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ECOLOGICALLY SIGNIFICANT AREAS | CASE STUDY: SALT MARSHES IN THE BAY OF FUNDY

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Case studies have been developed to inform the federal government consultation on the regulatory process to establish "ecologically significant areas" under Section 34 of the *Fisheries Act*.

I. OVERVIEW

A highly productive and resilient coastal ecosystem, salt marshes are one of only a few ecosystems that are recognized within international environmental legislation for their importance for biodiversity and fisheries recruitment, as well as for providing coastal protection and carbon sequestration.[1] In the Maritimes, salt marshes represent the climax community for coastal floodplains and they play an important role in the stability and diversity of the marine waters.[2] They filter sediments and pollutants and provide nutrients for adjacent ecosystems that are less productive.[3] Salt marshes also provide important habitat for a variety of marine species including birds, mollusks and fish, and play an important role in inshore fisheries, as they act as a nursery ground for commercially important species. It has been estimated that approximately two-thirds of all commercially harvested fishery resources rely on estuaries at some stage in their lives.[4] This includes species such as herring (*Clupea harengus*) and American eel (*Anguilla rostrata*) in Nova Scotia,[5] in addition to recreationally harvested striped bass (*Morone saxatilis*)[6] and species important to Indigenous fisheries such as gaspereau/alewife (*Alosa psuedoharengus*) and shad (*Alosa sapidissima*).[7]

Salt marshes provide major coastal protection benefits, including wave attenuation and shoreline stabilization. Marsh vegetation has been shown to reduce wave energy and height, even during high water levels and extreme weather events. Marsh substrate remains resistant to surface erosion under all conditions, so even under extreme conditions salt marsh ecosystems can be a valuable component of coastal protection schemes.[8] Vegetated foreshores (e.g. salt marshes) have been proven to be more cost-effective than dyke heightening to reduce wave loads on coastal structures such as dykes and dams, thereby mitigating current and future flood risk.[9] They are also

[1] Intergovernmental Panel on Climate Change. (2019). IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.- O. Pörtner, et al., (eds.)]. https://www.ipcc.ch/srocc/

[2] Parker, M., Westhead, M. & Service, A. (2007). Ecosystem Overview Report for the Minas Basin, Nova Scotia. DFO Oceans and Coastal Management Report 2007-05.

[3] Jinks, K.I. et al. (2020). Saltmarsh grass supports fishery food webs in subtropical Australian estuaries. Estuarine, Coastal and Shelf Science. 238.

[4] Musquash Estuary: A Management Plan for the Marine Protected Area and Administered Intertidal Area. https://waves-vagues.dfo-mpo.gc.ca/Library/344113.pdf

[5] Sherren, K., Ellis, K., Guimond, J. A., Kurylyk, B., LeRoux, N., Lundholm, J., Mallory, M.L., van Proosdij, D., Walker, A.E., Brown, T.M., Brazner, J,, Kellman, L. Turner, B.L. & Wells, E. (2021). Understanding multifunctional Bay of Fundy dykelands and tidal wetlands using ecosystem services—a baseline. FACETS.

[6] Baker HK, Nelson JA, and Leslie HM. (2016). Quantifying striped bass (Morone saxatilis) dependence on saltmarsh-derived productivity using stable isotope analysis. Estuaries and Coasts, 39(5): 1537–1542.

[7] Eberhardt AL, Burdick DM, Dionne M, and Vincent RE. (2015). Rethinking the freshwater eel: salt marsh trophic support of the American eel, Anguilla rostrata. Estuaries and Coasts, 38(4): 1251–1261. DOI: 10.1007/s12237-015-9960-4

[8] Moller, I. et al., (2014). Wave attenuation over coastal salt marshes under storm surge conditions. Nature Geoscience, 17, 727 -731.

[9] Vuik, V. et al., (2019). Salt marshes for flood risk reduction: Quantifying long-term effectiveness and life-cycle costs. Ocean and Coastal Management, 171, 96–110.

one of the world's most efficient sinks for atmospheric carbon dioxide, and the carbon stored in these ecosystems is stored for millennia—it has been estimated that the Bay of Fundy salt marshes currently store around 14.2 million tonnes.[10]

Few place-based protections for salt marshes exist in Nova Scotia or New Brunswick. Given the ecosystem function, carbon storage and coastal protection that they provide, the Ecologically Significant Areas tool under the modernized *Fisheries Act* offers a much-needed opportunity to mitigate threats and increase restoration efforts.

II. DESCRIPTION OF AREA

Located in the intertidal zone, salt marshes can be found throughout the Bay of Fundy, although it has been estimated that since 1604 more than 85% of the salt marshes have been lost through dyking and causeway construction.[11] Bay of Fundy salt marshes are usually characterized by two types of grasses, *Spartina alterniflora* (cord grasses that prefer lower parts of the marsh) and *Spartina patens* (salt hay grasses that prefer higher, landward portions of the marsh), which help to stabilize the sediment.

Minas Basin and Chignecto Bay lie at the head of the Bay of Fundy in the Inner Bay. The present-day extent of low salt marsh within the Minas Basin is about 1,330 hectares, almost 80% of which is concentrated around the Southern Bight.[12] Along the New Brunswick coast, some salt marshes can still be found next to tidal mud flats in Chignecto Bay, near Cape Enrage and the Hopewell Rocks, as well as in the estuaries of some salmon rivers west of Fundy National Park(Figure 1).

Closer to the Gulf of Maine, the Musquash Estuary represents the largest ecologically intact salt marsh estuary in the Bay of Fundy and has been protected as an *Oceans Act* marine protected area (MPA).[13] While the boundary of the Musquash Estuary MPA is defined by the water level at low tide, most of the intertidal area is also managed by DFO as the Administered Intertidal Area through an agreement between the Government of Canada and the Province of New Brunswick. Additional lands surrounding the MPA are privately protected or managed by other organizations such as Ducks Unlimited and the Nature Conservancy of Canada.

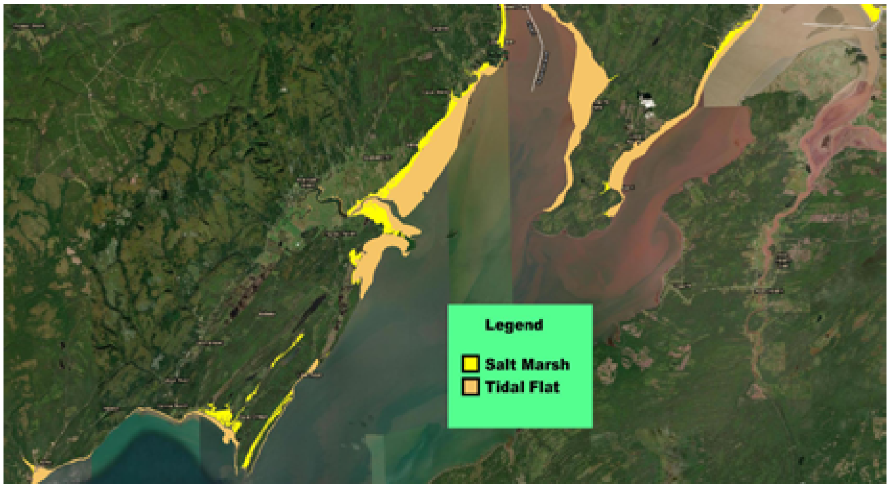

Figure 1: Salt marshes and their relationship to tidal flats between Cape Enrage and Hopewell Rocks, New Brunswick (copyright CPAWS New Brunswick).

10 Chmura, G. & van Ardenne. L.B. (n.d.). The Bay of Fundy Blue Carbon Story. Retrieved from https://mcgillgis.maps.arcgis.com/apps/MapJournal/index.html?appid=dfa52f8f91754c24804b6d63e782fb7f

11 Ganong, W.F. (1903) The Vegetation of the Bay of Fundy Salt and Diked Marshes: An Ecological Study.

12 Parker, M., Westhead, M. & Service, A. (2007). Ecosystem Overview Report for the Minas Basin, Nova Scotia. DFO Oceans and Coastal Management Report 2007-05.

13 Fisheries and Oceans Canada. (2019). Musquash Estuary Marine Protected Area (MPA): https://www.dfo-mpo.gc.ca/oceans/mpa-zpm/musquash/index-eng.html

III. ECOSYSTEM SERVICES PROVIDED

- Coastal protection through wave attenuation and shoreline stabilization
- Filters sediments and pollutants
- Provides nutrients for adjacent less productive ecosystems
- Important habitat for many species, including nursery ground for commercially important fish species, feeding area for migratory birds
- Efficient carbon sink
- Minimizes the local impacts of ocean acidification[14]

Figure 2: Salt marsh near Hopewell Hill, New Brunswick.

IV. CONSERVATION AND PROTECTION OBJECTIVES

- Protect habitat for important commercial and non-commercial fish species
- Protect ecosystems that protect against sea level rise and provide high rates of carbon sequestration
- Achieved by:
    - Preventing loss of existing salt marshes
    - Restoration of salt marshes that will then be protected

V. THREATS/ACTIVITIES THAT IF PERMITTED WOULD UNDERMINE ACHIEVING OF CONSERVATION OBJECTIVES:

- Conversion: 25-50% of the world's coastal wetlands have been converted to land for agriculture and aquaculture in the 20th century alone.[15] For agricultural or commercial development, salt marshes are drained, dredged, and filled, damaging the structure of their underlying sediment and releasing captured carbon back into the atmosphere.[16] Marshes may also be flooded for coastal aquaculture, killing overlying vegetation and accelerating erosion of the underlying carbon-rich sediments.[17]
- Coastal development and shoreline hardening: while vertical accretion may allow for further deposition and carbon sequestration in coastal salt marshes as sea level rises, heavy coastal development and shoreline hardening means marshes will disappear where there is no possibility of landward expansion, known as "coastal squeeze."[18]

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14 Ricart, A. M., Ward, M., Hill, T. M., Sanford, E., Kroeker, K. J., Takeshita, Y., Merolla, S., Shukla, P., Ninokawa, A.T., Elsmore, K. & Gaylord, B. (2021). Coast‐wide evidence of low pH amelioration by seagrass ecosystems. Global Change Biology, 27(11), 2580-2591.

15 McLeod, E., Chmura, G. L., Bouillon, S., Salm, R., Björk, M., Duarte, C. M., … Silliman, B. R. (2011). A blueprint for blue carbon: Toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Frontiers in Ecology and the Environment. https://doi.org/10.1890/110004

16 Laffoley, D.d'A. & Grimsditch, G. (eds). (2009). The management of natural coastal carbon sinks. IUCN, Gland, Switzerland. 53 pp.

17 Howard, J., McLeod, E., Thomas, S., Eastwood, E., Fox, M., Wenzel, L., & Pidgeon, E. (2017). The potential to integrate blue carbon into MPA design and management. Aquatic Conservation: Marine and Freshwater Ecosystems. https://doi.org/10.1002/aqc.2809

18 Laffoley, D.d'A. & Grimsditch, G. (eds). (2009). The management of natural coastal carbon sinks. IUCN, Gland, Switzerland. 53 pp.

- Runoff from land: eutrophication is a common consequence of human development in coastal regions, where discharge and terrestrial runoff from sewage as well as industrial and agricultural activity results in increased nitrogen inputs. This then leads to reduced belowground biomass and enhanced decomposition driven by nutrient enrichment.[19]
- Upstream changes in water flow: dam construction, mining or use of water for irrigation or human consumption can change the input of freshwater and sediment into rivers that flow into marsh ecosystems. Too much or too little sediment entering the marshes can change the composition of the ecosystem, potentially leading to marsh loss, and changes in water flow or quality can result in changes to species assemblages.[20]
- Physical damage: use of recreational vehicles such as ATVs or bikes in marshes can kill vegetation even after one or two passes.[21] Pipelines or powerlines crossing marshes can also lead to unvegetated areas and further erosion unless specific mitigation measures are taken.

JURISDICTIONAL ISSUES

- Overlapping jurisdictions between the provincial and federal governments creates confusion around who is responsible for managing what. Provincial jurisdiction goes to the ordinary low water mark, while DFO has jurisdiction over fish habitat.
    - The lack of clarity on jurisdiction can lead to issues with the Department of Justice as to what land-based activities can be dealt with by DFO, and an ESA tool could provide further clarity. Can agreements be reached whereby an ESA triggers management action outside the site itself?

Figure 3: Bay of Fundy salt marsh (copyright Nick Hawkins).

    - Important to note that Memoranda of Understanding (MoUs) can be created with provinces to manage impacts on salt marshes, as has been done for the Musquash Estuary MPA and the Associated Intertidal Area that surrounds it.
    - Need to recognise other pieces of legislation that may overlap (Provincial coastal protected areas, endangered species legislation).
    - Municipal actions such as climate planning may also create additional jurisdictional confusion.
- In Nova Scotia, Nova Scotia Environment has the primary regulatory and enforcement responsibilities (as per the *2007 Environmental Goals and Sustainable Prosperity Act*, which was not updated in the *2019 Sustainable Development Goals Act*), though other activities that could

19 Deegan, L. A., Johnson, D. S., Warren, R. S., Peterson, B. J., Fleeger, J. W., Fagherazzi, S., & Wollheim, W. M. (2012). Coastal eutrophication as a driver of salt marsh loss. Nature. https://doi.org/10.1038/nature11533

20 Adam, P. (2002). Saltmarshes in a time of change. Environmental conservation, 29(1), 39-61.

21 Adam, P. (2002). Saltmarshes in a time of change. Environmental conservation, 29(1), 39-61.

potentially impact salt marshes are managed under separate acts. As an example, agricultural run-off is regulated by the *Farm Practices Act* and the *Environment Act*, while industrial run-off is regulated by the Environment Act.

- In New Brunswick, New Brunswick Environment and local government has primary responsibility for regulating activities in wetlands through the *Clean Water Act* ("Watercourse and Wetlands Alteration Regulation" permitting process), guided by the Wetlands Conservation Policy.[22] Saltmarshes on Crown lands are managed as well through the forest management objectives in the *Crown Lands and Forests Act*. There is also a "A Coastal Areas Protection Policy"[23] that guides reviews of proposed development that may impact saltmarshes; however, regulations to enable the policy enforcement have not yet occurred.

VI. RESTORATION OPPORTUNITIES

- DFO can work together with provincial governments on salt marsh restoration. Nova Scotia Transportation and Infrastructure Renewal have restored salt marshes, among others.
- Managed realignment of dykes helps to promote restoration of this intertidal habitat, helping salt marshes to re-establish in approximately 10 years.
- Research has shown that Bay of Fundy dykelands are well suited to managed realignment because of high rates of sediment deposition and large elevation range of Spartina alterniflora and would therefore be successful without the need for additional infill material.
- The carbon burial rate in a restored salt marsh was measured to be five times that of a mature salt marsh, with the burial rate slowing as it matures.[24]

VII. MONITORING & RESEARCH NEEDS

- Extent of salt marsh coverage and type of vegetation
- Water quality monitoring (e.g. nutrient loads, sedimentation)
- Assessment of need for restoration (an expansion of current research)
- Ecological linkages between salt marshes and nearshore fisheries
- Carbon sequestration quantification

22 New Brunswick Natural Resources and NB Environment and Local Government. (2002). New Brunswick Wetlands Conservation Policy. https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Wetlands-TerreHumides/WetlandsTerresHumides.pdf

23 Government of New Brunswick. (2019). "A Coastal Areas Protection Policy for New Brunswick". https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Water-Eau/CoastalAreasProtectionPolicy.pdf

24 Wollenberg JT, Ollerhead J, Chmura GL. (2018). Rapid carbon accumulation following managed realignment on the Bay of Fundy. PLoS ONE 13(3): e0193930. https://doi.org/10.1371/journal.pone.0193930