



**PACIFIC SALMON
FOUNDATION**



Impacts of Climate Change on Shorelines, People and Salmon: Nature-based Solutions for Ecosystem Health

A Guide to Climate Change Impacts to Shorelines and the Value of our Natural Shorelines



STEWARDSHIP CENTRE
FOR BRITISH COLUMBIA


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COASTS**
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Figure 1– The Salish Sea. Source: The Pacific Salmon Foundation

Our Home

The Salish Sea stretches from the northern end of the Strait of Georgia to the southern end of Puget Sound. It opens to the Pacific Ocean at the Strait of Juan de Fuca and spans the Canada/US border. Within the Salish Sea are numerous connecting channels, bays and inlets, such as Haro Strait, Rosario Strait, Bellingham Bay, and the Hood Canal, as well as islands such as the San Juan and Gulf Islands (Fig. 1).

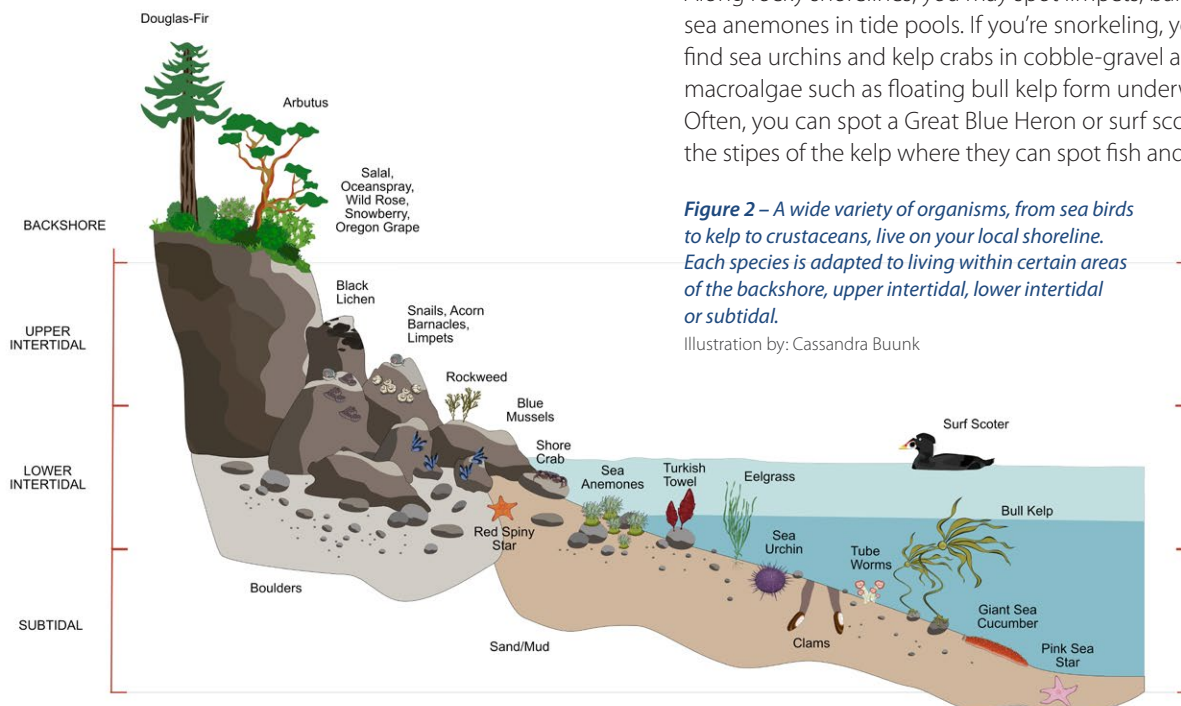
Communities around the Salish Sea are deeply rooted to this highly productive inland sea and the ways of life it nurtures. It is home to diverse ecosystems. Shorelines provide work, recreation, living space, and wonderful views. They are biologically rich, ecologically productive and culturally significant places. For all of us that live, work and play around the Salish Sea, it is important to remember that we share this ecosystem with the native wildlife and plants, and to respect that we are located on the unceded territories of many different Indigenous Peoples. We all benefit from the ecosystem services that healthy shorelines provide, such as clean air and water, carbon sequestration, and plentiful food sources, so we must all do our part to take care of our shorelines.

Your local shoreline is abundant with plants and animals that sustain one another, and us as well. If you live near a sandy beach, you may find clams, crabs and forage fish. Surf smelt and Pacific sand lance are forage fish that rely on pebble and sandy shorelines for spawning, and require healthy overhanging vegetation along the high tide line to shade their eggs and provide an input of nutrients. These incredible fish support Pacific salmon, shorebirds, and ultimately, larger iconic species such as killer whales. In some sheltered areas you may see underwater meadows made up of eelgrass. Eelgrass meadows serve as nursery areas for many species by providing shelter and refuge. This is critical habitat for juvenile Pacific salmon.

Along rocky shorelines, you may spot limpets, barnacles and sea anemones in tide pools. If you're snorkeling, you may find sea urchins and kelp crabs in cobble-gravel areas where macroalgae such as floating bull kelp form underwater forests. Often, you can spot a Great Blue Heron or surf scoter amongst the stipes of the kelp where they can spot fish and forage (Fig. 2).

Figure 2 – A wide variety of organisms, from sea birds to kelp to crustaceans, live on your local shoreline. Each species is adapted to living within certain areas of the backshore, upper intertidal, lower intertidal or subtidal.

Illustration by: Cassandra Buunk



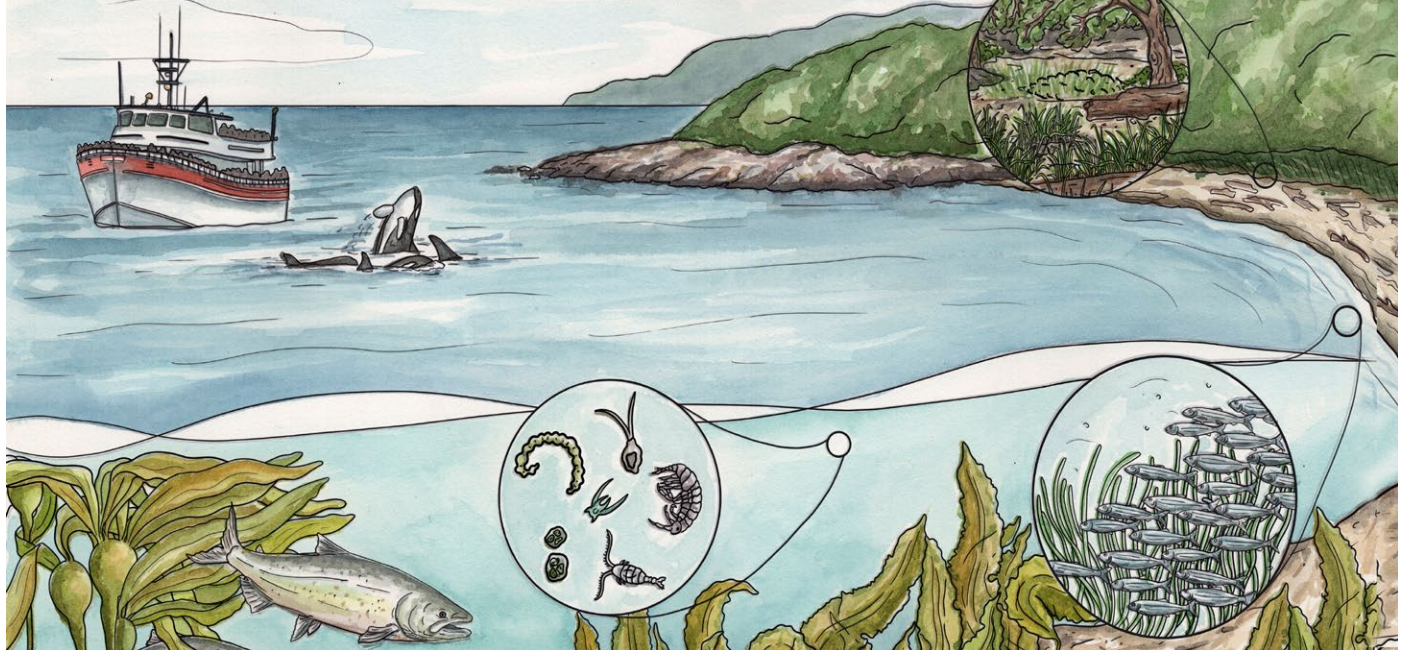


Figure 3 – The Salish Sea ecosystem is complex, supporting countless organisms like Pacific salmon, orca whales, forage fish, kelp, and people!

Illustration by: Holly Sullivan

In both sandy and rocky environments, you'll find marine riparian vegetation, such as shrubs and trees like Arbutus, Douglas fir, and ocean spray, growing along the shore above the high tide line. We may think of marine organisms and their particular habitats as separate entities, but they are intrinsically linked to one another. These nearshore plants, for instance, have many important functions, including stabilizing the shoreline as well as filtering out contaminants, thus keeping the habitat healthy and functioning for nearshore organisms.



Photo by: Mitch Miller



Photo by: Tom Harry

Figure 4 – Tom Harry jigging off Malahat Beach by Tozier Creek on a recent fishing trip with Elders of the Malahat Nation. He released the Jack Chinook to let it grow.



Photo by: Kyla Sheehan

The Value of Salmon

As British Columbians, many of us have grown up fishing and eating salmon, and witnessing the annual migrations and spawning events as salmon return to our local rivers — salmon are woven into our cultures and our way of life on the coast. Salmon are particularly significant to coastal First Nations whose traditional activities throughout the year are centered around harvesting, preserving, eating and celebrating this crucial food source. Through story-telling and ceremonies, Indigenous communities have passed down the importance of salmon through generations.

In recent years, we have seen historically low salmon runs. In 2020, the catch of Pacific salmon was the lowest it has been since 1982.¹ While not all species and populations of Pacific salmon are in decline, many populations of southern Chinook, Coho and Fraser River Sockeye are in significant decline.^{2,3,4} In a recent survey from Insights West, the Pacific Salmon Foundation, and Wild First, it was revealed that 86% of BC residents polled are extremely concerned about declining salmon stocks, and rated this as one of the top environmental concerns.⁵ Some of the main factors impacting Pacific salmon include overharvesting, habitat loss/degradation and climate change. These threats are complex, but we are seeing global change to help alleviate some of these impacts to salmon and countless other species.

Figure 5 – The annual average temperature changes in degrees Celsius between 1900 and 2013 throughout different regions of BC.

Source: Strait of Georgia Data Centre, Pacific Salmon Foundation

Climate Change

As a result of increased atmospheric greenhouse gas concentrations, the world is facing unprecedented climatic changes, and British Columbia is no exception. We are already experiencing alarming effects, such as the record shattering ‘heat dome’ and historic flooding of 2021.

Air Temperature

Throughout the province, there has been a warming trend in air temperature over the last 100+ years (Fig. 5). Projections for the Capital Regional District indicate that our winters will become milder, with days that dip below freezing becoming increasingly rare except at higher elevations.⁶

Precipitation

In the future it is anticipated that the cooler months will see more precipitation, but the summer will become drier.⁶ In winter, less precipitation will fall as snow due to warmer temperatures. This results in reduced snowpack in higher elevations and a loss of consistent melt waters that are so important to sustain streams through the dry season.

Sea Temperature

Warmer sea surface temperatures from climate change on top of natural climate fluctuations increase the risk of events known as marine heat waves. During marine heat waves, the thermal tolerances of marine species can be exceeded and result in stress or death. In the future, these are projected to increase in frequency, intensity, duration and spatial extent globally^{7,8} and El Niño events are projected to occur twice as often.⁸

Warmer waters have been implicated in the loss of important habitats such as eelgrass meadows and kelp forests which are crucial to the life cycles of many species including salmon. Pacific salmon fitness, growth and survival can be negatively impacted by warming waters while increased incidence of harmful algal blooms, biotoxins and disease outbreaks are also associated with warmer sea surface temperatures. This can mean cascading impacts to the food web.

Sea Level Rise

Sea level rise is projected to be greatest on the north coast, the Fraser Lowland and around southern Vancouver Island, ranging from 50 to 70cm by the year 2100 (median model change under RCP8.5; not accounting for the possibility of Greenland and Antarctic ice sheet disintegration), while the rest of Vancouver Island is projected to experience a much smaller relative rise in sea level.¹⁰ In Victoria, the sea level has risen at a rate of 6.6 cm per century, and this rate is accelerating.¹¹ Even at the modest end of this range, our coastlines as we know them will inevitably change.

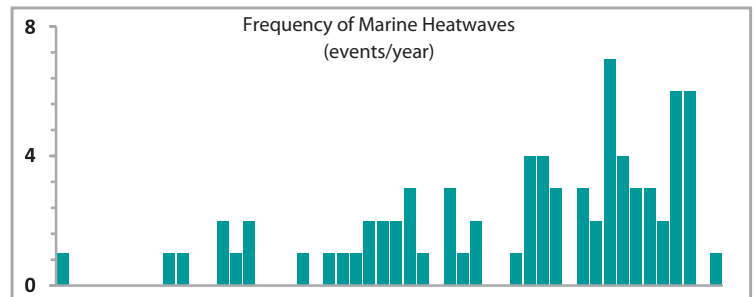
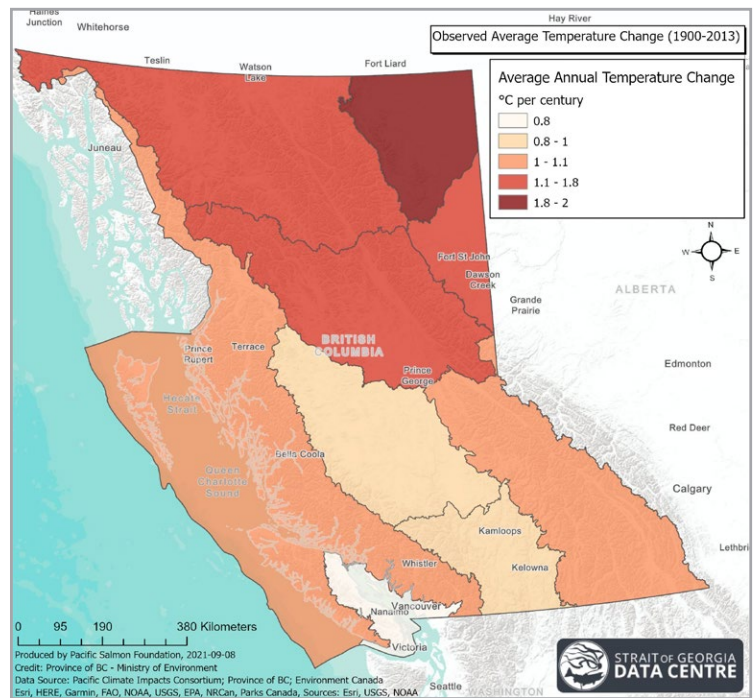


Figure 6 – Number of heatwaves experienced each year in Baynes Sound, east coast of Vancouver Island, based on marine sea surface temperature measurements at the Chrome Island Lightstation from 1969 to 2018. Criteria for a marine heatwave from Hobday et al. 2016⁹, defined as at least five consecutive days that the recorded temperature exceeded the 90th percentile for that calendar day of a baseline dataset of at least 30 years, in this case, the entire available data set of 50 years was used.

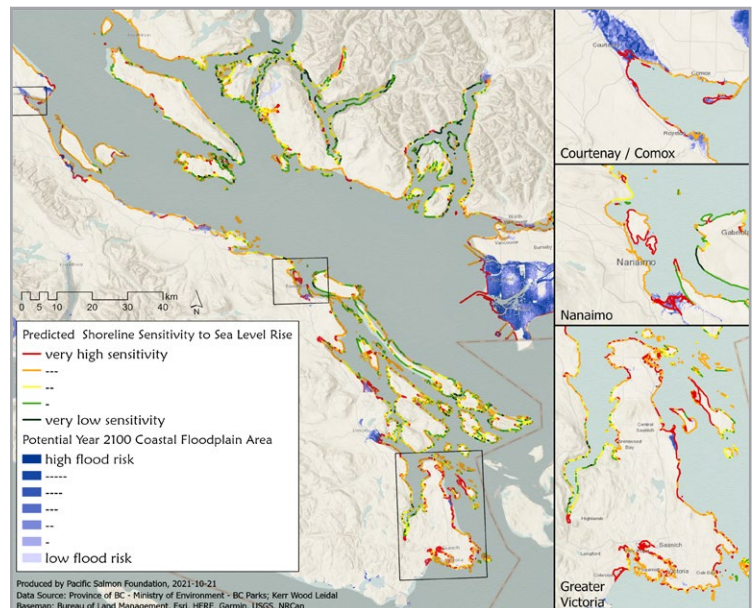


Figure 7 – Maps depicting coastal areas shoreline sensitivity to sea level rise and flood risk in a) Greater Victoria, b) Nanaimo and c) Courtenay/Comox. Degrees of sensitivity marked by red, amber, yellow, green and black in order from most to least sensitive. Areas that are projected to be vulnerable to coastal flooding by 2100 are shaded in blue. Data are from the Province of BC and Kerr Wood Leidal.

Together, the different impacts associated with climate change can work cumulatively to result in even greater consequences and challenges for the environment and people alike. This will be true when higher sea levels and larger and more intense winter storms come together. In addition to increasing sea level, low-lying regions will also experience increasing wind, wave height and storm intensity.⁸ This increase in storm intensity is expected to create even higher storm surges leading to a heightened potential for shoreline erosion, and will cause low lying regions to flood with regularity. By 2050, historical extreme flood events that occurred once per century, are projected to increase in frequency, occurring on average at least once a year in many low-lying regions.¹²

Erosion

Crashing waves hitting higher on the shoreline will cause increased erosion. Coastal bluffs will crumble at greater frequency than they had previously. Shorelines that have hard armour, like rip rap and seawalls, may be undercut causing them to fail. In many locations, accelerated erosion and flooding may damage culturally important places, threaten structures and impact intertidal habitats.



Flooding

Increased precipitation in the fall and winter is likely to create more frequent high river flow and run-off events, particularly because less will fall as snow. This can cause overland flooding and erosion along rivers, which could threaten homes and other structures. Heavy winter rainfall also has the potential to destabilize slopes, which could trigger mass movement events like landslides, as well as lead to blockages of logs and other debris, causing rivers to overflow their banks. Higher flows will impact salmon habitats by lowering water clarity due to increased sediment inputs, scouring spawning gravel and threatening the stability of riparian vegetation that provide salmon shade, cooler waters and insect food sources.¹¹ Stronger flows could potentially make migration much more difficult for Pacific salmon, and wash away salmon eggs from their redds (nests) in the gravel.

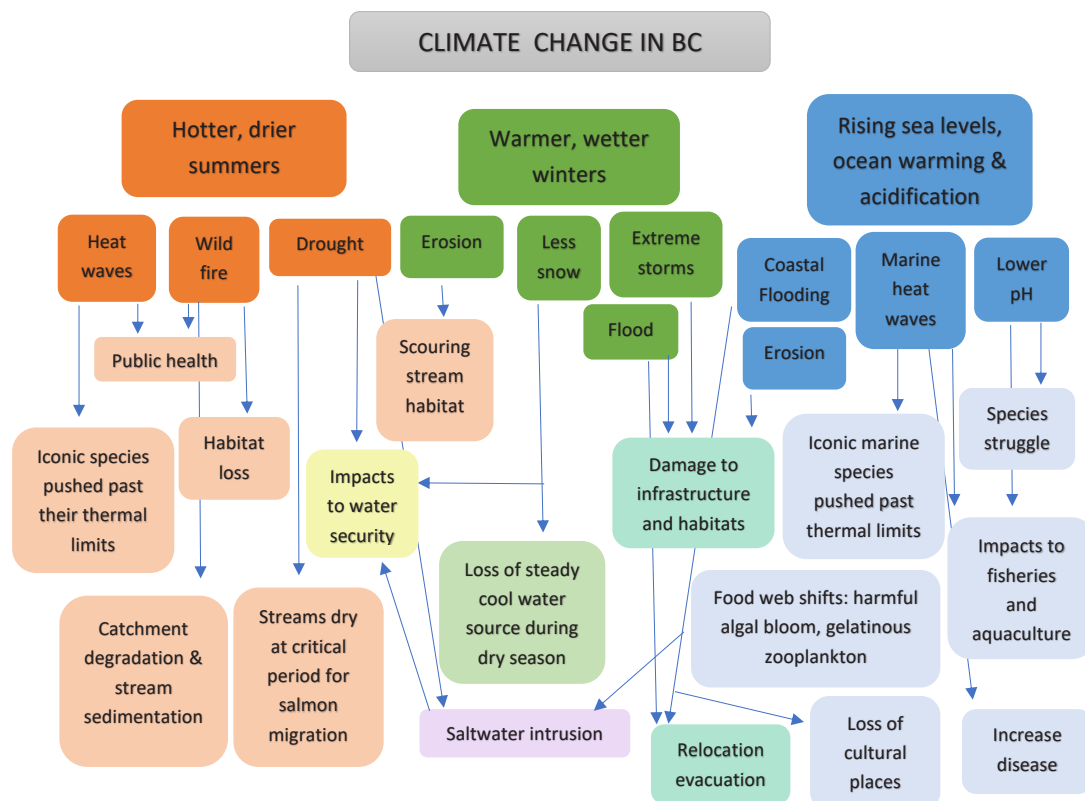


Figure 8 – Various impacts of climate change that are or will likely be felt throughout BC.

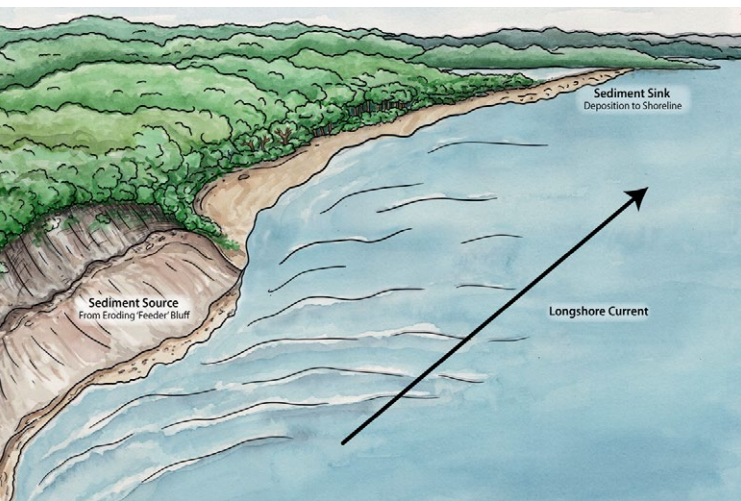


Figure 9 – All shoreline properties are part of a larger system driven by shoreline features: the landscape, as well as wind, waves, tides and currents that continuously move water and beach materials like logs and various sizes of sediment such as sand, gravel and cobbles.

Illustration by: Holly Sullivan

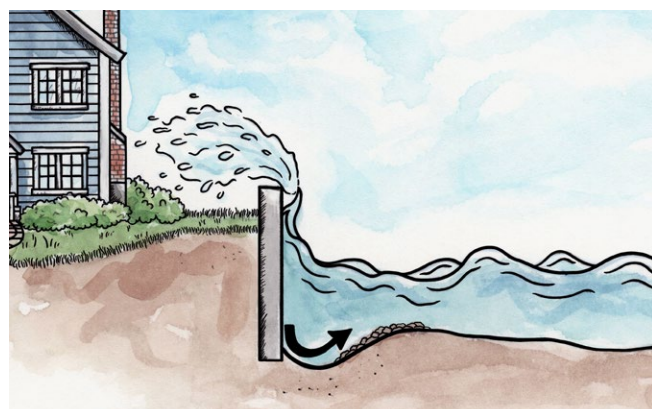


Figure 10 – Coastal squeeze occurs where structures like seawalls impede the natural shoreline to adjust to rising sea levels.

Illustration by: Holly Sullivan

Coastal Modification and Its Impacts on Salmon

Our Dynamic Coast

An ecosystem service that will become increasingly important in the face of climate change is the resilience and adaptive value of healthy intact shoreline systems. Natural shorelines are dynamic and, given the space to move, will adjust to rising sea levels and buffer storm energy. This capacity will help protect our coastal communities from storms surges and higher sea levels.

How Hard Armouring Impacts Coastlines

Development in coastal areas can disrupt natural shoreline processes. In many urban locations around the world more than 50% of the shoreline has been “hardened” by coastal armouring structures like seawalls, rip rap, groins and breakwaters.¹³

Beach Starvation

Deposition and erosion occur in harmony at the shoreline, but when structures like groins are installed, beaches are cut off from their supply of sediment and the dominant process becomes erosion. As a result, areas with hard armour will often experience a shift in substrate type — if the area is sandy, it may become more gravel-dominant, since sediment may no longer be nourishing the area.

Coastal Squeeze

When shorelines are hard armoured with seawalls and riprap, it prevents habitats from naturally migrating landward with sea level rise. As sea levels rise, the high-water line is restricted by these structures and coastal processes are impeded. This reduces intertidal habitat and eventually can cause a complete loss of intertidal areas and the associated species. This is known as coastal squeeze (Fig. 10).

Change along our coastlines is inevitable because that’s what coastal processes do — they make our coastlines dynamic! Any interventions we choose to do are temporary because natural processes will prevail. It is in our best interests to **work with nature, not against it!**



Runoff from Impervious Surfaces

Another consequence of coastal development is increased impervious surfaces, such as pavement, roads and roofs, that can accelerate waterflow into streams and coastal areas (Fig. 11). During stormwater runoff events currents can be altered and may carry away natural sediments as well as pollutants from these developed areas. It was recently discovered that car tires contain a chemical that is extremely toxic to Coho salmon, and road runoff contaminated with this chemical has caused die-offs in local streams.¹⁴

Reducing the amount of armoured shoreline and preventing future armoured is critical to the ecological resilience of BC's coasts. The fact remains that sea levels are rising, and protecting our communities is a priority. Learn about how you can protect your property AND conserve critical habitat through nature-based solutions using the Green Shores® design standard (see page 10).



Impacts to Salmon

Did you know that armoured shorelines impact the diets of Pacific salmon? Studies have found that shoreline armoured reduced the number and diversity of epibenthic invertebrates (critters that reside on or above the rock, sand and mud of the seafloor) compared to unarmoured shoreline.¹⁵ As a result, when young salmon are next to a seawall and other artificial structures, they end up feeding on alternative types of prey that might be harder to catch and less nutritious.

Other coastal infrastructure like piers and docks (also known as overwater structures) can influence salmon behaviour and put them more at risk of predation! Salmon avoid these areas. The lack of light seems to make salmon nervous, they cannot see predators, find ample prey, properly orient themselves, or school together. They end up altering their natural behaviours and avoid the shallow areas that should be their safe havens with plentiful food. Instead, salmon are swimming in deeper water, expending more energy, and exposing themselves to predators.¹⁶

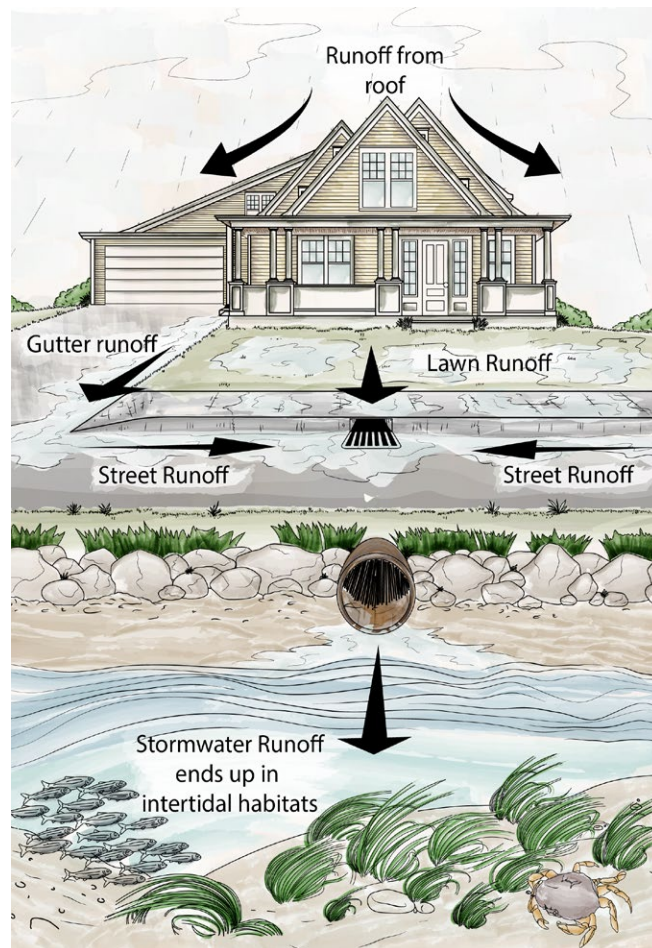


Figure 11 – Typical movement of water runoff to the shoreline via paved surfaces and anthropogenic features.

Illustration by: Holly Sullivan and Ravi Maharaj



Stewardship & Nature-based Solutions

Low Impact Development

Of course, we all want our homes to look beautiful and be functional, and we can use nature-based approaches to reduce the impact of development. Landscape architects can help you incorporate features to create an aesthetically pleasing property that also help reduce and manage runoff. Take a look at some nature-based approaches that can help filter runoff from roads, roofs, driveways and other paved surfaces before it enters our waterways. Not only can we improve the health of our aquatic ecosystems, we are adding habitat value in our communities as well!

- **Installing permeable pavers and systems:** You can replace paved areas with surfaces that allow rainwater to permeate the ground. This can include installation of permeable pavers, gravel or grass grid systems, and specialty concrete mixes, that allow storm water to filter through to the soils below.
- **Using environmentally friendly landscape and building products:** If you are looking to add some structure or walkways in some parts of your garden or property, consider using environmentally friendly materials like recycled concrete, terra cotta bricks, and untreated wood. You can also reduce costs by using materials like natural stones that are already on your property.
- **Creating a rain garden:** A rain garden is another nature-based solution that a homeowner can create to prevent stormwater from reaching the shoreline. Rain gardens are landscape features that are designed to collect, hold and soak in stormwater in depressions planted with native shrubs and flowers. In addition to recharging groundwater, they are highly effective at preventing pollutants from entering our waterways. The plants and soil of a rain garden help to increase infiltration of surface water down into the soil where it can be filtered, and then help to recharge sub-surface aquifers (Fig. 12).
- **Building a green roof:** Green roofs can also reduce rainwater runoff from your home. While constructing a vegetated roof might not be for everyone, a green roof is another example of harnessing nature's ingenuity to reduce runoff as well as insulate your home, increase the longevity of your roof, protect property from fires, create habitat, reduce urban heat affects and store carbon.

Be Water-Wise

- **Planting native species in your garden:** Native plants are better suited to local conditions and will use fewer resources like water and fertilizers, and are more likely to thrive during adverse conditions such as drought (Fig. 13).
- **Carrying out rainwater harvesting:** You can prevent runoff from your roof by collecting rain in rainwater harvesting tanks and other rainwater-capture methods to conserve water resources. Stored rainwater can later be used for your own needs in the garden or around the home.



Photo by: Paul de Greeff

Figure 12 – Mearns Library rain garden at the University of Victoria campus.



Photo by: toinane on Unsplash



Photo by: PSF 2012



Photo by: Kelly Loch



Photo by: Maria Catanzaro

Figure 13 – Plant native salmonberry to attract pollinators and provide a food source for wildlife in your yard!

- **Changing your car washing habits:** You can avoid washing your car over paved surfaces, by either going to a carwash that recycles and controls where its water ends up or wash your car over a permeable surface, such as a lawn, to prevent detergents and residues from your car directly entering storm drains. And remember to check the water restrictions!

Green Gardening

Insects are part of a healthy ecosystem — but in our gardens, we would prefer that insects don't snack on the broccoli and kale that we have grown for our dinner! Unfortunately, traditional chemical pesticides and fertilizers can be washed away with rain and overwatering, impacting nearby waterways. Do your part to keep harmful agricultural chemicals out of local waterways. Here are some tips on how to make your green thumb greener:

- **Manage garden pests through strategies that don't involve chemicals** such as crop rotation and encouraging predatory insects like lady bugs. You can manage unwanted insects in your garden by adding plants like nasturtiums that attract beneficial insects (Fig. 14), or plant species like peppermint that repel aphids. Manage weeds manually and embrace a few harmless dandelions for the bees.
- **Opt for natural nutrients** Instead of chemical fertilizers, consider using compost and plant nitrogen-fixing cover crops like hairy vetch over the winter time to keep your soil healthy. Composted kitchen scraps, manure and/or commercially available composts will release nutrients slowly to feed your plants and improve your soil at the same time. If we treat our gardens as a natural, functioning system, we can avoid the use of harmful chemicals. Learn more on our website (resilientcoasts.ca) about how to keep your garden chemical-free!
- **Reconsider lawns and landscaping** that require lots of fertilizer and water. Instead opt for perennial shrubs and trees and take a natural landscaping approach. Select native species that naturally thrive in our climate and soil conditions, while protecting the shoreline from erosion and providing habitat for insects and organisms. Visit your local native plant nurseries for resources and inspiration (check out the map at resilientcoasts.ca/resource/planting-a-native-garden).
- **Keep Trees and Snags** (standing dead trees) on your property. The foliage of live trees provides shade on the shoreline, as well as habitat for birds and beneficial insects. The roots of live and dead trees help to stabilize the soil, which is especially important on sloped properties. While snags will not produce new foliage, they are valuable as wildlife habitat, particularly for predatory birds like eagles, and cavity nesting species like the pileated woodpecker.
- **Remove Invasive plants** that could be disrupting the growth of native plants. Invasive plants tend to either physically outcompete other plants by shading or crowding, or releasing chemicals that alter the growing environment to make it difficult for native plants to grow. Take the time to remove invasive species like Himalayan blackberry, English Ivy, and spotted knapweed, report occurrences of those species to Environment Canada, and plant native species in their place. Invasives also tend to grow faster than other plants, so it is important to continue to manage those weeds until the native plants have become established and are less at risk of being crowded out.



Photo by: Maylee on Unsplash

Figure 14 – Plant nasturtium flowers to attract beneficial insects that help manage insect pests in your garden.



Photo by: Eva Elijas from Pexels



Photo by: Aaron J Hill from Pexels



Photo by: Maria Catanzaro



Figure 15 – A soft or natural shore offers habitat for many species, including us!

Illustration by: Holly Sullivan

Using Nature-based Solutions to Protect Shorelines

Stewardship of our shorelines provides opportunities and challenges to protect all the things that matter in and around these important areas for current and future generations. And how we approach these challenges will determine if our coastlines can sustain themselves and help us be resilient to climate change. Homeowners are finding that nature-based solutions can be used to protect their waterfront properties while also protecting and restoring habitats. For example, as alternatives to large concrete seawalls, docks with creosote treated pilings, and vegetation that is non-native, these new practices use a combination of structure setback, planting with native species, adding beach nourishment with sand, gravel and large woody materials, and slope modification to protect the characteristics of a natural shoreline while protecting the properties adjacent to them (Fig. 15). This helps to restore and maintain shoreline processes such as sediment movement. Additionally, managing the area above the shoreline, the upland, also benefits shoreline health. Every bit of effort helps reduce the cumulative impact of development on shorelines. Visit our Tool Kit at resilientcoasts.ca/building-awareness/tool-kit to learn more about applying nature-based solutions on your property.

You can take nature-based solutions one step further to receive credits and ratings from Green Shores®. Created by the Stewardship Centre for BC, Green Shores is a voluntary, incentive-based rating program focused on positive steps to reduce the impact of development on shoreline ecosystems. Maintaining and enhancing shoreline habitat diversity and function could include a Green Shores design that preserves or restores the riparian area through the use of natural woody materials, stones, and native plants that are well adapted to conditions of the shore environment (Fig. 16).

Green Shores uses a multi-disciplinary, integrated framework for shoreline management by encouraging adoption of nature-based solutions for the design and construction of projects on marine and lake shores. Those trained in Green Shores can assist homeowners with bringing the right professionals together to help create a restoration plan and process. Learn more about the Green Shores credit and rating system at stewardshipcentrebc.ca/green-shores-home.

Green Shores® Principles

1. Preserve the *integrity and connectivity* of shoreline processes
2. Maintain and enhance shoreline *habitat diversity and function*
3. *Minimize and reduce pollutants* to the shoreline environment
4. Reduce and reverse *cumulative impacts* to shoreline systems



Figure 16 – Using the principles of Green Shores for Homes, you can transform your shoreline from armoured and bare to lush and natural!

Illustration by: Holly Sullivan





Photo by: Bob Oxborrow

Figure 17 – In Seattle, salmon friendly seawalls have been built in the heart of their downtown waterfront. They are made up of glass sidewalks that allow light to dapple through to shallow rocky areas – to support salmon and their prey.

Stewarding Shorelines with Salmon in Mind

While protecting undeveloped shoreline habitat and restoring eelgrass or coastal riparian areas are important examples of stewardship, there are opportunities for stewardship in places where shoreline infrastructure is unavoidable too.

Since it is unrealistic to fully remove urban waterfronts, scientists, planners, and engineers are thinking beyond traditional solutions so that these areas can support more biodiversity once again. Seattle, Washington is leading the way by reconstructing their downtown waterfront with migrating Pacific salmon in mind. In areas that are covered with piers and walkways, they have installed glass blocks and grating that allow light to penetrate through to the water (Fig. 17). On and adjacent to seawalls, they have added surface complexity that mimics a more natural shallow habitat and converted waterfront parks into beaches with backshore habitat value. Together, these efforts turn areas of habitat that were lost long ago into places that are usable again for salmon.

Tips for Salmon-friendly Overwater Structures:

- Use fewer pilings and have your structure sit above the water like a bridge to allow more light to shine through
- Grating can be used in place of solid decking to also allow more light to reach the water below
- Avoid the use of creosoted or chemically treated footings, which are highly toxic
- Build only as many docks as necessary — share with neighbours if possible



Photo by: Maria Catanzaro

Figure 18 – Stewardship on Pender Island — volunteers help prepare eelgrass shoots for restoration in 2019 with SeaChange Marine Conservation Society.



Photo by: Christy Wilson

Interested in keeping our shorelines free of litter? Join a beach clean up event with local organizations like the Surfrider Foundation, World Wildlife Fund and Peninsula Streams Society. Visit resilientcoasts.ca/resource/join-a-local-stewardship-group to learn more!

Become a Steward in Your Community

Stewardship is about taking responsibility to promote, monitor, conserve and restore ecosystems for current and future generations of all species. You can become a steward in your community by volunteering your time with local organizations, donating money, land or other resources to environmental causes, and more!

BOTTOM LINE:

The need to protect communities, properties, culturally important places and resources, and overall ecosystems is urgent. We can choose to **manage our coastlines** to be as adaptive and resilient as possible.

Ultimately, we are all stewards of the shoreline and all citizens can contribute to the health and wellness of our environment! Our actions, small and large make a difference in how our shorelines will function and thrive. **Let's embrace our roles as shoreline stewards!**



Photo by: Mitch Miller

What happens on the shorelines connects us all. Let's act consciously and be stewards to help maintain these incredibly important ecosystems!

Want to Learn More?

Take a deep dive into the resources on our Resilient Coasts for Salmon website (resilientcoasts.ca), where you will find more nature-based solutions in our Tool Kit, and a comprehensive Educational Primer that covers this brochure in more depth.

Also check out the Stewardship Centre for BC (stewardshipcentrebc.ca), which has great information about the Green Shores Program and training sessions.

And learn about all the amazing work happening in the PSF Marine Science Program (www.marinescience.ca) by subscribing to PSF's newsletters and updates.

Open up your phone's camera and hold it over this QR code to continue learning at resilientcoasts.ca!



Your Feedback is Appreciated!

We recognize that many of you are stewards of your community already — please share your feedback with us and keep connected!

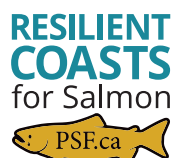
- What does living by the Salish Sea mean to you and your family? Let us know! Write to us and submit your photos of how you interact with your shoreline to salmon@psf.ca
- How can we support your community group? Let us know at salmon@psf.ca

References


1 - DFO. Government of Canada. (2021); 2 - Grant, S.C.H. et al. Canadian Technical Report of Fisheries and Aquatic Sciences 3332. (2019); 3 - DFO. Canadian Science Advisory Secretariat Science Advisory Report 2016/042. (2016); 4 - DFO. Canadian Science Advisory Secretariat 2018/017. (2018); 5 - Insights West. (2021); 6 - Capital Regional District (CRD). Capita Regional District, B.C. Can. (2017); 7 - Oliver, E.C.J. et al. Frontiers in Marine Science 6:734. (2019); 8 - IPCC. (2019); 9 - Hobday, A.J. et al. Progress in Oceanography 141: 227-238. (2016); 10 - Vadeboncoeur, N. Government of Canada, Ottawa, ON.207-252. (2016); 11 - British Columbia Ministry of Environment (MOE). Ministry of Environment, B.C., Can. (2016); 12 - Oppenheimer, M. et al. IPCC (2019); 13 - Gittman, R. et al. BioScience 66(9), 763-73. (2016); 14 - Tian, Z. et al. Science 371, 6525 (2021); 15 - Morley, S.A. et al. Estuaries and Coasts 35: 774-784. (2012); 16 - Munsch, S.H. et al. Journal of Applied Ecology 54: 1373-1384. (2017).



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