



Nature-based Solutions:

A Guide for Western Lake Ontario



Toronto and Region
Conservation
Authority



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About the Land to Lake Initiative

Established in 2022, the Land to Lake Initiative is a partnership network that aims to foster stronger, more coordinated collaborations to enhance capacity for actions that improve water quality and ecosystem health in Western Lake Ontario, stretching between the Niagara River and Cobourg.

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Glossary

Artificial reef: Submerged structures made of natural or human-made materials.

Backshore: The area immediately above the zone normally affected by wave action along a lake.

Beach (or bar): A shoreline area of a lake or river with high levels of disturbance from periodic high water levels and related physical effects such as ice scour, erosion, and deposition.

Bluff: A shoreline area of a river or lake with steep to vertical slopes of unconsolidated surficial deposits which are subject to active erosion from slumping, mass wasting, or toe erosion (at the bottom of the slope).

Breakwater: A shore-parallel structure built out into the lake to protect the shoreline from the force of waves.

Cobble: A rounded rock fragment between 80 and 250 mm in diameter.

Culvert: A conduit for carrying water through an embankment as related to a type of water crossing or discharge facility at a dam.

Dredging: Removal or displacement of any material from the bottom of a lake or stream.

Dune: A low hill or ridge of sand that has been sorted and deposited by wind.

Embayment: A natural or constructed area of sheltered water.

Emergent vegetation: Aquatic plants rooted in shallow water or wet soil, with the lower portion submerged while foliage, flowers, and stems grow above the water's surface.

Erosion: The degradation of a surface by chemical and mechanical weathering and the removal of materials by wind or water.

Floodplain: For river, stream, and small inland lake systems, this refers to the area, usually low lands adjoining a watercourse, which has been or may be subject to flooding hazards.

Fore dune: The ridge of sand closest to and parallel to the beach.

Foreshore: The zone between low and high water levels.

Gravel: Rock particles ranging in size from 2 mm to 8 cm in diameter; soil with a high proportion of gravel-sized particles.

Groyne (or groin): A hard structure that extends into the water and is often placed perpendicular to the shoreline.

Hardened shoreline: Hard structures (e.g., groynes, jetties, seawalls, revetments, and breakwater) are often placed in coastal environments to counteract erosion in sediment-deficient areas, or to deter accretion in sediment-rich areas such as inlets.

Hind dune (or back dune): A stable, landward ridge of sand located behind the fore dune.

Hybrid solution: An approach combining natural systems or soft engineering (e.g., wetlands, vegetation, beach nourishment) with grey infrastructure to improve resilience and performance.

Levee (or dike, embankment, berm): A long wall, bank, or mound built to prevent flooding.

Littoral cell: A length of shoreline within which there is an uninterrupted net transport of sediment alongshore in one direction, with boundaries across which there is little or no exchange of sediment with adjacent cells.

Marsh: A wetland with a mineral or peat substrate inundated by nutrient-rich water and characterized by emergent vegetation.

Meander: A bend or curve in a river or stream.

Nearshore: Zone that extends lakeward from the average water level, where wave action and currents directly influence the shoreline.

Sand: Mineral particles with diameters ranging from 0.05 to 2.0 mm.

Shoal: Aggregation of coarse materials placed along the shoreline such as armourstone, boulders, rubble, rip-rap, cobble, and gravel.

Sill (or marsh sill): A low-profile, shore-parallel structure located in the water just off the shoreline to dissipate wave energy and reduce erosion along vegetated shorelines, including coastal marshes.

Stone: Rock fragment with a diameter ranging from 25 to 60 cm.

Nature-based solutions: Actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits.

Reach: Segments of a shoreline that usually having relatively uniform physical characteristics; a longshore segment of a shoreline where influences and impacts, such as wind direction, wave energy, littoral transport, etc. mutually interact.

Revetment: A wall or facing of stone, or concrete, or other materials placed on a stream bank to prevent erosion.

Riparian: Adjacent to a river or lake.

Sediment accretion: The process by which sediment such as sand, silt, and organic material is gradually deposited and accumulated in coastal environments, leading to the vertical or lateral growth of landforms like beaches, dunes, and wetlands.

Seiche: A standing wave that moves back and forth.

Storm surge (or wind setup): An unusual rise in water levels, usually when strong winds push water into land.

Weir: A structure in a watercourse intended to raise the water level to partially or totally divert its flow.

Wave effects: The movement of water up onto a shoreline or structure following the breaking of a wave, including wave uprush, wave setup and water overtopping or spray; the limit of wave effects is the point of furthest landward horizontal movement of water onto the shoreline.

Wave overtopping (or wave spray): When the height of the natural shoreline, or of the protection work, above the stillwater level is less than the limit of uprush. As a result, waves overtopping the protection work can cause flooding of the onshore and can threaten the structural stability of protection works.

Wave setup: The mean increase in water level caused by the onshore transport of water due to waves breaking at the shoreline.

Wave uprush/runup: The time varying height above the stillwater level that the water runs up the shore face.

Wetland: Lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic (water-loving) plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs, and fens.

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Introduction

Introduction

*The beach is losing sand at an unsustainable rate.
The bluffs are eroding, threatening homes that sit on top.
The waterfront trail that flooded last summer is flooded again.
The dock broke loose and floated away with boats still attached.*

These stories are not uncommon among communities along Western Lake Ontario, which have been impacted by extreme high and low lake levels, more frequent and intense heatwaves, declining lake ice cover, and more invasive species and algal blooms¹.

Climate change poses a growing threat to communities and ecosystems along Western Lake Ontario, amplifying existing pressures such as residential development, port expansion, and industrial activities. But addressing these threats present opportunities to reimagine our waterfronts, protect water quality, and strengthen the health of Lake Ontario.

Much of the shoreline along Western Lake Ontario has been hardened (e.g., with large rock or concrete structures) to protect against coastal flooding and erosion. These limit access to the water and have knock-on effects on other parts of the shoreline such as flooding and erosion, water quality impairments, and habitat degradation. Meanwhile, the natural features and areas that do exist along these shorelines are highly fragmented.

As the pace and impacts of climate change accelerate, there is an urgent need for actions that provide multiple benefits. Nature-based solutions (NbS) are “actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits”². While the term is relatively new, efforts to protect, restore, and care for the land and water are not new and have been ongoing for many decades to millennia, including efforts by Indigenous peoples and communities around the world.

Nature-based approaches use natural features and processes like vegetation, beaches, dunes, and wetlands to protect the shoreline. Unlike conventional grey infrastructure (e.g., concrete sea walls), which is often designed for a single purpose, NbS can perform a variety of functions and provide multiple

¹ For more information on past climate and weather-related impacts in Western Lake Ontario, please see: Lam, S., Hill, J., & Caglayan, S.D. (2026). Western Lake Ontario: Compendium of Coastal Resilience Issues and Typology of Nature-based and Hybrid Solutions. Toronto and Region Conservation Authority. Toronto, ON.
² IUCN. (2016). Resolution 69 on Defining Nature-based Solutions (WCC-2016-Res-069). IUCN Resolutions, Recommendations and Other Decisions 6–10 September 2016. World Conservation Congress Honolulu, Hawai’i, USA. https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2016_RES_069_EN.pdf

co-benefits (e.g., reduce stormwater runoff and soil erosion, and provide natural cooling, recreational spaces, and habitat for wildlife).

Increasingly, knowledge and techniques around NbS are improving to ensure that they are just as effective as hard features in protecting the shoreline. In some cases, a hybrid (or combination) of natural and hard features may be used.

This guide presents 27 types of nature-based and hybrid solutions and how they can help address the impacts of climate-related hazards across Western Lake Ontario. Examples of existing nature-based and hybrid solutions are also highlighted to showcase the different types of techniques that have been implemented across Western Lake Ontario, from Niagara to Cobourg.

Every shoreline is different, and not all NbS will be appropriate everywhere. As the fastest developing area in the Great Lakes Basin, there is a continued need to balance environmental, economic, social, cultural, and recreational objectives among coastal communities along Western Lake Ontario. This guide offers a range of possible nature-based and hybrid solutions that may be relevant for this region. Further study is needed to assess their feasibility, costs, and maintenance requirements, but they offer a starting point for re-imagining our shorelines and coastal communities for enhanced climate resilience.

How This Guide Was Developed

This guide was developed based on a literature review and the collection and analysis of NbS case studies. A total of 1,173 shoreline NbS terms were extracted from 53 documents published between 1995 and July 2025³. Guided by the International Union for the Conservation of Nature’s (IUCN’s) Global Standard for Nature-based Solutions⁴, techniques that met the Standard’s definition of nature-based solutions were considered NbS. Interventions that rely on a significant grey-infrastructure component to function were identified as “hybrid solutions”. Actions that enable, support, or create the conditions for NbS delivery, but are not themselves NbS (e.g., policy tools, capacity building, monitoring frameworks), were identified as “enablers”.

³ Lam, S., Hill, J., & Caglayan, S.D. (2026). Western Lake Ontario: Compendium of Coastal Resilience Issues and Typology of Nature-based and Hybrid Solutions. Toronto and Region Conservation Authority. Toronto, ON.
⁴ IUCN. (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS [First edition]. IUCN. <https://doi.org/10.2305/IUCN.CH.2020.08.en>

Through an iterative process, the list of 1,173 NbS terms was pared down by removing irrelevant terms (e.g., marine NbS), duplicate values, synonyms, and overlapping concepts, resulting in 27 broad types of nature-based and hybrid solutions.

To provide further guidance on which types of NbS and hybrid solutions may be suitable to address different climate-related hazards and impacts, linkages to common hazards and impacts were identified based on the authors' best judgement. Each NbS and hybrid solution was evaluated based on their potential to address various hazard impacts that have been experienced across Western Lake Ontario such as beach loss and dune destabilization, bluff retreat and structural undermining, coastal/urban inundation, wetland loss, and habitat fragmentation.

The IUCN Global Standard was also used to evaluate case studies that were gathered through a combination of virtual observations using Google Earth, web searches, communications with subject matter experts, and site visits. A total of 30 case studies are referenced throughout this guide⁵, with additional resources noted in the Appendix.

Intended Audiences

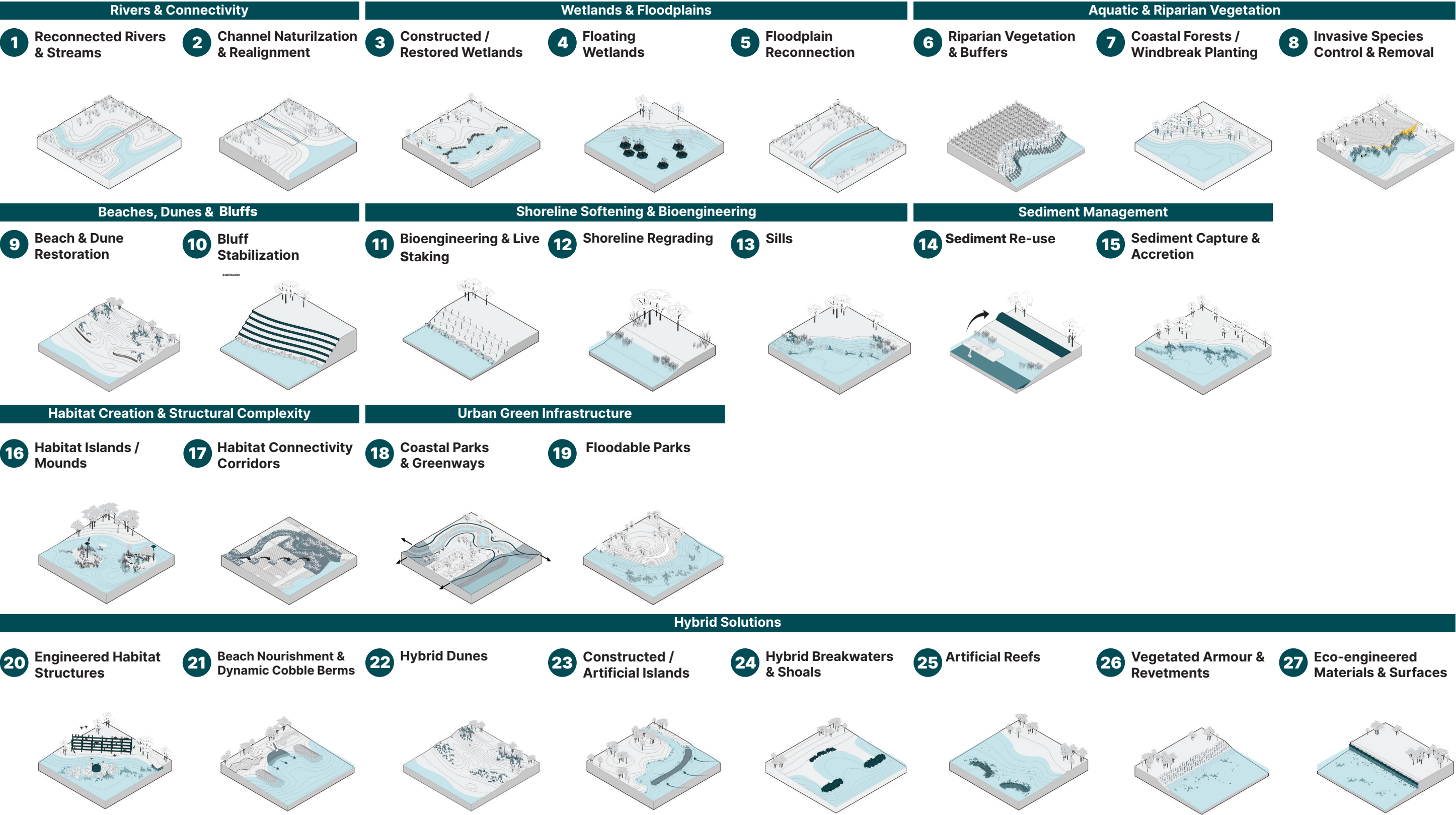
This guide is intended for conservation authorities, municipalities, provincial and federal governments, port authorities, utilities and other infrastructure owners/operators, non-profit organizations, community groups, and coastal property owners to help advance the implementation of nature-based and hybrid approaches along Western Lake Ontario.

Typology Overview

The typology is organized under 9 themes: Rivers and Connectivity; Wetlands and Floodplains; Aquatic and Riparian Vegetation; Beaches, Dunes, and Bluffs; Shoreline Softening and Bioengineering; Sediment Management; Habitat Creation and Structural Complexity; Urban Green Infrastructure; and Hybrid Solutions.

⁵ For summaries of all 30 case studies, please see: Lam, S., Hill, J., & Caglayan, S.D. (2026). Western Lake Ontario: Compendium of Coastal Resilience Issues and Typology of Nature-based and Hybrid Solutions. Toronto and Region Conservation Authority. Toronto, ON.

Overview of the Typology of Nature-based and Hybrid Solutions



How to Read This Guide

Alternative terms: Similar or other commonly used terms.

Synergies: Complementary techniques that can be used together for greater benefits.

Example visualization: A conceptual illustration of the NbS or hybrid solution.

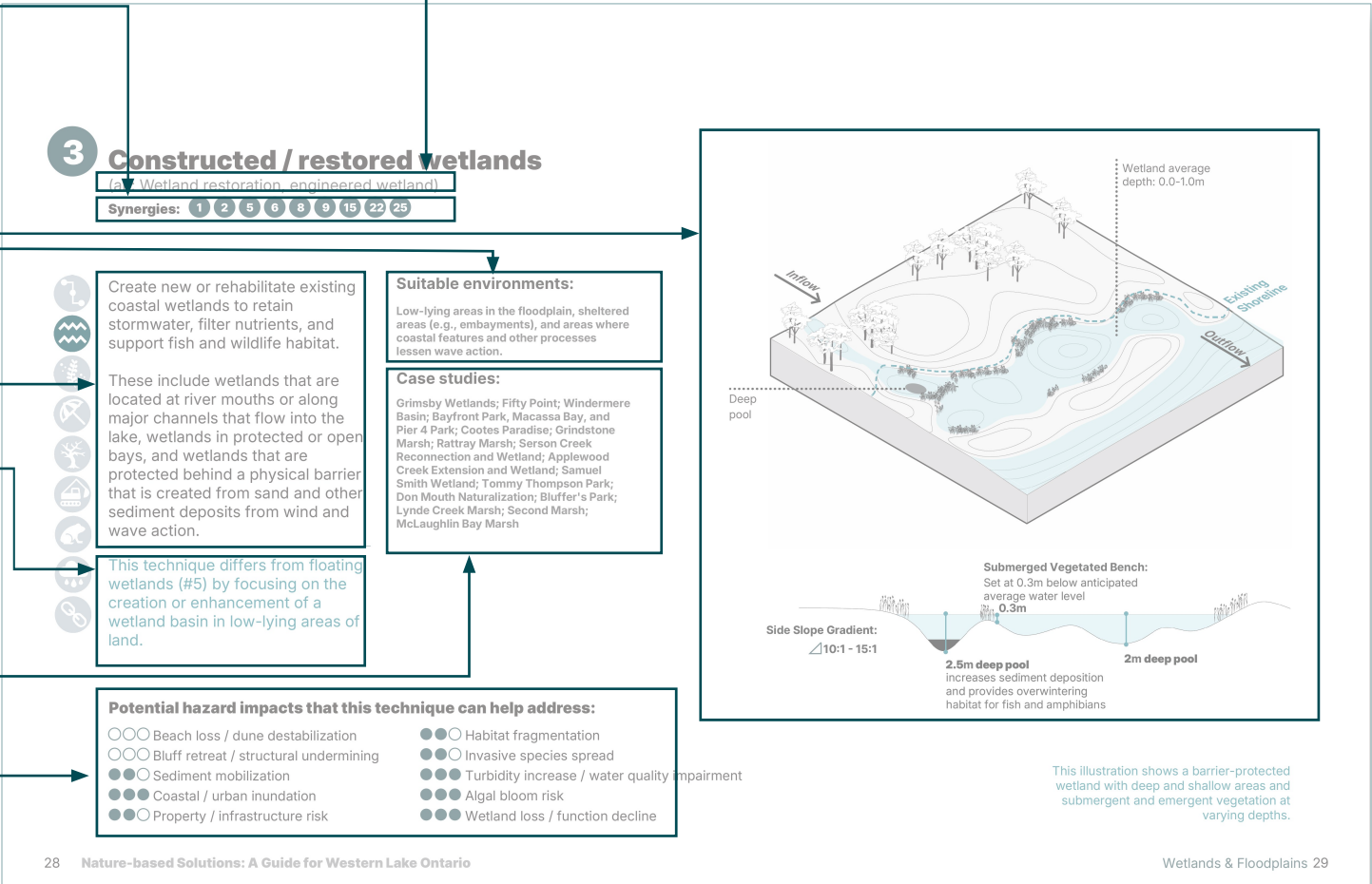
Suitable environments: Brief description of where the NbS or hybrid solution may be suitable.

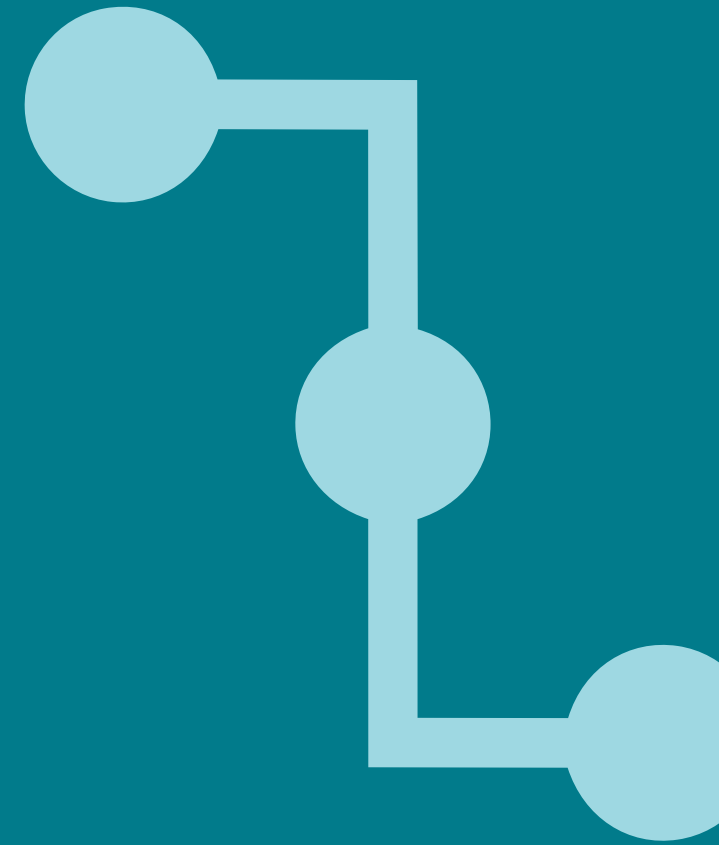
Description: Brief description of the NbS or hybrid solution.

Text in blue: How this technique differs from other conventional, nature-based, or hybrid techniques.

Case studies: Examples of existing NbS and hybrid solutions that have been used in Western Lake Ontario among our collection of 30 case studies.

Potential hazard impacts that this technique can help address: High-level linkages between the NbS or hybrid solution to different hazard impacts based on expert judgement. Ultimately, these linkages and the ability of NbS and hybrid solutions to reduce hazard impacts will vary by context and the design of the intervention.





Rivers & Connectivity

1 Reconnected rivers & streams

(alt: Barrier removal, fish passage restoration)

Synergies: 2 5 6 15 17



Remove or retrofit dams, weirs, and undersized or improperly designed culverts to restore the natural movement of water and sediment from tributaries to the lake, while considering the risk of aquatic invasive and non-native species spread.

Through integrated planning, barrier removal can help re-establish fish passage, improve channel function, and reconnect upstream habitats, while minimizing unintended consequences.

By targeting specific obstructions, this technique differs from channel naturalization projects (#2) that typically focus on reconfiguring entire reaches.

Potential hazard impacts that this technique can help address:

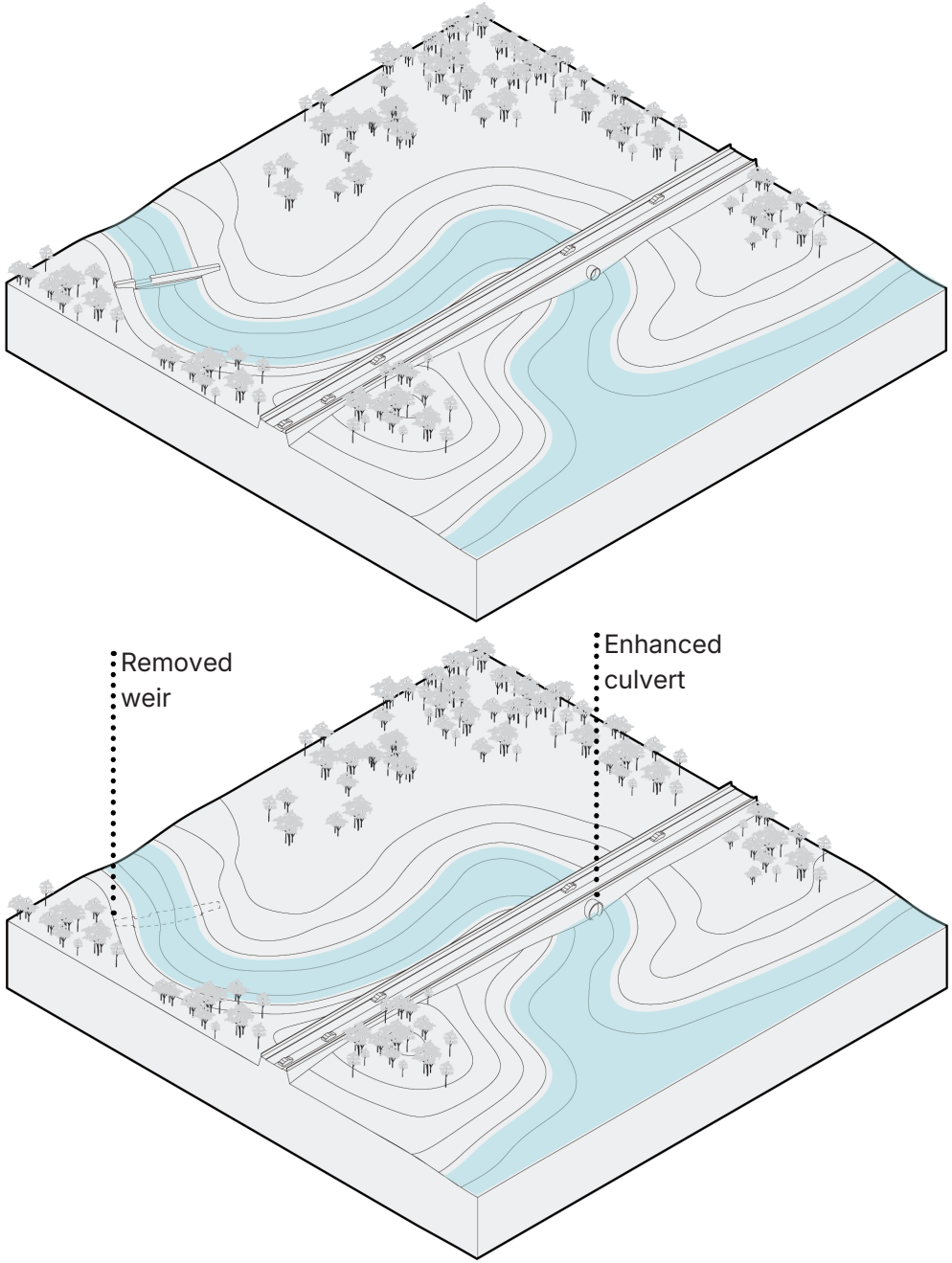
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|--|---|
| ○○○ Beach loss / dune destabilization | ●●● Habitat fragmentation |
| ○○○ Bluff retreat / structural undermining | ●●○ Invasive species spread |
| ●○○ Sediment mobilization | ●●○ Turbidity increase / water quality impairment |
| ●○○ Coastal / urban inundation | ●●○ Algal bloom risk |
| ●○○ Property / infrastructure risk | ●●○ Wetland loss / function decline |

Suitable environments:

Areas where a dam, weir, or culvert is failing, needs to be decommissioned, or is no longer needed.

Case studies:

Serson Creek Reconnection and Wetland; Wesleyville Marsh



This illustration shows the removal of a weir and replacement of an undersized culvert upstream from a river mouth.

2 Channel naturalization & realignment

(alt: Stream / river restoration, natural channel design)

Synergies: 1 5 6 8 11 13 17



Re-meander or reshape modified channels to restore more natural flow paths, habitat complexity, and floodplain interaction.



This may include uncovering (or daylighting) buried sections of rivers and streams or re-creating vegetated, low-energy outlets at lake interfaces.

This technique differs from reconnection projects (#1) by rebuilding channel form and function rather than simply removing barriers.

Suitable environments:

Areas where there is room for the river to re-meander or room to bring a buried waterway (often in a pipe or culvert) back to the surface.

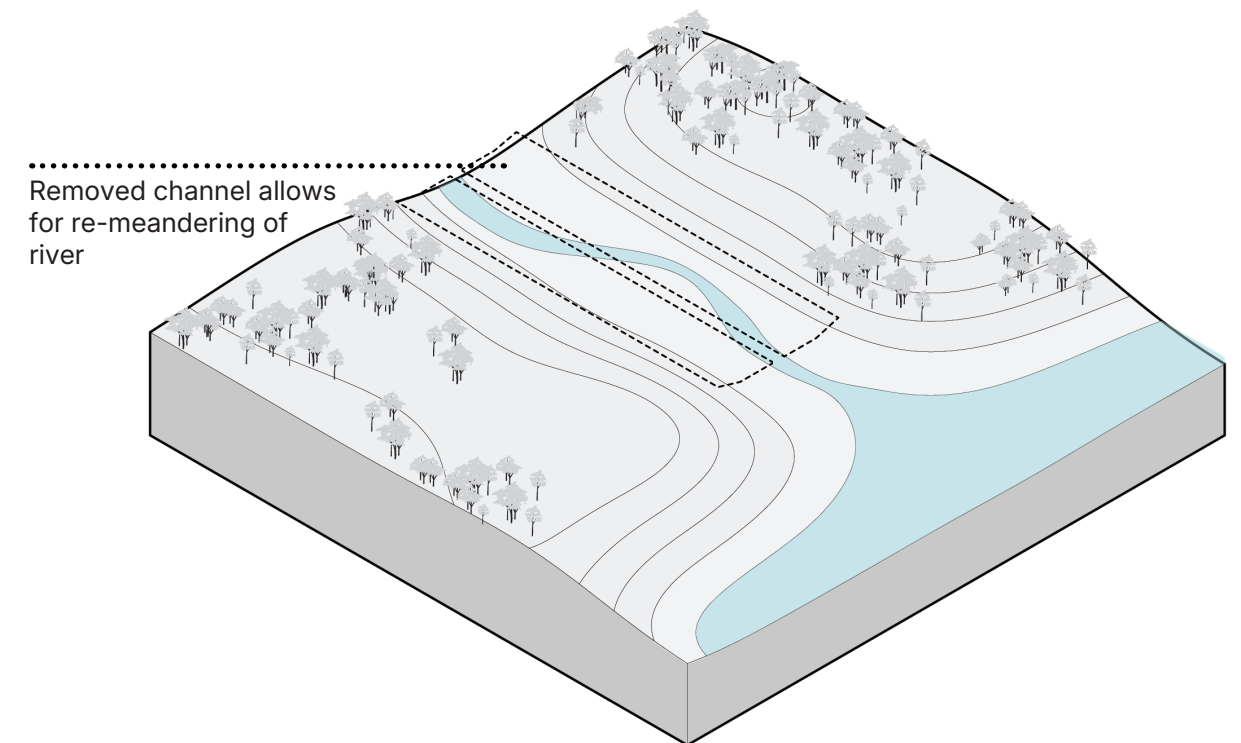
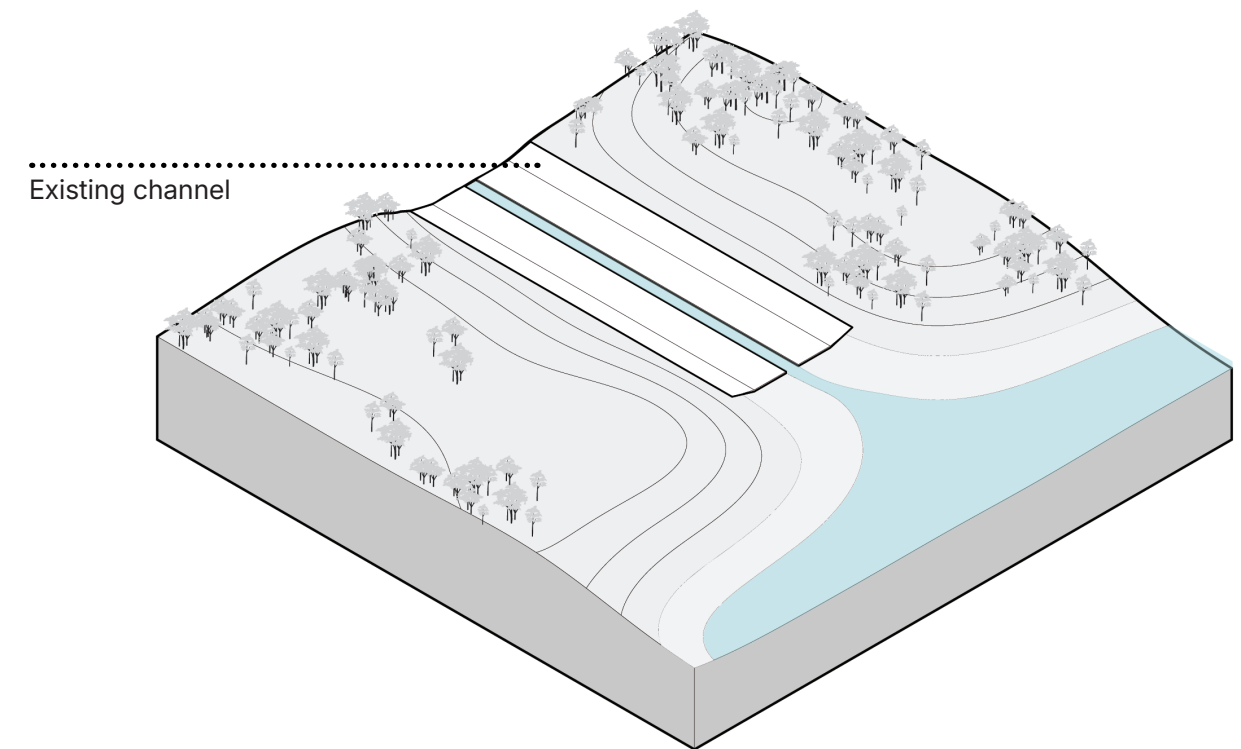
Case studies:

Fifty Point; Windermere Basin; Cootes Paradise; Grindstone Marsh; Coronation Park; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Don Mouth Naturalization; Bowmanville Westside Marshes

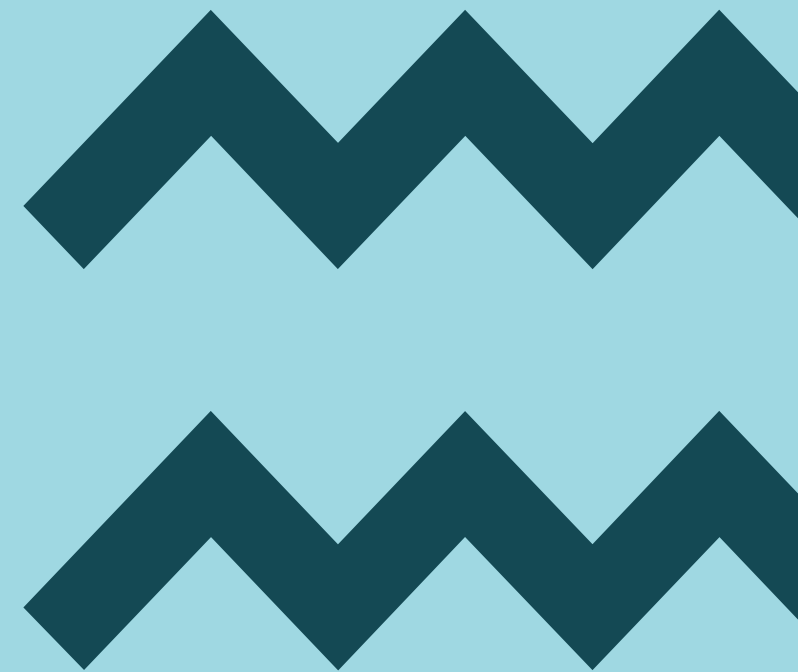
Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline



This illustration shows the removal of a straightened channel to allow the river to re-meander.



Wetlands & Floodplains

3 Constructed / restored wetlands

(alt: Wetland restoration, engineered wetland)

Synergies: 1 2 5 6 8 9 15 22 25



Create new or rehabilitate existing coastal wetlands to retain stormwater, filter nutrients, and support fish and wildlife habitat.



These include wetlands that are located at river mouths or along major channels that flow into the lake, wetlands in protected or open bays, and wetlands that are protected behind a physical barrier that is created from sand and other sediment deposits from wind and wave action.



This technique differs from floating wetlands (#5) by focusing on the creation or enhancement of a wetland basin in low-lying areas of land.

Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

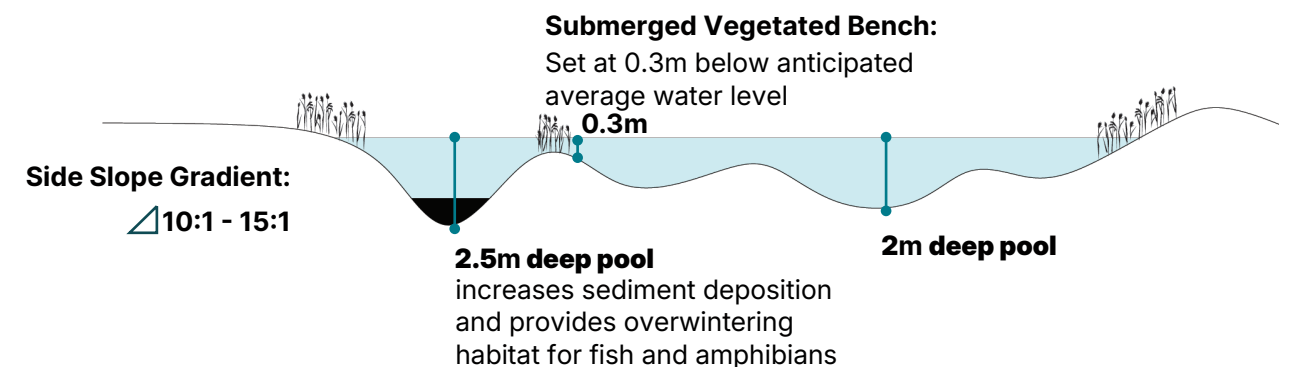
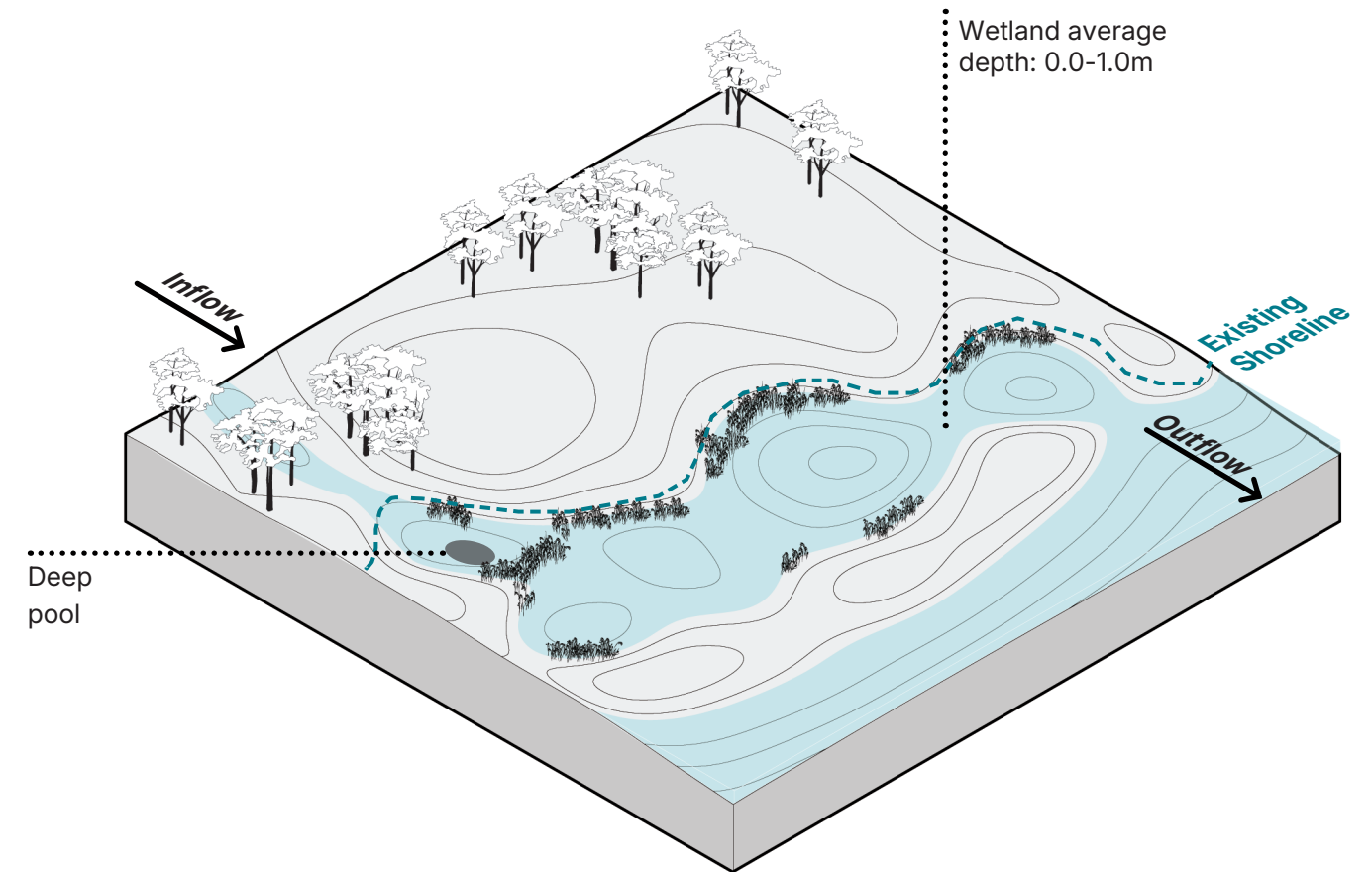
- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline

Suitable environments:

Low-lying areas in the floodplain, sheltered areas (e.g., embayments), and areas where coastal features and other processes lessen wave action.

Case studies:

Grimsby Wetlands; Fifty Point; Windermere Basin; Bayfront Park, Macassa Bay, and Pier 4 Park; Cootes Paradise; Grindstone Marsh; Rattray Marsh; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Samuel Smith Wetland; Tommy Thompson Park; Don Mouth Naturalization; Bluffer's Park; Lynde Creek Marsh; Second Marsh; McLaughlin Bay Marsh



This illustration shows a barrier-protected wetland with deep and shallow areas and submergent and emergent vegetation at varying depths.

4 Floating wetlands

(alt: Floating treatment wetlands, floating vegetation islands)

Synergies: 1 2 5 15 16

- Employ buoyant planting mats or modular rafts anchored in sheltered waters to provide water quality treatment and aquatic habitat and maintain regularly.
- The root zones of emergent vegetation absorb nutrients and trap fine sediments, while the floating structures offer refuge for fish and invertebrates.
- This technique differs from the creation or restoration of wetland basins (#3) that are found in transition zones between land and water. With a primary goal being water quality treatment, this technique also differs from habitat islands (#16) and artificial islands (#23).

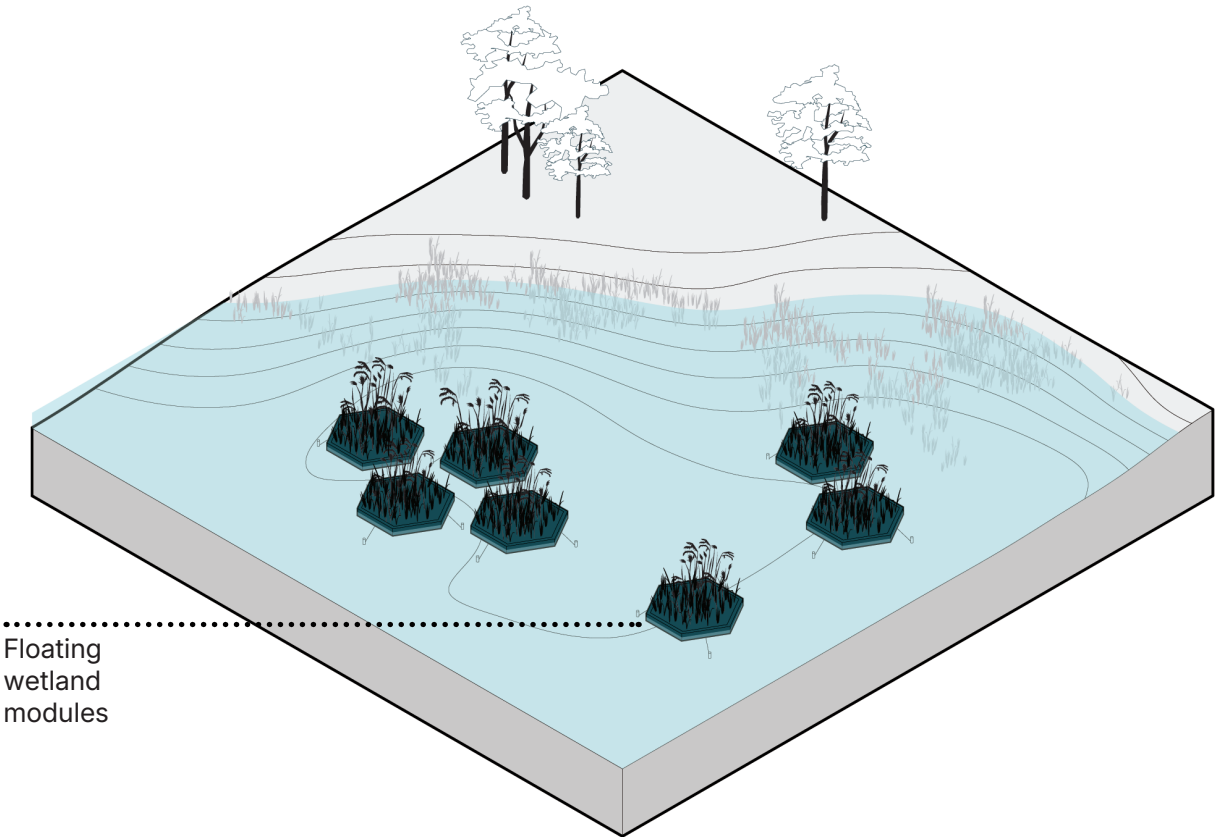
Suitable environments:
Areas with calm or slow-moving water.

Case studies:
Cootes Paradise

Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ○○○ Beach loss / dune destabilization | ●○○ Habitat fragmentation |
| ○○○ Bluff retreat / structural undermining | ○○○ Invasive species spread |
| ●○○ Sediment mobilization | ●●○ Turbidity increase / water quality impairment |
| ●○○ Coastal / urban inundation | ●●○ Algal bloom risk |
| ○○○ Property / infrastructure risk | ●●○ Wetland loss / function decline |

*Suitable plant species include native grasses, sedges, and rushes that thrive in wet conditions.



This illustration shows floating wetland modules with aquatic emergent plants growing in the water.

5 Floodplain reconnection

(alt: Levee removal / setback, floodplain restoration)

Synergies: 1 2 3 6 17 21



Remove or modify levees, dikes, embankments, or berms to allow rivers to access their natural floodplains, spreading floodwater and sediment across low-lying areas.

These interventions enhance flood storage capacity and ecological productivity.

This technique differs from channel naturalization (#2) by re-establishing natural inundation dynamics rather than channel form and function.

Potential hazard impacts that this technique can help address:

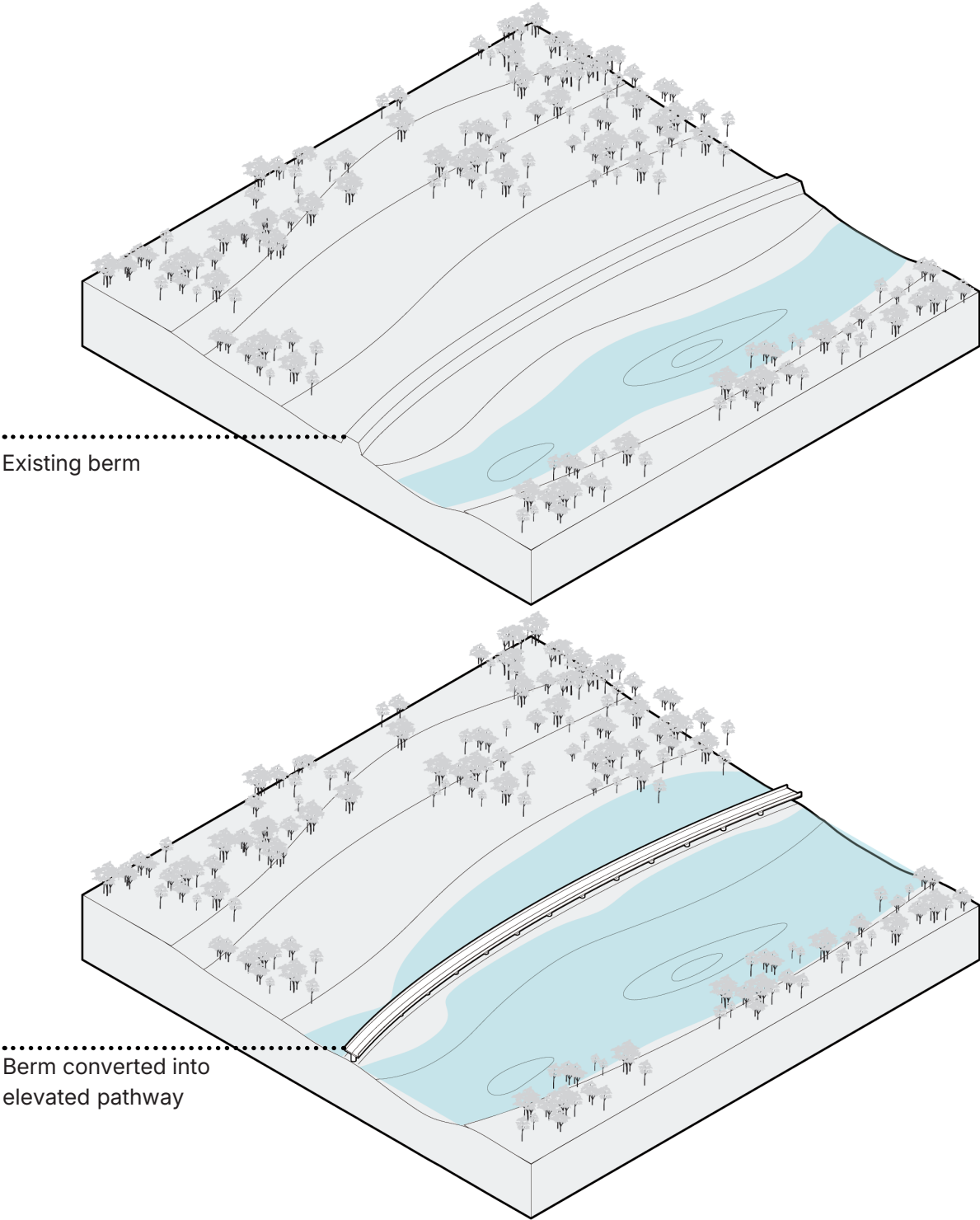
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| ○○○ Beach loss / dune destabilization | ●●● Habitat fragmentation |
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| ●●● Coastal / urban inundation | ●●● Algal bloom risk |
| ●●● Property / infrastructure risk | ●●● Wetland loss / function decline |

Suitable environments:

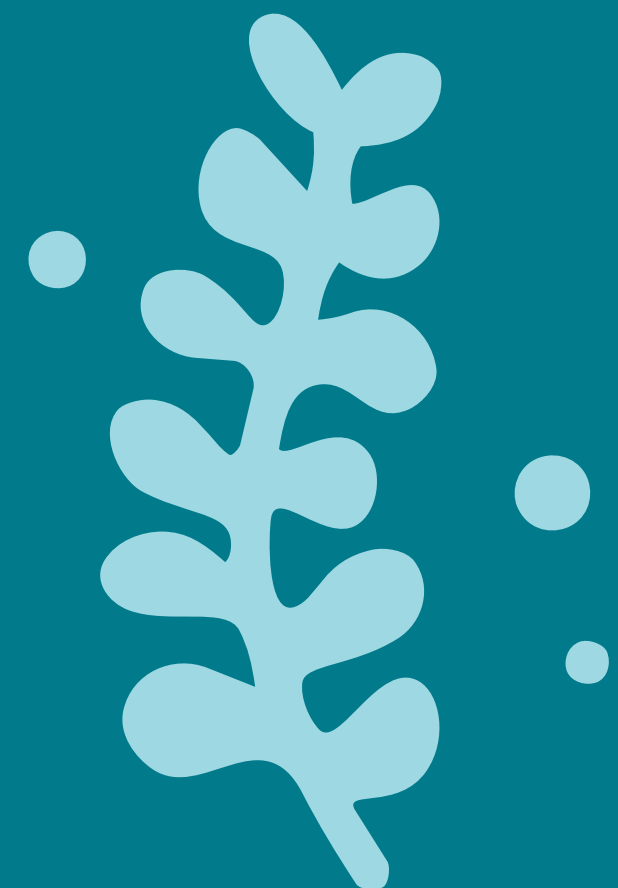
Areas where there is room to reconnect the river to its natural floodplain to increase flood storage.

Case studies:

Cootes Paradise; Rattray Marsh; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Don Mouth Naturalization; Bowmanville Westside Marshes



This illustration shows the conversion of a berm into an elevated pathway that allows the river to reconnect to its natural floodplain.



Aquatic & Riparian Vegetation

6

Riparian vegetation & buffers

(alt: Riparian habitat restoration, riparian corridor planting)

Synergies: 1 2 3 5 7 11 13 15 17 18 19



Plant appropriate native vegetation adjacent to the river or lake or further upland. This may include the establishment of continuous or heterogenous strips of native trees, shrubs, and herbaceous plants to filter runoff, stabilize banks, shade aquatic habitat, and adapt to changing water levels.



These buffers form vital transitions between human land uses and aquatic ecosystems, improving water quality, thermal regimes, and wildlife corridor connectivity.



This technique differs from general planting and revegetation projects by deliberately positioning them adjacent to a river or lake to filter pollutants, reduce erosion, stabilize banks, and provide wildlife habitat.

Potential hazard impacts that this technique can help address:

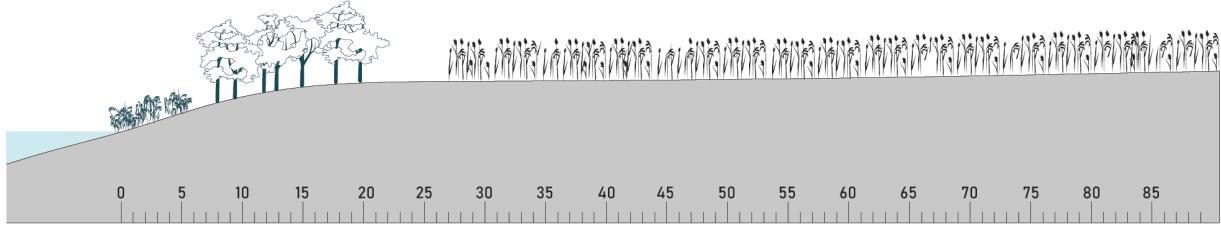
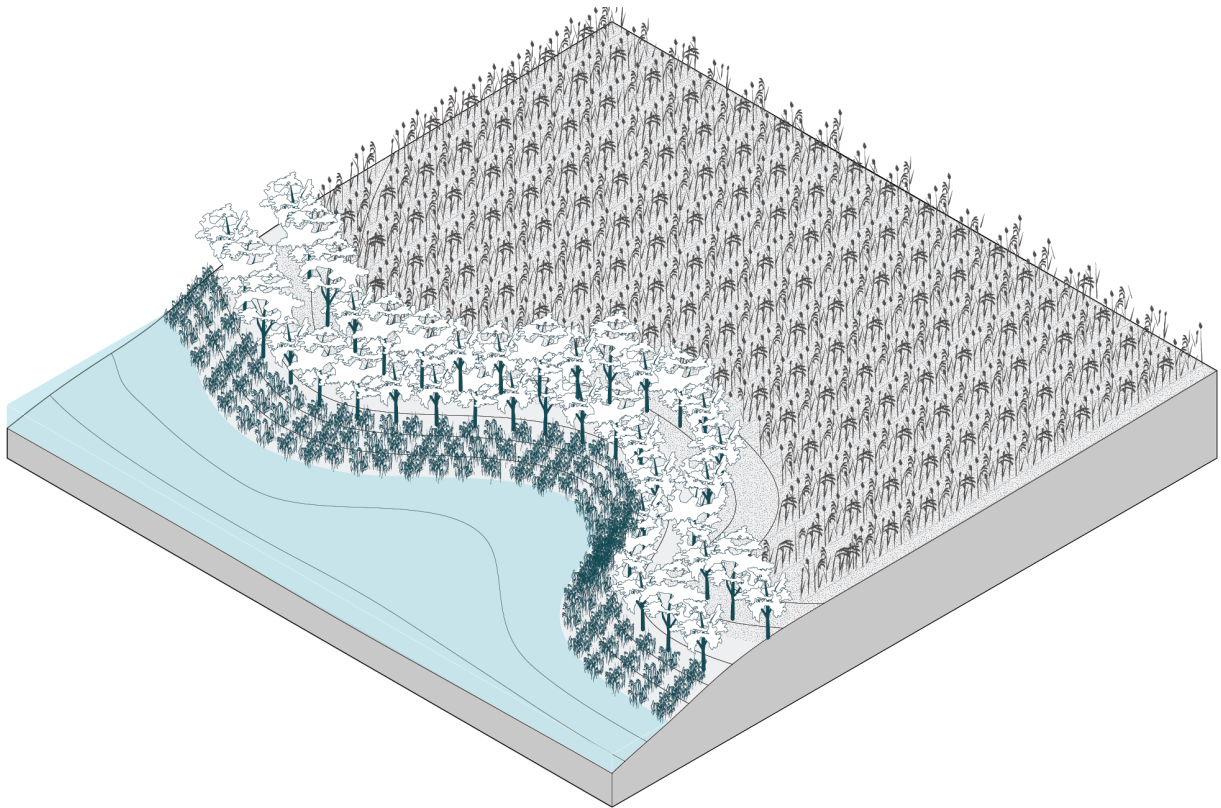
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| ○○○ Beach loss / dune destabilization | ●●● Habitat fragmentation |
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| ●●○ Coastal / urban inundation | ●●● Algal bloom risk |
| ●○○ Property / infrastructure risk | ●●○ Wetland loss / function decline |

Suitable environments:

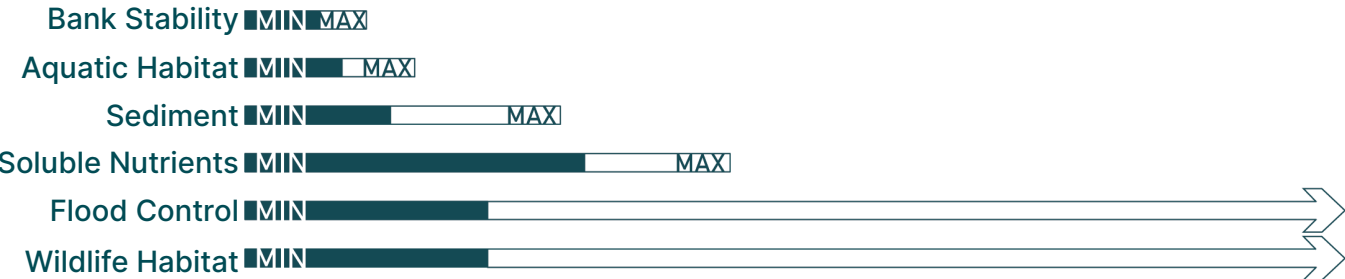
Areas where there is room to create or expand a vegetated buffer along a river or lake.

Case studies:

Grimsby Wetlands; Fifty Point; Windermere Basin; Bayfront Park, Macassa Bay, and Pier 4 Park; Cootes Paradise; LaSalle Park; Beachway Park; Burloak Waterfront Park; Coronation Park; Tannery Park and Waterworks Park; Rattray Marsh; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Samuel Smith Wetland; Gibraltar Point; Tommy Thompson Park; Don Mouth Naturalization; Bluffer's Park; Frenchman's Bay (South Shore); Lynde Creek Marsh; McLaughlin Bay Marsh; Bowmanville Westside Marshes; Wilmot Creek Marsh



Benefits in relation to buffer widths (m)



This illustration shows a vegetated strip along the shoreline with benefits increasing with buffer widths, including bank stability, water quality improvements, sediment and nutrient transport, flooding risk reduction, and wildlife habitat.

7 Coastal forests / windbreak planting

(alt: Coastal shelterbelt planting)

Synergies: 9 10 11 15 17 22



Plant native coastal trees and shrubs along the shoreline to buffer against wind and wave energy.

Vegetation in backdune areas or along the back of a beach can also help prevent erosion, support sediment buildup, and stabilize sandy or bluff-top soils. These plantings enhance microclimate, provide wildlife shelter, and protect built assets behind active dune or beach systems.

This technique differs from general planting and revegetation projects in upland areas, given its role and influence on coastal processes and exposure tolerance to wind and waves.

Potential hazard impacts that this technique can help address:

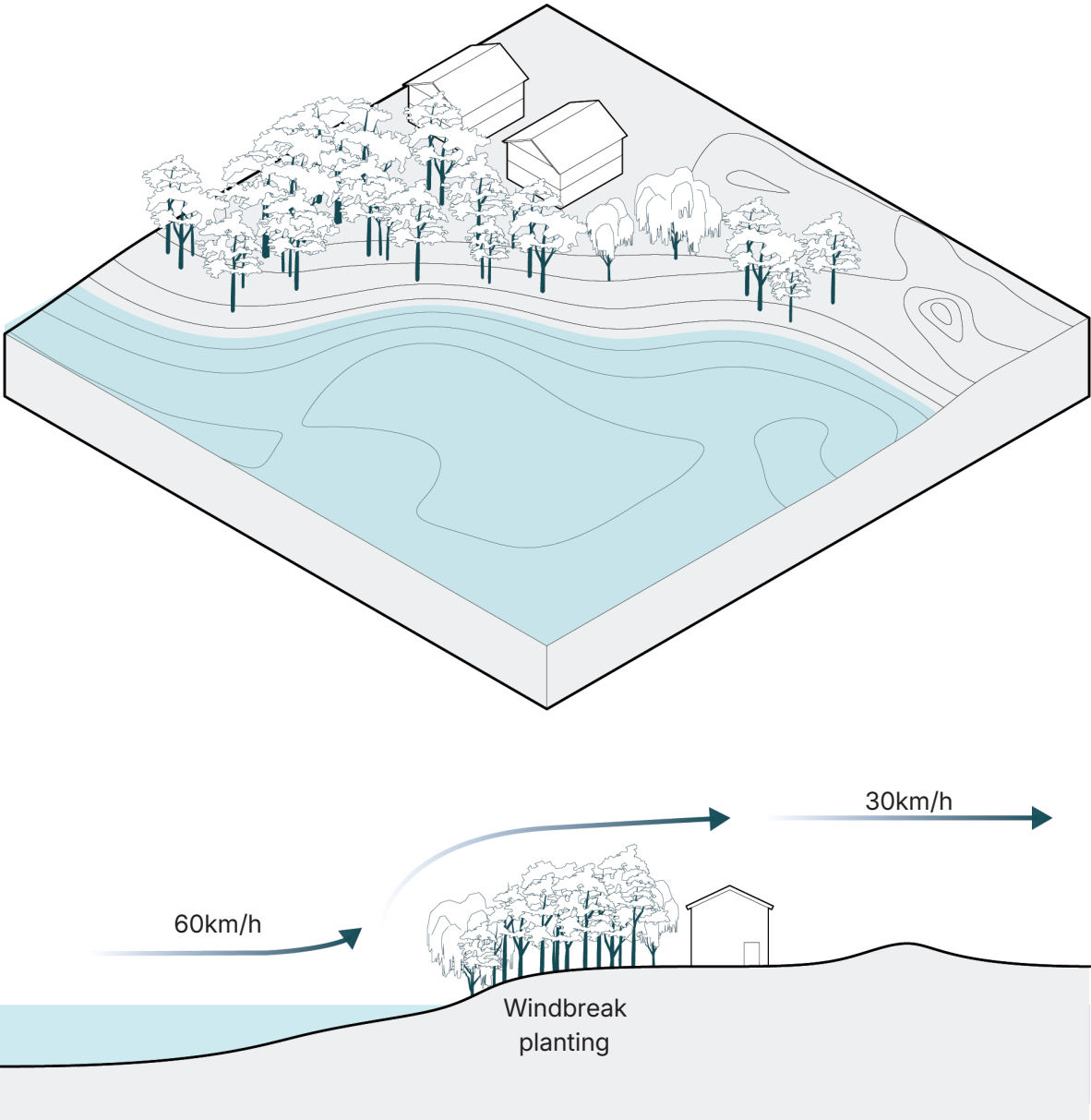
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| ●○○ Coastal / urban inundation | ●○○ Algal bloom risk |
| ●○○ Property / infrastructure risk | ●○○ Wetland loss / function decline |

Suitable environments:

Areas where there is room to plant trees and shrubs along the shoreline to buffer against wind and wave energy, including backdune areas or along the back of a beach.

Case studies:

Fifty Point; Bayfront Park, Macassa Bay, and Pier 4 Park; Beachway Park; Rattray Marsh; Gibraltar Point; Tommy Thompson Park; Don Mouth Naturalization; Woodbine Beach; Bluffer's Park



This illustration shows trees along the shoreline, helping to reduce wind speed.

8 Invasive species control & removal

(alt: Invasive species management, native species recovery)

Synergies: 2 3 5 6 7 9 10 11 13 18 19 22

Implement targeted removal, suppression, or containment of invasive species such as *Phragmites australis* or *Typha x glauca* to enable native vegetation recovery and improved ecosystem function in high-value ecological areas.

These actions are also a prerequisite for many wetland, dune, and shoreline projects across Western Lake Ontario.

This technique differs from general vegetation management by focusing on the threat of invasive plant species, which may impede the protection and restoration of important ecological areas.

Suitable environments:

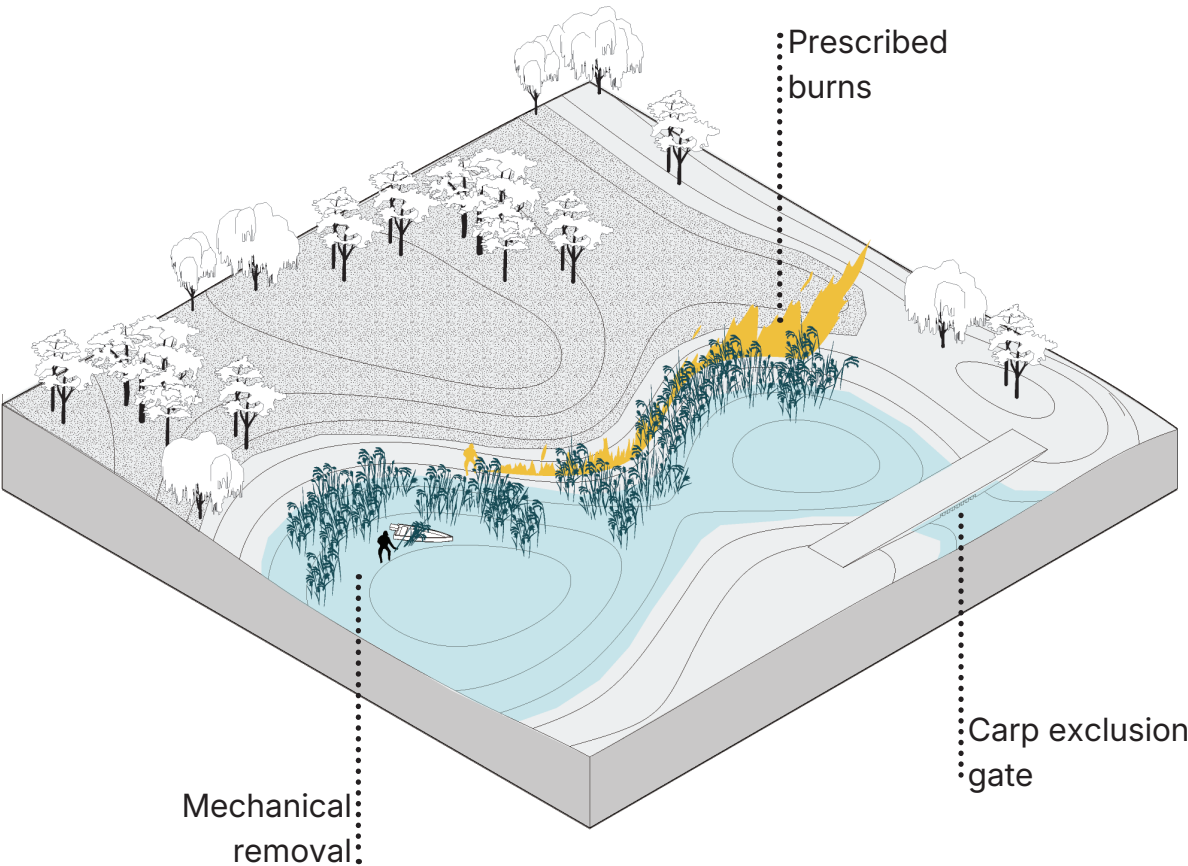
As part of a restoration project (e.g., site preparation, carp exclusion barriers) or as part of ongoing management to protect ecologically important or sensitive areas.

Case studies:

Grimsby Wetlands; Windermere Basin; Cootes Paradise; Grindstone Marsh; Beachway Park; Burloak Waterfront Park; Rattray Marsh; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Samuel Smith Wetland; Tommy Thompson Park; Don Mouth Naturalization; Woodbine Beach; Frenchman's Bay (South Shore); Lynde Creek Marsh; Second Marsh; McLaughlin Bay Marsh; Bowmanville Westside Marshes; Wilmot Creek Marsh; Wesleyville Marsh

Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk
- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline



This illustration shows different invasive species management techniques, including mechanical removal, prescribed burns, and carp exclusion gate.



Beaches, Dunes & Bluffs

9 Beach & dune restoration

(alt: Dune regeneration)

Synergies: 7 8 10 15 21 22 24 25



Restore natural beach and dune systems to buffer waves, reduce erosion, and provide habitat for coastal plants and wildlife. This may involve re-grading, planting native dune grasses (e.g., Marram grass), and managing sediment supply through natural geomorphic processes (e.g., source-to-sink or littoral cell management).



In some cases, sediment may need to be replenished through beach nourishment (#21).



This technique differs from hybrid dunes (#22), which combine sandy dunes with artificial cores or hard structures.



Potential hazard impacts that this technique can help address:

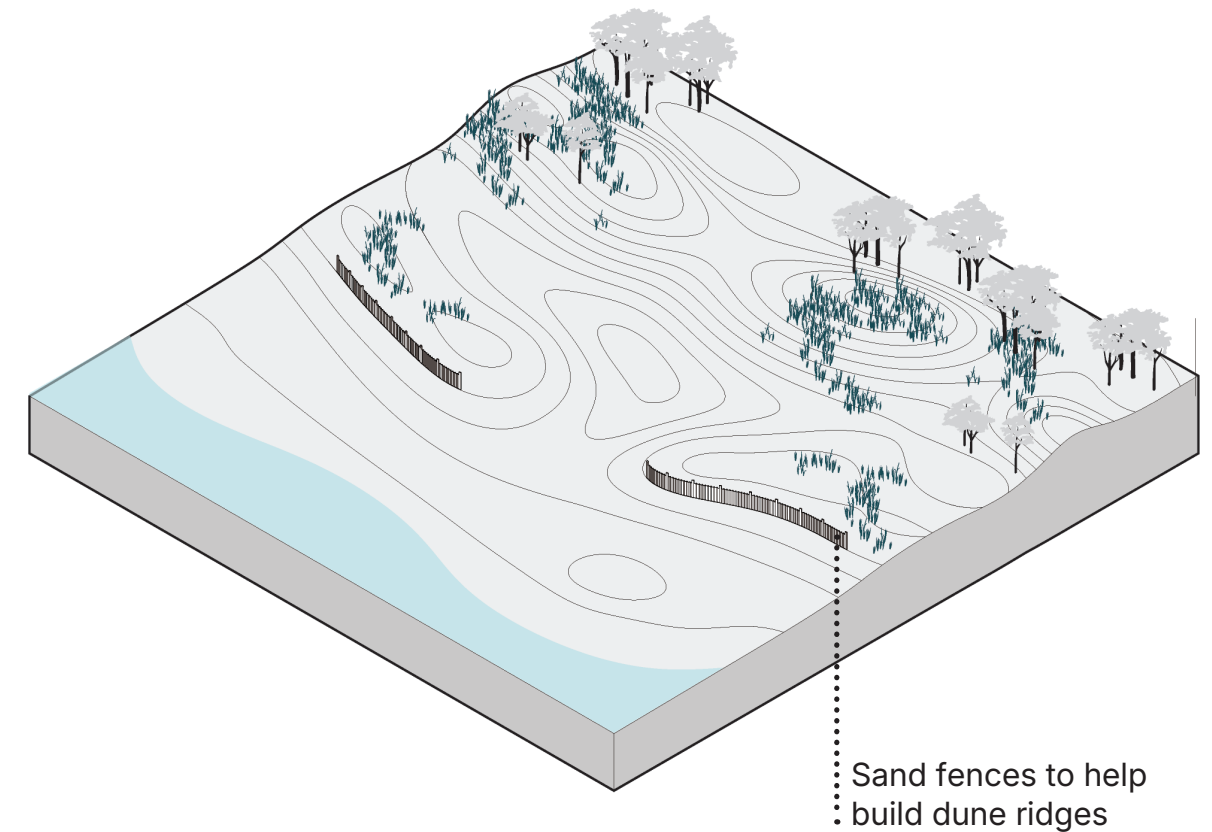
- | | |
|--|---|
| ●●● Beach loss / dune destabilization | ●●○ Habitat fragmentation |
| ●●○ Bluff retreat / structural undermining | ●○○ Invasive species spread |
| ●●○ Sediment mobilization | ●○○ Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ○○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●○○ Wetland loss / function decline |

Suitable environments:

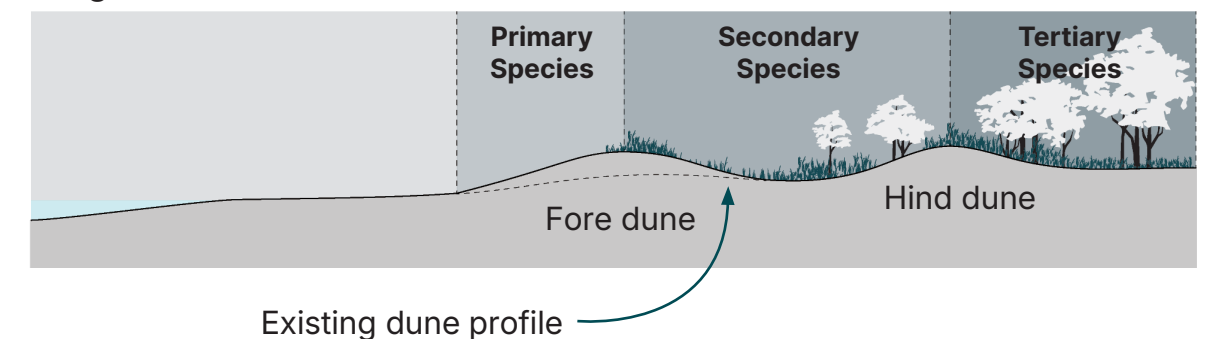
Areas where there is a sufficient supply of sand or sediment along the shoreline.

Case studies:

Bayfront Park, Macassa Bay, and Pier 4 Park; LaSalle Park; Beachway Park; Tannery Park and Waterworks Park; Gibraltar Point; Tommy Thompson Park; Don Mouth Naturalization; Woodbine Beach; Bluffer's Park; Frenchman's Bay (South Shore); Lynde Creek Marsh; McLaughlin Bay Marsh; Victoria Beach



Target Dune Profile



The illustration shows the placement of sand fences to support the building of a new fore dune and support the establishment of dune grasses.

10 Bluff stabilization

(alt: Slope stabilization)

Synergies: 7 9 13 17 22 24 25

- Maintain existing vegetation and/or use native grasses, shrubs, and deep-rooted prairie plants to stabilize bluffs.
- Where engineering approaches are needed to stabilize eroding bluffs and steep slopes, integrate habitat and natural elements, where possible.
- This approach blends erosion control with biodiversity enhancement, creating dry, open habitats characteristic of Great Lakes bluffs.
- This technique differs from engineered bluff stabilization by using vegetation structure and soil management instead of drainage or toe protection systems.

Potential hazard impacts that this technique can help address:

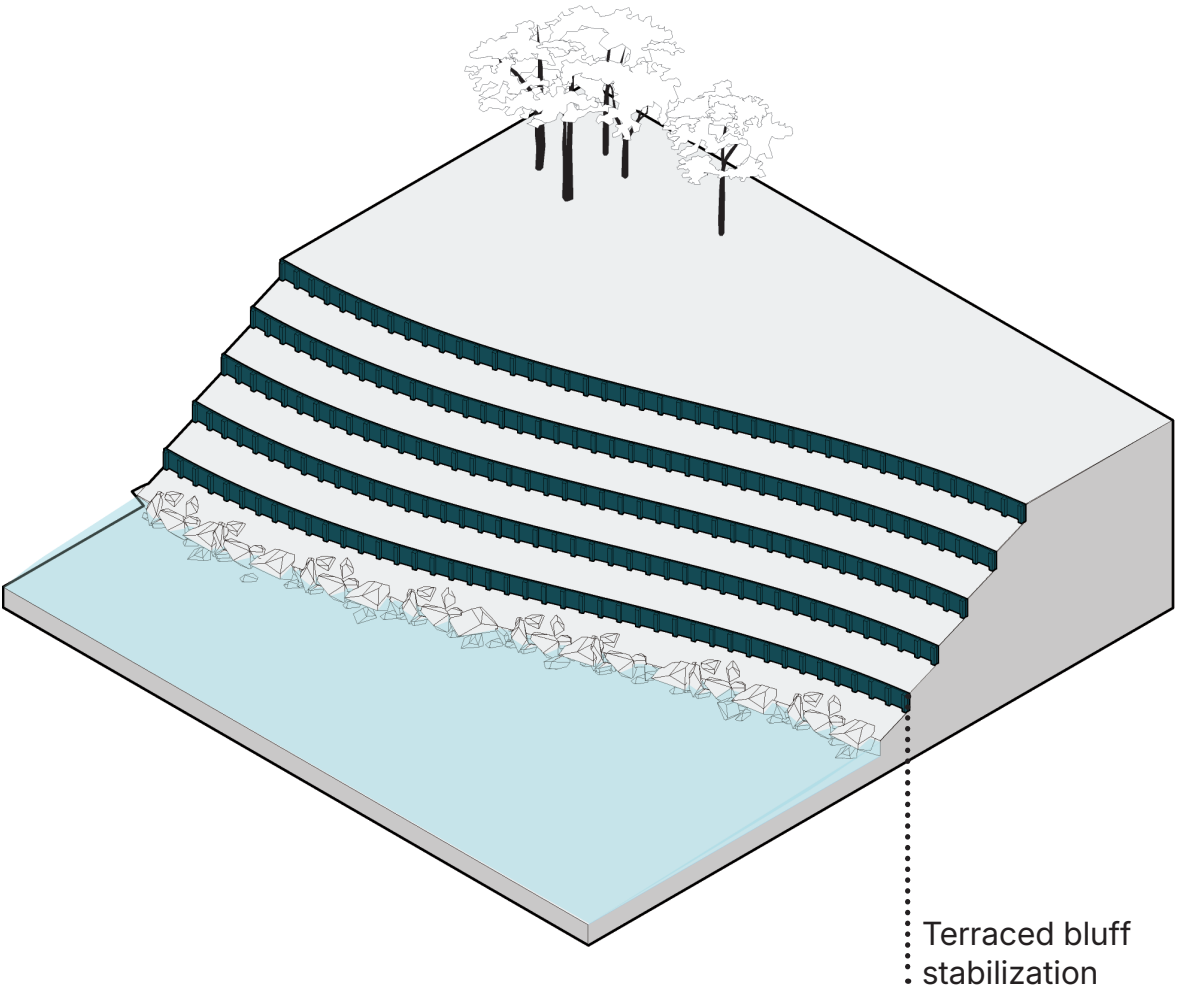
- | | |
|--|---|
| Beach loss / dune destabilization | Habitat fragmentation |
| Bluff retreat / structural undermining | Invasive species spread |
| Sediment mobilization | Turbidity increase / water quality impairment |
| Coastal / urban inundation | Algal bloom risk |
| Property / infrastructure risk | Wetland loss / function decline |

Suitable environments:

Areas where the slope is not too steep and can support vegetation establishment.

Case studies:

South Shell Park Nesting Wall; Bluffer's Park



This illustration shows vegetated terraces on the face of the bluff to reduce erosion.



Shoreline Softening & Bioengineering

11 Bioengineering & live staking

(alt: Soil bioengineering, vegetative bank stabilization)

Synergies: 2 5 6 13 15 17



Employ biodegradable materials and live woody stems or branches to stabilize banks, enhance infiltration, and encourage natural revegetation.



Used mainly along river mouths and sheltered lake edges, this method provides immediate soil retention that transitions to vegetative stability.



This technique differs from riparian vegetation and buffers (#6) by using live woody cuttings.



Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

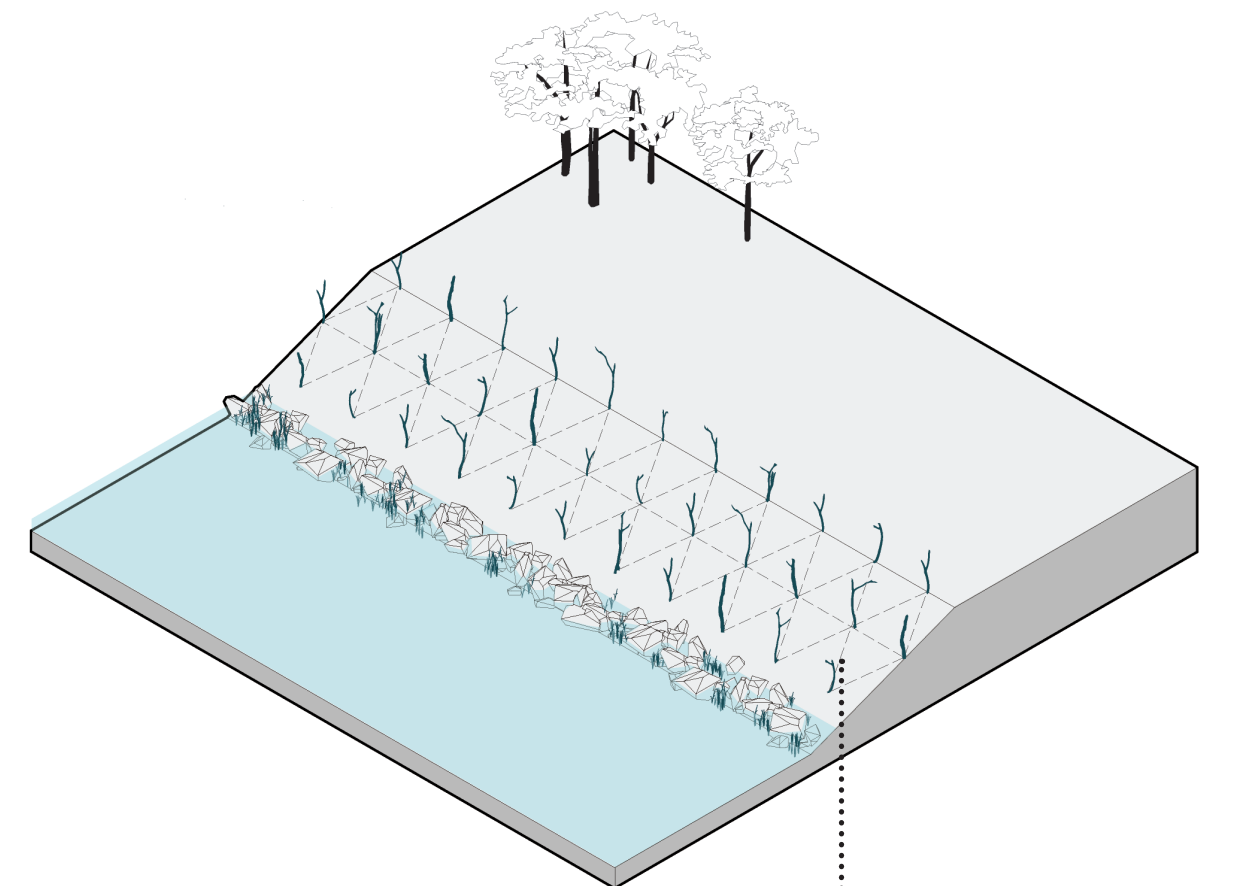
- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline

Suitable environments:

Along rivers, streams, and sheltered bays.

Case studies:

Grindstone Marsh; LaSalle Park; Burloak Waterfront Park; Tommy Thompson Park; Don Mouth Naturalization



Live woody stakes from native trees and shrubs

This illustration shows woody stems or branches planted along the water to stabilize the bank and encourage natural revegetation.

12 Shoreline regrading

(alt: Bank regrading)

Synergies: 3 6 11 19 21



Convert hardened or steep, eroding shorelines into gentle, vegetated slopes that restore natural processes and access.



This method often reuses on-site fill or rubble to create stable planting benches and transition zones.



This technique differs from floodable parks (#19) by focusing on creating a gentler shoreline gradient rather than multifunctional green spaces.



Potential hazard impacts that this technique can help address:

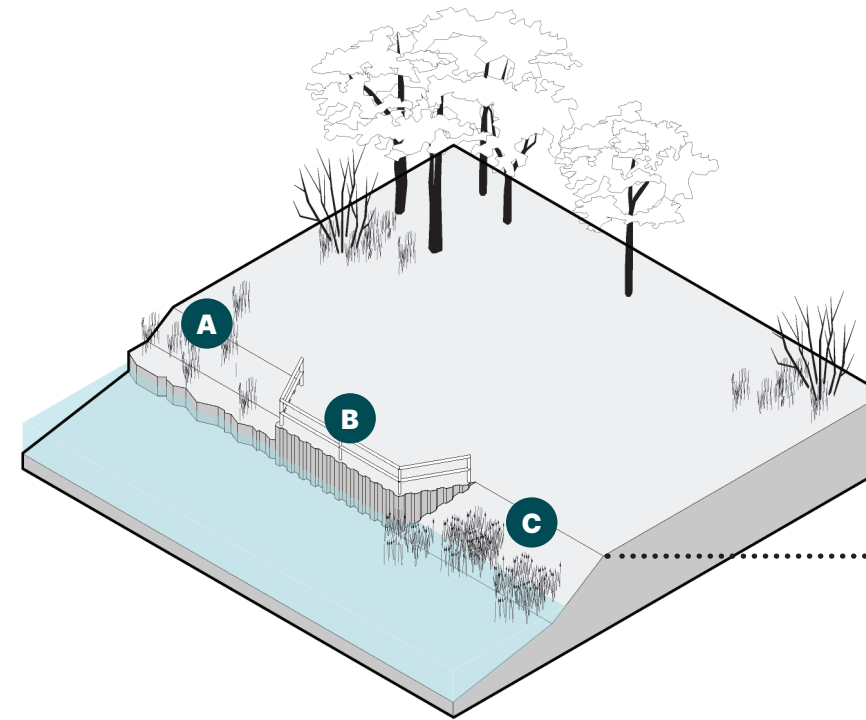
- | | |
|--|---|
| ●●○ Beach loss / dune destabilization | ●●○ Habitat fragmentation |
| ●●○ Bluff retreat / structural undermining | ●○○ Invasive species spread |
| ●●○ Sediment mobilization | ●●○ Turbidity increase / water quality impairment |
| ●○○ Coastal / urban inundation | ○○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●●○ Wetland loss / function decline |

Suitable environments:

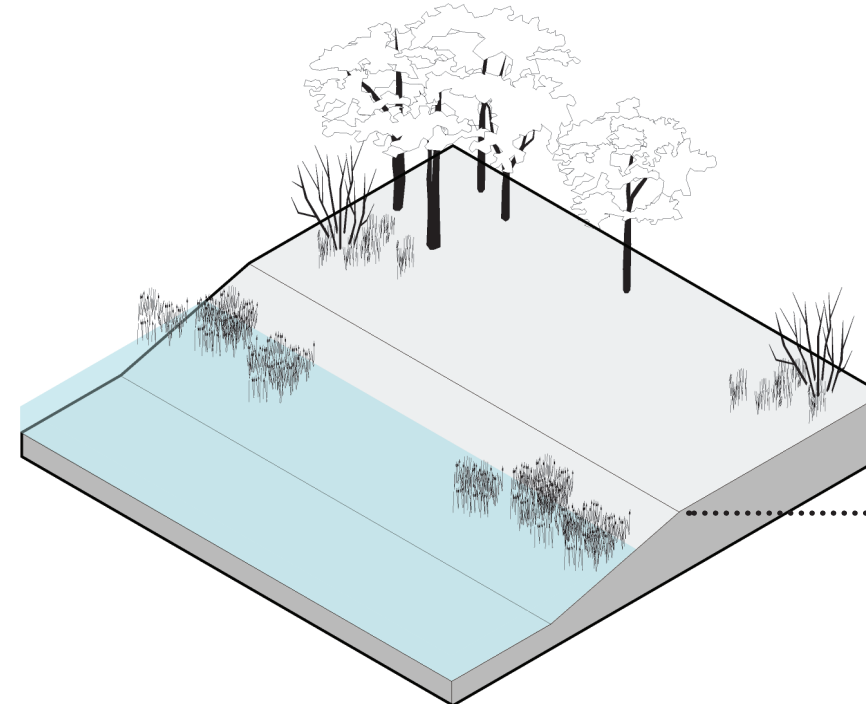
Areas where there is room to achieve gradual, gentle slopes to stabilize the bank and reduce erosion.

Case studies:

Bayfront Park, Macassa Bay, and Pier 4 Park; LaSalle Park; South Shell Park Nesting Wall; Tannery Park and Waterworks Park; Serson Creek Reconnection and Wetland; Tommy Thompson Park; Don Mouth Naturalization; Bluffer's Park; Victoria Beach



Hardened shoreline due to:
A. Erosion
B. Human structures
C. Steep slopes



Softened shoreline:
Preferred slope of 4:1 for stability and to support plant growth

This illustration shows the conversion of a hardened shoreline into a vegetated shoreline with a gentle slope.

13

Sills

(alt: Marsh sills, living shoreline sills)

Synergies: 3 6 15 24



Install low, nature-friendly edge structures off the shoreline of a marsh to reduce wave energy, promote sediment deposition, and support plant establishment.



Typically composed of rock, woody debris, or biodegradable materials and backfilled with sand, these features stabilize eroding marsh edges while maintaining ecological connectivity, especially when they are designed with gaps or allowed to overtop.

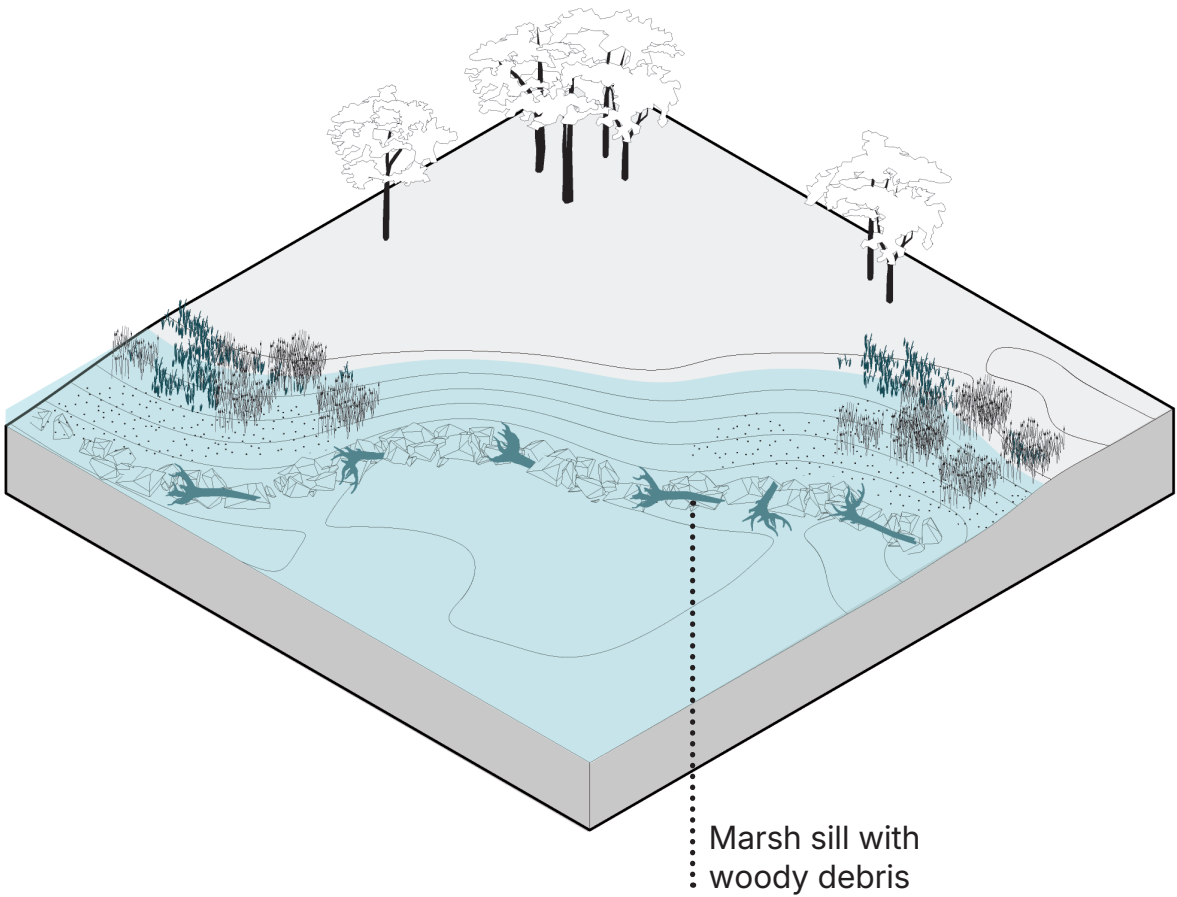
This technique differs from vegetated armour and revetments (#26) by creating a protected marsh area.

Suitable environments:

Newly planted marsh or marsh with eroding edges found along low to moderate energy shorelines.

Case studies:

Tommy Thompson Park; Don Mouth Naturalization



Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk
- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline

This graphic shows a sill comprised of woody debris off the shoreline of a marsh.



Sediment Management

14 Sediment re-use

(alt: Beneficial use of dredged material, material reallocation)

Synergies: 2 3 9 12 21 22



Clean sediment from dredging or excavation can be used to build wetland berms or renourish beaches, supporting both habitat creation and erosion control.

Thin-layer placement may be applied where subtle elevation gain is required for marsh establishment.

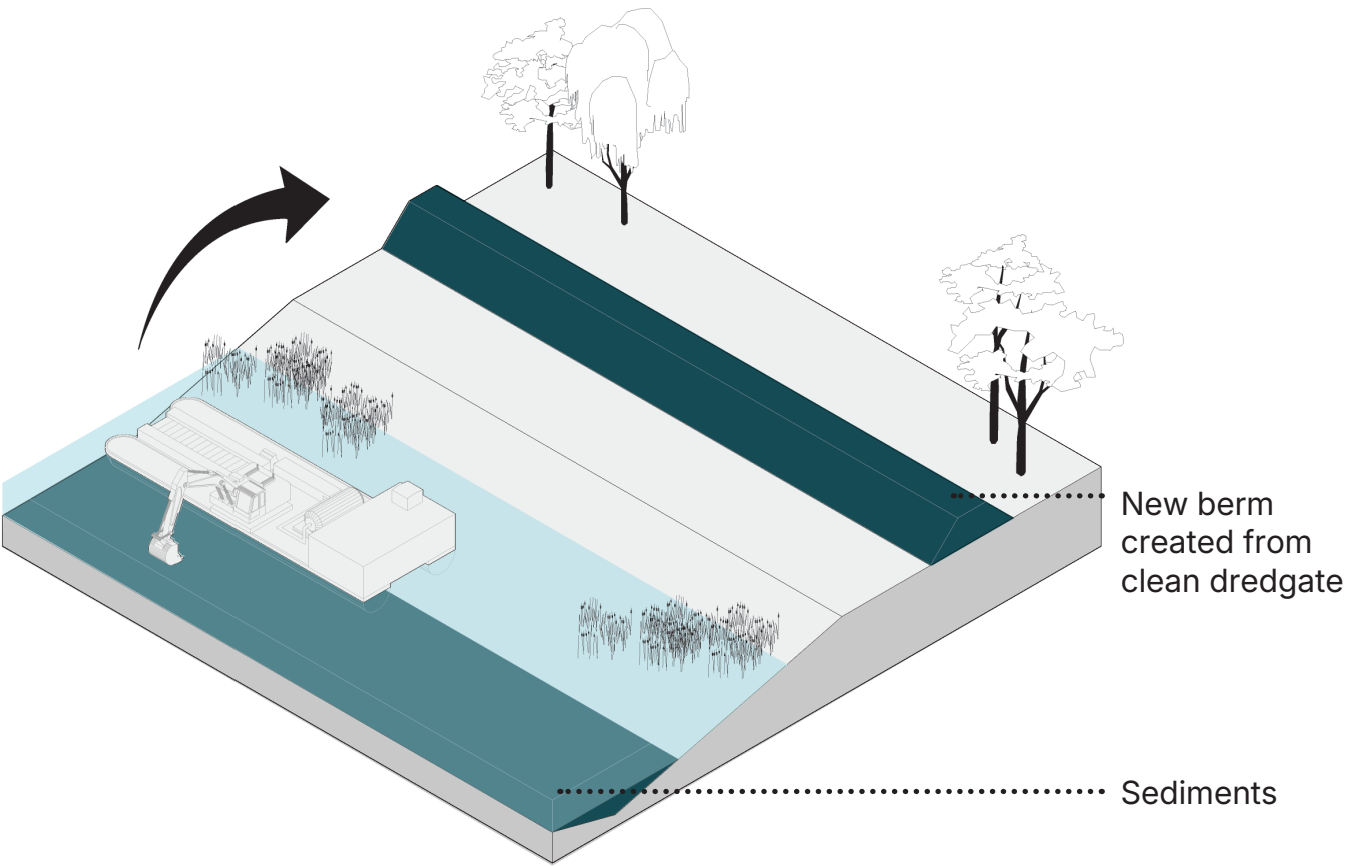
This technique differs from traditional disposal by viewing dredgate as a restoration resource rather than waste.

Suitable environments:

Areas that need to be dredged (e.g., for navigation) where clean sediment is found, as determined by the approved sediment testing protocols from applicable provincial and/or federal legislation.

Case studies:

Windermere Basin; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Don Mouth Naturalization; Bluffer's Park; Frenchman's Bay (South Shore); Victoria Beach



Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ●●● Beach loss / dune destabilization | ●○○ Habitat fragmentation |
| ●●○ Bluff retreat / structural undermining | ●○○ Invasive species spread |
| ●●○ Sediment mobilization | ●○○ Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ●○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●●● Wetland loss / function decline |

This illustration shows a berm created from sediment dredged on-site.

15

Sediment capture & accretion

(alt: Sediment trapping, accretion-based shoreline restoration)

Synergies: 2 3 5 6 9 12 13 16 21 22 23 24 26



Design vegetated foreshores or marsh edges that slow water velocity, trap fine sediment, and build natural elevation over time.

In Western Lake Ontario, this process is integral to living shorelines and wetland projects, aiding resilience under fluctuating lake levels.

This technique differs from engineered trapping structures by relying on biological roughness and self-maintaining vegetation. It also differs from beach nourishment (#21) by relying on natural sediment deposition.

Suitable environments:

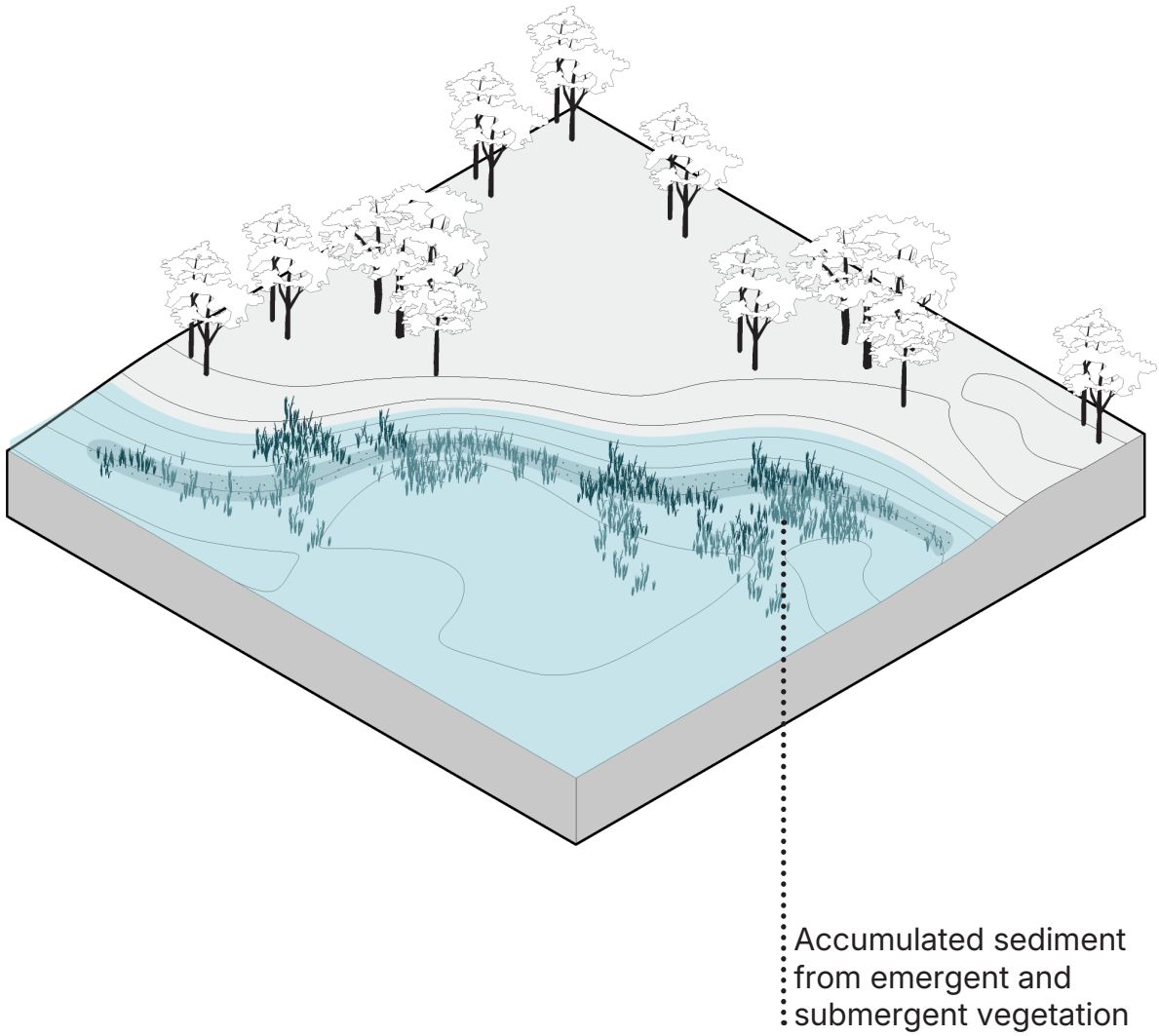
Low-energy shorelines where sediment is deposited.

Case studies:

Windermere Basin; Cootes Paradise; LaSalle Park; Beachway Park; Coronation Park; Tannery Park and Waterworks Park; Rattray Marsh; Applewood Creek Extension and Wetland; Tommy Thompson Park; Don Mouth Naturalization; Woodbine Beach; Bluffer's Park; McLaughlin Bay Marsh

Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ●●● Beach loss / dune destabilization | ●○○ Habitat fragmentation |
| ●●○ Bluff retreat / structural undermining | ●○○ Invasive species spread |
| ●●● Sediment mobilization | ●●● Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ●●○ Algal bloom risk |
| ●○○ Property / infrastructure risk | ●●● Wetland loss / function decline |



This illustration shows submerged and emergent vegetation at the edge of a shoreline helping to accumulate sediment in a sheltered bay.



Habitat Creation & Structural Complexity

16 Habitat islands / mounds

(alt: Stepping-stone islands)

Synergies: 3 4 15 17 20 23 24



Create small, elevated features in open-water or wetland settings to provide nesting, refuge, and feeding areas for birds, amphibians, and reptiles.



These are commonly constructed from dredged material or clean fill and may include various habitat features such as shrub clumps, rocky mounds, or woody debris piles to aid the dispersal of coastal species, reduce predation risk, and expand available habitat.



This technique differs from artificial islands (#23) by being smaller, purpose-built habitat patches rather than wave attenuating landforms. With a modular and distributed configuration, this technique can be used where continuous corridors (#17) are impractical (e.g., along fragmented parklands or hardened shorelines).



Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

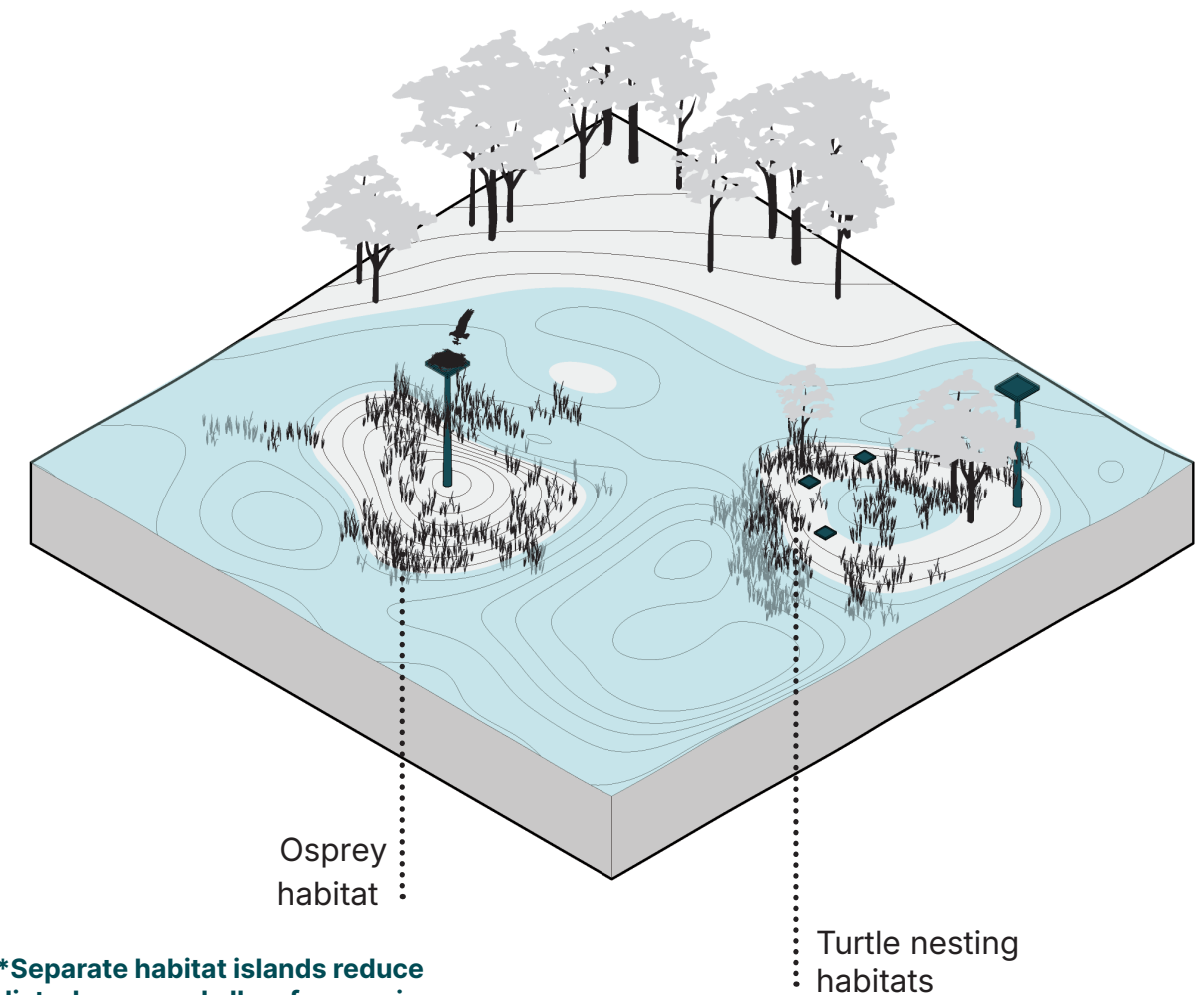
- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline

Suitable environments:

Low to moderate energy shorelines.

Case studies:

Windermere Basin; LaSalle Park; Northeastern Bird Islands; Samuel Smith Wetland; Tommy Thompson Park; Don Mouth Naturalization; Woodbine Beach; Frenchman's Bay (South Shore)



***Separate habitat islands reduce disturbance and allow for species-specific design conditions.** This enables tailored nesting, breeding, and refuge environments, improving overall ecological performance.

This illustration shows two vegetated habitat islands off the shore, equipped with habitat structures for Ospreys and turtle nesting.

17 Habitat connectivity corridors

(alt: Wildlife / ecological corridors)

Synergies: 2 3 4 5 6 7 9 11 17 19 20 22



Maintain or establish continuous or stepping-stone habitat linkages along the coastal zone to allow for species movement and migration.



In Western Lake Ontario, these corridors connect fragmented wetlands, beaches, and riparian areas, improving biodiversity resilience across urbanized shorelines.



This technique differs from individual restoration sites by emphasizing network design and landscape continuity. While similar to coastal parks and greenways (#18), these corridors may extend beyond individual parkland.



Suitable environments:

Areas where increased habitat connectivity is needed, enabling wildlife species to move safely between habitats.

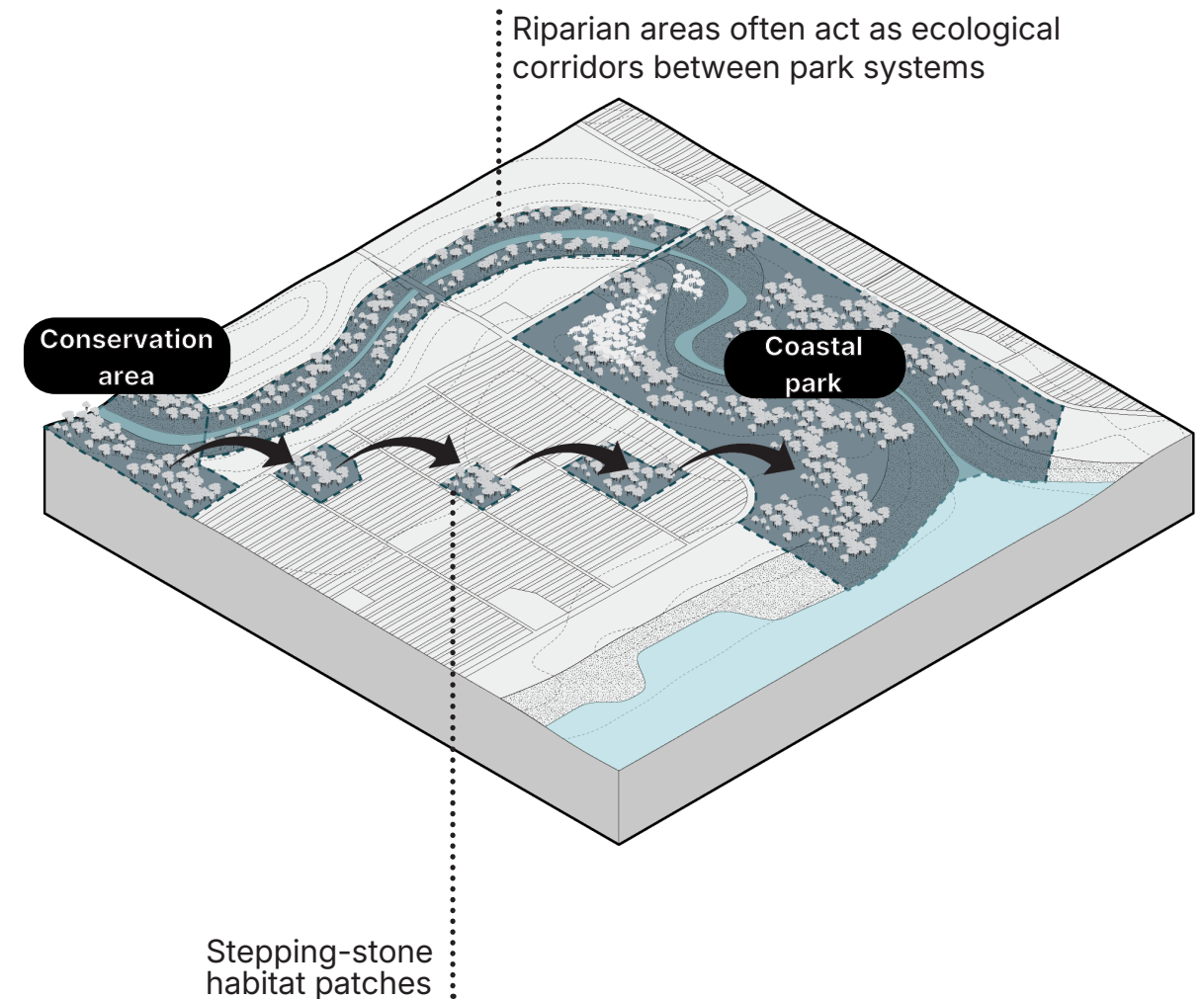
Case studies:

Grimsby Wetlands; Cootes Paradise; Grindstone Marsh; Tannery Park and Waterworks Park; Rattray Marsh; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Tommy Thompson Park; Don Mouth Naturalization; Lynde Creek Marsh; Second Marsh; Wilmot Creek Marsh; Wesleyville Marsh

Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline



This illustration shows a wildlife corridor along a watercourse, connecting a conservation area with a coastal park and stepping-stone habitat patches.



Urban Green Infrastructure

18 Coastal parks & greenways

(alt: Waterfront parks / greenways)

Synergies: 2 6 9 17 19 26



Design and maintain parks and green spaces along the shoreline to provide habitat and recreational opportunities.



Along Western Lake Ontario, these often serve as regional attractions, linking tributaries, wetlands, and shoreline habitats to create continuous ecological and recreational corridors (e.g., Waterfront Trail and Tommy Thompson Park). They also provide stormwater storage and cooling benefits.



This technique differs from habitat corridors (#17) by incorporating human access and landscape connectivity in urban settings.

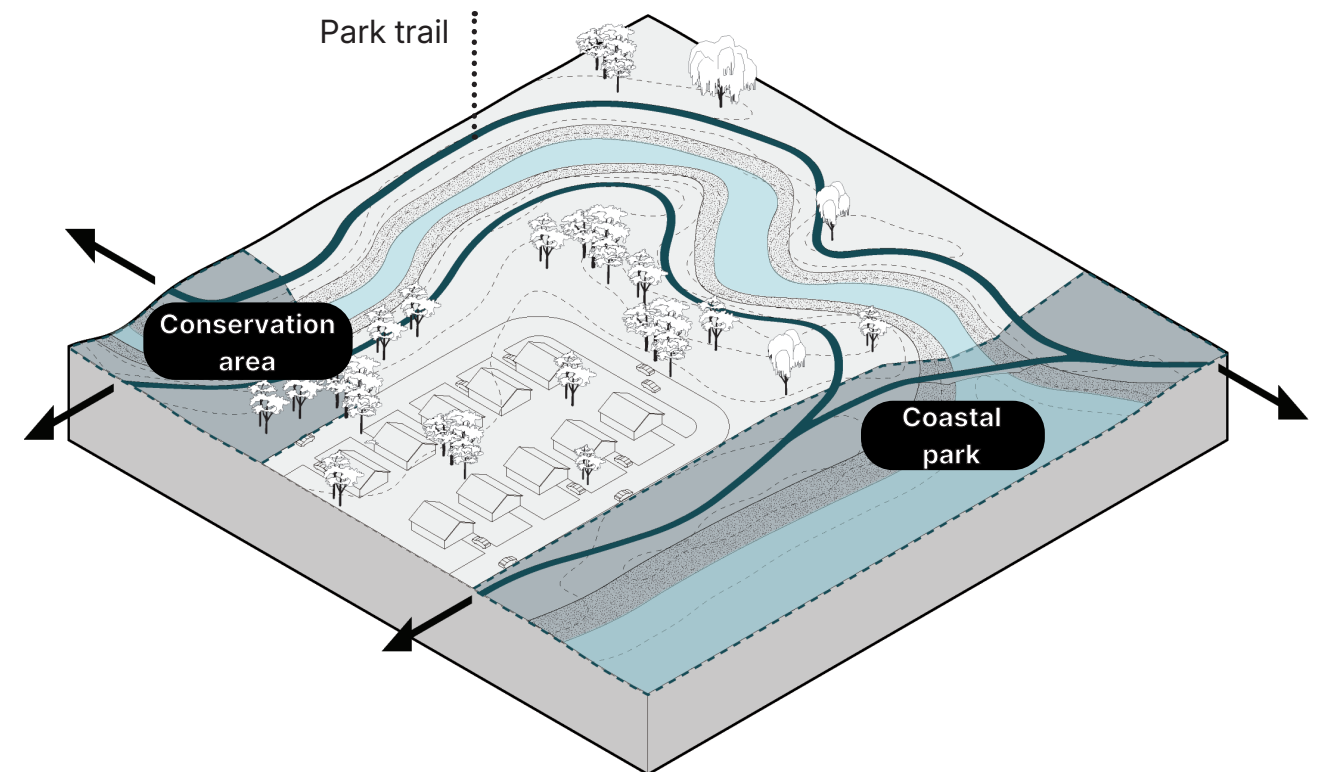


Suitable environments:

Areas where there is room for parks, green spaces, and multi-use recreational trails along the shoreline.

Case studies:

Fifty Point; Windermere Basin; Bayfront Park, Macassa Bay, and Pier 4 Park; Cootes Paradise; Grindstone Marsh; LaSalle Park; Beachway Park; Burloak Waterfront Park; South Shell Park Nesting Wall; Coronation Park; Tannery Park and Waterworks Park; Rattray Marsh; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Samuel Smith Wetland; Tommy Thompson Park; Don Mouth Naturalization; Woodbine Beach; Bluffer's Park; Frenchman's Bay (South Shore); Lynde Creek Marsh; McLaughlin Bay Marsh; Bowmanville Westside Marshes; Wilmot Creek Marsh; Wesleyville Marsh



This illustration shows trails connecting parks and green spaces along the shoreline and tributary to the lake.

Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline

19

Floodable parks

(alt: Floodable landscapes, stormwater park)

Synergies: 2 5 6 12 17 18



Create multi-use green spaces that safely store or convey floodwaters when needed, while delivering ecological and social benefits.

These areas are often designed with resilient plantings and gentle grades to attenuate high flows, recharge groundwater, and provide accessible parkland.

This technique differs from floodplain reconnection (#5) by being open, multifunctional landscapes that are intended for public use during dry conditions.

Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ○○○ Beach loss / dune destabilization | ●●○ Habitat fragmentation |
| ○○○ Bluff retreat / structural undermining | ●●○ Invasive species spread |
| ●○○ Sediment mobilization | ●●○ Turbidity increase / water quality impairment |
| ●●● Coastal / urban inundation | ●●○ Algal bloom risk |
| ●●● Property / infrastructure risk | ●●○ Wetland loss / function decline |

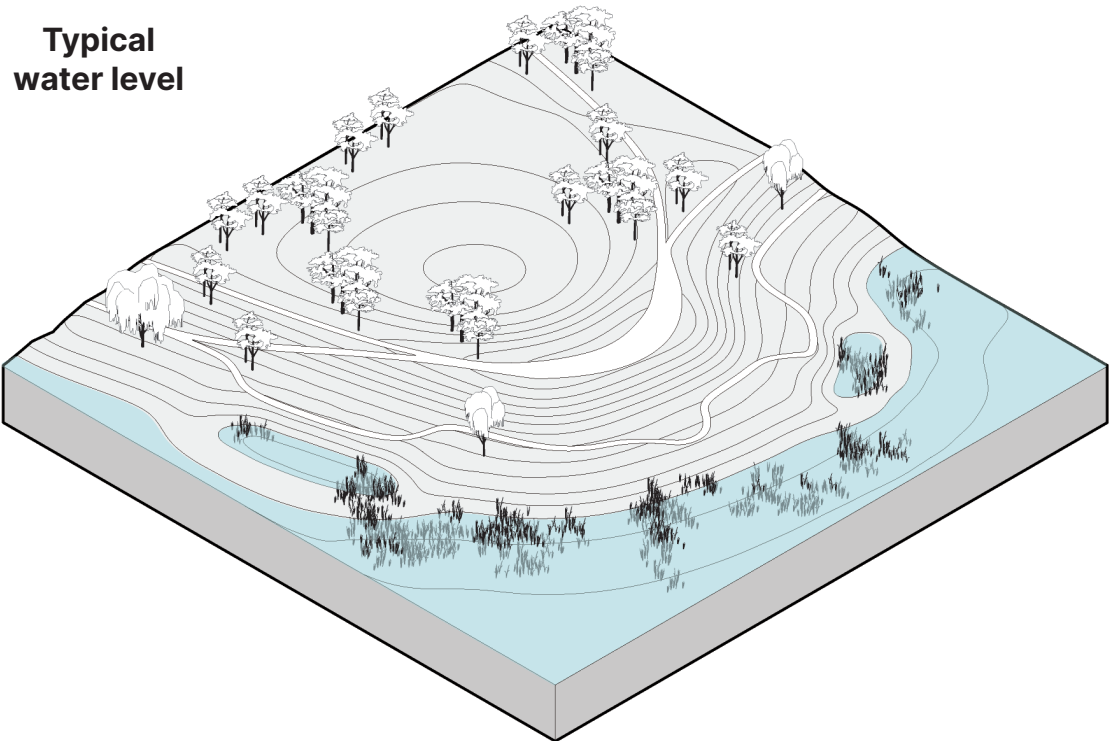
Suitable environments:

Areas where there is room for parks and greenspaces to safely store floodwaters when needed adjacent to a river or lake.

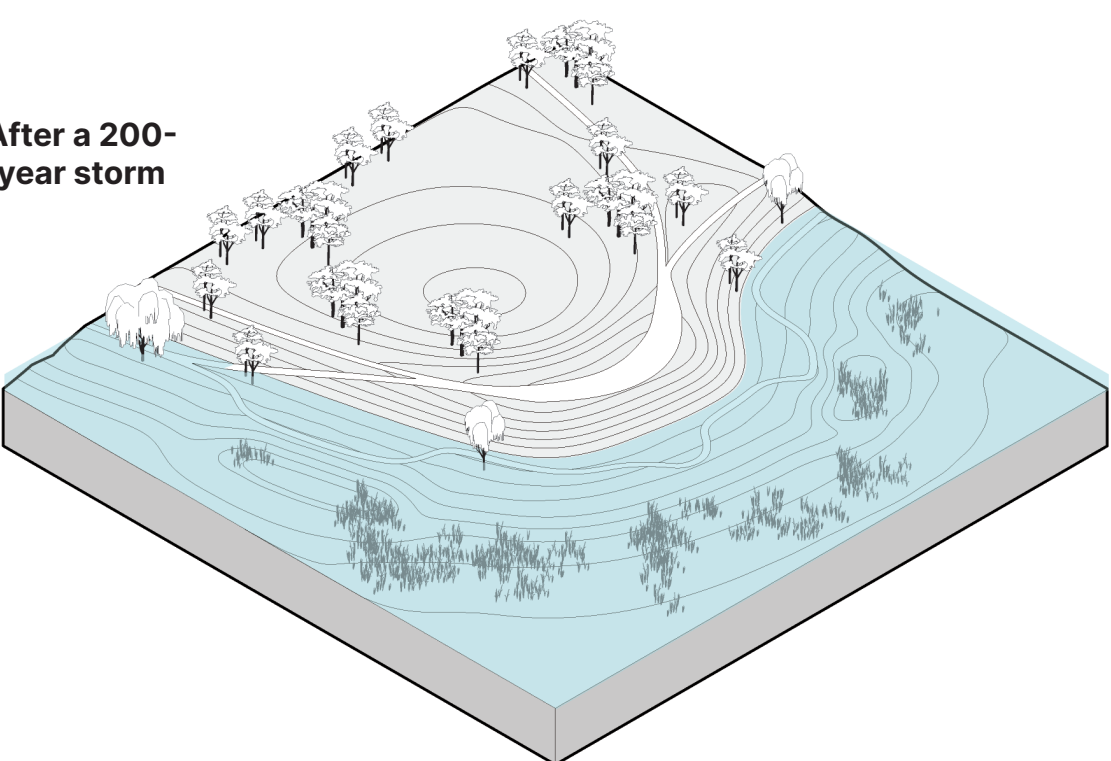
Case studies:

LaSalle Park; Serson Creek Reconnection and Wetland; Applewood Creek Extension and Wetland; Don Mouth Naturalization

Typical water level



After a 200-year storm



This illustration shows a floodable park under typical water levels and following a 200-year storm, which has a 0.5% chance of occurring in any given year.



Hybrid Solutions

20 Engineered habitat structures

(alt: Habitat enhancement structures)

Synergies: 2 3 4 16 18 19 22



Incorporate artificial benches, rootwads, logs, or rough substrates into engineered shorelines to create complex microhabitats for fish and invertebrates, while managing the risk of nuisance algae (e.g., *Cladophora*).



These structures are often used in harbours and channelized reaches to offset habitat losses from hard infrastructure.



This technique differs from habitat islands (#16) as habitat structures may vary in size and configuration, ranging from single structures to a collection of structures, and may be placed above or below water.

Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

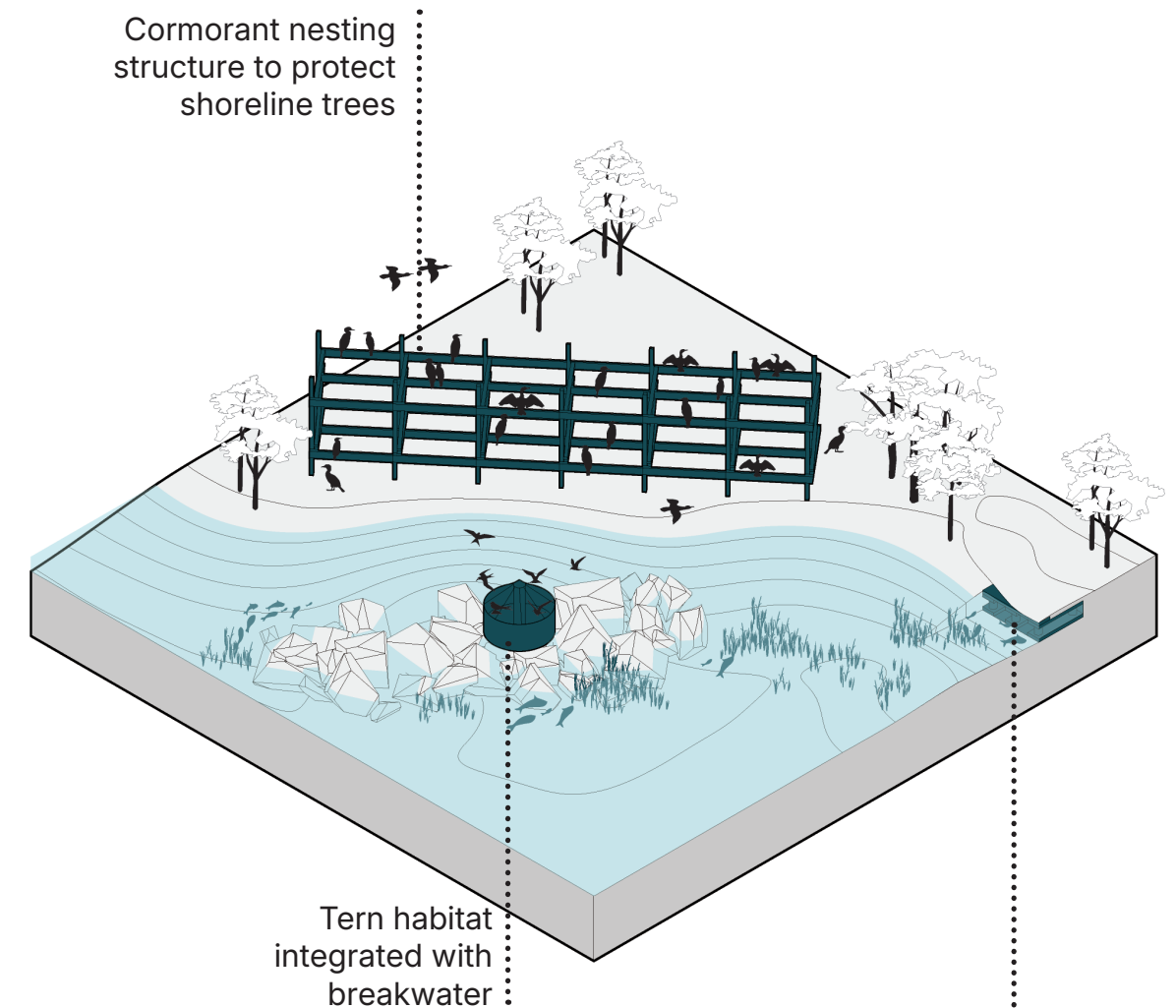
Suitable environments:

Low to moderate energy shorelines.

Case studies:

Grimsby Wetlands; Windermere Basin; Bayfront Park, Macassa Bay, and Pier 4 Park; LaSalle Park; South Shell Park Nesting Wall; Rattray Marsh; Samuel Smith Wetland; Gibraltar Point; Tommy Thompson Park; Don Mouth Naturalization; Bluffer's Park; Frenchman's Bay (South Shore); McLaughlin Bay Marsh; Bowmanville Westside Marshes; Wesleyville Marsh

- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline



***Each species requires specific distances, habitat conditions, and design guidelines. A single approach is not sufficient, so interventions must be tailored to support species-specific nesting, breeding, feeding, and disturbance needs across birds, turtles, and other species.**

Little underwater wooden structures for fish habitat, known as LUNKERS

This illustration shows various habitat structures along the shoreline, including a cormorant nesting structure, tern habitat integrated into an offshore breakwater, and a wooden fish habitat structure.

21 Beach nourishment & dynamic cobble berms

(alt: Beach replenishment / reclamation, dynamic revetments)

Synergies: 9 10 14 15 22 24 26



Place compatible sand or gravel to rebuild eroded beaches and replicate the function of natural beaches.



Dynamic berms composed of gravel or cobbles can be placed on the upper beach to protect the backshore from erosion and waves, while adjusting naturally to changing lake levels.



This technique differs from natural beach or dune systems (#9) by being engineered and periodically replenished for performance.



Suitable environments:

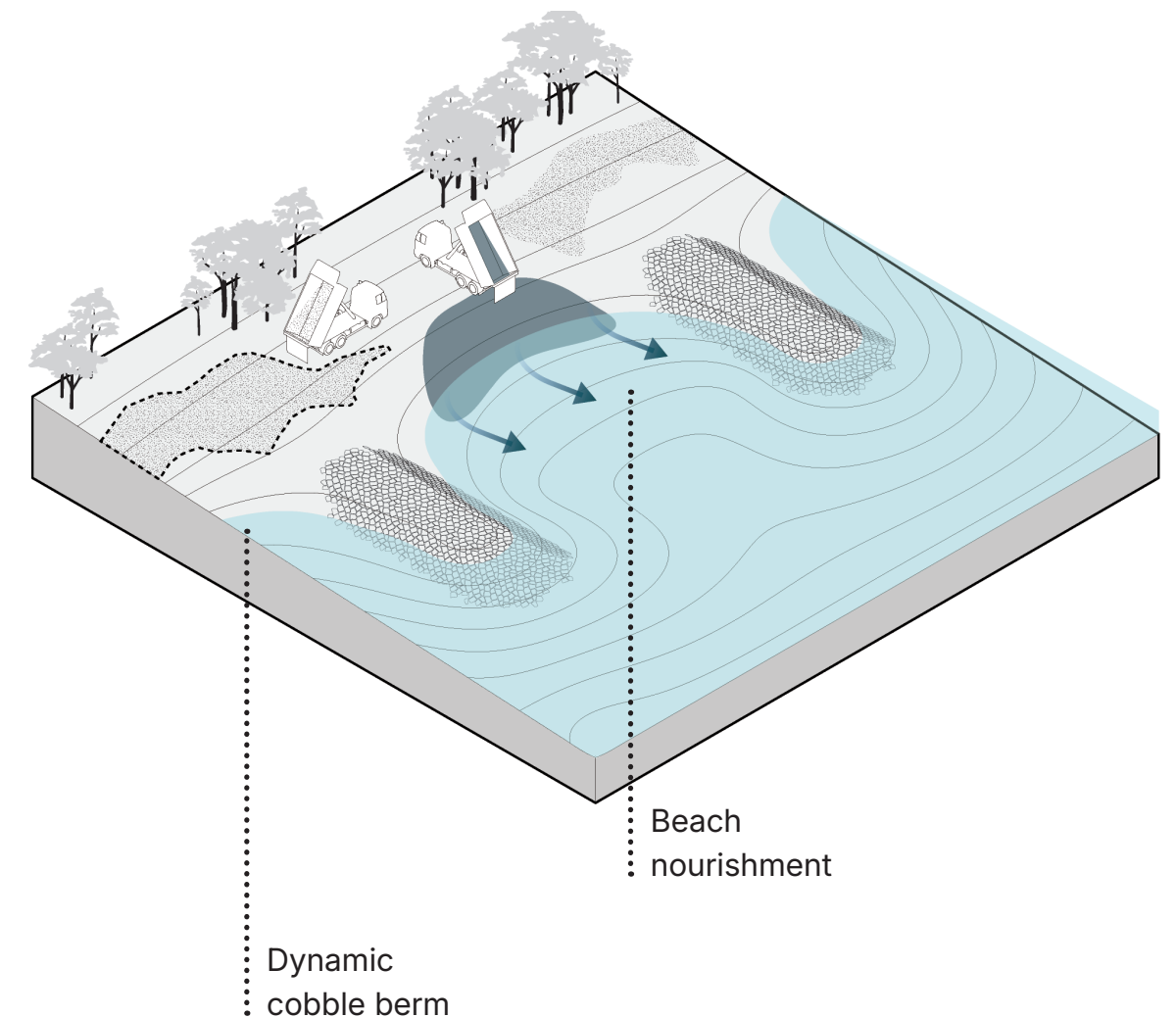
Areas with eroding beaches that require replenishment to maintain the beach system.

Case studies:

LaSalle Park; Beachway Park; Gibraltar Point; Woodbine Beach; Bluffer's Park; McLaughlin Bay Marsh; Victoria Beach

Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ●●● Beach loss / dune destabilization | ●○○ Habitat fragmentation |
| ●●○ Bluff retreat / structural undermining | ○○○ Invasive species spread |
| ●●○ Sediment mobilization | ●○○ Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ○○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●○○ Wetland loss / function decline |



This illustration shows sediment being replenished on a beach, located in between two existing groynes, with a dynamic cobble berm being created on the upper beach.

22 Hybrid dunes

(alt: Engineered / constructed dune system)

Synergies: 6 9 10 12 14 17 21



Construct protective dune ridges using imported sand or fill and vegetate them with native species to combine engineered stability with natural storm buffering.



These dunes are designed to absorb wave runup and ice loading while sustaining plant and wildlife communities.



This technique differs from natural dunes (#9), which are formed naturally on the landscape. It also differs from dynamic cobble berms (#21) by mimicking a natural dune system.

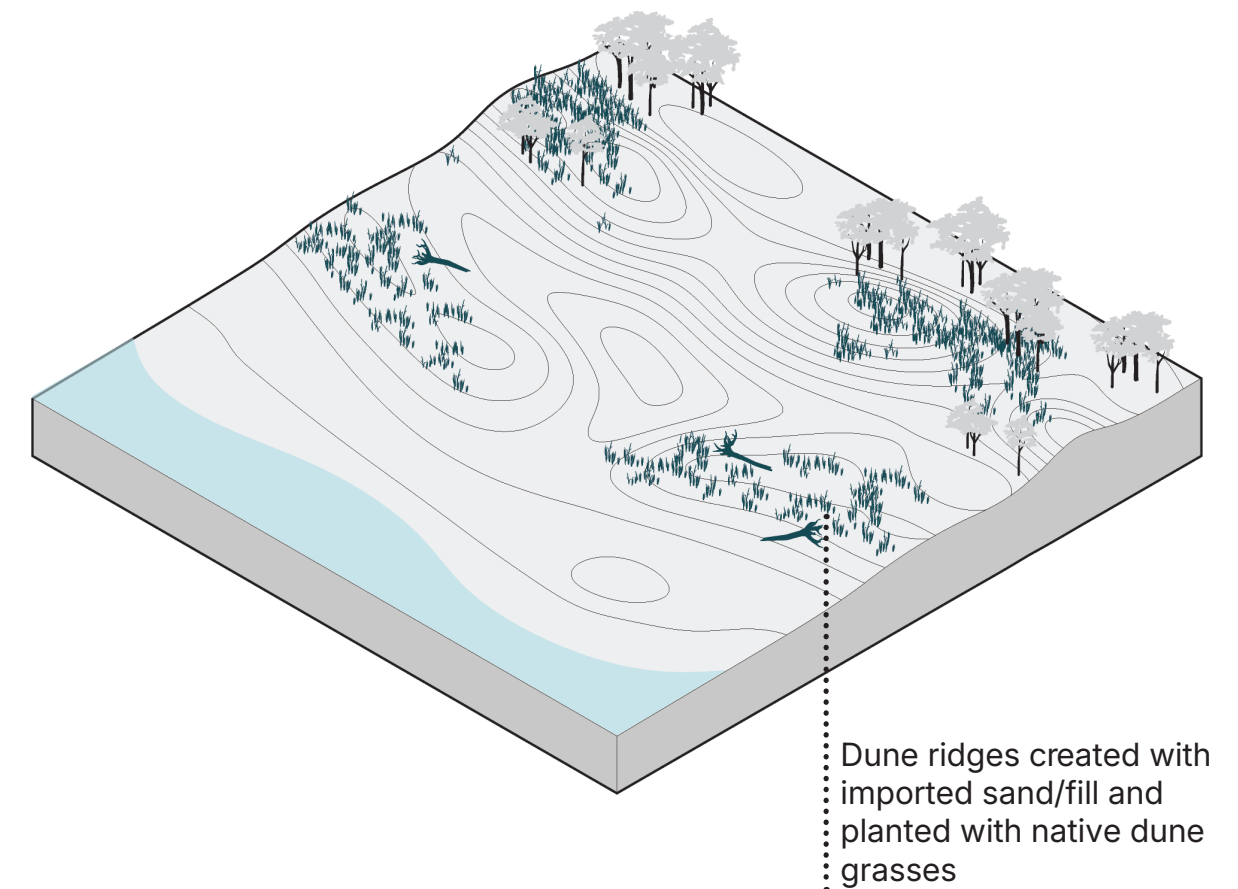


Suitable environments:

Areas where there is a sufficient supply of sand or sediment along the shoreline.

Case studies:

Gibraltar Point; Bluffer's Park



Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ●●● Beach loss / dune destabilization | ●●○ Habitat fragmentation |
| ●○○ Bluff retreat / structural undermining | ●●○ Invasive species spread |
| ●●○ Sediment mobilization | ●○○ Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ○○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●○○ Wetland loss / function decline |

This illustration shows a dune constructed with an artificial core that has been planted with native dune grasses.

23 Constructed / artificial islands

(alt: Purpose-built islands)

Synergies: 14 15 16 20 24



Create new island landforms using clean fill or dredged material to attenuate waves and expand habitat.

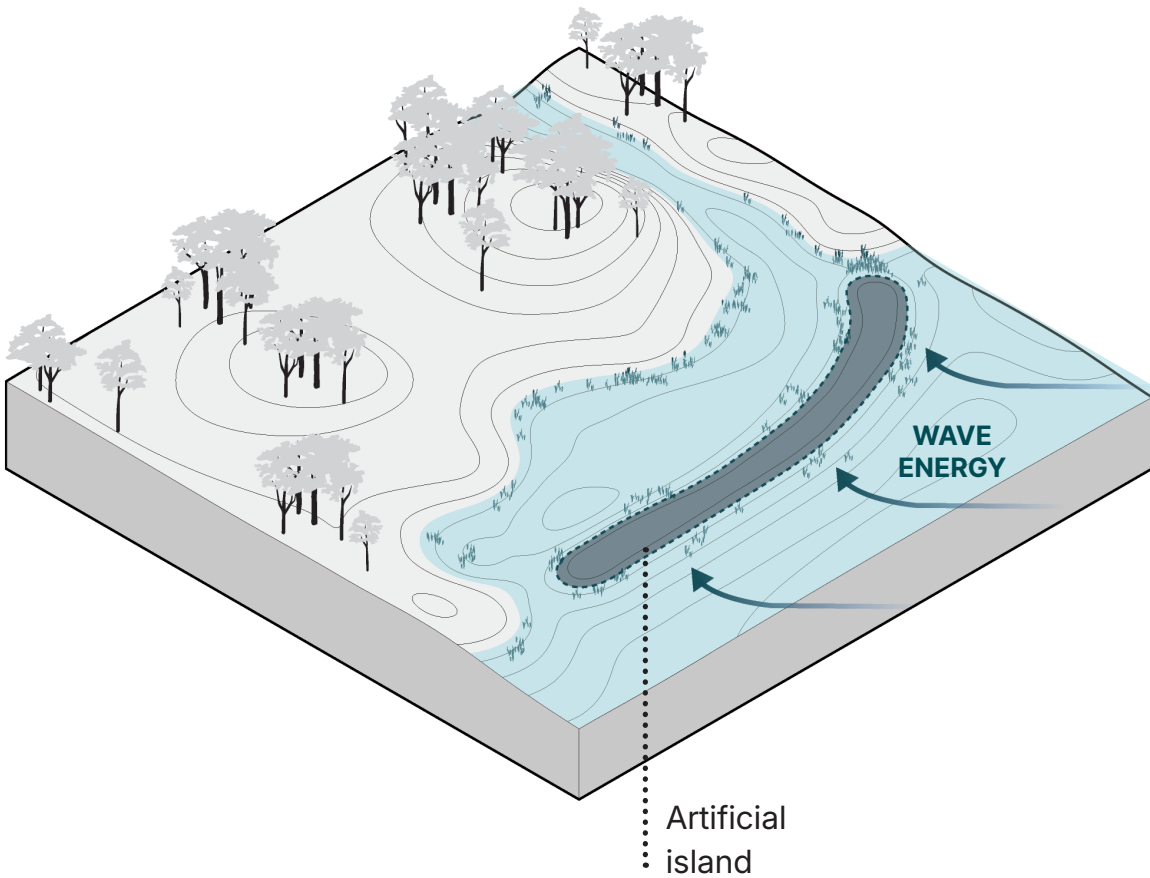
The outer slopes of these islands are often vegetated for stability and habitat creation.

This technique differs from small habitat islands or mounds (#16) by providing more protection from wave energy.

Suitable environments:
Moderate to high energy shorelines.

Case studies:
Windermere Basin; LaSalle Park; Northeastern Bird Islands; Burloak Waterfront Park; Applewood Creek Extension and Wetland; Tommy Thompson Park; Don Mouth Naturalization

- Potential hazard impacts that this technique can help address:**
- | | |
|--|---|
| ●○○ Beach loss / dune destabilization | ●●○ Habitat fragmentation |
| ●○○ Bluff retreat / structural undermining | ●○○ Invasive species spread |
| ●●○ Sediment mobilization | ●●○ Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ●○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●●○ Wetland loss / function decline |



This illustration shows an artificial island off the shoreline, helping to attenuate waves and provide habitat.

24 Hybrid breakwaters & shoals

(alt: Living breakwaters, shoreline shoals)

Synergies: 6 15 17 23 26

Construct low, submerged, or emergent features to attenuate waves and enhance aquatic habitat, combined with vegetation for enhanced ecological restoration.

These may come in the form of vegetated floating breakwaters, vegetated cobble shoals, or landward vegetation adjacent to the breakwater or shoal.

This technique differs from conventional breakwaters by integrating vegetation for a green-grey approach.

Suitable environments:

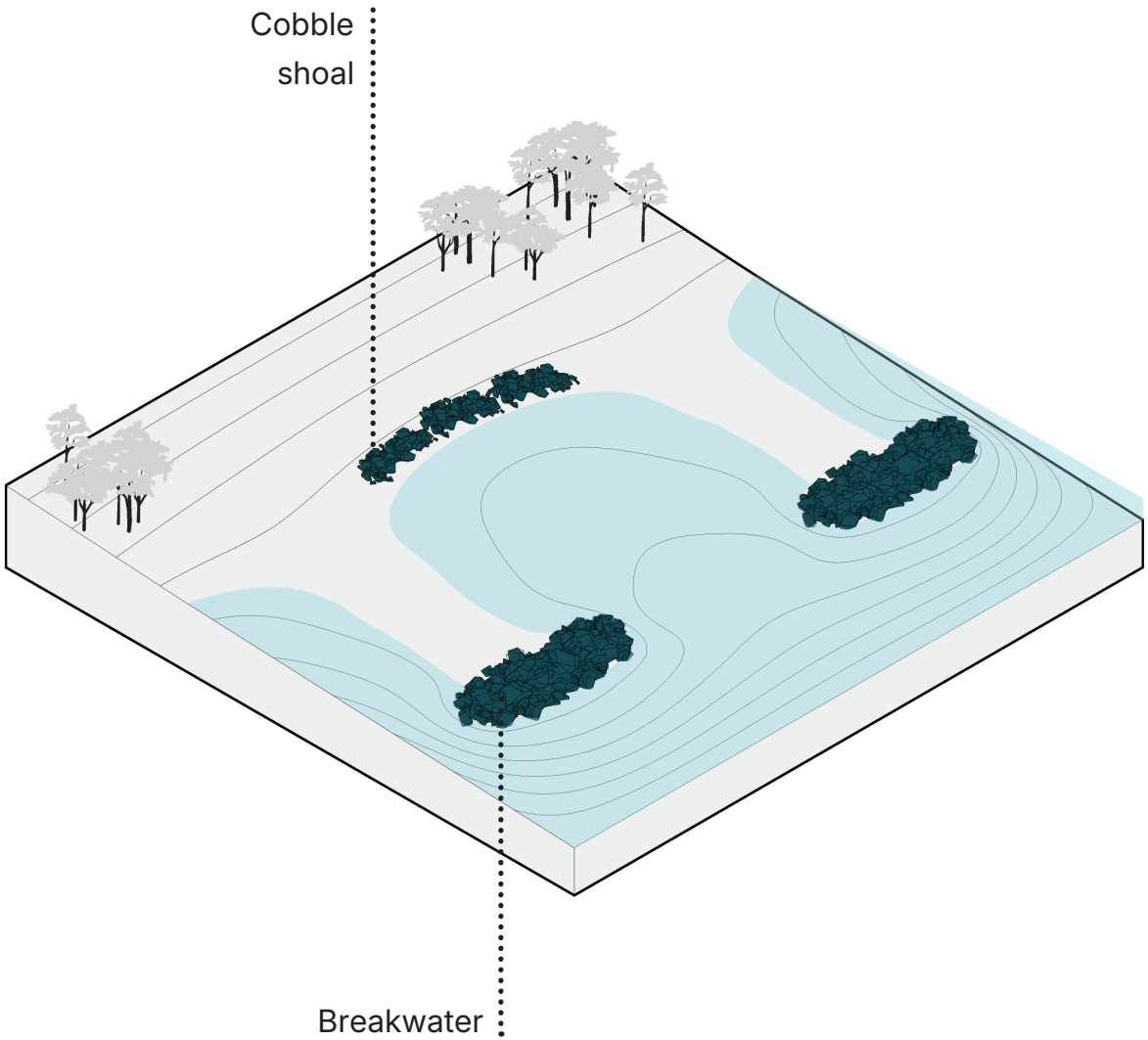
Low to high energy shorelines, depending on the design of the hybrid breakwater or shoal.

Case studies:

LaSalle Park; Burloak Waterfront Park; Tannery Park and Waterworks Park; Samuel Smith Wetland; Tommy Thompson Park; Don Mouth Naturalization; Woodbine Beach; Bluffer's Park

Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ●●○ Beach loss / dune destabilization | ●○○ Habitat fragmentation |
| ●●○ Bluff retreat / structural undermining | ○○○ Invasive species spread |
| ●●● Sediment mobilization | ●●● Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ○○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●●○ Wetland loss / function decline |



This illustration shows a breakwater attached to the shoreline and a cobble shoreline shoal with vegetation growing in between.

25 Artificial reefs

(alt: Offshore / nearshore reef)

Synergies: 9 10 15 20 22 27



Combine low underwater ridges or non-plastic reef modules with vegetation or rough natural material (e.g., cobbles or larger stones) to dissipate wave energy and support aquatic life.



In Western Lake Ontario, these hybrid systems can be found in nearshore and offshore environments, providing dual benefits of erosion control and ecological enhancement.

They differ from conventional or hybrid breakwaters (#24) by being submerged structures.

Potential hazard impacts that this technique can help address:

- Beach loss / dune destabilization
- Bluff retreat / structural undermining
- Sediment mobilization
- Coastal / urban inundation
- Property / infrastructure risk

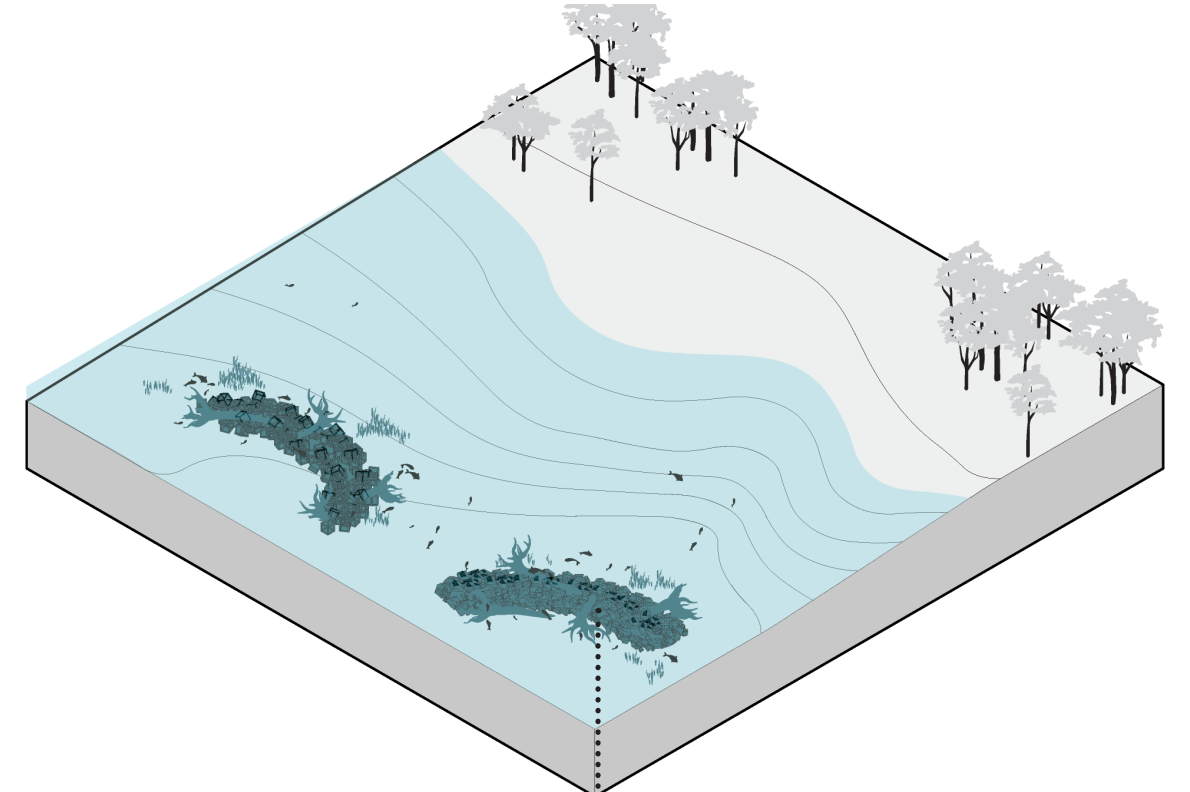
Suitable environments:

Moderate to high energy shorelines where the lakebed is not too steep.

Case studies:

LaSalle Park; Gibraltar Point; Tommy Thompson Park; Don Mouth Naturalization

- Habitat fragmentation
- Invasive species spread
- Turbidity increase / water quality impairment
- Algal bloom risk
- Wetland loss / function decline



Artificial reefs

Reef module made of non-plastic natural materials



This illustration shows two submerged artificial reefs off the shore, created using modular reef structures and woody debris.

26

Vegetated armour & revetments

(alt: Vegetated revetments, bio-engineered armouring)

Synergies: 7 15 18 24 27



Integrate rock or concrete protection with soil pockets, plantings, and habitat shelves to combine structural stability with ecological benefits.



These systems provide both flood defense and habitat complexity.



This technique differs from hybrid breakwaters and shoals (#24) by protecting a continuous stretch of shoreline.



Suitable environments:

High energy shorelines where protection is needed.

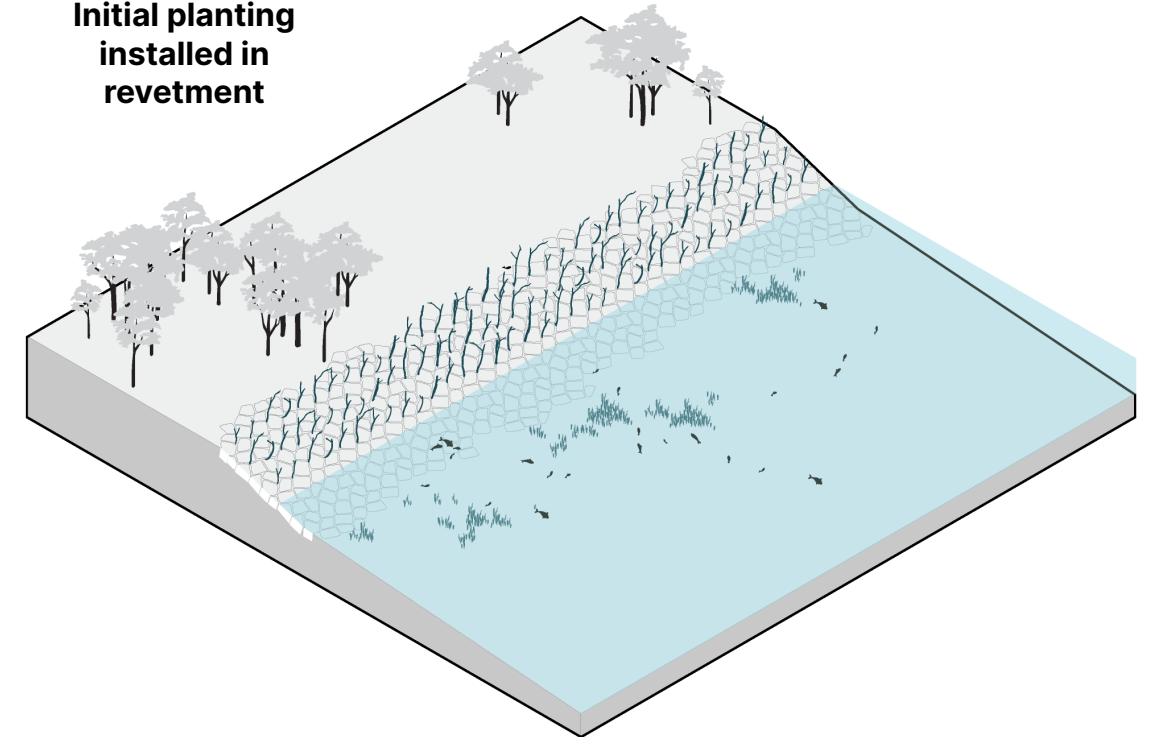
Case studies:

Bayfront Park, Macassa Bay, and Pier 4 Park; Burloak Waterfront Park; Don Mouth Naturalization

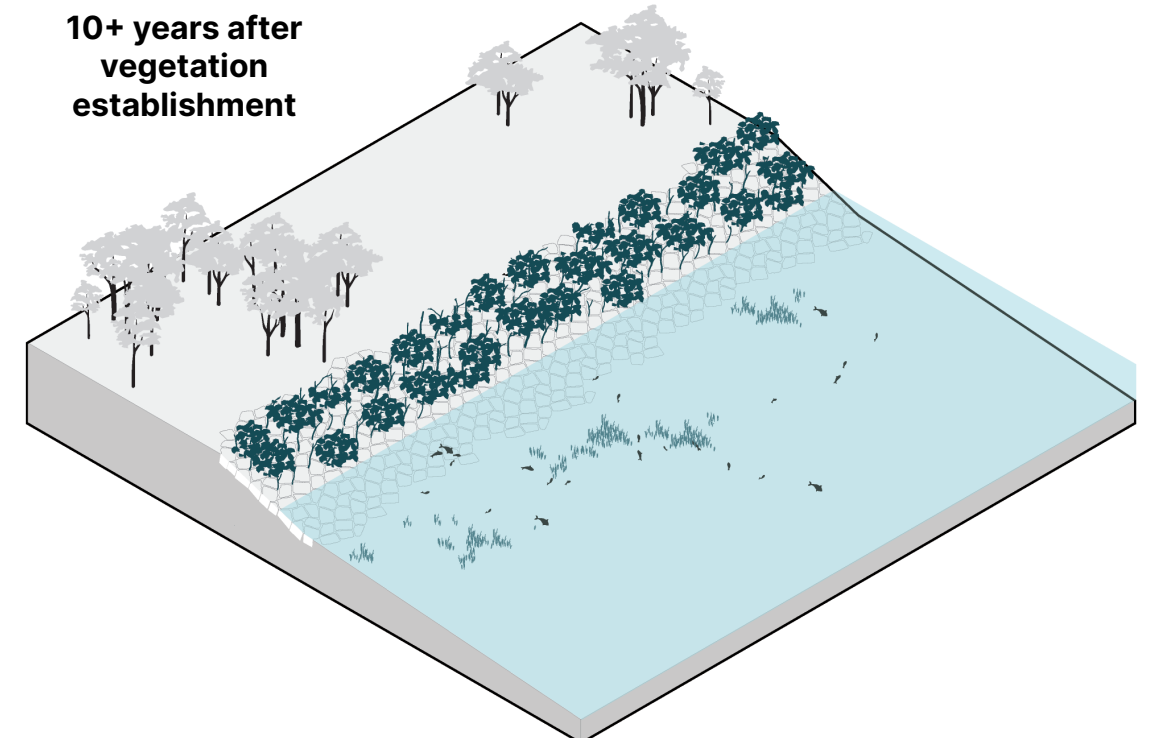
Potential hazard impacts that this technique can help address:

- | | |
|--|---|
| ●○○ Beach loss / dune destabilization | ●○○ Habitat fragmentation |
| ●●● Bluff retreat / structural undermining | ○○○ Invasive species spread |
| ●●○ Sediment mobilization | ●●○ Turbidity increase / water quality impairment |
| ●●○ Coastal / urban inundation | ○○○ Algal bloom risk |
| ●●● Property / infrastructure risk | ●○○ Wetland loss / function decline |

Initial planting installed in revetment



10+ years after vegetation establishment



This illustration shows initial planting of vegetation in soil pockets of a revetment and ten years later following vegetation establishment.

27 Eco-engineered materials & surfaces

(alt: Ecologically enhanced surfaces, living seawalls)

Synergies: 18 20 24 26



Apply textured, porous, or modular concrete and armour units to seawalls, revetments, and breakwaters to increase habitat and hydraulic roughness. Designed to improve ecological performance, these materials and surfaces provide surface complexity, voids, or bio-receptive coatings that help promote algal, invertebrate, and fish colonization while maintaining required structural stability.

In Western Lake Ontario, this technique has also been used to create artificial habitats for Bank Swallows to mimic their natural nesting environments.

They differ from engineered habitat structures (#20) by focusing on the texture and complexity of surfaces.

Potential hazard impacts that this technique can help address:

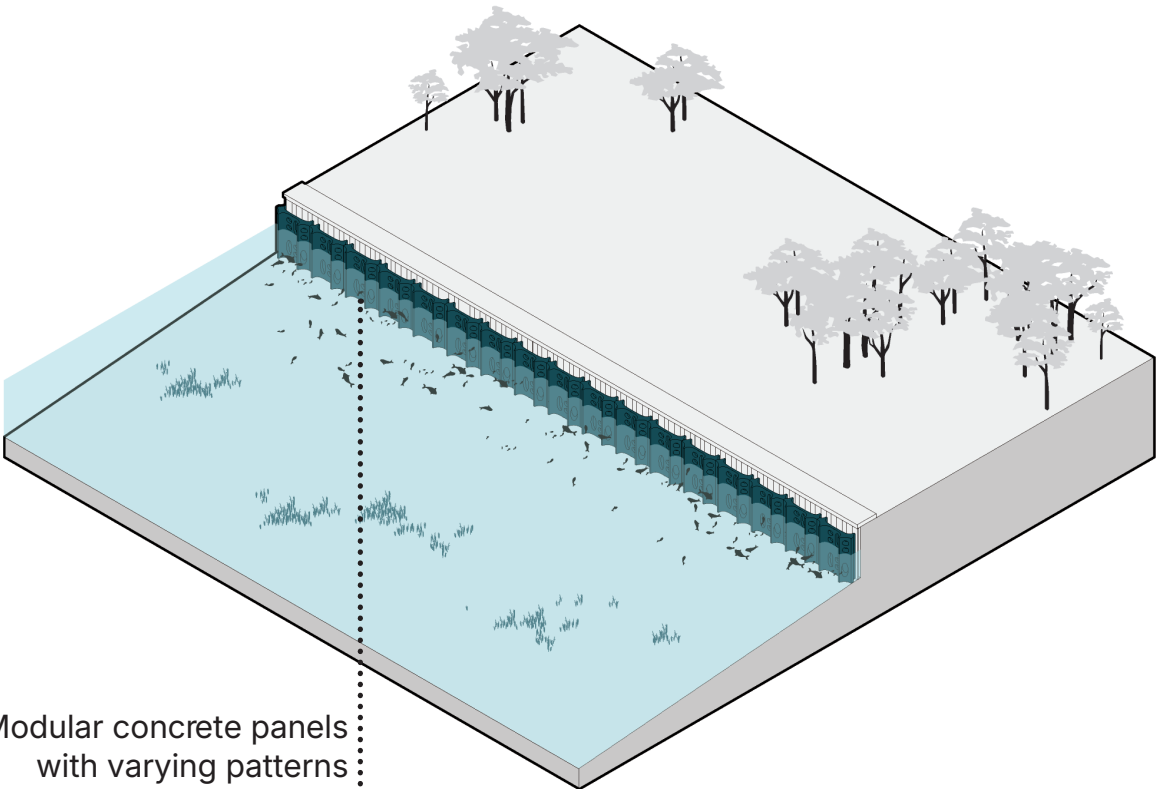
- | | |
|--|---|
| ○○○ Beach loss / dune destabilization | ●●● Habitat fragmentation |
| ●○○ Bluff retreat / structural undermining | ○○○ Invasive species spread |
| ●○○ Sediment mobilization | ●○○ Turbidity increase / water quality impairment |
| ●○○ Coastal / urban inundation | ○○○ Algal bloom risk |
| ●●○ Property / infrastructure risk | ●○○ Wetland loss / function decline |

Suitable environments:

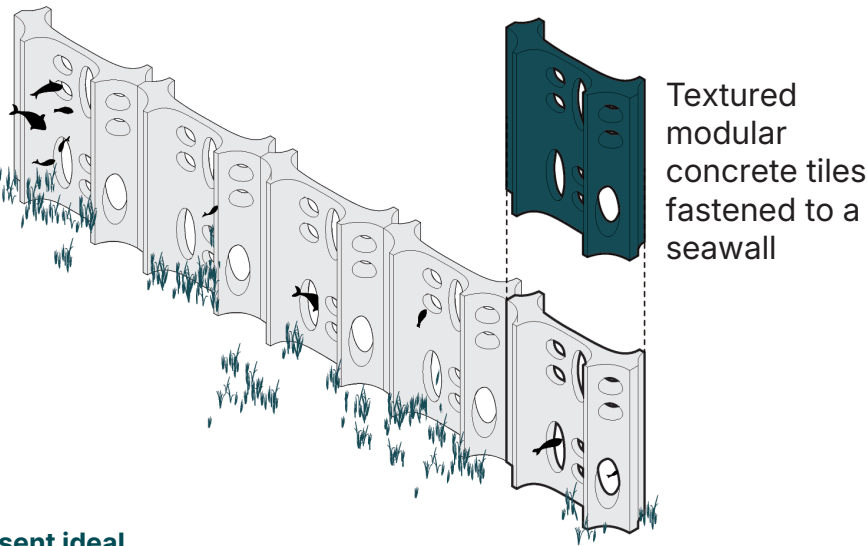
Moderate to high energy shorelines.

Case studies:

South Shell Park Nesting Wall



Modular concrete panels with varying patterns and gaps to support different aquatic species



Textured modular concrete tiles fastened to a seawall

***Hardened shorelines present ideal opportunities for eco-engineering interventions.** Retrofitting them with textured tiles, panels, or materials can transform otherwise sterile edges into productive habitats, enhancing biodiversity, improving water quality, and maintaining structural performance.

This illustration shows textured concrete added to a seawall to provide aquatic habitat.

Appendix

Additional Resources

1 Reconnected rivers & streams

Toronto and Region Conservation Authority. (2015). Crossings guideline for valley and stream corridors. https://sustainabletechnologies.ca/app/uploads/2015/12/TRCA_2015_Stream-Crossings-Guideline.pdf

Toronto and Region Conservation Authority. (n.d.). Wilket Creek rehabilitation project. <https://trca.ca/conservation/erosion-risk-management/restore/wilket-creek-rehabilitation-project/>

2 Channel naturalization & realignment

Natural Water Retention Measures (NWRM) Platform. (n.d.). Riverbed material renaturalization. <https://www.nwrm.eu/measure/riverbed-material-renaturalization>

The River Restoration Centre. (n.d.). Manual of river restoration techniques. <https://www.therrc.co.uk/manual-river-restoration-techniques>

3 Constructed / restored wetlands

ICEM. (2023). Constructed wetlands. LISA Climate Information System for Adaptation. <https://lisa.icem.com.au/nbs/constructed-wetlands/>

Toronto and Region Conservation Authority. (n.d.). Wetlands. <https://trca.ca/conservation/restoration/wetlands/>

4 Floating wetlands

Natural Water Retention Measures (NWRM) Platform. (n.d.). Riverbed material renaturalization. <https://www.nwrm.eu/measure/riverbed-material-renaturalization>

5 Floodplain reconnection

Toronto and Region Conservation Authority. (n.d.). Broadview & Eastern flood protection municipal class environmental assessment. <https://trca.ca/conservation/infrastructure-projects/broadview-eastern-municipal-class-environmental-assessment/>

The River Restoration Centre. (n.d.). Stage 0 floodplain reconnection. <https://www.therrc.co.uk/stage-0-floodplain-reconnection>

6 Riparian vegetation & buffers

Elsevier. (2018). Riparian buffers. ScienceDirect. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/riparian-buffers>

Kawartha Conservation. (n.d.). Riparian buffer fact sheet. <https://www.kawarthaconservation.com/media/g1aanicv/riparian-buffer-fact-sheet.pdf>

7 Coastal forest / windbreak planting

Alfrey, P. (2025, April 6). Windbreak/shelterbelt design for polyculture/permaculture and regenerative landscapes. The Polyculture Project. <https://thepolycultureproject.substack.com/p/windbreakshelterbelt-design-for-polycultureperma>

Woodland Information. (2021, June 3). Windbreaks. <https://woodlandinfo.org/windbreaks/>

8 Invasive species control & removal

Toronto and Region Conservation Authority. (2020). Invasive species management strategy 2020–2025. <https://pub-trca.escribemeetings.com/filestream.ashx?DocumentId=6533>

Nottawasaga Valley Conservation Authority. (2011). Invasive phragmites (*Phragmites australis*): Best management practices. <https://www.nvca.on.ca/wp-content/uploads/2023/07/Phragmites-control-best-practices.pdf>

9 Beach & dune restoration

Toronto and Region Conservation Authority. (n.d.). Gibraltar Point erosion control project. <https://trca.ca/conservation/infrastructure-projects/gibraltar-point-erosion-control-project/>

10 Bluff stabilization

Southeastern Wisconsin Regional Planning Commission. (1989). Alternative methods of bluff stabilization common in the Great Lakes [Figure]. In D. M. Mickelson, T. B. Edil, & D. E. Guy, Erosion of coastal bluffs in the Great Lakes. Retrieved from https://www.researchgate.net/figure/Alternative-Methods-of-Bluff-Stabilization-Common-in-the-Great-Lakes-SEWRPC-1989_fig4_287607879

11 Bioengineering & live staking

Rideau Valley Conservation Authority. (2023). How to naturalize your shoreline. <https://watersheds.ca/wp-content/uploads/2023/02/How-to-Naturalize-Your-Shoreline-by-Rideau-Valley-Conservation-Authority.pdf>

12 Shoreline regrading

Rideau Valley Conservation Authority. (2023). How to naturalize your shoreline. <https://watersheds.ca/wp-content/uploads/2023/02/How-to-Naturalize-Your-Shoreline-by-Rideau-Valley-Conservation-Authority.pdf>

13 Sills

Virginia Institute of Marine Science. (2021). Design elements: Marsh sills. https://www.vims.edu/research/units/programs/ssp/_docs/designelements_final_lr2.pdf

14 Re-use of dredged sediment

Spadaro, P., & Rosenthal, L. (2020). Example of a circular economy where contaminated sediments are employed in producing masonry materials for construction projects [Figure]. In River and harbor remediation: “Polluter pays,” alternative finance, and the promise of a circular economy. https://www.researchgate.net/figure/Example-of-a-circular-economy-where-contaminated-sediments-are-employed-in-producing_fig1_345397554

15 Sediment capture & accretion

Vahsen, M. L., et al. (2023). Marsh accretion occurs through the buildup of sediment and plant matter over time [Figure]. In New Phytologist. https://www.researchgate.net/figure/Marsh-accretion-occurs-through-the-buildup-of-sediment-and-plant-matter-over-time_fig1_373863022

16 Habitat islands or mounds

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Toronto and Region Conservation Authority. (n.d.). Creating habitat: A Guide for Community Groups. https://trca.ca/app/uploads/2016/04/2602-Stewardship_Habitat-SinglePg_PRESS.pdf

17 Habitat connectivity corridors

Toronto and Region Conservation Authority. (2015, September). Crossings guideline for valley and stream corridors. https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2018/12/13101341/TRCA_2015_Stream-Crossings-Guideline.pdf

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Toronto and Region Conservation Authority. (2015, September). Crossings guideline for valley and stream corridors. https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2018/12/13101341/TRCA_2015_Stream-Crossings-Guideline.pdf

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AECOM. (2018). Toronto and Region Conservation Authority Flood Protection Land Forming Technical Design Considerations. <https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2023/02/03180320/Flood-Protection-Land-Forming-Technical-Design-Considerations.pdf>

20 Engineered habitat structures

Toronto and Region Conservation Authority. (2003). Toronto Waterfront Aquatic Habitat Restoration Strategy. https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2017/09/17171923/TW_AHRS_STRATEGY11.pdf

21 Beach nourishment & dynamic cobble berms

Ontario Ministry of Natural Resources and Forestry. (2001). Great Lakes–St. Lawrence River system: Part 7 addressing the hazards. Lakehead Region Conservation Authority. <https://www.lprca.on.ca/wp-content/uploads/2020/12/GL-Tech-Guide-PART7-Addressing-the-Hazards.pdf>

22 Hybrid dunes

Figlus, J., Sigren, J. M., Armitage, A. R., & Tyler, R. C. (2014). Schematic showing interactions between storm waves, substrate and plants during elevated water level conditions [Figure]. In Erosion of vegetated coastal dunes. Retrieved from https://www.researchgate.net/figure/Schematic-showing-interactions-between-storm-waves-substrate-and-plants-during-elevated_fig1_270822592

23 Constructed or artificial islands

Toronto and Region Conservation Authority. (2014). Ashbridges Bay erosion and sediment control project: Environmental study report. <https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2016/04/20180751/Ashbridges-Bay-Environmental-Study-Report.pdf>

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Toronto and Region Conservation Authority. (2015). Ashbridges Bay landform project: Habitat enhancement plan. <https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2016/04/20174737/Ashbridges-Bay-Landform-Project-Habitat-Enhancement-Plan.pdf>

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