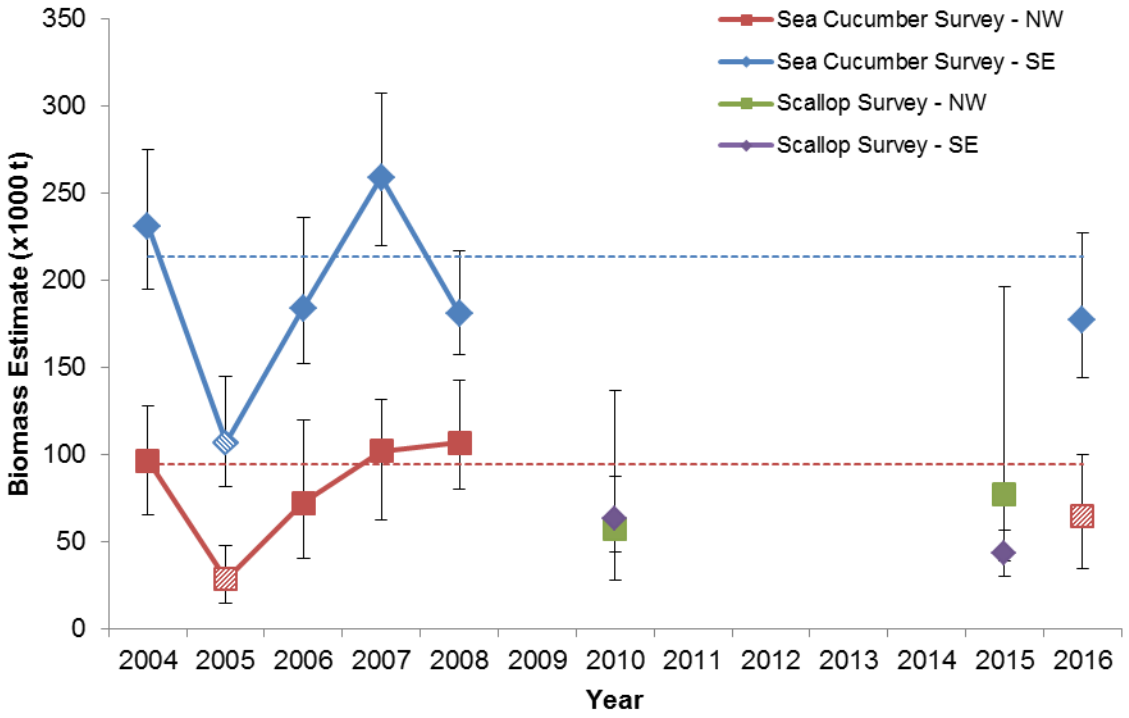

Figure 11. Annual biomass indices from 2004 to 2016 of Sea Cucumber in the northwest (NW) and southeast (SE) areas from emerging fishery surveys (2004-08), DFO Scallop surveys, and the DFO Sea Cucumber survey (2016) using Ogmap analysis (error bars indicate 95% Confidence Intervals). The 2005 estimate is not considered reliable due to gear configuration issues. The dotted lines represent the 2004-08 average biomass indices (excluding 2005) for the northwest (red) and southeast (blue) areas.

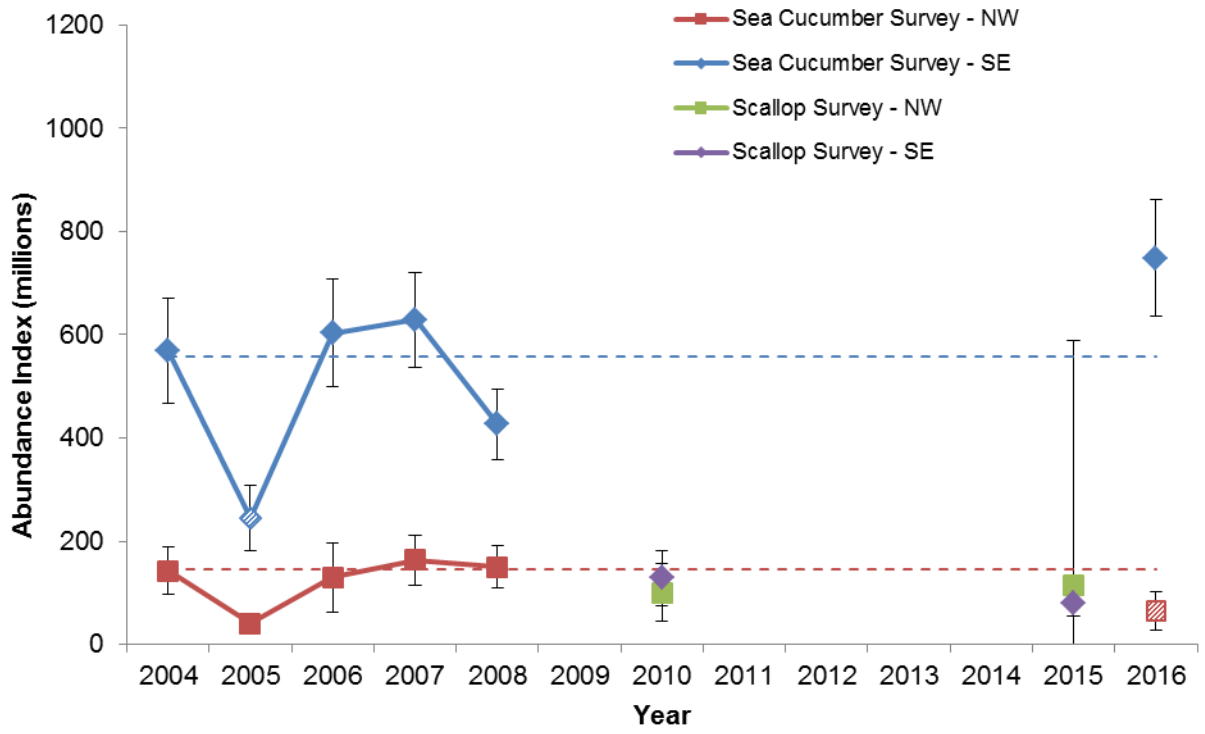

Figure 12. Annual abundance indices from 2004 to 2016 of Sea Cucumber in the northwest (NW) and southeast (SE) areas from emerging fishery surveys (2004-08), DFO Scallop surveys, and the DFO Sea Cucumber survey (2016) using STRAP analysis (error bars indicate 95% Confidence Intervals). The 2005 estimate is not considered reliable due to gear configuration issues. The dotted lines represent the 2004-08 average abundance indices (excluding 2005) for the northwest (red) and southeast (blue) areas.

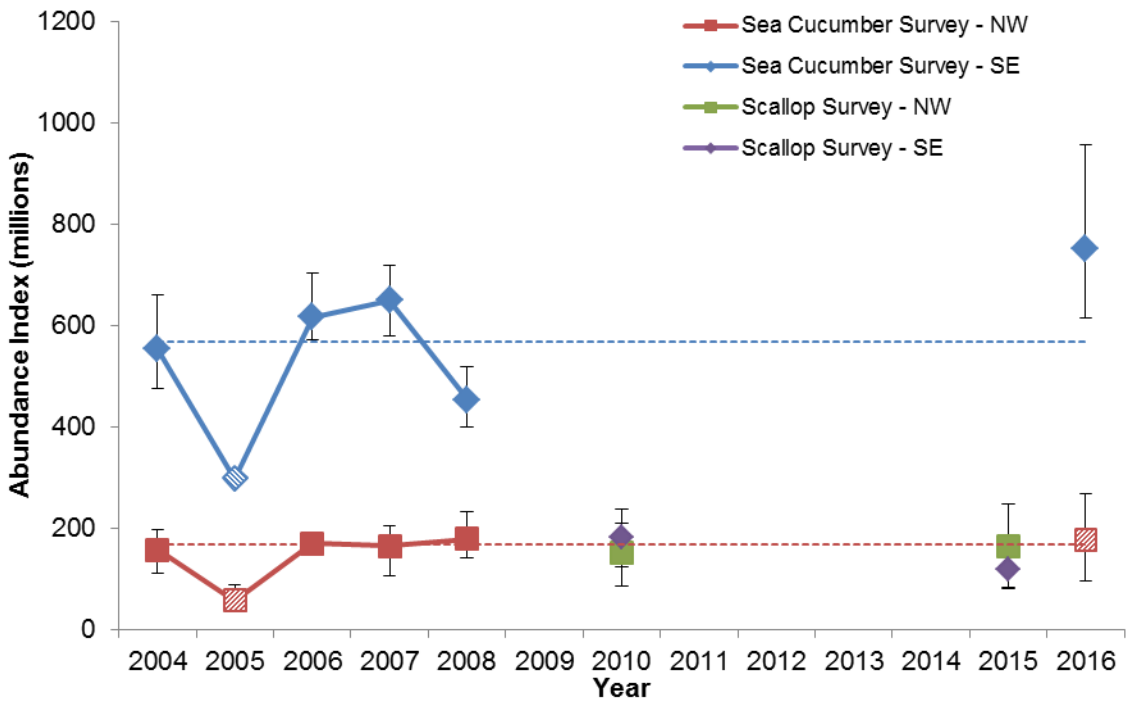

Figure 13. Annual abundance indices from 2004 to 2016 of Sea Cucumber in the northwest (NW) and southeast (SE) areas from emerging fishery surveys (2004-08), DFO Scallop surveys, and the DFO Sea Cucumber survey (2016) using Ogmap analysis (error bars indicate 95% Confidence Intervals). The 2005 estimate is not considered reliable due to gear configuration issues. The dotted lines represent the 2004-08 average abundance indices (excluding 2005) for the northwest (red) and southeast (blue) areas.

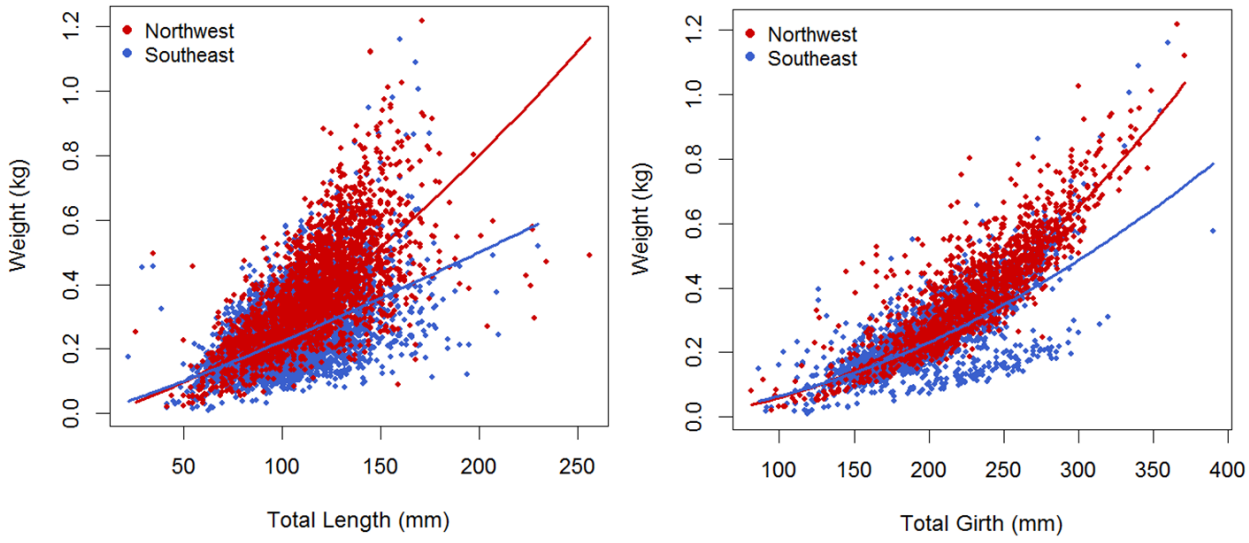

Figure 14. Weight-length (left panel) and weight-girth (right panel) model fits for the northwest and southeast areas based on the DFO Sea Cucumber survey in 2016.

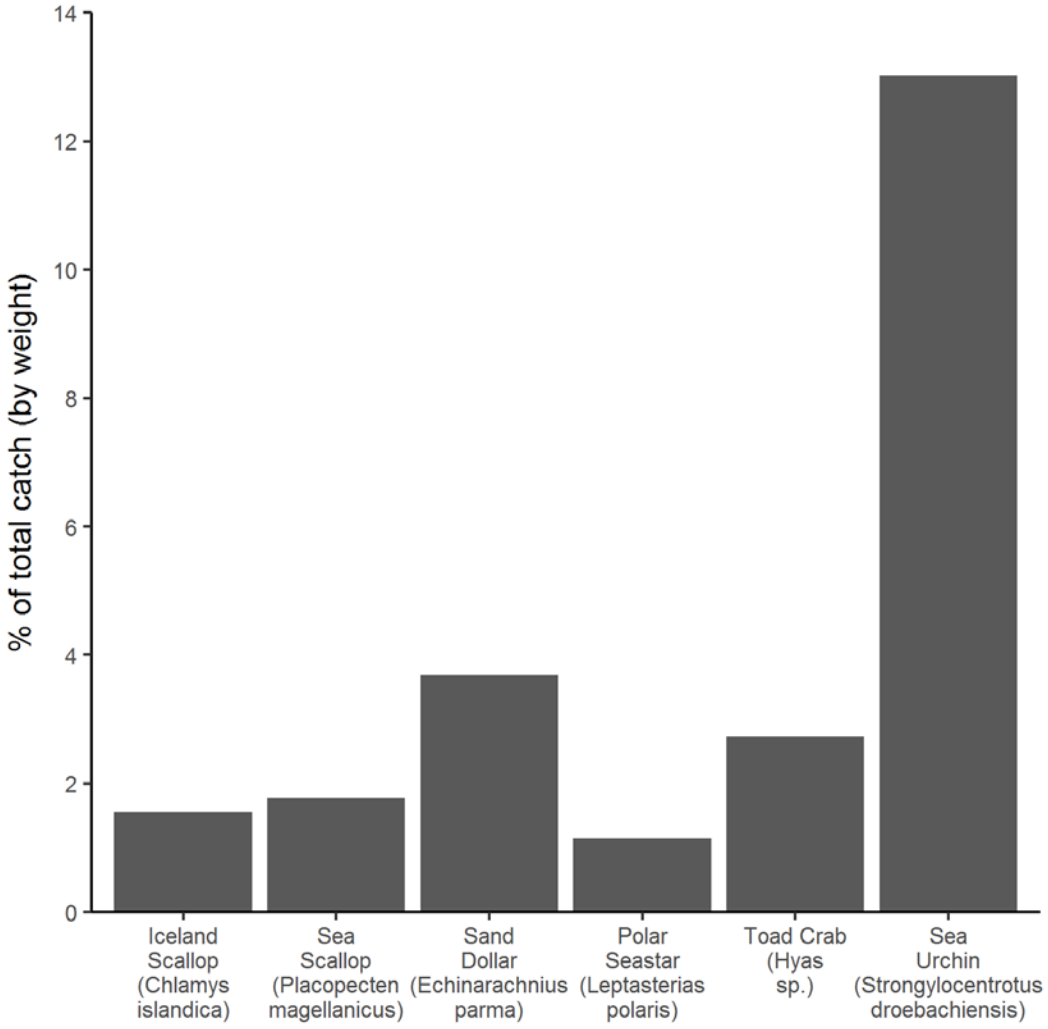

Figure 15. The percentage by weight (kg) of the most prominent bycatch species caught in the 2016 DFO Sea Cucumber survey on the St. Pierre Bank. Species which comprised at least 1% of the total catch by weight are displayed.

APPENDIX II - TABLES

Table 1. Mean length (mm), weight (kg), and girth (mm) of Sea Cucumber sampled in the northwest and southeast areas of the St. Pierre Bank during the DFO Sea Cucumber survey in 2016. The number in brackets is the number of Sea Cucumber sampled.

Biometric	St. Pierre Bank	Northwest	Southeast
Mean Length	108 (7118)	113 (1594)	104 (4645)
Mean Weight	0.30 (7090)	0.37 (1586)	0.25 (4625)
Mean Girth	214 (3655)	229 (962)	204 (2195)