2012 CLAM REPORT

A Population Survey of Soft-shell Clams (Mya arenaria) at Thorne's Cove, and Discussion of Future Management Directions for the Annapolis Basin, NS

Clean Annapolis River Project

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Prepared By:

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List of Acronyms

ACOA	Atlantic Canada Opportunities Agency
ADEDA	Annapolis Digby Economic Development Agency
ATV	All-Terrain Vehicle
AWRC	Annapolis Watershed Resource Committee
CARP	Clean Annapolis River Project
CCMP	Collaborative Coastal Monitoring Program/Collaborative Clam Management Plan
CFIA	Canadian Food Inspection Agency
CHA2	Clam Harvest Area 2
CMG	Annapolis Basin Collaborative Clam Management and Monitoring Group
CSSP	Canadian Shellfish Sanitation Program
DFO	Fisheries and Oceans Canada
EC	Environment Canada
GPS	Global Positioning System
KNP	Kouchibouguac National Park
MRC	Bay of Fundy Marine Resource Centre
PVC	Polyvinyl Chloride
SWNSCAC	South West Nova Scotia Clam Advisory Committee

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Executive Summary

The Annapolis Basin once had some of the most productive clamming areas of Nova Scotia. In recent years however, a number of factors have contributed to the decline of clam populations and the increasing closures of clam harvest areas. The status of current soft-shell clam (*Mya arenaria*) stocks in the Basin is unclear, as population surveys have been infrequent at best. The most recent population survey was conducted by CARP in 2006 at Karsdale and Deep Brook. In 2012, CARP conducted another population survey at Thorne's Cove, covering about ½ of the beach area.

The survey of the eastern half of the beach at Thorne's Cove revealed a relatively low density of clams, with a measured mean clam density of 24.84 ± 7.07 clams/m^2, and mean density of commercial-sized clams of 2.82 ± 0.95 clams/m^2. The density of clams did not meet the sustainable harvest criteria used by Parks Canada, which recommends that mean clam densities should be 100 clams/m^2 and 12 clams/m^2 for commercial-sized clams. The findings support anecdotal evidence of harvesters that clam stocks are depleted.

The size classes that contained the largest frequency of clams were the ≥ 15 and < 20 mm, and ≥ 20 and < 25 mm classes. Numbers of clams dropped significantly in the adult size classes, as expected for heavily harvested beaches, and for the expected survivorship within soft shell clam populations. The majority of juvenile clams were found in the high intertidal areas, close to shore, on the fringe of predator ranges, while adult clams were scattered throughout the sampling area.

The mean biomass for commercial-sized clams on the eastern half of Thorne's Cove was 19,170 kg, while the mean biomass for all clams was 31,471 kg. Commercial-sized clams comprised 11% of the total number of clams sampled, but comprised a much larger percentage of the overall biomass of sampled clams, at 60.9% because of their greater size. The biomass inventory at Thorne's Cove, when compared to a similar biomass assessment performed in the 1980s, showed a decline in overall biomass levels over the past 30 years.

Overall, the clam harvesting industry is suffering from unsustainable or lack of adequate management of the clam harvesting areas and the clams that inhabit them. The economy and employment realities of rural Nova Scotia make a strong case for working towards improved and sustainable management of the clam harvesting areas and soft-shell clam populations. In order to do so, initiatives that will foster collaborative management between stakeholders; maintain and enhance monitoring and reporting; and will promote further research and development are key. Specifically, the CCMP should be maintained, additional management strategies and guidelines for clam harvesting should be adopted, monitoring activities continued, and research should be conducted to address knowledge gaps in relation to clam survival, habitat alterations, sedimentation, and harvesting.

Introduction

The clam fishery has long been ingrained into the fabric of coastal life in Nova Scotia, with archaeological records dating back as far as 1000 B.C. indicating the use of clams by indigenous peoples of the Maritimes (Hawkins, 1985; DFO, 1997). Located within the Bay of Fundy, the Annapolis Basin is one of the major harvesting areas of Nova Scotia, containing approximately 1,960 ha of intertidal clam flats (Angus *et al.*, 1985). The large tidal range in the Annapolis Basin has helped to make it one of the most productive clamming areas of Nova Scotia, exposing an extensive breadth of tidal flats at low tide for harvesting (MacArthur *et al.*, 2010). Overall, the Annapolis Basin flats have historically produced over 30% of the soft-shell clams (*Mya arenaria*) harvested from the Scotia-Fundy region, and accounted for over 60% of all reported landings in Nova Scotia (Angus *et al.*, 1985; MacArthur *et al.*, 2010).

The Annapolis Basin clam fishery is both economically and ecologically important. The total estimated economic value of the local clam fishery was estimated to be $922,533 per year (Gardner Pinfold, 2010). Additionally, the presence of shellfish such as the soft-shell clam within the Annapolis Basin provide important ecological benefits by filtering microscopic algae out of suspension and thereby improving water clarity, and by stabilizing sediments, which helps to protect shorelines from erosion (Brumbaugh *et al.*, 2006).

In spite of their economic and ecological value to communities in the Annapolis Basin, populations of soft-shell clams have been on the decline over the past several decades, especially since the late 1970s and mid-1980s (Rowell and Woo, 1990). There has also been an increasing number of harvesting area closures since the 1970s (Rowell and Woo, 1990; Sullivan, 2007b). These declines are affected by environmental, biological, and resource management influences. For example, factors such as predation, competition, overfishing, lack of catch limits, oceanic acidification, sedimentation of flats, disease, and pollution all likely contribute to the losses being observed on clam flats in the Basin (Hawkins, 1985; Rowell and Woo, 1990; Leblanc and Miron, 2005; Green, 2009). The relationship between these factors and the survival of soft-shell clams is still relatively poorly understood in the Annapolis Basin, and merits further study.

In response to the derelict state of the clam fishery in the 1990s, conservation efforts were initiated in the 2000s, and included a wide variety of resource management efforts (Sullivan, 2007b). There have been no studies to evaluate the effectiveness of past efforts however, and the most recent assessment of clam stocks within the Basin was conducted on two open area beaches in 2006 (Sullivan, 2007a). A lack of information therefore exists about the current state of the clam stocks in the Basin – which is critical in moving forward with further management decisions for the clam fishery.

The Soft-shell clam

The soft-shell clam is a thin-shelled bivalve that can be found within intertidal and subtidal sediments in bays and estuaries along the Atlantic coast (Maine Dept. of Marine Resources, 1993). It has a wide distribution, ranging from North Carolina to the Arctic Ocean, and prefers salinities between 25 to 35 ppt, temperatures of 6 to 14°C, and bottom sediments composed primarily of fine sands or clays (Hawkins, 1985; DFO, 1997). The shell typically has a chalky white appearance; however, its colouring can also be of darker hue, either grey or blue in tone, depending on the organic content of the sediment in which the clams live (Hawkins, 1985; Sullivan, 2007a). Figure 1 shows an image of darker soft-shell clams from an area of higher organic sediment content.

Figure 1. Soft-shell clams are an important part of the local fishery of the Annapolis Basin, Nova Scotia. (Source: Clean Annapolis River Project)

Soft-shell clams have shells that are generally elongate and elliptical, and which do not usually exceed 10 cm in length (Hawkins, 1985; US Fish and Wildlife Service, 1986). They spend the majority of their lifecycles in a burrow, dug using a muscular 'foot' on the anterior end of their shells, and typically burrow to a depth of about 10-15 cm in sediments. They have a long 'neck' apparatus that extends to the sediment/water interface, and which uses a set of siphons for material exchange (Hawkins, 1985; Sullivan, 2007a). *M. arenaria* feed with the incurrent siphon on the posterior end of their shell, using it to filter microscopic plant and animal matter out of the water. They use their excurrent siphon to excrete fecal matter, as well as sperm and eggs when spawning (see Figure 2).

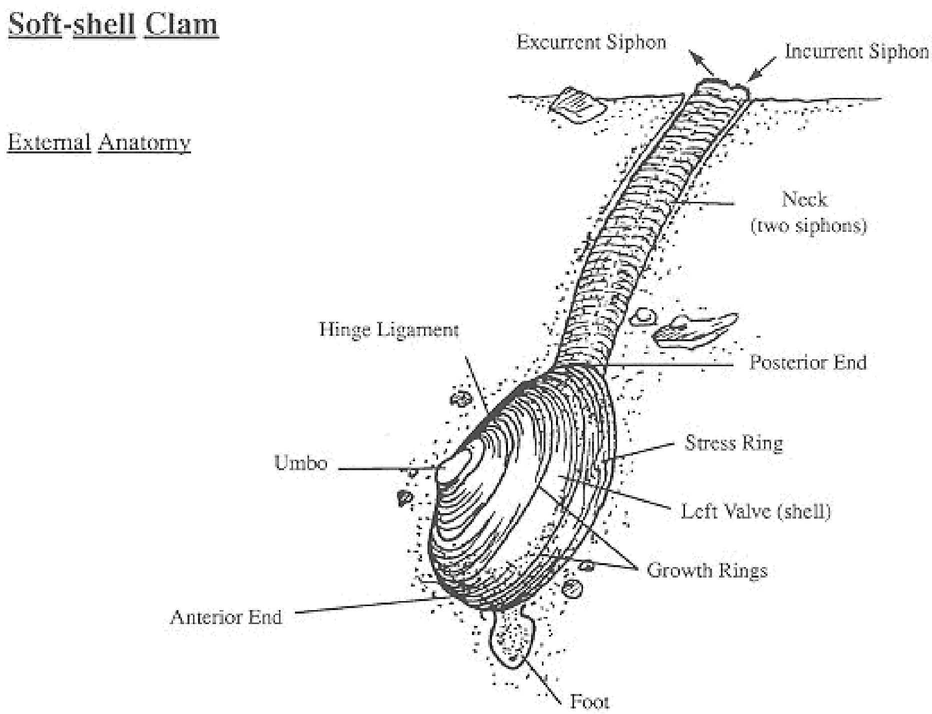

Figure 2. External Anatomy of the Soft-Shell Clam (*Mya arenaria*) (Source: Maine Dept. of Marine Resources, 1993).

Soft-shells clams begin their life stages as free floating larvae in the water column, which can last from 2 to 3 weeks. The clam larvae then settle and attach to the sediment; they transform into bottom-dwellers called 'spat', and begin to dig a permanent burrow using their muscular foot. It takes the clams about 2 or 3 years to reach maturity (25 mm), which is defined more by clam length rather than age (see Figure 3 for clam lifecycle) (Hawkins, 1985). When clams reach maturity, they can begin spawning. Spawning occurs in the summer, and is typically determined by factors such as the tidal cycle, water temperature, and food availability (Hawkins, 1985; US Fish and Wildlife Service, 1986).

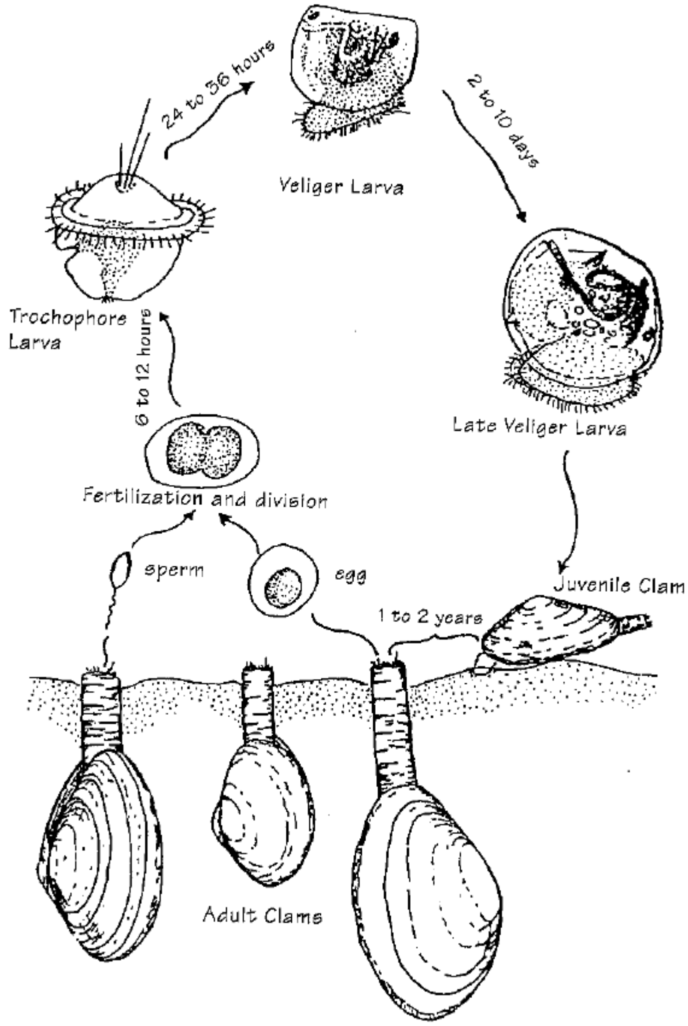

Figure 3. Soft-shell clam lifecycle. (Source: Maine Dept. of Marine Resources, date unk.)

M. arenaria follow a Type III survivorship curve (See Figure 4), meaning that life expectancy is low in juveniles, and increases as clams age (Brousseau, 1978; Dame, 1996). Soft-shell clams produce a large number of offspring and few eggs produced in a season settle successfully (0.1%), and of these, 1% actually survive to reach maturity (US Fish and Wildlife Service, 1986; Green *et al.*, 2004). Rates of growth of clams vary according to many environmental and biological factors, such as salinity, predation pressures, water temperatures, pollution, season, food availability, bottom type, intertidal location, etc. Therefore, the amount of time it takes a clam to reach commercial size (44.5 mm) is highly variable, but has been estimated to take approximately 5.5 to 6 years in the Annapolis Basin (Angus *et al.*, 1985; Wheaton *et al.*, 2008).

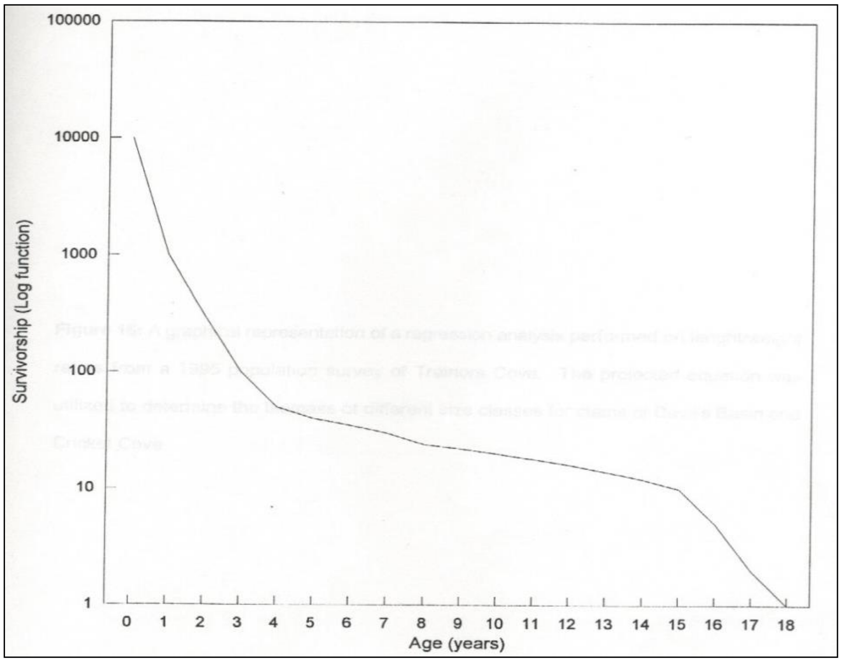

Figure 4. Survivorship Curve for *Mya arenaria*, Northeastern USA. (Source: Dame, 1996).

Threats to the survival of soft-shell clam species have been on the rise in recent decades, as the number of predators, parasites and diseases affecting the clam species have escalated with increased translocation of non-native species and contamination of waterways (US Fish and Wildlife Service, 1986; Brumbaugh *et al.*, 2006). These pressures, coupled with increased predation by humans through overfishing, and intensified environmental stressors such as rising water temperatures, escalating oceanic acidity, and changing salinities, have placed considerable strain on clam populations in the Annapolis Basin. The full impacts of these pressures remain largely unquantified, which makes management of the clam flats more challenging.

History of Clamming in the Annapolis Basin

The soft-shell clam fishery of the Maritimes has a long history in the Annapolis Basin, and was likely one of the first marine species to be exploited by humans (Robinson, 1997). Archaeological records show that the clams were harvested by First Nations' peoples as far back as 1,000 BC (DFO, 1997; Robinson, 1997). Once Europeans arrived and colonized the area, indigenous groups shared their clam harvesting techniques with them, and the Europeans began to consume clams in the early 1600s as a food source. These did not use the clams as a staple food, but rather a secondary source of food, in times of shortage. It was not until a few centuries later, in the 1800s, that clams began to become a valuable part of the commercial clam fishery – first sold as bait fish, for the long-line fishery (DFO, 1997; Robinson, 1997). The empty shells of the clams were also used in early construction materials to create a very durable plaster that can still be found in some older homes (Sullivan, 2007b).

Harvesting of clams in a commercial sense, other than for bait, only really began in the early to mid-1900s, when a canning industry was established, and more clams were harvested for foodstuffs (Robinson, 1997). Figures 5 and 6 show the reported clam landings in the Bay of Fundy (Figure 5) and the Annapolis Basin (Figure 6) over time (Robinson, 1997). Until 2011, reporting landings to DFO was not mandatory, and the data is therefore not a complete representation of all landings that occurred. Clam harvests were plentiful in the 1950s, but many flats had become depleted by the 1960s, after years of harvests without size class restrictions, and the construction of a tidal barrage/causeway at Annapolis Royal (Sullivan, 2007b). The causeway was built to protect upstream agricultural lands from flooding behind dyke systems that were deteriorating, but it is believed by the local clam harvesters that a consequence of its construction was a shift of intertidal sediments to a form that was less sandy, and much muddier than before (Sullivan, 2007b; T. Wilkins, personal comm., February 7, 2013). There was also a transition by clammers towards using ATVs to access clam flats for harvesting rather than boats, and concerns began to arise about the effect of ATV use on the beaches (Sullivan, 2007b). Intensive re-seeding efforts were begun at this time, to attempt to restore clam populations on depleted beaches, but no assessments were completed to determine the effectiveness of these efforts (Sullivan, 2007b).

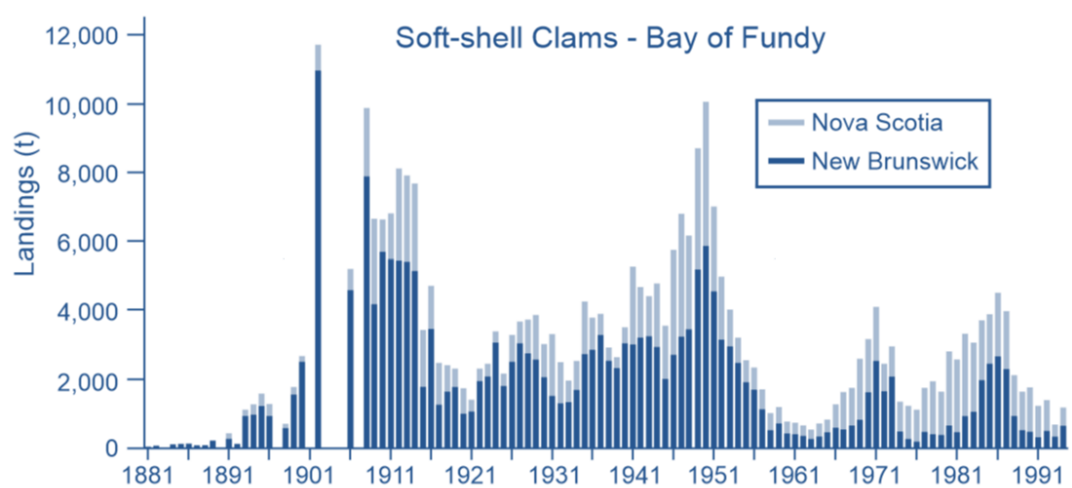

Figure 5. Historical soft-shell clam landings in the Bay of Fundy, in metric tonnes (Source: Robinson, 1997).

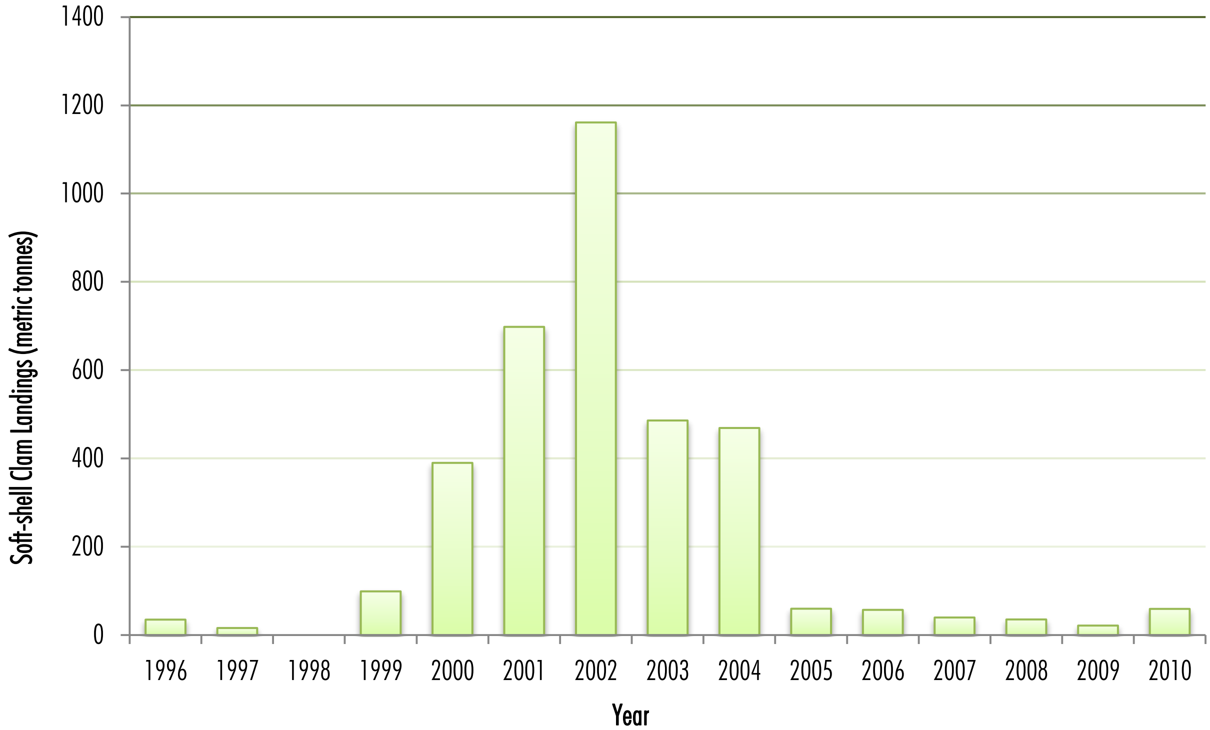

Figure 6. Historical soft-shell clam landings for the Annapolis Basin, Clam Harvest Area 2. (Source: Sullivan, 2007a; DFO, 2013).

By the 1970s and 80s, there were increasingly more beach closures, but the 70s still had high recorded landings, as a result of serious overfishing at the time (Sullivan, 2007b). The harvest of clams in the Basin represented the majority of the harvest in Nova Scotia at the time, almost 70% of all harvests (Angus *et al.*, 1985). This, coupled with the construction of the tidal generating station in the early 1980s, and its operation that began in 1984, resulted in a large depletion of the Basin's clam populations (Dadswell *et al.*, 1986; Sullivan, 2007b). Conservation efforts were initiated in the 2000s, but with the increased number of harvesters in the 1990s, and a lack of clear resource management and enforcement with the industry, the clam population levels have still not shown signs of improvement (Sullivan, 2007b).

Managing the Clam Resource

The depletion of soft-shell clam resources within the Annapolis Basin is a plight that has been characterized by a number of factors, one of those being resource management and regulation of the clam resource and harvesters. Many efforts have been initiated in the past to try and manage this shared resource, but to limited success. There has been a gradual paradigm shift throughout the fishery's history in the Bay of Fundy towards a more adaptive management approach of the clam resource. In 2013 a cooperative management plan was created by the industry and is discussed below.

Past Management

Until the 1940s, there was no regulation or management of the Annapolis Basin clam fishery – harvesting was unrestricted, limited only by the rate at which harvesters could collect and shuck clams by hand. The first attempt at managing or putting any sort of restriction on the fishery happened around the mid-1940s, when a size limit of 50.8 mm (2 inches) was put into place (Sullivan, 2007b). However, there was a return to unrestricted harvesting in the 1950s (Sullivan, 2007b). Around this time (in the 1950-1960s), there was also an attempt to use semi-automated hydraulic harvesting equipment by some harvesters, but this was not kept, and instead there was a return to the conventional hand-digging method of harvesting using a clam hack (DFO, 1997).

Management of the clam stock began to gain a little more momentum in the 1960s, when stocks sank to unsustainably low levels. At this point, some of the first attempts at reseeding beaches with clam stock were started. However, the results of this effort were limited, as reseeded beaches were quickly overfished (Sullivan, 2007b). The early 1970s saw further developments in managing the soft-shell clam resource, with the creation of the Canadian Shellfish Sanitation Program (CSSP), a collaborative between various federal departments to control the harvest of bivalves, and ensure the safety of clam meats. Beaches that regularly exceeded acceptable levels of fecal coliform were closed to regular harvesting (MacArthur, 2010; CFIA, 2011). In the 1980s, with increasingly more beach closures, there was more consideration given to leasing closed beaches out to private groups for depuration[1]. Depuration harvesting was brought into effect by the early 1990s, and this decade also experienced intensification in regulation of the clam harvest by the federal government (Sullivan, 2007b).

The early 1990s saw the introduction of clam harvesting licenses by Fisheries and Oceans Canada (DFO) (DFO, 1997). As opposed to unrestricted access to the fishery, this meant that only fishermen with harvester licences could harvest soft-shell clams. However, there were no limits set on the number of licences, and there was a large increase in the number of harvesters. This resulted in the DFO restricting access to new licences in 1996, and requiring harvesters to organize themselves into clam harvester associations. A new minimum size limit was also imposed by the DFO for the clams, of 44.5 mm (1 ¾ inches) (Sullivan, 2007b). The mid 1990s also saw restrictions placed on recreational digging, with a catch limit of 100 clams/day (DFO, 1997).

The turn of the millennium saw a shift towards adopting more conservation efforts in an attempt to find a sustainable way to manage the clam flats of the Annapolis Basin. These included: conducting baseline stock assessments of beaches to determine the state of the clam populations; introducing conservation areas; winter closures of beaches; water quality monitoring; conducting an economic valuation of the current clam resource; and the creation of a multi-stakeholder committee called the Annapolis Watershed Resource Committee (AWRC)

[1] Depuration is the term given to the process of removing impurities, cleansing or purifying bivalves.

(Sullivan, 2007a; 2007b). Some valuable research and network building was accomplished at this time, setting the groundwork for developing and bridging future relationships between stakeholders. However, the AWRC did not last past the mid-2000s, and a worthwhile effort dissolved when it had barely begun.

Current Management

At present, regulation of the soft-shell clam fishery in the Annapolis Basin is still being administered by the Canadian Food Inspection Agency (CFIA), Environment Canada (EC), and the DFO though the CSSP. Despite increasingly limited resources, EC still monitors water quality in the Annapolis Basin approximately 5 times a field season and is responsible for identifying unsafe water quality and classifying shellfish harvesting areas (CFIA, 2011; MacArthur, personal comm., 2012). Shellfish harvesting areas can be classified into 5 categories under the CSSP, based on their water quality: approved, conditionally approved, restricted, conditionally restricted, and prohibited. For further information, refer to Appendix A.

The DFO is responsible for enforcing closure regulations, licences and licence conditions, for controlling the harvests from closed areas, and for opening and closing clam flats after contamination events (MacArthur, 2010). The CFIA coordinates the CSSP program, and is responsible for the control of shellfish and monitoring of shellfish for marine toxins (CFIA, 2011).

A size limit on harvests still exists, where only clams larger than 44.5 mm can be commercially harvested. A catch limit still exists for recreational harvesters of 100 clams/day but this is a challenge to enforce (DFO, 1997; Hicks and Oulette, 2011). Harvesting on shellfish growing areas is still prohibited in the winter (from January through March). There is still no existing catch limit for commercial clam harvesters, despite requests from harvesters to impose a catch limit of 6 buckets/tide (Sullivan, 2007b). In 2011, however, the DFO made it mandatory for clam harvesters to report all landings, including nil reports for those inactive in the harvesting season, which has since resulted in a significant increase in the number of reported landings for the Basin (Farqharson, 2013).

Although the AWRC is no longer in existence, the research activities that were conducted for it by supporting members like CARP and the Bay of Fundy Marine Resource Centre (MRC) provided useful baseline information that was used in the creation of a new Collaborative Coastal Monitoring Program and/or Collaborative Clam Management Plan (CCMP) initiative (see Appendix B for the CCMP report). The creation of the CCMP for approved and conditionally approved areas began in 2011, with ADEDA as the fiscal manager of the program. The project management team consisted of ADEDA (Liz Morine), CARP (Monik Richard), NS Fisheries and Aquaculture (Bill Whitman) and the Municipality of the County of Annapolis (Cody Joudry). The program aimed to bring stakeholders such as the harvesters, buyers, and regulators together to develop and maintain a collaborative monitoring and management plan for clam harvest areas within the Annapolis Basin (Farquharson, 2012). A consultant was retained by the project management team (Susan Farquharson) who helped bridge gaps and concerns from the key industry representatives. A new committee, named the Annapolis Basin Collaborative Clam Management and Monitoring Group (CMG) was created and is chaired by CARP. Through this committee, the harvesters of the CHA2 Clammers Association developed a collaborative management plan for 2013-2016 for approved and conditionally approved areas which was submitted for approval to the South West Nova Scotia Clam Advisory Committee (SWNSCAC) for approval. It is anticipated that when this plan is approved by the regulatory bodies that it will be a condition of obtaining licence conditions for harvesting in CHA2 approved and conditionally approved areas.

CARP's Role

Clean Annapolis River Project (CARP) has been collaborating with clam management activities since the creation of the AWRC and now with the CMG, where it was invited to act as a neutral mediator between stakeholders, and to provide scientific support to the committee.

In the summer of 2012, CARP began to complete a population assessment of the soft-clams at Thorne's Cove as part of its involvement in the CCMP, to generate baseline data about the status of the clam stock in that area. It is anticipated that this information may be of further use in future decision-making regarding management and the feasibility of reseeding in the area in the future.

Materials and Methods

Study Site

Study sites that were identified as key areas for stock assessment in the Annapolis Basin were the approved harvest areas of Karsdale and Thorne's Cove. The conditionally approved harvest area of Goat Island was also identified in the past as an area of interest by harvesters for further management activities (Farquharson, personal comm., 2012). It was decided that Thorne's Cove would be assessed, as it is the most easily accessible of the two harvesting sites, is more frequently used by the harvesters, and was more feasible to complete within a limited time frame. Thorne's Cove covers an area of about 88.2 ha (or 881,801 m^2) in size, compared to the Goat Island harvesting area, which covers an area of about 242.4 ha (or 2,424,378 m^2). Thorne's Cove was once considered one of the most important open areas left in the Annapolis Basin, and was historically densely populated with soft-shell clams (Sullivan, 2007a). Figure 7 shows the location of the Thorne's Cove beach in the Annapolis Basin, and Figure E1 (in Appendix E) shows that Thorne's Cove beach is classified as a 'Conditionally Approved' harvesting area, meaning that it can be closed to shellfish harvesting during intermittent pollution discharges that can contaminate the clam beds beyond acceptable levels, such as heavy rainfalls (MacArthur, 2010).

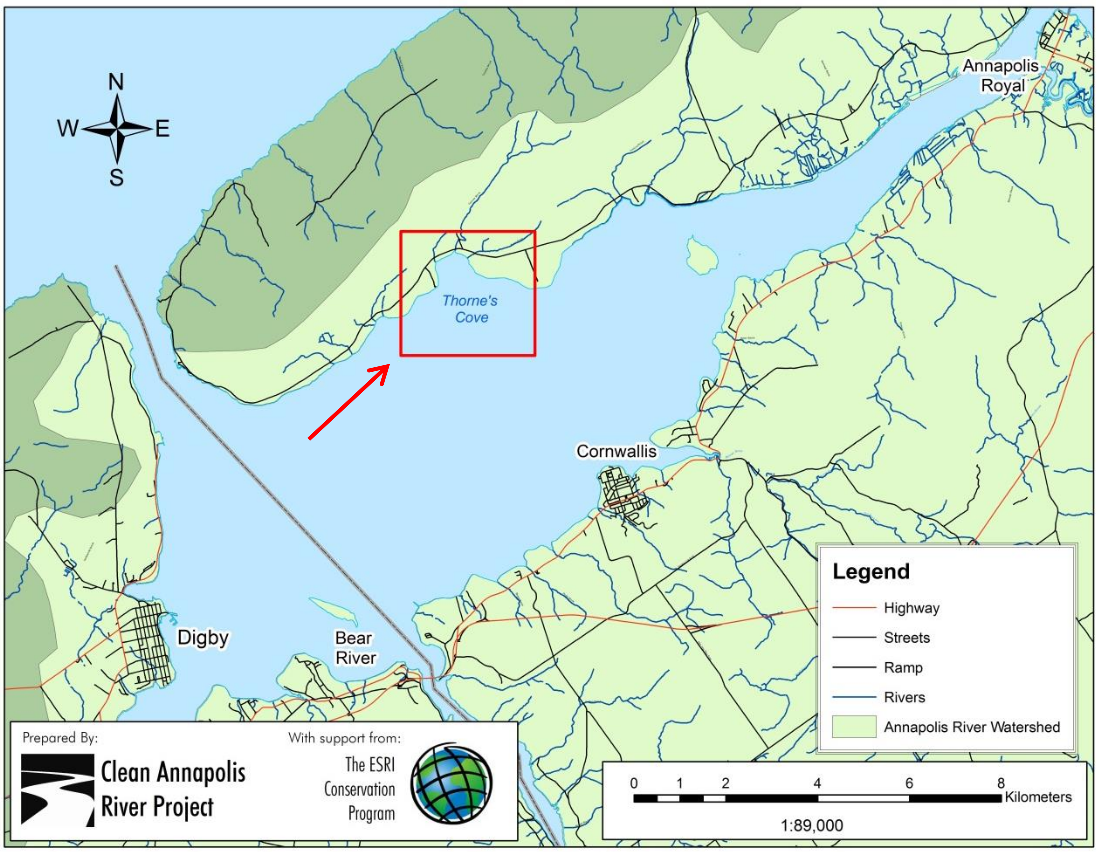

Figure 7. Sampling location of Thorne's Cove in the Annapolis Basin.

Population Assessment

The survey methodology used to conduct population assessments at Thorne's Cove was adapted from that used by Sullivan (2007), who undertook a literature review to identify standard survey methods for soft-shell clam population assessments. The review revealed that past assessments of stocks within the Basin had no consistent methodology, and therefore an approach selected by Parks Canada at Kouchibouguac National Park, New Brunswick, was used (LeBlanc, 2006). This involved sampling the beach using a transect grid technique, where a baseline was placed approximately parallel to the coast, and marked at 50m intervals with PVC pipe. Transects were then run perpendicular to the baseline in either direction, inland to the shoreline, and seaward to the low water mark (see Figure 8). Sampling plots were marked at every 50m along transect lines, and their positions recorded using a handheld GPS unit.

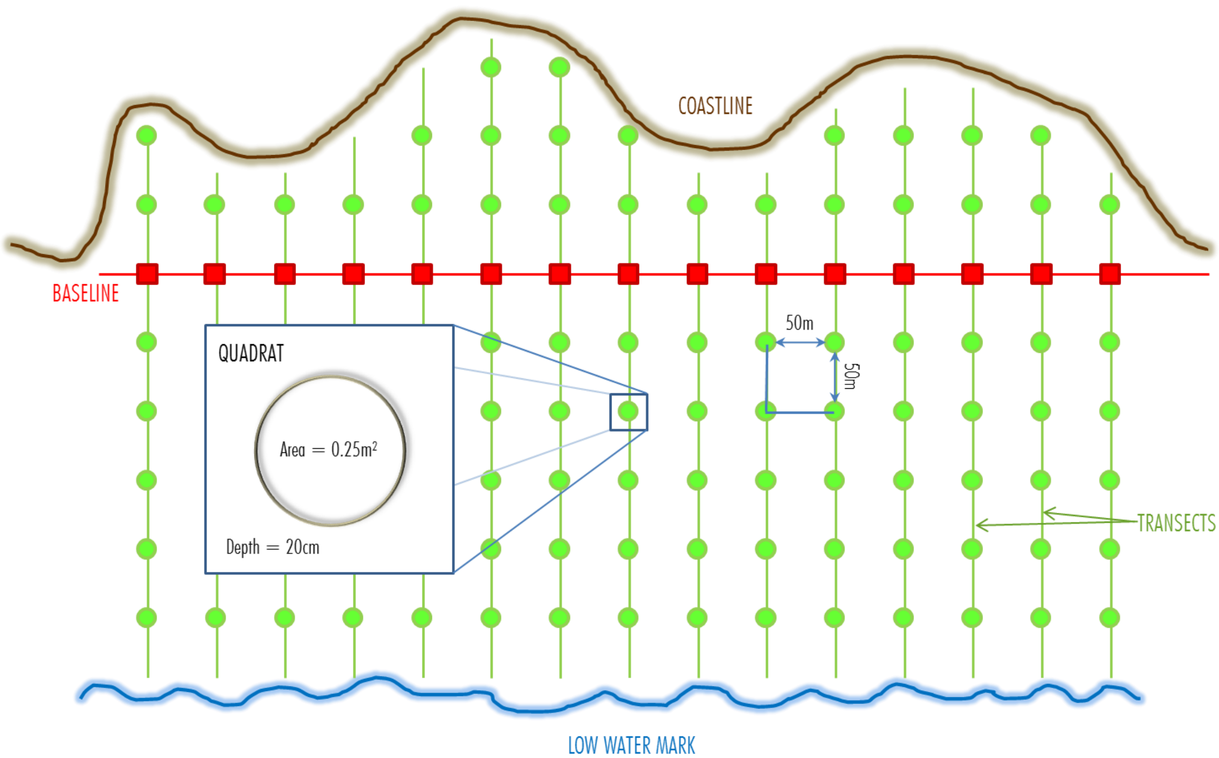

Figure 8. Transect grid for sampling of soft-shell clams.

Transects were positioned at the beach in Thorne's Cove using the above methodology, however the baseline in this case was far removed from the high water mark, simply because the cove stretched so far inland beyond the coastline. Figure 9 illustrates the transect setup at Thorne's Cove. The beach at Thorne's Cove was divided in half, and half of the transects (denoted as Part A in Figure 10) were sampled this field season, due to constraints on human and financial resources.

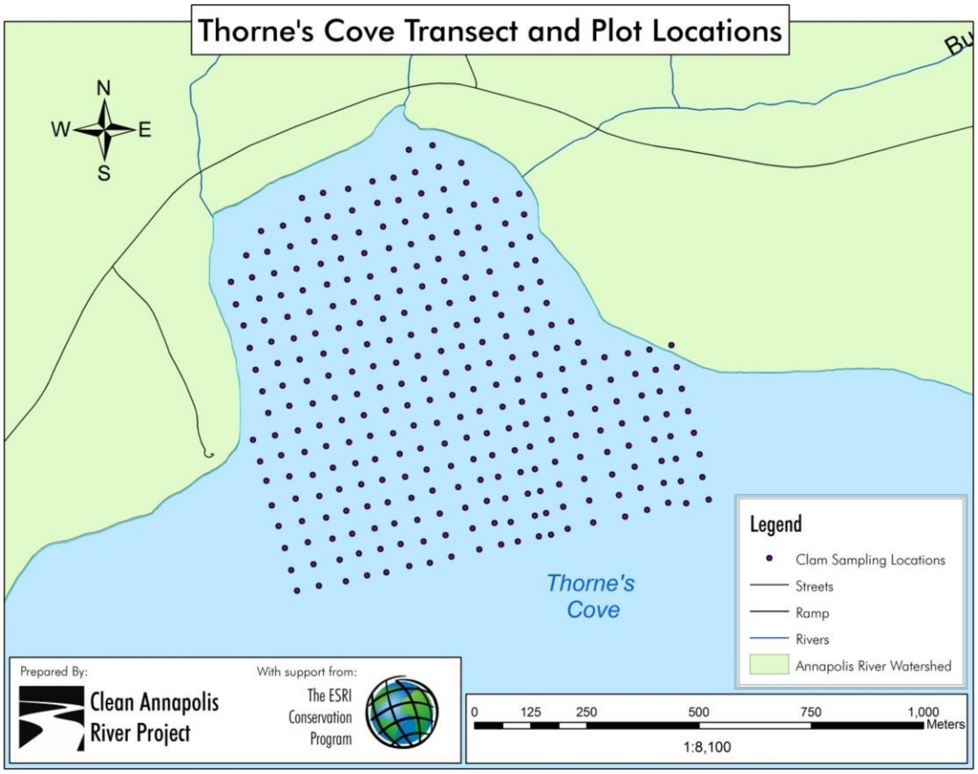

Figure 9. Sampling grid at Thorne's Cove.

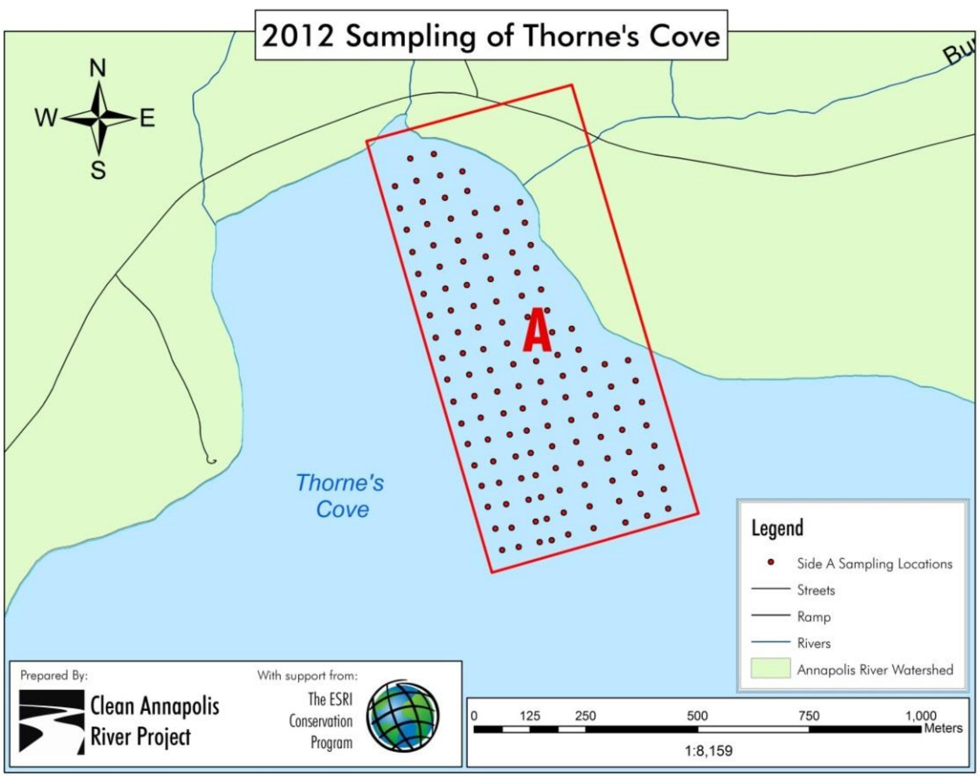

Figure 10. 2012 Sampling locations at Thorne's Cove.

Sampling was completed using a stock sampler, a sampling device whose prototype was developed during the spring and summer of 2006, in consultation with individuals from the DFO and Kouchibouguac National Park. This prototype was tested and evaluated by CARP staff in the summer of 2007 (Sharpe, 2007). The prototype samples a larger area (0.25 m^2) than the conventional hand-digging method (0.0625 m^2). In testing studies, it was found that with the stock sampler, 0.22 m^2 per person-hour could be sampled, as opposed to the 0.04m^2 per person-hour by hand digging. A lower breakage rate was also found, with 29% as compared to 48% of clams being broken during handling with the stock sampler, and hand digging methods, respectively (Sharpe, 2007).

The population assessment methodology used by Sullivan (2007a) was therefore adapted for use with a stock sampler – plots were still sampled using transect grids. However, rather than hand digging and sieving samples, a gasoline powered water pump was used to pump water through a venturi to create a suction. This suction was used to lift sediments and clams out of a 0.25m^2 round sampling ring pushed into the sediment, and samples were taken to a depth of 20cm. The material was washed through a mesh, and samples were retrieved from the mesh, sieved and sorted. The venturi portion of the stock sampler and the full device in use from a boat at Thorne's Cove are illustrated in Figures 11 and 12.

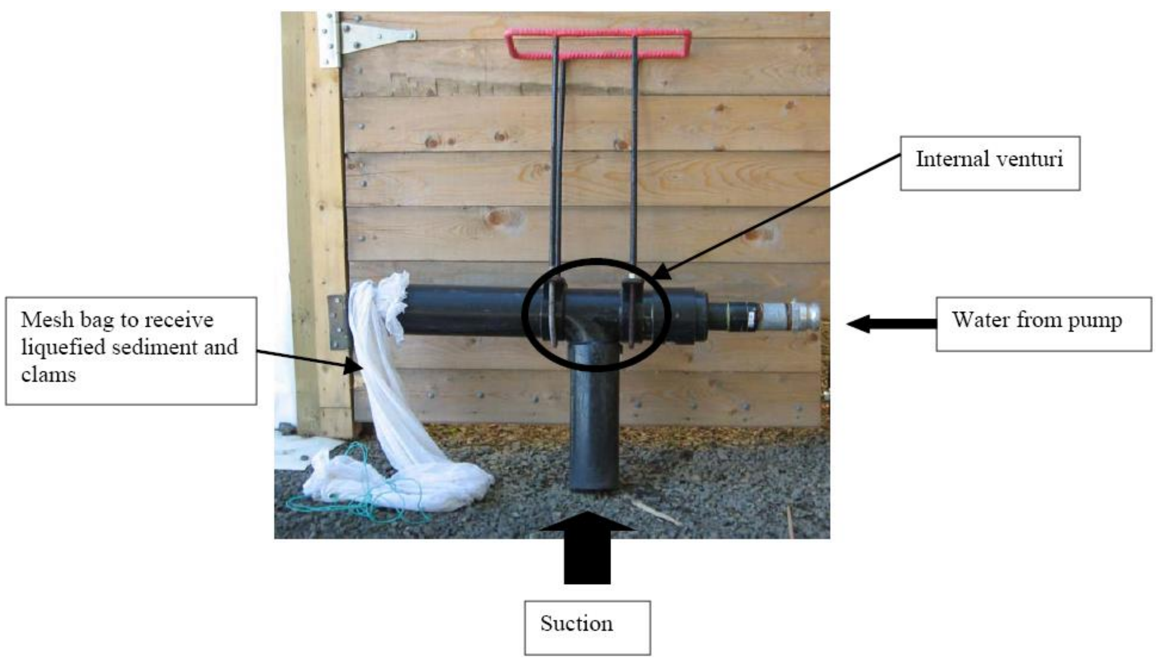

Figure 11. Venturi suction device used to extract clams from sediments.

Figure 12. Stock sampler in use at Thorne's Cove.

Once samples were retrieved from the mesh bag attached to the venture suction device, they were sieved using a 5 mm mesh, and clams were retrieved from samples. The number of clams and their shell lengths were tallied on a data sheet, and weights were taken of clams collected from every 25th sample (refer to Appendix C for the data sheet). All clams were then returned to the sampled area. A coarse and rapid assessment of sediment types was also conducted at each sampling site by grabbing a fistful of mud and categorizing sediment types using a feel test. It should be noted however that further quantification of sediment types should be conducted using sieves to improve accuracy of sediment identification. Establishment of a sampling grid took place from July 17-25, 2012, and sampling occurred between August 16th and September 11th, 2012.

A regression analysis was done on the lengths and weights of the clams, to generate a formula that could be used to estimate the biomass of different clam size categories. See Figure D1 in Appendix D for the regression analysis. The methodology used for the statistical analysis and biomass calculations were the same as those used by Sullivan (2007), and were taken from LeBlanc (1997).

Results

Clam Densities and Length Distributions

The portion of Thorne's Cove (Side A) that was sampled in 2012 had a wide variation in clam densities between sampling sites on the beach. There was also a variation between densities of various size classes of clams within a site. A total of 129 plots were sampled on Side A of Thorne's Cove this past season. Overall, the mean density of clams at Thorne's Cove (Side A) was 24.84±7.07 clams/m^2. Table 1 shows the total number of clams retrieved for each size class, as well as the mean density and standard error for clams sampled at Thorne's Cove.

Table 1. Total Number, Density and Standard Error of Clams at Thorne's Cove (Side A), Annapolis Basin, 2012.

Size Category (mm)	# Clams Measured	Mean Density (clams/m^2)	Standard Error
≥ 5 and <10	134	4.16	0.95
≥10 and <15	56	1.74	0.48
≥15 and <20	167	5.18	1.41
≥20 and <25	189	5.86	1.55
≥25 and <30	46	1.43	0.35
≥30 and <35	31	0.96	0.34
≥35 and <40	47	1.46	0.74
≥40 and <45	40	1.24	0.30
≥45 and <50	35	1.09	0.33
≥50 and <55	31	0.96	0.27
≥55 and <60	11	0.34	0.12
≥60 and <65	9	0.28	0.11
≥65 and <69	1	0.03	0.03
≥69	4	0.12	0.09
Total Commercial Size (> 45 mm)	91	2.82	0.95
Total	801	24.84	7.07

A total of 801 clams were retrieved from the sample plots, and of these, 91 (11%) were large enough to be used for commercial purposes. The mean density of commercial size classes (≥45 mm) was 2.82±0.95 clams/m^2 for Side A. Figure 13 illustrates the numbers of clams of each size class found at Thorne's Cove, with the commercial sized clams represented by the purple bars. Figure 14 shows the mean density of commercial sized clams for each size class.

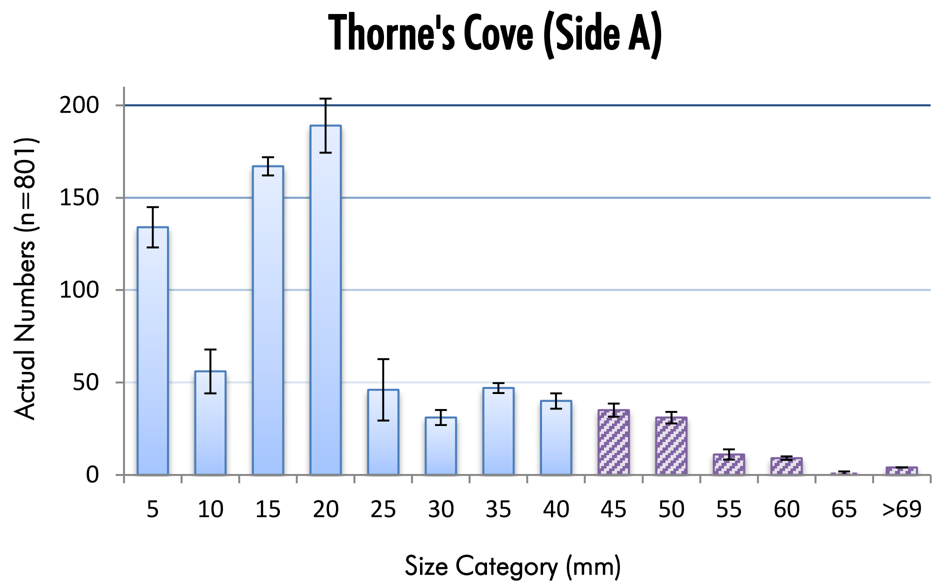

Figure 13. Length frequency distributions of Soft-shell clams at Thorne's Cove with standard error bars (Side A). Blue bars denote size non-commercial size classes, and the purple patterned bars indicate commercial size classes.

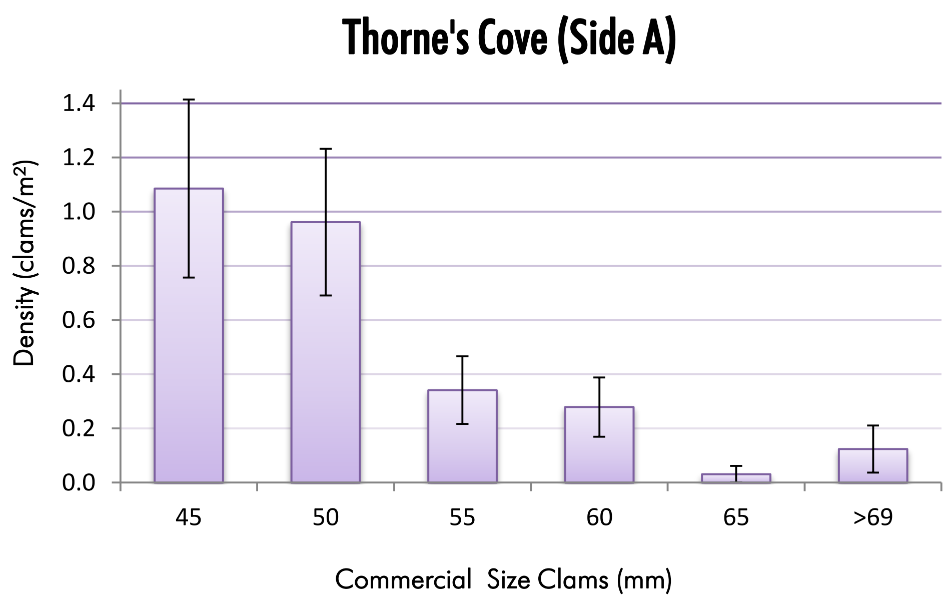

Figure 14. Density of commercial clams across multiple size classes, with standard error bars, for Thorne's Cove (Side A).

The majority of clams collected were in the smallest size classes (<25 mm), and clams from 15 to 24 mm were found to have the largest length frequency distributions, with 167 measured in the ≥ 15 and <20 size class, and 189 measured clams in the ≥ 20 and <25 class (denoted by 15 and 20, respectively, in Figure 13). Fewer clams were found in the size classes above 25 mm, and relatively limited numbers were found overall in the commercial size classes.

The density of commercial-sized clams at Thorne's Cove was overall poor, with the highest densities in the ≥ 45 and <50 mm category, at 1.09 ± 0.33 clams/m^2, followed by those in the ≥ 50 and <55 mm size class, at 0.96 ± 0.27 clams/m^2. Overall density of commercial clams at Thorne's Cove (Side A) was found to be 2.82 ± 0.95 clams/m^2 compared to 22.03 ± 6.12 clams/m^2 overall for undersized clams.

The distribution of soft-shell clams was also mapped out across the beach, to illustrate where areas of denser pockets of clams were found. Figures 15 through 30 display maps of the distribution frequencies of the clams for all size classes at Thorne's Cove (Side A). The higher frequencies of clams are represented by increasingly larger circles. Overall, the highest distribution frequencies were found in plots closer to shore.

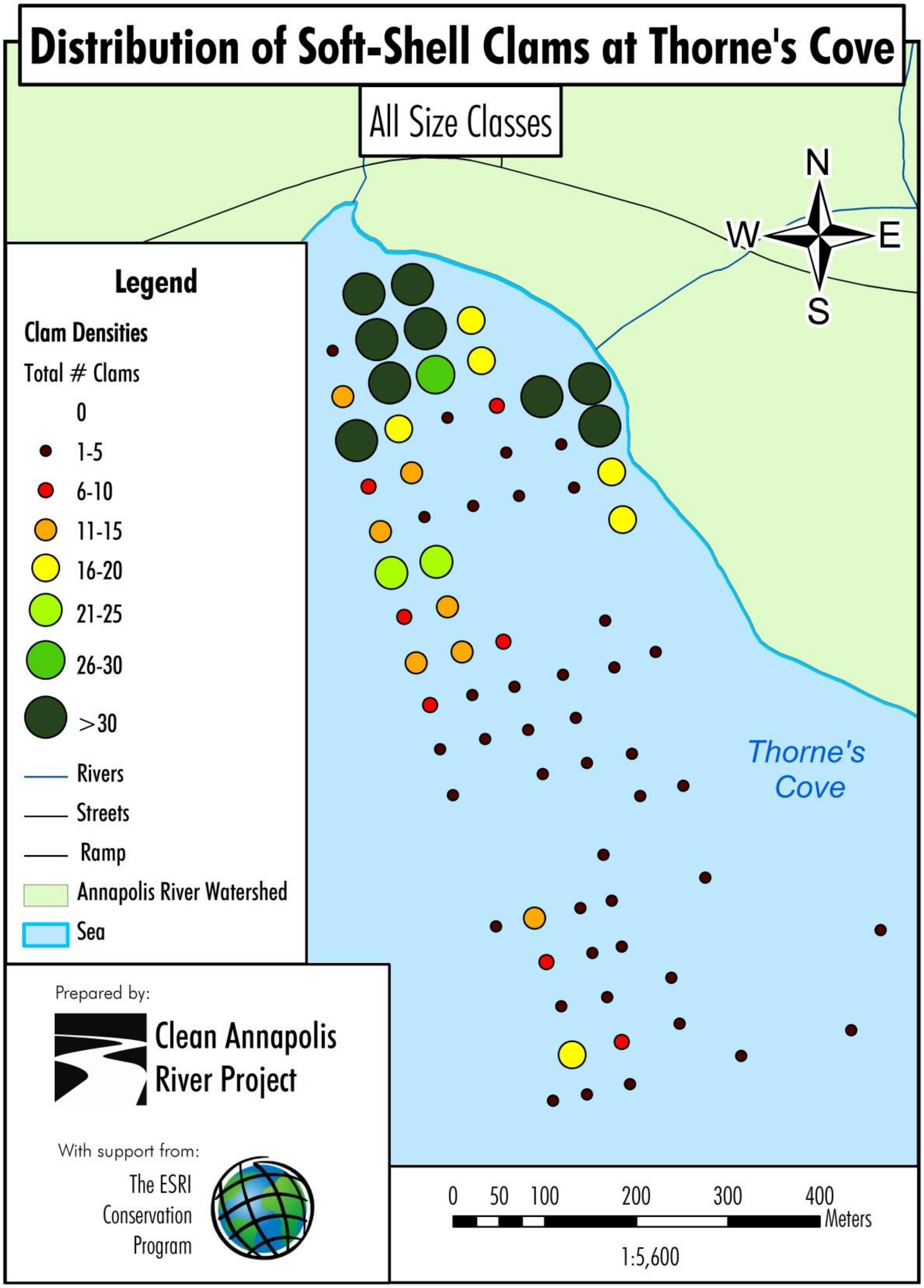

Figure 15. Geospatial frequency distribution of all clam lengths at Thorne's Cove (Side A).

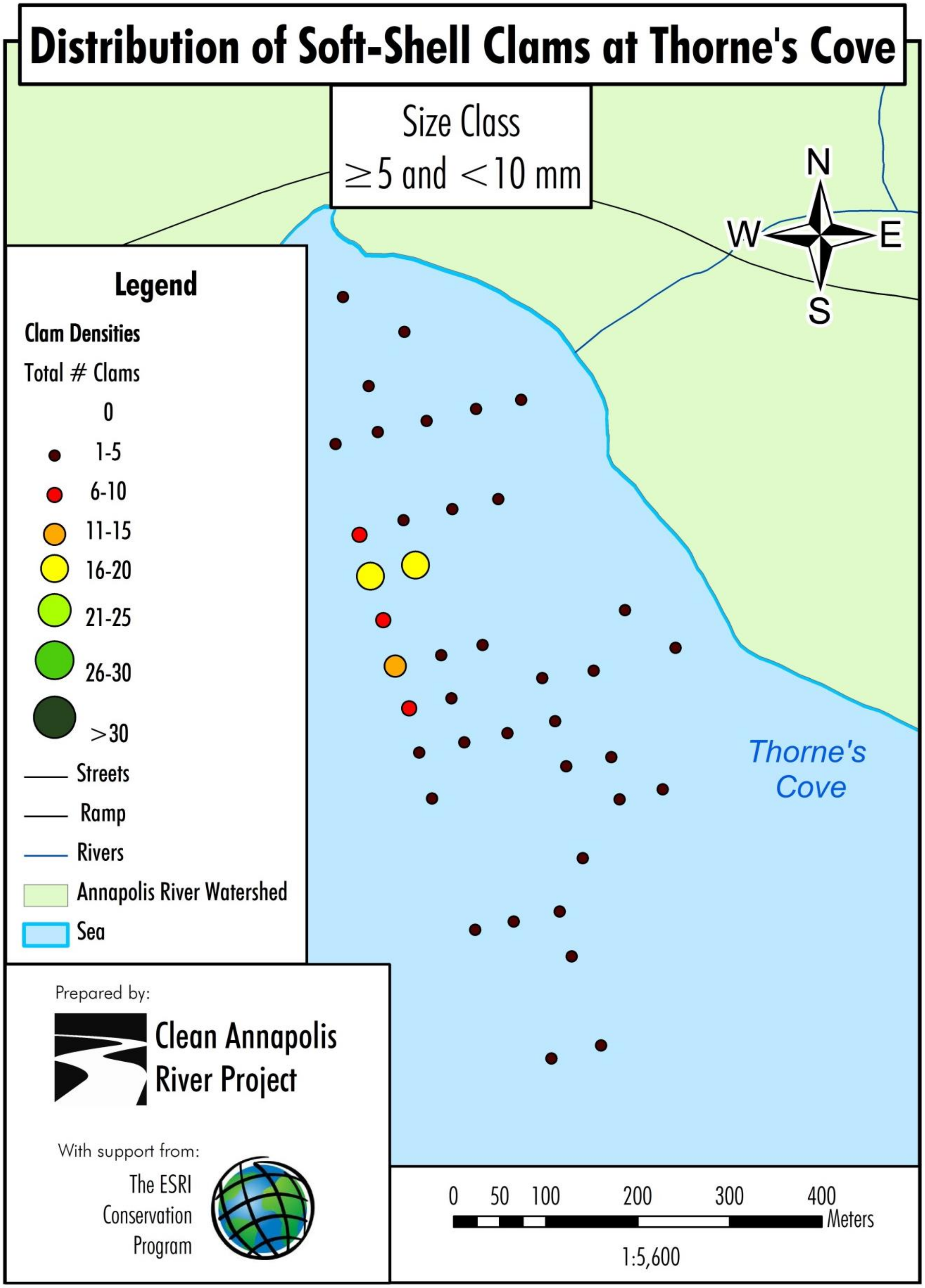

Figure 16. Geospatial frequency distribution of clams ≥5 and <10 mm in length, at Thorne's Cove (Side A).

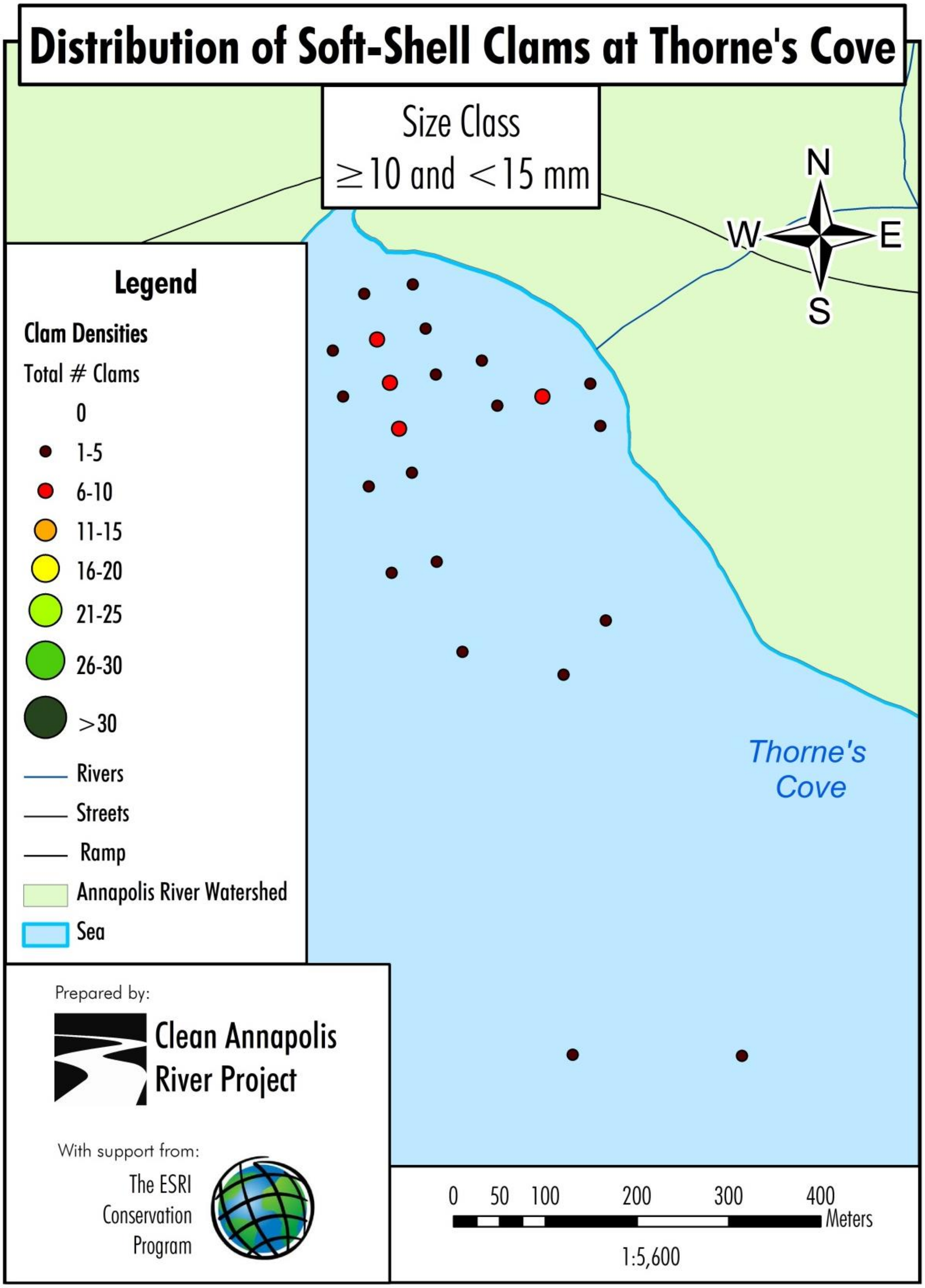

Figure 17. Geospatial frequency distribution of clams ≥10 and <15 mm in length, at Thorne's Cove (Side A).

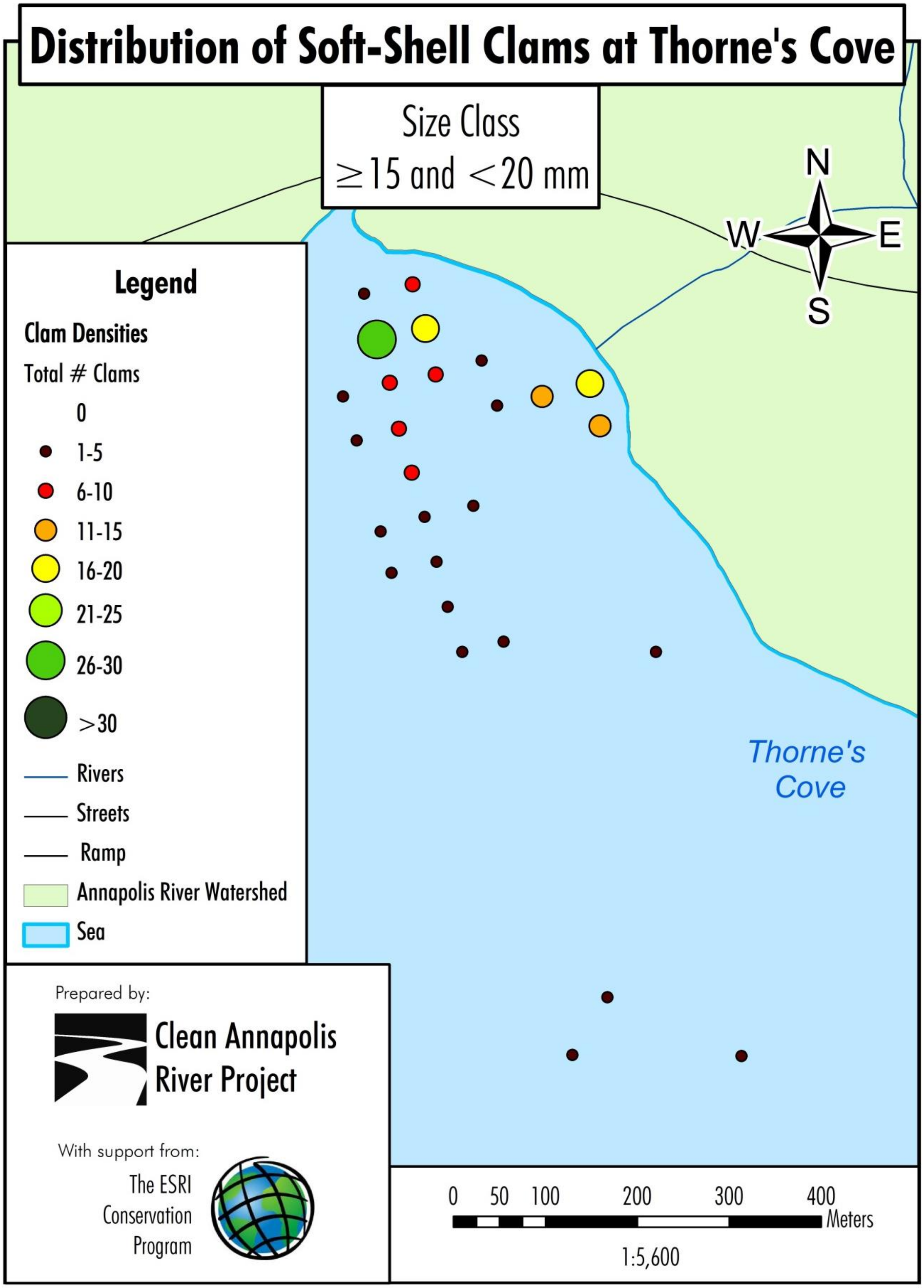

Figure 18. Geospatial frequency distribution of clams ≥15 and <20 mm in length, at Thorne's Cove (Side A).

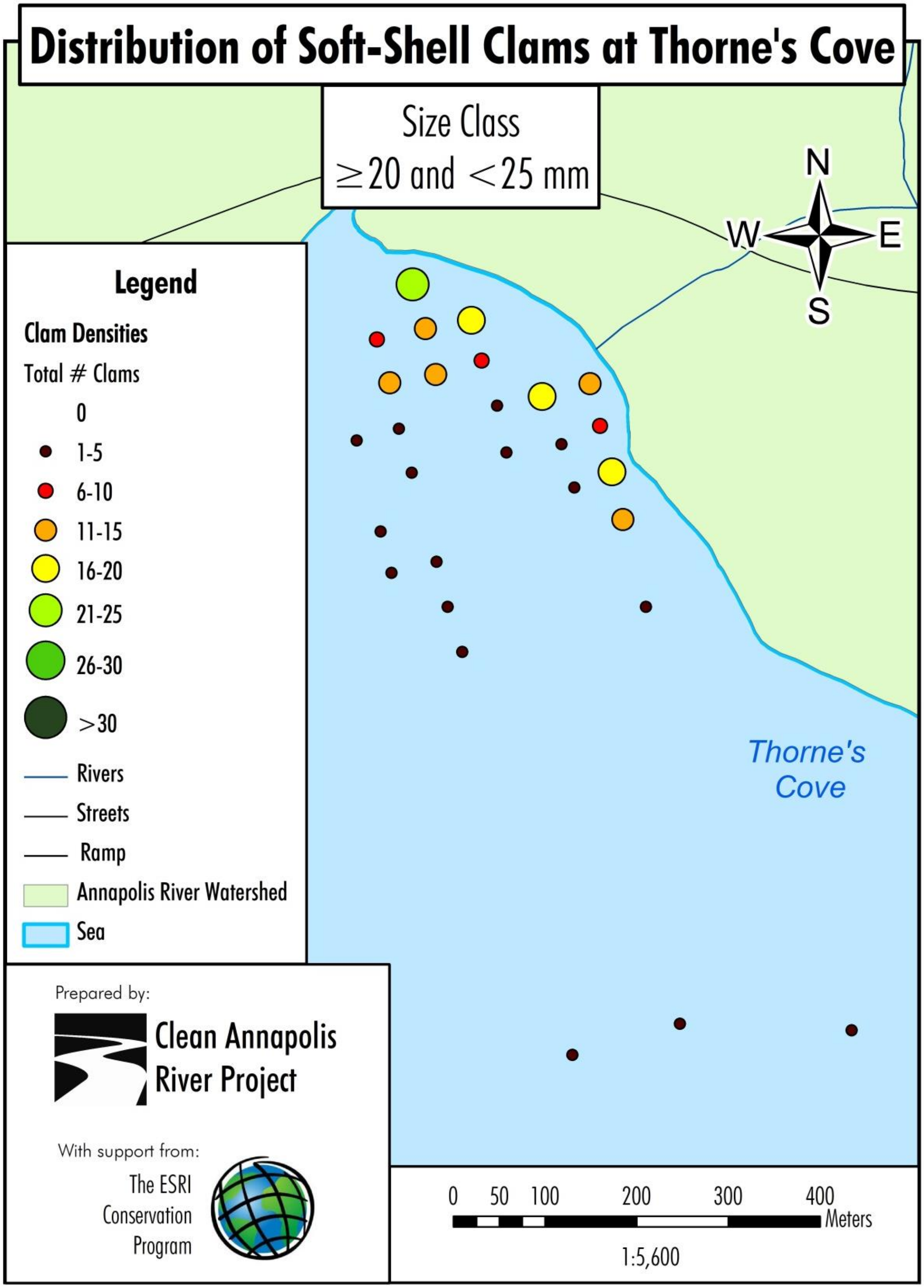

Figure 19. Geospatial frequency distribution of clams ≥20 and <25 mm in length, at Thorne's Cove (Side A).

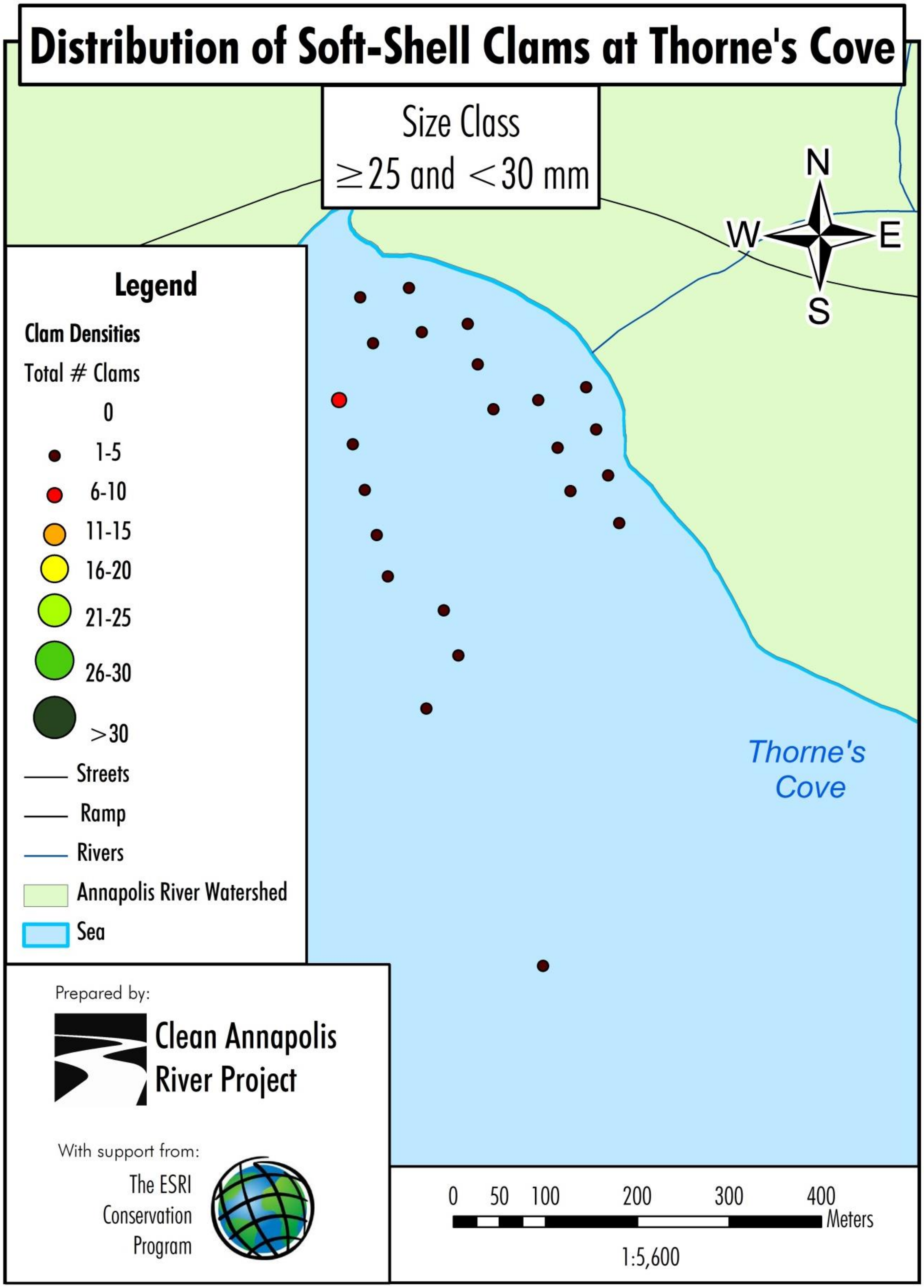

Figure 20. Geospatial frequency distribution of clams ≥ 25 and <30 mm in length, at Thorne's Cove (Side A).

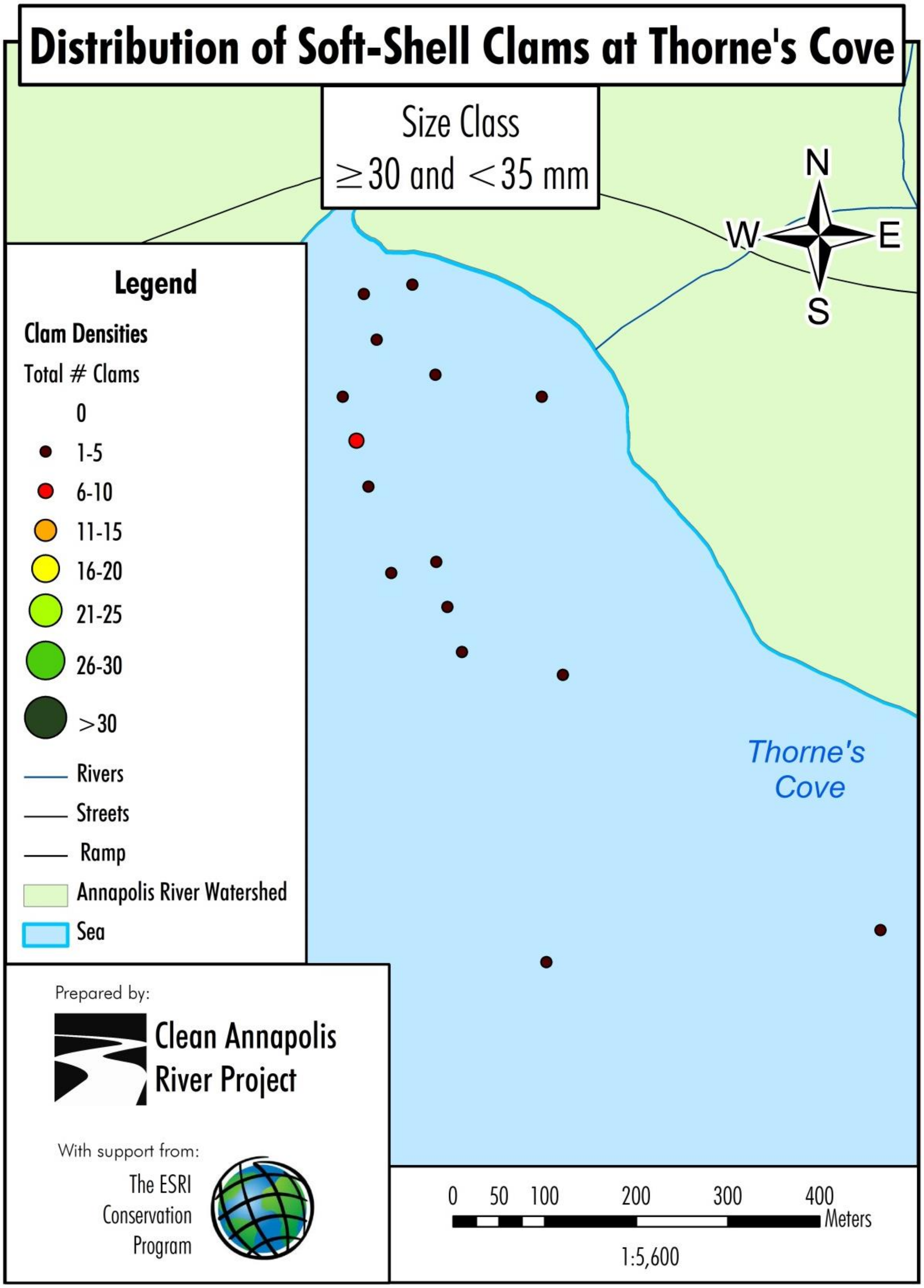

Figure 21. Geospatial frequency distribution of clams ≥30 and <35 mm in length, at Thorne's Cove (Side A).

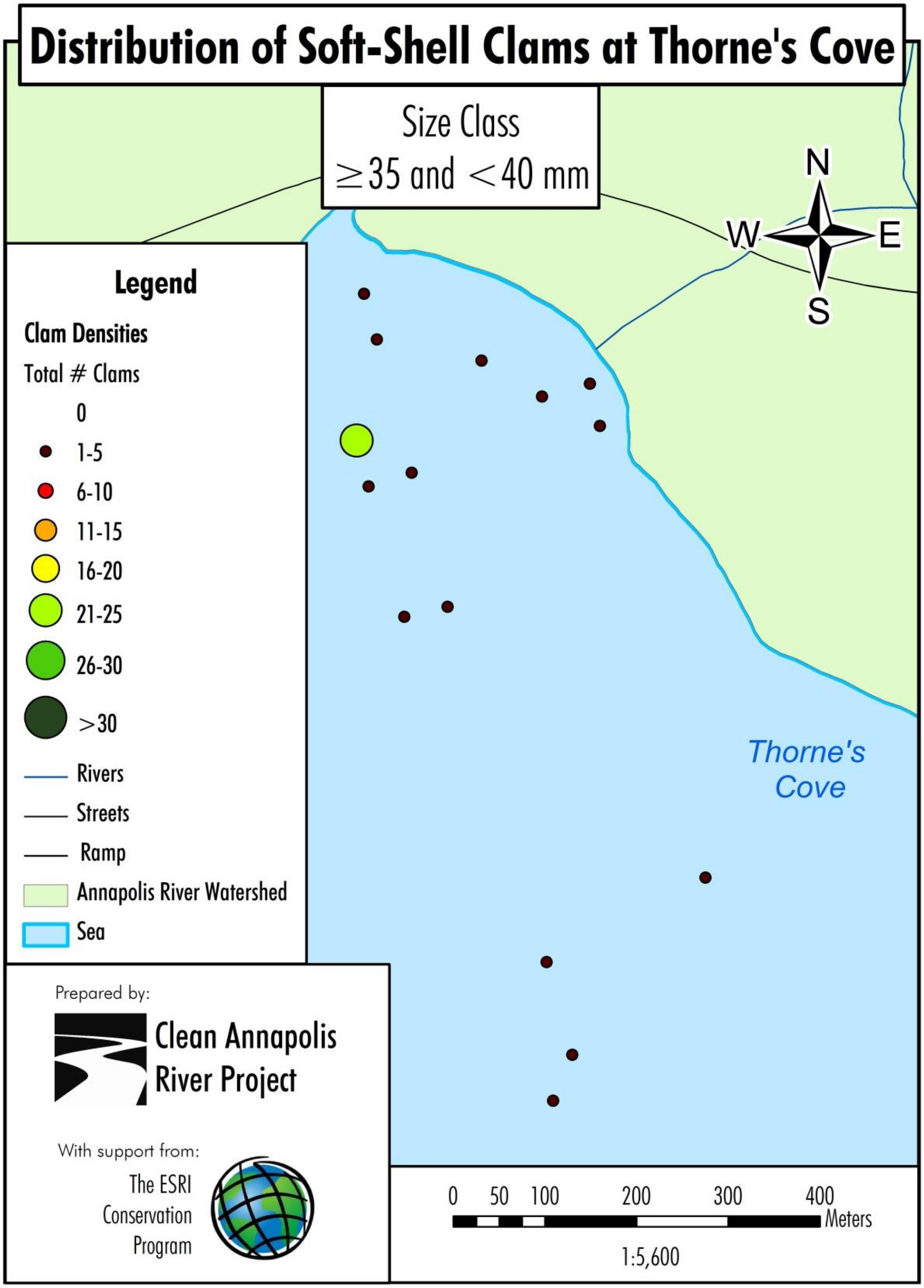

Figure 22. Geospatial frequency distribution of clams ≥35 and <40 mm in length, at Thorne's Cove (Side A).

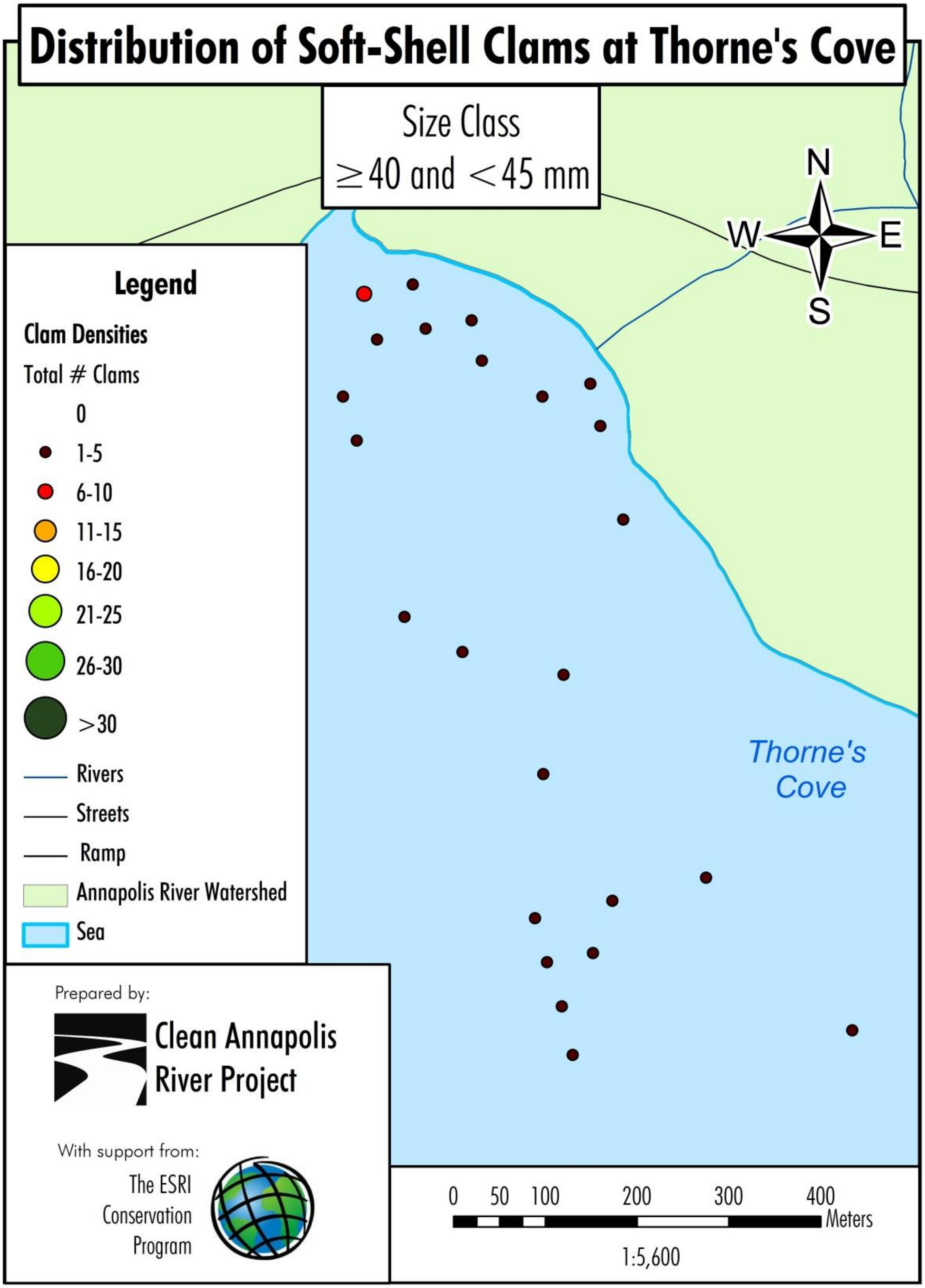

Figure 23. Geospatial frequency distribution of clams ≥40 and <45 mm in length, at Thorne's Cove (Side A).

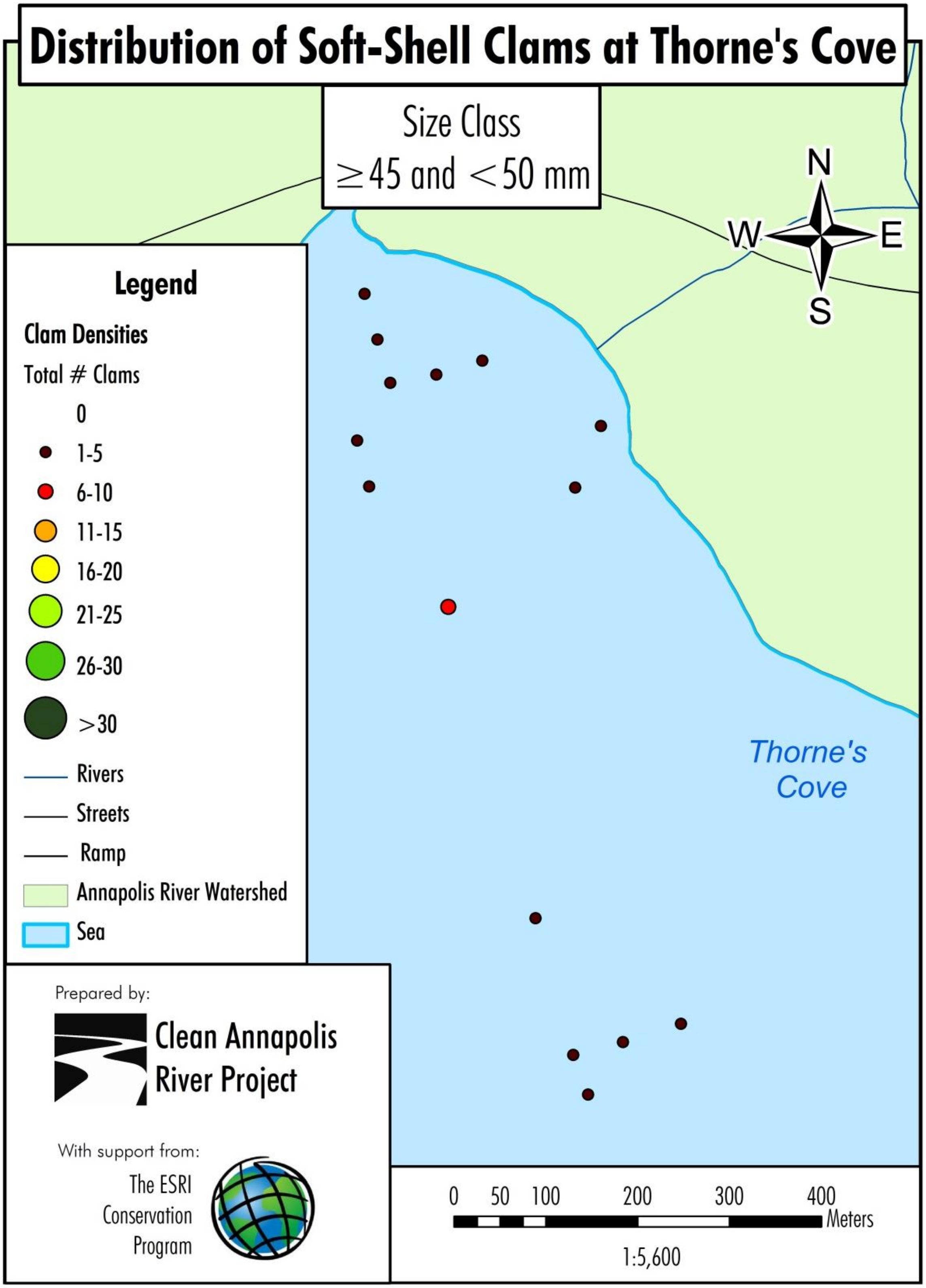

Figure 24. Geospatial frequency distribution of clams ≥45 and <50 mm in length, at Thorne's Cove (Side A).

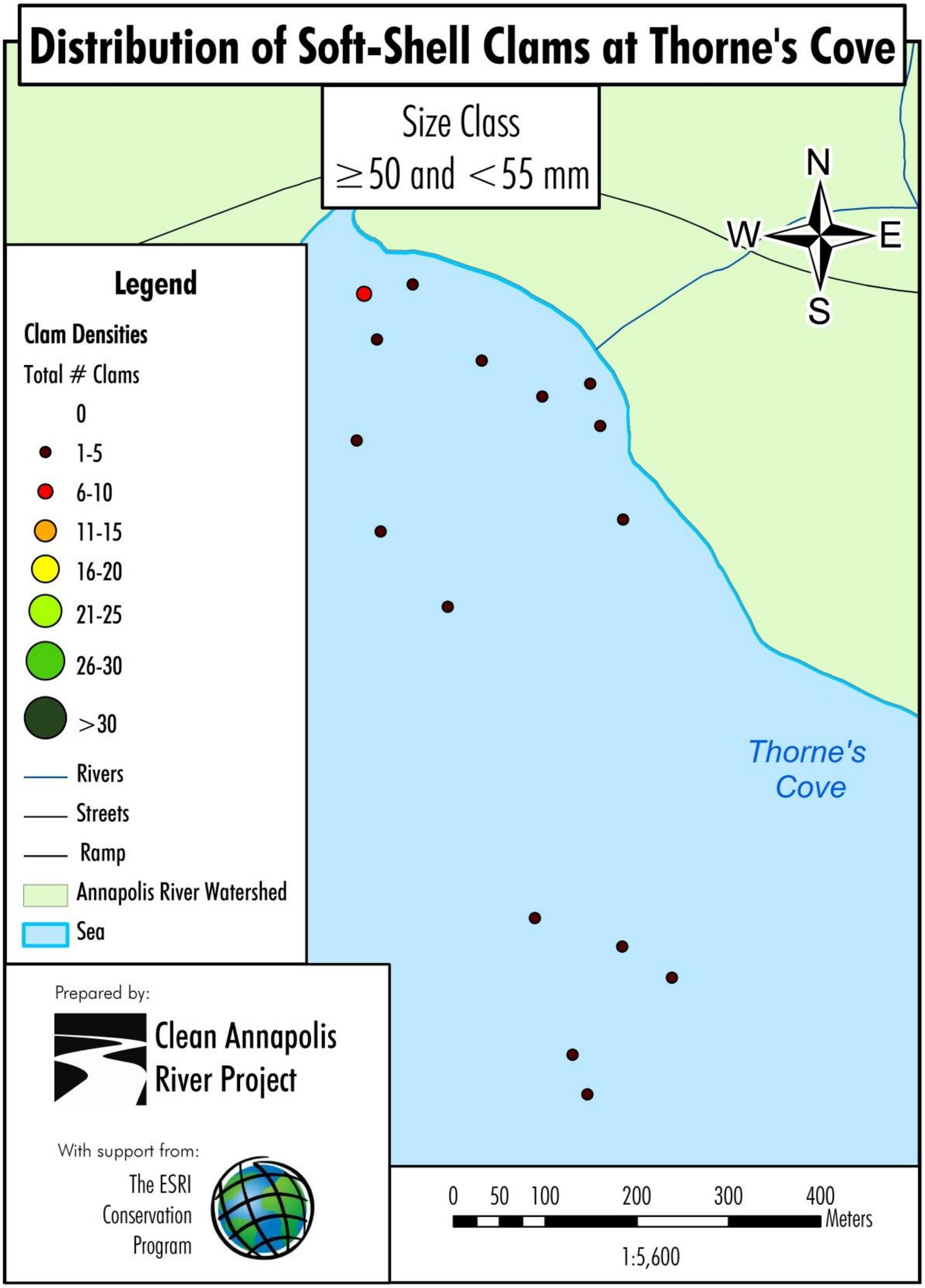

Figure 25. Geospatial frequency distribution of clams ≥50 and <55 mm in length, at Thorne's Cove (Side A).

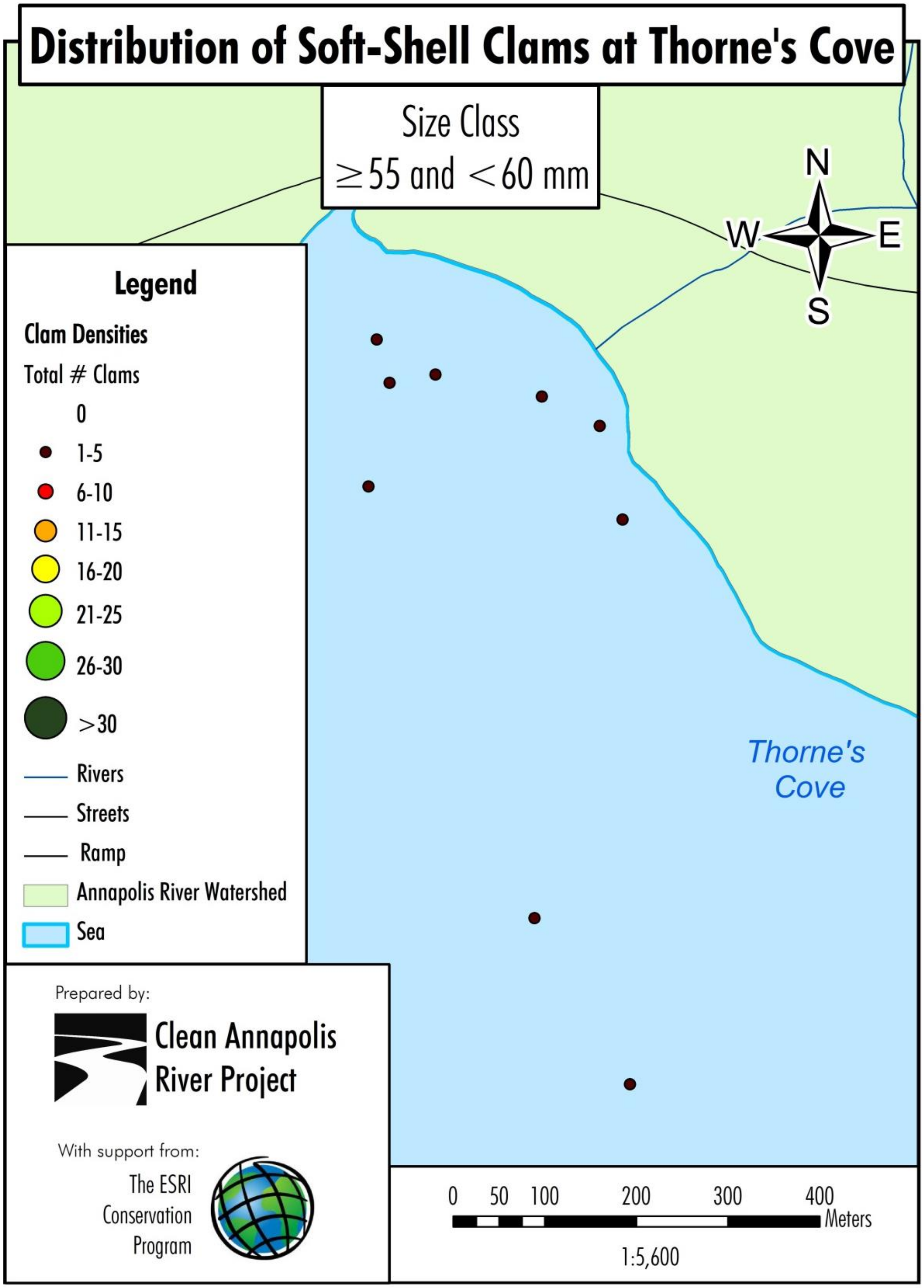

Figure 26. Geospatial frequency distribution of clams ≥55 and <60 mm in length, at Thorne's Cove (Side A).

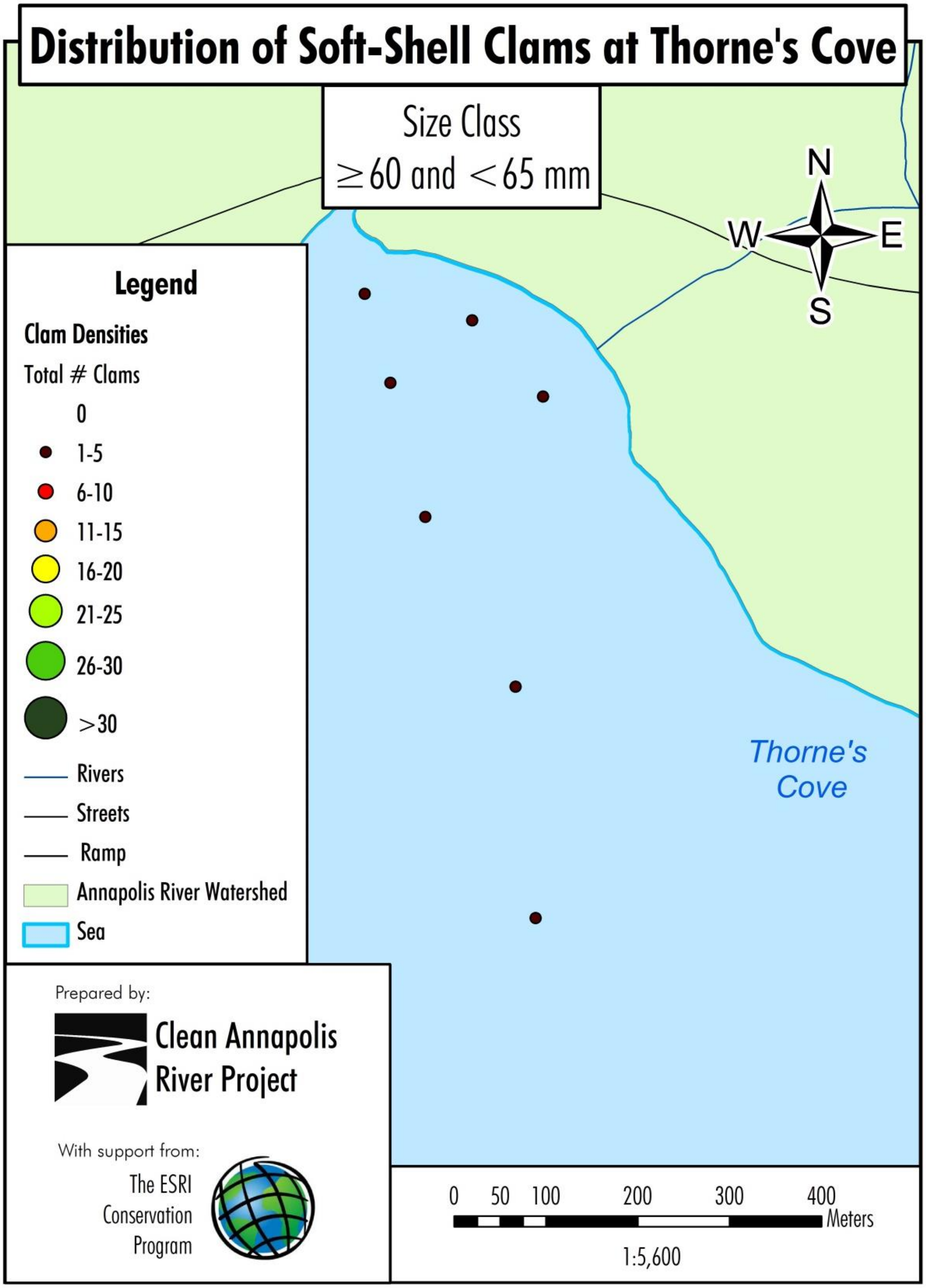

Figure 27. Geospatial frequency distribution of clams ≥60 and <65 mm in length, at Thorne's Cove (Side A).

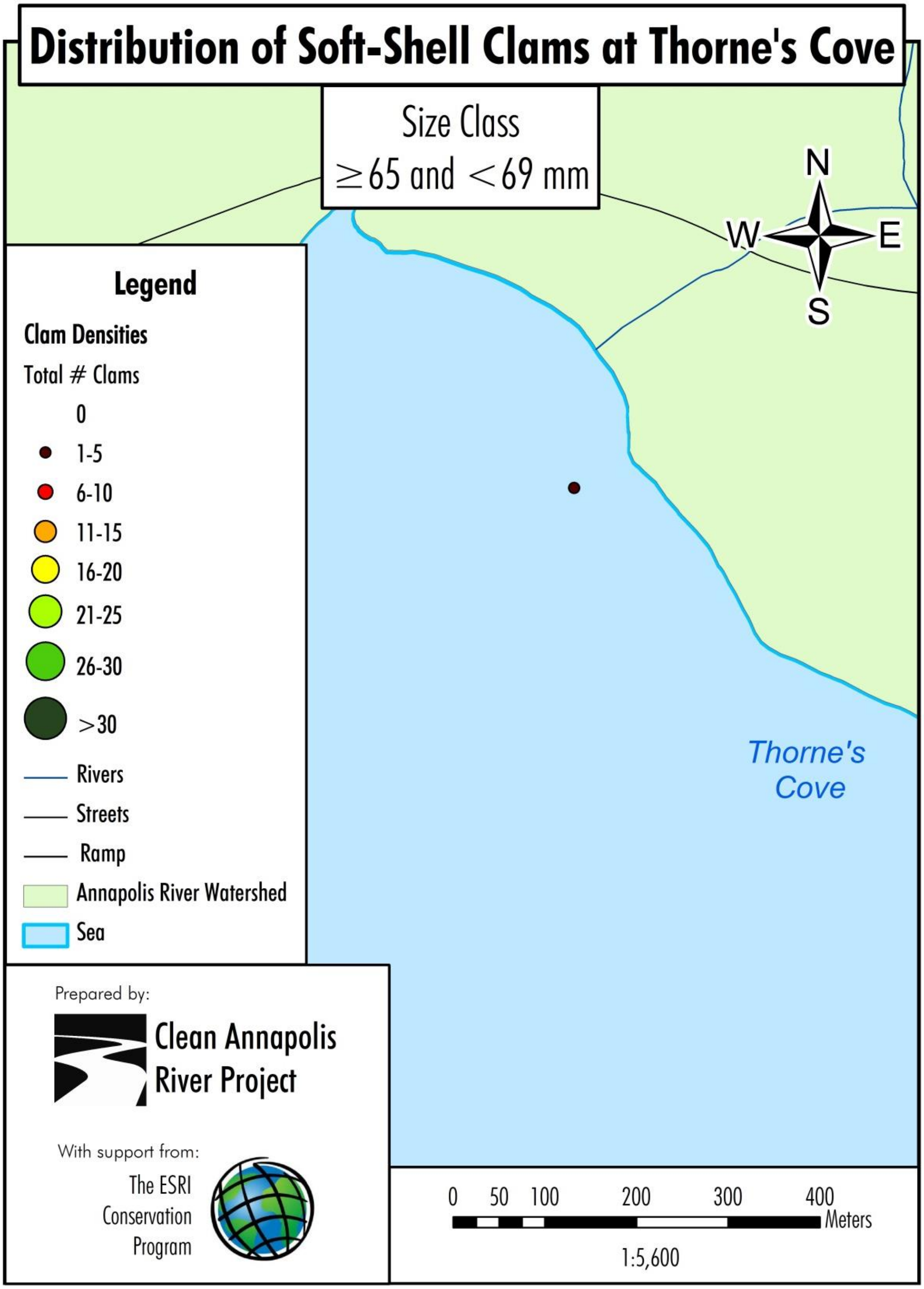

Figure 28. Geospatial frequency distribution of clams ≥65 and <69 mm in length, at Thorne's Cove (Side A).

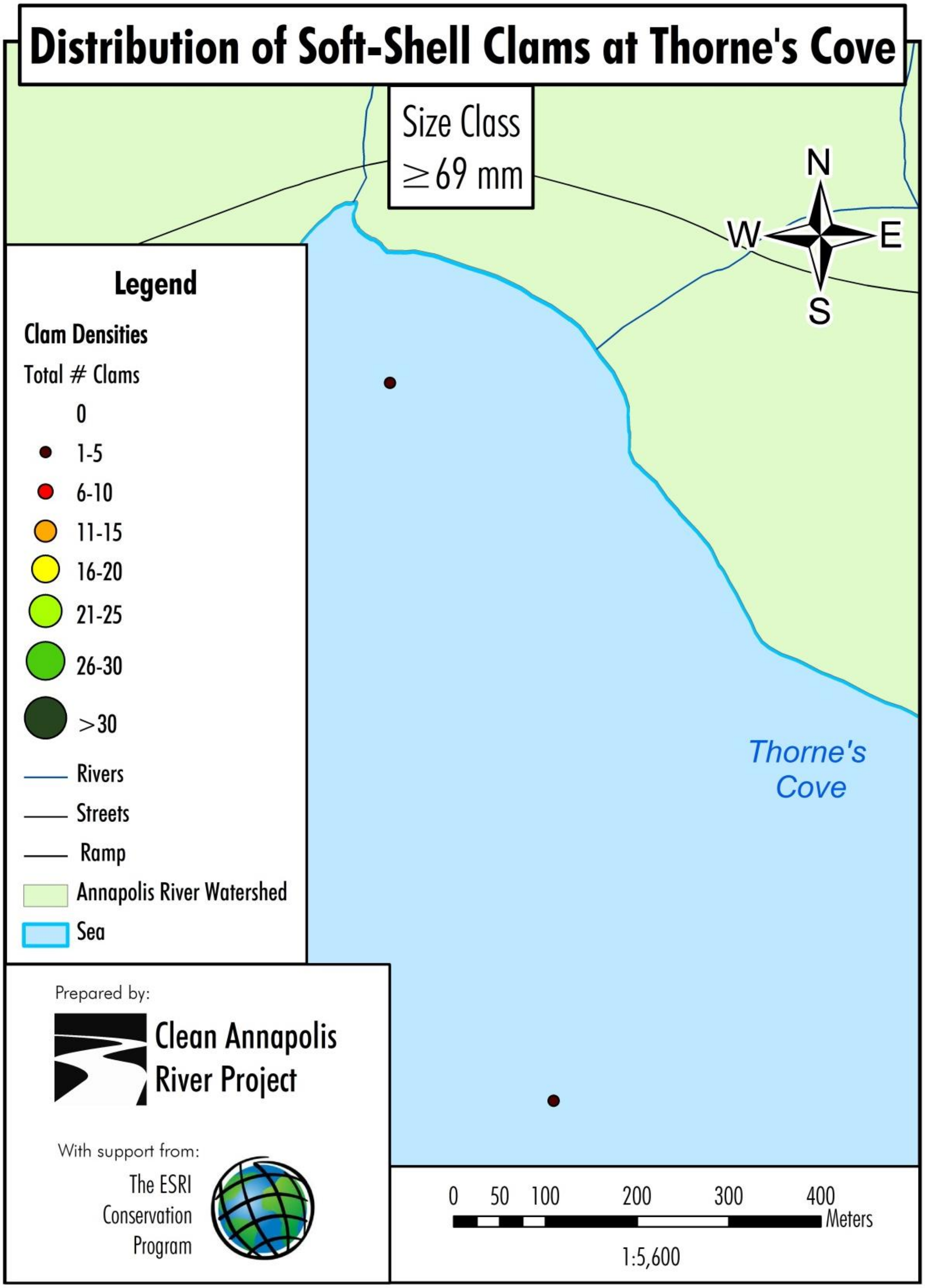

Figure 29. Geospatial frequency distribution of clams ≥69 mm in length, at Thorne's Cove (Side A).

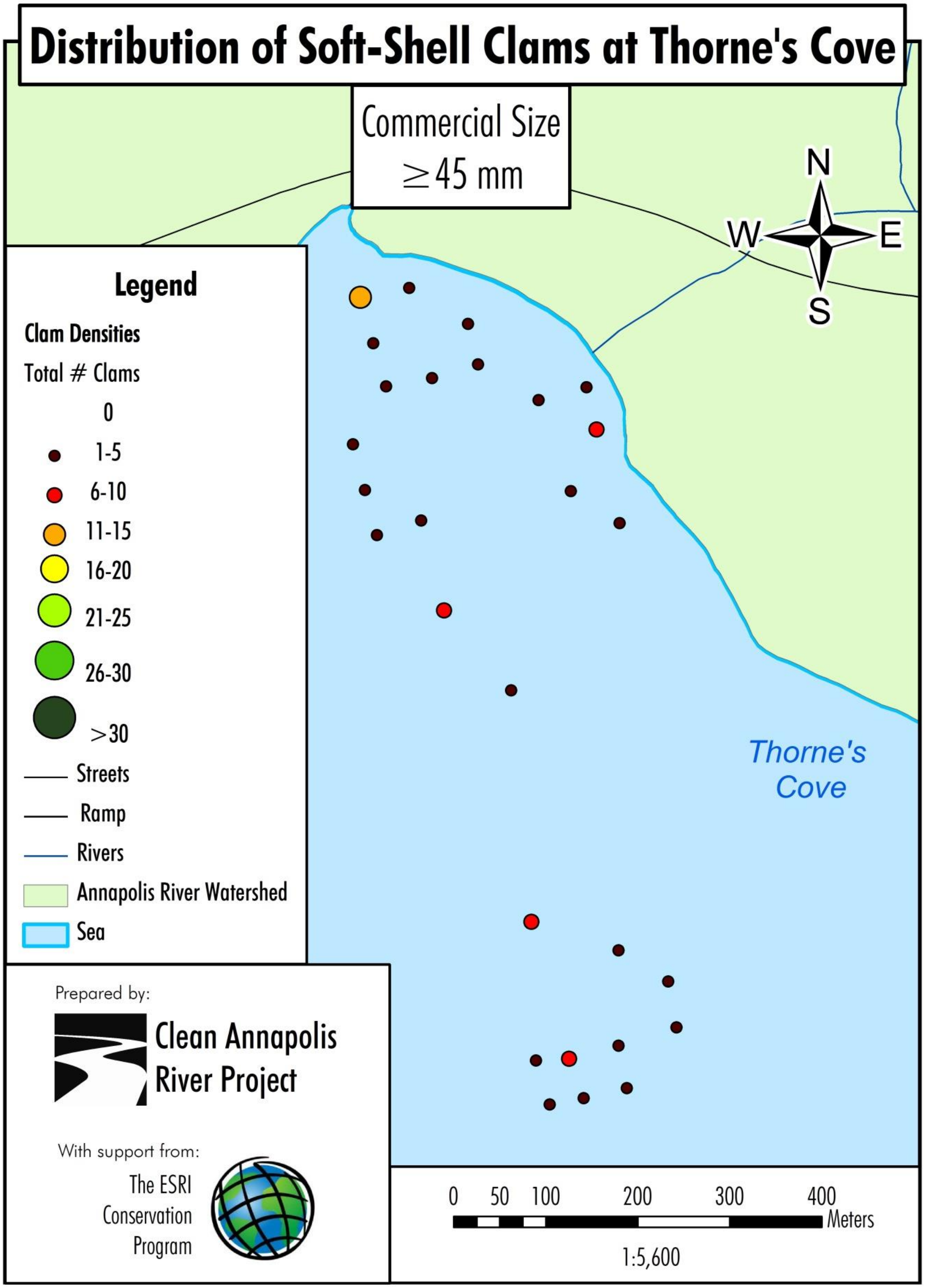

Figure 30. Geospatial frequency distribution of commercial-sized clams ≥45 mm in length, at Thorne's Cove (Side A).

Biomass Estimates

The mean biomass of commercial sized soft-shell clams was estimated for Thorne's Cove (Side A) at 19,170kg, and biomass values ranged from approximately 12,162 to 26,177 kg (Table 2). Consequently, the mean biomass of all clams (commercial and non-commercial sizes) was estimated to be 31,471 kg and ranged from 20,738 kg to 42,204 kg (Table 3).

Table 2. Biomass of commercial-sized clams at Thorne's Cove (Side A).

Calculation	≥45 to <50 mm Regression X=47.5	≥ 50 to <54 mm Regression X=52.5	≥ 55 to <59 mm Regression X=57.5	≥ 60 to <64 mm Regression X=62.5	≥ 65 to <69 mm Regression X=67.5	≥69 mm Regression X=70	Total
Mean Mass/Plot (g)	3.07	3.49	1.55	1.56	0.21	0.92	-
Standard Error (g)	0.93	0.98	0.57	0.61	0.21	0.65	-
Lower Confidence Interval (g)	2.14	2.50	0.98	0.95	0.00	0.27	-
Upper Confidence Interval (g)	4.00	4.47	2.12	2.17	0.42	1.56	-
Biomass (kg) (lower CI)	3804	4449	1746	1682	0	482	12162
Biomass (kg) (upper CI)	7109	7935	3759	3854	744	2776	26177
Mean Biomass (kg)	5457	6192	2752	2768	372	1629	19170

Table 3. Biomass for commercial-sized and non commercial-sized clams at Thorne's Cove (Side A).

Calculation	Commercial-Sized Clams	All Clams	% Commercial-Sized
Biomass (kg) (lower CI)	12162	20738	58.6
Biomass (kg) (upper CI)	26177	42204	62.0
Mean Biomass (kg)	19170	31471	60.9

Sediment Types

Sediment types were characterized by feel and were estimated from sediments grabbed from sample plots. More detailed analyses should be completed to gain a more accurate picture of the sediment composition at Thorne's Cove. Figure 32 shows the results of the coarse sediment characterizations completed during sampling in the summer of 2012. Observations indicated that the sampling area in Thorne's Cove (Side A) was comprised of relatively dense sediments, with heavy clays and silty clays being the most predominant substrates. There were also a few pockets of coarser substrates such as sands and gravels closer to shore, and in pockets closer to the low water mark area as well, where a gravel bar was located.

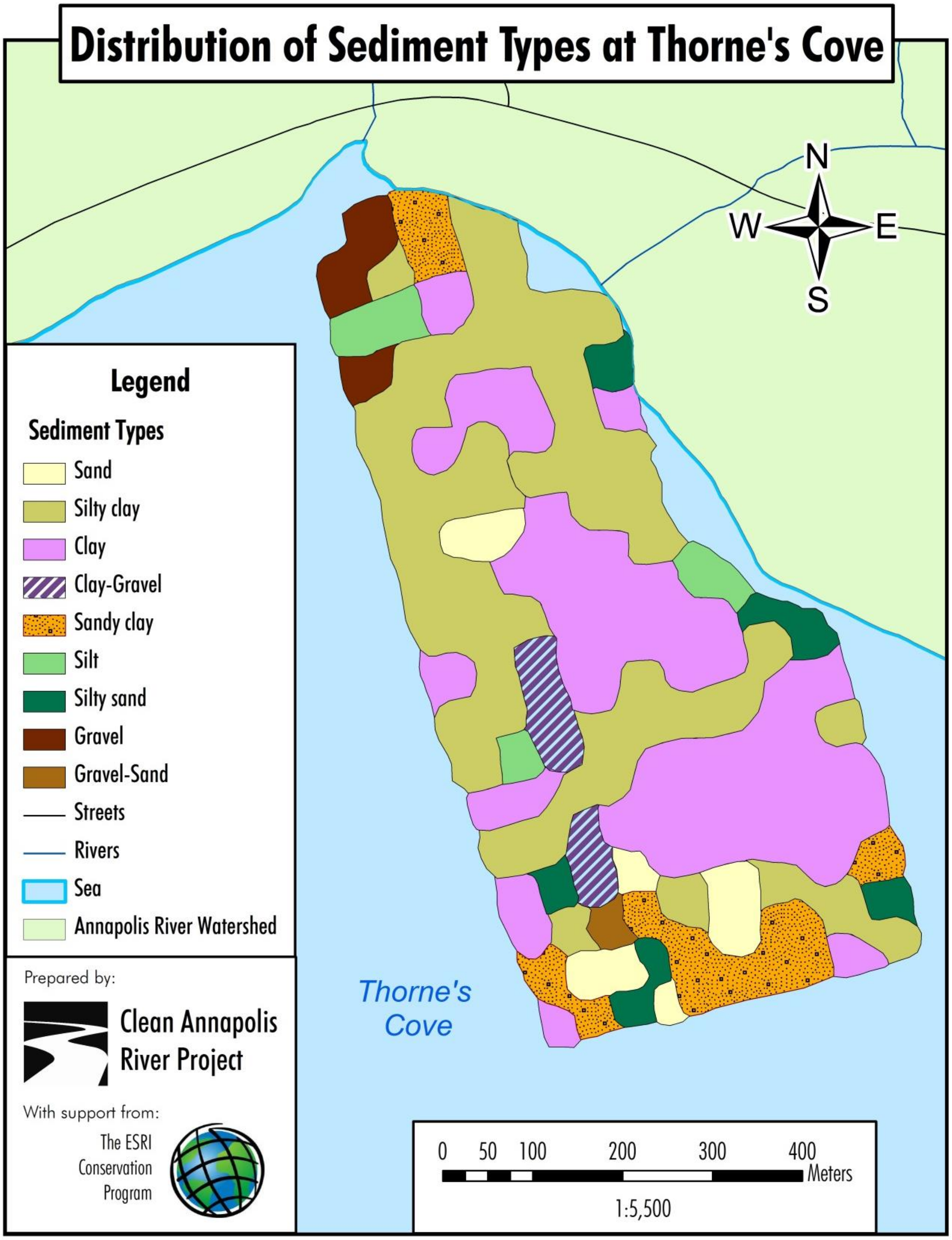

Figure 31. General sediment types found during surveys at Thorne's Cove (Side A). NOTE: These were not quantitative surveys. Actual sediment analysis should be completed in the future at this site.

Discussion

Density and Length Frequency Distributions

The 2012 population survey at Thorne's Cove (Side A) revealed lower population numbers than those found by Sullivan (2007) at Deep Brook and Karsdale in 2006, and do not meet the sustainable harvest minimum density criteria used by Kouchibouguac National Park (KNP). The most recent previously documented assessment at Thorne's Cove was completed in 1995, using two transects placed 50m apart, to measure clam recruitment levels ($<$15 mm) on the East and West sides (Thorpe and Robinson, 1995). The majority of clam densities observed by Thorpe and Robinson (1995) were found in the mid- and lower- intertidal ranges, and the highest densities were observed for clams that were $<$5 mm in length. This data is not very comparable to that collected by CARP in 2012, as clams smaller than 5 mm in length were not captured in our study.

Angus *et al.* (1985) had completed the most intensive population survey to date at Thorne's Cove prior to CARP's 2012 survey, using 5 transects to span the entire beach. They found densities of clam populations to be 1.8 clams/m^2 for pre-recruits (43-50mm) and 2.7 clams/m^2 for recruits (51+mm). In the 2012 CARP survey of Side A of Thorne's Cove, 1.1 clams/m^2 were found for the 'pre-recruit' class ($\geq$45 and $<$50 mm), and 1.7 clams/m^2 were found for recruits (50+ mm), using the most intensive and thorough surveying technique to date. Table 4 outlines the past and current population survey results at Thorne's Cove. As methods and sampling areas were not identical, it is difficult to determine with certainty whether there has been a decline in the clam population at Thorne's Cove since the mid-1980s. We do know however that clam levels are depleted and that this area was heavily stressed by harvesters in the past.

Table 4. Comparison of mean clam densities between a past (Angus *et al.*) and current (CARP) stock assessment of Thorne's Cove.

Mean Density (clams/m^2)	"Pre-recruit"	"Recruits"
Angus *et al.* (1985)	$\geq$43 and $<$51 mm	51+ mm
	1.8 clams/m^2	2.7 clams/m^2
CARP (2012)	$\geq$45 and $<$50 mm	50+ mm
	1.1 clams/m^2	1.7 clams/m^2

The sustainable harvest levels used by KNP require a minimum mean density of 12 clams/m^2 for commercial-sized clams (50+ mm), and an overall density of 100 clams/m^2 at the beach. While it is impossible to draw conclusions at this time for the entire beach at Thorne's Cove, the portion that was sampled (Side A) contained low densities that did not meet these criteria (see Table 5). Mean commercial size density for clams $\geq$50 mm at Thorne's Cove (Side A) was 1.73 $\pm$0.62 clams/m^2 and overall mean density was well below 100, at 24.84 $\pm$7.07 clams/m^2.

It is possible that the observed densities will be higher on the other side of Thorne's Cove, as there were regions in Side A which contained areas with thick, hard clay substrates that did not contain any clams, and which may be too difficult for the clams to burrow in. It is believed that Side B of the beach may contain higher levels of soft, coarser sediments such as silt and sand (as opposed to thick clays), which may favour greater clam propagation (Audrie-Jo and Linds, 2007). However, a population assessment and sediment analysis of the west side of the beach (Side B) should be conducted to determine what is actually present in that area.

Table 5. Mean density and total numbers of clams at Thorne's Cove (Side A), Annapolis Basin, compared to the KNP standard for sustainable harvest levels.

Mean Density (clams/m^2)	KNP Standard	Thorne's Cove (Side A)
Commercial Sized clams ($\geq$ 50mm)	12	1.73 $\pm$ 0.62
Total Clams	100	24.8 $\pm$ 7.07

The observed results were collected in August and September, after the beach at Thorne's Cove had been open to harvesters since April (mid-season), therefore results may not be representative of standing stocks that are present at the start of the harvesting season. The depleted numbers also indicate that the stock at Thorne's Cove would not support harvest sustainably until the end of the season in December.

The frequency of distribution of clams at Thorne's Cove varied across the range of size classes, however the highest frequencies seemed to occur in the $\geq$15 to $<$20mm, and $\geq$20 to $<$25 mm classes (Figure 13). While they tend to show a general trend towards higher juvenile recruitment, one would expect the observed frequencies to be highest in the lowest size classes and fall from there (Type III survivorship). In contrast, there is a sharp drop-off in survivorship between the $\geq$5 to $<$10 mm and the $\geq$10 to $<$15 mm classes. Populations rose again between the 15 mm and 25 mm sizes, but this was succeeded by a sharp decline in numbers in the $\geq$25 to $<$30 mm class. The higher size classes stabilized at the lower numbers, which is consistent with a Type III survivorship curve.

The observed differentials in frequencies between size classes may be a result of a variety of factors. Redjah *et al.* (2010) noted that larger juveniles (greater than 5-9 mm) were more susceptible to shear and transport at the sediment surface than smaller ones, which may explain some of the drop in clam numbers between the $\geq$5 to $<$10 mm and the $\geq$10 to $<$15 mm classes. Additionally, it has been established that as juveniles age, they tend to burrow deeper, and that as a clam burrows deeper, it is more likely to avoid green crab predation (Whitlow, 2009). Therefore, as juveniles age and burrow deeper, they may be able to more effectively avoid predation. Figures 16 through 18 show the geographical dispersal of clams at Thorne's Cove for a range of juvenile size classes.

The majority of the clams measured in the juvenile sizes from 10 to 25 mm were located in the high intertidal range, which may be attributable to both sediment type and decreased predation. Sediments in the high intertidal range (near shore) tended to have fewer thick clays, and were likely easier for the juvenile clams to burrow in. The high intertidal range can also provide a refuge and nursery for juvenile clams, as it is located at the fringe of clam predator ranges, such as with the clam worm *Cerebratulus lacteus*. Therefore, predation pressures on the shallower juveniles would be reduced (Rowell and Woo, 1990; Bowen and Hunt, 2009). CARP field staff also observed that substrate close to the shore was softer and siltier than the offshore substrates, whereupon there were a far greater number of areas composed of thick, compacted clays. The softer sediments likely played a role in the distribution pattern of the smaller clams, as they would seed more easily in the soft substrates as opposed to the hard substrates (Audrie-Jo and Linds, 2007).

The larger adult clams ($>$30 mm) were found to cluster primarily near shore in the upper intertidal range, and offshore in the lower intertidal range, where fewer of the juveniles were found. The greater proportion of adult clams found offshore as opposed to juveniles may likely be due to the fact that larger clams can burrow deeper to avoid the heavier predation pressures at the mid- and lower-intertidal ranges. Also, the larger clams can benefit from the longer submersion times at the lower tidal ranges to maximize feeding times and growth (Bowen and Hunt, 2009). One would expect, therefore, to find higher amounts of adults clams offshore overall, but the numbers and distributions observed may have also been affected by harvesting pressures. Generally, however, the frequency of individuals decreased with increasing length in the adult size classes, which is expected given the survivorship patterns in soft-shell clams. Changes in length distributions may also be attributable to any number of additional factors, such as the high mortality rates in juveniles, predation, overharvesting, or habitat alterations as a result of changes to the biophysical environment in which the clams live.

Biomass Estimates

The standing stock of soft-shell clams at Thorne's Cove is severely depleted, and has reached a point where the clam harvesters can no longer earn a living (K. Weir, personal comm., February 6, 2013). A lack of information exists on the amount of clam biomass present at the cove prior to the mid-1980s, and therefore it is nearly impossible to quantify the extent to which beaches like Thorne's Cove have been decimated. Angus *et al.* (1985) estimated biomass at Thorne's Cove to be 409 kg/ha for clams $\geq$50 mm. This equates roughly to about 18,160 kg for Side A of Thorne' Cove. Comparatively, in our assessment, clams $\geq$50 mm had a biomass of 13,713 kg for the same area. This demonstrates that stocks have continued to decline.

Although the commercial-sized clams constituted 11% of the total number of clams at Thorne's Cove (Side A), they had a much more significant contribution in terms of biomass, comprising 61% of the total clam biomass on the beach. This is largely due to the greater mass occupied by the clams with the longer shell lengths. The biomass values presented in Tables 2 and 3 could be used to conduct an economic valuation of current clam stocks at Thorne's Cove, which is outside the scope of this document.

Sediment Types

Sediment type should be further studied by in-depth sediment analyses, to link sediment types and preferred clam habitats. Overall, it appeared as though those areas of Side A that did not have the thick clay substrates contained the highest numbers of clams. A number of studies have noted that clams tend to be able to burrow better in softer substrates than harder ones (Audrie-Jo and Linds, 2007; Bowen and Hunt, 2009). Chances of clam survival would also be reduced in the compacted sediments, as their burrowing depth and speed would be limited by the compaction of the substrate, and it would be more difficult for their siphons to reach the surface (Emerson *et al.*, 1990). This would result in increased susceptibility to predation or crushing by burial.

A double layer was observed in the sediments at many of the sampled sites at Thorne's Cove. The double layer consisted of a top layer composed of fine, compacted sediments, overlying another distinct layer of sediments (i.e. silty clays). The underlying sediment layer was filled with large, closed white clam shells that were packed with sediments. It is possible that this may be a result of the sedimentation of the flats that has been observed by clam harvesters since the construction of the causeway and tidal power plant. It is believed that these fine sediments have been smothering clam populations on beaches within the Annapolis Basin (Terry Wilkins, personal communication, February 7th, 2013). Further study is required to confirm or deny this phenomenon on the beaches of the Basin.

Moving Forward

The harvest of soft-shell clams in eastern Canada is considered to be a relatively young industry, and is still very much at a research and development level (Redjah *et al.*, 2010). Understanding and reporting of the processes and conditions affecting the survival of clam populations within the Annapolis Basin are limited, and the sustainable management of this resource may be facilitated through a number of initiatives, such as improved management, monitoring, and investigative research.

Collaborative Management

The regulation and management of the clam industry in the Annapolis Basin is a multi-stakeholder endeavour, and therefore fostering collaboration and improved communication between all involved parties is an important consideration moving forward. The CCMP committee should continue to be developed and maintained, as its long-term goals are to provide a more collaborative and integrated approach to managing clam harvesting areas in the Basin (Farquharson, 2012). The CCMP will assist with communication between stakeholder parties, and provide local clam harvesters with greater involvement in the management of their industry.

The clam harvesters from CHA2 have recently developed a 3 year business and management plan for the clam harvesting areas in the Annapolis Basin. The creation and development of this plan has been 8 years in the making, based on past collaborative efforts and research projects (K. Weir, personal comm., Feb. 7th, 2013). The acceptance and implementation of this plan will provide a focused, clear avenue in which to concentrate collaborative efforts in the short, medium and long-term. There are also provisions in the clam harvesters' plan for an improved management regime by providing a strategy for enhancement efforts, further biomass assessments, and conservation closures of open area beaches. The adoption of conservation closures is a viable option for allowing stocks time to replenish. Very few beaches currently have conservation closures; however the new clam industry plan has added provisions for rotating seasonal conservation closures across open area beaches over the next three years. This is a progressive step in moving towards improved management of the clam flats in the Annapolis Basin, and can be effective provided there is adequate support from enforcement bodies in ensuring that harvesting does not occur during times of closure.

The 3-year plan developed by the clam harvesters is a good starting point; however, additional management guidelines and efforts will be necessary to ensure sustainability of the clam harvest. Other management options that have been used successfully in other areas that could be considered include reducing the number of licenses, increasing harvestable size limit of clams to 50 mm (2 inches), restricting harvest volumes (i.e. imposing catch limits or daily quotas), using artificial clam spat collection techniques (i.e. snow-fencing, Astro-Turf mats, etc.), and limiting when and where harvesting can occur (Beal, 2006; Myrand *et al.*, 2012). It is important that whatever management techniques are adopted be applicable and equally enforceable for all harvesters that collect clams from the Annapolis Basin. Sullivan (2007a) also recommended imposing mandatory memberships and conservation time for all license holders through their recognized harvesters' association, such as the CHA2 clammers association.

Monitoring and Reporting

Continuation of monitoring activities and improved reporting will be required to achieve sustainable management of the clam resource in the Annapolis Basin. Currently, there is limited information about how much harvesting pressure exists on the clam resource (Hicks and Ouellette, 2011). Improved reporting of the number and location of landings will help to better analyze the economic value of the industry and estimate the economic impacts resulting from a decline or improvement to clam stocks. Also, many efforts to improve approved area beaches have been completed by a few clam harvesters in the past, independently (Sullivan, 2007b). There has been a lack of documentation of what has been done, and this makes it difficult to evaluate the effectiveness of such remediation efforts. Future concerted remediation efforts by harvesters could be reported to CARP and documented to improve the availability of information about the CHA2 clam resource, and thereby assist with the collaborative management of beaches in the area.

Increased scientific monitoring of restoration and enhancement activities should be completed, so that the effectiveness of remediation efforts can be documented and evaluated for their efficacy. Stock assessments should be completed where possible prior to enhancement, so that baseline data may be obtained for all approved and conditionally approved area beaches. Additionally, water quality assessments and surveys should be continued, in collaboration with CARP and all stakeholders, to enhance existing data as well as to attempt to identify and remediate, where possible, sources of contamination that are affecting the clam beds. Such monitoring and remediation efforts could potentially open new areas for harvesting.

Research and Development

There are still many knowledge gaps that exist when it comes to soft-shell clams, their habitats and threats to their survival. In order to improve collaborative management of the clam flats in the Annapolis Basin, continuing scientific research and development is essential. There are many potential avenues for future research. First of all, the response of clam habitats in the Annapolis Basin to changing environmental conditions is largely undocumented or unknown. In order to better manage the habitats in which the clams live, it is necessary to understand how these have or will respond to changes in environmental conditions, such as ocean acidification or beach sedimentation. Research should be conducted into various methods to try and cope with these habitat changes, and how to improve survival conditions for clams through habitat restoration or enhancement activities.

Secondly, there are many perceived threats to the survival of soft-shell clams in the Annapolis Basin with the construction of the causeway and tidal power generating station, climate change, ocean acidification, introductions of invasive species, waterway eutrophication, overfishing, and predation pressures from various fauna. In order to improve collaborative management of the clam flats, it is imperative to first gain a better understanding of what the potential threats to clam survival are, and how these threats affect clam reproductive success and survival (i.e. through habitat alteration, etc.). For instance, it has been remarked upon that green algae have been observed at some of the clam flats in the Basin, such as Thorne's Cove (J. Halliday, personal comm., February 7th, 2013). It is possible that these are actually green macroalgal mats, which occur in areas of higher nutrient loading. These mats have been observed to cause hypoxic conditions in sediments, resulting in shallower burial depths of clams, and thereby increased susceptibility to predation (Auffrey *et al.*, 2004). The presence of these mats has been poorly documented in the Annapolis Basin however, and it is not well understood how they may affect soft-shell clam populations on open and conditionally approved beaches. Other avenues for further research into clam threats include:

effects of tidal generation on sedimentation of clam flats; how to mitigate ocean acidification and its effects on soft-shell clams (aka. crushed shell treatments, etc.); the effects of coastal eutrophication in the Annapolis Basin; and importance of predation on the survival and distribution of soft-shell clams on open and conditionally approved beaches.

Investigation of sediment types on the beaches is also important in moving forward. An in-depth analysis of sediment cores should be completed on beaches to identify what type of deposits are present in harvestable areas, as well as to provide a comprehensive analysis of sediment profiles on beaches. These analyses could assist in the identification and delineation of areas most susceptible to sedimentation as well as areas that will provide the most suitable habitat for reseeding work. This would assist in the adoption of a management scheme to administer restoration and reseeding activities to ensure the best chance for successful clam survival.

Lastly, continuing research into improving the effectiveness of harvesting and spat collection methods can help to improve both the effectiveness of harvesting and minimize the damage to remaining clams left on the flats by harvesters. Emerson *et al.* (1990) studied the effects of clam digging on the viability of leftover clams, and determined that any efforts by fishermen to reduce the size of tailings piles could potentially improve survival of leftover clams. Beal (2002) also investigated ways in which harvesters could increase the value of harvested stock using clam impoundments. Expanding on these and other research initiatives could potentially increase the effectiveness and economic returns of harvesting, while simultaneously investigating methods of improving the overall effectiveness of clam harvesting and spat retrieval.

Summary of Recommendations

- Improve communication and collaboration between all stakeholders.
- Continue to develop and maintain the CCMP.
- Adopt additional management strategies and guidelines that can be equally enforceable for all harvesters collecting clams from the Annapolis Basin (i.e. artificial spat collection, catch limits etc.).
- Continue of monitoring activities such as water quality surveys and stock assessments to generate baseline data, to identify and remediate sources of contamination.
- Continue scientific research to address knowledge gaps. Possible avenues for further research include:
    - Response of clam habitats to changing environmental conditions
    - Potential threats to clam survival and how clam populations respond to the threats
    - Sediment analyses of beaches to identify areas most susceptible to sedimentation and/or most suitable for reseeding activities
    - Improving the effectiveness and sustainability of harvesting and spat collection methods.

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Appendices

Appendix A – CSSP Harvest Area Classifications

Taken from the CSSP Manual of Operations (2011):

Definitions

Approved Area – The classification of a shellfish growing area which has been approved by the shellfish control authority for growing or harvesting shellfish for direct marketing. The classification of an approved area is determined through a sanitary survey conducted by the shellfish control authority. An approved shellfish growing area may be temporarily placed in the closed status when a public health emergency, resulting from for instance, a hurricane or flooding, is declared.

Conditionally Approved Area – The classification of a shellfish growing area which has been determined by the shellfish control authority to meet approved area criteria for a predictable period. The period is conditional upon established performance standards specified in a conditional management plan.

Conditionally Restricted Area – The classification of a shellfish growing area which has been determined by the shellfish control authority to meet, at a minimum, the restricted classification criteria for a predictable period. The period is conditional upon established performance standards specified in a conditional management plan.

Growing Area – An area which supports or could support live shellfish.

Prohibited Area – The classification of a shellfish growing area determined by the shellfish control authority where shellfish harvesting for food purposes is not permitted.

Restricted Area – The classification of a shellfish growing area determined by the shellfish control authority where shellfish shall not be harvested for direct consumption. **Note:** Restricted areas were formerly classified as 'closed' areas.

Appendix B – Annapolis Basin CCMP Report (2013 - 2016)

ANNAPOLIS BASIN - COLLABORATIVE CLAM MANAGEMENT PLAN (CCMP)-2013 - 2016

SUBMITTED BY:

SUSAN A. FARQUHARSON
DUE SOUTH STRATEGIES
FEBRUARY 2013

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ANNAPOLIS BASIN - COLLABORATIVE CLAM MANAGEMENT PLAN (CCMP)-2013 - 2016

Submitted to the Collaborative Clam Management Group (CMG) by the CHA2CA

March 2013

EXECUTIVE SUMMARY

CHA2CA Directors have recommended a multi-year, multi-season collaborative clam management plan (CCMP) and a revenue strategy (to support the plan activities) for the Annapolis Basin (The Basin).

The CCMP has been developed with a comprehensive focus to address a number of the key challenges of clam management at a local level. These challenges, recorded in Phase 1, include better communications with the CSSP regulators, an industry revenue contribution model to support sustainable management activities, multi-site stock enhancement and harvest access strategies, as well as the designation of enforcement priority areas.

The CCMP includes three overarching goals and sixteen objectives, presented on behalf of the CHA2CA, which are multifaceted. They include seasonal rotation of areas through conservation (management) plan closures, the application of enhancement techniques (encouraging natural seed recruitment, stock relay, and seed transfer), designated research areas (i.e., First Run) and enforcement priority areas (i.e., Second Cove, Poney Road, Pump Rock). Additionally, water quality monitoring areas have been designated as a project partnering with Nova Scotia Community College, Applied Geomatics Research Group (AGRG), Clean Annapolis River Project (CARP) and Environment Canada to conduct water quality modeling in the Annapolis River investigating impact of sediments on Basin clambeds and origin of non point sources of pollution, and determining the efficacy of managing the Goat Island harvest at a different season then previously recommended.

The areas identified for the CCMP work over a 3 year inclusive period are Approved and Conditionally Approved areas with the exception of one Conditionally Restricted (not a lease area) and one Prohibited area (no direct harvest permitted). The CCMP focuses on twelve priority areas[2] of the Annapolis Basin as recommended by the CHA2CA and outlined in priority area as:

[2] Names align with the mapping tool provided in Appendix 1

- Second Cove (Smiths Cove)
- Karsdale
- The Big Joggins (Conditionally Restricted - non lease area)
- Poney Road
- Goat Island
- First Run Beach
- Pump Rock (Deep Brook)
- Thornes Cove
- Queen Anne Marsh
- Bear River
- Twin Cove
- The Joggins (Prohibited -the non lease section)

To support the work outlined in the plan, the CHA2CA is recommending piloting a <.01/lb (.02/kg) levy on soft-shell clams harvested from the managed areas outlined in this plan. The levy would be tracked at the processor level as well as through the CHA2CA (#3015688 NS Registry of Joint Stock Companies) account, who would be responsible for providing records on its use annually to its' members. The CHACA2 will be partnering with the four key processors in the Basin to collect the levy on their behalf.

It is anticipated that the management objectives outlined in this plan may be reviewed to determine how they can be included in an Integrated Fisheries Management Plan (IFMP) being developed by Fisheries and Oceans Canada for the region. The objectives of this CCMP align well with the IFMP objectives (Conservation: Productivity, Biodiversity, Habitat; and Social/ cultural /economic: culture, sustenance and prosperity).

Finally, the plan, has acknowledged the need for open areas during peak market seasons as discussed with local processors during the development process. As such, it provides a balance of open areas and management closures on both sides of the Basin. Although an increase of harvestable clam size is not mentioned specifically, the industry has recommended that it should be discussed once this pilot management strategy has been implemented for 2 years at which time an evaluation of the success of the techniques to provide a sustainable biomass should be undertaken by the CMG.

BACKGROUND

In 2012 the Annapolis Digby Economic Development Association (ADEDA) contracted a scoping paper to determine feasibility and support of the development of a clam management plan for the Annapolis Basin. The report (*Determining the Feasibility of a Collaborative Coastal Monitoring Program (CCMP) Supporting Management of the Coastal Waters and Soft-Shell Clam Resource in the Annapolis Basin*) was submitted in

May 2012. Subsequently, it was agreed that a team of key stakeholders would be formed and terms of reference developed to commence a planning phase.

In September 2012 the Annapolis Basin Collaborative Clam Management and Monitoring Group (CMG) was formed (See Terms of Reference, Appendix 2) and agreed to the development of an integrated clam harvest plan for the conditionally approved and approved areas of the Annapolis Basin. The CMG is composed of representation from the clam industry association (CHA2CA), the Province of Nova Scotia Department of Fisheries and Aquaculture, Fisheries and Oceans Canada, the Canadian Food Inspection Agency, Environment Canada, the Clean Annapolis River Project, Annapolis Digby Economic Development Association, and the Municipality of the County of Annapolis. Technical expertise for the CMG for mapping is provided by Nova Scotia Community College Applied Geomatics Research Group (AGRG). The Nova Scotia Department of Environment has been included in all communications to ensure they are aware of the proposed CMG program as the licensors of waste water treatment plants (WWTPs) in the Basin.

THE PLANNING AREA - ANNAPOLIS BASIN SECTION OF CHA2

The Annapolis Basin watershed is the third largest watershed in Nova Scotia. It is approximately twenty-six kilometres long and six kilometres wide at its widest point. It encompasses the towns of Digby (pop. 2092), Smith's Cove (pop. Approx 600), Bear River (pop. 881), Cornwallis, and Annapolis Royal (pop. 444). Human activity in the watershed includes fishing, aquaculture, seaweed harvesting, tourism, forestry and agriculture. The Annapolis River and Bear River are the main tributaries that drain into the Annapolis Basin. Soft-shell clams *(Mya arenaria)*, scallops (*Placopecten magellanicus*) and limited populations of Blue mussels (*Mytilus edulis*) can be found within Annapolis Basin. The basin waters flow into the Bay of Fundy through Digby Gut, which is less than one kilometre wide. The tidal range in Annapolis Basin, much like those of the Bay of Fundy, exposes extensive tidal flats at low tide. This makes it one of the most productive clamming areas of Nova Scotia. Historically, Annapolis Basin has accounted for over 60% of the total landings of soft shell clams in Nova Scotia. Soft shell clams are harvested by "open area" diggers as well as harvested for depuration. *(Marine Water Quality Re-Evaluation Report - NS-18-010-001 - Annapolis Basin, Environment Canada, MacArthur, D et al 2010))*

There are five (5) Clam Harvesting Areas in mainland Nova Scotia (*Figure 1,* Fisheries and Oceans Canada). Within the Annapolis Basin section of CHA2 there are three (3) shellfish closure zones as per Fisheries and Oceans Canada *(Figure* 2) in Annapolis Basin.

The shellfish closures zones were designed recognizing the number and locations of WWTPs in the Basin to ensure implementing harvest closures in particular zones when the WWTPs failed were addressing product safety (pers. comm. Fisheries and Oceans, November 2012).

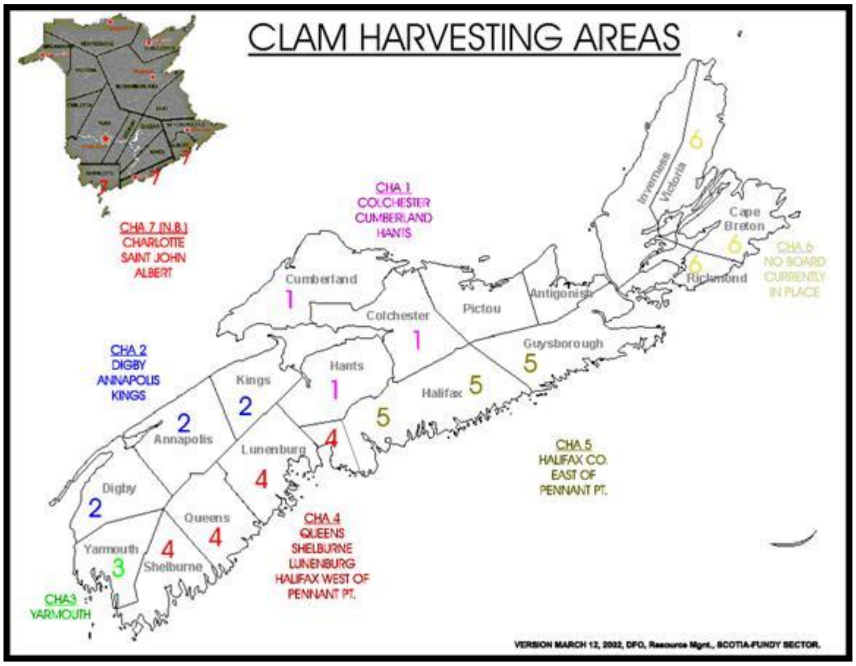


FIGURE 32 NOVA SCOTIA CLAM HARVESTING AREAS, DFO 2012

Currently Conditionally Restricted and Restricted area classifications utilize approximately 40% of the total accessible harvestable shellfish area in the Annapolis Basin and River. Additionally the Prohibited Areas, those adjacent to waste water treatment facilities (WWTP) and point discharges, make up another approximated 22%. This leaves approximately <1000 hectares, or an estimated 40%, of the clam beaches available for direct harvest activities at the time of this plan. (Estimation of areas utilizing mapping provided in Appendix 1)

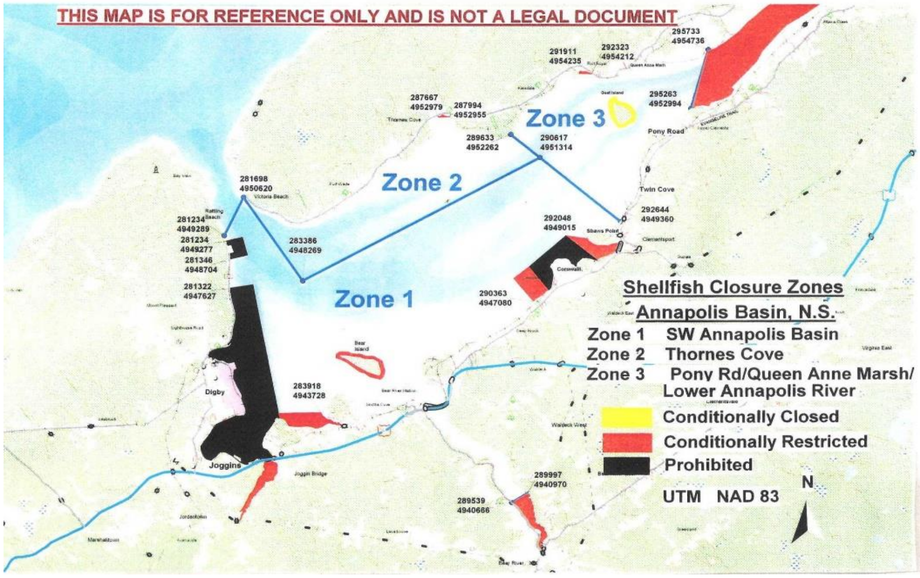


FIGURE 2: SHELLFISH CLOSURE ZONES - ANNAPOLIS BASIN

PLAN GOALS:

To support the CMG terms of reference, the goals of the CCMP are:

1. Implement an innovative and sustainable soft-shell clam harvest and stock enhancement plan for the Annapolis Basin based on a co-management model that fits within an integrated fishery management plan;
2. Understand and mitigate impacts that reduce access to the Conditionally Approved and Approved areas for soft-shell clam harvest;
3. Conduct research that can provide results and information required to better manage the clam fishery.

PLAN IMPLEMENTATION:

The CHA2CA will implement the CCMP through the Clam Management and Monitoring Group for the Annapolis Basin (CMG) formed in September 2012. The CMG, Chaired by the Clean Annapolis River Project (CARP), will provide guidance, recommendations and process evaluation in support of the successful implementation of the CCMP. It is recommended that a plan evaluation occur annually to determine status of the plan and modify as required.

The implementation objectives to support the goals are provided as short, mid and long-term and are outlined to support ongoing process requirements as well as site specific clambed management objectives.

A budget for the short term objectives (2013-2014) and an industry revenue strategy are provided to 1) allow for harvester investment in the management of the Conditionally Approved and Approved areas, 2) ensure the resources required to support the successful implementation are understood, and 3) understand resource gaps where new partnerships and funders will need to be sourced.

SHORT TERM OBJECTIVES (2013 - 2014)

Process Objectives

Process Objective 1: **Communicate final plan to CHA2CA harvesters (public meeting, website advertisement) (March 2013)**

Process Objective 2: **Present the CCMP at South West Nova Scotia Clam Advisory Committee (SWNS CAC). (March 2013) and the NS Working Group. (April 2013)**

Process Objective 3: **Submit the CCMP to Fisheries and Oceans to determine support systems. (March 2013)**

Process Objective 4: **Determine and implement process for collecting harvester .02/kg levy on shellstock harvested in the areas outlined in the CCMP. (June 2013)**

- Proposed Model to support Objective 4:
  CHA2CA to develop processor agreements (Sample provided in Appendix #3) with key local processors consulted (Dave's Fresh Clams, Casey Fisheries and Innovative Fishery Products Inc) which outlines the process to collect the .02/kg (.01/lb) levy on product harvested in the managed Conditionally Approved and Approved areas outlined in this plan. Processor interest in matching the levy to be determined pending success of pilot and their participation in CCMP implementation.

Clam Management Objectives

- **Second Cove (aka Smith's Cove) - A near shore Approved harvest area in Zone 1 (probability of closure if WWTP failure reported) adjacent to an offshore broodstock area (with limited accessibility). Currently harvested April - December annually as per the Soft Shell Clam Conservation Harvesting Plan Southwest Nova Scotia 2012. Noted as a PRIORITY ENFORCEMENT AREA by the CHA2CA due to concerns of unsustainable harvest levels and harvesting of illegal size.**

Clam Management Objective 1: **Enhance Stock**

Apply spat collection techniques (developed during 2009) and transfer clam stock (<1 inch) from Poney Road clambed. Number of clams transferred to be determined in consultation with Fisheries and Oceans. An application for Introductions and Transfers (I&T) should be completed for seed transfer within the Basin, whether from Approved to Approved area or Closed to Closed area. (Information on I&T has been provided in Appendix 4)

Timeframe: April - September 2013

Required Resources: Budget as reflected on Page 13. Application for Introductions and Transfer to DFO, Industry in field support for CARP.

Clam Management Objective 2: **Change Harvest and Conservation Closure Timeframe to support stock enhancement.**

Adjust harvest timeframe to May - September to support rotational harvest.

Timeframe: March 2013

Required Resources: CHA2CA to make recommendation to DFO via the SWNS Clam Advisory Committee.

- **Karsdale Cove - An Approved harvest area in Zone 2 (not impacted by WWTP failures) currently harvested April - December annually as per Soft Shell Clam Conservation Harvesting Plan Southwest Nova Scotia 2012 Resource valuation assessment of the area, conducted in 2006, indicated total shucked value of soft-shell clams at >$1M.**

Clam Management Objective 3: **Enhance Stock**

Transfer clam stock (<1 inch) from Poney Road clambed. Number of clams transferred to be determined in consultation with Fisheries and Oceans.

Timeframe: September 2013

Required Resources: Application for a Section 52 licence and possibly an Introductions and Transfer to DFO (Application for License Issued pursuant to Section 52 of the Fishery (General) Regulations: https://www2.glf.dfo-mpo.gc.ca/fam-gpa/bssp-saps/s52/form-e.php?form_lgE=e), Industry in field support for CARP.

Clam Management Objective 4: **Change Harvest and Conservation Closure Timeframe to support stock enhancement.**

Adjust harvest timeframe to May - August to support rotational harvest.

Timeframe: Initiate May 2014

Required Resources: CHA2CA to make request to DFO through the SWNS CAC.

- **Big Joggins Clambed (The Little Joggins) - A Conditionally Restricted area in Zone 1 (probability of closure if WWTP failure reported) adjacent to a Prohibited area. Currently only depuration harvest permitted based on an annual request to Fisheries and Oceans and provision of a permit to a licensed depurator. Noted as a PRIORITY ENFORCEMENT AREA by the CHA2CA due to concerns of illegal harvesting.**

Clam Management Objective 5: **Implement a Conservation (Management) Closure to allow area to naturally restock.**

Timeframe: April 2013 - April 2014

Required Resources: CHA2CA to make formal request to DFO via SWNS CAC.

- **Poney Road - A summer harvest area adjacent to a Conditionally Restricted area in Zone 1 (probability of closure if WWTP failure reported). Currently managed as "Closed from September 01 to July 15, August 01 to 15; Open July 16 to 31 (inclusive) and August 16 to 31 inclusive)". Site of a clam enhancement project in 2009 to test spat recruitment techniques and clam growth rates. Noted as a PRIORITY ENFORCEMENT AREA by the CHA2CA due to concerns of unsustainable harvest levels and harvesting of illegal size**

Clam Management Objective 6: **Seed Stock Source for Karsdale and Second Cove**

Transfer clam stock (<1 inch) from Poney Road clambed in support of Objectives 1 and 3.

Clam Management Objective 7: **Change Harvest and Conservation Closure Timeframe.**

Adjust harvest timeframe to September - December to support rotational harvest.

Timeframe: May - September 2013

Required Resources: Application for Introductions and Transfer to DFO, Industry in field support for CARP; CHA2CA to make formal request for closure to DFO via SWNS CAC

- **Goat Island - A Conditionally Approved summer harvest area in Zone 3 that has not been managed since 2008 due to variable shell stock results. Industry suggests clambeds are being negatively impacted by river flows. Environment Canada indicates resident bird populations in area during May to September monitoring season**.

Clam Management Objective 8: **Adjust Conditional Harvest Time**

Determine efficacy of operating the Conservation Management Plan (CMP) during a later seasonal timeframe (September - November).

Make formal request to review conditions of the MOU with CSSP regulators to determine and agree on conditions.

Timeframe: April - September 2013

Required Resources: Analytical costs (in budget, Page 13), Industry in field support for CARP. CSSP partners support to administer and enforce MOU.

- **First Run (1st Run Beach) - An Approved harvest area in Zone 3 currently open April - December and harvested primarily in the summer months. Site of 2009 clam enhancement project to encourage spat recruitment and determine clam growth rates. Industry noted as an area that is overharvested and significantly impacted by sediments in comparison to adjacent harvest areas.**

Clam Management Objective 9: **Designate Area as a Research Site under a Conservation (Management) Closure**

Timeframe: May 2013

Resources Required: CHA2CA to make formal request to DFO via SWNS CAC

MID-TERM OBJECTIVES (2014 - 2015)

Clam Management Objectives

- **Pump Rock Clambed (Deep Brook)- A Conditionally Approved harvest area in Zone 1 (probability of closure if WWTP failure reported). Noted as a valuable broodstock area by industry. Resource valuation conducted in 2006 suggested biomass shucked value of $500K. Noted as a PRIORITY ENFORCEMENT AREA by the CHA2CA due to concerns of unsustainable harvest levels and harvesting of illegal size.**

Clam Management Objective 10: **Conduct biomass assessment to update science information of current size and abundance of resource to determine actual harvest area and sustainable harvest level.**

Timeframe: May - September 2014

Resources Required: Funds to support science resource person at CARP, industry infield support. DFO enforcement support.

- **Big Joggins Clambed (The Little Joggins) - A Conditionally Restricted area in Zone 1 (probability of closure if WWTP failure reported) adjacent to a Prohibited area. Currently only depuration harvest permitted based on an annual request to Fisheries and Oceans and provision of a license to a licensed depurator. Noted as a PRIORITY ENFORCEMENT AREA by the CHA2CA due to concerns of illegal harvesting.**

Clam Management Objective 11: **Implement a Conservation (Management) Closure to allow area to naturally restock.**

Timeframe: April 2013 - April 2014

Resources Required: CHA2CA to make formal request to DFO via SWNS CAC; DFO enforcement support.

Clam Management Objective 12: **Determine feasibility of reclassification to a Conditionally Approved area based on Environment Canada 2013 classification monitoring as required by Canadian Shellfish Sanitation Program (CSSP).**

Timeframe: April 2014

Resources Required: N/A

- **Thornes Cove Clambed - A Conditionally Approved area in Zone 1 (probability of closure if WWTP failure reported) open for harvest between April - December annually. Primarily harvested during June - August. Biomass assessment conducted on eastern portion of the harvest area in 2012 (CARP) reported low abundance of soft -shell clam stocks particularly in the mid to lower clambed area. Noted as a PRIORITY ENFORCEMENT AREA by the CHA2CA due to concerns of unsustainable harvest levels,**

Clam Management Objective 13: **Conservation Closure to Support Stock Enhancement**

Implement seed recruitment techniques in mid to lower tidal zone areas.

Timeframe: Initiate May 2014

Resources Required: Industry infield support for CARP science resource person. DFO enforcement support.

- **Inner Annapolis Basin/River (Allains Creek area) - Develop a joint project with NSCC - AGRG to utilize the Water Quality Modeling program, Clean Annapolis River Project and Environment Canada to investigate non-point sources of contaminants.**

Clam Management Objective 14: **Determine origin of non-point contaminant sources that may impact Conditionally Approved and Approved areas of the Basin.**

Timeframe: May 2014 - December 2014

Required Resources: Project proposal to be developed at the CMG.

LONG-TERM OBJECTIVES (2015 - 2016)

Note, resources required have not been included in this section as a review of the success of the short and midterm objectives will be required to define status of the plan, planning areas and available resources.

Clam Management Objectives

- **Queen Anne Marsh - An Approved harvest area in Zone 3 closed for harvest from August 16 to June 30, July 16 to July 31 (inclusive) and open July 1 to 15 and August 1 to 15 (inclusive) annually as per the SWNS Clam Harvest Management Plan 2012.**

Clam Management Objective 13: **Adjust Harvest Season to Encourage Natural Stock Enhancement and Support Multi-Season Harvest Access**

Timeframe: May 2014 - December 2014

- **Bear River - A Conditionally Approved harvest area in Zone 1 (probability of closure if WWTP failure reported) open for harvest April through December 31. Two thirds (2/3) of the Bear River WWTP transferred to Smiths Cove new WWTP system as of January 2013 *(pers comm., Municipality of the County of Annapolis 2013)*. Industry noted as a PRIORITY ENFORCEMENT AREA as the area provides for extended harvest access and opportunity for over harvesting per tide**

Clam Management Objective 15: **Adjust Harvest Season to Encourage Natural Stock Enhancement and Support Multi-Season Harvest Access**

Modify annual Soft Shell Clam Conservation Harvesting Plan Southwest Nova Scotia 2012 to support a September - December harvest.

Timeframe: September 2014 - December 2014

- **The Joggins - A Prohibited (No clam harvest permitted) area in Zone 1.**

Clam Management Objective 16: **utilize as a seed source (from non-leased area) for potential natural depuration relaying project.**

Determine feasibility of broodstock transfer to restock a Management Closure area for research.

Timeframe: September 2015 - April 2016

PROPOSED PLAN IMPLEMENTATION BUDGET - 2013-2014

The budget for the pilot year (2013 - 2014) presented in Table 2 has been developed based on the following assumptions:

- Line 1: .02/kg value is based on 2011 CHA2 total landings recorded by DFO (392,471kgs) and assumes 120 harvesters who reported would contribute

- Line 2: processors match harvester contributions at their respective plants

- Line 5: Cost of water and shellstock samples for Goat Island CMP

- Line 6: 5 roundtrips to Maxxam Lab facilities in Bedford (435km roundtrip) + Lunch @$12 (lunch), 15 shell stock analytical[3] and Purolator shipping costs, and local infield travel estimated at 2500km. (Sampling of Goat Island).

- Line 7: Anticipates industry infield support with people, boats and motors.

- Line 8: Support resource person office location

Revenues:

1.	Industry Revenue: (.02 cents /kg)	$ 7850.00
2.	Fish Processor Revenue (.02 cents/kg)	$ 7850.00
3.	Potential Total Industry Revenues	$ **15,700.00**

Expenditures:

4.	Resource Person (50%)	$ 17,500.00
5.	Analytics	$ 3,088.00
6.	Travel/Shipping	$ 2,375.00
7.	Boat gas/oil	$ 400.00
8.	Office	$ 1,500.00
9.	Insurances/Certifications	$ 1,500.00
10.	Miscellaneous field expenses	$ 3,000.00

[3] Conversations with CFIA to determine actual number of samples required and if they will cover a portion of the costs to be completed.

Total Expenses $ **29,363.00**

Revenue Short Fall $ **13,663.00**

CCMP CLAM REVENUE MODEL

The Annapolis Basin is the most productive clam harvest area in the CHA2 (pers comm. CHA2CA Directors). Historically providing 60% of the soft shell clams harvested in Nova Scotia, the total landings recorded by Fisheries and Oceans (Table 1, 2013) for South West Nova Scotia (SWNS) in 2011 was valued at >$1.2M, the most landing value recorded since 2003. Of the $1.2M total value of clams harvested in SWNS, >$850K was harvested in CHA2 (Fisheries and Oceans 2012). This increase in landings may be due in part to the fact that as of 2011, harvesters were required to complete dockside monitoring reports as a mandatory requirement to receive their license conditions (pers comm. Fisheries and Oceans 2013).

Of the 271 soft-shell clam licenses in CHA2, only 120 reported landings for the 2011 reporting period. Of those 120 licenses that reported, total income from soft -shell clam harvest ranged from $40.00 to $25, 000 in 2011 (pers comm. Fisheries and Oceans 2013).

	2003	2004	2005	2006	2007	2008	2009	2010*	2011*	2012*
Catch(mt)	402	350	159	135	108	106	109	176*	600*	274*
Value ($000)	928	876	453	338	235	243	225	330*	**1,294***	570*

TABLE 1: TOTAL CLAM LANDINGS FOR SWNS FISHERIES AND OCEANS CANADA 2013

One can assume based on these figures, that if the 120 licenses that reported in 2011 supported the implementation of the CCMP for the Annapolis Basin by incorporating a levy on the total harvested shell stock, they could generate ~$8K annually for less than a penny a pound (=.o2/kg = a penny for every dollar harvested).

That investment by harvesters is key to sustaining a program to implement the objectives recommended in this plan and leveraging additional funds through industry and economic support opportunities such as Industry Research Assistance Program to support long term soft shell clam management approaches in the Annapolis Basin.

Submitted to the CHA2CA Directors

February 2013

ADDITIONAL INFORMATION LINKS

MARITIME PROVINCES FISHERIES REGULATIONS:

http://laws-lois.justice.gc.ca/eng/regulations/SOR-93-55/index.html

- Section 29: Taking Shellfish for Replanting
- Section 32: Clams

FISHERIES (GENERAL) REGULATIONS:

http://laws-lois.justice.gc.ca/eng/regulations/SOR-93-53/page-6.html#h-17

- Section 22: Conditions of Licenses

MANAGEMENT OF CONTAMINATED FISHERIES REGULATIONS:

http://laws-lois.justice.gc.ca/eng/regulations/SOR-90-351/index.html

NATIONAL CODE ON INTRODUCTIONS AND TRANSFERS OF AQUATIC ORGANISMS:

http://www.dfo-mpo.gc.ca/Science/enviro/ais-eae/code/forward-avantpropos-eng.htm

WATER QUALITY ANALYSIS:

Maxxam Analytics

ISO 170025 Certified

Deliver samples within 6hrs of acquiring sample

- $56/sample *(minimum $250 submission)* + applicable taxes

Contact: Leonard Muise
(902) 420-0203 or
1(800) 565-7227
105-200 Blue Water Road
Bedford, Bedford, Nova Scotia

(http://www.companylisting.ca/Maxxam_Analytics_Inc3/default.asp)

SHELLSTOCK ANALYSIS

Impact Microbiology:
Download SCC Certificate and Scope of testing, the procedure for clams is MFHPB-19. Deliver samples within 48hrs of sampling.

The price is $50.00 per sample For Coliforms and Faecal coliforms reported as:

Faecal Coliforms (MPN)/100g *MFHPB-19* *(April 2002)*

Additional cost for Ecoli spp confirmation

Contact: Elena Connors
Director of Microbiology
Impact Microbiology Services
2 Garland Court
Fredericton, NB
Phone (506) 459-7033

(www.impactmicrobiology.com)

APPENDICES

APPENDIX 1. ANNAPOLIS BASIN MAP

APPENDIX 2. CMG TERMS OF REFERENCE

Annapolis Basin Collaborative Clam Management and Monitoring Group (CMG)

Terms of Reference

Amended February 2013

Vision: A sustainable collaborative clam management model for the approved and conditionally approved areas of the Annapolis Basin

Purpose: To provide a collaborative forum for the review and planning of research, management and monitoring activities related to the soft-shell clam resource in the Annapolis Basin where industry, regulators and community can participate equally.

- Collectively provide the capacity to plan and work together for a common goal of cleaning the coastal waters of Annapolis Basin impacting access to the soft-shell clam resource through the development of a collaborative coastal monitoring plan which supports the goals and/or mandates of the CMG participants;
- Work together to develop an innovative and sustainable soft-shell clam harvesting and stock enhancement plan based on a community co-management model that fits within an integrated fishery management plan;
- Collaboratively plan research activities that can provide results and information required to address contaminants impacting the coastal zone and potentially improve the classification of clam harvest areas as the indicator of remediation success.

Participants: The CMG is comprised of representatives from governments, First Nations, industries and other organizations that are directly involved in the management, monitoring, research or harvesting of soft-shell clam areas (Approved or Conditionally Approved) areas including. These include Nova Scotia Fisheries and Aquaculture, Fisheries and Oceans Canada, Canadian Food Inspection Agency, Environment Canada, CHA2CA Directors, and the Municipality of the County of Annapolis.

The CMG will review membership on an annual basis.

Communications: All meetings and correspondence will be conducted and communicated in English.

- Minutes will be distributed to the CMG members within two weeks of each meeting;
- CMG communications will be respectful, honest and open and take into consideration the origin of certain information being shared by the participants;
- CMG members shall liaise with their respective organizations regarding the CMG activities;
- The need, content and format of communications with the general public or related initiatives will be determined by the CMG

Meetings: The meetings will be Chaired by the Clean Annapolis River Project;

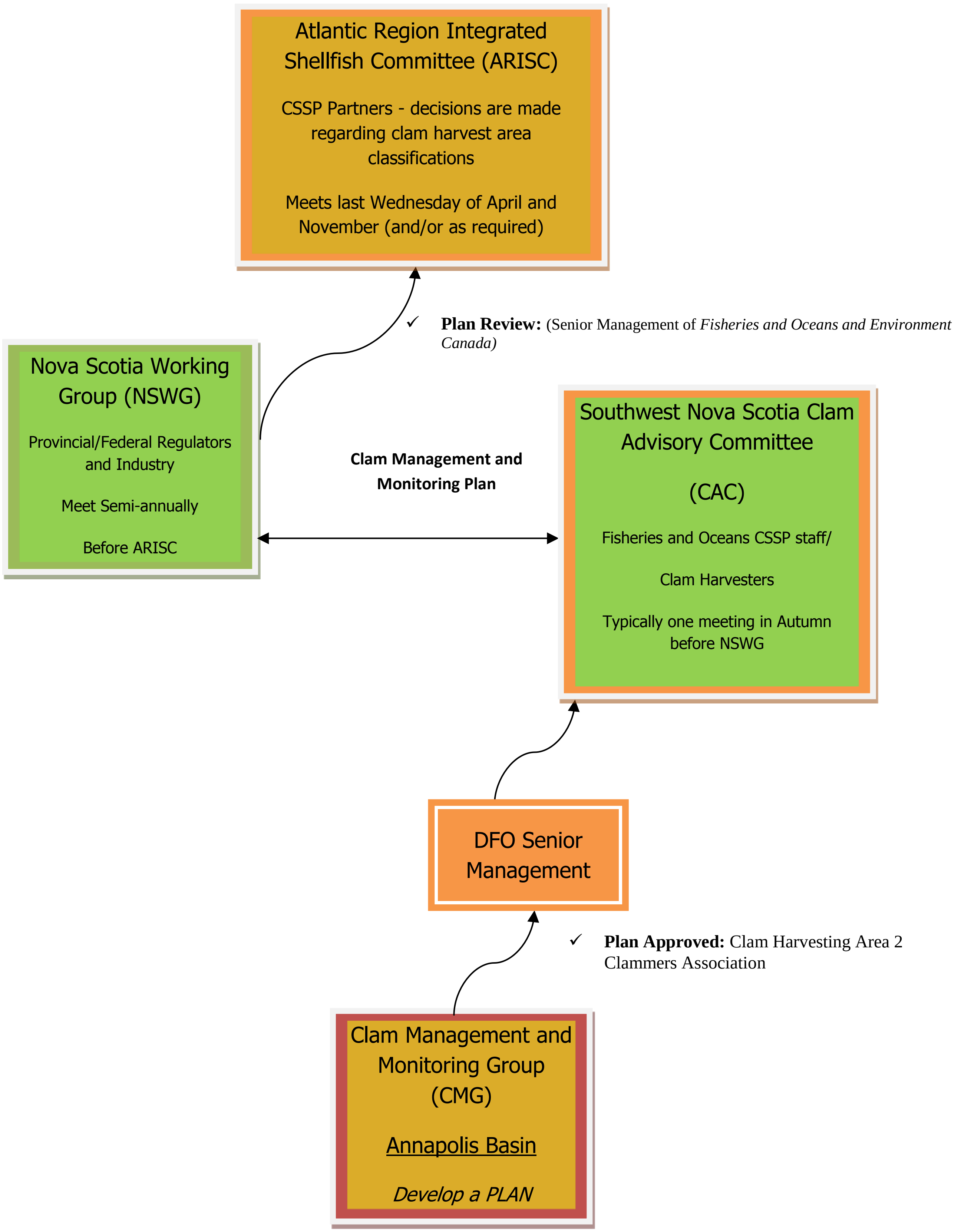
- The CMG will meet as required or at a minimum quarterly during the planning and action implementation phases;
- Each member is asked to bring a perspective based on their organizations roles, their respective contributions and support of the CMG purpose;
- Each member may provide an alternate who may attend in his/her absence and those participants should facilitate the exchange of information within their respective organizations or agencies;
- Members will contribute, through their own programs (when they exist), and new or ongoing activities through resource sharing, funding and/or in-kind support;

- The CMG members may bring additional technical expertise as they deem required; members should provide advanced notice to the Co-Chairs when doing so.

Responsibility: The CMG members are responsible for administering and editing these Terms of Reference as required.

- The CMG members will strive to make decisions through consensus that are consistent with the vision and purpose statements contained in these Terms of Reference, respecting the regulatory requirements of the day.
- In the event that consensus is not reached, the Co-Chairs will discuss options with individual members before bringing forward a recommendation.

Soft-shell Clam Reporting and Management Structure -Nova Scotia



APPENDIX 3. SAMPLE AGREEMENT TEMPLATE

AGREEMENT BETWEEN CHA2CA AND FISH PROCESSOR

TO SUPPORT THE CCMP IN THE ANNAPOLIS BASIN

Between: Clam Harvesting Area Two Clammers Association (CHA2CA)

AND

Clam Processor: ____

Definitions:

"Annual" shall refer to the 12-month period commencing the ____ day of _____ 20__ and ending the ______day of _____ 20__ to be reviewed for renewal purposes each year not later than 30 days before the expiry.

"Services" shall refer to the activities outlined in the CCMP for the Annapolis Basin and approved by the CMG annually.

"Individual Harvester" shall refer to those harvesters whose names are provided to the processor, named in this agreement and to Fisheries and Oceans Canada, by the CHA2CA no later than March 31 of each year, who have agreed to participate in the implementation of the CCMP via a levy on product harvested from the Approved and Conditionally Approved areas. These harvesters will receive license conditions to permit their harvest access to the CCMP managed beaches.

Terms of Agreement:

Upon signing of this agreement, ______processor______________ in support of the CCMP for the

Annapolis Basin agrees to collect (and match with an equal contribution) and provide to the CHA2CA the individual harvester contribution of 2 cents per kilogram on product harvested from the Approved and Conditionally Approved areas.

The contributions will be paid by cheque in quarterly installments to the CHA2CA with accompanying records outlining total kilograms and contribution of each harvester and total value commencing _____________, 20__ .

The CHA2CA agrees to maintain record of the funds received and distribution of the monies for reporting purposes and to make said documentation available upon request to the processor/buyers. CHA2CA agrees to report via the CMG at bi-annual meetings or as requested by the group.

Cheque payments should be mailed to ____________________________________ by July 31st, October 31st, January 31st, and April 30th each year.

The arrangements outlined in this contract are to commence immediately upon signing by all parties and will conclude when all conditions of this agreement have been met to the satisfaction of the parties.

We, as per signatures below, agree to abide by the terms of this agreement as set out in herein.

_______________________________ _________________________________

On behalf of CHA2CA Witness:

On behalf of Processor name: ______________________ Witness: ______________________

Date: ______________________ Date: ______________________

APPENDIX 4: INTRODUCTIONS AND TRANSFER APPLICATION FORM; AND PROCESS FOR HARVESTING IN A CLOSED AREA, FISHERIES AND OCEANS CANADA

Application for Licence Issued Pursuant to
Section 52 of the Fishery (General) Regulations

Fisheries and Oceans Canada   Pêches et Océans Canada

Canada

Licence Application Form

Application for Licence Issued Pursuant to Section 52 of the Fishery (General) Regulations

Please note: application should be received at least 15 working days prior to the proposed date of activity.

1) Licence Type (see attachment)

Request for Licence to fish is for:

__ Educational purposes

__ Experimental purposes

__ Public display ($100 fee applies)

__ Scientific purposes

2A) Applicant Information

____________________________ Name of Applicant (Surname, First Name)

____________________________ Position

____________________________ Company

____________________________ Address 1

____________________________ Address 2

____________________________ City

____________________________ Province

____________________________ Postal Code

____________________________ Counrty

____________________________ E-mail (op)

____________________________ Phone 1

____________________________ Phone 2 (op)

____________________________ Fascimile

2B) Other individuals working under the authority of the licence holder

Only individuals listed below will be permitted to fish under the authority of the proposed licence

Name	Organization	Telephone

3) Purpose of the project

Specify the purpose of the project. Describe the activities and pertinent details.

4) Areas of activity

Specify location(s) of the activities

5) Species

Species	Size	Number to be Caught and Sampled		
		To be Caught	To be Released	To be Retained

6) Samples

What will be done with the samples collected?

7) Gear (see attachment)

Unattended gear must be identified with the name of the licence holder and the licence number

Gear Type	Specifics (op)	Mesh Size (op)	Number of Units (op)	Tended (Yes/No)

8) Vessel Identification

If no vessel is used, leave fields empty

Vessel Name	VRN

9) Period of Activity

When will this activity take place?

From _________ (YYYY-MM-DD) to ____________ (YYYY-MM-DD)

Comments (op)

10) Additional information

Please provide any additional information pertinent to this project (op)

11) Applicant Signature

___________________________ Name

___________________________ Signature

___________________________ Date (YYYY-MM-DD)

Attachment

Section 52 Licences Types

SECTION 52 LICENCES

Educational Purposes:

Activities associated with capturing aquatic organisms for the sole purpose of demonstrating sampling techniques, aquatic diversity, biological principles and public relations. This may include retaining organisms for further analysis.

Experimental Purposes:

Activities associated with determining abundance, distribution, and fishing methods for aquatic species which have not been exploited in the past or not exploited with the particular fishing method proposed. Experimental activities would be associated with assessing the feasibility of capturing organisms and assessing the viability of these fisheries.

Public Display:

Activities associated with capturing organisms for the purpose of retaining the animals (dead or alive) and displaying these in public venues. Examples would be school aquaria, "touch tanks", "living streams", etc. The organisms are specifically destined to be removed from the wild and held in captivity and are not to be returned to the wild after capture. Generaly, these organisms would be destroyed after the public display purposes are fulfilled. (Fee $100.00)

Scientific Purposes:

Activities associated with capturing aquatic organisms for the purpose of measuring species abundance, distribution, and biological characteristics for the purpose of assessing stock status, for environmental impact assessment, for environmental monitoring programs or for experiments in field or laboratory. These activities are not intended to evaluate feasibility of fisheries but would include activities associated with gear selectivity experiments.

Please note as per application site: "applications should be received at least 15 working days prior to the proposed date of activity."

Application Protocol For Relay And Depuration Harvesting Licenses

As The Lead Shellfish Control Agency Responsible For Licensing, DFO Will Coordinate The Application Process.

APPLICATION PROTOCOL

1. Where there is an interest to harvest shellfish in a closed area, the proponent must submit a completed application to the Shellfish Control Agency responsible for licensing (DFO) harvest access to closed areas. The proponent must also submit a draft **Decontamination Plan** where applicable to DFO pursuant to section 4(2) of the *Management of Contaminated Fisheries Regulations (MCFRs)*. DFO will coordinate the application process, and forward the necessary information to the appropriate representatives of DFO, EC, CFIA and Provincial Regulatory Agencies for review and approvals.

2. The Application will include, but may not be limited to the following information:
   i) A description of the area requested for harvest, including a map showing the boundaries of the harvest area with UTM grid references (specify NAD 27 or NAD 83),
   ii) The method of harvest, harvest controls (master digger, tagging details, Monitoring Requirements), transportation and storage of the product.
   iii) The proposed decontamination plan, including process description and controls, standards for the operation and its evaluation. See Chapter 10 CSSP Manual. Approved Depuration Decontamination Plan template available.
   iv) For Relay (Natural and Container) permits, the proponent must indicate the Aquaculture Lease Number which will be used for the decontamination process, as well as a map of the lease site including details of the portion of the site to be used for the relay operation. In addition, special consideration must be made with respect to **Introductions and Transfer** Permit requirements.
   v) Any other specified information as required.

3. The responsibilities to review the application are as follows:
   i) EC reviews the water quality data and sanitary information available for the harvest area and determines if the area meets the requirements for the proposed method of decontamination. EC signs the application and provides comments on its finding to the Shellfish Licensing Control Agency (DFO).
   ii) CFIA evaluates the proposed Decontamination Plan or verifies the validity of the existing decontamination plan associated with the application request and determines if it meets the requirements to purify the shellstock. CFIA will verify the facility is fulfilling the HACCP components of their QMP. CFIA will also verify that the facility process water is from an approved source. CFIA then provides any comments and a letter approving the decontamination Plan to the Shellfish Licensing Control Agency (DFO). CFIA shall maintain records of Decontamination Process Approval as well as sampling and compliance verification audit results.
   iii) For a Relay operation, the Proponent shall be responsible to prove to DFO that the harvested product will be relayed to an approved Aquaculture Lease, which is licensed for the specified species and culture method
   iv) DFO will consider resource utilization issues with regard to the proposed harvesting area. DFO will develop licence conditions for the fishing, handling, and transportation and the monitoring of the shellfish.
   v) The proponent must ensure that they apply for Nova Scotia Fish Processor Licence or an amendment to their existing Licence to conduct Depuration or Relay Processing of bivalve shellfish.
   vi) DFO will communicate the decision regarding the application to the Proponent, EC, CFIA and the Provincial Department responsible for processing and purchasing licenses and/or Aquaculture leases. This may come in a letter format or via the application, with approval yes/no section completed.

vii) Once the application and decontamination plan has been approved, the Proponent may be issued a Licence and Licence Conditions referencing the approved Decontamination Plan and outlining conditions of fishing, transporting and monitoring.

4. The Shellfish Licensing Control Agency (DFO) will maintain records of the Application, Special License, and the Decontamination Plan. The CFIA will maintain documents relating to the verification of the decontamination plan.

COMMUNICATION

5. Each Shellfish Control Agency will submit annual reports regarding closed area harvesting under a Special Licence issued pursuant to the *Management of Contaminated Fisheries Regulations*. DFO will coordinate the final report to be presented at the Atlantic Region Interdepartmental Shellfish Committee (ARISC).

6. A standard information package for proponents will include a copy of Chapter 10 of the CSSP Manual of Operations, an Application form, and a decontamination plan template. An application check list will be maintained by the Shellfish Licensing Control Agency (DFO) to ensure this protocol and additional consultations are made on a timely basis. Applications will only be considered complete when all required information has been submitted to the Shellfish Licensing Control Agency.

DEFINITIONS

Decontamination Plan: The details of the method to be used to decontaminate the shellfish as outlined in Chapter 10 of the CSSP Manual. Approved templates available for depuration and relay

BACKGROUND INFORMATION

- Environment Canada (**EC**) is the lead agency in the administration of the CSSP with regard to recommending the appropriate classification of shellfish growing waters based on comprehensive sanitary and bacteriological surveys of shellfish growing waters. Upon request, EC will provide DFO with available information of water quality for harvesting areas proposed for Depuration or Relay purposes. Refer to Chapter 2 of the Canadian Shellfish Sanitation Program (CSSP) Manual.

- The Canadian Food Inspection Agency (**CFIA**) is the lead agency in the administration of the CSSP with regard to the handling, processing, import and export of shellfish, the marine biotoxin program, and the microbiological monitoring program for bivalve molluscs. CFIA will be responsible for reviewing referrals from DFO with regards to harvesting from closed areas for Relaying or Depuration purposes. CFIA will review harvest and/or relay areas for history or potential of biotoxin risks. CFIA will evaluate the proposed decontamination plan against the criteria set out in Chapter 10 of the CSSP Manual and provide approval of the plan.

- The Department of Fisheries and Oceans (**DFO**) is the lead agency in the administration of the CSSP with regard to the opening and closing shellfish growing areas on the basis of recommendations from EC and CFIA. DFO will post, patrol and enforce shellfish closures in accordance with the Fisheries Act. DFO provides notification to CFIA, EC, stakeholders and other interested parties on locations, boundaries and timing of harvesting closures and openings. DFO will issue Special Licenses pursuant to Section 4(2) of the *Management of Contaminated Fisheries Regulations*, following EC approval of harvest areas, and relay site, and CFIA approval of the decontamination plan. DFO will determine the necessary conditions of license, which will help ensure that the harvested product is handled according to the process, set out in the Decontamination Plan.

- The Government Department(s) responsible for will be the lead agency for applicable Aquaculture Leasing and Licensing provisions.

Appendix C – Stock Assessment Data Sheet

Name of clam flat: ______________________ Survey Crew: ______________________

Date of Survey: ______________________ Plot Size: ______________________

Time of Survey: ______________________ Mesh Size: ______________________

Tran #	Plot #	Sediment	Broken	5-9mm	10-14mm	15-19mm	20-24mm	25-29mm	30-34mm	35-39mm	40-44mm	45-49mm	50-54mm	55-59mm	60-64mm	65-69mm	> 69mm

Appendix D – Regression Analysis of Length/Weight Ratio of Soft-shell Clams, Thorne's Cove (Side A)

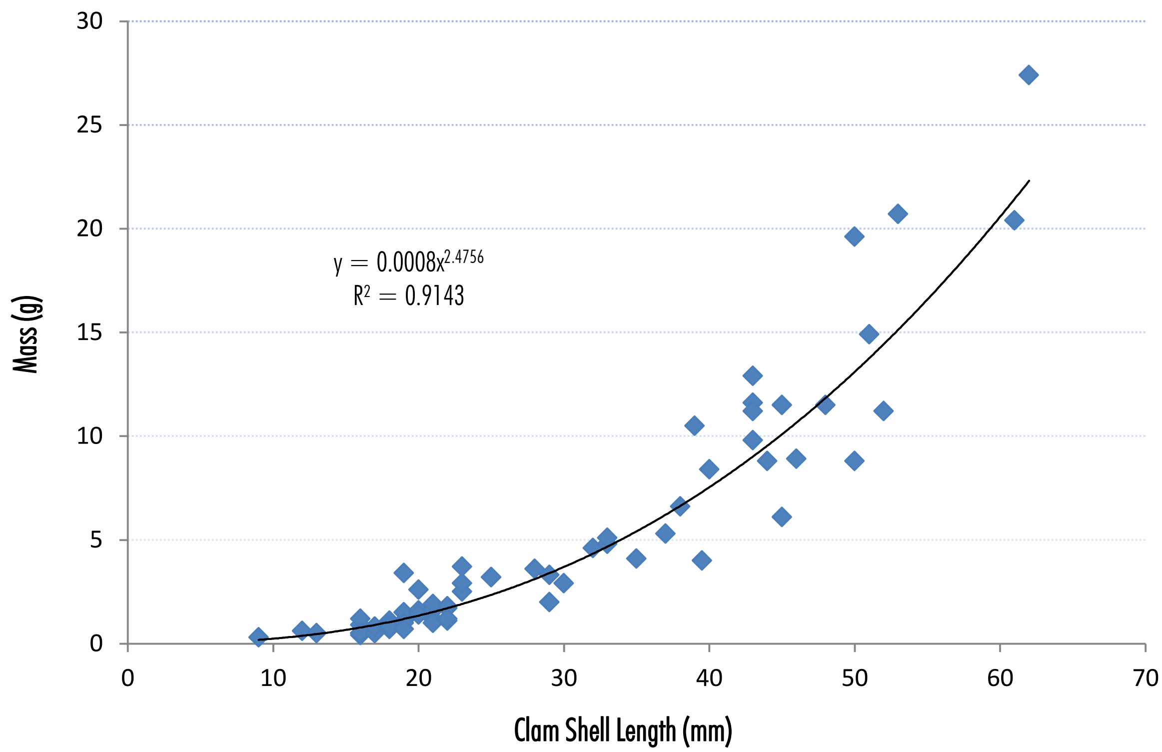


Figure D1. Clam shell lengths (mm) compared to clam weights (g).

Appendix E – Map of Annapolis Basin Clam Harvest Areas

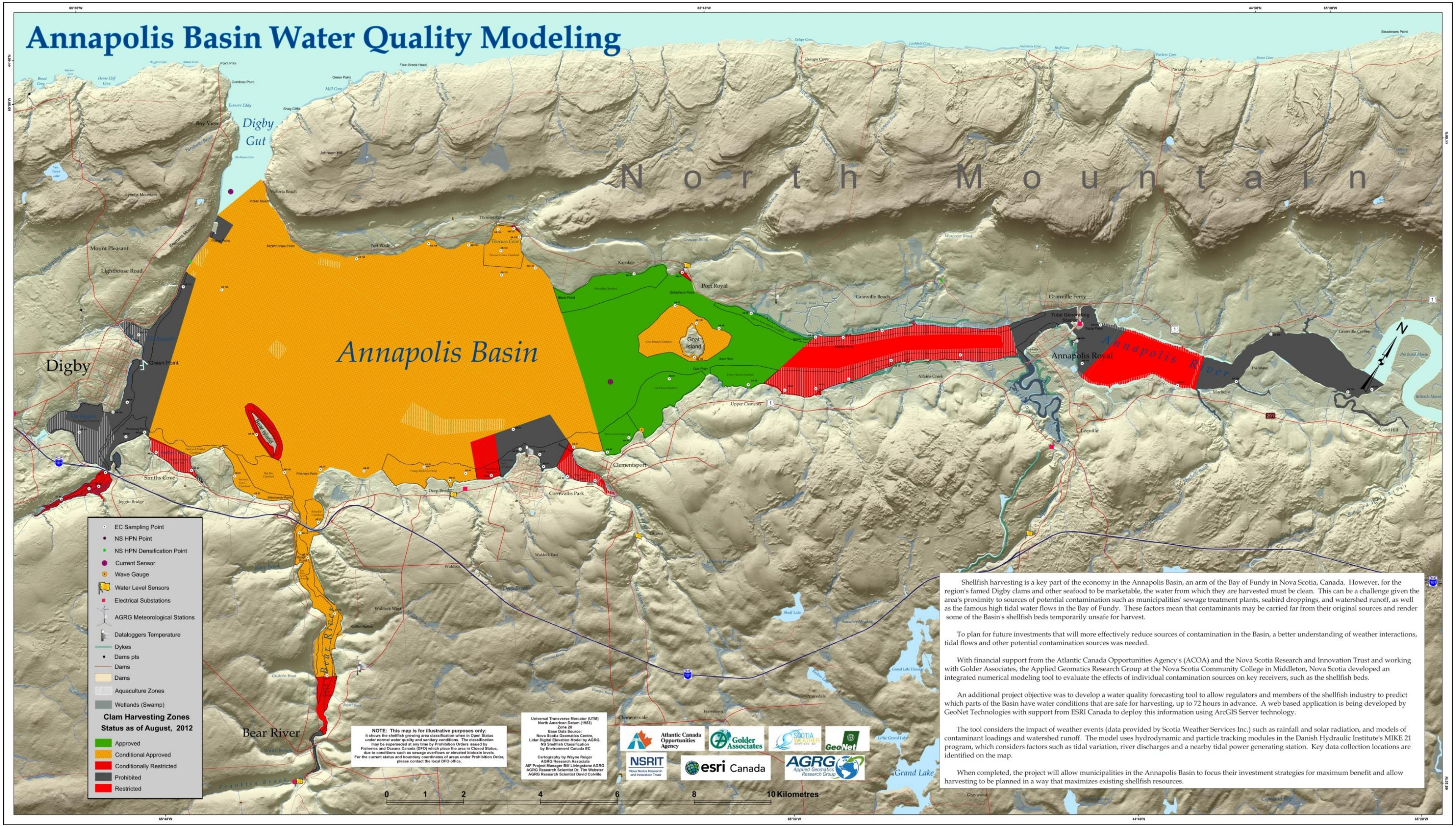


Figure E1. Clam Harvest Area map of the Annapolis Basin. (Source: AGRG, 2013)