

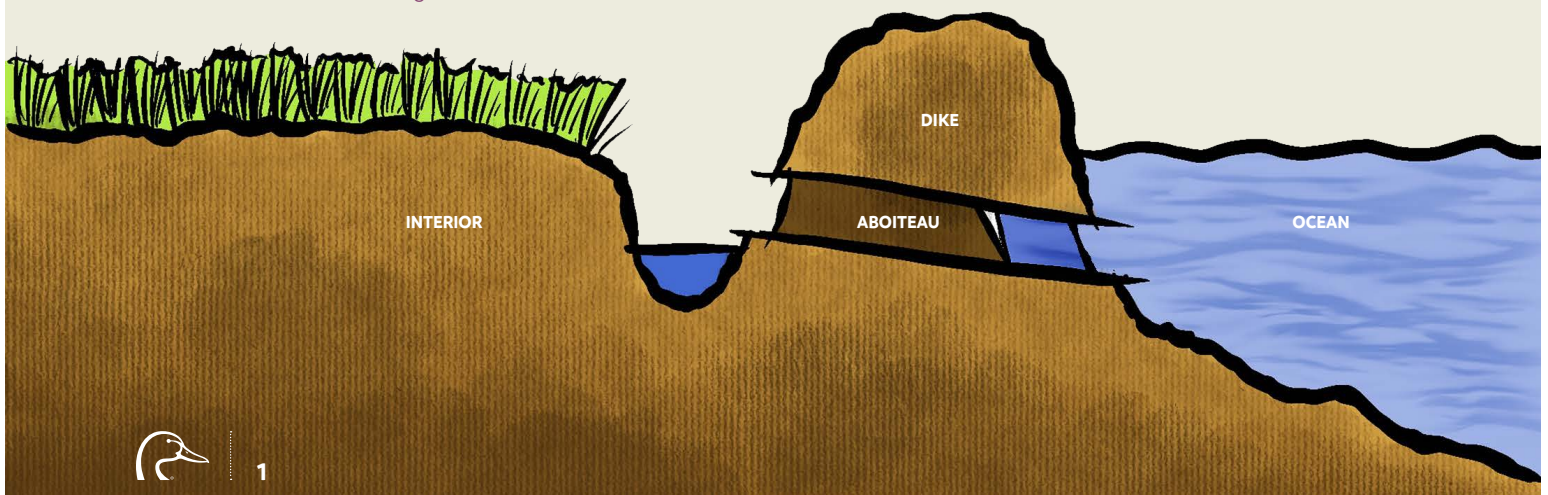
# How do salt marsh restorations help us adapt to sea level rise in Atlantic Canada?

## THE SEA LEVEL RISE CASE STUDY

The Acadian Dykelands are a part of history that have shaped some of the coastal landscapes in Nova Scotia and New Brunswick, mainly along the Bay of Fundy. Colonialism started in Canada when European explorers arrived in the 1600s on this land, home to the members of the Wabanaki Confederacy. These settlers, known today as Acadians, decided to use the lowlands (salt marshes) for agriculture, when they realized these lands had more potential for agriculture than the uplands, which consisted of cliffs and heavily forested areas. In the lowlands, soils from the salt marshes were rich in nutrients that the plants trapped when tide-water flowed in and out onto that land.

Acadians decided to build structures known as dikes (man-made walls) and aboiteaux (structures designed to keep saltwater from flowing in but allowing freshwater to leave during mid and low tides), to start using that fertile land for agriculture. This early ingenuity in technology allowed agriculture to take place on lands that were not suitable otherwise. However, over the next 400 years, this agricultural practice helped contribute to the loss of 85 per cent of salt marshes found in the Bay of Fundy. In turn, this had repercussions on the cultures of the Wabanaki Peoples and the natural ecosystems they had relied upon for generations.

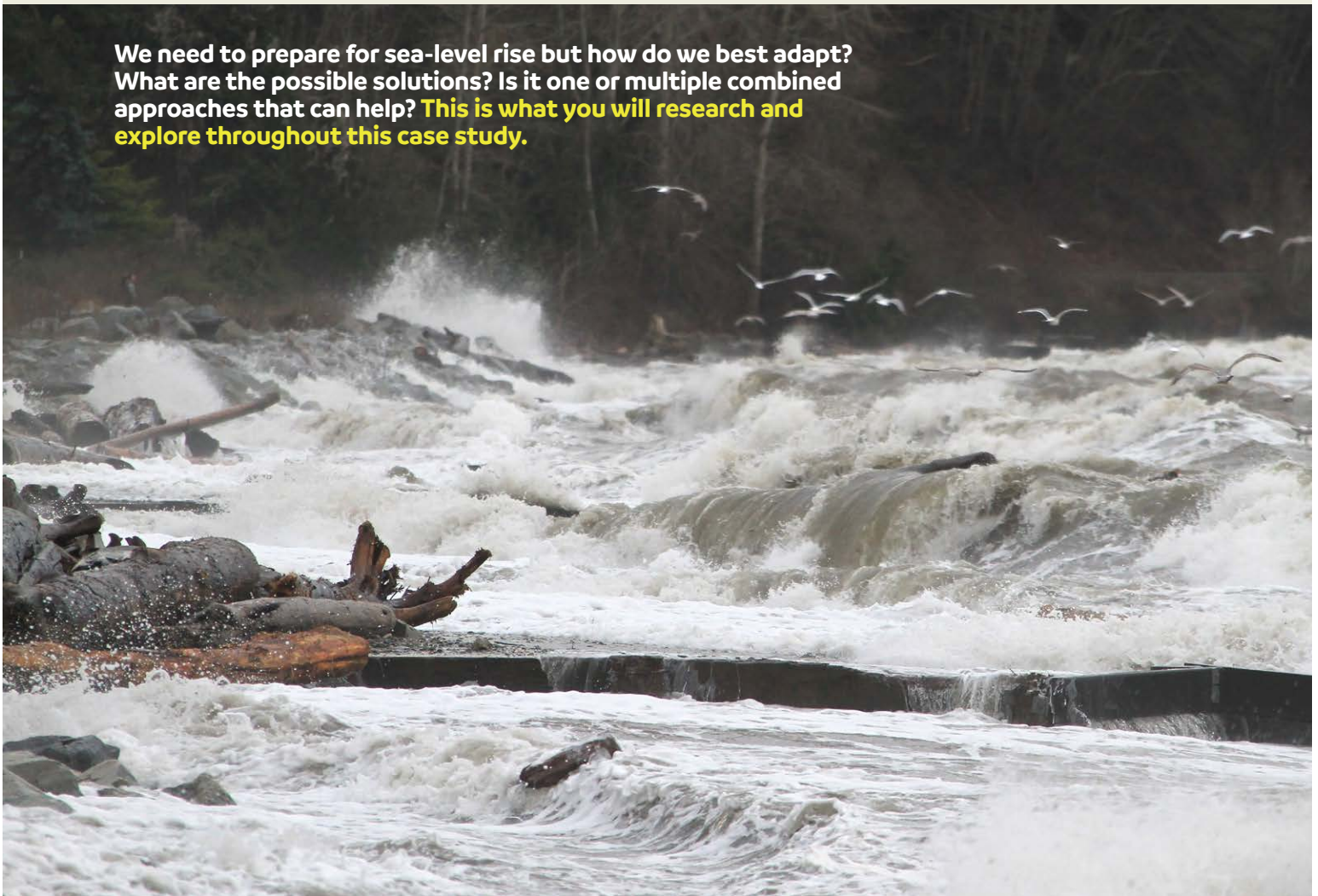
*Below: Dikes are walls constructed of soil built to stop saltwater from entering salt marshes. An aboiteau is a tunnel with a flap built into the dike. At low tide, the flap opens to allow freshwater captured within the dike to drain from the land to the ocean (if not, freshwater would accumulate on the land to become artificial lakes). During high tide, the flap closes; this prevents saltwater from flowing back onto the land. Over many years, the former salt marsh loses much of its salinity and as a result, the land becomes suitable for agriculture.*



At the start of the 20th century, the Canadian economy was struggling. The price of hay went down and farmers had less money to invest in the maintenance of the dikes. Then, the Great Depression hit in 1929, which meant there was little to no money available to maintain the dikes. Lack of maintenance caused some of the dikes to fall apart. Since that time, the federal and provincial governments have invested money to repair and maintain the dikes. Meanwhile, the way communities use the land that the dikes protect has also changed. Some agricultural land has been abandoned and new buildings, offices, malls, homes and transportation routes have been built over the fields. Some neglected dykelands have also since been restored to natural salt marshes.

Today, the consequences of climate change — which include sea level rise and the increasing severity of storms — is putting coastal areas under a lot of pressure, including on the aging dikes. Comparing the 2050 climate projections to the current dikes' capabilities indicates that the dikes will not be sufficient to protect the inland from sea-level rise and storm surges.

**We need to prepare for sea-level rise but how do we best adapt? What are the possible solutions? Is it one or multiple combined approaches that can help? This is what you will research and explore throughout this case study.**



*Ducks Unlimited Canada would like to acknowledge the ancestral and unceded territory of the Wabanaki Confederacy, whose land was developed into the Acadian Dykelands by European settlers dating back to the early 1600s, which is the land this case study alludes to. This territory falls within the Peace and Friendship Treaties signed by the Mi'kmaq, Wolastoqey, Passamaquoddy and Penobscot peoples prior to 1779, and recognizes and affirms the existing rights of Indigenous Peoples by the Canadian Constitution.*



**Location: Atlantic Canada**

## Welcome to the sea-level rise case study.

This activity dives into a real-life example of conservation, collaboration and innovation. We recognize that this case study encompasses many interesting subjects. For the simplicity of this case study, it is focused on creating a climate change adaptation plan for sea-level rise, but it can easily be adapted for different environmental studies, history, geography and civics classes. We encourage you to adapt it to meet your curriculum.

**Please note: Students should already be familiar about the causes of climate change.** This case study will work on identifying an adaptation strategy to climate change consequences (sea-level rise, erosion and storm surges) specific to coastal regions.

For more information on how wetlands help mitigate climate change, check out Ducks Unlimited Canada's (DUC) [new wetland and climate change resource pack online](#).

At the end of the case study, students will have developed problem-solving skills and have learned about:

- + History of Atlantic Canada
- + Wabanaki Confederacy
- + Climate change consequences specific to Canadian coastal regions (sea level rise, storm surges, erosion)
- + Climate change adaptations
- + Salt marsh ecosystems
- + Engineering achievements
- + Evolving land use
- + DUC's conservation work
- + Psychology of change
- + Reaching consensus



## Method

This case study should be done in two class sessions.

### Session 1

**Part 1:** Students answer the questions about the history of the Bay of Fundy, individually or in groups.

**Part 2:** Divide your class into three groups, so they can all focus on elements for consideration A, B and C.

- + Group A: Analyse to Restore Salt Marshes
- + Group B: Analyze Dike to Improve Dikes
- + Group C: Analyze Community Involvement in Decision-Making

### Session 2

**Part 3:** Create multiple groups – that each have at least one member of the groups A, B and C – to work together to find a climate change adaptation plan for the parcel of land in the student section.

**At the end (optional):** Once students' plans are done, you can [upload one to the WCE hub](#). You will then get access to the case study video explainer, highlighting DUC conservation and science staff who will explain how they would approach the issue at hand.



## Materials

- + Access to the internet
- + Library (optional)

**Note:** Talking about climate change can be stressful for youth. It is important to let your students know that it is normal to feel afraid, angry or hopeless in the face of climate change. They are not alone in their feelings; many people feel the mental health effects of thinking and hearing about climate change constantly. To move forward, we'll need to identify these feelings, and then find ways your students can be heard and supported. To help you discuss these emotions, please visit [The Climate Change Conundrum](#) cartoon and the [Coping with the Climate Change Conundrum: Addressing the Emotions](#) teacher's guide.

## Suggested Resources

**Note:** These links vary in terms of media and depth of content. It also contains plain language articles and peer-reviewed articles. These are suggested readings and media to assist students' research. Because these links vary in complexity, make sure to direct your students to the most appropriate articles for their level.

### Audio

- + Sea Level Rise, Part 2 – DUC Podcast. <https://www.ducks.ca/podcast/sea-level-surge-part-2/>

### Book Chapters

- + Milligan, D. C., 1987. Maritime Dykelands: The 350-year struggle. Nova Scotia Department of Agriculture and Marketing, Halifax, Nova Scotia, Canada. <https://novascotia.ca/agri/documents/MARITIME-DYKELANDS.pdf>
- + Sherren, K., T. Bowron, J. Graham, H.M.Rahman, and D. Proosdij. 2019. Coastal infrastructure realignment and salt marsh restoration in Nova Scotia, Canada. Responding to Rising Seas: OECD Country Approaches to Tackling Coastal Risks. OECD Publishing, Paris, France. **We suggest the selected excerpts:**

*1. Canada has the world's longest coastline, bordering three oceans, and is thus highly exposed to sea level rise (SLR) (Lemmen and Warren, 2016). Approximately 38% of Canada's population lives within 20 kilometres of a coast (Manson, 2005). Climate impacts and risks vary across the three coasts in Canada (Lemmen et al., 2016). The Arctic coast comprises 70% of Canada's shoreline, comprising mostly small villages of largely Indigenous inhabitants, where sea levels are expected to drop, but where livelihoods and cultures will be affected by declining sea ice, melting permafrost and coastal erosion and instability. The Pacific coast is dominated by the large population centres of Vancouver and Victoria, both located in the Fraser Lowland area that is expected to see the highest relative SLR for the region. Lemmen and Warren (2016) note, however, that the Pacific region faces higher vulnerability to storm surges than SLR.*

*2. The Atlantic coast hosts a few small cities but many towns and villages, including unincorporated shoreline developments, all expected to be affected by and vulnerable to SLR and increasingly extreme weather events (Lemmen and Warren, 2016). Examples of climate adaptation planning are coming from especially vulnerable places, such as Les Îles-de-la-Madeleine in the Gulf of St. Lawrence, which has no alternative but to engage in coastal retreat (McClearn, 2018). Nova Scotia is another jurisdiction with significant exposure to SLR, and numerous local innovations. This chapter describes one such project in Nova Scotia, a dyke realignment and tidal wetland restoration project that was largely achieved because of its alignment with government policies unrelated to climate such as wetland compensation and dyke divestment.*

*10. The Nova Scotia Department of Agriculture (NSDA) is responsible for the management and maintenance of the province's 260 aboiteaux (one-way drains used for land reclamation) and 241 kilometres of dykes. The resource (human, financial) and engineering requirements to maintain and upgrade this infrastructure stock to withstand SLR exceeds the Department's current capacity. NSDA is mandated to protect agricultural*



landscapes, but a significant portion of the 17 400 ha of land they protect is now used for non-agricultural practices and developments. NSDA is prioritizing which dykelands could potentially be decommissioned (breached) and restored to salt marsh (Bowron et al., 2012, van Proosdij et al., 2014). In some of these cases, where built assets would still require protection, the construction of new, shorter, dykes built to modern specifications (including SLR projections) is being considered (MacDonald et al., 2010), a process called dyke realignment. File:///C:/Users/duc1023/Downloads/TruroCaseStudy-OECDreportRG.pdf

### Master's Thesis

- + Fudge, A. 2019. Memory, place & change: A landscape narration of the Tantramar marshes. Thesis, University of Guelph, Guelph, Ontario, Canada. [https://atrium.lib.uoguelph.ca/xmlui/bitstream/handle/10214/16037/Fudge\\_Aiden\\_201905\\_MLA.pdf?isAllowed=y&sequence=1](https://atrium.lib.uoguelph.ca/xmlui/bitstream/handle/10214/16037/Fudge_Aiden_201905_MLA.pdf?isAllowed=y&sequence=1)

### Newspaper Article

- + McClearn, M. March 19, 2018. Short on options, Îles-de-la-Madeleine residents make a strategic retreat from rising seas. Globe and Mail, Toronto, Ontario, Canada.

### Peer-Reviewed Articles

- + M-MacDonald, G.K., P.E. Noel, D. van Proosdij, and G.L. Chmura. 2010. The legacy of agricultural reclamation on channel and pool networks of Bay of Fundy salt marshes. *Estuaries and Coasts* 33:151-160. (Optional)
- + Manson, G.K. 2005. On the coastal populations of Canada and the world. Proceedings of the 12th Canadian Coastal Conference. Dartmouth, Nova Scotia, Canada. (Optional)
- + Tuihedur Rahman, H.M., K. Sherren, and D. van Proosdij. 2019. Institutional Innovation for Nature-Based Coastal Adaptation: Lessons from Salt Marsh Restoration in Nova Scotia. *Sustainability* 11:6735. (Students should only read parts 1 and 3.) <https://www.mdpi.com/2071-1050/11/23/6735/htm>

### Government Report

- + Lemmen, D.S., F.J. Warren, T.S. James, and C.S.L. Mercer Clarke (Editors). 2016. Canada's marine coasts in a changing climate. Government of Canada, Ottawa, Ontario, Canada.

### Video

- + Rudin R & Hébert B, 2020, Unnatural landscapes. 20 minutes. <http://www.unnaturallandscapes.ca/>
- + Ducks Unlimited Canada, 2019, On The Rise – DUC & Sea Level Rise. 4:09. <https://youtu.be/IA6KNU4zkhs>

### Online Articles

- + CTV News: Projects will help Nova Scotia prepare for rising sea levels, storms. <https://atlantic.ctvnews.ca/projects-will-help-nova-scotia-prepare-for-rising-sea-levels-storms-1.4383685>
- + Ducks Unlimited Canada: Lessons in adaptation help address sea-level rise at Musquash Marsh. <https://www.ducks.ca/stories/atlantic/sea-level-rise-at-musquash-marsh/>
- + Ducks Unlimited Canada: Rising up. <https://www.ducks.ca/stories/atlantic/saving-prince-edward-island-from-the-threat-of-sea-level-rise/>
- + Ducks Unlimited Canada: Saltwater Solution. <https://www.ducks.ca/stories/atlantic/saltwater-solution/>
- + Government of Nova Scotia: Dykelands. <https://novascotia.ca/natr/wildlife/habitats/dykelands/>
- + Mi'kmaq Indian fact sheet. [http://www.bigorin.org/mikmaq\\_kids.htm](http://www.bigorin.org/mikmaq_kids.htm)
- + National Geographic: Examples of Dikes. <https://www.nationalgeographic.org/encyclopedia/dike/>
- + Native Land Digital Map: <https://native-land.ca/>
- + NSERC ResNet Network: Bay of Fundy. <https://www.nsercresnet.ca/landscape-1---bay-of-fundy.html>
- + The Acadians and the creation of the Dykelands. <http://www.landscapeofgrandpre.ca/the-acadians-and-the-creation-of-the-dykeland-1680ndash1755.html>

