Slide 1

How is climate changing in the Gulf Islands?

Presentation to the Islands Trust
October 27, 2020
Ruth Waldick

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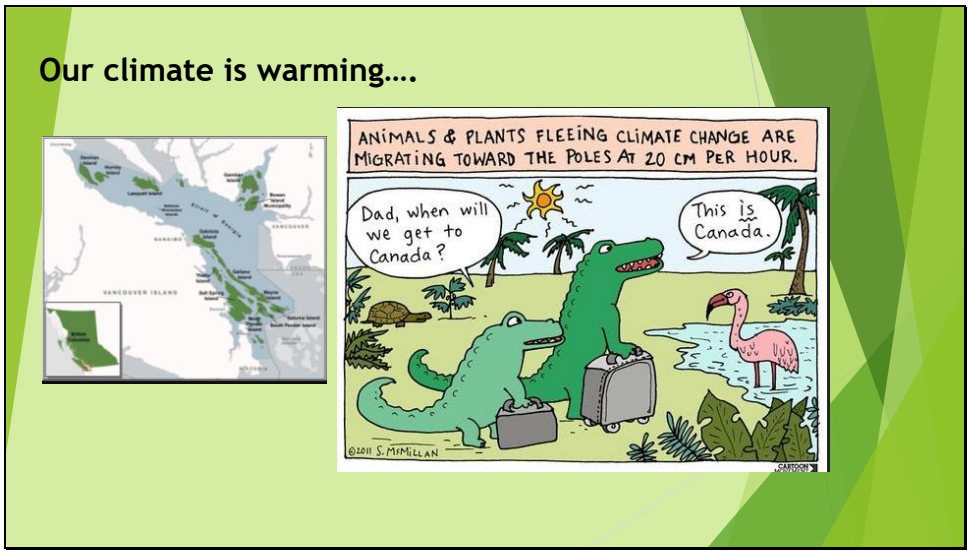

The phenomenon of Global Warming and Climate Change are often discussed in terms of the degree to which the temperature is expected to increase (2 degrees C or 4 degrees C). These numbers give the impression that Canada will be increasingly warmer over time. But these numbers are averages, and averages capturing change over large areas. They have been used to communicate relative change (often referring to global average change), but fail to capture the nuances, that weather variability will increase through all seasons. And that not all areas will be equally affected.

Where we are in the Coast Salish region, climate projections suggest we will experience less severe changes than many other parts of North America. This area has a unique microclimate; weather conditions are more moderate. During the last glaciation, the milder conditions in this area allowed it to serve as a refuge to many species. As the conditions warmed, these species recolonized surrounding areas. In the future under global warming, this region is expected to once again serve as an important climate refugia.

Notes:

- although many of our native species of plants, trees and wildlife are adapted to drought and wet conditions, some are doing better than others…

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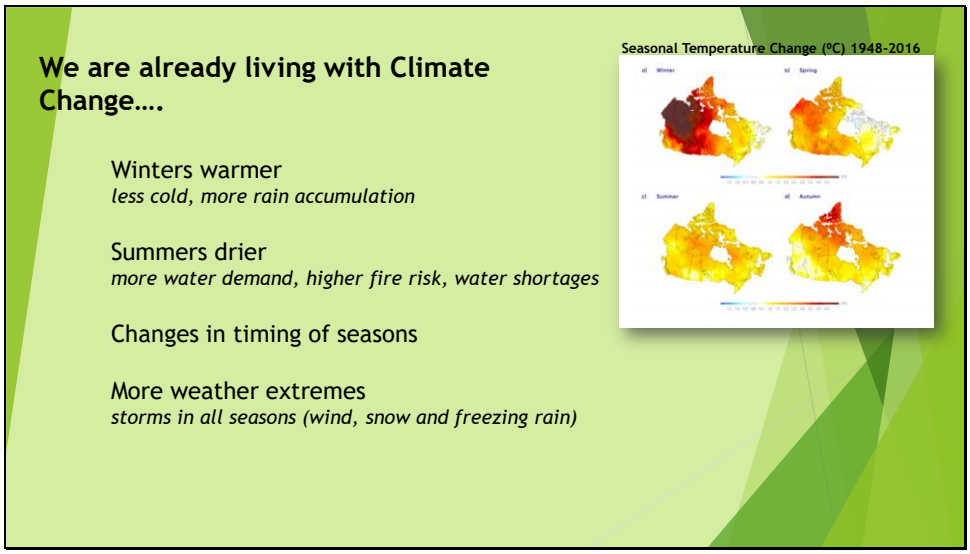

An important point to make about climate change and global warming, is that we have and are already living with it. The map inset here shows how the average temperature increase, by season, across Canada between 1948 and 2016. Although Vancouver Island and the Salish Sea are not visible on this map, we experienced similar trends through this period. However, our average (annual) warming during this time was moderate - ~1.3 degrees Celsius.

We already have a very good sense of how climate change will affect us, as we are experiencing these effects already:

- warming winters (less absolute low temperatures, but still cold bouts); more rainfall in the winter (less in summer), much of which is as single or short periods of intensely heavy rain (~25% comes as such events)
- drier summers – increased water demand and stress on plants, more fire season and higher fire risk (four of worst fire seasons in BC records occurred between 2014 - 2019). The frequency of drought and extreme fire risk years in increasing.
- the timing of seasons is becoming more unpredictable, and variable – as a result of large airshed changes which alter the pattern of El Nino and La Nina
- weather extremes, which are also very difficult to predict or anticipate, are also occurring more often, and during all seasons (wind storms like those seen this October, 2020, and December 2019). With environmental and infrastructure implications, for instance, to services like hydro.

Information from Environment and Climate Change Canada – for more visit:
https://www.theweathernetwork.com/ca/news/article/how-climate-change-could-impact-agriculture-in-canada

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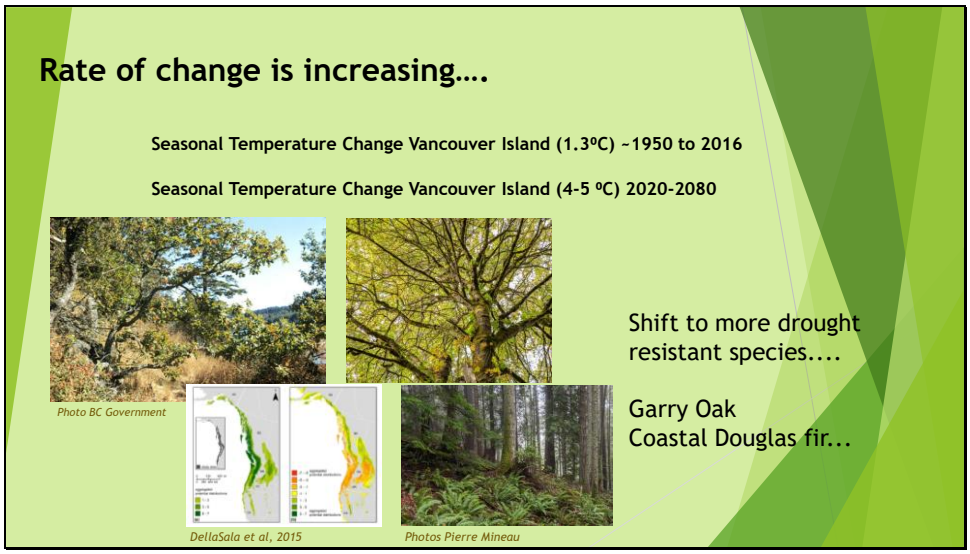

Climate change feels more real to us now because changes are happening more rapidly than in the previous century. The rate of change (warming in this example), in the past 60 years was around 1.3 degree Celsius (Vancouver Island area), whereas, in the next sixty years, we are projected to see warming in the range of 4-5 degrees Celsius.

Increasing exposure to wind, heat, and drought by trees and other plants is becoming more evident in the Gulf Islands. We see stressed trees along road edges. Species range shifts are changing for a number of species, with some expanding and some contracting. Coastal Douglas fir, Garry Oak and Broad leaf maple are all expected to persist during the period of warming. These are more drought adapted. Among those species expected to experience a range reduction are the western red cedar, which are not tolerant of dry and hot conditions. WRC are expected to continue to persist but in protected areas and moist, wetland areas (eg., northern, more protected exposures and wetland areas).

Some interesting reads:

DellaSala, D. A., Brandt, P., Koopman, M., Leonard, J., Meisch, C., Herzog, P., ... & von Wehrden, H. (2015). Climate change may trigger broad shifts in North America's Pacific Coastal rainforests. *Reference Module in Earth Systems and Environmental Sciences.*

DellaSala, D. A., & Hanson, C. T. (2019). Are Wildland Fires Increasing Large Patches of Complex Early Seral Forest Habitat?. *Diversity*, *11*(9), 157.

DellaSala, D. A., & Hanson, C. T. (2015). *The ecological importance of mixed-severity fires: nature's phoenix*. Elsevier.

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The stress on our trees is not just from warming, but also the way we have managed our landscape and forests; human induced fragmentation increases wind, heat and evaporative exposure. As such, trees that are isolated, such as the linear strips along roadsides, experience much greater stress from drought, windstorms and solar radiation. The recent windstorms this month, and the severe one day windstorm of 2019 illuminate the importance of forests being kept intact so as to reduce the direct impacts of weather extremes. These events are also cumulative in their effects. During windstorm events, roadsides and ridges where trees have been reduced to narrow bands, are subject to high windfall and storm damage (with impacts on transportation, hydro, and other costs to communities).

This shift in ecosystems is natural, and many of the Gulf Islands ecosystems (and species) include species with adaptations to drought (and fire). But, given our land use activities, and the growing intensity of droughts and storms, we need to start asking - how will our islands be affected? Where are areas of concern, and what strategies are needed to (understand and) accommodate changes in ecosystem and species distributions? By understanding how climate change is affecting our environment, we can identify how (and where) we can reduce these risks.

It is also important to remember that not all of the stressed trees we see are caused by climate change. During the December 2019 wind storm, a great number of the trees that fell were not part of an intact forest, but were rows of trees along ridges, road edges, or other exposed areas – where **they directly experience the higher temperatures, and the full force of storms.** (human land management effects on forests and plants also include historic and ongoing fire suppression, which has allowed Coastal Douglas fir to expand into areas where they are less well suited and are now showing signs of stress, such as exposed areas at elevation, with little soil and high exposure to wind and heat).

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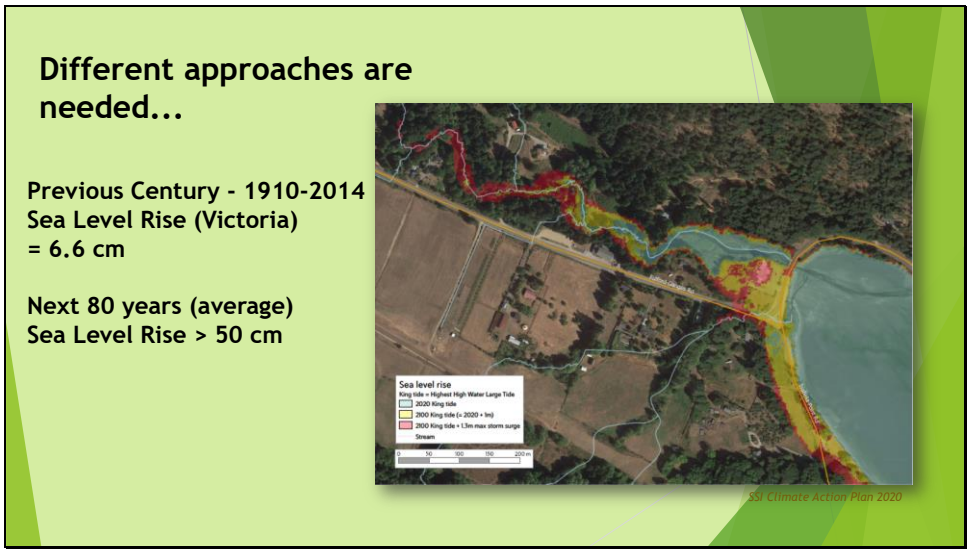

Rates of change are also projected to increase for sea level rise during the next century .
https://catalogue.data.gov.bc.ca/dataset/4458bace-7dc2-4c64-9ec8-c5df75117dbd/

What has worked in the past for us will not be appropriate in the future:
Example from Fulford harbour (Fulford Creek shown). This is a coastal, low lying area dominated by cleared lands and agricultural fields (relying on well water).
The shoreline and creek are already prone to storm surge and inundation (light blue denotes current King Tide level which extends into Fulford Creek). Marine and riparian species are adjusting to changes in saltwater exposure.
By 2100, the CRD is preparing for Sea Level Rise of 1 m. At King Tide, the front during high water - King Tide – appears in yellow (red indicates storm surge penetration). Infrastructure (road and buildings) will be affected and zoning will need to consider not only coastal storm surge, but road closures. A bridge or different road access will be needed to address the inundation of the single road in and out of the lower southwest communities on SSI (an area of especially high fire risk in which the jurisdiction for fire management falls to the Province).

Effects will accumulate: Although the farms and houses further inland will not be directly affected by SLR, the potential exists for groundwater resources to be affected (salt water intrusion). Multi year drought, lack of recharge to aquifers, and sea level rise can act together to increase risk of salt water intrusion into groundwater. For the farms near low lying coastal areas, there are a number of options: withdraw, shift to drought tolerant crops/perennial farming methods, restore or enhance wetlands.

Sea level rise (waves, storm surges, erosion, inundation)

- Inundation – a permanent state change of sea level – shorelines permanently submerged – between 0-90 cm rise over next 80 years (2100)
- storm surge (change in shoreline erosion patterns)
- Salt water intrusion (coastal aquifers and creeks and rivers – changing ecologies of coastal systems – brackish and impacts on well water)
- change in intertidal and marine species distribution

A list of interesting references are presented on Page 10 of this presentation.

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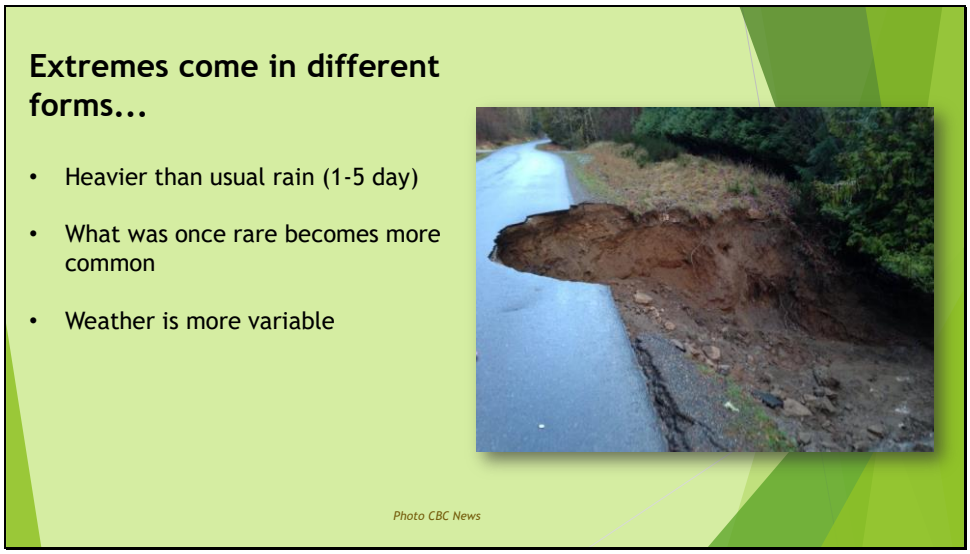

We often think of extreme weather as extreme hot days, or cold days and storms. However, extremes can take different forms. Sometimes the impacts of what seem to be single or 'one-off' extreme weather bouts accumulate over time. One day of heavy rain might not seem like an extreme event. However, extremes need to be considered together, not as single events. Drought and heavy rain in particular combine to great effect.. Droughts stress plants and lead to soil compaction (loss of integrity of soils), this in turns increases stress on plants. Droughts are always followed by heavy rainfall events, which further compact the soil and lead to flash flooding, erosion, and washouts. In other words, droughts can make heavy rainfall events more destructive*.

NOTES:

- Islands Trust Climate Report and other Climate Change Resources: http://www.islandstrust.bc.ca/trust-council/projects/climate-change/
- *Yusa, A., Berry, P., J Cheng, J., Ogden, N., Bonsal, B., Stewart, R., & Waldick, R. (2015). Climate change, drought and human health in Canada. *International journal of environmental research and public health*, *12*(7), 8359-8412.
- "Wildfires are dangerous, so is wildfire smoke" – University of BC https://www.spph.ubc.ca/wildfires-are-dangerous-and-so-is-wildfire-smoke/.
- The 2019 December windstorm was the most damaging storm in BC Hydro's history (https://www.bchydro.com/news/press_centre/news_releases/2019/storm-report-most-damaging-storm.html).
- It would be interesting to note where most of the windfall occurred, was it along roadsides? How did intact forests stand up? These are the types of analysis required to help us reduce risk from extreme storms and weather.
- Year over year drought (increasing number of days without rain) the Islands Trust Climate Report suggests 35 days (just over one month) are expected without rain by 2050, although this is an average for the region, and will also vary by location and island…. The post effects of poor land management decisions combined with storms work together to increase fire risk the following season.
- The highest period of drought (summer) coincides with the highest demand on water on our islands - the growing and tourist season - and the period of high fire risk.

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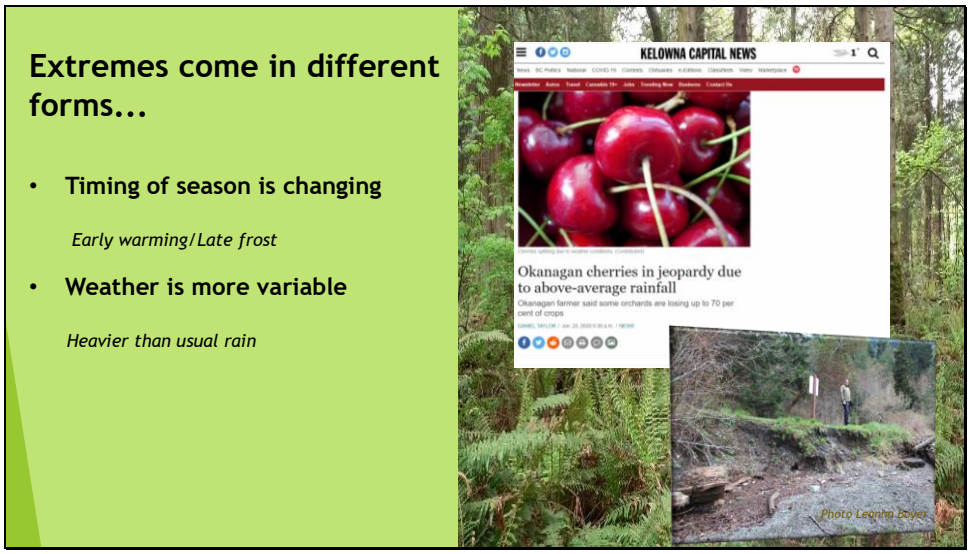

Shifting seasons

The timing of seasons is changing. When combined with increased weather variability, this is having impacts on agriculture, water cycles, and natural systems.

Examples:

- Implications on salmon spawning in the autumn – as delays in rainfall mean that salmon remain offshore facing increased period of harvesting/predation, and energy demands prior to spawning.
- False starts to flowering season – unusually warm early springtime temperatures can induce buds to open. If followed by seasonable frost nights, this can damage or kill buds affecting fruit production.
- Unseasonable, heavy rain and cloud in 2019 threatened fruit crops in the Okanagan as the fruits were at risk or disease and rot. Such effects can be great for agriculture and natural ecosystems, including both marine, freshwater and forested systems.

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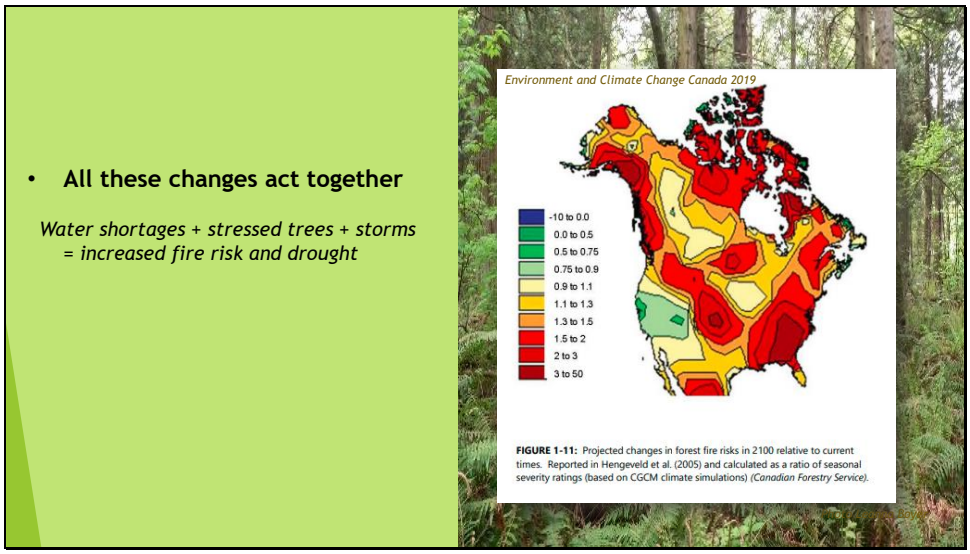
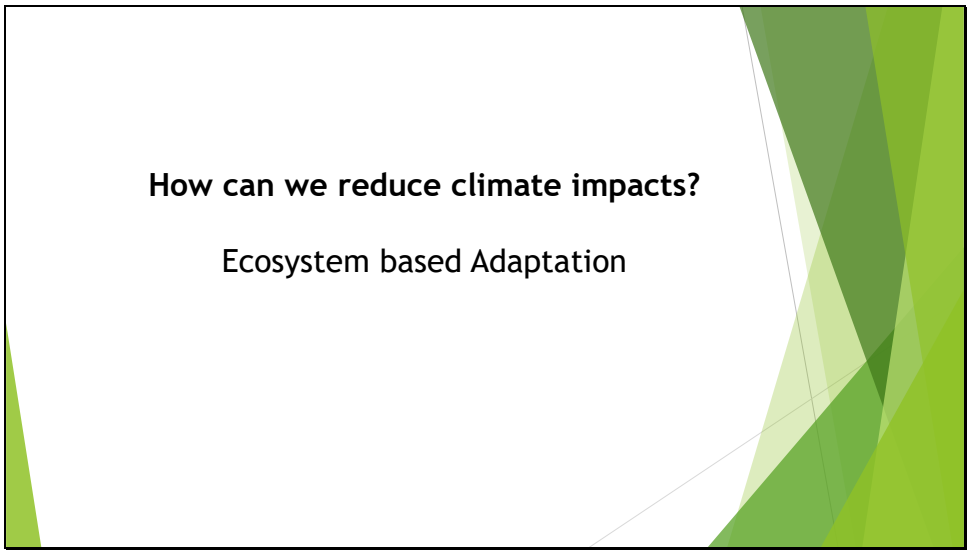


Multiple years of drought (increasing number of days without rain) are already being observed, with accumulating effects on our ecosystems. The Islands Trust Climate Report projects 35 consecutive rainfree days (just over one month) by 2050. Estimates to 2100 suggest 90 days without rain, which will be seen in the summer months. In both cases, these are averages for the region, and will vary by location and by island…. And their severity will depend on current land use, past land use decisions (eg., fire suppression and fuel loads), and how they manifest. The highest period of drought (summer) coincides with the highest demand on water on our islands - the growing and tourist season - the period of high fire risk.

NOTES:

- Islands Trust Climate Report and other Climate Change Resources: http://www.islandstrust.bc.ca/trust-council/projects/climate-change/
- Outlook North American Fire Assessment: US, Canada, Mexico. 2020. https://www.predictiveservices.nifc.gov/outlooks/NA_Outlook.pdf
- We know between 2014-2019, BC had four unprecedented fire seasons since this was first recording. This indicates that fires are becoming larger and occurring more frequently, generally in areas of human activity or occupation. As islands, it is going to be important for us to adapt and manage our fire risks locally, because it may take time for outside resources to come to assist if fires are occurring throughout the province….
- We also know that the impacts will differ on different islands and different regions of an island, so we must consider CC impacts relative to where we are – no single approach to CC adaptation – *no one size fits all..*
- A recent analysis of the causes of the unprecedented fires in BC during the summer of 2017 found that human activities were a significant factor (https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018EF001050)
- "Wildfires are dangerous, so is wildfire smoke" – University of BC https://www.spph.ubc.ca/wildfires-are-dangerous-and-so-is-wildfire-smoke/.
- The 2019 December windstorm was the most damaging storm in BC Hydro's history (https://www.bchydro.com/news/press_centre/news_releases/2019/storm-report-most-damaging-storm.html). It would be interesting to note where most of the windfall occurred, was it along roadsides? How did intact forests stand up? These are the types of analysis required to help us reduce risk from extreme storms and weather.

Slide 10



INTERESTING REFERENCES AND CLIMATE RESOURCES FOR OUR AREA: Sea Level Rise

- http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/452793/sea_level_changes_08.pdf
- https://www.crd.bc.ca/docs/default-source/climate-action-pdf/reports/2017-07-17_climateprojectionsforthecapitalregion_final.pdf?sfvrsn=bb9f39ca_12
- https://www.cbc.ca/news/canada/british-columbia/climate-change-report-bc-coastal-cities-1.5083449
- https://www.crd.bc.ca/about/data/climate-change/coastal-flood-inundation-mapping-project
- https://www.bcagclimateaction.ca/wp/wp-content/media/RegionalStrategies-VancouverIsland.pdf
- https://www.fws.gov/pacific/Climatechange/changepnw.html
- https://coast.noaa.gov/slr/#/layer/slr
- https://northsaanich.ca/wp-content/uploads/Relative-Sea-level-Project-in-Canada-Adjacent-Mainland-US.pdf

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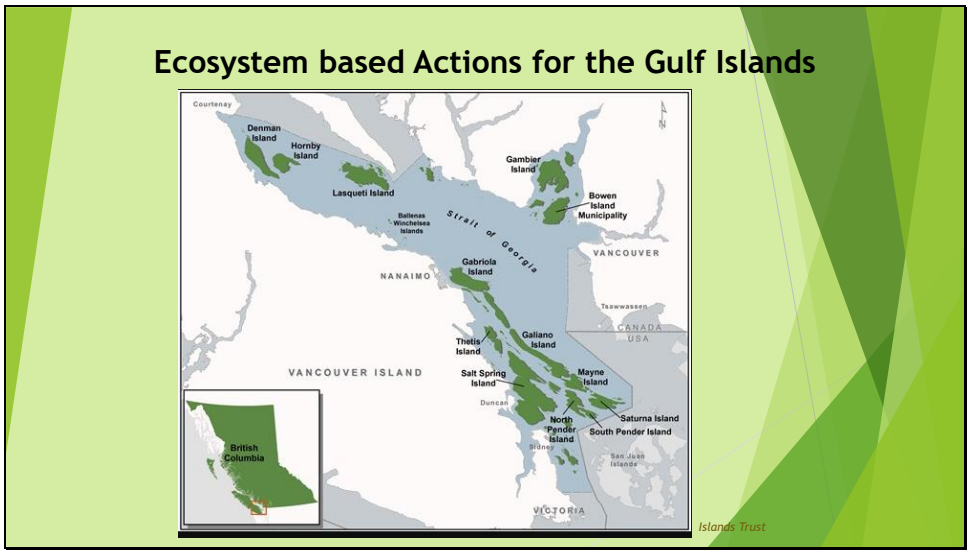

Our focus today is on the benefits of ecosystem based approaches in adapting to climate change. This approach recognizes that our environment is being affected by climate change in ways that affect its' ability to sustain the ecological services (water and nutrient cycles, fire risk reduction, food provisioning, etc) that we have relied on.

EbA is also an especially useful lens with which to consider climate impacts, risk and adaptation, because this approach considers multiple risks and solutions. In other words, rather than considering fire risk management as a means to reduce risk to property and people, fire risk is viewed in terms of holistic risks to water supplies, wildlife, clean water, nutrient cycles, food production, collectively. It recognizes the role of our natural system in reducing our vulnerability to climate change (especially extreme weather), and as the most powerful means of reducing GreenHouse Gas Emissions.

This requires a different approach to what we are used to. I will walk through an example drawn from the Salt Spring Island Climate Action Plan Risk work I was involved with during the past two years in which we asked the questions – what are the risks to SSI from climate change? Where are we most vulnerable? And what can we do about it? (CAP 2.0 https://www.saltspringclimateactionplan.com/).

INTERESTING REFERENCES:
https://transitionsaltspring.com/ssi-climate-action-priorities/
https://webinars.ethelo.org/

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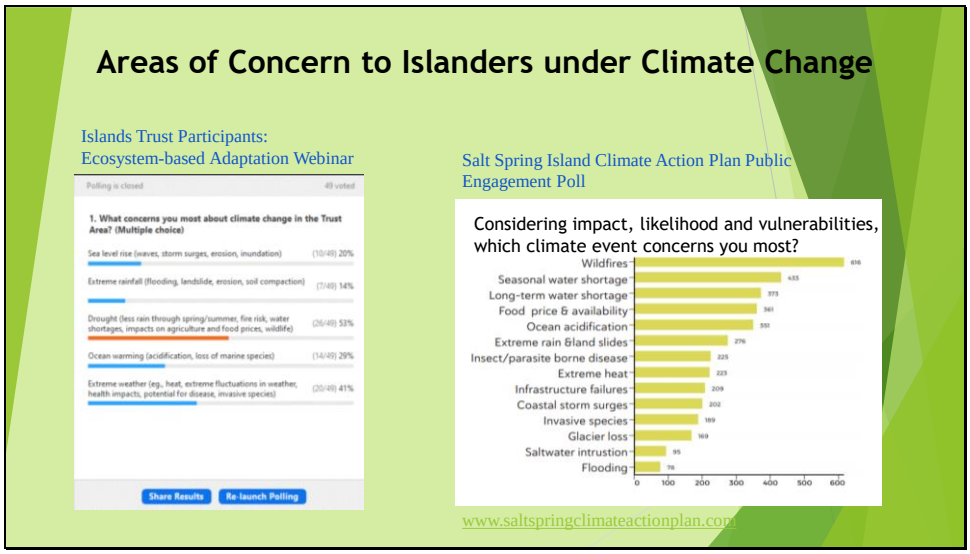

I asked for this poll to be taken among the participants of our Islands Trust Webinar on Ecosystem based Adaptation (EbA) to get a sense of whether or not the priorities were similar or different among those on this webinar. Drought and associated risks (fire, water shortages, stress on natural and agricultural systems) was by far the top concern. Similar priorities were seen among community members on SSI during our public engagement part of our Climate Action Plan (CAP), with fire, drought, and food impacts comprising the areas of impact of greatest concern.

For the remainder of the webinar, I will walk through some concrete actions that we can take to reduce our vulnerability to fire where we live. These actions arose from our CAP for SSI. Our risk analysis identified the single most important action we can take to reduce many of the greatest impacts from climate change as **protecting existing forests**. Particularly older trees. This work included input from local ecological, fire, water, carbon mitigation and land use experts - https://transitionsaltspring.com/ssi-climate-action-priorities/).

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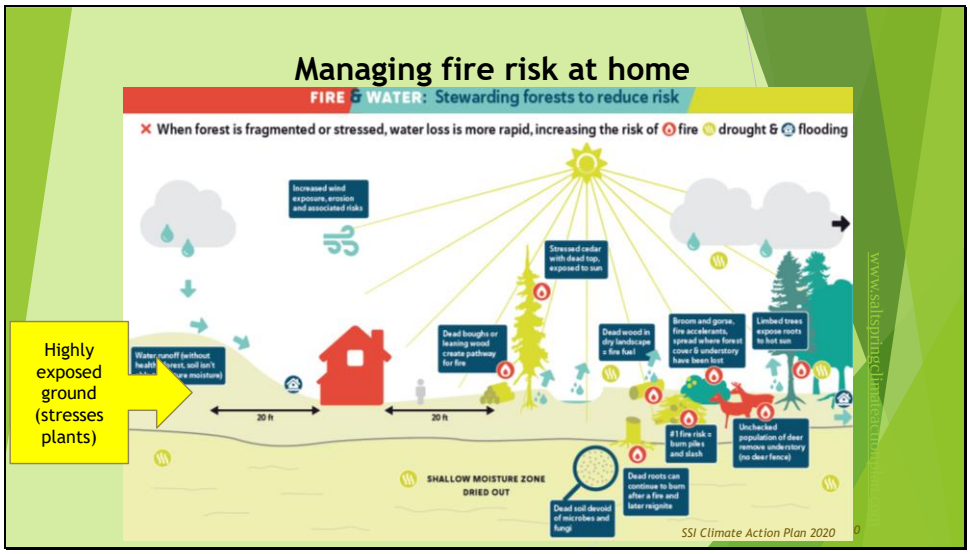

Take Stock of Risk from Fire:
To consider fire risk, the first step is to understand what makes us vulnerable (and where). This diagram highlights many things, but there are two I want to focus on. First:

- **Dry, exposed soils**

Presence of exposed, soil. This creates an environment of extremes, where local climate conditions are stressful for most plants and soil organisms. This has the effect of reducing organic content in soils, and biological activity (and water retention capacity). The absence or low number of roots (or shade from above ground plants and trees) increases soil surface temperature, evaporative losses and erosion. These changes in soils affect water cycle and water retention, but also the levels of heat, exposure to wind (erosion, windfall) and microclimate. These exposed areas create circumstances that affect moisture conditions locally through:

- soil compaction
- increase risk of erosion and flash floods (related to compacted soils)
- runoff following heavy rains (as predicted in winter months, as extreme rainfall events) leading to increased surface flows into water courses (marine and freshwater), and reducing potential groundwater recharge
- absence of vegetation to slow runoff and root systems to slow surface water and facilitate soil penetration

NOTE It is estimated in our area that **27%** of our total annual precipitation will occur in the winter months as extreme rainfall events **(1-5 day duration)**. Such rains are unable to penetrate into dry soils, particularly after summer droughts and heat (which are projected to become the norm leading into winter rainy season).

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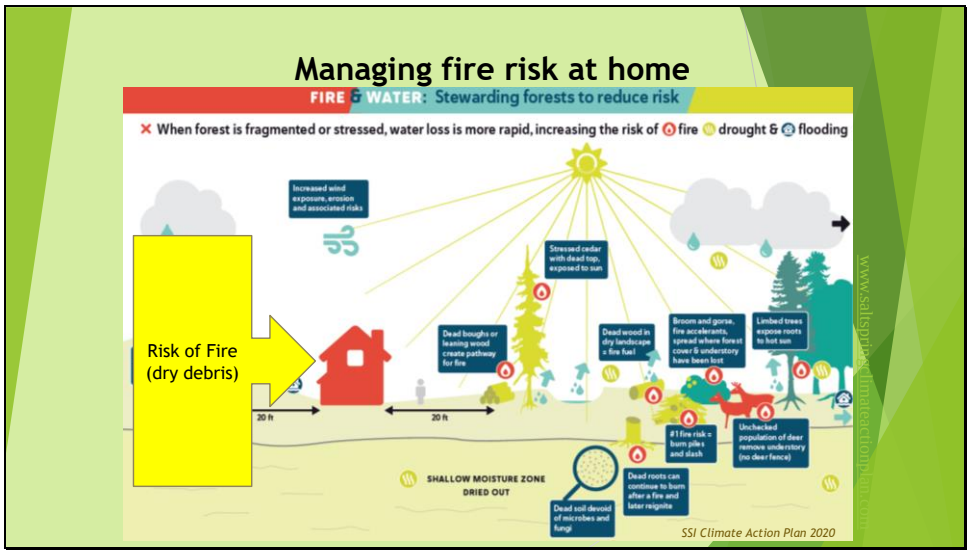

Take Stock of Risk from Fire

Second, is to look at for hazards. These can be exacerbated by the exposure of a site such as in this example. Exposed areas are prone to heat and weather extremes. By contrast, forest species act together in moderating local conditions. In isolation and in exposed conditions, these same species will be highly stressed. Some are more susceptible than others (eg., western red cedar). By contrast, Garry Oak, Arbutus and Ocean Spray are examples of species that can do well under these conditions.

ii) Dry exposed areas are subject to increased fire risk as a result of:

- increased potential for heat (and drought) in the summer
- increased stress from exposure to wind, heat, and drought of trees and vegetation
- increased evaporative losses from soil, exposed wetlands, ponds, etc
- erosion of soils and risk of landslides (during wind events and heavy rain, respectively)
- loss of soil moisture and therefore, loss of vegetation
- woody materials will be exposed to heat, sun and wind, which causes them to dry and become hardened, and highly flammable (eg., fire wood, stumps and logs or woody debris in open, dry conditions)
- isolated trees, especially western red cedar, seen in this example, are especially stressed by heat (of roots), wind and sun (evaporative losses), and wind (windfall). This leads to their death, and the loss of branches (with fire laddering risk), over time, creating fire risk.

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Top action to reduce fire risk where you live from our SSI Risk Analysis (relevant to coastal Salish Sea communities and Gulf Islands, and can be applied to larger scale)

Although I am focusing on adaptive benefits of protecting forests, I want to mention the results of a study on the loss of carbon through clearcutting we did on SSI. A forest carbon modeller and local ecologists measured the loss of trees to consider age, species, and biomass (above and below ground) to calculate the loss of carbon through clearcutting. Looking at one 10 ha clear-cut (which included 90 year old Douglas fir and took place over approximately 2 years), emissions were found to equal ALL car/ferry traffic on and off Salt Spring Island over one (normal) entire year.

This undoes very quickly all the gains in other areas, including switching to EV's and retrofitting homes to increase energy efficiencies. Replanting these areas is not the solution. To recover the emissions from the loss of this forest, which contained a number of moderately older trees, requires nearly 100 years. This is just to REGAIN THE CARBON THAT WAS LOST from this single 10 ha forest. Not only a loss, a step back. Replanting is not equal to protecting our forests.

Forests can also be managed to slow the spread of fire. The structure of forest stands also reduces windsheer, moderate air temperatures through shading, build soils, and the roots help to reduce surface flows and erosion, while increasing water uptake deep into the soil. In fact, keeping large trees within forests has been identified in silviculture as key to reducing fire spread.

By protecting existing forests (and enhancing their structural and species diversity and size – they help to reduce exposure and risk from drought and heat). There are many benefits (see above), from protecting forests and native vegetation – notably managing (reducing) fire risk, supporting and sustaining water cycles, reducing erosion and flooding, and moderating temperature extremes.

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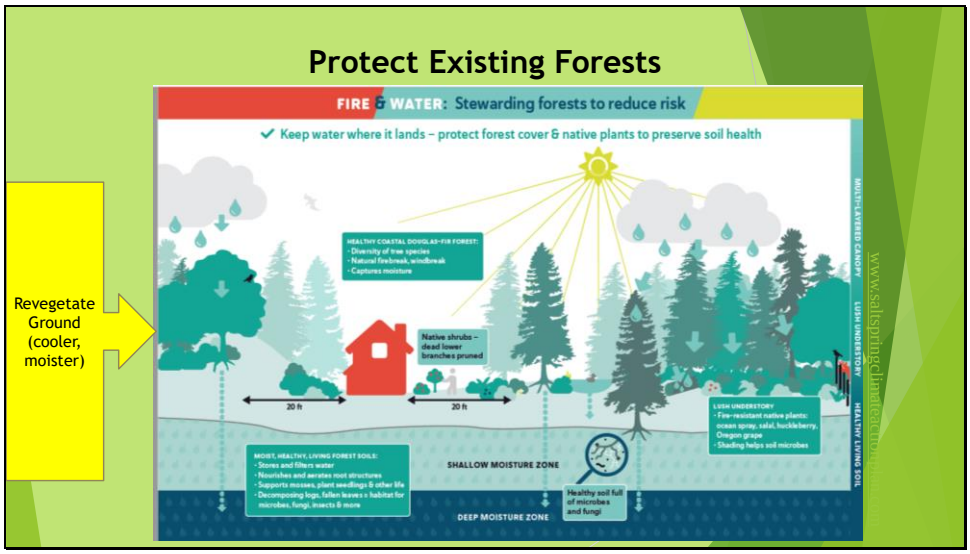

Benefits of Vegetation

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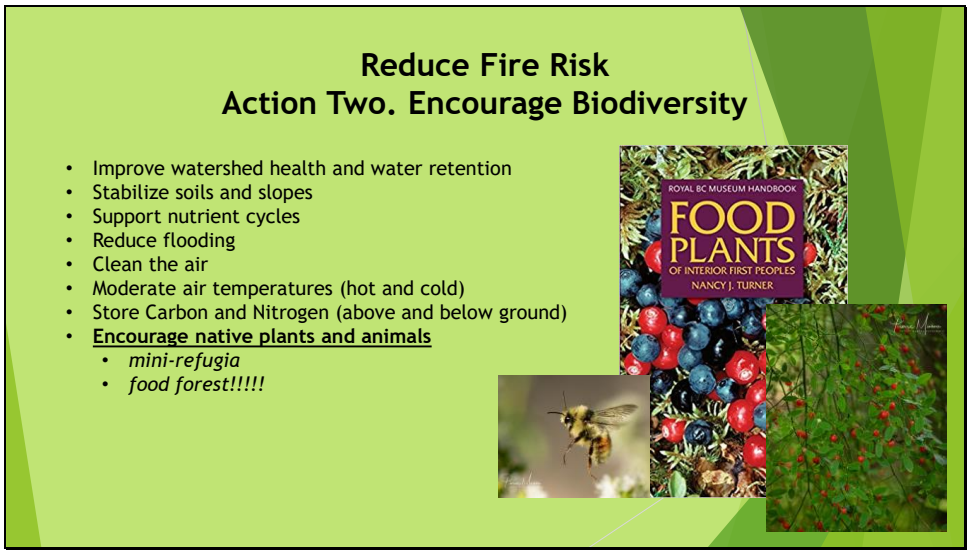

Action two: encourage biodiversity to build healthy soils that can better support plants and trees (and resist drought, extreme weather, etc).

Encouraging native plants and animals, including helping to maintain areas of contiguous forest and connectivity (especially around watersheds), increases resilience of ecological functions and natural water and nutrient cycles. It also helps to ensure that species can adjust their range in response to climate change, and to adapt, or shift as needed.

This adds to the benefits of fire risk reduction. It also protects native biodiversity in this unique region of the world. A number of native plants in our area are also fire resistant and will help slow the spread of fire, as well as providing direct benefits to plants (and local agriculture) through pollination services for our gardens, food (thimbleberry, huckleberry, salal, etc), and beauty.

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Action three: To really understand risks around your island, and to become a steward, you need to get to know your local environment. Are you in an important water recharge area, is the forest near you part of a contiguous area of forest that it is important to protect for the watershed? For Biodiversity? If you are on a farm, what is the state of your water? What plants and ecosystems might be contributing to your local water or natural ecosystems (eg., wetlands, riparian areas).

Change is not new in this area; changes have been experienced through the Salish Sea for thousands of years. Glaciation, mini-ice ages, and now, a period of rapid warming. We need to make time to understand our local ecosystems, but also weather and how it affects our environment. Traditional Knowledge (TK) of the Salish Sea is extensive, constituting a long term perspective, based on observation and experience with change (and the importance of weather Matthews and Turner, 2017).

The way we manage our islands can put us at risk (left photo) or, alternatively, can be used to support us. Farmers and other rural residents have been using EbA for thousands of years. Modernization and automation have changed farming practices toward efficiencies of production. The photo on the right shows Foxglove Farm on SSI, these farmers have adopted more traditional farming practices that acknowledge the importance of the surrounding forest in enhancing water resources, reducing risk from drought and storms (eg., windstorms), moderating the microclimate (humidity and temperature), building soils, enhancing pest and pollination services… etc.

Find ways to learn about local weather, seasons, and ecological knowledge from local knowledge holders.

Mathews, D. L., & Turner, N. J. (2017). Ocean cultures: Northwest Coast ecosystems and indigenous management systems. In *Conservation for the Anthropocene Ocean* (pp. 169-206). Academic Press.

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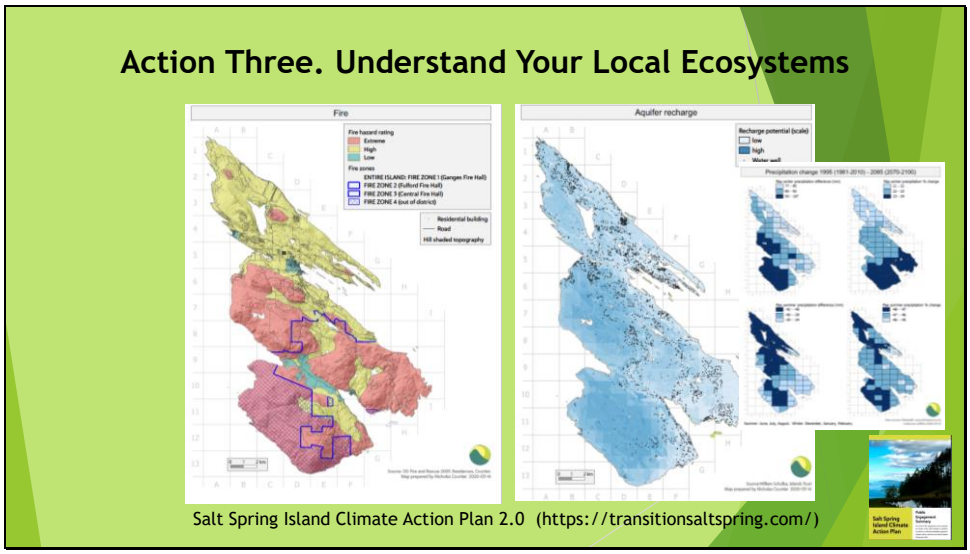


The risk assessment on Salt Spring for our CAP 2.0 started with taking stock or risks on SSI. Not all risks are caused by climate change, and, in fact, many of the risks we face are a result of the approach we have used to manage and modify land (land use). Fortunately, more appropriate forest and land use management practices are being defined to reduce fire risk and protect local watersheds, rural communities and natural systems. It is a matter of changing how we do things, starting with understanding risk.

As part of our risk evaluation for the whole island, we have begun to 'layer' the various risks, to help identify areas of particular importance (priorities for action). This step also helps us to initiate the conversations among different responsible authorities and groups to work together. What you see here are two map layers used in our expert discussion about risk from fire (left) and vulnerabilities to our watersheds and groundwater resources (centre). The map on the far right shows how rainfall is projected to change on SSI seasonally, and spatially. The combining of information in this way allows future risks to be discussed with greater insight. **For those interested in looking more deeply into risk mapping techniques – examples may be found at:**
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1559762/#!po=31.8182 ;
http://www.columbia.edu/~amd155/de%20Sherbinin_etal_2019_ClimateVulnerabilityMappingSystematicReview_WIRES-CC_submitted_version_Sept2018.pdf.

Forests, watersheds and natural ecosystem information can now be added as an overlay, along with projected climate impacts, to help islanders (especially Islands Trust and IT Conservancy) identify areas of greatest concern, greatest potential value, including those actions that can serve multiple priority goals (eg., forest protection and its role in regional fire risk reduction, watershed protection, and retention and protection native biodiversity).

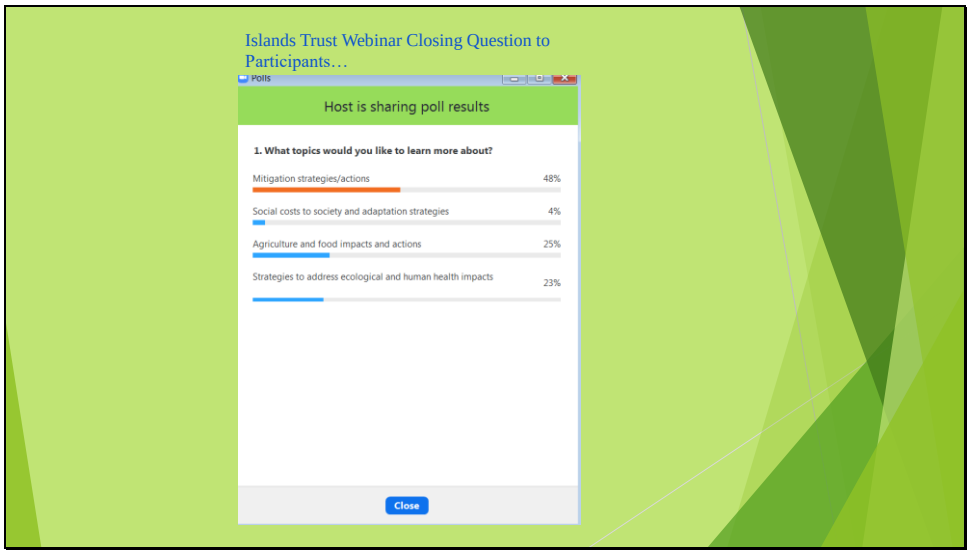
Slide 20

Summary of actions you can take where you live….

Slide 21

Please sign up to receive news and information as it is released from the SSI Climate Action Plan - https://www.saltspringclimateactionplan.com/

Slide 22



Results of final poll of webinar participants, indicating topic areas of additional interest (note: mitigative actions were a top priority).