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Basin Head Marine Protected Area: 2018-2019 Operational Management Plan Implementation Progress Report

Fisheries and Oceans Canada, Gulf Region
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2021

Gulf Region Basin Head Management Series 2021/01

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.

Gulf Region Basin Head Management Series

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACCRONYMS

AGRG ..... Applied Geomatics Research Group
AIS ..... Aquatic Invasive Species
BHMPAR ..... Basin Head Marine Protected Area Regulations
C&P ..... Conservation and Protection
CAMP ..... Community Aquatic Monitoring Program
DFO ..... Fisheries and Oceans Canada
MCFR ..... Management of Contaminated Fishery Regulations
MPA ..... Marine Protected Area
MPFR ..... Maritime Provinces Fishery Regulations
NRC ..... National Research Council
OMP ..... Operational Management Plan
SAB ..... Souris and Area Branch of the Prince Edward Island Wildlife Federation
UPEI ..... University of Prince Edward Island

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 2018-19 fiscal year (April 2018 to March 2019). This report also highlights the different management actions taken in 2018-19 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 2018-19 (avril 2018 à mars 2019). Ce rapport met également en lumière les différentes mesures de gestion prises en 2018-19 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 only by fragmentation, does not reproduce sexually or by producing spores (Tummon Flynn et al. 2018), 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. The exploration of genetic differences between this and the other Irish moss population is a logical next step to try to understand the uniqueness of this strain. The use of microsatellite genomes to compare Irish moss strains may provide further insight on the differences among populations (see studies by Krueger-Hadfield et al. 2011, 2013, 2015). What is especially interesting and requiring management and protection is the giant Irish moss dependence on mussels for attachment.

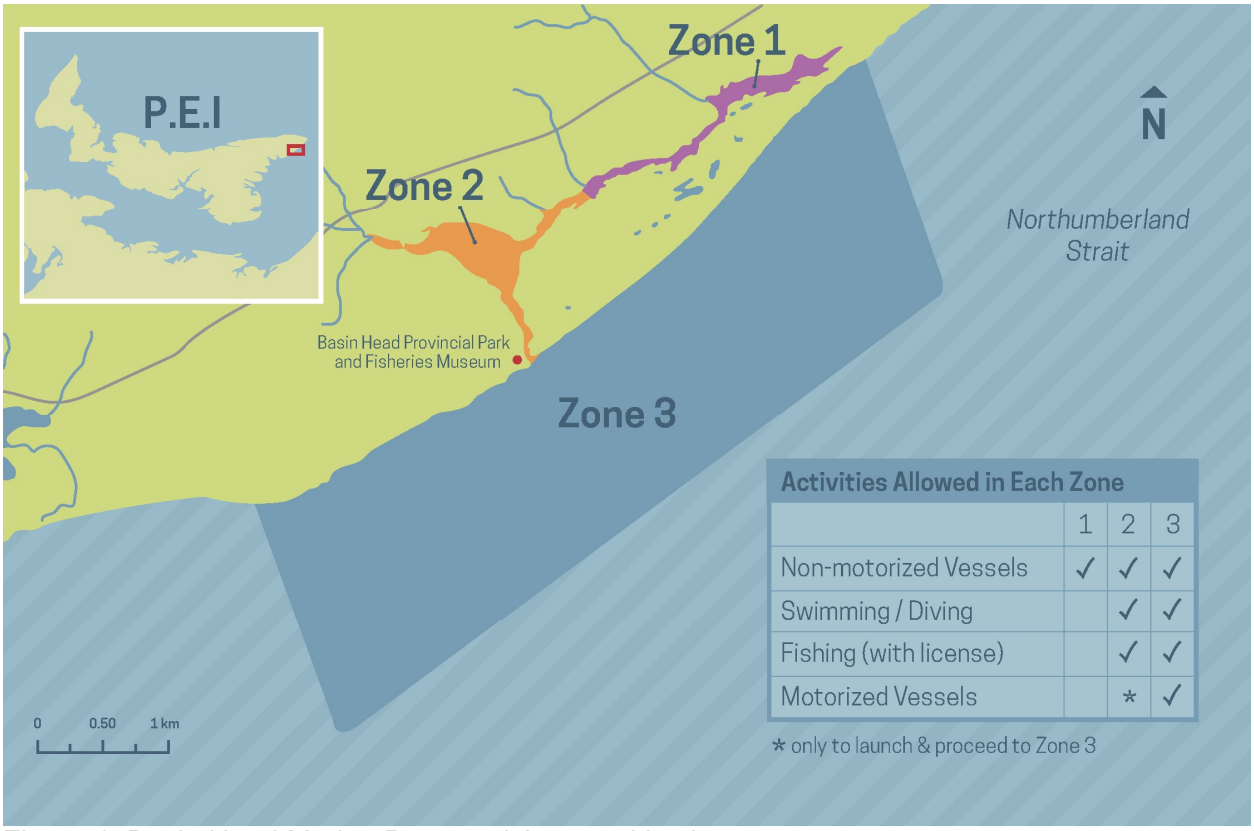

Figure 1: Basin Head Marine Protected Area and its three management zones.

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 last 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 and is due for review 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 2018-19 fiscal year (April 2018 to March 2019) 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 Marine Planning and Conservation 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 Committee.

2.0 MANAGEMENT HIGHLIGHTS FOR 2018-19

(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 2018 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 48 hours. 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 in 2018, resulting in a year-to-year increase in Irish moss biomass in Northeast Arm (see Figure 3).

- Starting in 2018, subsampling along 2-m wide permanent transects (swaths) replaced the full comprehensive wading surveys of the past (between 2014 to 2017) because the beds contained too many clumps to be individually surveyed with existing resources. The survey swaths, designed to encompass roughly 10% of the clumps present in each bed in 2017, were confined to Fireweed Bank (n=5), Main Bed (n=5) and Corduroy Road (n=6). All mussel clumps in each swath were counted whether or not they held Irish moss. The diameters of all Irish moss fronds attached to mussels were measured and the GPS position of each Irish moss frond was recorded using a Trimble GPS unit. These data, were then compared to the estimated number of Irish moss-mussel clumps occupying the same area of bottom at the end of the 2017 field season. Because planting went on after the 2017 comprehensive survey and positions of planted clumps are not individually recorded, this method has a potentially large margin of error but it will indicate whether or not there has been a catastrophic loss of Irish moss requiring a change in planting strategy and/or threat mitigation efforts.
- To estimate the 2018 Irish moss coverage, that following information was taken into consideration. We know that Irish moss is always lost from the beds over winter but expect that planting efforts will at least make up for the losses. The average % loss per bed was calculated by simply averaging the % change in Irish moss cover on all swaths in the bed. Because more than half of the swaths run along the edges of the beds rather than through the middle where habitat is better, losses are likely overestimated. For each bed, the % loss over winter 2017-18 was subtracted from the estimated total cover in November 2017 to provide an estimated square meter of cover remaining in spring 2018. The Irish moss planted in 2018 was then added to this estimate to obtain a conservative approximation of cover at the end of 2018. This methodology is still under development and we are looking into ways to reduce error margin. Therefore the estimated square coverage will like change slightly.
- In 2018, 4,769 clumps were planted in Main Bed, Corduroy Road and Fireweed Bank for an approximate total of 9,700 clumps planted during the four year span (2015-2018). The estimated area covered by Irish moss at the end of 2018 was approximately 91 m² compared to 65.7 m^2 at the end of the 2017 season (see Figure 3).
- Based on past survival rates confirming the potential of this restoration method for rehabilitating the Irish moss population, restoration efforts have continued in 2018.
- Monitoring of a test plantation at Oyster Cross (immediately west of Main Bed) continued in 2018. 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. A total of 157 mussel and Irish moss clumps were planted in 2015. These were checked in July 2018 and 42 clumps with Irish moss were found.
- During the winter of 2018-19, half 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.
- In August 2018, a drone survey was carried out by Applied Geomatics Research Group (AGRG) in all three Irish moss beds (Corduroy, Main Bed, Fireweed Bank) in the hopes of providing high quality images to perform comprehensive aerial surveys to estimate Irish moss coverage in the Basin Head MPA. Due to turbidity, surface glint from wavelets and limited light during evening low tides, image quality was not as good as the previous year.

As such, work continued with the 2017 images to see whether drone-based aerial photography could be suitable to map and quantify moss abundance.

Water quality monitoring and hydrodynamic model

- In 2018, 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 2018 (May – November), as well as monthly water samples for pH analysis from June – September.

Sediment Sampling

- Sediment sampling started in various locations of the MPA in October 2016. Penetrable sediment thickness was documented at Oyster Cross (immediately west of Main Bed) in July 2018. It varied between 12-32 centimeters (cm).

Marsh edge erosion

- Sods eroded by ice 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 2018, seven of the ten sods tagged, measured and sampled in 2017 were found and re-measured to determine rates of degradation. From the missing three sods, mounds of sediments were found where the sods had been in two cases and in one case, the sod disappeared entirely. The length, width and height of each remaining sod was measured, and the percentage of volume lost from each sod was calculated. A minimum of 7% loss of volume was recorded for a sod sitting on the marsh that had maintained its grass cover. The maximum recorded loss (68%) occurred in the smallest sod, which lay in shallow water (30 cm at low tide) and would have been affected by ice during low tides. Degrading sods lost height but sometimes increased in width, producing a debris field on surrounding bottom.
- Monitoring of rebar posts along the edge of the salt marsh near the Main Bed continued in 2018. Initial results showed that the marsh edge had retreated, on average, by 0.198 cm/week (range 0.025-0.632 cm/week) since January 2017.
- Eutrophication may weaken the roots of salt marsh grasses, leading to increased rafting of marsh sods by winter ice, and erosion of the marsh edge. Monitoring of marsh edge erosion and marsh sod decomposition rates were initiated in 2017 and continued in 2018.

Green Crab trapping

- In 2018, invasive European Green crabs (*Carcinus maenas*) were trapped over 88 days between May and November. Fishing was conducted each month from May to November. The amount of days fished per month was based on the Department of Fisheries and Oceans contract specifications; 21 days for the months of May, July and October and eight consecutive days for the months of June, August, September and November. The recommended number of days fishing each month was fulfilled except for the month of October and November, ten total days were missed during these two months due to acute fall/winter weather conditions. During this third season of trapping, 44,893 crabs were removed from Basin Head. A 33% sub-sample was measured and sexed. From this, 54% were males, with a proportion of 16.2% measuring over 55 millimetres (mm), 54.5% measuring between 35-55 mm, and 19.4% measuring below 35 mm. From that same 33% sub-sample, 46% were females, with a proportion of 3.2% measuring over 55 mm, 71% measuring between 35-55 mm, and 24.9% 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 2018 focused on the influence of Irish moss clumps on predator-prey interactions between Green crabs and a small, native mud crab species. 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 2018 by UPEI. Those surveys showed mean densities of Green crab ranging between 0 and 88 Green crabs/trap/day in the Northeast Arm and mean densities ranging between 0 and 25 crabs/trap/day in the main basin area of the lagoon. Green crab abundances did not appear to be depressed compared to previous sampling years (2015-2017). However, a shift in demographics towards a higher female:male ratio and a decrease in carapace width of the males may be due to the trapping removal program conducted from 2016-2018.

Overall ecosystem health in Basin Head

- In general, before 2015 there was an overall decline in ecosystem health in Basin Head. 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. A resurgence of eelgrass was noted in 2018 with small patches evident throughout Northeast Arm. There is still seasonally heavy coverage of large areas of the bottom by fast-growing macroalgae (*Ulva lactuca* and associated algae).

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. Analysis of this data was ongoing throughout 2018, with maps being developed to illustrate land use patterns. Results will be communicated to the farming community to foster collaboration to address land use impacts on the estuary.
- The Interdepartmental Letter of Agreement between DFO Gulf Region and the NRC, for the maintenance of 10 kilograms of Basin Head *Chondrus* at the NRC's Sandy Cove facility, was renewed for 2018. 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 27, 2018 in Souris, PEI. Members were updated on research, communication and outreach activities conducted during the 2018 field season. Several presentations described the research and monitoring conducted in Basin Head. Dalhousie University, an academic guest, also presented an overview of their proposed study on estuary thermal regimes, focusing on their patterns, drivers, and climate change implications in the Basin Head area.

- Eelgrass restoration in the Northeast Arm was tested in 2017 for the first time in Basin Head. That same year, one 100 m^2 eelgrass plot was planted using uprooted eelgrass shots from Souris Harbour and threaded through oyster shells. The plot was monitored in 2018 to evaluate survival rate and was deemed successful based on eelgrass shoot density and area coverage surveys for the restoration site. In order to increase biodiversity in the Basin Head Marine Protected Area, two more 100 m^2 eelgrass plots were planted in 2018; one in the main lagoon and the other in the Northeast Arm. All three eelgrass plots will be monitored annually to evaluate survival rates and also to determine if the restoration rate is effective and could allow for reproduction and natural growth of eelgrass in Basin Head.
- In 2018, Souris and Area Branch of the PEI Wildlife Federation (SAB) conducted approximately seven kilometers of stream restoration work on Basin Head Creek, which falls outside the MPA boundaries.
- Discussions continued with local farmers, provincial government, and watershed groups on the possibility of planting willow trees in the buffer zone to reduce the nutrient and sediment loading in the system, but have been put on hold for now.
- 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. In 2018, the regular sampling was conducted in July.
- 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 with species confirmation from aquatic invasive species (AIS) monitoring program). Therefore, in 2018 six biofouling collector lines for early detection of AIS were deployed in Basin Head as part of the larger annual AIS biofouling monitoring program in the Gulf Region. In 2018, clubbed tunicates (*Styela clava*) were detected on the lines used to suspend Giant Irish moss and Blue mussel for restoration work in Basin Head MPA. Lines were taken out, stripped cleaned and dried to kill tunicates.

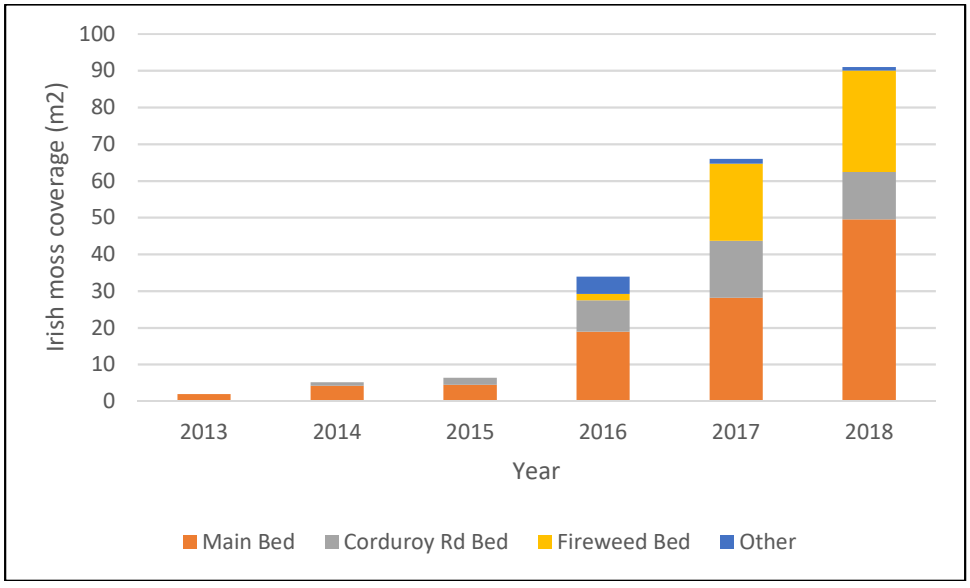

Figure 3: Chondrus cover (m^2) in Northeast Arm from 2013-2017 (determined by comprehensive surveys) and in 2018-2019 (estimated from surveys of 2-m wide permanent transect swaths and tallies of planted clumps).

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 2018-19 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 2018-2019**
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, 2018, near high tide. From those 11 stations, nine where located within the MPA and two stations were located in streams flowing into the MPA Dissolved oxygen continuous loggers were deployed at three locations in the Northeast Arm in 2018. Continuous pH probes were deployed in Basin Head and monthly sampling for pH analysis also occurred from June – September in 2018.

	Management Goals	Action Taken in 2018-2019
	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 2001-2018 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.	Investigations of erosion from the marsh edge over time, and documentation of marsh sod decomposition rates were performed in 2017. Monitoring continued in 2018. In January 2017, rebar posts were placed along the edge of the salt marsh near the Main Bed. Distances from the marsh edge were monitored to determine the rate of erosion. Soil erosion into the lagoon was documented photographically in 2018. Analysis of the 2017 land use survey data was conducted in 2018.
	Develop a water circulation model to evaluate water circulation changes.	In 2018, tide flux (water pressure) were re-deployed at Robertson's, Main Bed and Corduroy Rd.
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 2018 a new survey system was piloted, based on subsampling clump retention along selected two meters wide swaths in each Irish moss bed. Drone-based photography from 2017 was further examined in 2018 to determine whether the number and size of Irish moss clumps in Main Bed could be determined from georeferenced and processed photomosaics, using MapInfo GIS.
	Continue weekly photo mosaic at three locations (i.e. eastern end of	Photographs were taken at Ching's Bridge, Elliot's Look out from May to

	Management Goals	Action Taken in 2018-2019
	the arm, vicinity of the *Chondrus* bed and Ching's Bridge) to quantify the green algae (*Ulva lactuca*) coverage.	October 2018, to establish a record of green algal (*Ulva*) bloom development and decline. Camera surveillance of Main Bed continued in 2018-19 and has 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.	Sock cultivation of Irish moss in western Northeast Arm (below Robertson's field) continued through 2018 using cultivated stock from the NRC marine station at Sandy Cove. The Interdepartmental Letter of Agreement with NRC was renewed for the maintenance of Basin Head *Chondrus crispus* (minimum 10 kilograms) at the NRC research facility in Sandy Cove, NS. In 2018, for a fourth 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. As a result, Main Bed and Corduroy Road beds have grown and there is now a new/re-established bed thriving at Fireweed Bank in Northeast Arm.
Regulatory Conservation Objective: Maintain the overall ecological integrity of the Basin Head lagoon and inner channel.	**Short Term Goals (3 years):** To continue the Community Aquatic Monitoring Program (CAMP) to monitor trends in community abundance and diversity of fish and benthic invertebrates within the Basin Head lagoon.	The CAMP Program was conducted in July 2018 in Basin Head.
	To create detailed maps of percent cover by major aquatic plant species.	A drone from AGRG was used to collect images for mapping and monitoring of Irish moss in the Basin Head MPA. The survey was focused on three identified Irish moss beds: Fireweed, Main, and Corduroy. Collection occurred during the lowest

	Management Goals	Action Taken in 2018-2019
		annual tides in August, as *Ulva* presence is in decline, thus reducing risk of obscuring Irish moss clumps on the seabed. Due to turbidity, surface glint from wavelets and limited light during evening low tides, image quality was not as good as the previous year.
	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 2015-2018 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 2018-2019
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 Souris on November 27, 2018.

	Management Goal	Action Taken in 2018-2019
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 plan.
	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 2018. 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 delivered a paper on the restoration work at Basin Head to the Coastal Zone Canada conference in St. John's (NL) in July 2018. Field site tours for UPEI and Holland college students were conducted in 2018.
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 2018, SAB also conducted a Green crab removal project. Also in 2018, UPEI continued their study evaluating the interactions among Green crabs, Irish moss and Blue mussels.

	Management Goal	Action Taken in 2018-2019
	Development of Activity Plans and Approvals as outlined in Section 5.0 of the Basin Head MPA Regulations.	Approval Process in Place; eight activity plans for 2018 season were submitted and approved.
	Long Term (10 years): To continue to identify potential partners for collaborative research projects.	Collaborative research with UPEI continued and publications are in progress to report on research into interactions among Irish moss, Blue mussels, Green crab, Rock crab and herbivorous amphipods in Basin Head MPA.
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. Discussions continued with local farmers, provincial government, and watershed groups on the possibility of planting willow trees in the buffer zone to reduce the nutrient and sediment loading in the system, but have been put on hold for now.
	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 AIS program at DFO and the 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 2018-19.

	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.	April 26, 2018
2	Basin Head Ecotours	Siobhan Curry	DFO – Gulf	Provide “hands-on” educational experience to explore the marine life in Basin Head. (Twice a week, July – August 2018 and no more than six additional times in June and September for schools)	April 26, 2018
3	Irish moss – Green crab interactions in Basin Head MPA (Season 2018)	Dr. Pedro Quijon	UPEI	Assessing Green crab relative densities and their potential effects on the Irish moss (August 2014 – December 2019)	May 1, 2018
4	Water quality monitoring – multi-site	Siobhan Curry	DFO – Gulf	Annual water quality monitoring (continuous probes recording water parameters) and hydrographic parameters (May – November 2018).	April 26, 2018
5	Giant Irish moss and mussel bed monitoring and recovery in the 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 (May – November 2018)	April 26, 2018
6	Community Aquatic Monitoring Program	Monica Boudreau	DFO – Gulf	Monitor the ecological health of estuaries and coastal lagoons (June – August 2018)	May 1, 2018

7	Aquatic invasive species biofouling monitoring program	Renée Bernier	DFO – Gulf	Deploy six biofouling collector lines for early detection of aquatic invasive species (AIS biofouling monitoring program).	April 26, 2018
8	Water quality monitoring and eelgrass restoration	Siobhan Curry	DFO – Gulf	Monitor long-term changes in Basin Head nutrient concentration. Plant 1,000 eelgrass shoots within Basin Head's lagoon/Northeast Arm in two separate locations.	April 26, 2018

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 (C&P) officers patrol the area regularly to ensure compliance under the Management of Contaminated Fishery Regulations (MCFR) and the Basin Head Marine Protected Area Regulations (BHMPAR) as well as the Maritime Provinces Fishery Regulations (MPFR).

These C&P land-based patrols are conducted throughout the year but more frequent in the operational fishing season when commercial and recreational fisheries are more prevalent. The harvesting of Oysters under the Spring Relay Program, within the authorized Zone 2, was the only commercial fishing recorded in Basin Head in the spring of 2018. There are 2-4 fishers that fish this area and although not required, those fishers usually call the local C&P office to advise of their activity prior to their fishing activities in the event we receive any public complaints. Fishers are aware they are not to use their motors in Zone 2. Water based patrols are also conducted to observe any activity within Zone 3. Activity in Zone 3 is essentially noted as recreational watercraft activity and this activity occurs primarily in the months of July and August. C&P Staff have witnessed very little activity of watercraft transiting from the boat launch within Zone 2 into Zone 3 as permitted by the BHMPAR.

There have been no non-compliance issues identified that required an enforcement action in regard to contraventions of the MCFR, BHMPAR or MPFs in the fiscal year 2018-19. Also, those involved in Scientific Monitoring of the BHMPA were also observed in the area at various instances throughout the Operational Season carrying out their respective duties. The presence of Scientific Staff, we believe, is helpful as a deterrent to any potential non-compliance issues that could occur.

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 2018.

During the summer of 2018, SAB continued to lead the “Beyond the Beach” eco-tours. These educational activities consisted of a beach seine haul with “hands-on” experience to explore the marine community within the Basin Head MPA. This was part of an authentic PEI experience and occurred every Tuesday and Thursday in July and August.

Basin Head Interpretive Park was still underway in 2018-19. The old wharf was removed and replaced with island sandstone. The parking lot was completed and the crib for the slipway were completed and installed. The boardwalk, research building, equipment compound and gazebo were underway in late 2018/early 2019 with work anticipated to be completed by June 2019. Discussions began in 2018 on interpretative panels input from SAB, DFO, Mi’kmaq Confederacy of PEI and PEI Museums and Heritage Foundation. The Interpretive Park is located next to the Basin Head Provincial Park, Basin Head Beach and the Basin Head Fisheries; an ideal location for the interpretative activities related to the Basin Head MPA.

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 2019 to March 2020). Priorities include:

- Continue annual monitoring of water quality, habitat integrity and biota so that the management activities required to maintain ecological integrity for the long term can be triggered.
- Synthesis/analysis of water quality monitoring data and validation of the hydrodynamic model.
- Initiate development of a watershed sediment and nitrate loading model.
- Continue restoration activities including Irish moss cultivation, importation of mussels, clump making and planting.
- Continue to monitor clump retention along permanent transects in each Irish moss bed.
- Monitor success of eelgrass plantations as well as naturally recruited patches of eelgrass.
- Explore other ways of monitoring Irish moss including aerial photography using drones.
- 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 (main basin) and additional Interpretative day park at that same location.
- Improve research infrastructure at Robertson’s field to ensure worker health and safety.

8.0 REFERENCES

Basin Head MPA Regulations, Canada Gazette Part 1, June 18, 2005. https://laws-lois.justice.gc.ca/eng/regulations/SOR-2005-293/index.html

Basin Head Watershed Management Plan (2010) Souris and Area Branch, PEI Wildlife Federation, http://www.souriswl.com/

DFO 2016. Basin Head Marine Protected Area: 2014 Operational Management Plan. Basin Head Management Series. 2016/01: viii + 40p. http://waves-vagues.dfo-mpo.gc.ca/Library/362274.pdf

Krueger-Hadfield, S.A., Collén, J., Daguin-Thiébaut, C., and Valero, M. 2011. Distinguishing among genets and genetic population structure in the haploid-diploid seaweed *Chondrus crispus* (Rhodophyta). J. Phycol. 47: 440–450.

Krueger-Hadfield, S.A., Roze, D., Mauger, S., and Valero, M. 2013. Intergametophytic selfing and microgeographic genetic structure shape populations of the intertidal red seaweed *Chondrus crispus*. Mol. Ecol. 22: 3242–3260.

Krueger-Hadfield, S.A., Roze, D., Destombe, C., Correa, J., and Valero, M. 2015. O father, where art thou? Paternity analyses in a natural population of the red seaweed *Chondrus crispus*. Heredity, 114: 185–194.

Management of Contaminated Fishery Regulations, SOR/90-351. https://laws-lois.justice.gc.ca/eng/regulations/sor-90-351/index.html

Maritime Provinces Fishery Regulations, SOR/93-55. https://laws-lois.justice.gc.ca/eng/regulations/sor-93-55/index.html

Tummon Flynn, P., Garbary, D., Novaczek, I., Miller, A., and Quijon, P.A. 2018. The unique giant Irish moss (*Chondrus crispus*) from Basin Head: health assessment in relation to reference sites on Prince Edward Island. Botany 96: 805–811. https://cdnsciencepub.com/doi/10.1139/cjb-2018-0081