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Basin Head Marine Protected Area: 2020-2021 Operational Management Plan Implementation Progress Report

Fisheries and Oceans Canada, Gulf Region
343 Université Avenue, P.O. Box 5030
Moncton, NB, E1C 9B6

2022

Gulf Region Basin Head Management Series 2022/01





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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2020-2021 OPERATIONAL MANAGEMENT PLAN IMPLEMENTATION
PROGRESS REPORT

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DFO/2021-2119
Cat. No. Fs146-1-01E-PDF
ISSN 2368-5999

Published by:

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

DFO 2022. Basin Head Marine Protected Area: 2020-2021 Operational Management Plan Implementation Progress Report. Gulf Region Basin Head Management Series. 2022/01: vii + 19p.



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LIST OF ACCRONYMS

AIS	Aquatic Invasive Species
BHMPAR	Basin Head Marine Protected Area Regulations
CA.....	Contribution Agreement
C&P	Conservation and Protection
CAMP	Community Aquatic Monitoring Program
CPUE.....	Catch per unit effort
DAL	Dalhousie Universtiy
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
UPEI.....	University of Prince Edward Island
SAB	Souris and Area Branch of the Prince Edward Island Wildlife Federation



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 2020-2021 fiscal year (April 2020 to March 2021). This report also highlights the different management actions taken in 2020-2021 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 2020-2021 (avril 2020 à mars 2021). Ce rapport met également en lumière les différentes mesures de gestion prises en 2020-2021 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 now under review. 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 OMP was reviewed in 2020 and the update will be finalized in 2021.

The purpose of this yearly Progress Report is to report on activities and achievements in the Basin Head MPA during the 2020-2021 fiscal year (April 2020 to March 2021) 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 (formerly known as 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 Committee.

2.0 MANAGEMENT HIGHLIGHTS FOR 2020-21

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

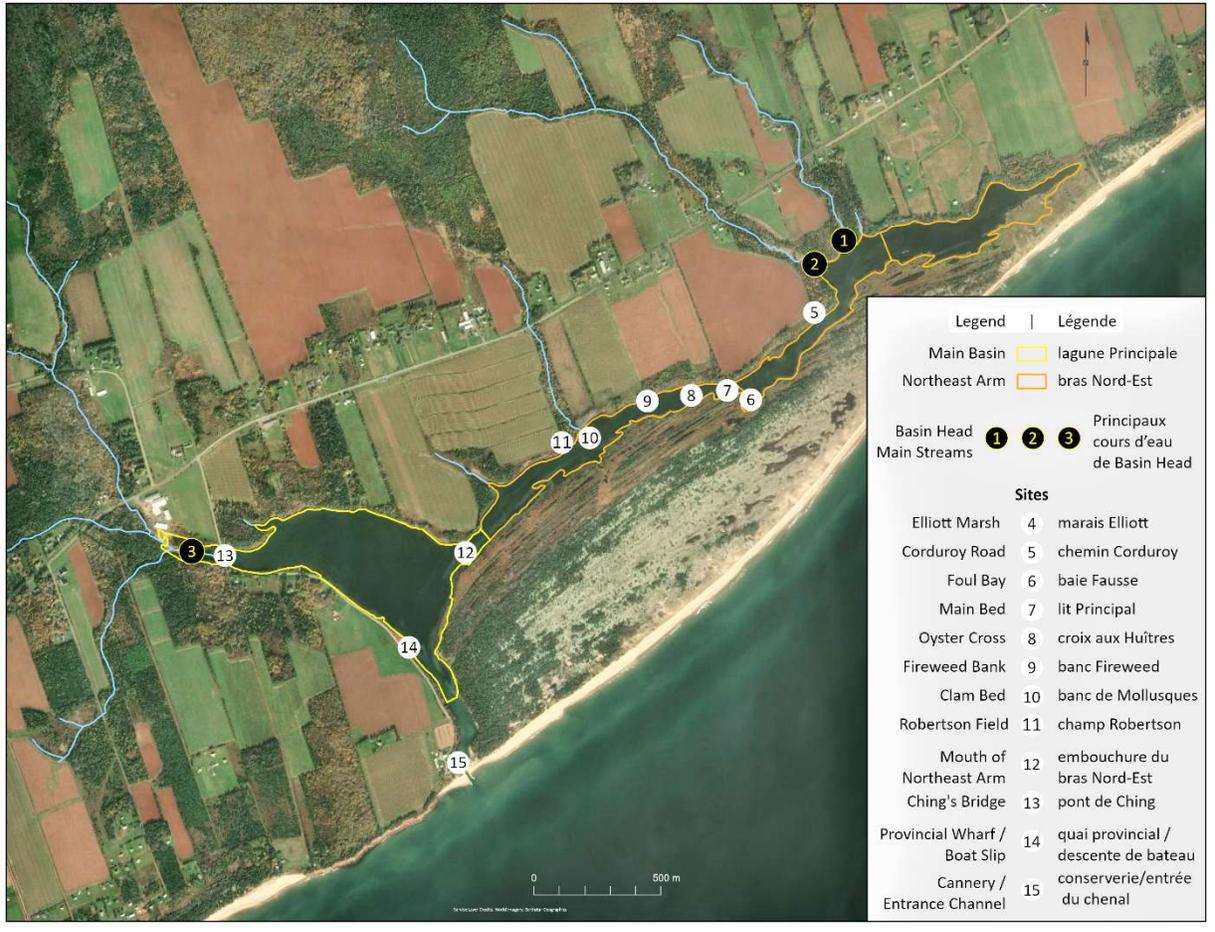


Figure 2: Map of Basin Head Marine Protected Area with numbered streams and sites.

Monitoring not conducted due to the COVID-19 pandemic in 2020

- No continuous probes were deployed.
- No 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.
- The Community Aquatic Monitoring Program (CAMP) was not conducted in the MPA. The nearshore fish community has been monitored since 2003 in Basin Head at six stations in the main basin using the CAMP protocol.
- During the summer of 2020, SAB was unable to run the “Beyond the Beach” experiential experiences. These educational activities consist of a beach seine haul with “hands-on” experience to explore the marine community within the Basin Head MPA.

Irish moss monitoring and restoration

- Sock cultivation of Irish moss in the western portion of Northeast Arm resumed in 2020 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. In 2020, Confederation Cove Mussel Co. Ltd. switched to solely processing oysters, meaning that new suppliers needed to be found. Mussels were acquired first from Prince Edward Aqua Farms, then at Canadian Cove Mussels due to the revocation of shellfish transfer permits as the presence of invasive species was identified in some bays. These conservation and restoration activities continued in 2020 resulting in a year-to-year increase in Irish moss biomass in Northeast Arm.
- In 2020, 2 549 clumps were planted in Main Bed (1 451 clumps), Corduroy Road (211 clumps) and Fireweed Bank (887 clumps) for a total of 15 217 clumps planted during the six-year span (2015-2020) bringing the estimated area covered by Irish moss at the end of 2020 up to 187.6 m² from 176.7 m² at the end of the 2019 season (see Figure 3).
- In 2020, subsampling along 2-m wide swaths on both sides of the permanent transects (survey swaths) was conducted, for a total of 20 swaths surveyed (10 permanent transects surveyed on either side; Four meters per permanent transect). This was done to reduce the margin of error in estimates of % loss of Irish moss cover over winter.
- The estimated number of Irish moss plants was reduced over the winter along the outer edges of Fireweed Bank, but increased in the central Fireweed swaths because planting focused on this area of good habitat. In Main Bed, a slight decline was observed in the west swath, but increases were found throughout the rest of the Main Bed swaths. One Corduroy Road swath (west) registered a small decline in numbers of clumps but the others saw a gain. Irish moss average frond size decreased in Fireweed Bank where average diameter went from 17.1 cm in 2019 to 12.1 cm in 2020, whereas frond size remained stable in Main Bed and slightly increased in Corduroy Road. This decrease observed in Fireweed Bank could be due to the later survey period, potentially allowing the plants to begin fragmenting.
- Monitoring of a test plantation at Oyster Cross (immediately west of Main Bed) continued in 2020. The estimated total cover of Irish moss on the plantation was 0.64 m² in 2020, which is more than an estimated 0.58 m² in 2019. Clumps within the Oyster Cross plantation have become more dispersed, making the arms of the cross indistinct, causing difficulty in distinguishing clumps while surveying from one arm to the next.
- Using current speed and water level data from the Northeast arm and LIDAR data, the updated hydrological model was used to determine areas of optimal habitat for restoration.
 - The cutoff between good and poor habitat occurs where average current speeds are around 10 cm/s.
 - The boundary for plantable habitat is where current speed is greater than 10 cm/s for at least 50% of the time, whereas optimal habitat has current speeds greater than 15 cm/s for at least 29% of the time.
 - Low tide water depths less than 10 cm and penetrable sediment thicknesses greater than 19 cm are considered unsuitable planting habitat.
- During the winter of 2020-21, 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. The location of this camera was moved in September of 2020 to a more stable tree. A second field camera at Elliott's Marsh, the furthest

eastern tip of the Northeast Arm, was re-installed after falling in order to further document ice conditions as well as *Ulva* blooms.

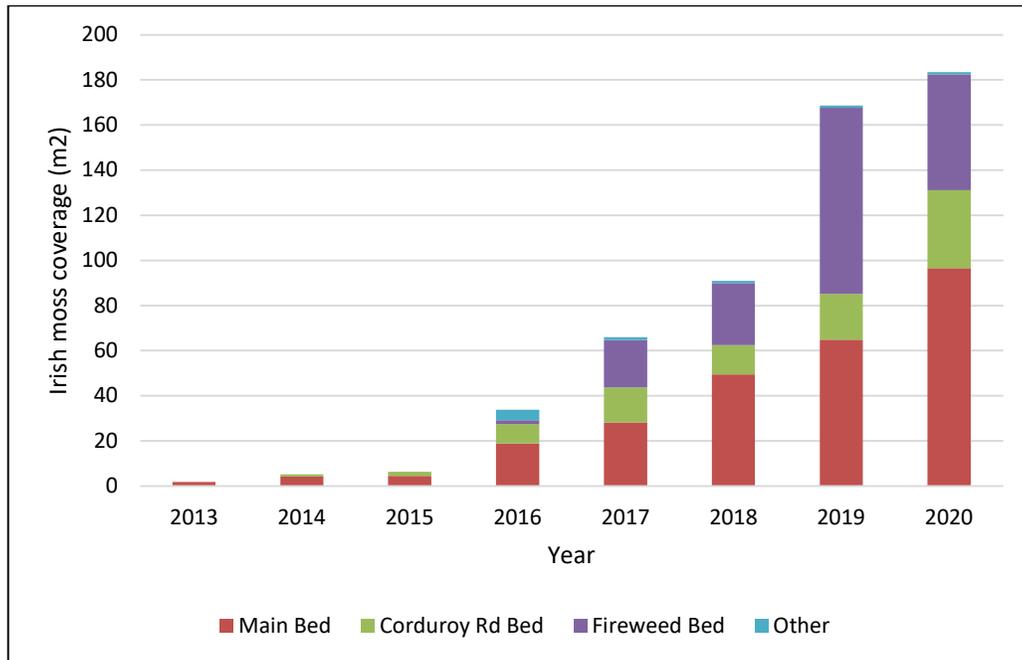


Figure 3: *Chondrus crispus* cover (m²) in Northeast Arm from 2014-2020 (determined by comprehensive surveys of each moss bed).

Water quality monitoring

- Continuing to follow the recommendations from the Canadian Science Advisory Secretariat (CSAS) meeting that took place in June 2019 (DFO 2020), stream flow monitoring and water samples were taken in order to quantify nutrient loading (product of base flow and average nitrate concentration) at freshwater inputs, including monitoring at two outlet control points (at Northeast Arm into Main Basin, and from Main Basin to the Gulf). A total of 9 sites were sampled in 2020, 6 freshwater (above head of tide, flowing into the MPA) and 3 estuarine (within the MPA). This was repeated monthly from July-November, as well as opportunistic monitoring that took place once during a dry period, and once during a heavy rain event.
- During the fall of 2019, four probes were unable to be located (two water level loggers and two water temperature loggers). Field staff searched again the summer and fall of 2020, finding one of the missing data loggers; a water level logger in Main Bed.

Marsh edge erosion

- Monitoring of rebar posts along the edge of the salt marsh near the Main Bed continued in 2020. Of the 16 rods, 15 were found, and 14 were able to be measured for erosion rate. The rate of erosion from June 2019 – August 2020 averaged 3.4 cm/year, similar to that for 2018-19 (3.8 cm/yr) and much less than the rate for 2017-18 (9.3 cm/yr).
- For the first time in 2020, erosion markers were placed into the south bank of the marsh at Corduroy Road. In a line, 18 markers were placed at 5 meter intervals, 30 cm from the edge of the bank. This was done in response to observations of the deteriorating marsh edge since 2018. Monitoring will begin yearly to assess the rate of erosion at this site.
- Digitization of the south bank from Corduroy Road to Clam Bed was also conducted for this first time in 2020. Using a Trimble GPS, the marsh edge was traced, including areas of significant channels and perimeters of large sod islands. This data will serve as a baseline

of the marsh edge that can not only be compared to future tracings, but also be compared to aerial photography of the area dating back to 1935 in order to determine rate of erosion. This type of monitoring will be repeated every 3-5 years or when a severe erosion event was observed.

Green crab trapping

- In 2020, invasive European Green crabs (*Carcinus maenas*) were trapped over 50 days between July and October. The number of fishing days per month was based on the DFO contract with Souris and Area Branch of the PEI Wildlife Federation (SAB). As per the contract, one week of fishing in July and three weeks of fishing in August, September, and October occurred. The majority of the days fished were done consecutively, though some exceptions occurred due to adverse weather in September and October. All missed days were made up for to fulfill the contract obligations.
- After the first week of trapping in July, the decision was made to increase the number of traps within the lagoon as there was a significant increase in the number of crab caught during the same time in 2019. Ten additional traps were placed towards the north of the lagoon. Due to the extra traps and high number of crabs, DFO decided to only have SAB subsample 10 traps for sex identification and size classification (Traps 2, 4, 5, 7, 10, 13, 21, 23, 24, and 28). The size of the subsample also changed, sizing and sexing a maximum of 50 crab from each of these 10 traps (if there were less than 50, the whole trap was sampled), and counting the rest. These 10 subsampled traps are considered permanent monitoring traps, and did not move in location during the trapping efforts.
- During the 2020 trapping season, 80 515 Green crab were removed from Basin Head. Of the 10 traps subsampled (15 138 crab), 52.8% were males, and 47.2% were female, slightly different than the 50-50 split in males and female in 2019. Of the males, 2.7% were less than 35 mm, 63.2% were between 35-55 mm, and 34.1% were above 55 mm. Of the females, 5.5% were less than 35 mm, 84.6% were between 35-55 mm, and 9.9% were above 55 mm. Figure 4 shows the comparison between 2019 and 2020.

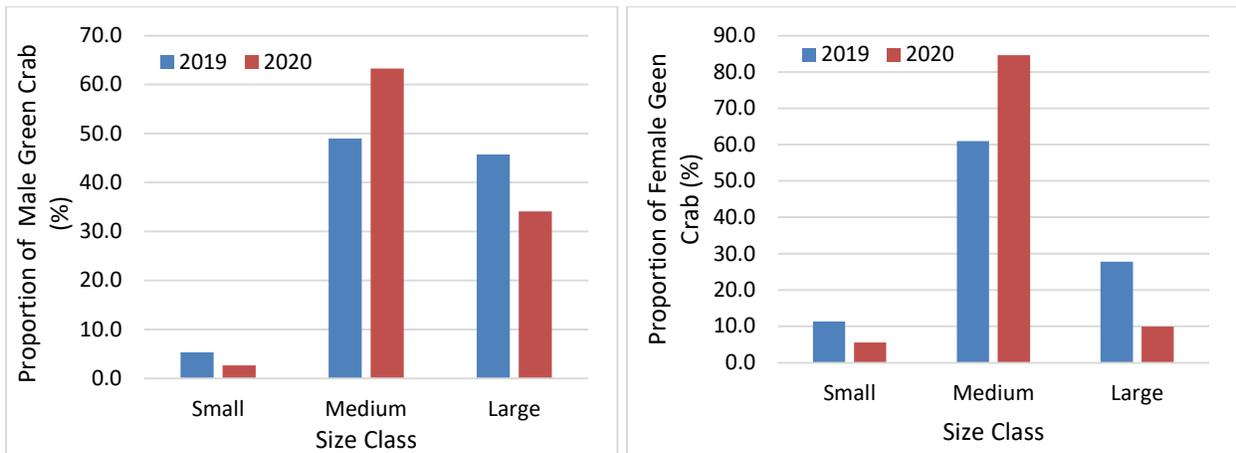


Figure 4: Proportion (%) of Green crab size for male (left) and female (right) in 2019 and 2020; Small: <35mm, Medium: 35-55mm, Large: >55mm.

- The average catch per unit effort (CPUE) for traps in the Main Basin was 76.99 green crabs per trap per day up from 36.70 in 2019. The average CPUE for traps in the Northeast Arm was 34.09 green crabs per trap per day, also up from 4.30 in 2019. This increase was expected due to the overall increase in the number of Green crab throughout entire Northeast Arm and Main Basin.

Table 1. Green crab trapping thresholds targets.

Thresholds (Crab/Trap/Day)			
	Poor	Fair	Good
Measure	<25% CPUE reduction from inferred reference	25-50% CPUE reduction from inferred reference	>50% reduction from inferred reference
Main Basin	>58	39-58	<39
Northeast Arm	>26	17-26	<17

- Green crab thresholds were calculated to provide a target for trapping that would indicate an improvement in overall green crab abundance within the MPA. Thresholds were made by taking the average CPUE for each the Main Basin and the Northeast Arm, and calculating a 50% reduction for good ecosystem health, a 25% reduction for poor ecosystem health, with the range between the two indicating fair ecosystem health. The inferred reference used was the 2020 CPUE from the 10 permanent monitoring sites throughout the Main Basin and Northeast Arm.

Thermal regime: influence of seeps and springs

- During the 2020 field season, a Master's student from Dalhousie University continued his project in Basin Head to characterize the volumetric discharge, temperature and nitrogen concentration of the different water inputs into the Basin Head estuary and assess how the different water inputs control the overall temperature and nutrient regime. The following objectives were accomplished:
 - Continued stream flow monitoring in the three primary tributaries and continued monitoring of the water table level, temperature, and conductivity of groundwater in the installed well;
 - Operation and maintenance of the climate station and air pressure transducer;
 - Thermal monitoring of surface and bottom water temperatures in the upper NE harbour channel; Computation of spring thermal plume surface areas; and measurement of temperature at three springs over the summer and fall;
 - Short-term deployment of a freshwater nitrate sensor in the primary tributary;
 - Identification of 37+ springs along the northern shores of the harbour using drone-assisted thermal imagery;
 - Discrete sampling of radon, conductivity, temperature and nutrients of select springs and radon analysis of pore water and estuary water near the outlet;
 - Development of orthomosaic visual imagery products and a conceptual model for the groundwater model

Winter ice monitoring

- For the winter of 2021, an amendment was made to the Contribution Agreement with SAB to conduct ice monitoring at Main Bed. Regular checks were made above Main Bed to determine if ice has formed, and if it was stable enough to be walked on. Once the ice was stable, holes were to be bored into the ice every 5 meters, taking ice depth, water depth, salinity, and temperature readings at each hole. Four photos at each hole were to be taken (North, East, South and West) to see if any clumps are sticking to the bottom of the ice. Due to lack of stable ice, workers were not able to bore any holes into the ice in order to take any measurements or photos. The thickest the ice was at the height of winter was approximately 3 inches and slushy, not thick enough to support a worker.

Land use survey

- An interview with farmers with fields within the Basin Head watershed to determine the agricultural use between 2016-2020 was conducted the winter of 2021. This was done to create a long-term time series of land use within the Basin Head watershed. Questions were similar to the ones asked in the previous survey in 2017, with questions regarding erosion control, crop rotation and fertilizer regime. Additional questions were added to this years survey regarding participation in Agriculture and Agri-Food Canada's Living Laboratory Initiative, knowledge of erosion control provincial funding programs, and willingness to voluntarily use the 60 meter buffer zone.
- A total of 10 farmers participated in the interview led by SAB. Once completed, a report on how the interviews went and the farmers database was submitted by SAB to DFO.
- Fields farmed in the Basin Head watershed are dominated by one farmer who accounts for 55% of the fields. This results in all trends being dependent on what that farmer is doing in a particular year. For example, in 2018, this farmer has less potatoes in rotation, and the overall amount of potato in the watershed is also at its lowest point (Figure 5).

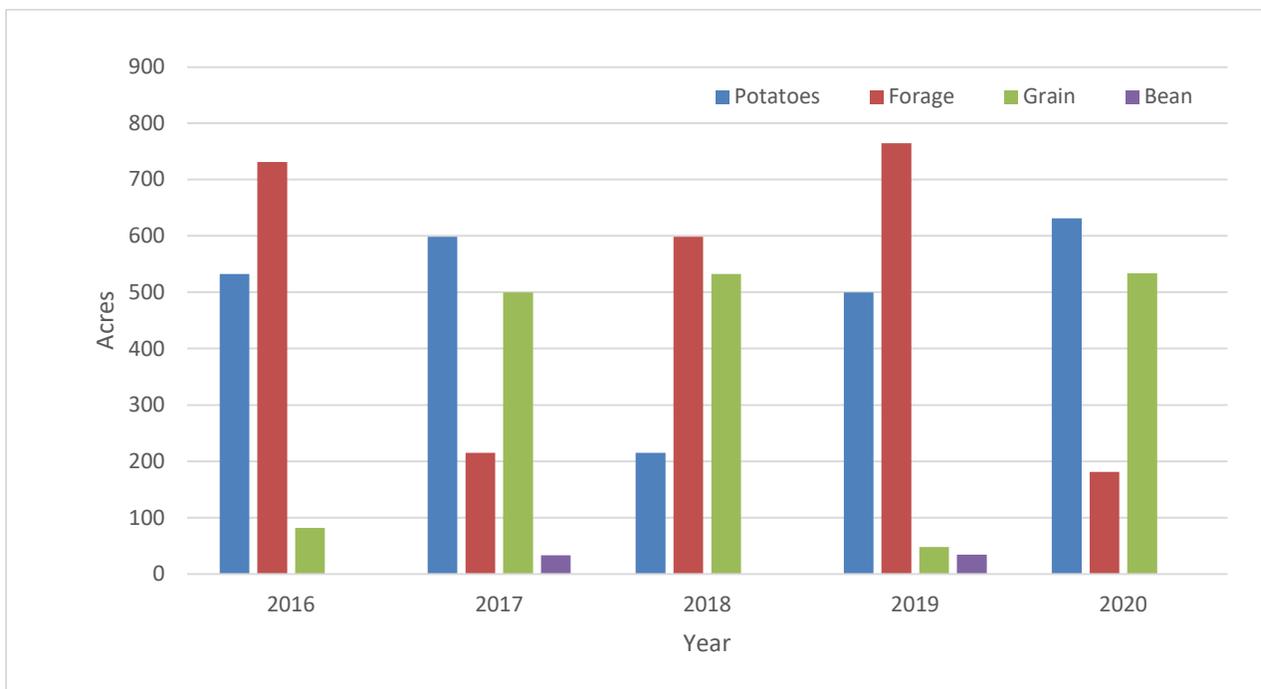


Figure 5: Acres of crop per year within the Basin Head watershed from 2016-2020.

- There were three Agriculture and Agri-Food Canada's Living Laboratory initiative trials within the Basin Head watershed in 2020. Two were in fields by Farmer 1: BMP 7 – Slow release nitrogen trial, and BMP 1- Fall cover crop after potato rotation. The third trial is by Farmer 10: BMP 2.4 – A precision nitrogen trial.

Overall ecosystem health in Basin Head

- As of 2015 we have seen an improvement in overall ecosystem health where natural recruitment of oysters has improved bottom conditions by filtering and trapping otherwise mobile sediments. A resurgence of eelgrass was again noted in 2020, as there was a large increase in visible eelgrass throughout the Northeast Arm. There is still seasonally heavy coverage in large areas of the bottom by fast-growing macroalgae (*Ulva lactuca* and associated algae). Also observed when planting clumps was that sculpins and other smaller

fish would make their way into the clump bags, and at the end of November, sculpin eggs were found in these bags. A seal was also often seen as far up the arm as Fireweed bank when conducting Green crab trapping and Irish Moss restoration.

Highlights – Various

- In early September 2019, post-tropical storm Dorian hit PEI, causing major storm surge and high winds in Basin Head. By summer of 2020, the run and entrance of the lagoon was infilled with sand. Much like the summer of 2019, water levels were too low for recreational use, causing the Province of PEI to close the beach. Dredging occurred on June 25th, 2020, with the same environmental footprint to the dredging that took place in 2019. Unfortunately, the dredging was not effective and the run was filled in only 2 weeks later. This resulted in the Department of Transportation, Infrastructure and Energy commissioning a sediment transport study at Basin Head. The consultant, contracted from CBCL in Halifax, accessed DFO hydrological data and deployed probes to determine the cause of sediment infilling. The final report indicates there are many sediment sources to the system. Coastal sources have increased in the last decade due to loss of ice cover, and various storm events overtopping the dunes. The prevailing source in the last decade appears to be erosion of the inner east bank, compounded by the loss of the old training wall. No major storm surges to the extent of Dorian occurred in 2020.
- A multi-year Interdepartmental Letter of Agreement (ILA) between DFO Gulf Region and the NRC, was signed for collaboration until March 2024 for the maintenance of 10 kg of Basin Head *Chondrus* at the NRC's Sandy Cove facility. Biomass from the holding stock at NRC was reintroduced to Basin Head and placed into cultivation on site to provide plants for restoration work.
- The Basin Head Marine Protected Area Advisory Board met virtually this year due to provincial health restrictions to combat the Covid-19 pandemic. Split over two days, the Advisory Board members participated in the annual meeting on the mornings of December 2nd and 4th, 2020. The members were updated on research and monitoring, and a focused discussion took place to review different sections of the management plan that have been updated for the latest version of the Operational Management Plan.
- In 2020, SAB conducted approximately 3 km of stream restoration work on Basin Head Creek, which drains into the MPA boundaries.
- While conducting the marsh edge digitization, a survey was performed of the free-floating *Ascophyllum nodosum var. mackii*, an marine alga, and the warm temperate ribbed mussel *Geukensia demissa* populations on 1.3 km of the southern marsh from Corduroy Road to Clam Bed. Quarter meter quadrats were sampled at the edge of each plant found, the percent cover estimated, the plants removed, cleaned and then weighed. In total, 51 isolated plants and 6 patches were counted and measured, with the average fresh weight in 32 samples equaling 280 g (equivalent to 1120 g/m²). Only two *Geukensia demissa* (60-64 mm long) were seen along the entire length of marsh inspected; both were in association with *Ascophyllum*.

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 2020-21 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 2. Basin Head MPA Regulatory Conservation Objectives and Monitoring/Management Actions.

	Management Goals	Action Taken in 2020-2021
Regulatory Conservation Objective: Maintain the quality of the marine environment supporting the Basin Head <i>Chondrus crispus</i>	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 for nutrient loading at 6 freshwater sites and 3 estuarine sites were sampled on an outgoing tide monthly from July to November. Flow rate monitoring also occurred at the freshwater sites. No DO probes were deployed in Basin Head this year.
	To monitor continuous water temperature in the Inner Channel station and the main basin.	No continuous data loggers were deployed in 2020. The two missing temperature loggers have not yet been recovered.
	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 2001-2019 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	Long Term Goals (10 years): Monitor the land use activities and erosion of the watershed area.	Continued measuring marsh edge erosion relative to rebar posts inserted into the southern bank at Main Bed's western end.

	Management Goals	Action Taken in 2020-2021
physical structures of the ecosystem supporting the <i>Chondrus crispus</i>		<p>New rebar posts installed into the southern bank of Corduroy Road to measure marsh edge erosion.</p> <p>Digitization of the southern bank from Coduroy Road and Clam Bed was completed using a Trimble GPS.</p> <p>Analysis of the 2017 land use survey data continued into 2020.</p> <p>Provincial government assessed entrance channel, detected sand buildup and obtained a permit to dredge 1 m of sand from between the wharves.</p> <p>Sediment transport study was conducted to determine source of sediment infilling of the run.</p> <p>An interview of local farmers was conducted to determine the agricultural land use between 2016-2020.</p>
	Develop a water circulation model to evaluate water circulation changes.	No tide flux (water level) loggers were deployed in 2020. One missing logger was recovered from 2019 in Main Bed.
<p>Regulatory Conservation Objective:</p> <p>Maintain the health (biomass and coverage) of Basin Head <i>Chondrus crispus</i></p>	<p>Short Term Goals (3 years):</p> <p>Establish monitoring transects within the <i>Chondrus crispus</i> bed to evaluate biomass and coverage. Due to drastic decline in <i>Chondrus</i>, 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.</p>	<p>Sampling for clump retention along permanent selected 2 m wide swaths in each Irish moss bed was repeated in 2020. Swaths were placed on either side of the permanent transect markers for a total coverage of 4 m for each transect.</p> <p>Clump retention on Oyster Cross was documented.</p> <p>No further progress was made examining whether georeferenced and processed photomosaics are useful for surveying Irish moss through the use of drone photography.</p>
	Continue biweekly photo mosaic at two locations (i.e. eastern end of the arm and Ching's Bridge) to quantify the green algae (<i>Ulva lactuca</i>) coverage.	Photographs were taken at Ching's Bridge, and Elliot's Lookout from July to November 2020, to establish a record of green algal (<i>Ulva</i>) bloom development and decline.

	Management Goals	Action Taken in 2020-2021
		<p>Camera surveillance of Main Bed provided additional information on near-shore development of Ulva mats in central Northeast Arm.</p> <p>A second camera was reinstalled to monitor Ulva at Elliot's marsh.</p>
	<p>Long Term Goals (10 years):</p> <p>Maintain the biomass and coverage of the Basin Head <i>Chondrus crispus</i> at healthy and sustainable levels.</p>	<p>Sock cultivation of Irish moss in western Northeast Arm (below Robertson's field) continued through 2020 using cultivated stock from the NRC marine station at Sandy Cove.</p> <p>The ILA with NRC was renewed for the maintenance of Basin Head <i>Chondrus crispus</i> (minimum 10 kg) at the NRC research facility in Sandy Cove, NS.</p> <p>In 2020, for a sixth 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 depurated commercial mussels were brought in and used to make the clumps.</p>
<p>Regulatory Conservation Objective:</p> <p>Maintain the overall ecological integrity of the Basin Head lagoon and inner channel.</p>	<p>Short Term Goals (3 years):</p> <p>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.</p>	<p>The CAMP Program was not conducted in 2020 due to the Covid-19 pandemic.</p>
	<p>To create detailed maps of percent cover by major aquatic plant species.</p>	<p>No drone flights were conducted to estimate Irish Moss coverage in 2020.</p> <p>A Southern Gulf of St. Lawrence Coalition on Sustainability project mapped eelgrass patches in the entrance channel, lagoon, and the western half of the Northeast Arm.</p>
	<p>Long Term Goals (10 years):</p>	<p>Ongoing research has flagged Green crab and eutrophication as the primary threats to the giant Irish</p>

	Management Goals	Action Taken in 2020-2021
	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.	<p>moss population that remains. Rising summer seawater temperatures may also pose a threat in the future.</p> <p>Planting of clumps made from commercial mussels and cultivated giant Irish moss between 2015-2020 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.</p>

Table 3. Basin Head MPA Non-Regulatory Conservation Objectives and Monitoring/Management Actions.

	Management Goal	Action Taken in 2020-2021
<p>Non-Regulatory Objective:</p> <p>To ensure the participation of interested and affected stakeholders in the operation of the MPA.</p>	<p>Short Term:</p> <p>Continuation of annual Advisory Board meetings to ensure stakeholder support and involvement.</p>	<p>An Advisory Board meeting was held virtually on the mornings of December 2nd and 4th, 2020.</p>
<p>Non-Regulatory Objective:</p> <p>To increase the public awareness of the Basin Head <i>Chondrus crispus</i>, the ecosystem of the Basin Head MPA and its conservation measures.</p>	<p>Short Term:</p> <p>To develop a Basin Head MPA website</p>	<p>There is an existing link to Basin Head MPA information on the DFO website. No update to the website was done in 2020.</p>
	<p>To enhance the existing on-site laboratory to maximize education potential.</p>	<p>The on-site wet lab at the cannery wharf was not used in 2020 since no laboratory work was done. The shed at Robertsons and the research building at the Interpretative park provide an easily accessible facility to conduct work and store equipment.</p> <p>There is an interactive computer kiosk and brochures about the MPA in the Basin Head Fisheries Museum.</p>

	Management Goal	Action Taken in 2020-2021
	<p>Long Term: To increase public awareness through publication of brochures, interpretive touchscreen kiosk, and involvement in community events.</p>	<p>SAB communicates regularly with local stakeholders through the “Souris and Area Watershed News” on activities that involve Basin Head.</p> <p>November 4th, 2020, CBC conducted an interview, showcasing the work that is being done restoring the Giant Irish Moss population. This interview was aired through TV and radio, as well as a written online article.</p>
<p>Non-Regulatory Objective:</p> <p>To promote scientific research to increase the level of understanding of the Basin Head MPA.</p>	<p>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.</p> <p>Development of Activity Plans and Approvals as outlined in Section 5.0 of the Basin Head MPA Regulations.</p>	<p>A contribution agreement between SAB and DFO was developed for 2020-2023 for summer, fall, and winter monitoring work. In 2020, SAB also conducted a Green crab removal contract.</p> <p>Approval Process in Place; 9 activity plans for 2020 season were submitted and 6 were approved.</p>
	<p>Long Term (10 years): To continue to identify potential partners for collaborative research projects.</p>	<p>Doctoral student from UPEI continued to develop publications to report on research in Basin Head MPA.</p> <p>In 2020, a Masters student from Dalhousie University is finishing up research in looking at the dynamics of hydraulic thermal regimes in the Basin Head MPA, possibly influencing the regrowth of <i>Chondrus crispus</i> and of <i>Mytilus edulis</i>.</p> <p>Proposed research from Dalhousie University for 2021 includes a PhD student to model nitrate mixing from groundwater and stream sources.</p>
<p>Non-Regulatory Objective:</p> <p>To maintain and enhance the quality of the Basin Head ecosystem.</p>	<p>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.</p>	<p>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.</p> <p>Agriculture and Agri-Food Canada’s Living Laboratory Initiative has trial</p>

	Management Goal	Action Taken in 2020-2021
		fields within Basin Head. Current trials focus on reducing nitrogen, and a proposed trial to reduce water runoff is in the works.
	To reduce the spread of aquatic invasive species in the Basin Head ecosystem by public awareness or stewardship initiatives.	Efforts are 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. CAMP and the Eco-tours were not run in 2020.

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 4. Activity Approvals in Basin Head MPA during 2020-21. Note that some activity plans were submitted by the proponents but were not approved since it was decided that the activity would not take place in summer 2020 due to the pandemic and limited field activity approved.

	Study Name	Researcher	Affiliation	Purpose	Date Approved
1	Thermal and Nutrient Regime Monitoring	Dr. Barret Kurulyk	Dalhousie University	Studying the dynamics of the hydraulic thermal and nitrogen concentration regimes in Basin Head.	July 10, 2020
2	Water quality monitoring using continuous probes	Venitia Joseph	DFO - Gulf	Annual water quality monitoring (temperature, dissolved oxygen and hydrographic parameters) (July – November 2020).	July 10, 2020

3	Nutrient Loading Sampling	Keila Miller	Souris and Area Branch of the PEI Wildlife Federation	Water sampling and stream flow monitoring at 3 estuarine and 6 freshwater sites (July – November 2020)	July 10, 2020
4	Green crab removal	Keila Miller	Souris and Area Branch of the PEI Wildlife Federation	To reduce and control the population of the invasive European Green crab, which are predated on Blue mussels in the Basin Head MPA.	July 10, 2020
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 (April – November 2020)	July 10, 2020
6	Marsh edge erosion and Influence of ice	Dr. Irene Novaczek	DFO - Gulf	Document the influence of ice within and below the main Irish moss bed and the marsh erosion (May – November 2020).	July 10, 2020
7	Aquatic invasive species (AIS) biofouling monitoring program	Chantal Coomber	DFO - Gulf	Deploy 6 biofouling collector lines for early detection of aquatic invasive species (AIS biofouling monitoring program).	Plan withdrawn and not submitted for approval
8	Community Aquatic Monitoring Program	Monica Boudreau	DFO - Gulf	Monitor the diversity of fauna and flora captured in the Basin Head lagoon (June to August 2020)	Plan withdrawn and not submitted for approval
9	Ecotours (“Beyond the Beach”)	Keila Miller	Souris and Area Branch of the PEI Wildlife Federation	Provide “hands-on” educational experience to explore the marine life in Basin Head. (Twice a week, July – August 2020 and no more than 6 additional times in June and September for schools)	Plan withdrawn and not submitted for approval

5.0 ENFORCEMENT AND COMPLIANCE

As the Basin Head area is a frequent tourist destination and high traffic area for both visitors and locals, however, due to the Pandemic situation of 2020 this activity was greatly reduced. The local DFO Conservation and Protection (C&P) officers patrol the area regularly to ensure compliance under the Management of Contaminated Fishery Regulations (MCFR), the Basin Head Marine Protected Area Regulations (BHMPAR), The Atlantic Fishery Regulations (AFR's), The Fishery (General) Regulations (FGR's), The *Fisheries Act* as well as the Maritime Provinces Fishery Regulations (MPFR).

C&P conducts both land and sea based patrols in all Zones within the MPA throughout the year. Patrols are 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 Zone 2) and some rock crab and lobster fishing within Zone 3, were the only commercial fisheries observed within the confines of the Basin Head MPA in the spring, summer and fall of 2020. There are 2-4 fishers that fish oysters within Zone 2 and those fishers usually notify 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. There are potentially only 2 rock crab fishers that will fish in Zone 3 but their activity is limited and only one fisher was active in 2020. Other activity in Zone 3 is noted as recreational watercraft activity and recreational fisheries such as striped bass and a small amount of bar clam. 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. These vessels usually launch out of Souris or have a homebase at the Souris Marina.

There has been no non-compliance issues identified that required an enforcement action in regard to contraventions of the MCFR, BHMPAR or MPFRs in the fiscal year 2020-2021. 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 2020. Unfortunately, due to the Covid-19 pandemic and provincial health and travel restrictions, less visitors were observed at both the beach and the fisheries museum, so exposure to the kiosk was limited.



On November 4th, 2020, CBC conducted an interview highlighting the restoration efforts that are ongoing to rehabilitate the Giant Irish Moss population, focusing on making the artificial clumps and planting them in the Northeast Arm. This interview was aired on CBC PEI's Compass, on CBC radio, and a written article was posted on the CBC website and CBC PEI's Facebook page.

While work on the Basin Head Interpretive Park was completed in 2019, some improvements were made in 2020 to enhance user experience and safety. It was observed that during periods of very low tides, the floating dock would be resting on the exposed ground, not providing a stable surface for visitors to walk on. To try and fix this SAB extended the ramp portion of the dock by 2 feet, a fix will be tested once the dock is reinstalled in the summer of 2021. Also under consideration is replacing the current wooden stairs with an aluminium set that would allow for easy removal at the end of the field and tourist season.

7.0 NEXT STEPS AND PRIORITIES

DFO will focus on several priorities related to the implementation of the management plan in the next fiscal year (April 2021 to March 2022). Priorities include:

- Development of calculation method to determine nutrient load into Basin Head to further the changes in water sampling and stream flow updates in the methodology.
- Continue to work with land use and weather data to strengthen understanding of nitrogen loading and how it interacts with *Ulva* blooms.
- Analyze the Southern Gulf of St. Lawrence Coalition on Sustainability ecosounder data collected in July 2020 to determine bathymetry for future hydrodynamic modelling.
- Continue ecosystem restoration, with periodic monitoring to document the expected increases in species diversity and productivity associated with Irish moss beds, oyster reefs and eelgrass patches.
- Explore the interactions between Irish Moss clumps and eelgrass patches to determine if eelgrass contributes to smaller Irish Moss frond size and clump survival.
- Continue to develop drone-based aerial photography as a potential comprehensive survey method and provide proof of concept that the photomosaic accurately identifies clump location and Irish moss coverage.
- Continue to monitor marsh edge erosion, development of eelgrass patches, and the biomass and spatial distribution of *Ascophyllum* and *Geukensia*.
- 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.
- Connect with the new UPEI Climate change research program to be situated at St. Peters, to ensure that Basin Head lagoon becomes a climate change research site.

8.0 REFERENCES

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