Slide 1

Goodmorning folks! My name is Kellie Merrell, I'm an aquatic ecologist with the Lakes and Ponds Management and Protection Program and for over 20 years it has been my privilege to monitor the status and trends in Vermont's inland lakes for compliance with the Clean Water Act and Vermont Water Quality Standards. Today, I'm going to give you some background as to why Natural Shoreland Erosion Control is so important to our lakes to help put today's training into perspective for you.

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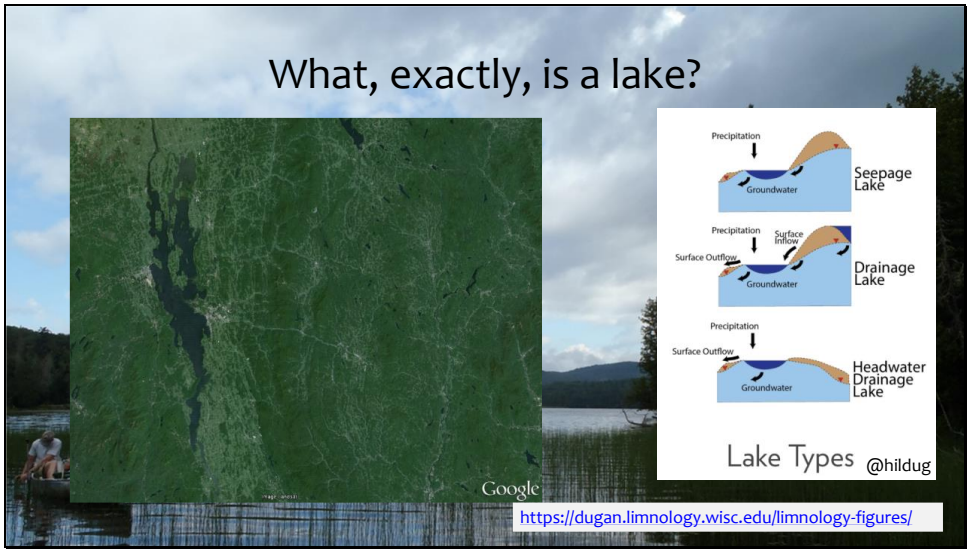

But first, let's start by defining what, exactly, a lake is. Lakes and Ponds are depressions in the land where water collects. They are permanent and they hold a large amount of water year-round.

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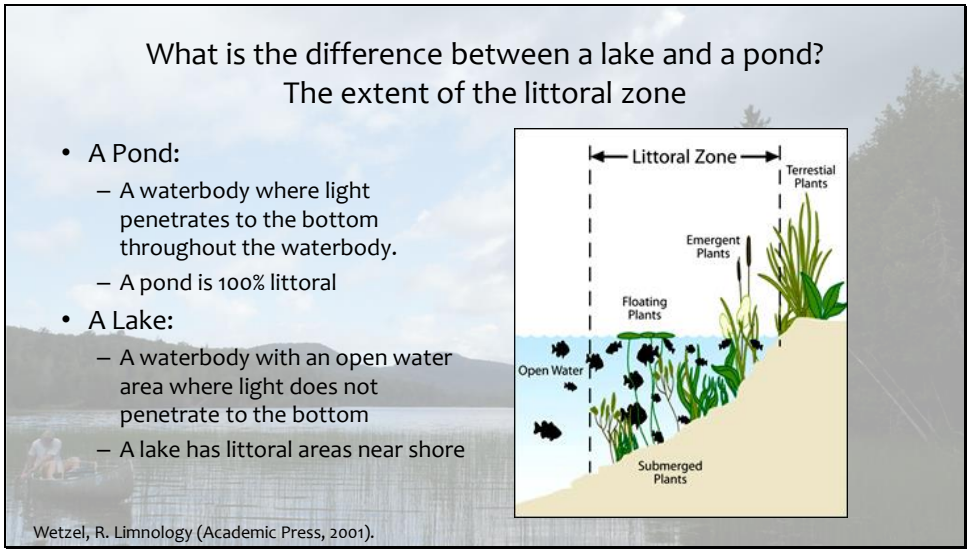

In the study of lakes, the field called Limnology, lakes and ponds differ from each other in terms of depth. The Limnology textbook defines a pond as a waterbody where light penetrates to the bottom throughout the waterbody and hence aquatic plants can grow everywhere. We call the area that light penetrates, the littoral zone. In contrast, a lake is a waterbody with an open water area where light does not penetrate to the bottom, this area tends to be cold and dark and plants don't grow here

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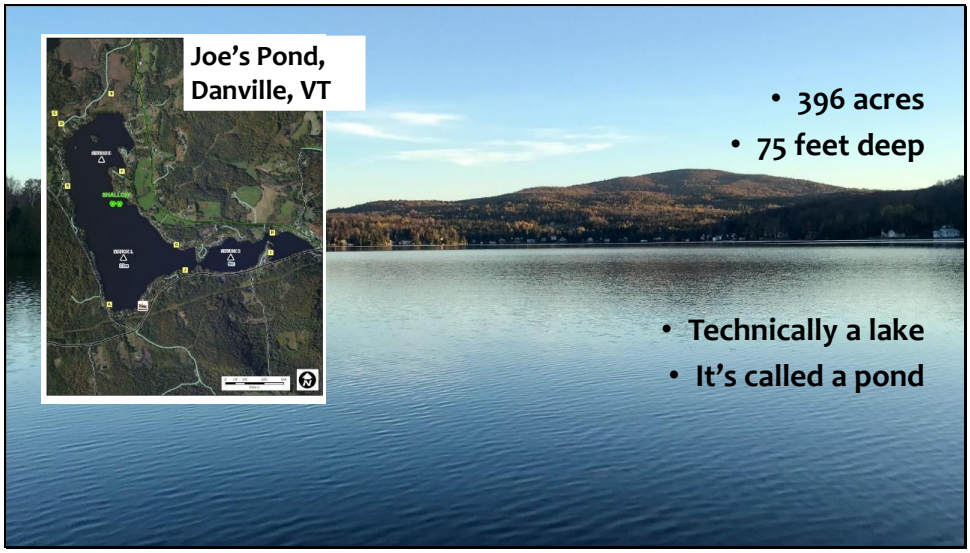

But what we call lakes and ponds is whatever we like. So, this is an example of a lake that's called a pond.

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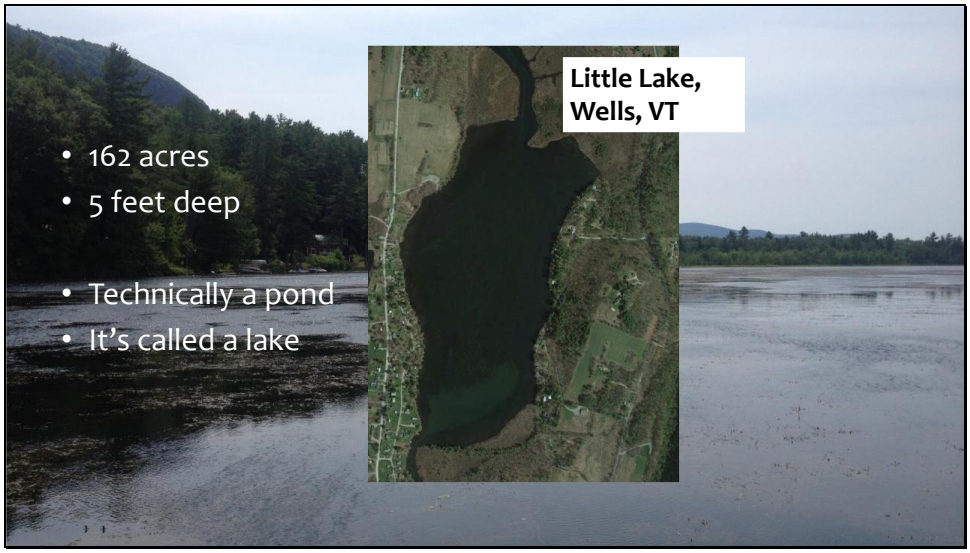

And this is an example of a pond that's called a lake. So hopefully, that now clarifies any confusion you have had over the years about what's the difference between lakes and ponds and why we call them what we do!

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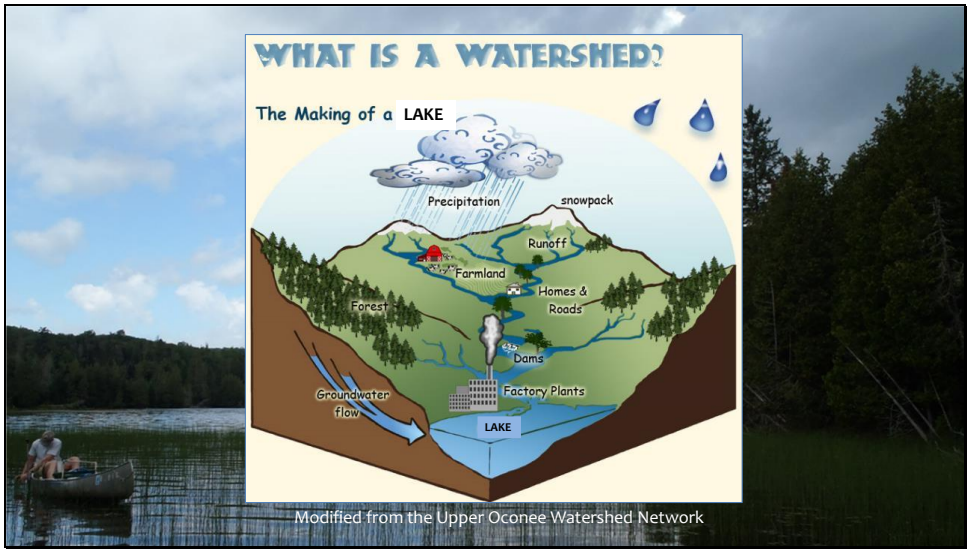

Lakes and ponds are the sinks or basins where the water from the watershed ends up. And many of the activities that humans do on the land in the watershed, despite being miles from the lake or pond, can result in delivering pollution to a lake. Hence, we have all kinds of regulations and voluntary activities geared toward protecting our lakes and ponds in the watershed miles from them.

Slide 7

We have stormwater regulations that box stores like Lowes have to comply with,,

Slide 8

…that ski areas have to comply with

Slide 9

And wind farms have to meet

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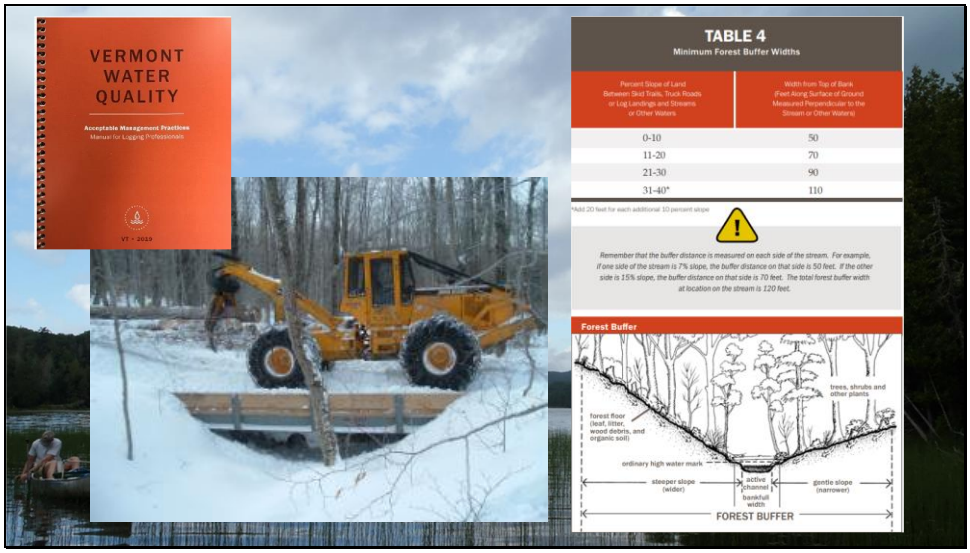
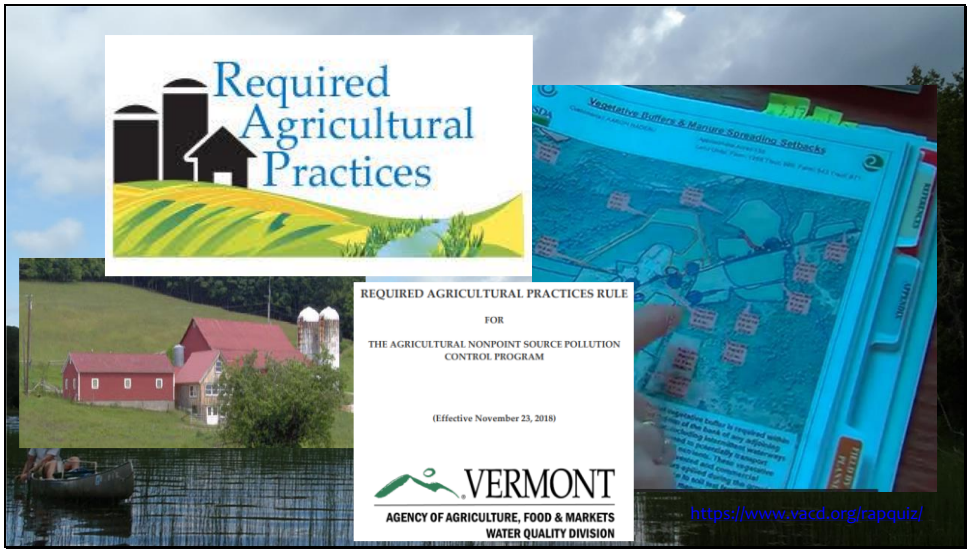


We have acceptable management practices that logging operations must meet.

Slide 11



And we have required agricultural management practices that farms have to meet.

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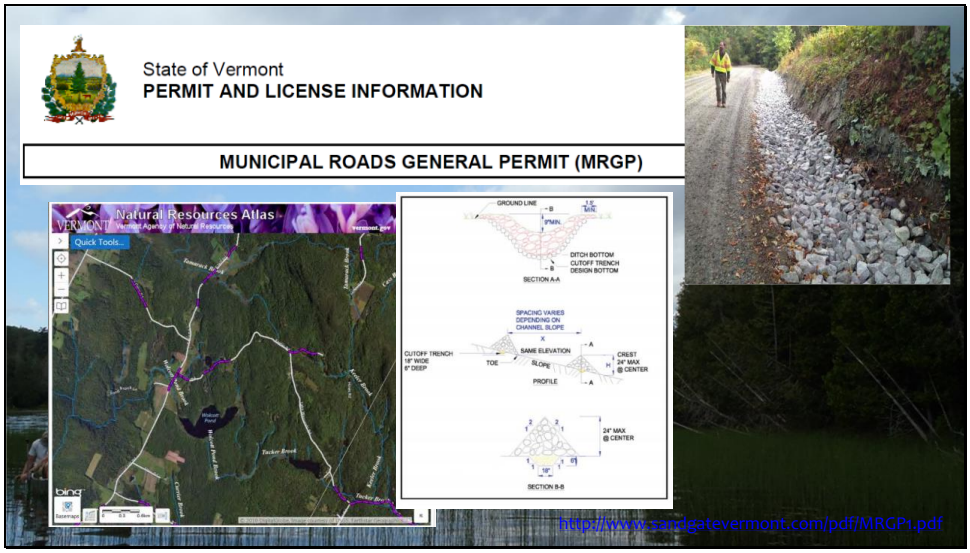

Towns now need to bring their non-compliant hydrologically-connected roads up to new standards through the Municipal Roads General Permit

Slide 13

We have individuals picking up their pet’s waste and we even individuals picking up other people’s pet waste.

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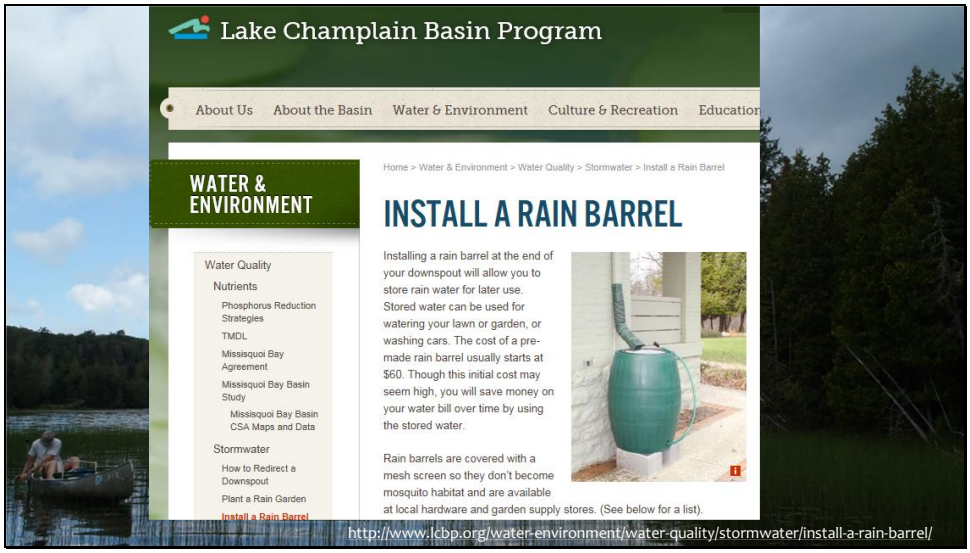


We have homeowners putting rain barrels on their house to intercept the runoff from their roofs.

Slide 15

We have parks putting in pervious pavement to infiltrate the water.

Slide 16

All of these people, municipalities, farms and businesses are doing these practices to reduce the pollution they send to our lakes and ponds. So we can all, including owners of lakeshore residences, enjoy our lakes now and into the future.

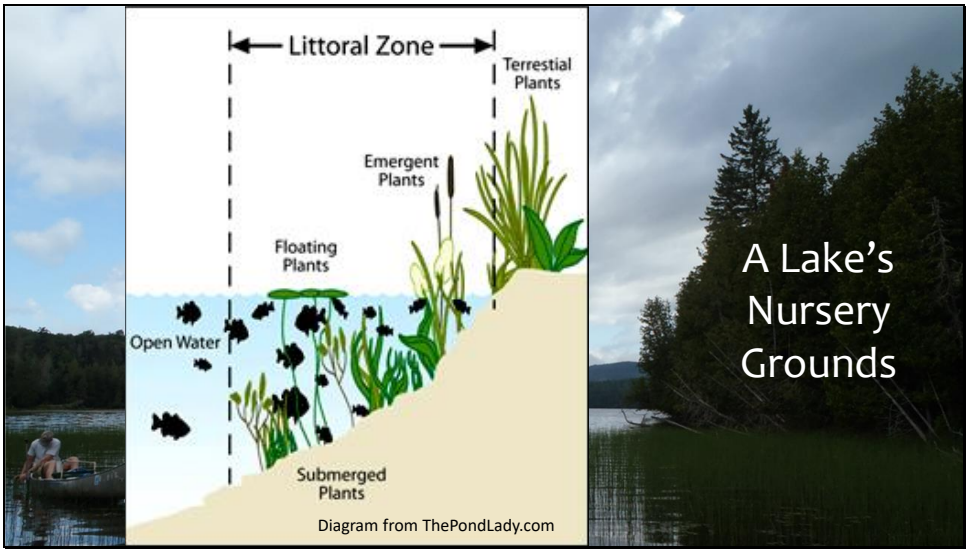
Slide 17

But what happens on the lakeshore is important to a lake or pond as well. All of these development practices were legal in Vermont until 2014.

Slide 18

This development happens in what is a critical habitat area of a lake and in addition to the impact it has on the lakeshore habitat it also impacts the

Slide 19



The littoral zone, which is considered the nursery ground of a lake. And again, the littoral zone is the area of a lake or pond where light penetrates to the bottom.

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If you have ever been out on a large lake in a storm, you know the ferocity with which winds and waves can beat on the nearshore environment. As a terrestrial species, we see this world during a storm as a very dynamic and sometimes dangerous environment. Certainly the prospect of being bashed against a rocky shore is frightening if you are caught out in a boat during such a storm.

Slide 21

However, if you happen to be in that water snorkeling or scuba diving at 8’ depth or more, as I have during some storms, the perspective is completely different from below the surface.

Slide 22

So, let’s take a moment and dive below the surface and see what this world is like.

Slide 23

Slide 24

The submersed aquatic world of a lake, doesn't really experience the rapid extreme changes in physical conditions that we in the terrestrial world experience. And that is part of what makes it is a perfect nursery ground

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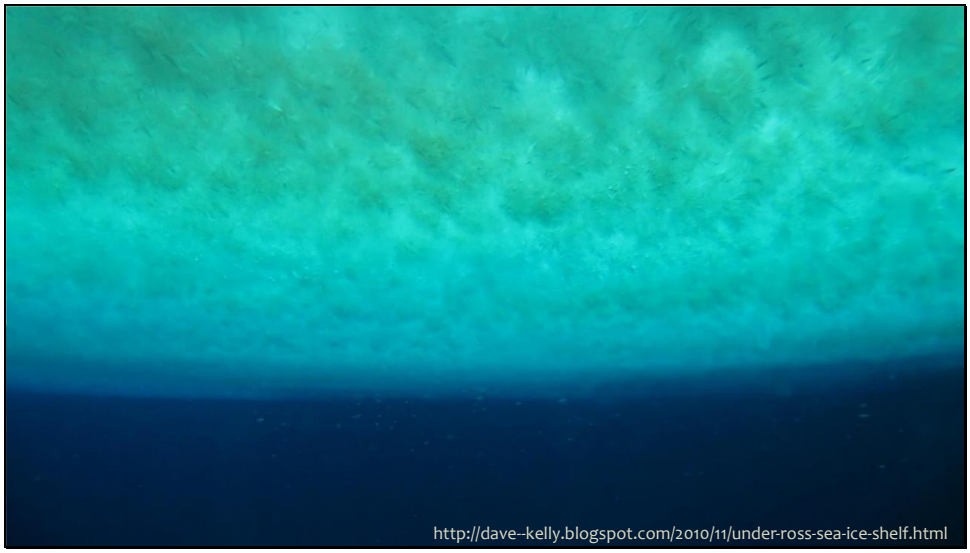

In winter, nature builds a protective ceiling of ice that shelters the lake and pond life from the fierce winter storms and below freezing temperatures.

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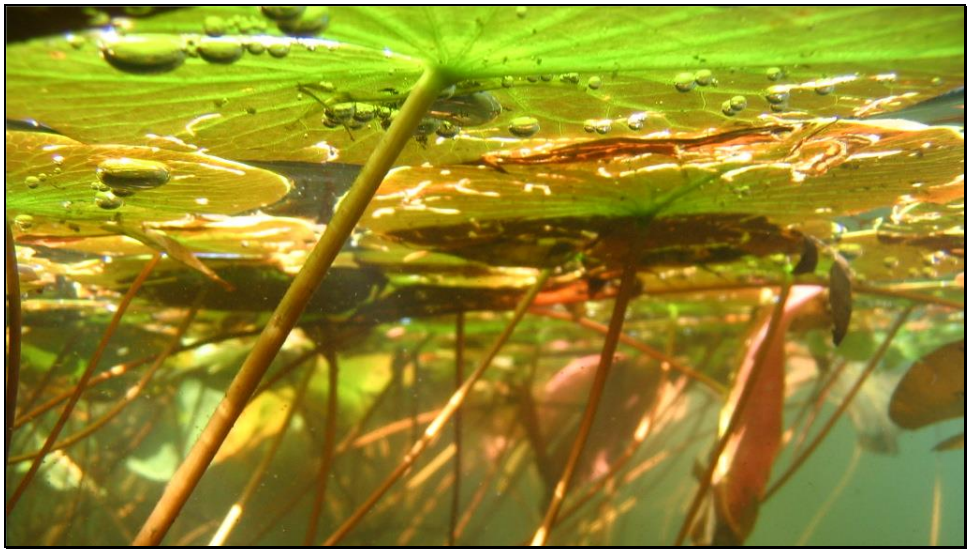

Change in the littoral world is slow, things are relatively static here compared to a river or even the terrestrial world.

Slide 27

Snorkeling through it you can feel a sense of peace here that exists in the terrestrial world but really isn’t the norm.

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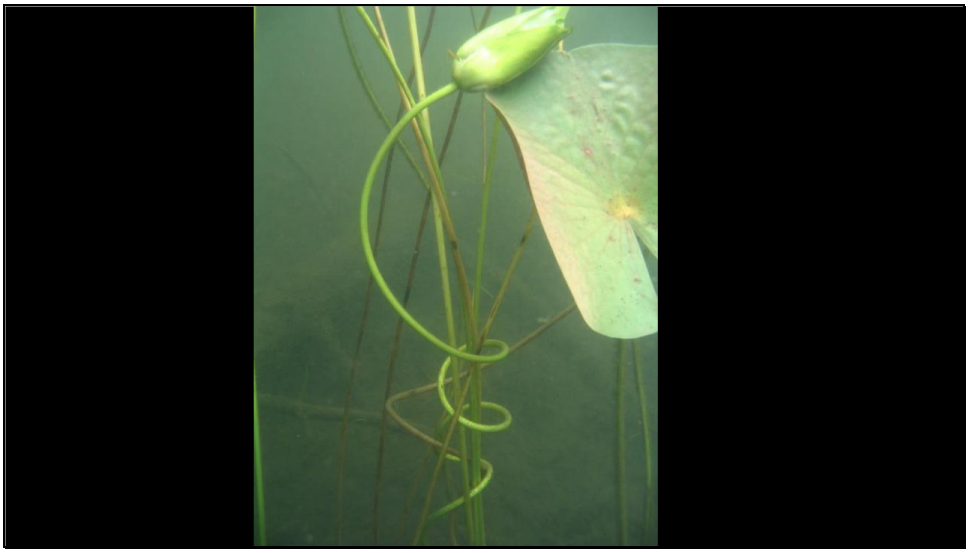

I have snorkeled and measured habitat parameters at over 650 different sites on more than 75 lakes and ponds in Vermont and Maine. I realized just how unchanging the littoral zone is when I had to return to a number of these sites to survey them again 5 years later.

Slide 29

What was amazing, was that at the undeveloped sites, things hadn't changed. There was the same percent coverages of woody structure and plants.

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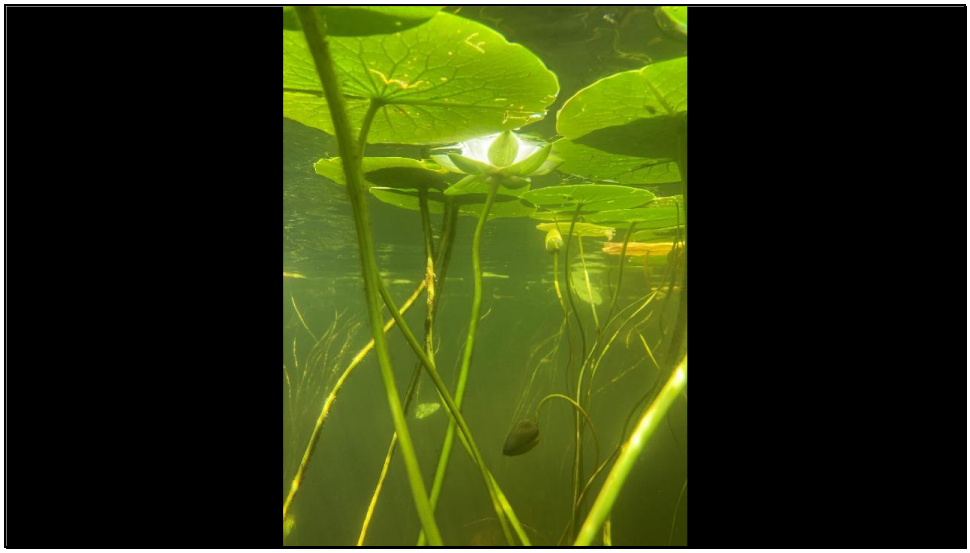
It was that experience,

Slide 31



which made me realize how static the physical environment

Slide 32

of the littoral zone of our lakes and ponds can be.

Slide 33

No wonder so much incredible life has evolved to use this part of our lakes. Food here is bountiful. Whether you are a vegetarian, carnivore, omnivore or phototroph there is something for you in the littoral zone of a lake.

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It is for this reason that so many species lay their eggs here

Slide 35

and make their nests here in the shallow nearshore environment.

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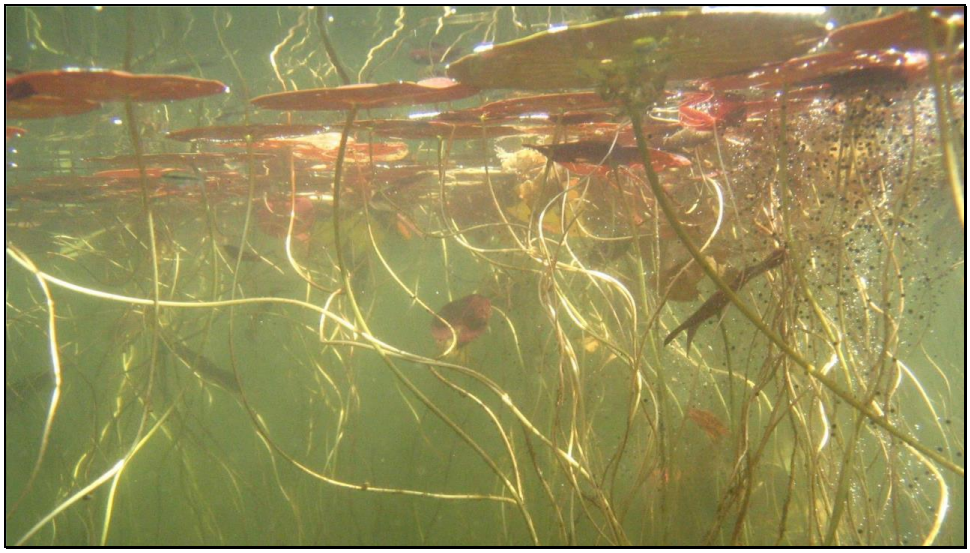
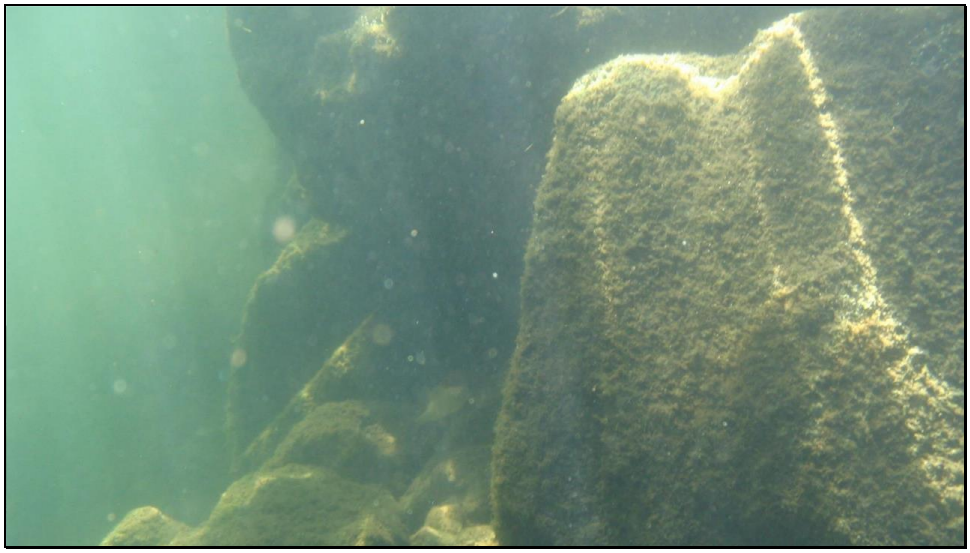


The diversity of structure available from plants to woody structure

Slide 37



to boulders and cobbles makes this a place of food and refuge for all kinds of biota.

Slide 38

Just look at the complexity of the habitat

Slide 39

The diversity of structure

Slide 40

There are all kinds of interstitial spaces between these rocks for macroinvertebrates, snails and fish to take refuge in and live.

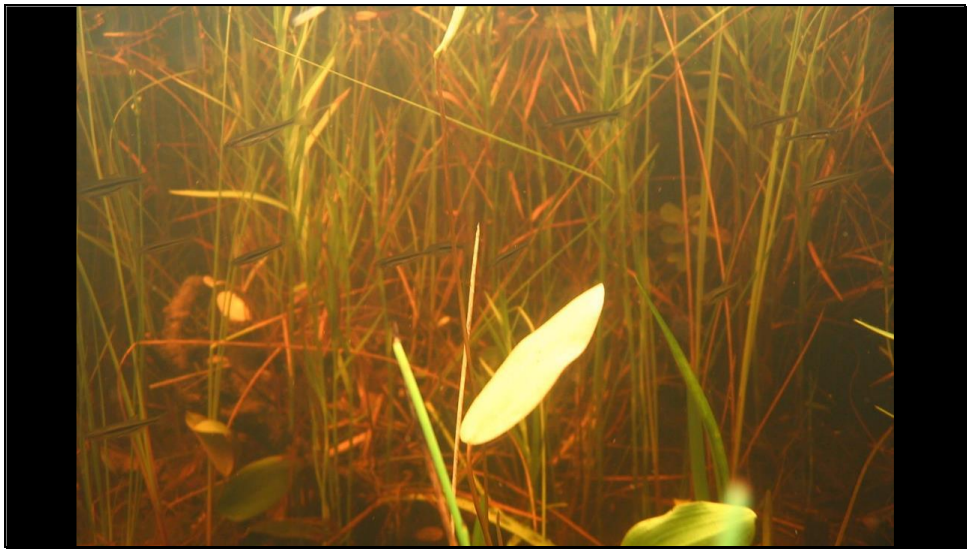
Slide 41

The diversity of life in the littoral zone is amazing

Slide 42

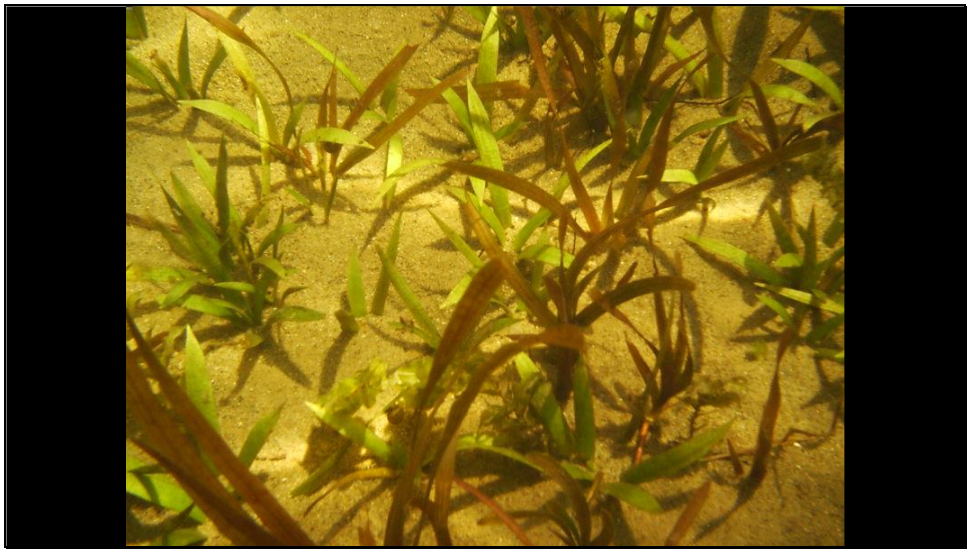
Plants are aquatic life, but they are also habitat.

Slide 43



Small fish find refuge and food in aquatic plant beds.

Slide 44



And there are a diversity of plants

Slide 45

There’s freshwater sponges

Slide 46

fish

Slide 47

More plants

Slide 48

mussels

Slide 49

And more fish

Slide 50

The nearshore nursery is shaped largely by what the lakeshore is like. Wetlands provide structure for eggs to be attached, refuge for fish avoiding predators, and abundant food that grows on and around the plants. The plants themselves alter the energy of the place, by dampening the effects of waves. Which causes particles to settle out here and continue to enrich the sediments which support the plant growth.

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In Vermont, there are two major types of lakeshore, wetland or forest. Forests form the majority of lakeshore habitat across the state, and Vermont's rich diversity of aquatic and terrestrial species have evolved to use the complex habitat structure that exists along these shores. As we have seen there is a diversity of structure and habitat off of forested shores, but there are some things our forested shores consistently provide that organisms in the lake have evolved to depend upon. The forested lakeshore provides shading..

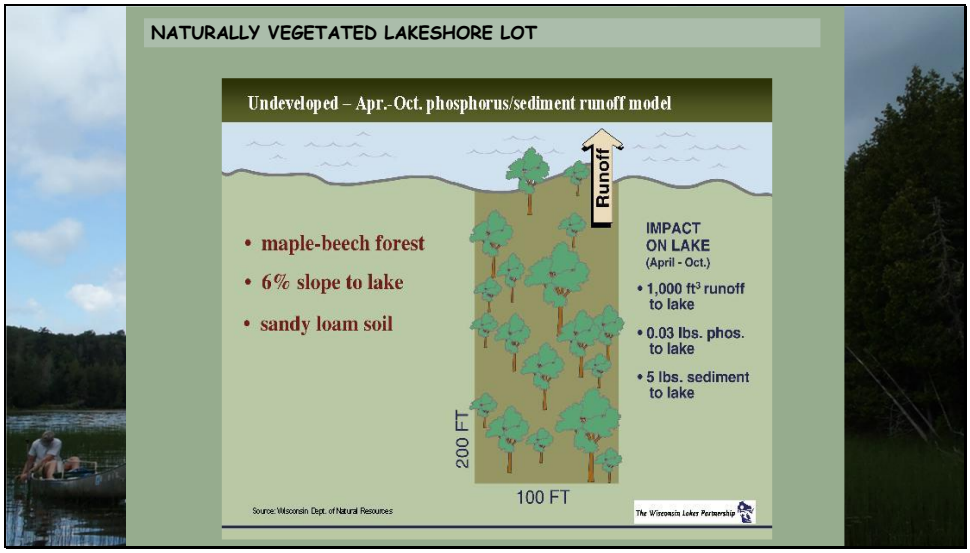
Slide 52

It provides leaf litter

Slide 53

It provides woody structure from small sticks to big fallen trees

Slide 54



And it provides a source of nutrient enrichment, with water, phosphorus and sediment running off at rates and concentrations that are natural. We think of phosphorus and sediment as pollutants, but a pollutant can be the excess of something that exists naturally.

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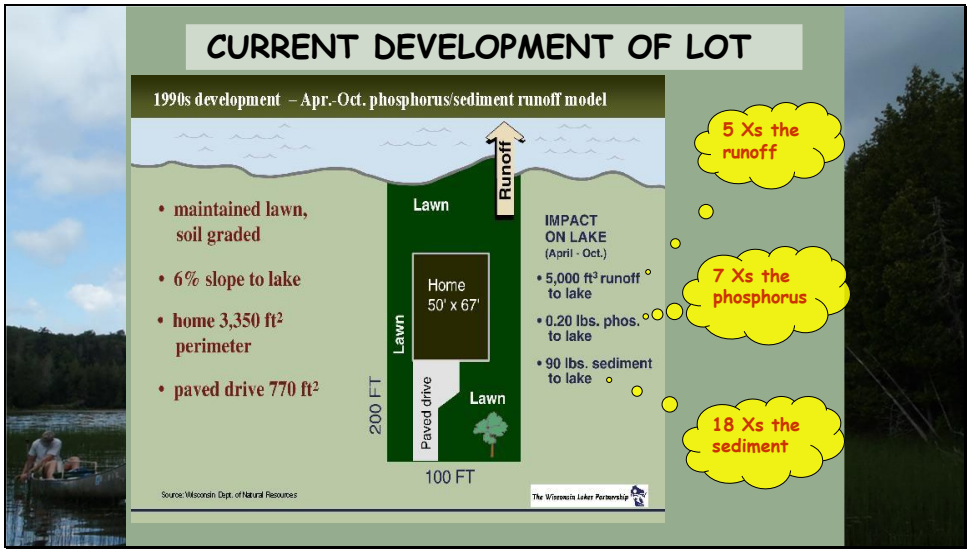

Contrast that forested site with what a developed site devoid of trees and covered by lawn and impervious surfaces delivers to the littoral zone. Such a developed site delivers 5 times the runoff, 7 times the phosphorus and 18 times the sediment to the littoral nursery.

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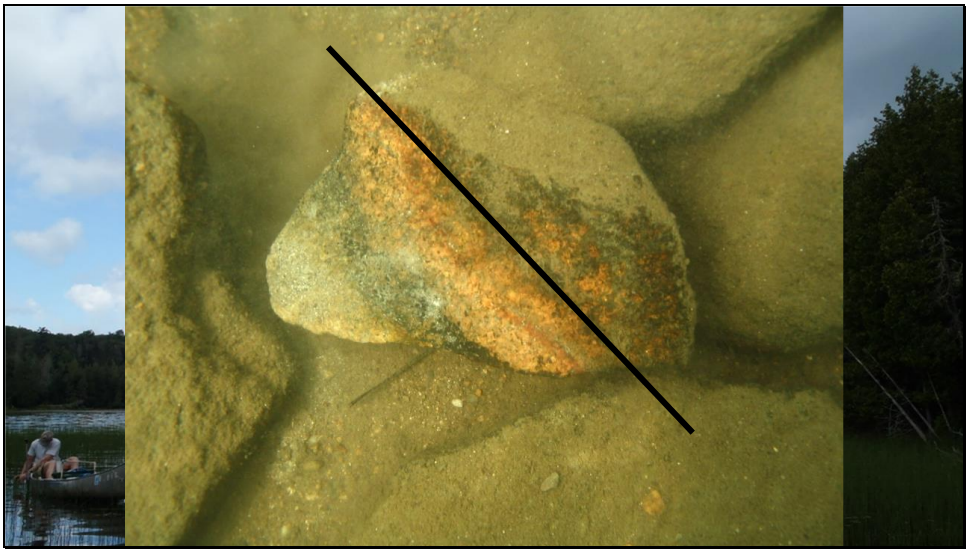
All that sediment runoff washes into the lake and buries the cobbles and interstitial spaces important to fish and macroinvertebrates. It buries the eggs laid in these nursery grounds and prohibits them from getting enough oxygen to survive. This is a rock that was pulled from the sediment off a developed site. The top line represents how far it was embedded into the sediment, how much it had been buried.

Slide 57



This rock looks like it was about 50% embedded.

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This is the desert like habitat we create off our developed sites, by importing artificial sand and putting it on the shore in addition to what is running off from the lawns and impervious surfaces located adjacent to the littoral nursery grounds. We remove aquatic plants and woody structure. We desire this type of habitat for our recreation, but we can't make the whole lake this way, it disrupts the ecological balance in the lake.

Slide 59

Now while the natural state of the nearshore aquatic habitat of a lake is very stable, there is a force of nature that is dramatically altering it. Humans. We are drawn to our lakes and as such, we want to get as close to them as we can and we bring our suburban values of neat and tidy lawns and powerwashed houses with us.

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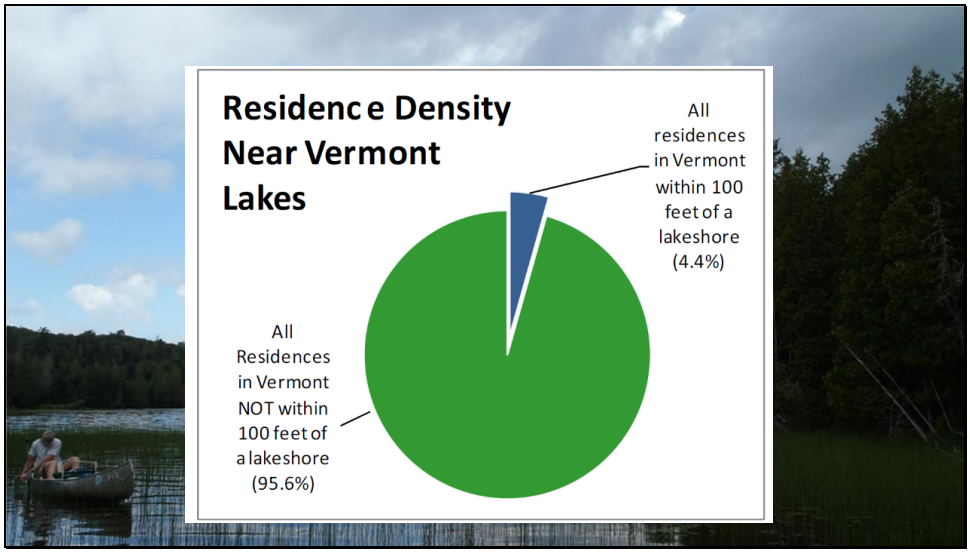
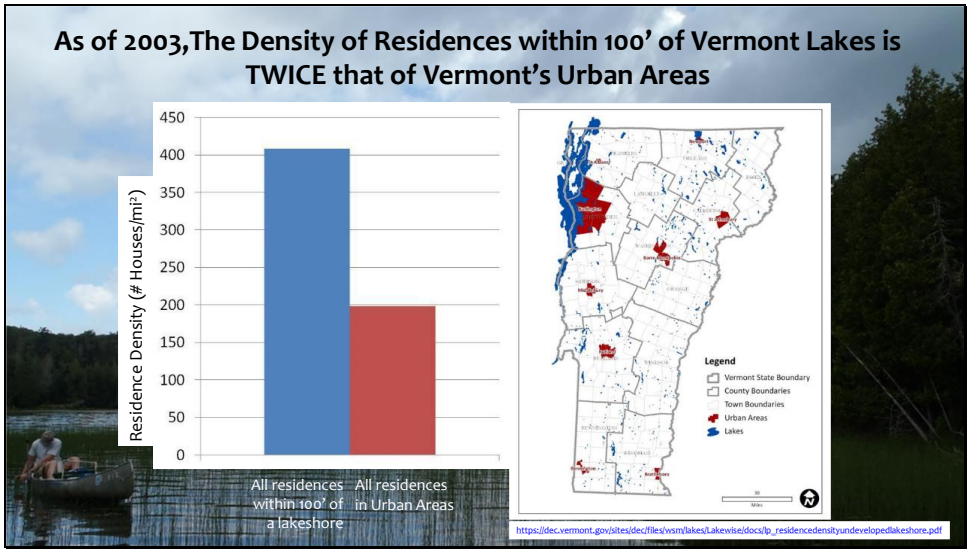


But there is a limited supply of lake area in the state. Lakes make up less than 4% of the Vermont landscape and as of 2003, less than 5% of Vermont residences are located within 100 feet of a lakeshore.

Slide 61



As of 2003, 45% of our lakeshores were developed and they are densely developed, with the density of residences within just 100 feet of a lakeshore being twice that of our urban areas. I'd like to emphasize this point. So, since 1972 Maine has not allowed residences to be built within 100 feet of their lakes, meanwhile our lakeshores have SO MANY RESIDENCES WITIN 100 feet of our lakeshores that the density of residences around our lakes is greater than that in our urban centers.

https://dec.vermont.gov/sites/dec/files/wsm/lakes/Lakewise/docs/lp_residencedensityundevelopedlakeshore.pdf

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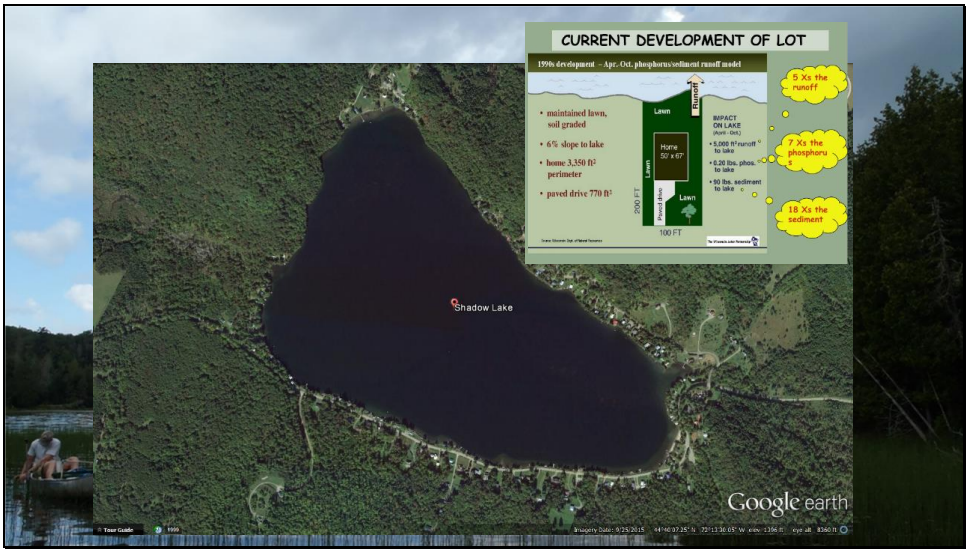

Now, lake ecosystems can withstand some level of poor development practices. A lake like Shadow Lake in Glover for example, could be resilient to some of its lakeshore being poorly developed with a camp or two.

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But 68% of Shadow Lake's natural shoreline is gone. As of 2003, 68% of Shadow Lakes' shoreline has been converted to lawn, buildings, patios, decks, and other impervious surfaces.

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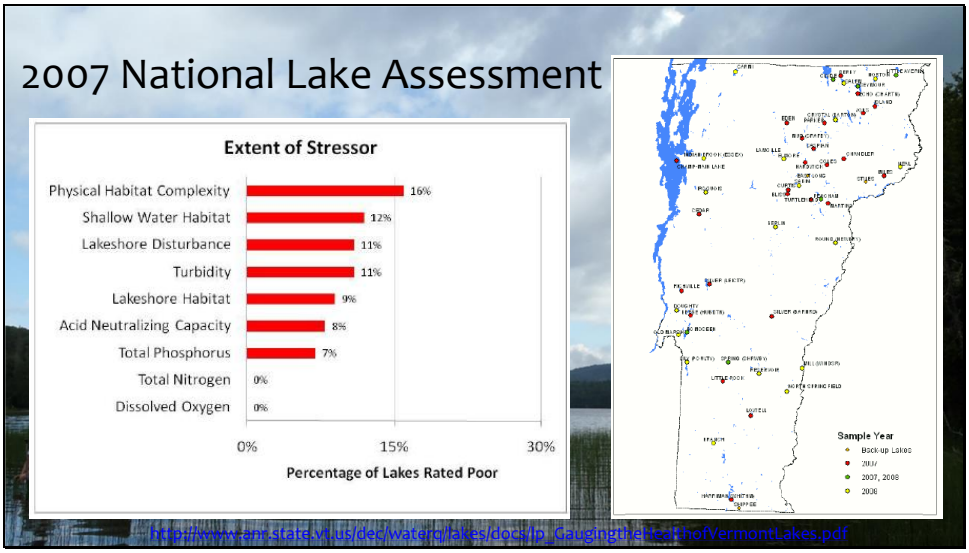
If all this impervious surface was one landowner, say Lowes, that landowner would have to reduce the runoff, phosphorus and sediment coming off of its impervious surfaces and draining into the lake.

Slide 65

But it’s not one land owner, its lots and lots of small landowners and they don’t have to get stormwater permits like Lowes does.

Slide 66



Results from the 2007 National Lake Assessment found that in Vermont, the largest proportion of lakes in poor condition was for physical habitat complexity. Poor physical habitat complexity affects twice the percent of Vermont lakes that are affected by high levels of phosphorus and acidification from acid rain. Physical habitat complexity is a measure of the condition of the lakeshore and the shallow water habitat combined.

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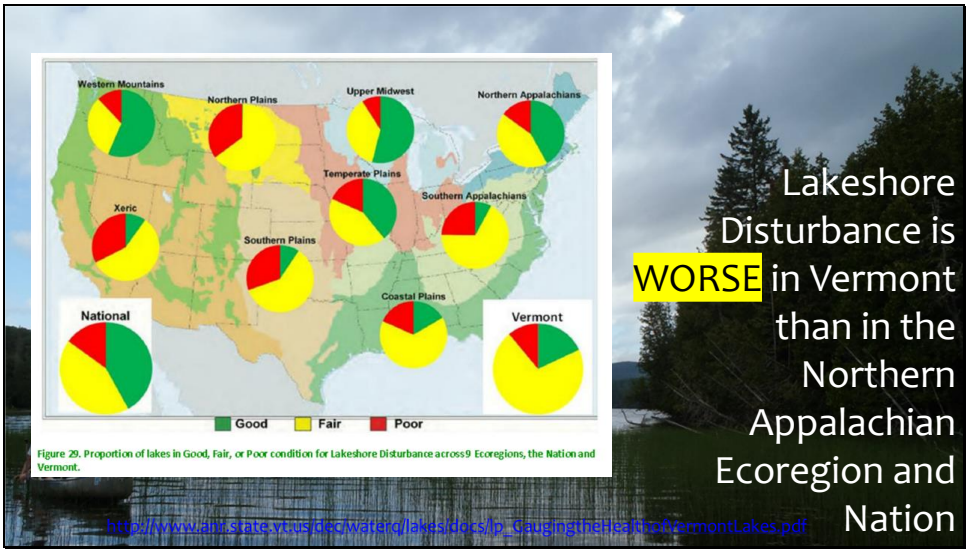
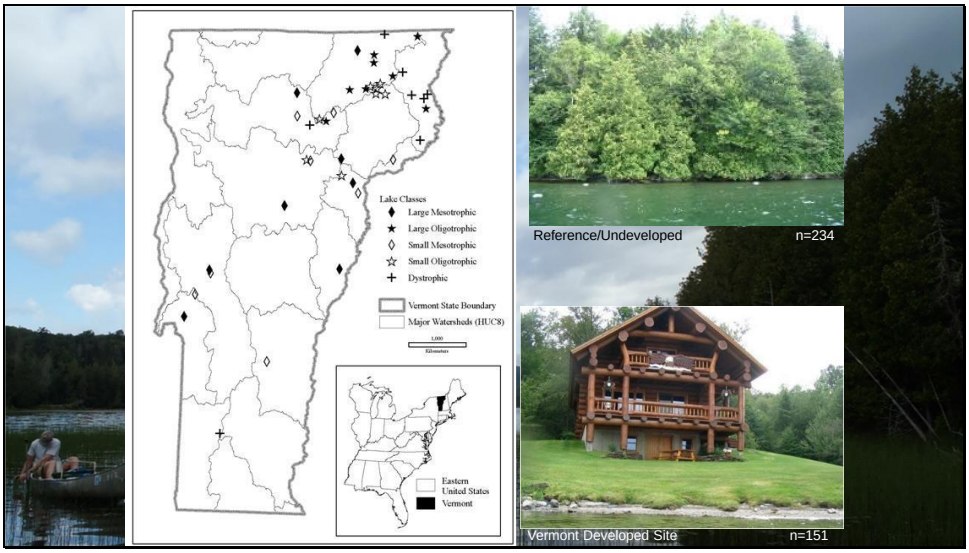


That same study measured the presence of human activity on the lakeshore and in the nearshore area as Lakeshore Disturbance, which can be thought of as how intensively we use our lakeshores and the likelihood that evidence of human activities will be visibly present on or near the lakeshore. As of 2007, more than 80% of Vermont's lakes were determined to be in fair or poor condition for Lakeshore Disturbance, which is notably worse than both the Nation and Northern Appalachian Ecoregion. That's because many states had restricted development immediately on or near the shoreline. Something Vermont had not done.

Slide 68



We determined from another study we did on 40 lakes in Vermont that the unregulated development of Vermont's lakeshore has had a deleterious effect on aquatic habitat and biota in conflict with Vermont's Water Quality Standards. We sampled 151 developed sites that had converted the forested shore to lawn, and impervious surfaces and compared that to 234 reference undeveloped forested sites.

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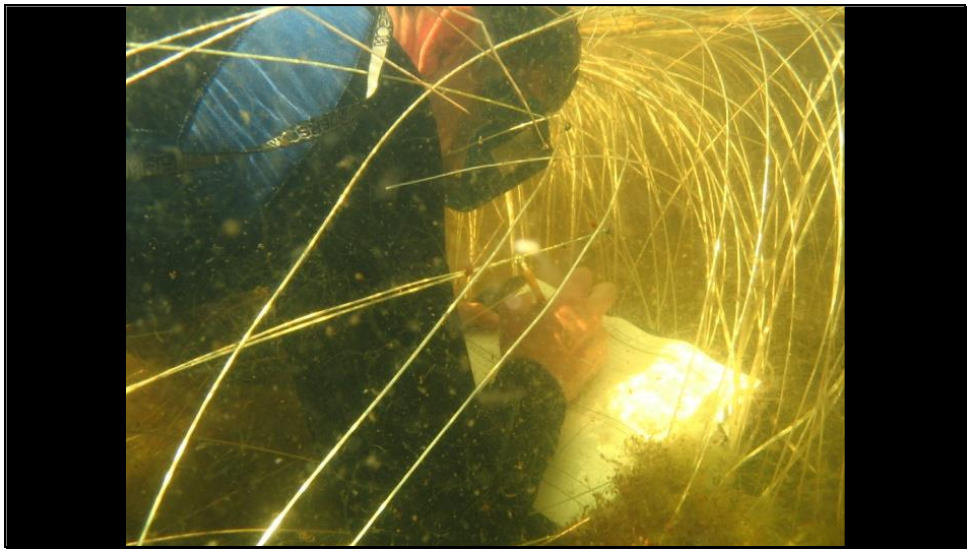

We collected habitat and biological data at each of the sites.

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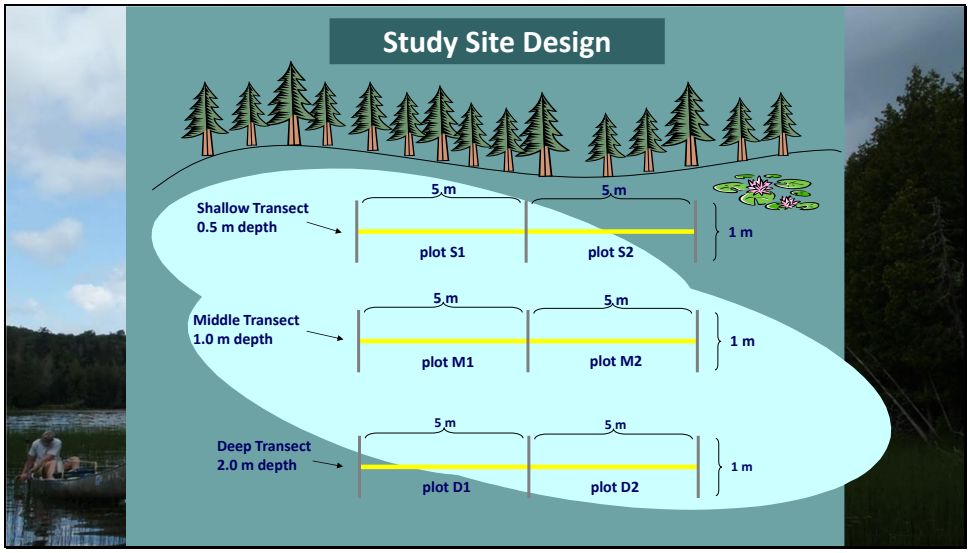

We snorkeled transects parallel to the shore

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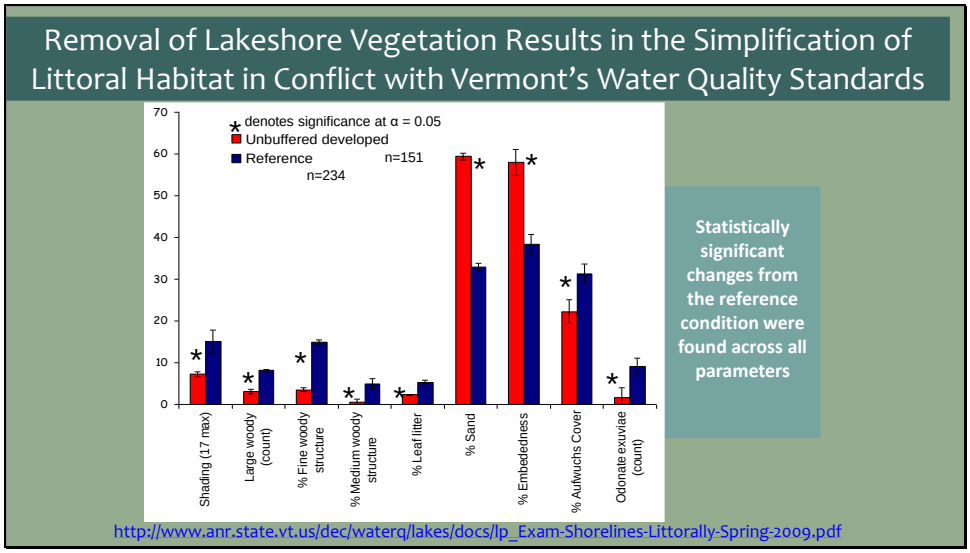
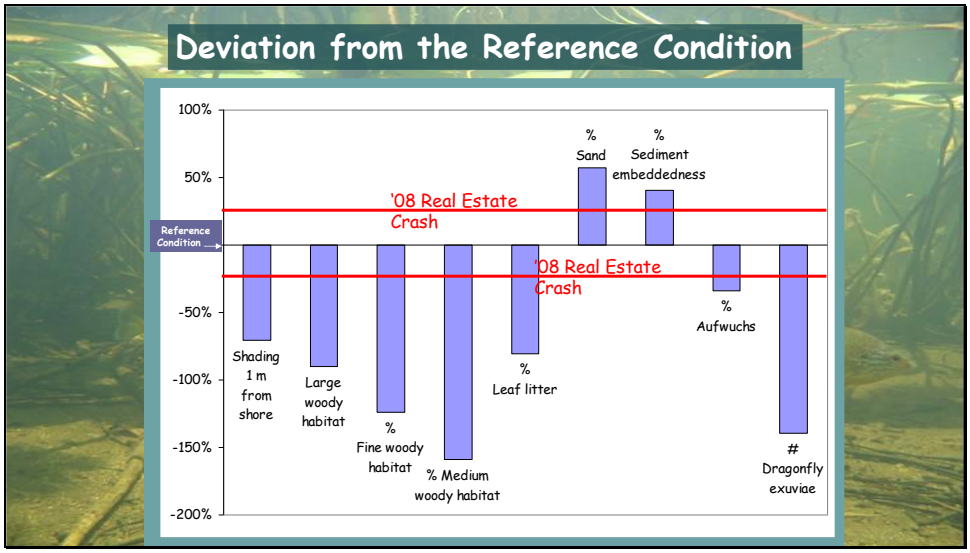


What we found was that across the board, for every habitat and biological parameter we measured, we found a statistically significant difference from the reference condition.

Slide 72



When the magnitude of this change was compared to the magnitude of change that happened to the real estate and banking industry in 2008 that brought down the world economy, it turned out the change we were causing to the littoral environment was orders of magnitude greater. The magnitude of change this kind of development is having on the habitat and biota that live in the littoral zone is dramatic and it is in conflict with Vermont's Water Quality Standards.

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We also found that when aquatic plants are abundant, lakeshore owners go into the lake and remove the plants in front of their camps and residences. If you do this throughout a lake or pond, you can switch a lake from a clear water lake dominated by aquatic plants, to a turbid and murky lake or pond dominated by algae. This is what happened to the pond in Prospect Park, in Brooklyn, NY when the nuisance plant community was removed, it switch to a pea soup pond. Without the plants, the sediments aren't anchored and wave energy isn't dampened and the bottom sediments are resuspended. Any phosphorus reductions needed for a lake or pond that has undergone this switch is even greater than what would have been needed when the lake's dominant photosynthetic biota was aquatic plants (http://edis.ifas.ufl.edu/m/#publication?id=SG128).

https://custom.cvent.com/FC469F3A209E4BC3BDE91EEC849E5474/files/event/1E1CEEE955BF40E6B3BC569A49971737/066be08d443a40029969fae0f19074fd.pdf

New York City Municipal Water and Eutrophication of Prospect Park Lake in Brooklyn, N.Y.

Brett Branco, Detbra Rosales and John Jordan

Abstract from NALMS 2015, Saratoga Springs, NY

Managing shallow urban lakes in the parks of New York City present a grand challenge. Prospect Park Lake in Prospect Park (Brooklyn, N.Y.) is a man-made shallow lake perched atop a terminal glacial moraine. When the lake was completed in the 1860s, its primary source of freshwater was a shallow aquifer accessed by the world's largest well. In the mid-20th century, the inflow was connected to the New York City municipal water supply. In October 1992, the city began adding orthophosphate to the municipal water to minimize heavy metal concentrations in drinking water from antiquated plumbing systems. Comparisons of our water quality testing

from 2011 with values reported in 1995 indicate a catastrophic shift in conditions. Summertime chlorophyll concentrations increased from < 20 mg cm-3 to > 100 mg cm-3. Macrophytes that covered >90% of the bottom in 1995 are absent from the lake now. In 2011, the lake experienced extended periods of anoxia in spite of its shallow mean depth (1.6 meters). Cyanobacteria blooms producing measurable toxicity are regular summertime occurrences. The phosphorus concentration of the inflow is 0.5 – 0.7 mg-P L-1, suggesting that the municipal water is the driver of eutrophication, and has caused a regime shift in Prospect Park Lake. In spite of the deteriorated conditions in the lake, the fish population remains abundant and diverse, supporting a popular recreational fishing use. Innovative solutions are needed to address the cyanobacteria dominance in Prospect Park Lake.

During the talk, the speaker talked about the aquatic plant harvesting efforts that helped switch the lake to become algale dominated.

Note, harvester is harvesting scum and not the aquatic plants, although it was the harvesting of the aquatic plants that facilitated the switch.

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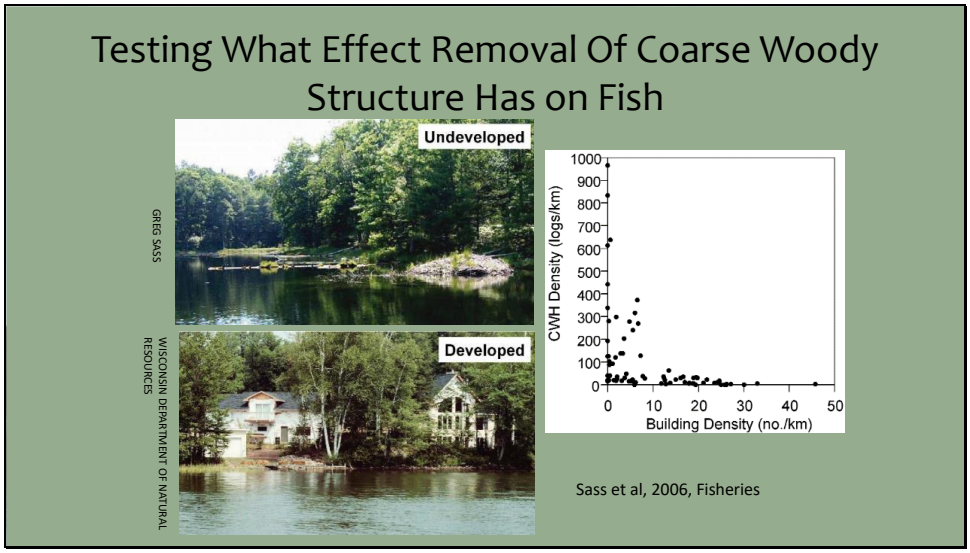

Lakeshore owners not only remove trees from the shore, but they remove coarse woody structure from within the lake as well in an attempt to 'clean up the lake'. With no more trees along the shore, there is no recruitment of new coarse woody structure into the lake.

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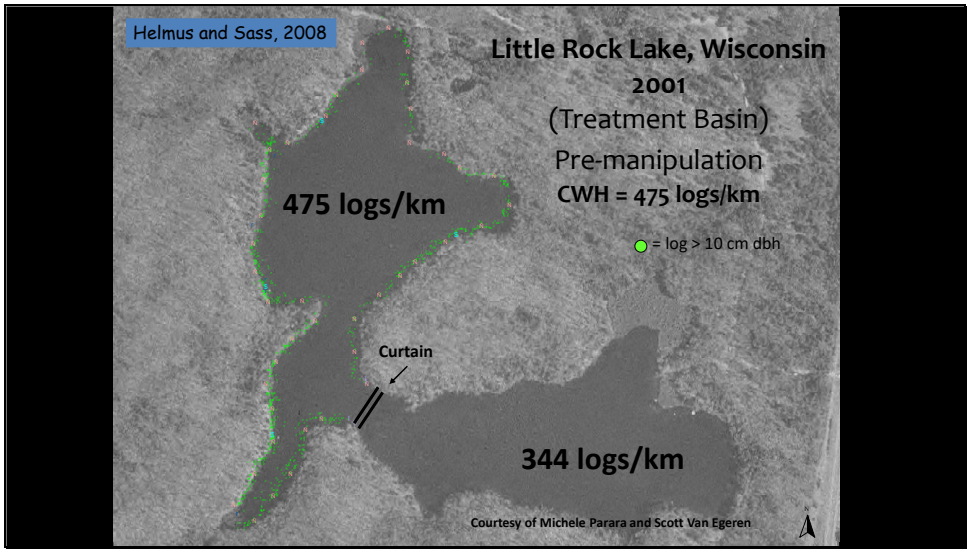

In Wisconsin, they studied what affect this was having on fish. Because Wisconsin has so many lakes, they can do whole lake experiments like this. They took this lake that has two basins and put a curtain up between the two basins. They measured the abundance and growth rates of fish in both basins

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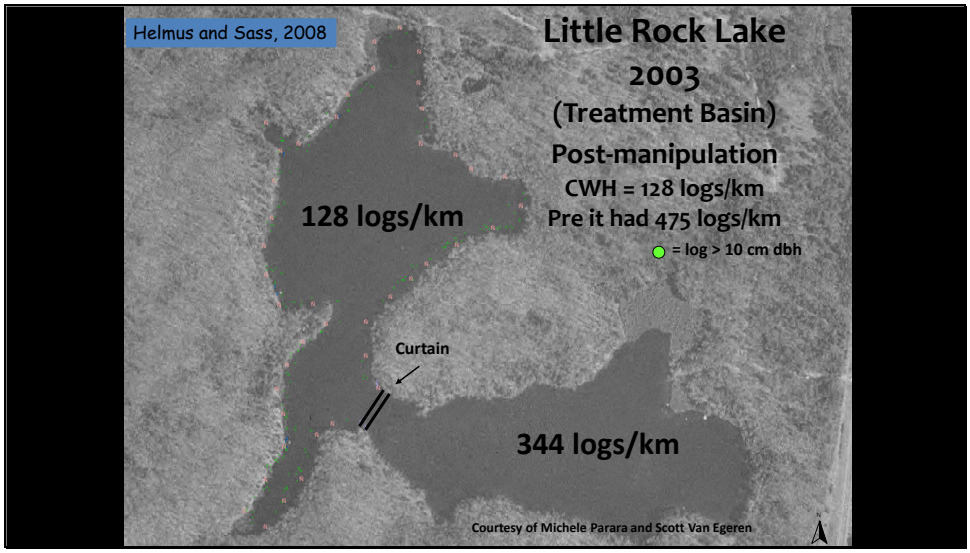
and then they set out removing the large woody structure from the one basin.

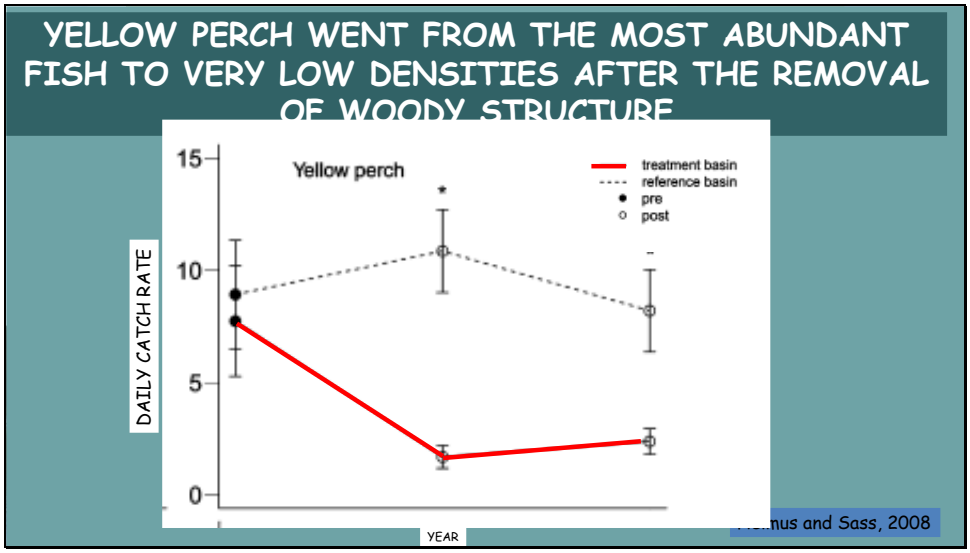
Damon Krueger, Greg Sass, Brian Roth, Jeff Biermann, and Motomi “Genkai” Kato remove coarse woody habitat.

Slide 77



Then they went in and monitored the effect it had on the fish populations.

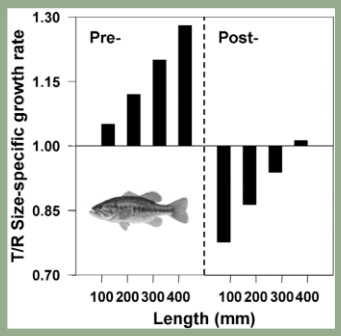
Slide 78



What they found was that the yellow perch population crashed in the treatment lake, the one with all the woody structure removed.

Slide 79

Pre treatment, the largemouth bass in the treatment basin which had 131 more logs/km than the reference basin had higher growth rates



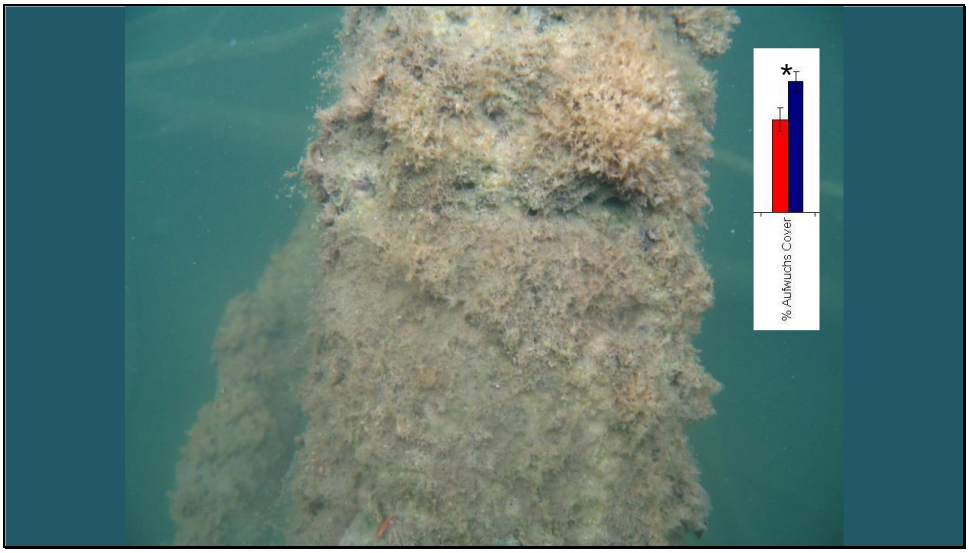
Sass et al, 2006, Fisheries

After treatment, the largemouth bass in the treatment basin had 216 less logs/km than the reference basin and had lower growth rates, especially for smaller/younger fish

And they found that prior to the removal of the large woody structure, the Bass in the treatment basin had higher growth rates than bass in the reference basin. But, after the treatment of removing all the woody structure, what they found was that the growth rate of Bass declined and was less in the treatment basin than in the reference basin, with the younger smaller bass seeing a real decline in their growth rates.

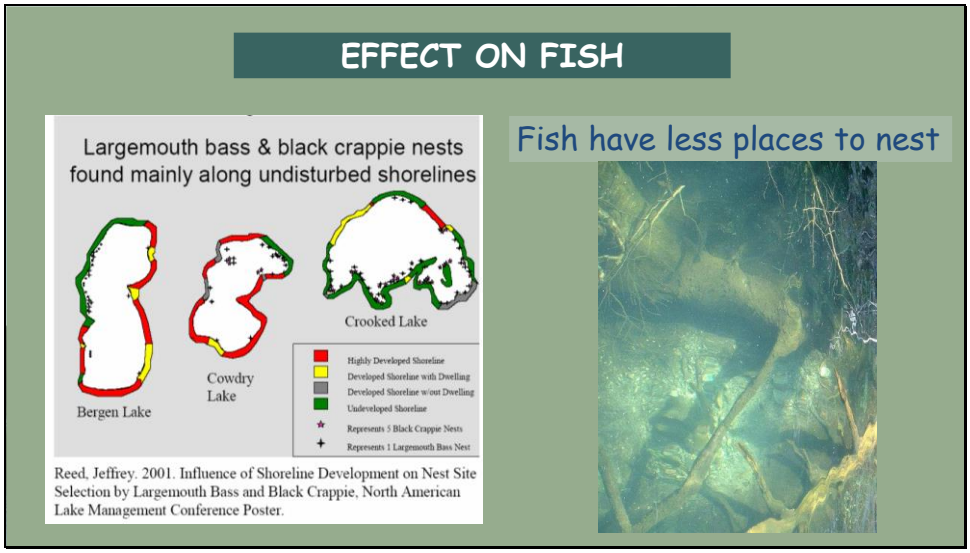
Figure 5. Ratio of treatment basin (T) largemouth bass (*Micropterus salmoides) size-specific* growth rate to reference basin (R) size-specific growth rate for 100, 200, 300, and 400 mm size classes in Little Rock Lake before (pre-) and after (post-) the CWH removal.

Slide 80



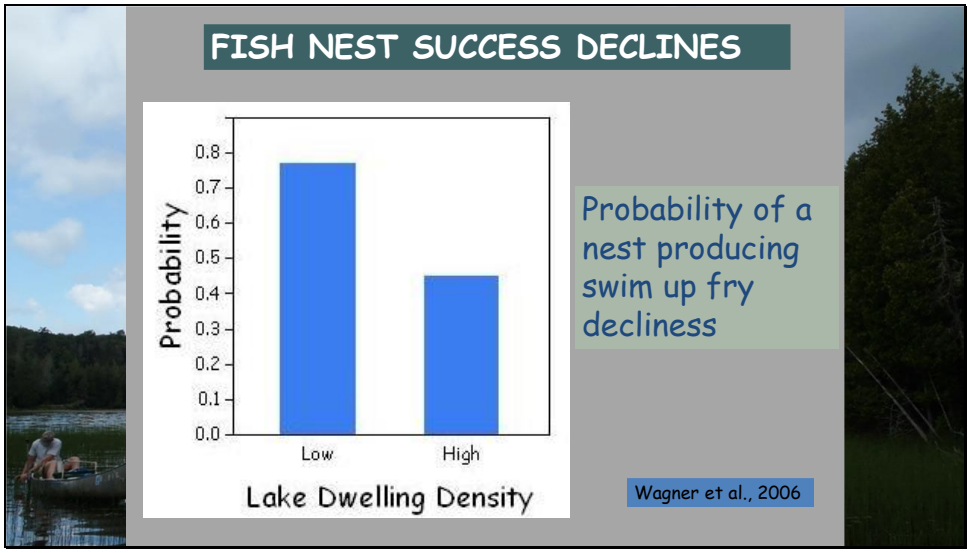
The removal of woody structure, also removes the substrate that a whole community of organisms lives on. This community is made up of microscopic animals, plants and bacteria that is an important food source for fish and macroinvertebrates. We found statistically significantly less of this community, what is called Aufwuchs off the developed sites vs undeveloped sites in our study on Vermont lakes.

Slide 81



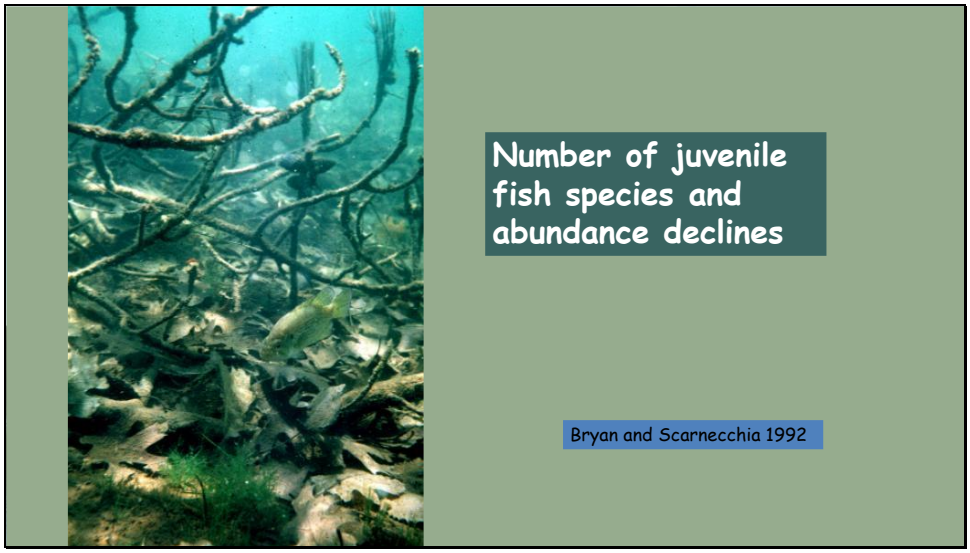
This study by Reed in 2001 showed that bass choose undeveloped sites to nest.

Slide 82



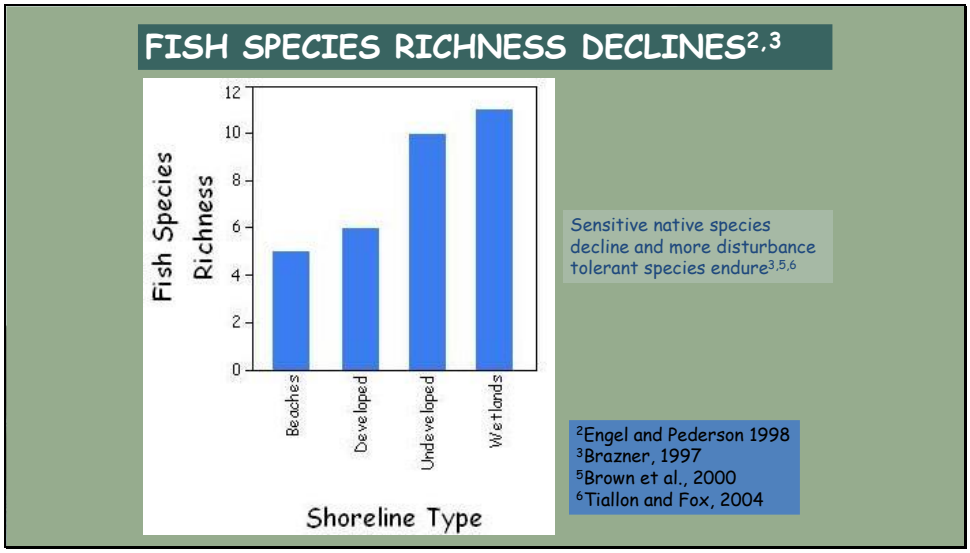
Another study found fish nests on lakes with denser development were less likely to produce swim up fry.

Slide 83



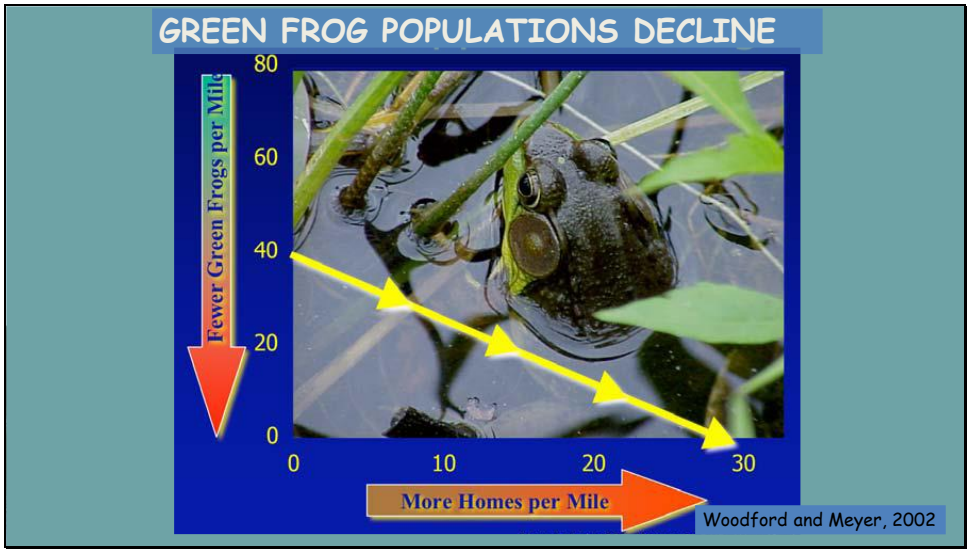
This study published in 1992 found that the diversity and abundance of fish decline with development.

Slide 84



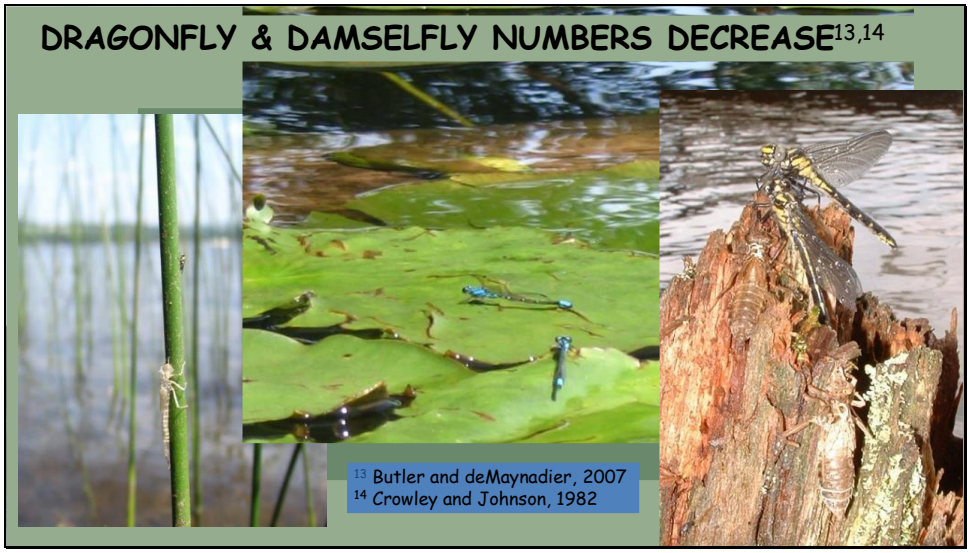
And another study found that the diversity of fish found off developed lakeshore was less than that off of undeveloped shores.

Slide 85



A study from Wisconsin showed that green frog abundance declines with increased homes per mile

Slide 86

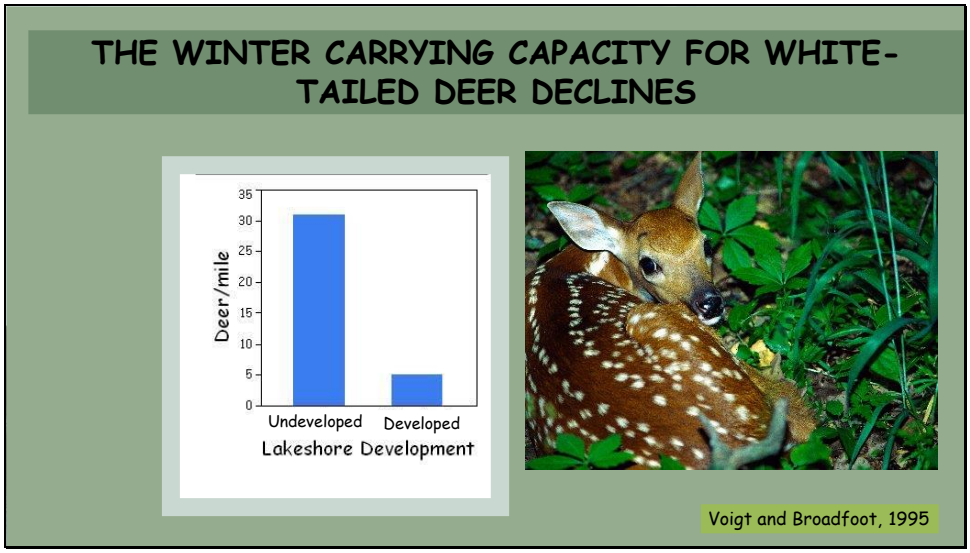


Two other studies found that dragonflies decrease with poor development practices. Dragonflies eat mosquitos as adults and are food for fish when living in the lake.

Slide 87

This study in Ontario found the winter browse supply for deer was four times lower on developed lakeshore lots than undeveloped lots

Slide 88



This 1995 study found that the winter carrying capacity of white tailed deer decline without that winter browse.

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In central Ontario they found that mink activity decreased as a function of the level of lakeshore development. Along buffered shores, mink activity varied depending on tree types. Shores dominated by deciduous trees were not used much by mink. As the proportion of coniferous trees along the lakeshore increased, so did mink activity. The clearing of vegetation from developed lots was responsible for the decline in mink activity along developed shores.

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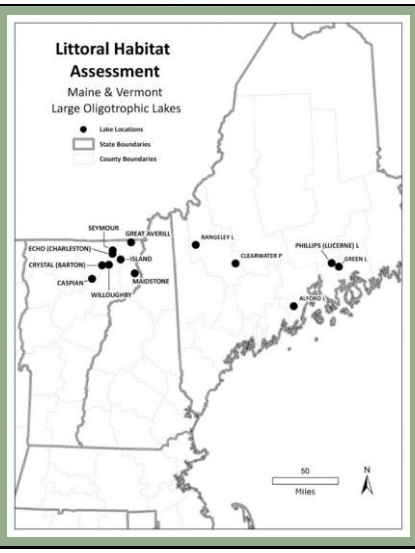
So, I've told you how poor lakeshore development practices harm lakes and are in conflict with Vermont's water quality standards. But is it even possible to develop a lakeshore and protect aquatic habitat, biota and water quality? In 2011, VTDEC teamed up with scientists from the Maine Department of Environmental Protection to perform the same sampling we did in Vermont, in Maine. We sampled developed sites meeting Maine's Mandatory Shoreland Zoning Standards

Slide 91

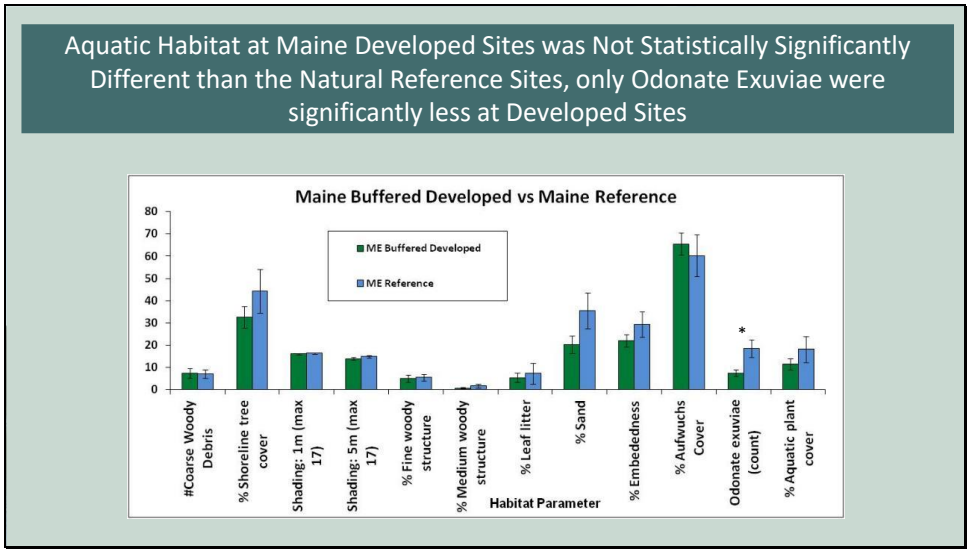
Reference/Undeveloped N=13

Developed Site Meeting Maine Standards N=36



We went to thirty-six buffered developed sites and 13 reference (undeveloped) sites on five lakes in Maine. The goal was to determine whether Maine's standards are effective for protecting aquatic habitat.

Slide 92



What we found was that across the board all but one of the parameters measured were not statistically different from the reference undeveloped condition. The only exception was dragonflies, they were still significantly less than at the developed sites, but their abundance was still greater than what we found at reference sites in Vermont. What this study found was that it is possible to develop a lakeshore and protect aquatic habitat and biota, it just meant doing so in a manner that met Maine's mandatory shoreland zoning standards.

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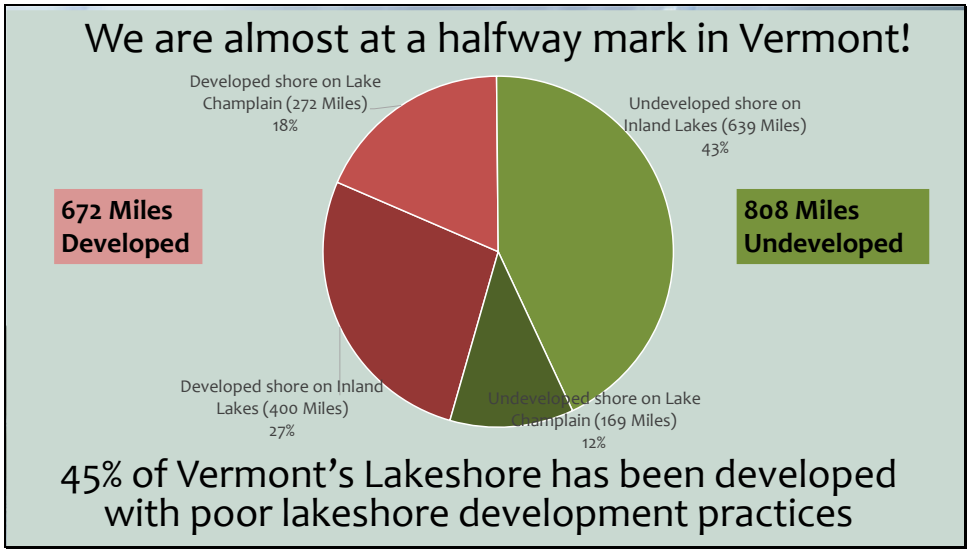
In 2013 Vermont launched the Lake Wise Program, modeled after Maine's Lake Smart Program and in 2014 Vermont passed the shoreland protection act, modeled after Maine's standards. These are 2 new tools Vermont has to address poor lakeshore development practices in Vermont.

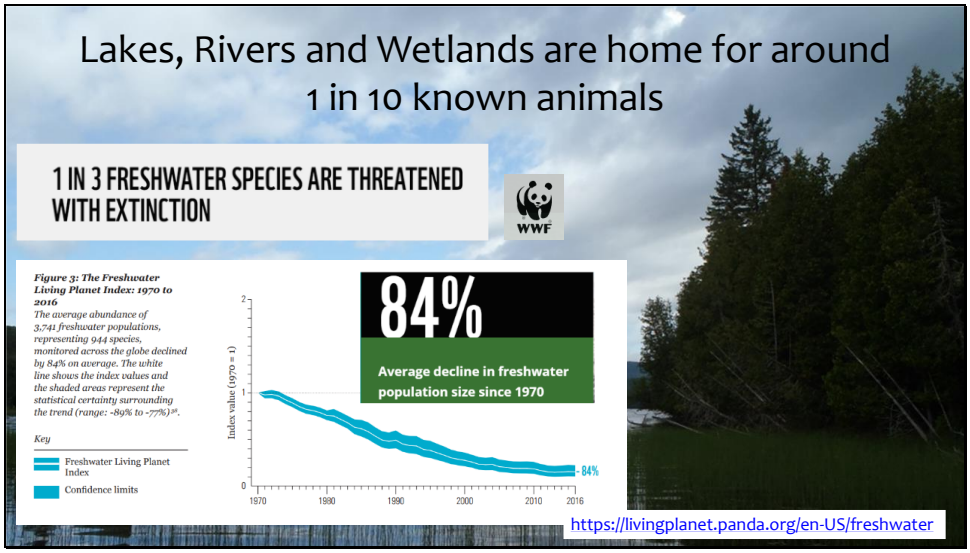
Slide 94



As of 2012, we were almost at the halfway mark in Vermont. We've got roughly 1,500 miles of lakeshore on all our lakes 10 acres in size or greater. 45% of it has been developed with poor lakeshore development practices. How we develop the remaining 808 miles of undeveloped lakeshore and redevelop the already developed 672 miles of lakeshore WILL determine the future of Vermont's Lakes. And that's why we have to change our lakeshore development practices and behavior in Vermont and we are counting on you folks to help with that and that is what this training is geared at today.

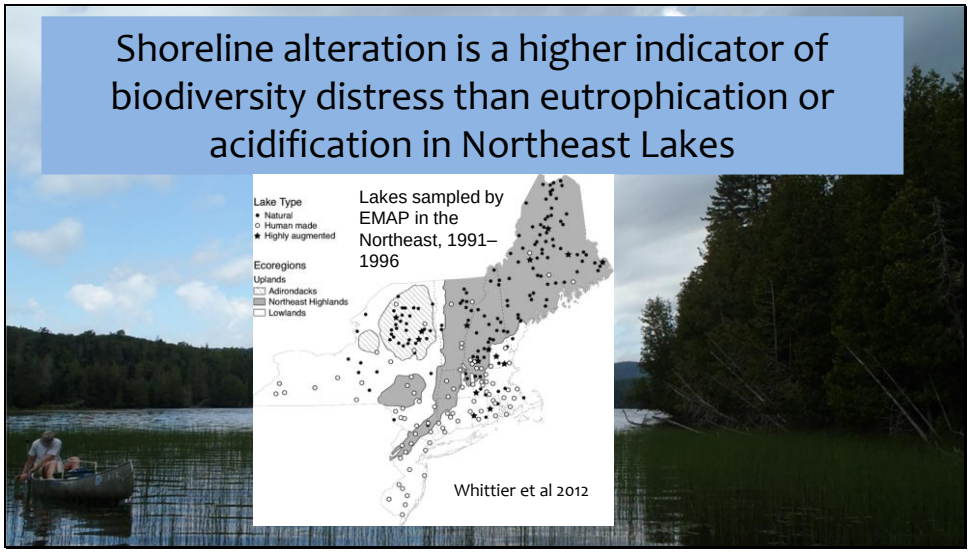
http://www.anr.state.vt.us/dec/waterq/lakes/docs/lp_undevelopedlakeshore.pdf

Slide 95



In closing, I'll leave you with some stark findings recently released to put this into a global context. According to the 2020 WWF Living Planet Report, Lakes, Rivers and Wetlands are home for around 1 in 10 known animals, and freshwater diversity is declining far faster than that in our oceans or forests. From 1970 to 2016, there has been an 84% decline in the average global freshwater population size. In Vermont, we can help bend this trend by protecting and restoring lakeshore and littoral habitat around our lakes and ponds.

Slide 96



Because this study of northeast lakes found that shoreline alteration is a higher indicator of biodiversity distress than eutrophication or acidification (Whittier et al. 2012).

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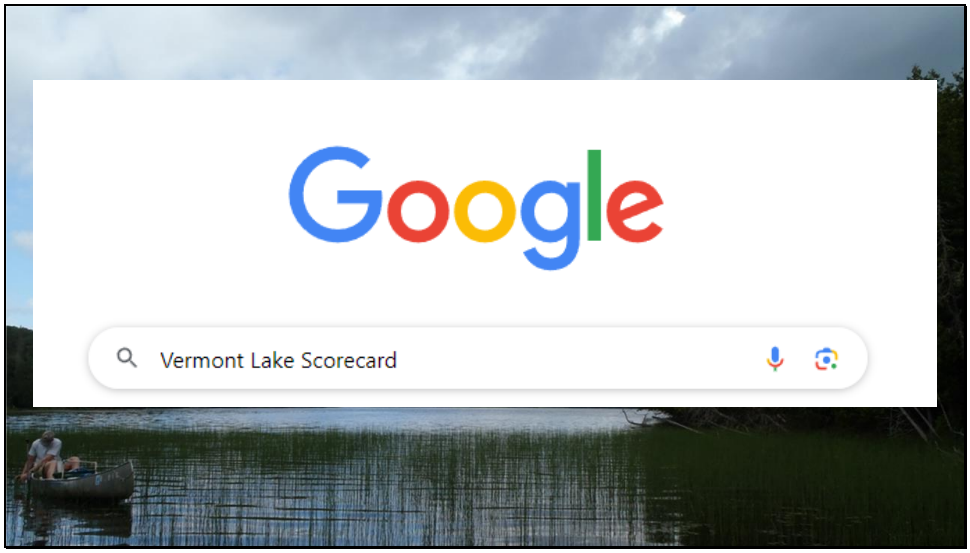
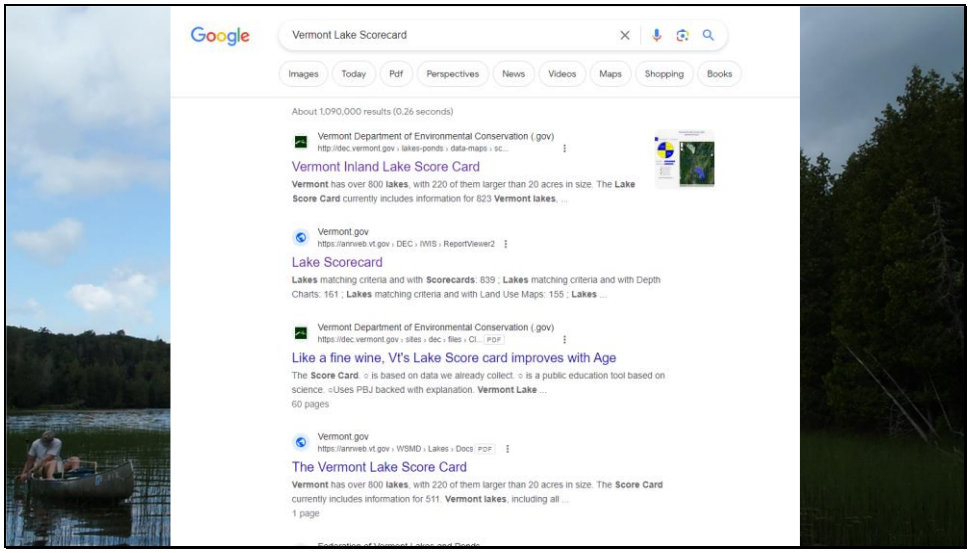
Kevin Stohlgren © 2014
Thank you!
Spotted Turtle, Endangered Species in Vermont
https://www.vpr.org/post/levin-spotted-turtles

Slide 98



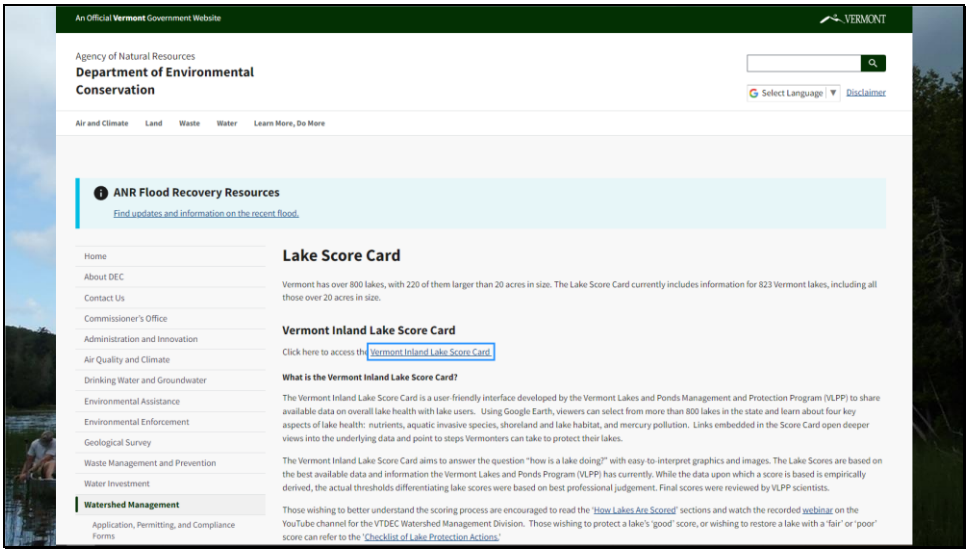
Since we have a little time left, I thought I'd share with you a way for you to see how well a lake, pond or reservoir scores for its shoreland and shallow water or littoral habitat. Just google Vermont Lake Scorecard

Slide 99



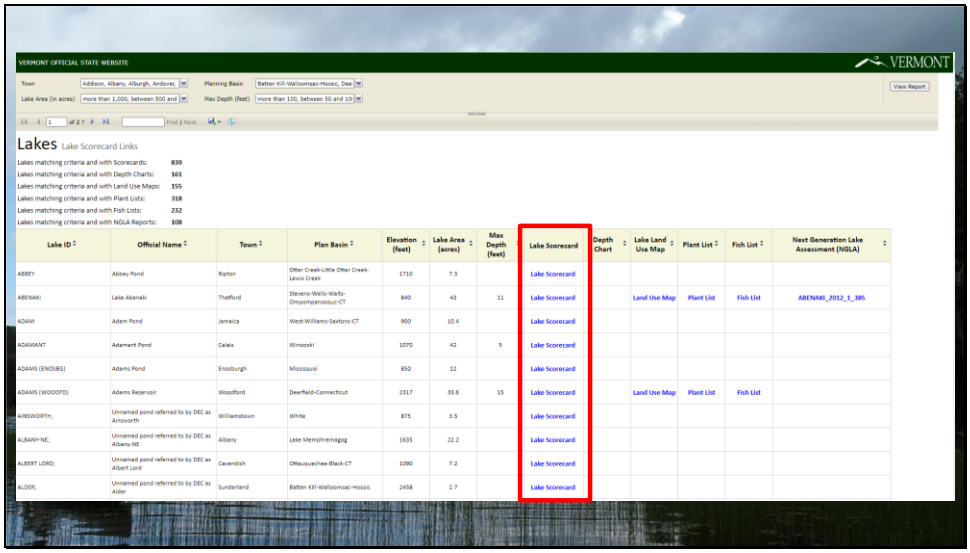
Choose the top choice, which will

Slide 100



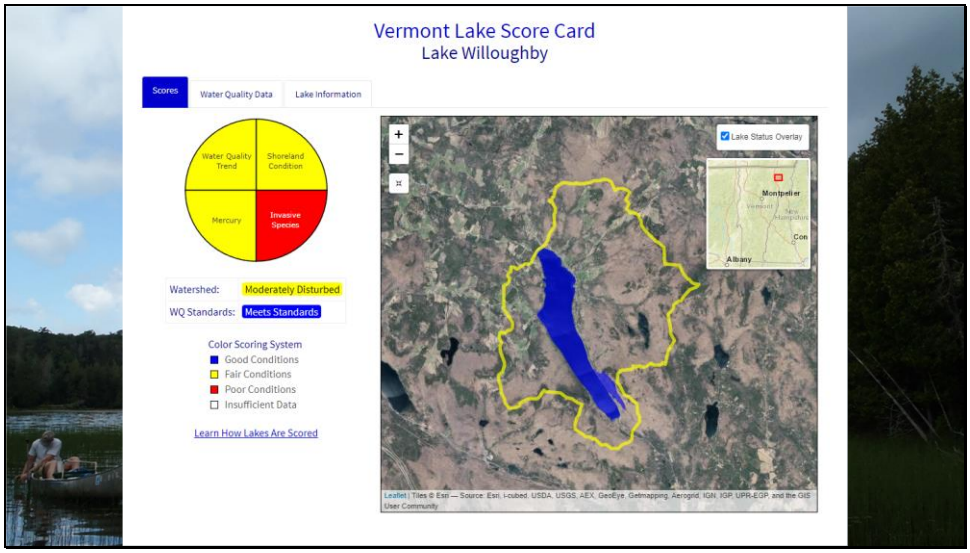
Bring you to this page and then you click on the Vermont Inland Lake Score Card link

Slide 101



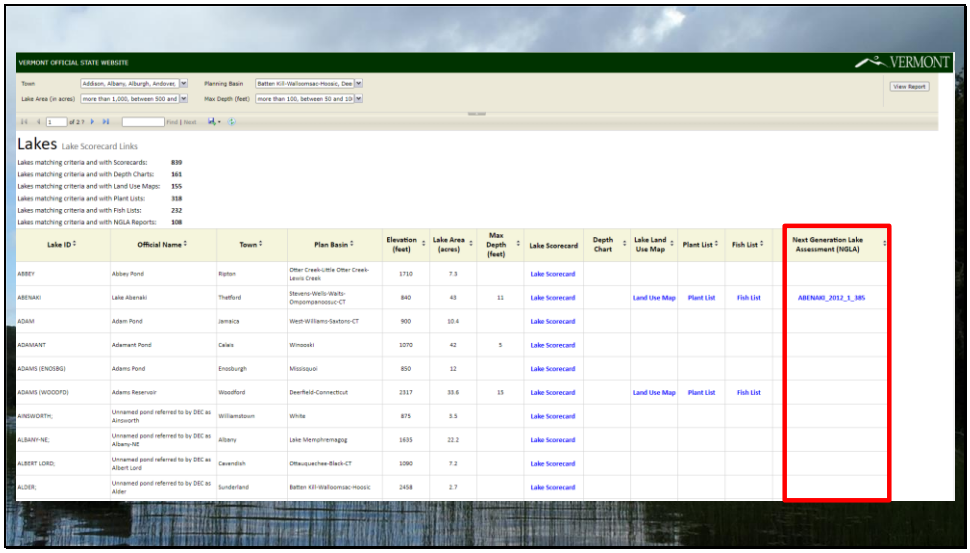
Which will bring you to this table of lakes, ponds and reservoirs and you can then scroll to the lake you are interested in and hit the Lake Scorecard hyperlink

Slide 102



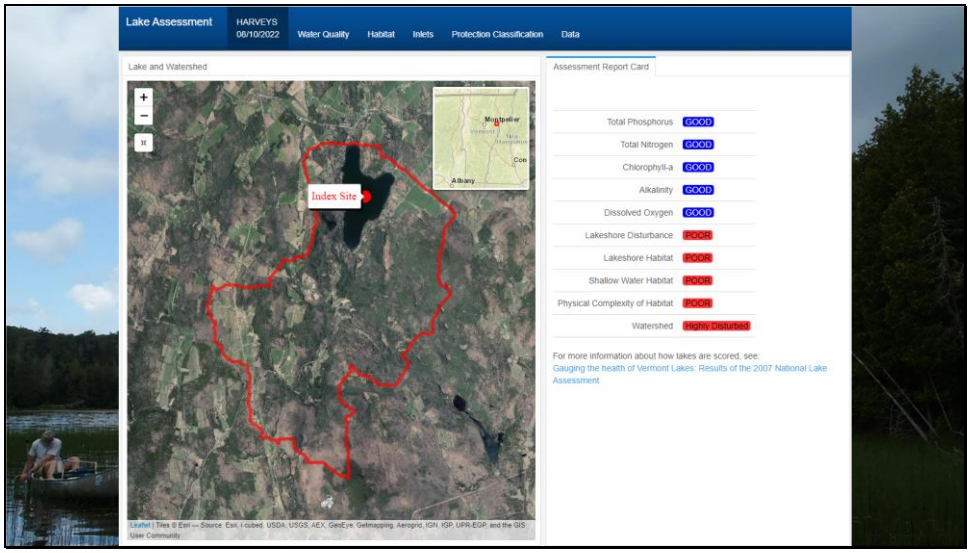
This is the lake score card for Lake Willoughby, which you see the score for the shoreland condition is yellow, or fair. There are scores for the condition of the watershed, whether there are invasive species present and whether the trend in the water quality is good, fair or poor.

Slide 103



For more detail, some lakes have Next Generation Lake Assessment Reports you can view and interact with in the far-right column. If you click on that for Harveys Lake

Slide 104



We see that Harveys scores poor for lakeshore disturbance, lakeshore habitat, shallow water habitat and physical habitat complexity.