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Basin Head Marine Protected Area: 2017-2018 Operational Management Plan Implementation Progress Report

Fisheries and Oceans Canada, Gulf Region
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2020

Gulf Region Basin Head Management Series 2020/01

Canada

Gulf Region Basin Head Management Series

The Gulf Region Basin Head Management Series publications are reports on management initiatives and monitoring undertaken in the Basin Head Marine Protected Area. This series consist of monitoring progress reports, operational management plan, consultant reports, scientific studies, workshops and other public documents related to the Basin Head Marine Protected Area. The Basin Head Management Series was established in 2014. Reports in this series have been written by or prepared under the guidance of staff of the Department of Fisheries and Oceans - Gulf Region. The content of this series is intended to be a source of information for public and internal dissemination.

Série sur la gestion de Basin Head dans la région du Golfe

La série de publications sur la gestion de Basin Head de la région du Golfe regroupe des rapports au sujet d'initiatives de gestion et de surveillance entrepris dans la zone de protection marine de Basin Head. Cette série se compose principalement de rapports de progrès sur la surveillance effectuée à Basin Head, plan de gestion opérationnel, d'études scientifiques, de rapports de consultants, d'ateliers et d'autres documents publics reliés à la zone de protection marine de Basin Head. La série sur la gestion de Basin Head fut créée en 2014. Ces rapports furent rédigés par le personnel du Ministère des Pêches et des Océans ou furent préparés sous la direction de ceux-ci – dans la région du Golfe. Le contenu de cette série se veut une source d'information pour une diffusion publique et interne.

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DFO/2020-1985
Cat. No. Fs146-1/2020-01E-PDF
ISSN 2368-5999

Published by:

Fisheries and Oceans Canada
Gulf Region
343 University Avenue
P.O. Box 5030
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Correct citation for this publication:

DFO 2020. Basin Head Marine Protected Area: 2017-2018 Operational Management Plan Implementation Progress Report. Gulf Region Basin Head Management Series. 2020/01: vii + 18p.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

This Progress Report for the Basin Head Marine Protected Area outlines the activities and monitoring associated with the four conservation objectives that occurred during the 2017-18 fiscal year (April 2017 to March 2018). This report also highlights the different management actions taken in 2017-18 and the future steps and priorities for the integrated management of the Basin Head Marine Protected Area.

RÉSUMÉ

Ce rapport de progrès pour la zone de protection marine de Basin Head décrit les activités et la surveillance associée aux quatre objectifs de conservation qui ont eu lieu au cours de l'année financière 2017-18 (avril 2017 à mars 2018). Ce rapport met également en lumière les différentes mesures de gestion prises en 2017-18 ainsi que les prochaines étapes et les priorités pour la gestion intégrée de la zone de protection marine de Basin Head.

1.0 INTRODUCTION

The Basin Head Marine Protected Area (MPA) was designated on September 26, 2005 via regulations under the statutory authority of Canada's *Oceans Act* (Basin Head Marine Protected Area Regulations http://laws.justice.gc.ca/eng/regulations/SOR-2005-293/). The MPA was designated under the *Oceans Act* Section 35, paragraph (1) c (conservation and protection of unique habitats), as well as paragraph (1) e (to fulfil the mandate of the Minister).

The MPA encompasses Basin Head Lagoon and an adjacent offshore buffer zone in eastern Prince Edward Island within the Northumberland Strait (Figure 1). The MPA was designated by regulations to conserve and protect a distinct form of an otherwise common marine alga, Irish moss (*Chondrus crispus*). This form of *Chondrus,* also known as the giant moss, is thought to exist only within the confines of Basin Head. It reproduces by fragmentation, does not reproduce sexually or by producing spores, and has no holdfast but is held in place by byssal threads of Blue mussels (*Mytilus edulis*). Sheltered habitats often influence morphology of algae; this has resulted in relatively expanded blades for the giant Irish moss in Basin Head. However, spriggy outer coastal plants (i.e. narrow blades) sharing the habitat are attached to hard objects by holdfasts and have not developed into the giant form (Novaczek & Cairns in prep). Microsatellite genomes of the spriggy and giant populations have been found to be different (Novaczek & Provan in prep.); therefore, this giant moss is also genetically distinct, and not simply an artifact of environmental conditions. What is especially interesting and requiring management and protection is the giant Irish moss dependence on mussels for attachment.

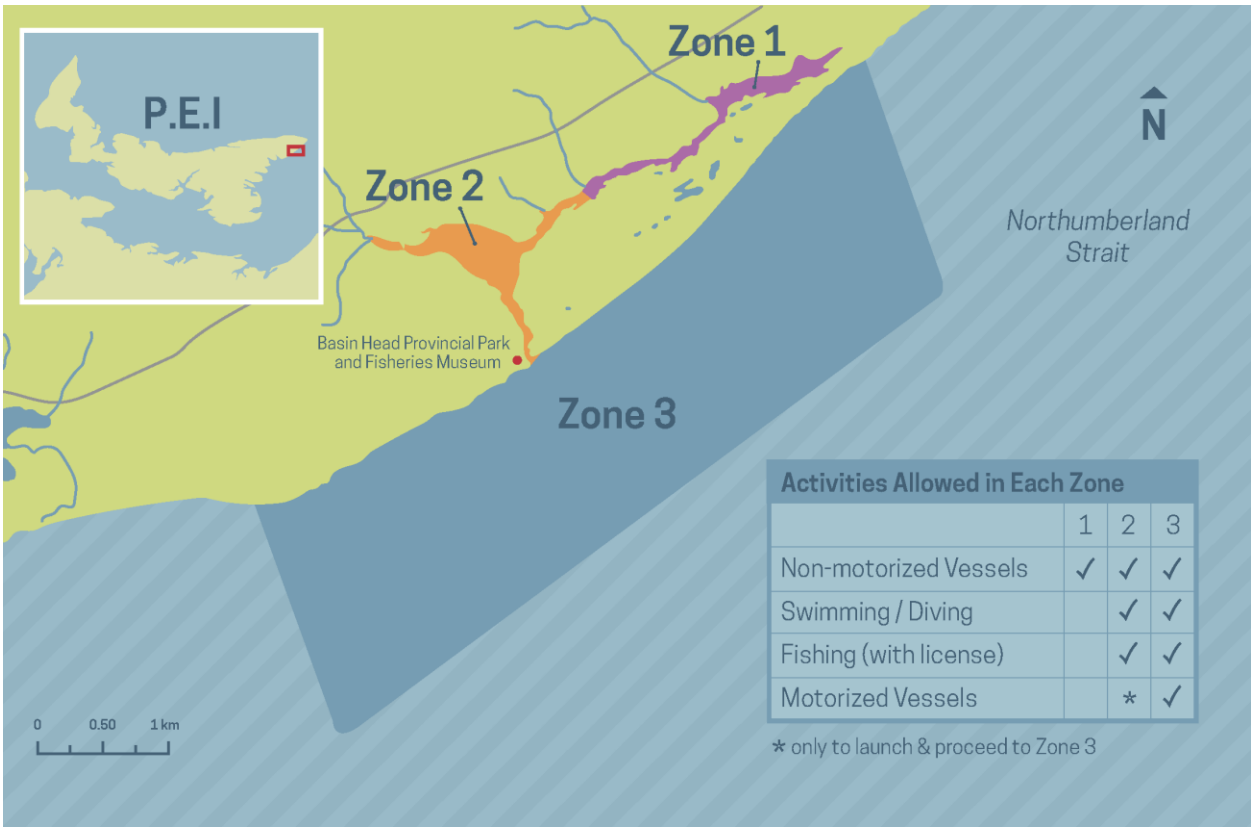

Figure 1: Basin Head Marine Protected Area and its three management zones.

Zone 1: Northeast Arm
Basin Head's Northeast Arm extends from the main basin to the east for approximately three kilometres. This inner channel has been given the highest level of protection because this is where the unique form of Irish moss is found. Because of its vulnerability, motorized vessels are not permitted in this zone; there is no commercial or recreational fishing, nor any other potentially destructive activities allowed. Swimming and diving are also not permitted in this zone, except under a scientific research activity plan.

Zone 2: Main Basin
This zone includes the main basin of the lagoon, the western end of Northeast Arm and the channel leading to the entrance to Northumberland Strait. This zone acts as a buffer for the more sensitive inner reaches of Northeast Arm. The zone can tolerate minor disturbance; therefore swimming, diving, and non-vessel based fishing activities are allowed. It includes a boat slip from which motorized vessels may be launched, but these vessels must proceed directly to the open water (zone 3).

Zone 3: Outer Coast
The outer coastal area protects the integrity of Basin Head's sand dune structure. This zone extends seaward from the mouth of the lagoon for one nautical mile and covers an area of coast three nautical miles long (southwest to northeast) adjacent to the entrance channel. In this zone, the only restrictions are on those activities that could alter the coastline in such a way as to endanger the fragile dune system, and therefore the lagoon itself. All other activities are allowed.

The Basin Head MPA Operational Management Plan (OMP) was updated in 2014. The OMP serves as a guide to support decision making in the management of this unique ecosystem and forms the basis for the development of comprehensive conservation and management strategies. It provides information on regulatory and non-regulatory measures, monitoring, governance structure, enforcement and compliance and management actions once ecological triggers have been reached. It also provides the details required to ensure that management decisions, prohibitions, and activity applications and processes are clearly understood.

The Basin Head MPA OMP is intended to serve as a "living" document which may be amended as required to ensure management objectives and monitoring requirements are met. The OMP is scheduled to be reviewed every five years. The next review of the OMP will begin in 2019. The periodic reviews examine the conservation objectives of the MPA to determine if they remain appropriate, evaluate the success of management actions in achieving the conservation objectives, and identify emerging priorities for subsequent reviews of the OMP.

The purpose of this yearly Progress Report is to report on activities and achievements in the Basin Head MPA during the 2017-18 fiscal year (April 2017 to March 2018) that contribute to the implementation of the management plan. This report and past reports will serve as guides for the Operational Management Plan review.

Personnel from Oceans Management Program, Fisheries and Oceans Canada (DFO), Gulf Region are responsible for efforts aimed at achieving the conservation objectives described in the OMP. Management of the MPA is also guided by the advice of DFO science, the local community and stakeholders, other federal and provincial government departments, academic partners and Indigenous groups, acting through the Basin Head MPA Advisory Board.

2.0 MANAGEMENT HIGHLIGHTS FOR 2017-18

(refer to the map of Basin Head MPA Fig. 2 for locations of the areas named below)

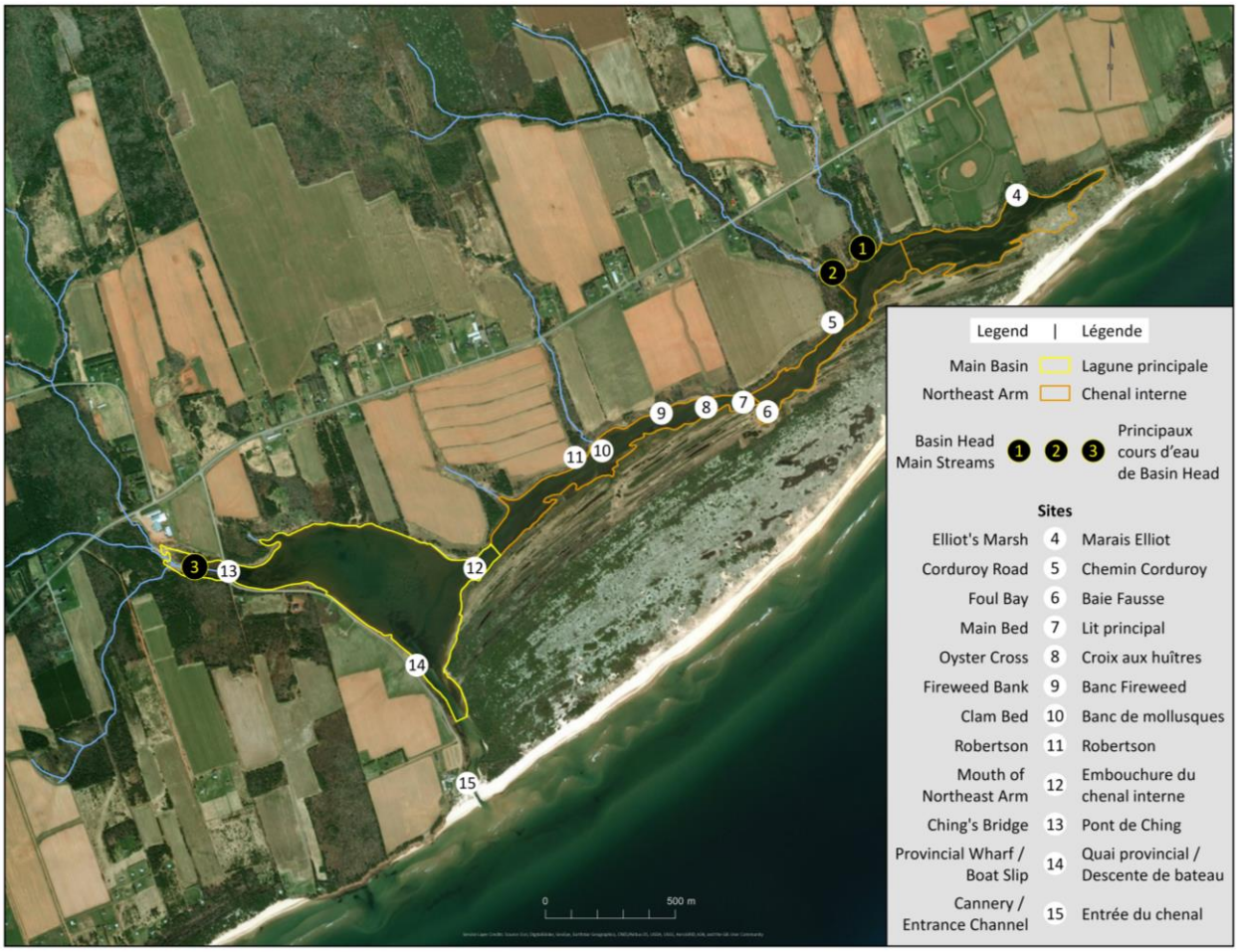

Figure 2: Map of Basin Head Marine Protected Area with lettered streams and numbered sites.

Irish moss monitoring and restoration

- Sock cultivation of Irish moss in the western portion of Northeast Arm resumed in 2017 using Basin Head Irish moss supplied from on-land tank cultivation at the National Research Council (NRC) marine station at Sandy Cove, Nova Scotia. The aim was to develop biomass both for field experiments and for rehabilitating portions of the Northeast Arm where the Irish moss-mussel ecosystem had been drastically declining.
- Starting in 2015, cultivated Blue mussels from the Confederation Cove Mussel Co. Ltd were brought into Basin Head to stabilize the remnant Irish moss population and to provide anchorage for giant Irish moss that was propagated in suspended cultivation. Natural clumps of Irish moss and mussels attached by byssal threads were generated by putting them together in cultivation bags for a minimum of 48h. The Irish moss-mussel clumps were then introduced into areas similar in depth and bottom type to the preferred habitat of the remnant population, and monitored. These conservation and restoration activities continued

through 2016 and 2017, resulting in a year-to-year increase in Irish moss biomass in Northeast Arm (see Figure 3).

- In 2017, 3,059 clumps were planted in Main Bed, Corduroy Road and Fireweed Bank (Figure 2) for a total of 4,154 clumps planted during the three year span (2015-2017). The estimated area covered by Irish moss at the end of 2017 was approximately 65.7 m^2 compared to 30.7 m^2 at the end of the 2016 season (see Figure 3).
- It is estimated that approximately 90% of planted and enhanced Irish moss-mussel clumps have survived during those three years of restoration work (2015-2017). This success rate confirms the potential of this restoration method for rehabilitating the Irish moss population.
- In August 2017, a drone survey was carried out in all three Irish moss beds (Corduroy, Main Bed, Fireweed Bank) to test the ability of drone photography to map and quantify moss abundance.
- Monitoring of a test plantation at Oyster Cross (immediately west of Main Bed) continued in 2017. All clumps were exposed to smothering by Ulva from spring through summer. Mussel clumps and Irish moss nevertheless survived well on areas of the plantation that were on firm bottom. Irish moss disappeared from clumps placed on softer bottom.
- Seven test strips of Irish moss–mussel clumps were planted outside of the existing beds on bottom that appeared to hold potential for clump survival (limited sediment thickness and intermediate depth). Areas tested lay just west of Corduroy Road (2 transects), and Fireweed Bank. Survival in each area was assessed in 2017. All mussel clumps and 73% of Irish moss fronds survived at Fireweed Bank. On other transects mussel clump and Irish moss survival ranged from 0 - 50%; in some cases this was attributed to sedimentation that overwhelmed the clumps.
- During the winter of 2017-18, hourly photographs taken by a field camera at Main Bed in Northeast Arm were catalogued to allow for comparative evaluation of ice conditions year to year in relation to clump retention over winter.

Water quality monitoring and hydrodynamic model

- In 2017, DFO deployed continuous temperature, dissolved oxygen, pH, light flux density and tidal flux loggers in the Basin Head MPA. Regular weekly nutrient monitoring (nitrate, nitrite, phosphate, ammonia and silicate) for water quality continued in 2017 (May – November).
- Over the past two years, data have been collected to test the pre-existing hydrodynamic model developed in 2011 for Basin Head. In 2017, seven water pressure loggers to measure tidal flux and two Acoustic Doppler Current Profilers (ADCPs) to measure current strength were deployed in Basin Head. Information on abiotic conditions such as current flow, sediment thickness and bathymetry were gathered to identify areas that favour giant Irish moss and mussel growth to be mapped. An updated hydrodynamic model could help highlight areas where conservation efforts should be prioritized and areas that are currently inhospitable for the giant Irish moss.
- A limited test of light loggers in 2016 led to redesigning the deployment method and data collection during the summer of 2017.

Sediment Sampling

- Penetrable sediment thickness, sediment nutrient concentrations (% nitrogen, % carbon, % sulfur and ppm ammonium on dry weight basis), sediment pore water pH, grain size distribution and % organic content were documented at 11 sampling stations in Northeast Arm, starting in October 2016. Sampling sites included the *Ulva* bed at Elliot's marsh and other sites along the soft edges of the estuary from Corduroy Road to Clam Bed (Zone 1,

fully protected area). In 2017, further samples were taken in the spring, summer, and autumn to monitor seasonal changes in mobile silt thickness and chemistry.

Marsh edge erosion

- Sods eroded from the salt marsh edges litter the bottom every spring. When these sods decompose over the summer and fall they can smother Irish moss clumps. In 2017, 10 sods were tagged, measured and sampled for nutrients (% nitrogen, % carbon, % sulfur and ppm ammonium in dried sediment samples), sediment pore water pH, % organic matter content, and particle grain size distribution. Samples of sediment surrounding the sods were also analysed. The sods will be re-measured in 2018 to determine rates of degradation.
- In January 2017, rebar posts were placed along the edge of the salt marsh near the Main Bed and the distances from rods to the marsh edge were monitored in the summer of 2017 to determine the rate of erosion. Monitoring will continue in 2018.
- A preliminary assessment of marsh thickness and integrity was performed by coring. Sediment cores were examined to document the thickness of living marsh grass roots, dead roots and degraded peat. Marsh root pore water samples were also collected to assess salinity and nutrient content. These data will help assess if eutrophication is contributing to the marsh erosion that affects Irish moss habitat and clump survival.

Green Crab trapping

- In 2017, invasive European Green crabs (*Carcinus maenas*) were trapped 2-3 times a week during August, September and November and every day in October. During this second season of trapping, 32,821 crabs were removed from Basin Head. Seventy percent were males with a proportion of 66% measuring over 55 mm, 27.5% measuring between 35-55 mm, and 6.5% measuring below 35 mm. Thirty percent were females with a proportion of 3% measuring over 55mm, 74.3% measuring between 35-55 mm, and 22.7% measuring below 35 mm.

Irish moss – mussel – crab interactions

- A series of studies were initiated in 2014 with the University of Prince Edward Island (UPEI) to evaluate Irish moss and Green crab interactions in Basin Head. Green crab population assessments were conducted by UPEI using various trapping methods. Laboratory and field experiments focused on the direct and indirect interactions among Green crabs, Irish moss and Blue mussels. Further experiments in 2017 focussed on the influence of Irish moss clump sizes on those interactions. UPEI researchers have been granted a two year extension of funding to continue field research, which will end in March 2019.
- Standard Green crab surveys of two sites within Basin Head and two sites located in a reference location (Murray Harbour) were continued during the field season of 2017 by UPEI. Those surveys showed densities of Green crab ranging between 14 and 75 Green crabs/trap/day in the Northeast Arm and densities ranging between 0 and 12 crabs/trap/day in the main basin area of the lagoon. A reduced density in the main basin in 2017 could possibly be linked with the removal of 30,000 Green crab in 2016.
- Field experiments conducted by DFO field staff in 2017 tested for mutualism between Irish moss and adult Blue mussels. Results showed no evidence of increased growth in Irish moss and mussels, or of enhanced gonad development in mussels, when each grew in proximity to the other, compared when growing in isolation. However, mussel and oyster spat settled more heavily on Irish moss relative to mussels or shell litter. Mussel spat also grew faster in the presence of Irish moss, compared to spat growing on mussel-only clumps.

- An experimental plantation established at Fireweed Bank in May 2017 was sampled in July, August and September. Both mussels and Irish moss grew rapidly and some mussel clumps that initially did not have Irish moss attached had captured Irish moss fragments by the end of summer. Juvenile mussels survived in the clumps despite the presence of predators including Green crab. Various species (oysters, soft shell and hard shell clams, slipper shells, limpets, periwinkles, whelks, hermit crabs, mud crabs, barnacles, amphipods, annelid worms) recruited into the area where clumps were planted and were found associated with clumps at the time of sampling.

Overall ecosystem health in Basin Head

- In general, there was an overall decline in ecosystem health in Basin Head between 2000 and 2015. Irish moss biomass and bed size suffered net loss year to year, and eelgrass cover within the Northeast Arm was almost entirely eliminated. The suite of species formerly associated with the Irish moss-mussel bed also disappeared, leaving the bottom almost barren. That trend is now being reversed in areas where clumps are being planted. As of 2015 natural recruitment of oysters has improved bottom conditions by filtering otherwise mobile sediments. In 2017 there were also several small patches of eelgrass discovered in the western end of Northeast Arm. There is still seasonally heavy coverage of large areas of the bottom by green macroaglae (*Ulva lactuca* and associated algae) and the abundance and diversity of benthic invertebrates is poor outside of the Irish moss beds. There are persistently high concentrations of nitrogen and phosphorus in the water and hypoxic or anoxic conditions at the inner end of Northeast Arm in the summer. There is a noticeable loading of sediments into the estuary each year from agricultural runoff, *Ulva* bloom decomposition and degradation of ice scoured marsh sods.

Highlights – Various

- Interviews with farmers in the Basin Head watershed were conducted in 2017 to document crops, types, rates and timing of application of fertilizers, timing of ploughing and presence of erosion control structures. These data will be used to better understand nitrogen loading from the watershed into the estuary, and to explore the relationships among weather patterns, land use and estuarine water quality. Results will be communicated to the farming community to foster collaboration to address land use impacts on the estuary.
- The Interdepartmental Letter of Agreement (ILA) between DFO Gulf Region and the NRC, for the maintenance of 10 kg of Basin Head *Chondrus* at the NRC's Sandy Cove facility, was renewed for 2017. Biomass from the holding stock at NRC was reintroduced to Basin Head and placed into cultivation on site to provide plants for both experimental purposes and for planting trials.
- The Basin Head Marine Protected Area Advisory Board met on November 21, 2017 in Charlottetown, PEI. Members were updated on research, communication and outreach activities conducted during the 2017 field season. Several presentations described the research and monitoring conducted in Basin Head. A member of our Advisory Committee, The Island Nature Trust, also presented an overview of their activities.
- Eelgrass restoration in the Northeast Arm was tested in 2017 for the first time in Basin Head. One 100 m^2 eelgrass plot was planted using rooted eelgrass from Souris Harbour and attached to oyster shells. The plot was planted in the fall of 2017 and will be monitored in 2018 to evaluate survival rate. If successful, additional plots will be established in 2018.
- In 2017, Souris and Area Branch of the PEI Wildlife Federation (SAB) conducted approximately 7 km of stream restoration work on Basin Head Creek, which falls outside the MPA boundaries.

- The coastal fish community has been monitored since 2003 in Basin Head at six stations in the main basin using the Community Aquatic Monitoring Program protocol. The regular sampling continued in 2017 from June to August.
- In 2015, vase and clubbed tunicates (both aquatic invasive species) were detected on Irish moss, although they were not detected in 2016 (Irene Novaczek, personal communication). Therefore, in 2017, two biofouling collector lines for early detection of aquatic invasive species (AIS) were deployed in Basin Head as part of the larger annual AIS biofouling monitoring program in the Gulf Region. No aquatic invasive species were detected on these biofouling collector lines in Basin Head MPA in 2017.

Figure 3: Change in Irish moss recent coverage between 2013 and 2017.

3.0 CONSERVATION OBJECTIVES AND ACTIONS TAKEN

Conservation objectives describe the desired ecological outcome of establishing an MPA and are based on the best available scientific and traditional ecological knowledge. These objectives guide the MPA establishment and management process by providing the basis for determining management measures. They also allow the setting of limits within which the nature and magnitude of human impacts on ecosystems and/or key ecological features of the MPA are assessed. Economic opportunities compatible with these conservation objectives may be permitted within the MPA or within specific zones.

There are four conservation objectives for Basin Head MPA:

Conservation objective 1: Maintain the quality of the marine environment supporting the *Chondrus crispus.*

Conservation objective 2: Maintain the physical structures of the ecosystem supporting the *Chondrus crispus*.

Conservation objective 3: Maintain the health (biomass and coverage) of the Basin Head *Chondrus crispus*.

Conservation objective 4: Maintain the overall ecological integrity of the Basin Head lagoon and inner channel. This includes avoidance of excessive *Ulva* growth, maintenance of adequate oxygen levels, and maintenance of diversity of indigenous flora and fauna.

Management and monitoring actions taken during the 2017-18 fiscal year to fulfill short and long-term management goals for both regulatory and non-regulatory conservation objectives are shown in Table 1 and 2, respectively.

Table 1. Basin Head MPA Regulatory Conservation Objectives and Monitoring/Management Actions.

	Management Goals	**Action Taken in 2017-2018**
Regulatory Conservation Objective: Maintain the quality of the marine environment supporting the Basin Head *Chondrus crispus*	**Short Term Goals (3 years):** To maintain twice monthly water quality monitoring (May through October) at 11 water stations within the MPA. Information will be collected on nitrate, nitrites, phosphates, chlorophyll, turbidity, temperature, dissolved oxygen and salinity.	Water quality at 11 sites sampled weekly from May to November, 2017, near high tide. Dissolved oxygen continuous loggers were deployed at three locations in the Northeast Arm in 2017. pH continuous loggers were deployed at the old boat slip in the main basin and in Main Bed in 2017.
	To monitor continuous water temperature in the Inner Channel station and the main basin.	Temperature loggers at three permanent locations were retrieved, downloaded, and re-deployed to provide year-round monitoring. Temperature was recorded every 60 minutes.
	Long Term Goals (10 years): By using the data collected, determine if there is a significant decline in the quality of the marine environment supporting the Basin Head Irish moss.	DFO researchers have analyzed the 2001-2017 water chemistry data and preliminary results suggests there are no signs of consistent improvement or decline in water quality over this time period.
Regulatory Conservation Objective: Maintain the physical structures of the ecosystem supporting the *Chondrus crispus*	**Long Term Goals (10 years):** Monitor the land use activities and erosion of the watershed area.	Eutrophication may weaken the roots of Basin Head salt marsh grasses, leading to increased rafting of marsh sods by winter ice, and erosion of the marsh edge. Investigations of erosion from the marsh edge over time, and documentation of marsh sod decomposition rates were performed in 2017 and will continue in 2018. In January 2017, rebar posts were placed along the edge of the salt

	Management Goals	Action Taken in 2017-2018
		marsh near the Main Bed. Distances from the marsh edge were monitored to determine the rate of erosion. A land use survey was conducted in the winter of 2016-17 for analysis in 2017-18. Sediment samples collected at 11 sites in the estuary in 2017 were monitored for thickness and analysed for pH and nutrient content. Young's Hill Road continued to be monitored by SAB as a point source of sedimentation in 2017. Observations of runoffs into the lagoon were noted.
	Develop a water circulation model to evaluate water circulation changes.	In 2017, tidal flux (water pressure) loggers were re-deployed at Robertson's, Main Bed and Corduroy Rd. Additional current meters and water level loggers were also placed throughout the basin including one site in the outer portion of the lagoon. These data will be used to refine the hydrodynamic model for Basin Head. Salinity measurements may also indicate water circulation trends over time.
Regulatory Conservation Objective: Maintain the health (biomass and coverage) of Basin Head *Chondrus crispus*	**Short Term Goals (3 years):** Establish monitoring transects within the *Chondrus crispus* bed to evaluate biomass and coverage. Due to drastic decline in *Chondrus*, aerial photography and glass bottom boat deemed no longer useful and Irish moss survey is now done by walking/swimming along transects spaced 4 m apart until biomass increases.	In 2017, a full wading transect survey was conducted at all three beds (Main, Corduroy & Fireweed) and test strips were planted to monitor survival of Irish moss outside of these beds.
	Continue weekly photo mosaic at three locations (i.e. eastern end of the arm, vicinity of the *Chondrus* bed and Ching's Bridge) to quantify the green algae (*Ulva lactuca*) coverage.	Photographs were taken at Ching's Bridge, Elliot's Look out and Foul Bay from May to November 2017, to establish a record of green algal (*Ulva*) bloom development and decline. Camera surveillance of Main Bed continued in 2017-2018 and has

	Management Goals	Action Taken in 2017-2018
		provided additional information on near-shore development of *Ulva* mats in central Northeast Arm.
	Long Term Goals (10 years): Maintain the biomass and coverage of the Basin Head *Chondrus crispus* at healthy and sustainable levels.	A major factor in the *Chondrus* decline has been the invasive Green crab (Cairns *et al.* 2012), which removed successive year classes of mussels, leaving only a few ageing individuals to hold the Irish moss population in place. Experiments have shown that eutrophication and the resulting smothering of areas by *Ulva* and anoxic silts also contributes to the loss of clumps. Sock cultivation of Irish moss in western Northeast Arm (below Robertson's field) continued through 2017 using cultivated stock from the NRC marine station at Sandy Cove. The ILA with NRC was renewed for the maintenance of Basin Head *Chondrus crispus* (minimum 10 kg) at the NRC research facility in Sandy Cove, NS. In 2017, for a third season, artificially constructed mussel clumps with Irish moss were planted in areas similar in depth and bottom type to the preferred habitat of the remnant population. Sandy Cove Irish moss cultivars and commercial mussels were brought in and used to make the clumps. Data from test strips conducted in previous field seasons guided the plantings for 2017. As a result, there is now a new/re-established bed thriving at Fireweed Bank in Northeast Arm.
Regulatory Conservation Objective: Maintain the overall ecological	**Short Term Goals (3 years):** To continue the Community Aquatic Monitoring Program (CAMP) to monitor trends in community	The CAMP Program was conducted in 2017 from June to August in Basin Head.

	Management Goals	Action Taken in 2017-2018
integrity of the Basin Head lagoon and inner channel.	abundance and diversity of fish and benthic invertebrates within the Basin Head lagoon.	
	To create detailed maps of percent cover by major aquatic plant species.	A drone was used to collect images that could be stitched together and georeferenced to develop a mosaic for mapping the locations of Irish moss clumps in Northeast Arm. The images also aid in monitoring marsh edge erosion and appearance and disappearance of marsh sods in the channel.
	Long Term Goals (10 years): Maintain the diversity of indigenous flora and fauna within the Basin Head MPA by evaluating the effectiveness of the monitoring plans, indicators and triggers up to date.	Current conditions revealed by systematic sampling are dramatically different from the baseline data on *Zostera*, *Ulva* and *Chondrus* that were collected prior to 2007. *Zostera* was almost completely absent from Northeast Arm as of 2014 and the Irish moss had been reduced by 99.9%. Ongoing research has flagged Green crab and eutrophication as the primary threats to the giant Irish moss population that remains. Rising summer seawater temperatures may also pose a threat in the future. Planting of clumps made from commercial mussels and cultivated giant Irish moss in 2015-2017 has stabilized and augmented the Irish moss population and increased biodiversity on the bottom. Oysters and eelgrass have both increased naturally over the same period.

Table 2: Basin Head MPA Non-Regulatory Conservation Objectives and Monitoring/Management Actions.

	Management Goal	Action Taken in 2017-2018
Non-Regulatory Objective: To ensure the participation of interested and affected stakeholders in the operation of the MPA.	**Short Term (3 years):** Continuation of annual Advisory Board meetings to ensure stakeholder support and involvement.	An Advisory Board meeting was held in Charlottetown on November 21, 2017.

	Management Goal	Action Taken in 2017-2018
Non-Regulatory Objective: To increase the public awareness of the Basin Head *Chondrus crispus,* the ecosystem of the Basin Head MPA and its conservation measures.	**Short Term (3 years):** To develop a Basin Head MPA website.	There is an existing link to Basin Head MPA information on the DFO website. The website was updated to include on-line instructions on how to apply for an activity permit.
	To enhance the existing on site laboratory to maximize education potential.	The on-site wet lab at the cannery wharf is frequently used to process samples. Visitors who stop by to ask questions are welcomed by the field staff. There is an interactive computer kiosk and brochures about the MPA in the Basin Head Fisheries Museum
	Long Term (10 years): To increase public awareness through publication of brochures, interpretive touchscreen kiosk, and involvement in community events.	Eco tours in the main basin were conducted by SAB in 2017. SAB communicates regularly with local stakeholders through the "Souris and Area Watershed News" on activities that involve Basin Head. The senior research scientist made community presentations in Souris and has been invited to speak to Abegweit First Nation. Field site tours for UPEI and Holland college students were conducted in 2017.
Non-Regulatory Objective: To promote scientific research to increase the level of understanding of the Basin Head MPA.	**Short Term (3 years):** To continue to collaborate with Island Nature Trust, SAB and UPEI to meet the monitoring requirements identified in the Operational Management Plan.	A contract with SAB was in place to provide assistance with the summer and fall water monitoring program. In 2017, SAB also conducted a Green crab removal project. UPEI faculty and students performed research on Green crabs in 2017-2018. A study was continued in 2017 with UPEI to evaluate the interactions among Green crabs, Irish moss and Blue mussels.
	Development of Activity Plans and Approvals as outlined in Section 5.0 of the Basin Head MPA Regulations.	Approval Process in Place; 10 activity plans for 2017 season were submitted and approved.

	Management Goal	Action Taken in 2017-2018
	Long Term (10 years): To continue to identify potential partners for collaborative research projects.	Dr. Gail Chmura (McGill University) and her students assisted with research on the salt marsh in 2017.
Non-Regulatory Objective: To maintain and enhance the quality of the Basin Head ecosystem.	**Long Term (10 years):** To implement best management practices to reduce the impacts of nutrient enrichment on marine environmental quality within the Basin Head ecosystem.	Through the land use survey it was reported that farmers are more diligent in the use of fertilizer, partly because of the cost; also new farm practices are being examined or considered for soil conservation. Preliminary discussion with local farmer and watershed group on the possibility of planting willow trees in the buffer zone to reduce the nutrient and sediment loading in the system was initiated.
	To reduce the spread of aquatic invasive species in the Basin Head ecosystem by public awareness or stewardship initiatives.	On-going through the monitoring and education being done by the Aquatic Invasive Species (AIS) program at DFO and the Community Aquatic Monitoring Program (CAMP) as well as the Eco-Tours

4.0 ACTIVITY PERMIT APPLICATIONS

MPA regulations recognize that certain activities within an MPA may be consistent with conservation objectives. For some of these activities, Basin Head MPA regulations require the submission of an activity plan and specify approval conditions. Ministerial approval of activity plans is one of the primary means of governing the activities proponents undertake in MPAs.

Proposed activity plans are reviewed to assess environmental impacts of the individual activity along with the cumulative effect of all activities in the MPA, and to ensure that the activity is for the purpose of the conservation and/or management of the MPA, or for allowable scientific or educational purposes. Thus, the requirement of the submission of an activity plan for certain activities is an important regulatory mechanism used to limit human impacts in MPAs before they occur.

Table 3. Activity Approvals in Basin Head MPA during 2017-18.

	Study Name	Researcher	Affiliation	Purpose	Date Approved
1	Green crab removal	Siobhan Curry	DFO - Gulf	To reduce and control the population of the invasive European Green crab, which are predating on Blue mussels in the Basin Head MPA.	March 27, 2017
2	Data collection in support of hydrodynamic modelling	Dr. Thomas Guyondet	DFO - Gulf	Acquisition of new tidal data with 7 tidal loggers and 2 Acoustic Doppler Current Profilers. (May – November 2017)	May 4, 2017
3	Giant Irish moss and mussel interactions	Dr. Irene Novaczek	DFO - Gulf	Explore potentially synergistic effects that giant Irish moss and Blue mussels have on each other. Assess the growth and survival of Irish moss and mussels.	May 4, 2017
4	Irish moss – Green crab interactions in Basin Head MPA (Season 2017)	Dr. Pedro Quijon	UPEI	Assessing Green crab relative densities and their potential effects on the Irish moss (August 2014 – December 2019)	May 10, 2017
5	Water quality monitoring – multi-site	Siobhan Curry	DFO - Gulf	Annual water quality monitoring (nutrient load and hydrographic parameters) (April – November 2017).	March 27, 2017
6	Giant Irish moss and mussel bed monitoring and recovery in Basin Head MPA	Dr. Irene Novaczek	DFO - Gulf	Enhancing the Irish moss biomass by cultivation of giant Irish moss, engineering of mussel-moss clumps, and planting of clumps (April – November 2017)	March 27, 2017

7	Community Aquatic Monitoring Program	Monica Boudreau	DFO - Gulf	Monitor the diversity of fauna and flora captured in the Basin Head lagoon (June to August 2017)	May 4, 2017
8	Investigating mussel spat settlement and mussel predation in Northeast Arm	Dr. Irene Novaczek	DFO - Gulf	To undertake a preliminary exploration of predation pressure on mussels by exposing loose mussels and clumps to natural predation on shallow bottom in an area of hard substrate in Northeast Arm. (May – November 2017)	May 4, 2017
9	Sediment sampling, Northeast Arm 2017	Dr. Irene Novaczek	DFO - Gulf	Collection of sediment samples to allow documentation of seasonal changes in mobile silt thickness and chemistry.	March 27, 2017
10	Aquatic invasive species (AIS) biofouling monitoring program	Renée Bernier	DFO - Gulf	Deploy 2 biofouling collector lines for early detection of aquatic invasive species (AIS biofouling monitoring program).	April 3, 2017

5.0 ENFORCEMENT AND COMPLIANCE

As the Basin Head area is a frequent tourist destination and high traffic area for both visitors and locals, the local DFO Conservation and Protection officers patrol the area regularly to ensure compliance under the Management of Contaminated Fishery Regulations (MCFR's) and the Basin Head Marine Protected Area Regulations (BHMPAR) as well as the Maritime Provinces Fishery Regulations (MPFR's). There have been no issues reported, or identified, in regard to contraventions of the MCFR's or MPFR's. No enforcement issues were identified in the fiscal year 2017-18. These land-based patrols are conducted throughout the year. Note that oyster harvesting at the boundary of Zone 1 was the only commercial fishing recorded in Basin Head in the summer of 2017.

6.0 PUBLIC AWARENESS AND EDUCATION

Public education and outreach are critical factors in ensuring the long-term success of an MPA. Greater compliance with MPA regulations is observed when community members, MPA users

and the general public are aware of objectives and management strategies of an MPA. Education and outreach tools are most effective when they target appropriate user groups, stakeholders and the public, present a straightforward message, and use the most appropriate product to communicate the message.

Currently brochures and display panels explaining the purpose of the MPA are available to the public at the nearby Basin Head Fisheries Museum.

An interactive display kiosk was installed at the Basin Head Museum in 2014 using a computer monitor with touch-screen technology to give historical and biological information on Basin Head, as well as general information on the Canadian MPA program. This kiosk was still displayed in the Basin Head Museum and used by its visitors in 2017.

During the summer of 2017, SAB conducted educational activities consisting of a beach seine haul, which provided “hands-on” experience to explore the marine community within the Basin Head MPA. This activity was part of an authentic PEI experience and occurred every Tuesday and Thursday in July and August.

7.0 NEXT STEPS AND PRIORITIES

DFO will focus on several priorities related to the implementation of the operational management plan in the next fiscal year (April 2018 to March 2019). Priorities include:

- Continue annual monitoring of water quality, habitat integrity and biota, to maintain ecological integrity for the long term.
- Synthesis/analysis of water quality monitoring data and validation of the hydrodynamic model.
- Continue multi-year studies, which include Irish moss cultivation, trial plantings and studies on population dynamics, clump dynamics and the effects of Green crabs on the Irish moss.
- Explore other ways of monitoring Irish moss including drone surveying.
- Continue and improve the Green crab removal program.
- Explore other ways of mitigating nutrient and sediment input in the system.
- Enhance educational and outreach efforts with the upgrade of the old boat slip and additional Interpretative day park at that same location.

8.0 REFERENCES

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