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Good Afternoon! My name is Scudder Mackey and I am a Visiting Research Professor at the University of Windsor. I have been asked to report on the status of land use/land cover changes and the potential impact of those changes on nearshore areas of the Great Lakes.

There is no question that changes on the landscape affect the Great Lakes, especially in the nearshore zone where the land meets the water. First we need to define what we mean by the nearshore zone.

The nearshore zone has had many definitions, and I think for most of us we envision the nearshore as beaches, breaking waves, and the shallow water areas immediately adjacent to shoreline. The question is… where are the boundaries of the nearshore zone and how far into the lake does it extend? (**Click to next slide**)

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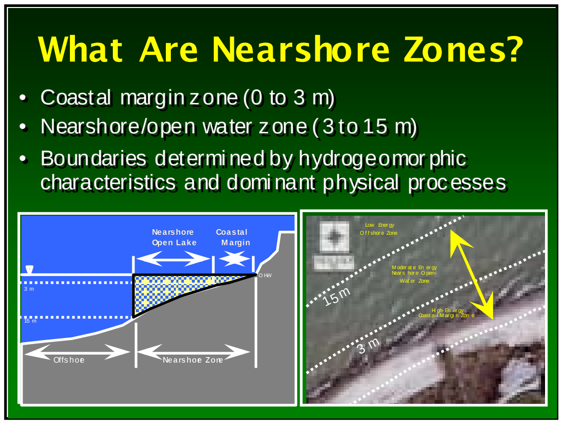
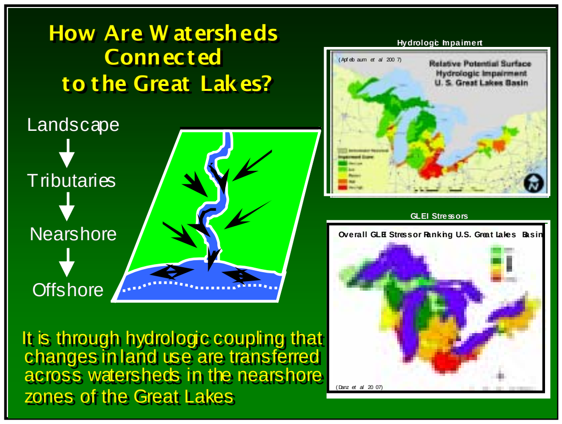


Each of the Great Lakes has different hydrogeomorphic and limnological characteristics. For our purposes, we define the nearshore zone as extending from Ordinary High Water to water depths of 15 m (**Click**).

We then subdivided the nearshore into two sub-zones – a coastal margin zone defined as the area between Ordinary High Water extending lakeward to the water depths of 3 m, and a nearshore/open-water zone that extends lakeward from water depths of 3 m to water depths of 15 m.

These sub-zones were differentiated based on the substantial energy differences and dominant coastal processes acting on those areas. In general, coastal margin areas are higher energy and are dominated by littoral coastal processes. Nearshore/open-water areas have aspects of lower-energy open lake circulation except during major storms when littoral coastal processes dominate.

The 15 m water depth boundary was also selected because of distinct differences in fish community structure and limnological characteristics associated with that water depth. However, in larger and deeper Great Lakes, such as Lake Superior, recent expansion of nearshore benthic communities may extend lakeward into water depths approaching 100 meters. (**Click to next slide**)



Second, we need to understand how landscapes are connected to the Great Lakes… in other words, how do actions taken many tens of kilometers landward of the coastline affect the Great Lakes?

Landscapes are linked to the Great Lakes by hydrologic processes that control how water, energy, and materials move from watersheds into Great Lakes tributaries **(Click)**, and ultimately into coastal margin, nearshore **(Click)**, and offshore areas of the Great Lakes **(Click)**.

Changes in land use and land cover affect how water moves across the landscape, and alters tributary and nearshore flow regimes. Altered flow regimes affect seasonal timing and may result in increased erosion, sediment transport, and reduced water quality in tributaries and nearshore areas of the Great Lakes. These changes may modify nearshore aquatic habitat structure and alter ecological functions.

Recent studies have attempted to evaluate how changes on the landscape impact the Great Lakes. Comparing the two maps to the right, the GLPF hydrologic impairment map compares favorably with the overall GLEI stressor map , which suggests that altered flow regimes are an important factor that directly links changes on the landscape and hydrologic alterations to ecological impairment. (**Click to next slide**)

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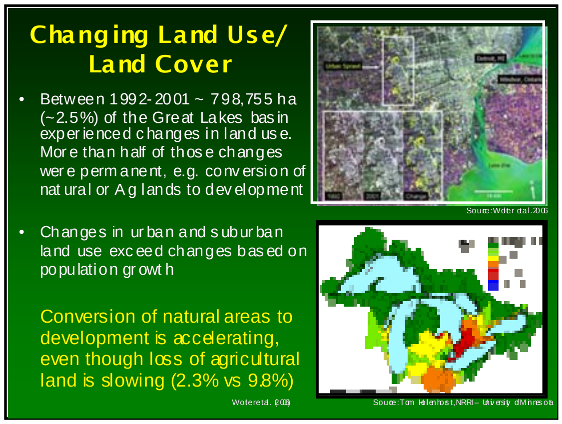

For the period 1992 to 2001, approximately 800,000 hectares or 2.5% of the Great Lakes basin experienced a change in land use. These changes were dominated by conversion of forested and agricultural lands to either: high or low intensity development, transportation (roads), and/or upland grasses and brush (Early Successional Vegetation).

More than half of these changes are considered to be irreversible and permanent. Conversion rates exceeded predictions based on population growth alone. For example, in the Chicago area, urban and suburban land use increased by 19%, while population growth in the same area increased by only 2.2%.

These results suggest that losses of both agricultural and forested lands are continuing in the basin. However, recent data suggests that the rate of conversion of agricultural lands appears to be slowing. In the decade prior to 1992, U.S. EPA reported that agricultural land use declined by 9.8% in the Great Lakes basin.

For the time period 1992 to 2001, agricultural land use declined by only 2.3%, which is a substantial reduction in the rate of loss of agricultural lands. Interestingly, even though wetlands are protected, wetland losses continue with more than 38% of wetland losses occurring within 10 km of a Great Lakes shoreline.

In summary, **the conversion of natural lands to development continues, but conversion of agricultural lands in the basin appears to be slowing. (Click to next slide)**

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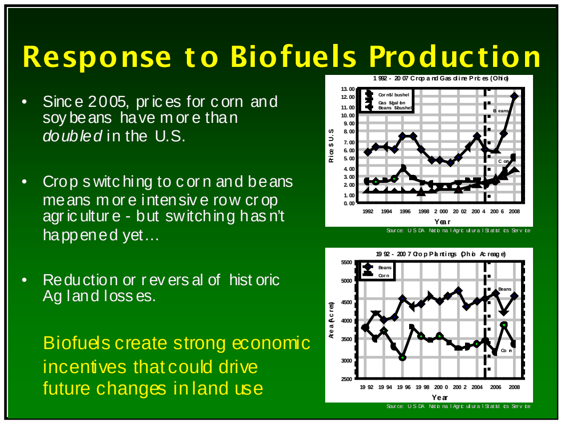

Since 2005, prices for corn and soybeans have more than doubled in the U.S. as illustrated in the slide to the upper right. Increases in the price of gas and Federal subsidies for ethanol from corn may be driving the rapid increase in price for these crops. The rapid rise in the price of gasoline also makes ethanol production more economic as well.

High prices for corn and beans provides an enormous economic incentive for farmers to convert existing agricultural lands and/or natural lands into row crop agriculture.. These changes **may** be expressed by crop switching and/or conversion of land back into agriculture. However, the plot on the lower right shows that crop plantings for beans and corn have not increased significantly in the past several years.

Of course you may want to be somewhat skeptical of these plots, as they are the result of a Geologist mucking about with Ag statistics. It should also be noted that crops and/or acreage planted for energy production are **not** currently reported or tracked in most agricultural datasets. Given **potential** future impacts of these land use changes on the Great Lakes, monitoring of these types of metrics may be warranted.

In summary, biofuels and crops grown for energy production may provide strong economic incentives that could drive future changes in land use. (**Click to next slide**)

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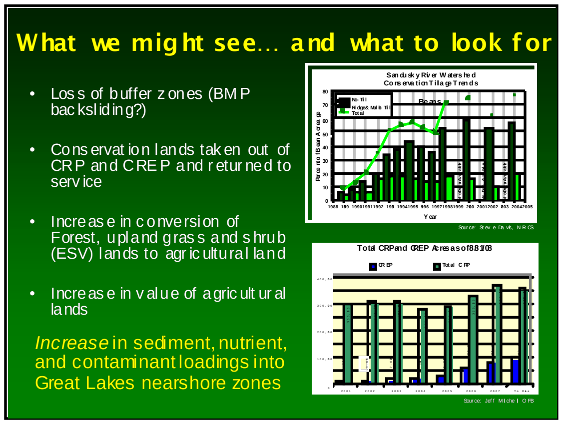

In the Great Lakes basin, the implementation of Best Management Practices (BMPs), conservation tillage programs, and financial incentives (such as the CRP or CREP programs) has led to considerable success managing soil loss, erosion, sediments, and nutrient runoff. However, in the U.S. we may have already picked most of the "low hanging fruit" as acreages have generally stabilized over the past eight to ten years.

In Ontario, Environmental Farm Plan BMPs evaluate environmental aspects of all agricultural operations and develop plans to minimize environmental impacts. OMAFRA reports acreage operating under EFPs and/or conservation tillage increased 21% during the period 1991 through 1996 - and updated assessments are currently underway. Moreover, in many areas, the dollar value of agricultural lands has skyrocketed in response to higher crop prices. This may be one reason why the rate of loss of agricultural land has recently declined in the basin.

In summary, **it is imperative that existing conservation programs be maintained and expanded, especially if crop switching and/or conservation lands are converted back into agricultural production. Otherwise, it is anticipated that will see an increase in sediment, nutrient, and contaminant loadings into Great Lakes nearshore zones.** (**Click to next slide**)

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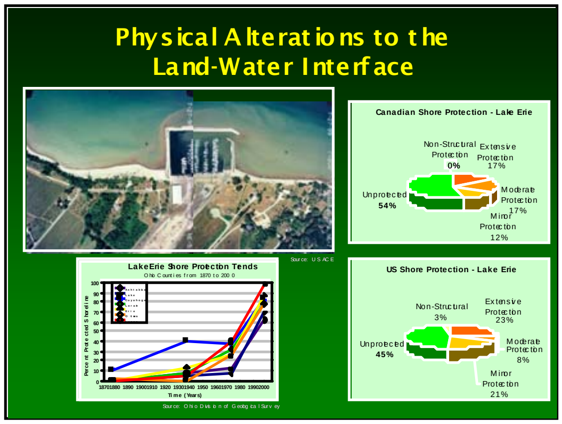

A commonly overlooked land-use/land-cover change is physical alteration to the shoreline. As coastal areas are developed, shorelines are armored to protect property and infrastructure.

Large navigation structures, marinas, and launch ramps are constructed to promote commerce and recreational uses. In Ohio, more than 75% of the coastline was armored in 2000, and recent recession-line mapping showed a significant increase in the number of shore protection structures installed between 1990 and 2004.

Physical alterations of to land/water interface disrupt natural coastal processes which, over time, can have a significant regional impact on nearshore and coastal margin substrates, habitat, hydraulic connectivity, and nearshore water quality.

Shoreline hardening reduces the availability of coarse-grained littoral sediments that create and maintain beaches, which become progressively narrower with the passage of time. Modifications to tributaries and river mouths (filling, hardening, channelization, and dredging) have altered river mouth processes and nearshore flow regimes, and destroyed coastal margin habitats. (**Click to next slide**)

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Along many Great Lakes coastlines, cohesive clays are exposed on the lakebed along with coarse boulder-cobble substrates. Loss of littoral sand accelerates lakebed erosion of these exposed cohesive clays due to mobilization lag deposits during high energy events (the sandpaper effect). The erosion of lakebed clays is permanent and irreversible.

As shown in the slide to the upper right, coarsening of nearshore substrates provides ideal habitat for lithophyllic species such as dreissenids (zebra and quagga mussels), Cladophora, and round gobies (**Click**).

Moreover, nearshore water quality is degraded due to lakebed erosion of cohesive clays and resuspension of fine-grained sediments. The slide to the lower right shows the impact of lakebed erosion on nearshore water quality. Also note that storm events are not necessary for degradation of nearshore water quality to occur.

Reductions in sediment supply threaten thin barrier beaches that protect coastal wetland complexes in the Great Lakes. During high water events, these barriers are breached and peeled back exposing soft, easily erodible wetland substrates to direct wave attack and erosion. Examples of coastal wetland loss include Sheldon Marsh, Metzger Marsh, and Potters Pond on the south shore of Lake Erie.

In summary, **physical alteration of the land-water interface directly impacts coastal processes and has significantly altered nearshore habitat structure.** (**Click to next slide**)

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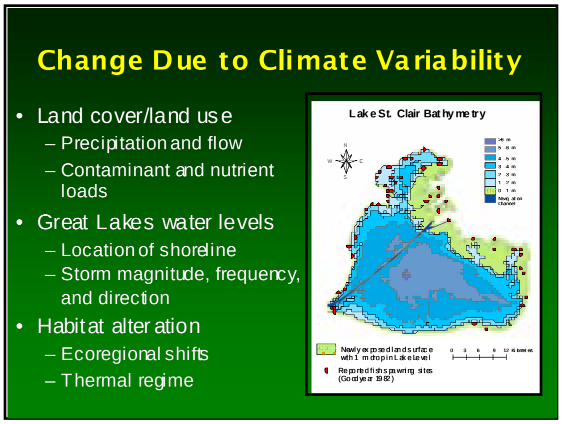

What we have **not** considered is the potential impact of climate variability on the landscape. Changes in land use/land cover will undoubtedly occur in response to climate variability, including altered flow regimes and contaminant and nutrient loadings into tributaries and Great Lakes coastal margin and nearshore zones.

Current climate change models predict an overall lowering of Great Lakes water levels over the next 50 to 70 years, even though the models also predict increased variability in water levels as well. Change in water levels will alter the location of the land-water interface and may result in a lakeward shift of the shoreline, especially in low slope shallow-water areas (such as shallow embayments or lakes).

For example, in the area of the St. Clair delta in Lake St. Clair, the shoreline may shift lakeward a distance of up to 5 km. The net result of these shoreline shifts may be the loss of critical nearshore spawning and nursery habitats, including hydraulic connectivity with adjacent coastal wetlands.

Work by the University of Michigan has suggested linkages between water levels and storm magnitude, frequency, and direction. If these linkages are correct, then we may be forced to change how we develop, manage, and protect Great Lakes coastlines. Finally, changes in thermal regime and ecoregional shifts may substantially change vegetative cover and aquatic species distributions in the nearshore zone

What is needed is some "out of the box" thinking on this subject and the development of a set of scenarios that explore potential impacts and associated management options over a range of different climatic conditions. (**Click to next slide**)

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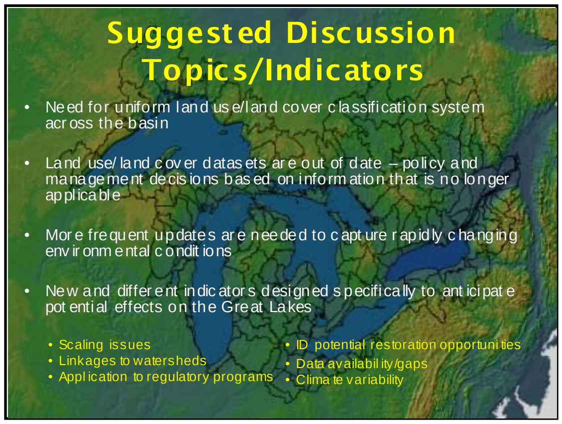

Finally, this slide lists a number of potential discussion topics for the upcoming session later today. This list is by no means exhaustive but is meant to start the creative juices flowing in anticipation of robust discussion later today on this topic.

Specific topics of interest include the lack of a uniform land use/land cover classification across the Great Lakes basin, which severely limits our ability to evaluate basinwide changes to the landscape.

Second, many land use/land cover datasets are out-of-date. For example, many wetlands datasets may be more than three decades old. We are making important policy and management decisions based on information that may be no longer applicable.

Third, for these very same reasons, land use/land cover datasets need to be updated more frequently, certainly more than the current 10 to 15 year update cycle.

To conclude, **even though steps have been taken to mitigate land use impacts and impairments, continued population growth and development will continue to cause further degradation of coastal margin and nearshore habitats (Click).**

Thank you. (**End of Presentation**)

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