Changes in the Humber Bay Benthic Macroinvertebrate Community Structure:

1990 - 2012

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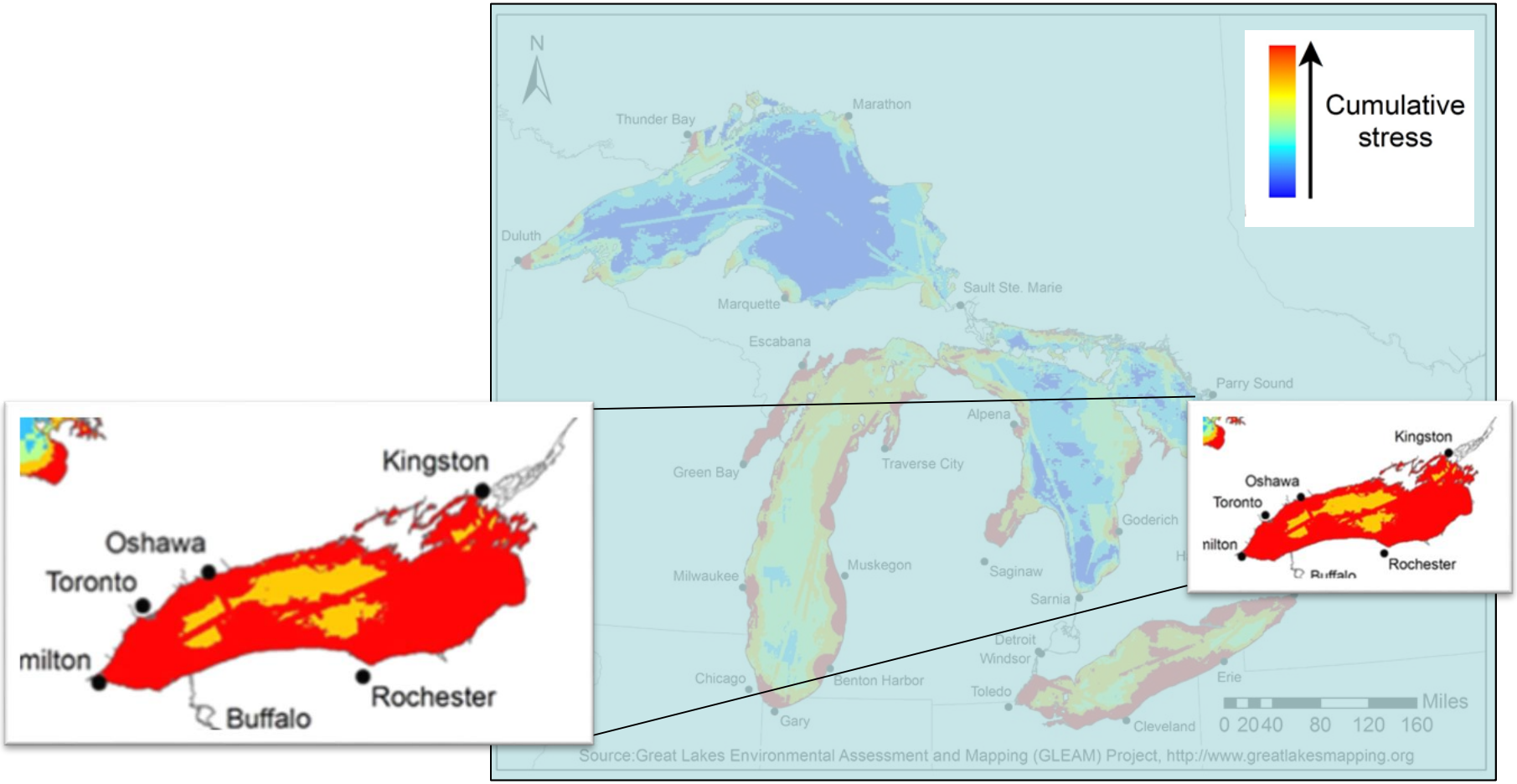
Ontario Ministry of the Environment, Conservation and Parks

Presented Nov 21, 2018 Toronto RAP Seminar @ Toronto, ON

Lake Ontario is Stressed



Prioritizing on-the-ground actions is challenging when dozens of stressors are in play (Allen et al. 2013)

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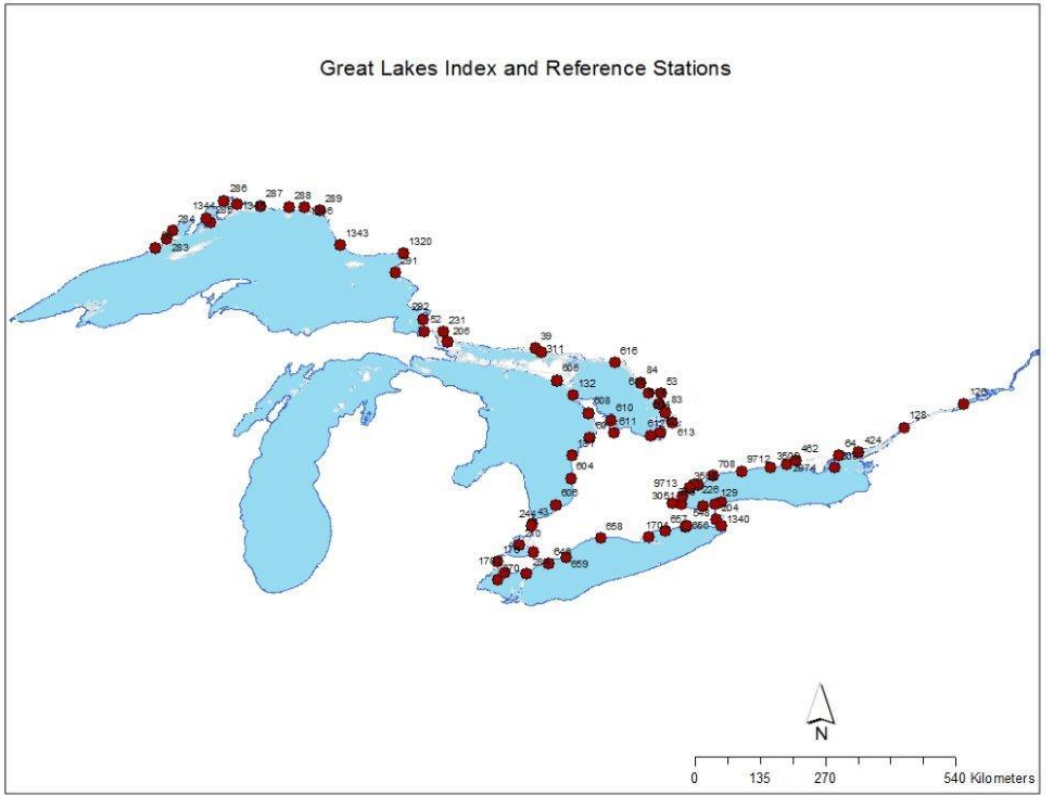
Great Lakes Nearshore

MECP* index station monitoring program:

Study of

- levels and features of anthropogenic stress
- lake ecology and nutrient dynamics



* MECP = Ontario Ministry of the Environment, Conservation and Parks

See also https://www.ontario.ca/data/ for Great Lakes Nearshore water and sediment chemistry and (soon!) benthos

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Benthos as an Ecosystem Change Indicator:

- Benthos differ in their tolerance to pollution and integrate effects of stressors over time

- Humber Bay can be used as an example of other urbanized sites in Lake Ontario

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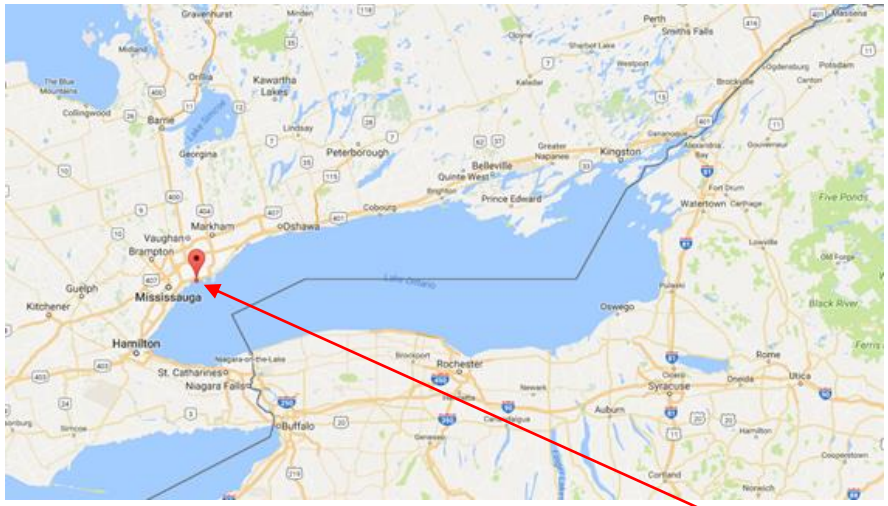
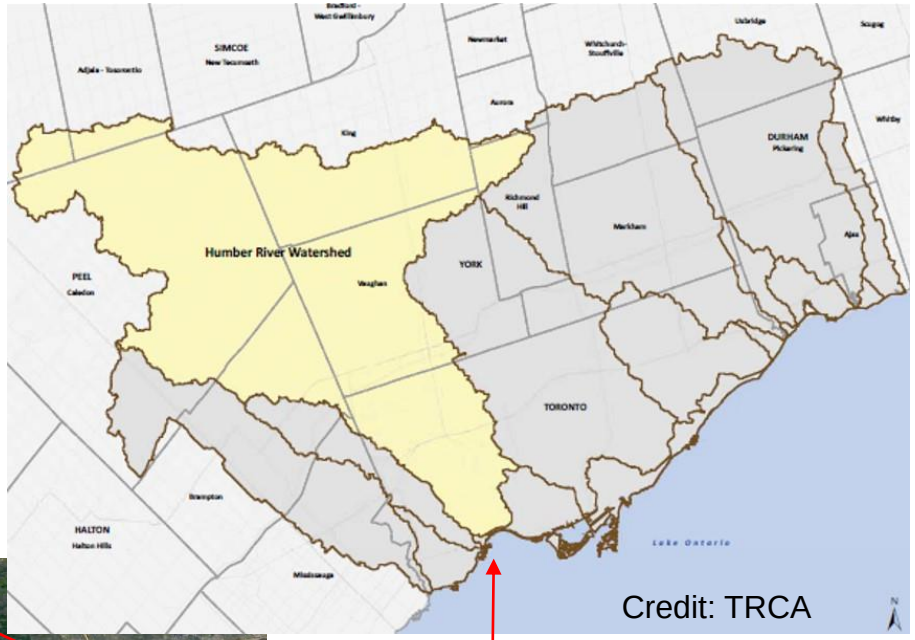
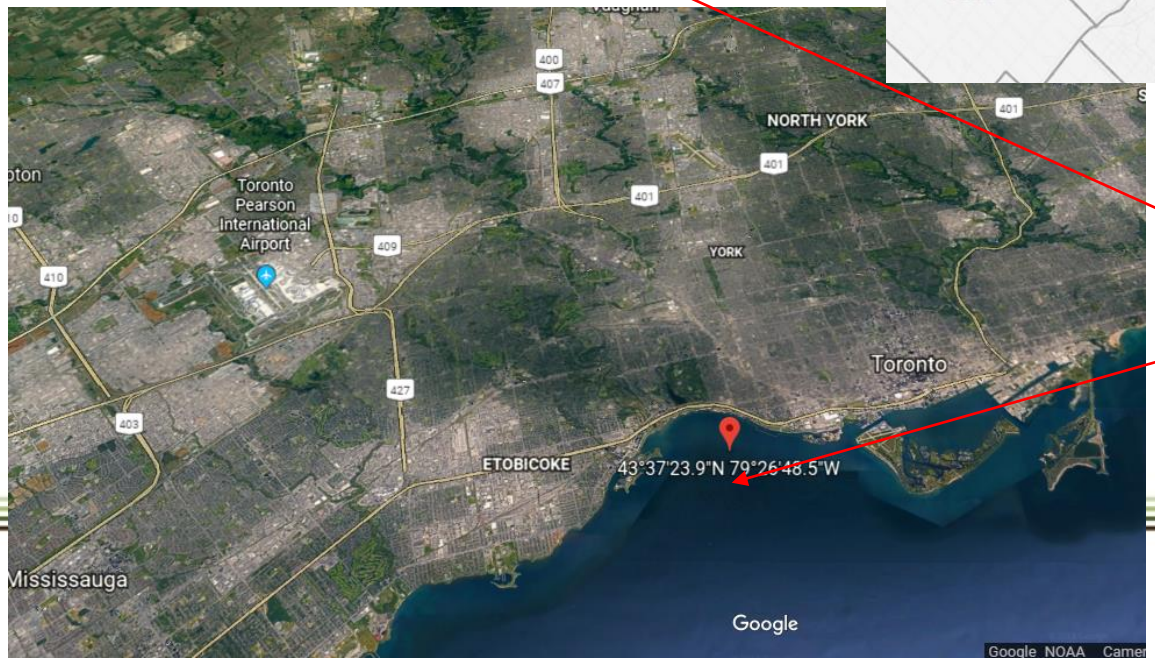
Where?







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Why Humber Bay?

Receives input from largest watershed in Toronto AOC

Dramatic change in urbanization and ↑ in impervious cover

Change in Phosphorus input greater than other watersheds

↑ in Population has been dramatic

(↑ >2x in 20 yrs to ~860,000)

Photo credits: TRCA

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Humber Bay Stressors:

INTERNAL

Invasive Species:

- Phytoplankton & Benthos
- Benthic Algae

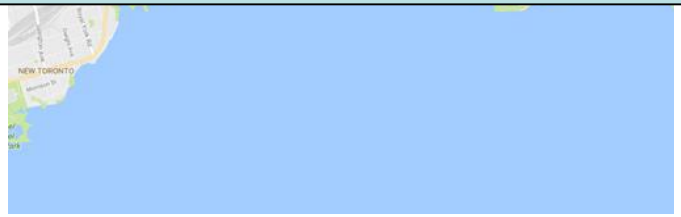
EXTERNAL

↑ population

- ↓ phosphorous

Fisheries Management

How did these known stressors influence the Humber Bay benthic community?



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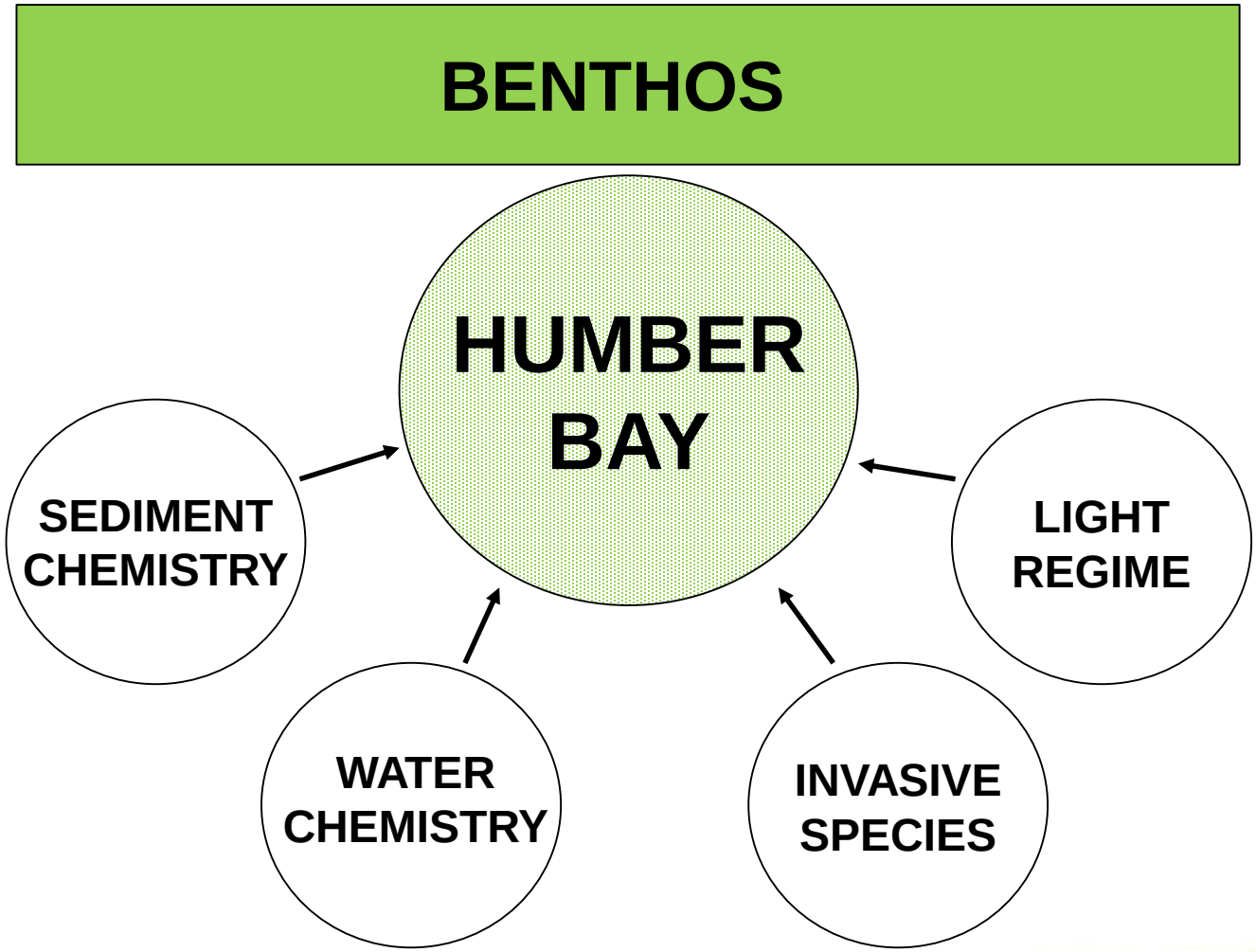
How?

- **Water, sediment & benthos samples were collected within a 100 m radius of Humber Bay Index**
  - **Stn. 600012047 (43.62331, -79.44681)**
  - **1990, ‘94, ‘97, 2000, ’03, ‘06, ‘09 and ’12**
  - **Water grab (n=1, ≥3x/year) 1m above substrate**
  - **Surface sediment (n=3*, July-Aug) Shipek**
  - **Benthos (n=5^, July-Aug) 9” Ponar, 600 µm mesh**
- **Humber River discharge information from Environment Canada hydrometric data**
  - **Stn 02HC003**
- **Round goby arrival data from TRCA**

*2009 n = 2; ^2006 n = 3

Hypothesized Drivers of Change:



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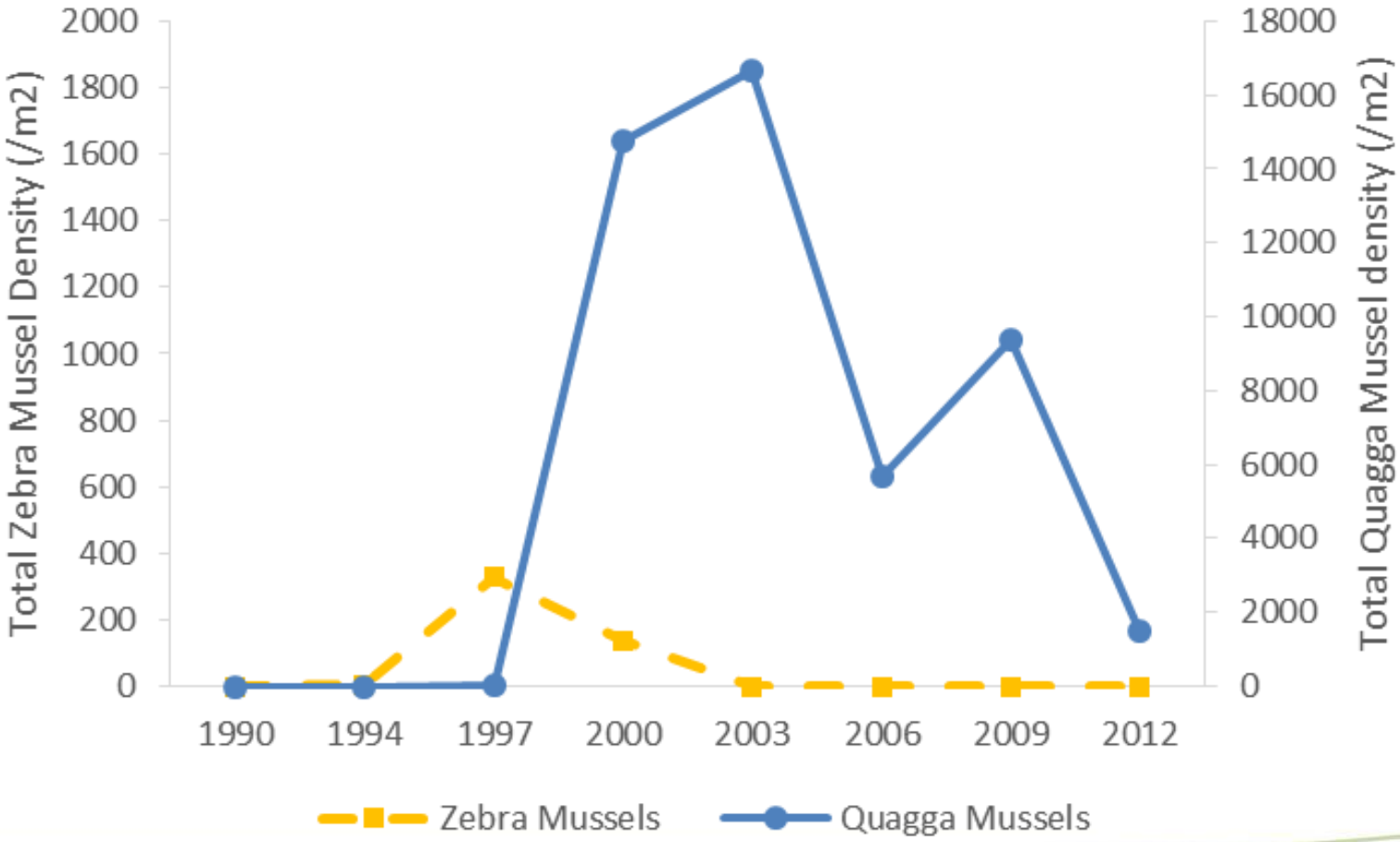
Humber Bay Has Changed -
The Arrival of Invasive Species



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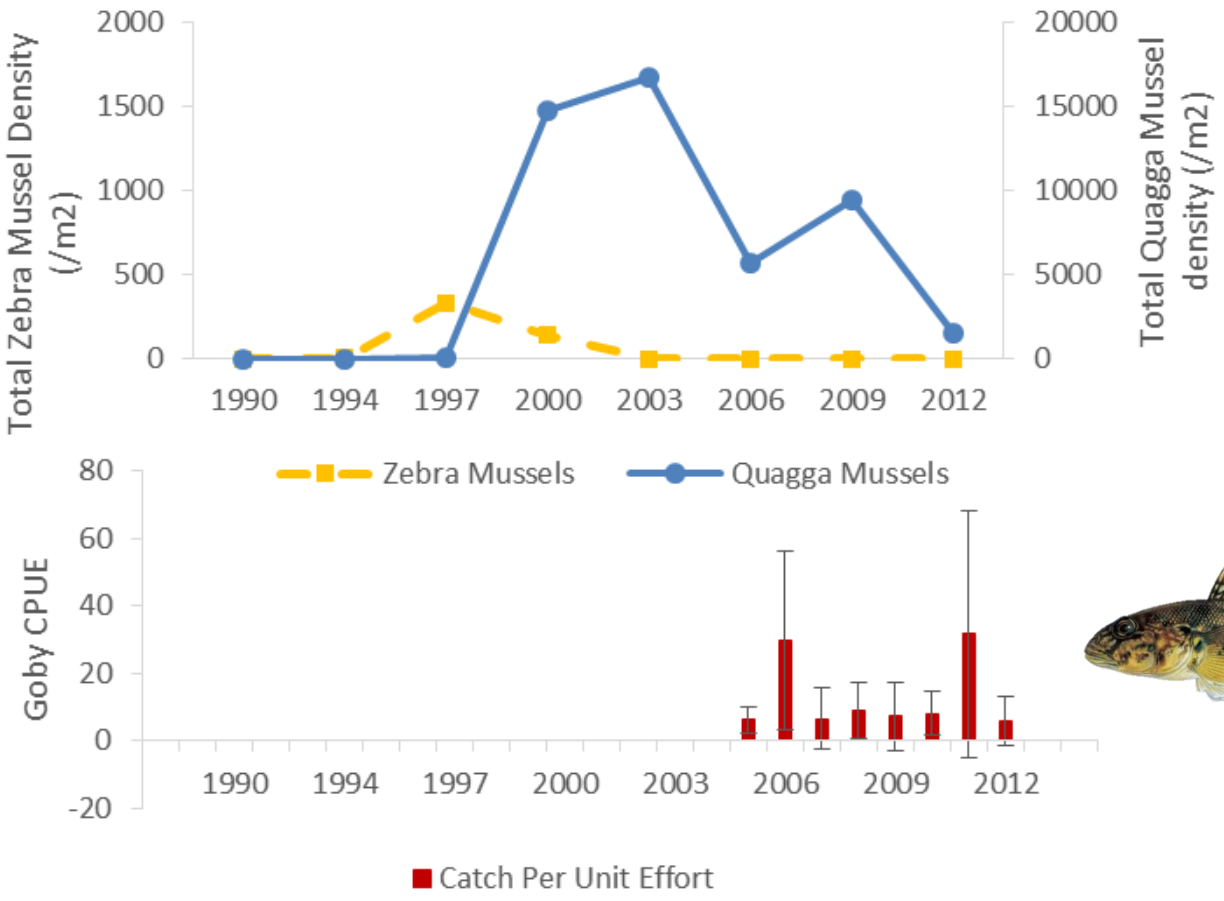

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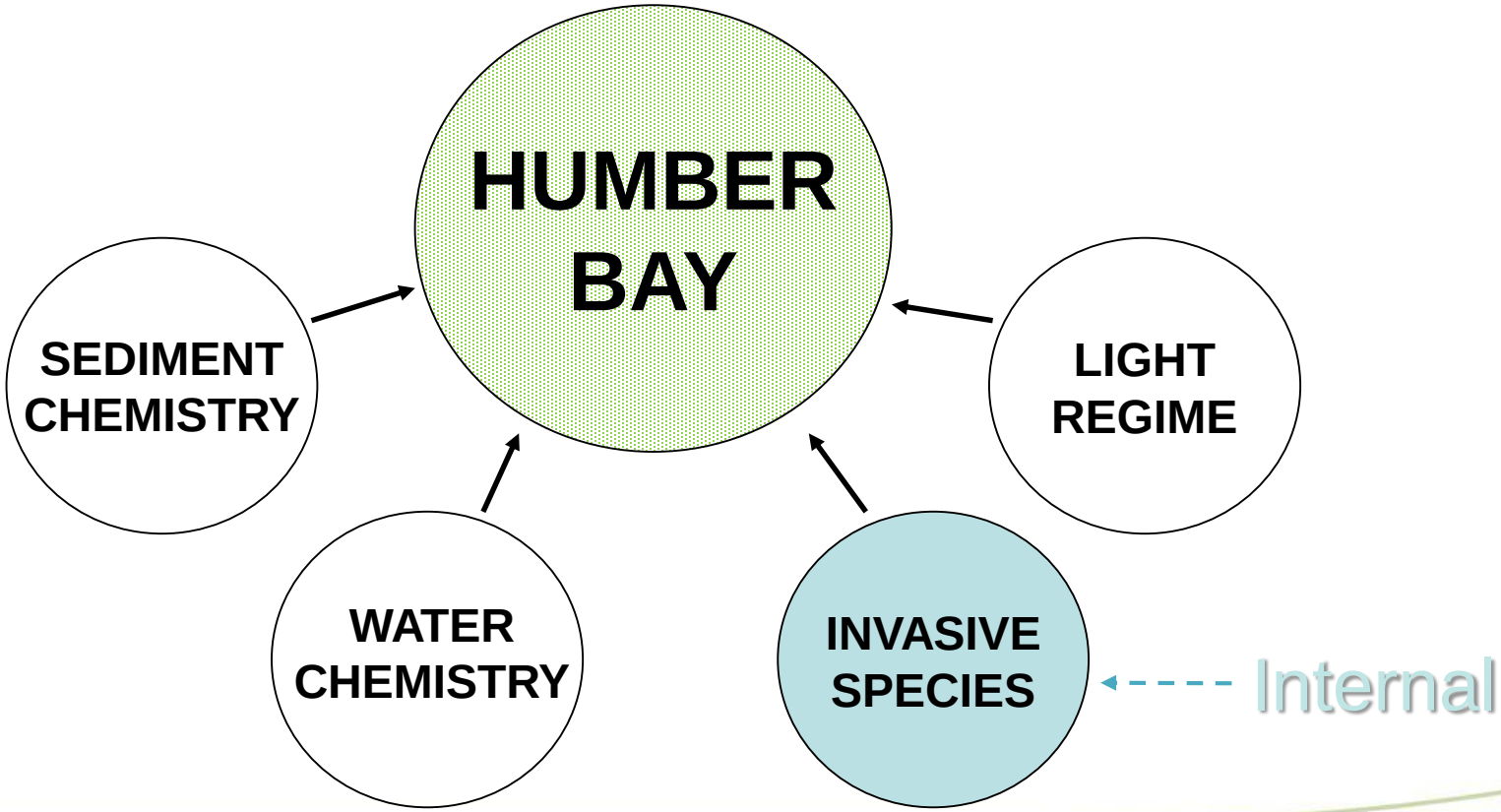
Drivers of Change:

BENTHOS



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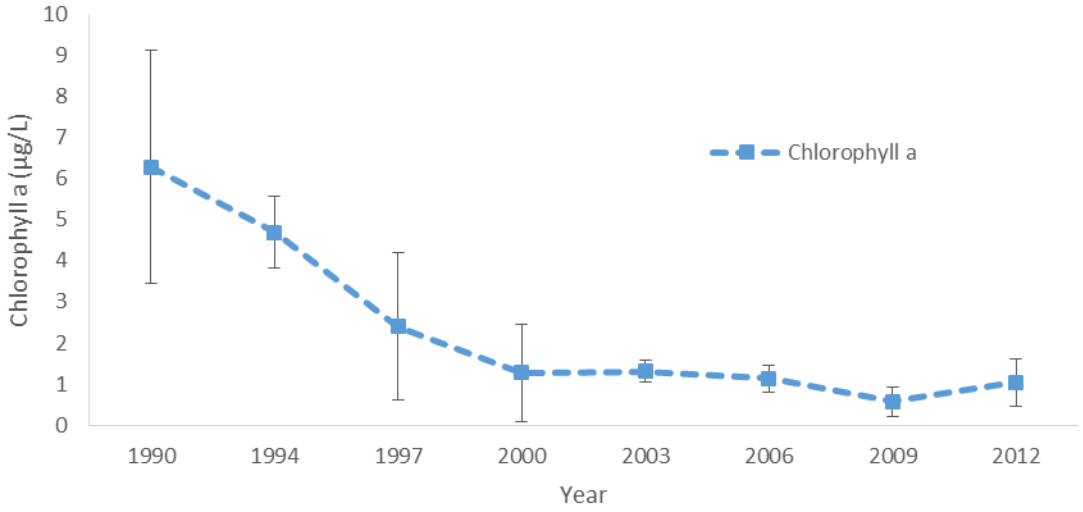
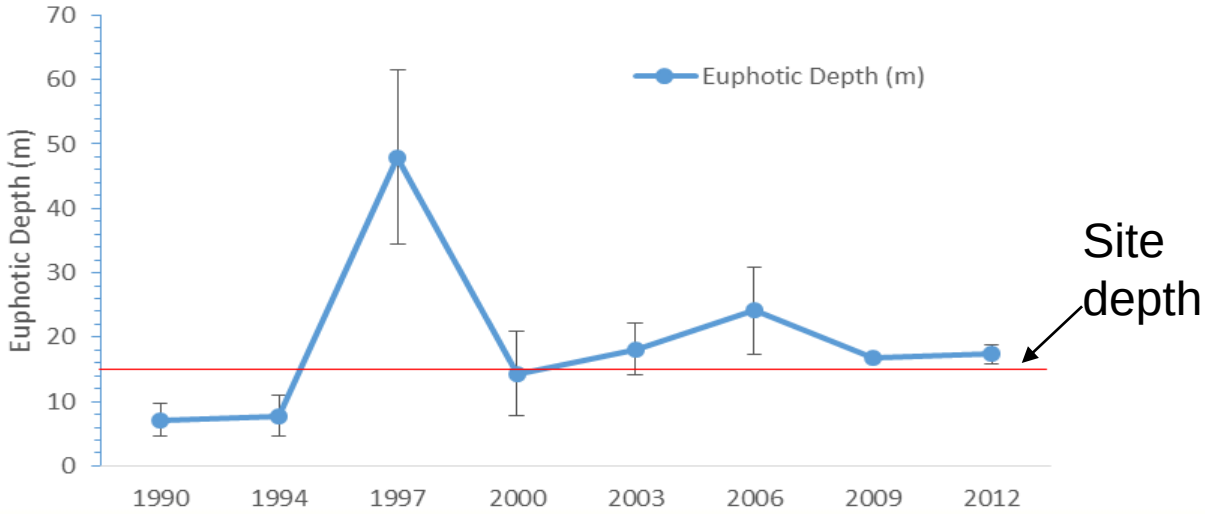
CHLOROPHYLL a



EUPHOTIC DEPTH



Humber Bay Has Changed - Light Penetration

- Chlorophyll a was reducing before dreissenids possibly due to influence of Lake Erie and TP management
- Chlorophyll a remained low after gobies decreased dreissenid density
- Light reaching substrate since 1997

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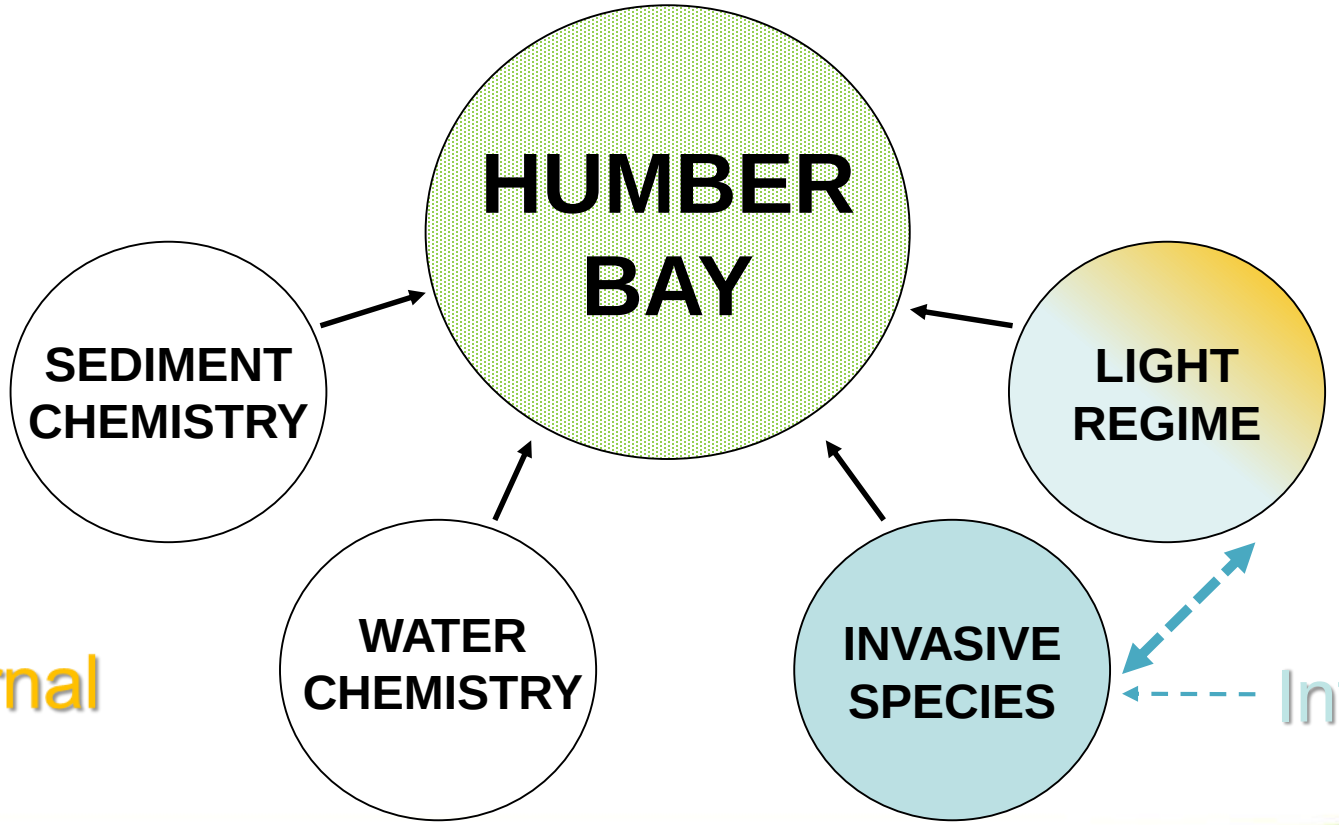
Drivers of Change:

BENTHOS



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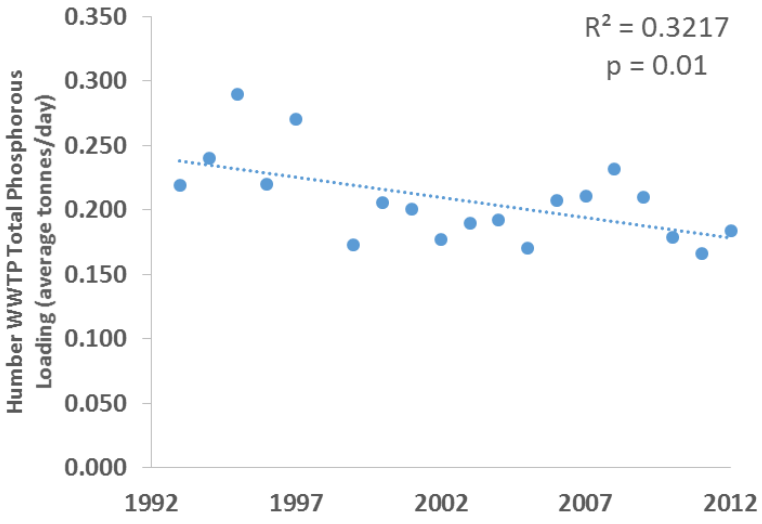
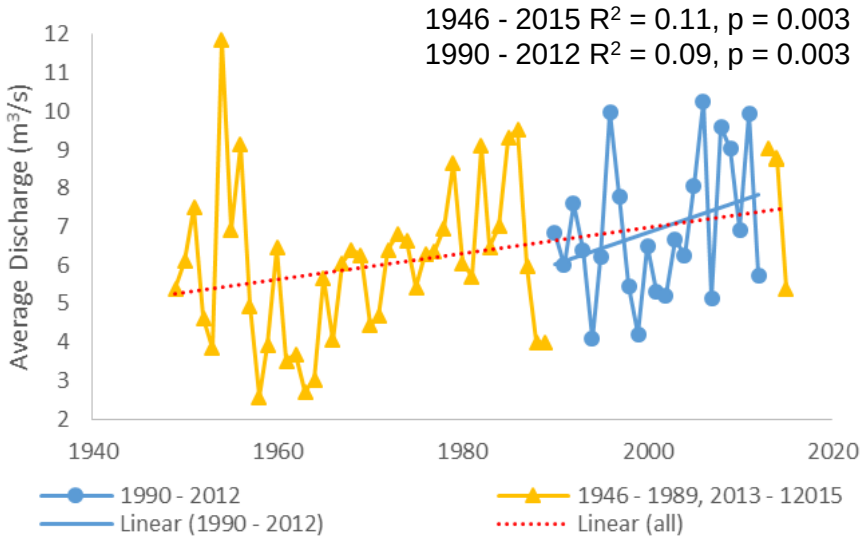
Humber Bay – Have External Stressors Changed Water Chemistry?

- Humber Bay nearshore Index receives input from a major WWTP*, a major river system and a large urbanized watershed





- Decline in total phosphorous (TP) from the Humber WWTP has been significant
- There has been a significant increase in average discharge from the Humber River

* WWTP = waste water treatment plant

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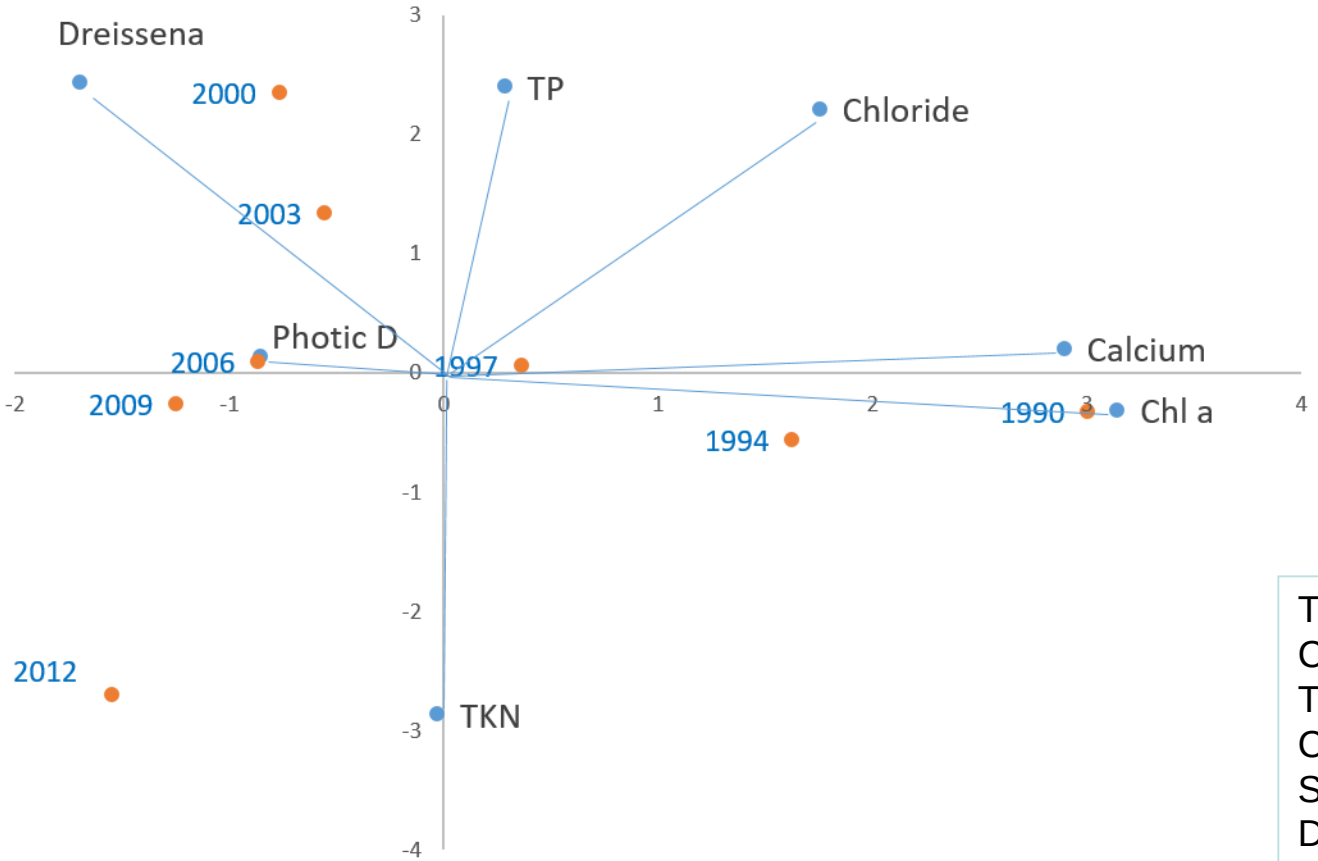
Humber Bay Has Changed – Changes in Water Chemistry (External and Internal drivers)



36% of the variation in chemistry over the years was explained on the first axis (66% on 2 axes) when *Dreissena* count is included

TKN = total kjeldahl nitrogen
Chlor = chloride
TP = Total phosphorous
Chl_a = Chlorophyll a
SECCHI = secchi depth
Dreiss = Dreissenid count

Principal Components Analysis (PC1 = 35.5%, PC2 = 30.8%)

*Environmental Variables eigenvalues multiplied by 5

https://www.ontario.ca/data/water-chemistry-great-lakes-nearshore-areas

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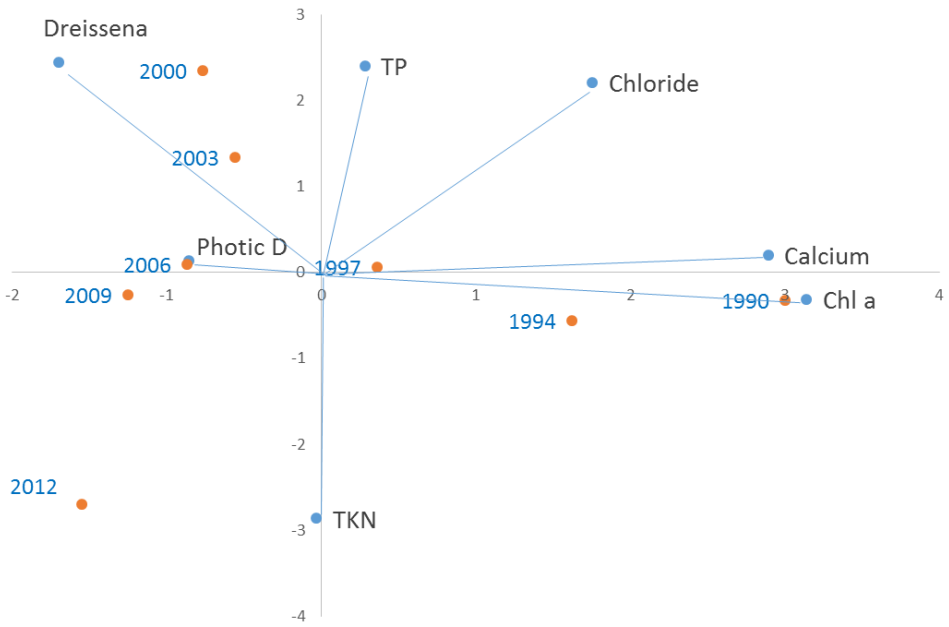
Water Chemistry cont…



- 1990 - 1994 high calcium, chlorophyll a and low photic depth
- 1997 similar to ‘90 and ‘94 but photic depth increased
- 2000 and 2003 primarily influenced by high densities of *Dreissena* and increased photic depth
- 2006 – 2009 still influenced by high *Dreissena* count and photic depth but also further decreases in chlorophyll a and calcium
- 2012 and 2009 had much lower average and much more variable chloride than other years and 2009 influenced by elevated and highly variable total phosphorous and total kjeldahl nitrogen

DIFFICULT TO RELY ON CHEMISTRY DUE TO VARIABILITY AND THE SCALE OF THE PATTERN AND CHANGE

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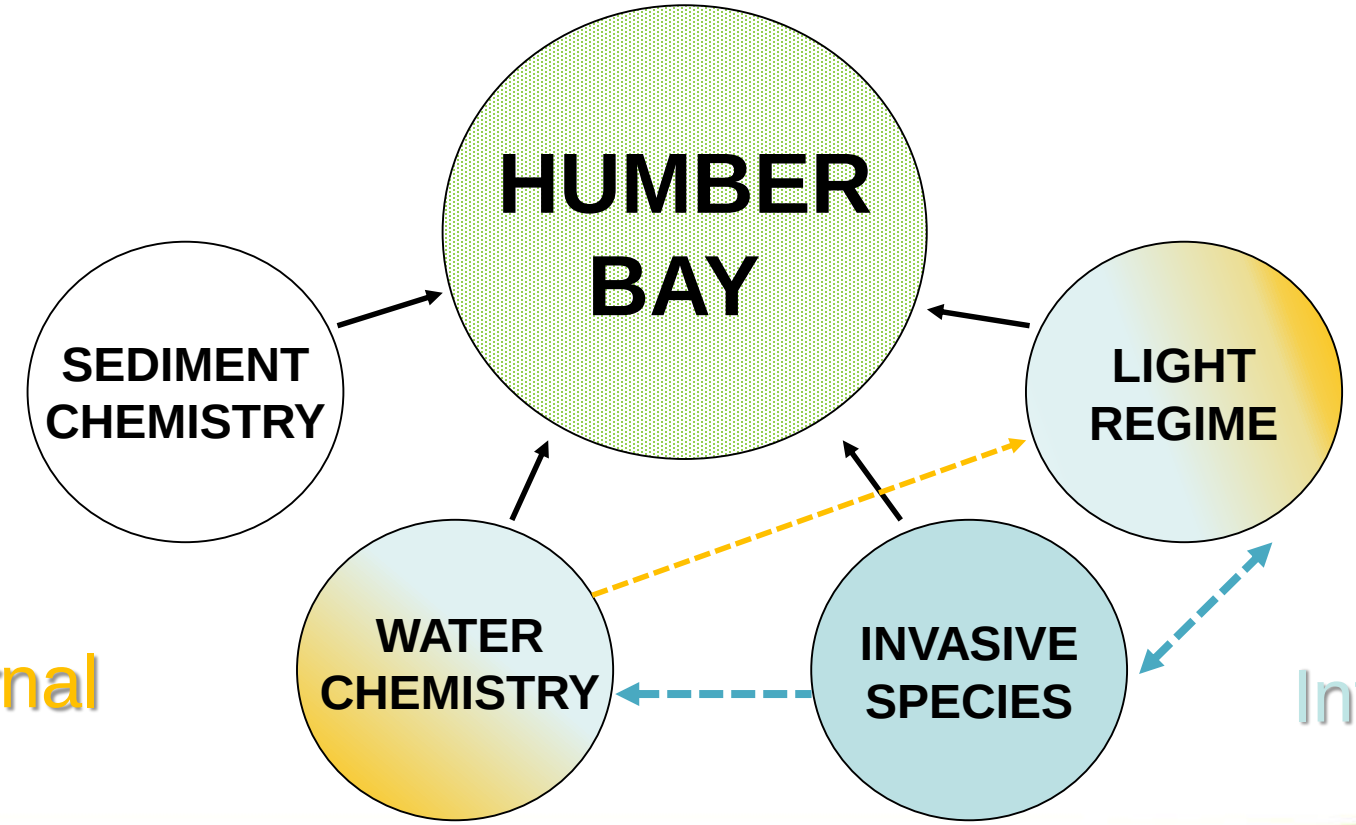
Drivers of Change:

BENTHOS



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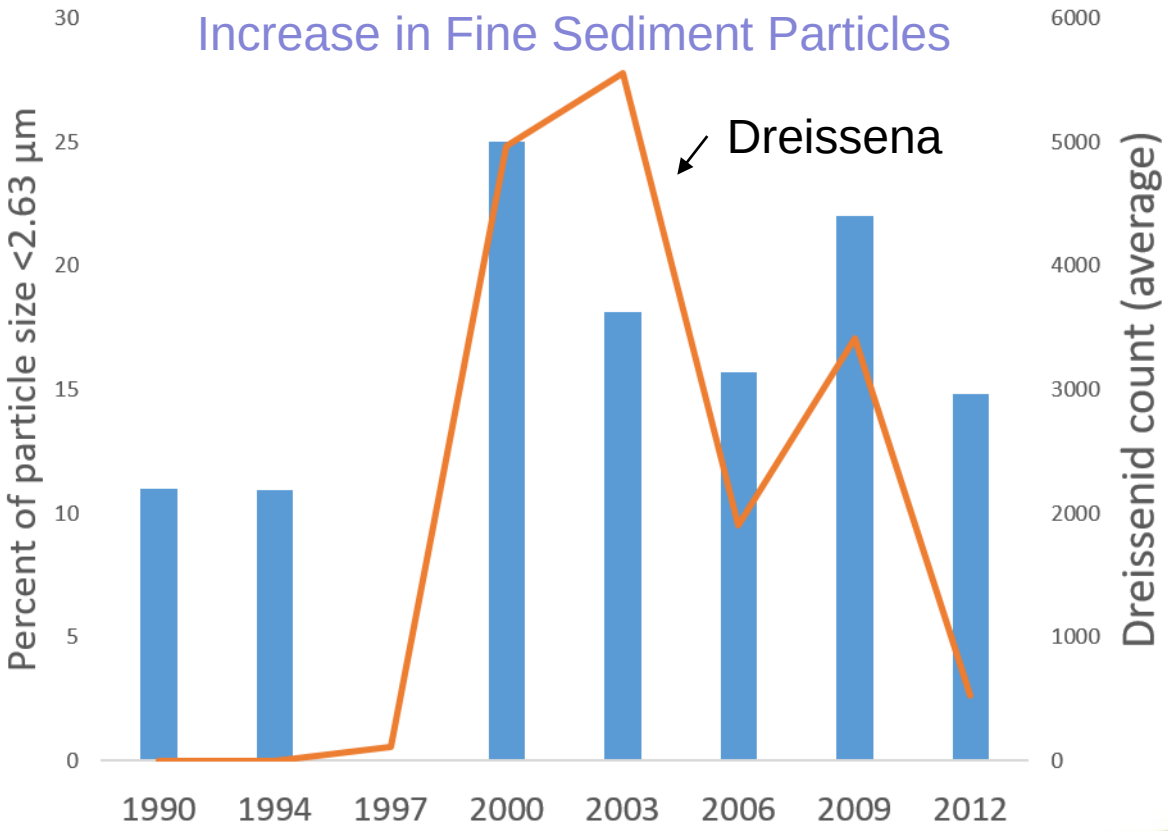
Humber Bay Has Changed -

Changes in Sediment Chemistry and Composition

- No Severe Effect Level Exceedances
- LELs exceeded for chromium, cadmium, copper, lead, and nickel in some or all years
- No trend over time
- Emerging compounds not addressed



https://www.ontario.ca/data/sediment-chemistry-great-lakes-nearshore-areas

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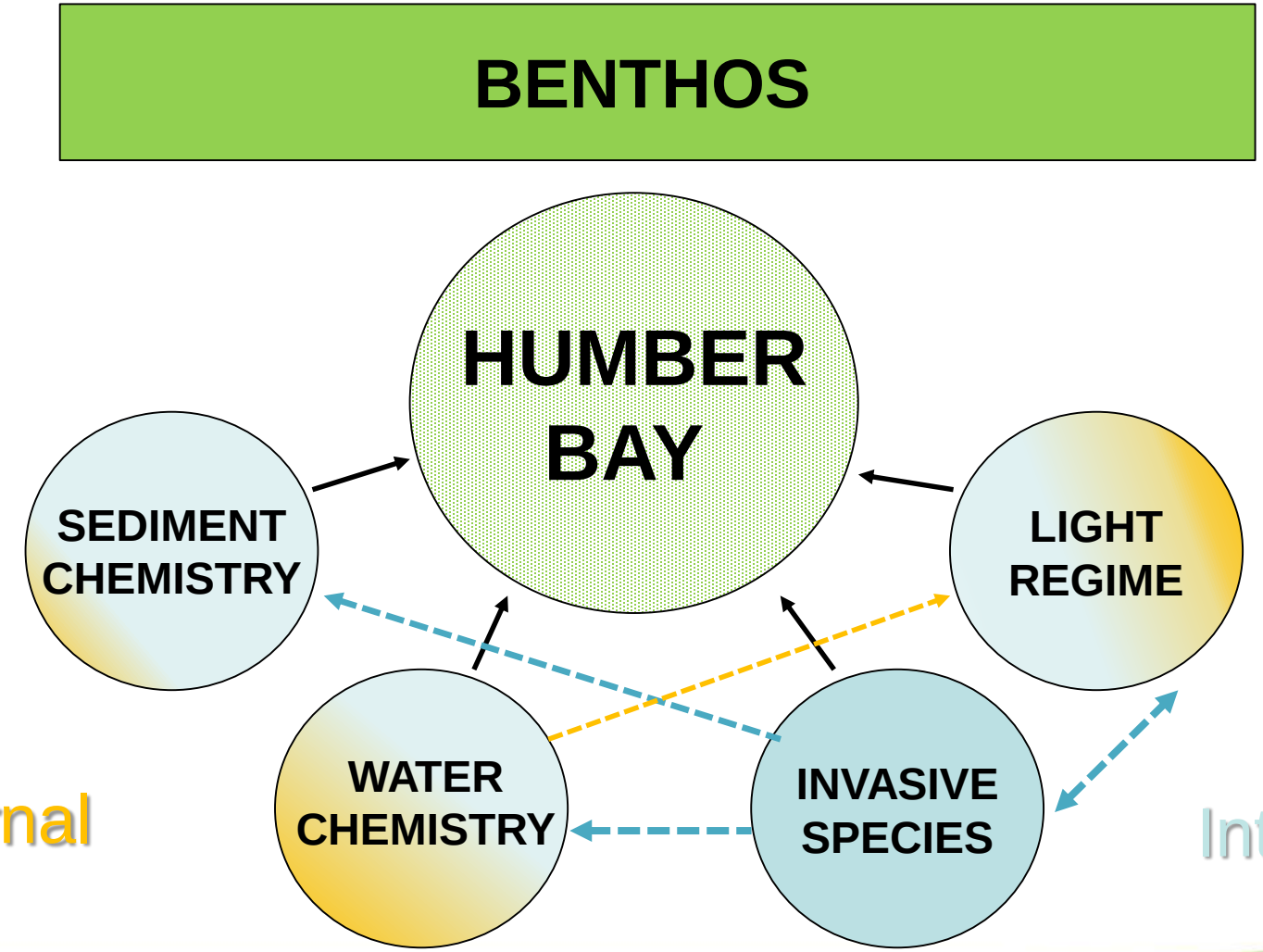
Drivers of Change:



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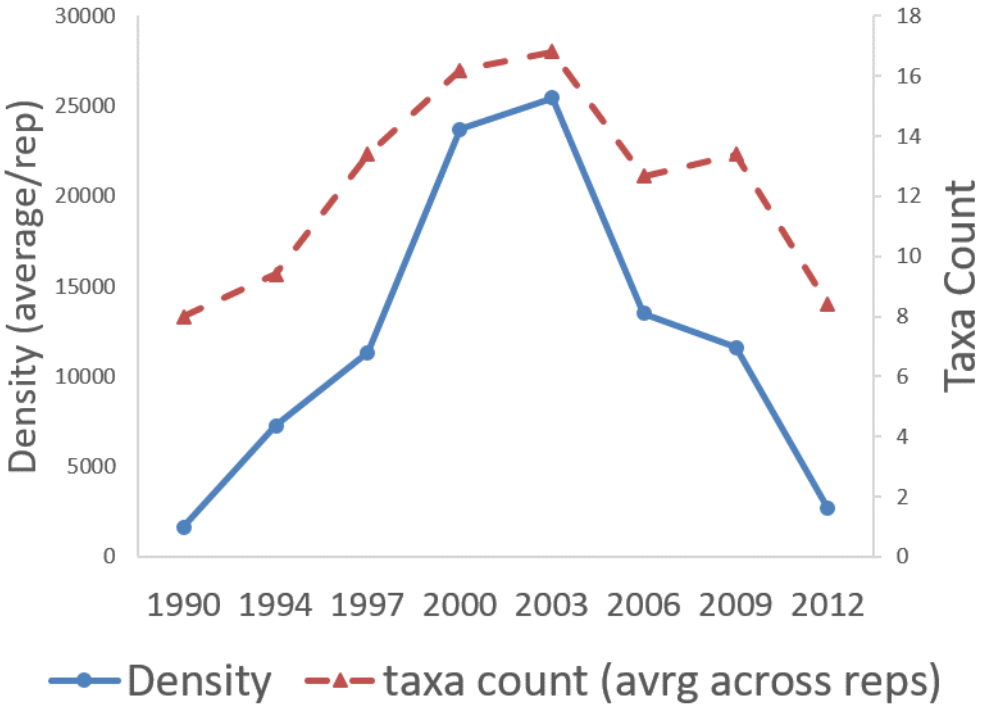
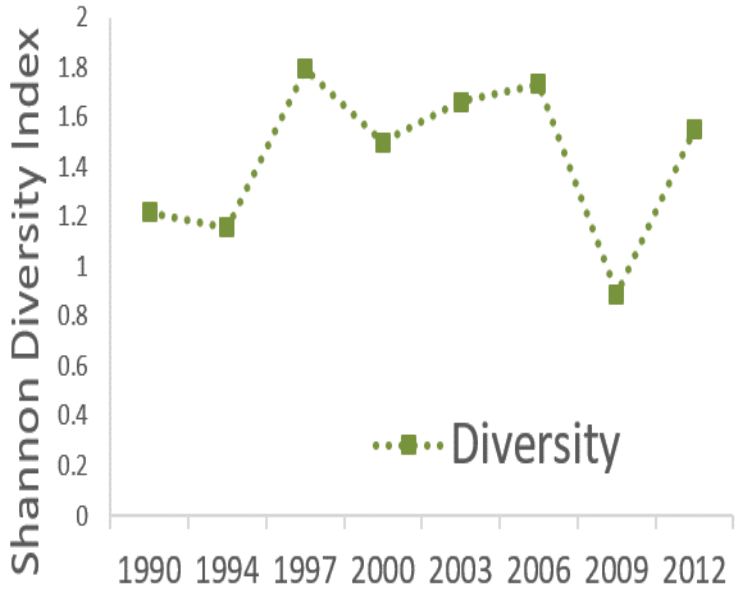
Humber Bay Has Changed -

Changes in Benthic Density, Richness & Diversity





2000 - 2012, Dreissenidae >65% of the total density, all other families <10% of the total, 2009 Dreissenidae =82% of total

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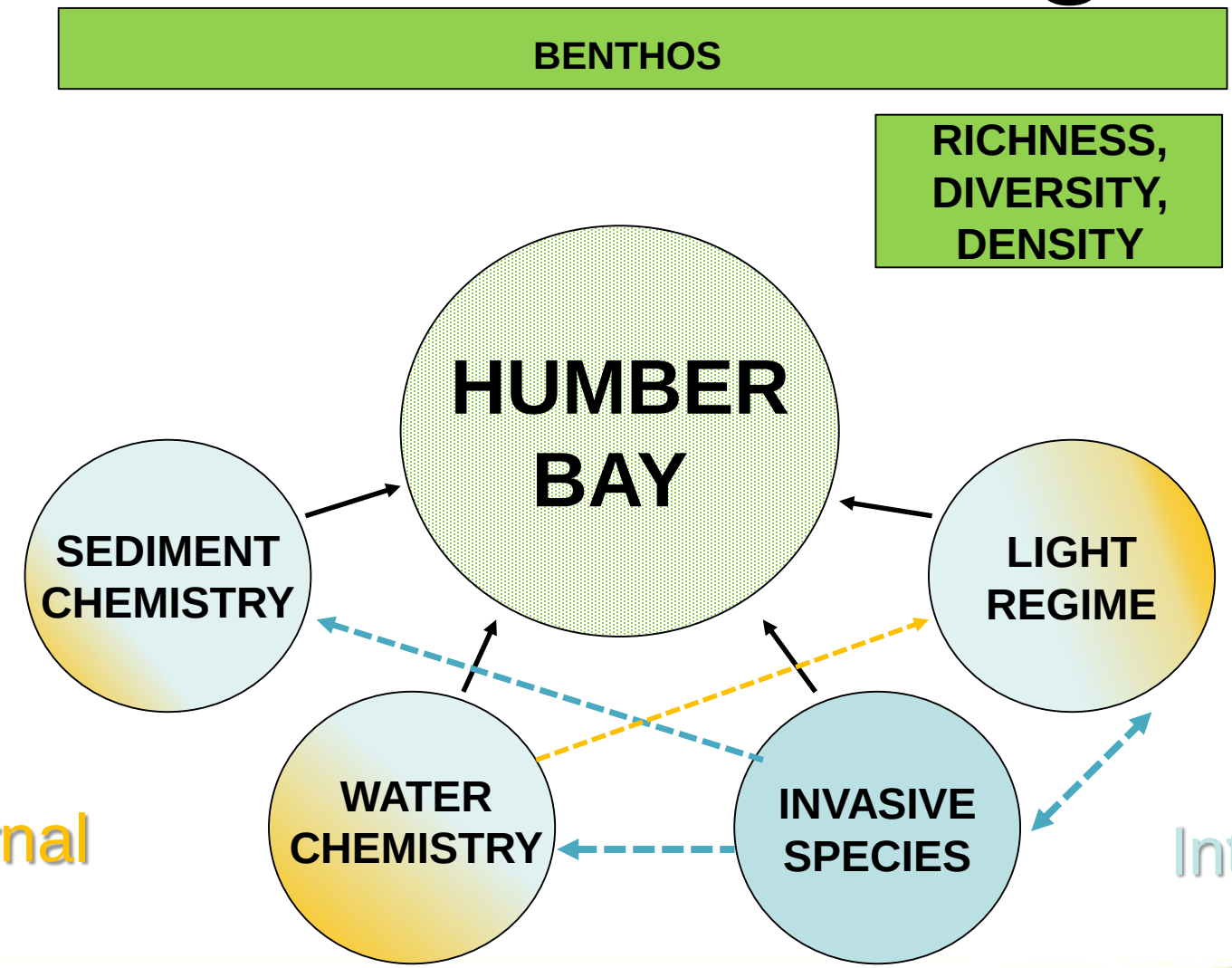
Drivers of Change:



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Humber Bay Has Changed -

Changes in Community Structure


wikipedia


www.glerl.noaa.gov


wikipedia


Associated Press


Amy Benson- USGS

Family level, rare species removed

Correspondence Analysis (LN X+1) (CA1 = 38.5%, CA2 = 24.4%)

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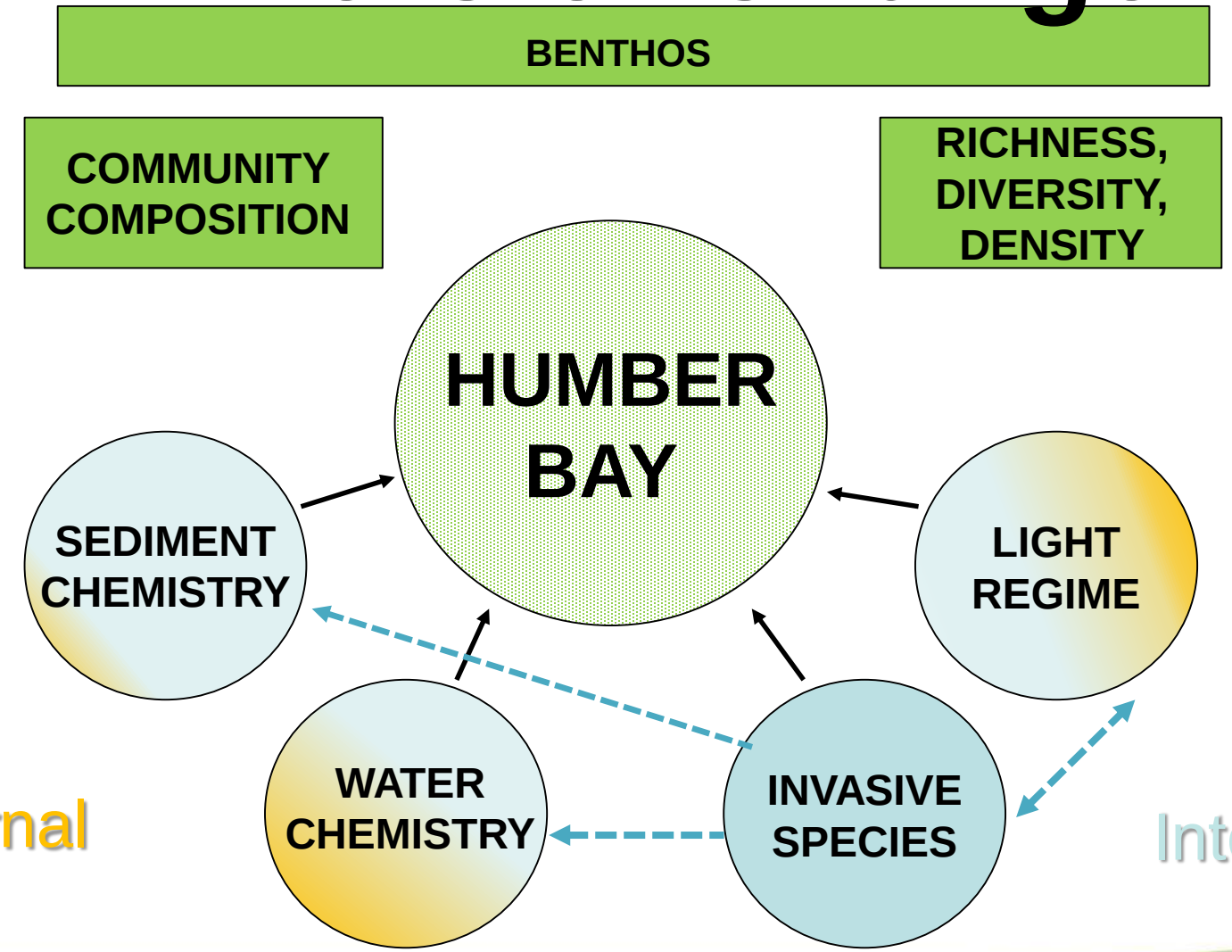
Drivers of Change:



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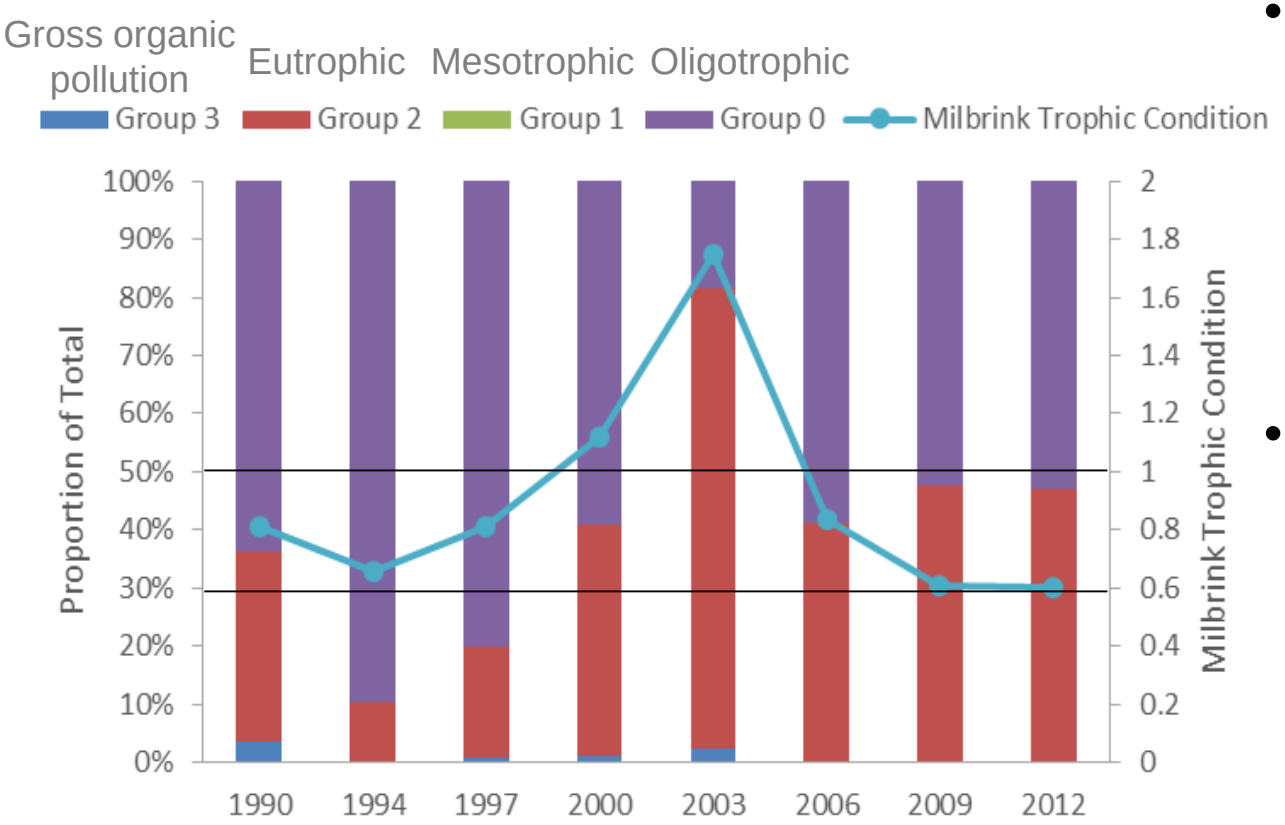
Humber Bay Has Changed -
Changes in Trophic Condition



- Except in 2000 and 2003 oligochaete community indicated mesotrophic conditions
- In 2000 and 2003 tolerant Group 2 species dominated and some Group 3 species increased while sensitive species decreased

Milbrink Trophic condition:
>1 = eutrophic; 0.6 – 1.0 = mesotrophic; <0.6 - oligotrophic

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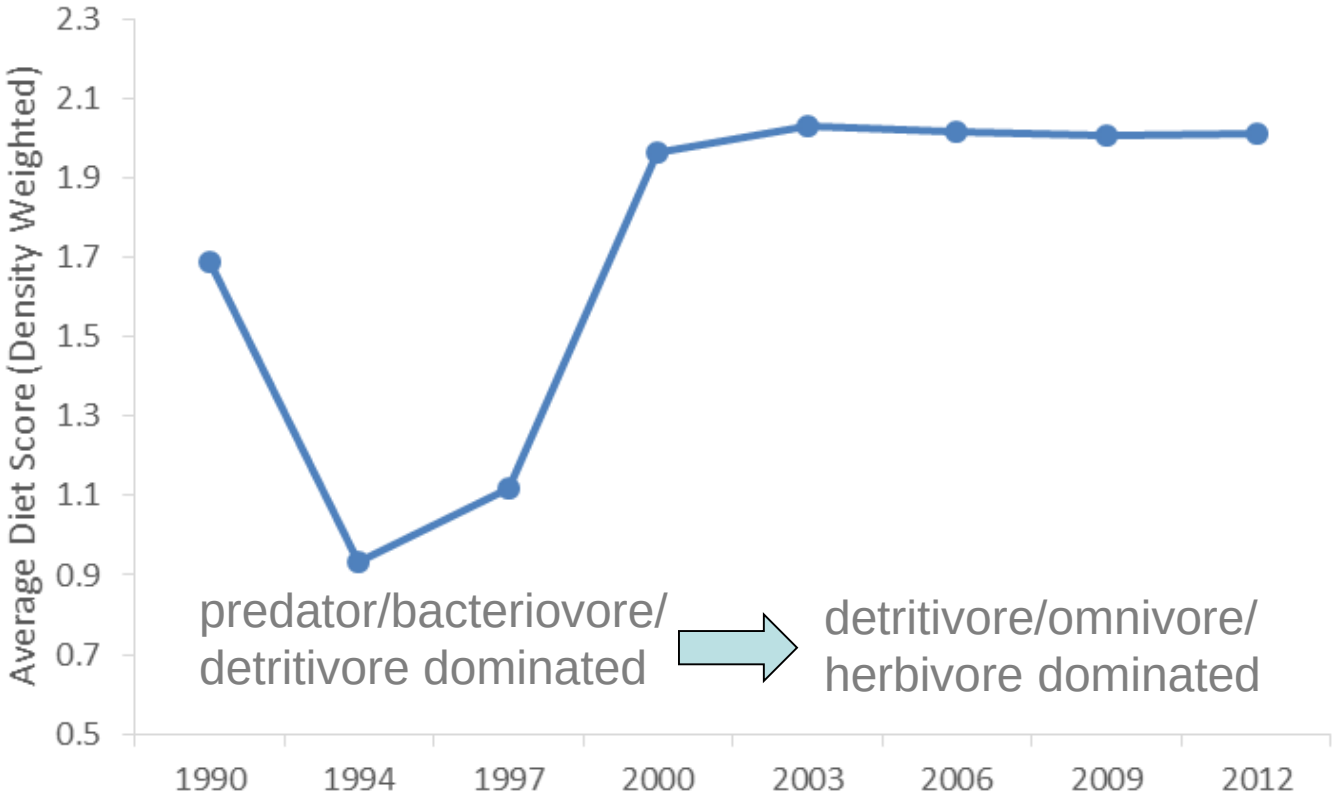
Humber Bay Has Changed -

Changes in Community Trophic Structure*



Predator – 0; Bacteriovore – 0; Detritivore – 2; Omnivore – 3; Herbivore - 3

*Dr. David Barton, personal communication

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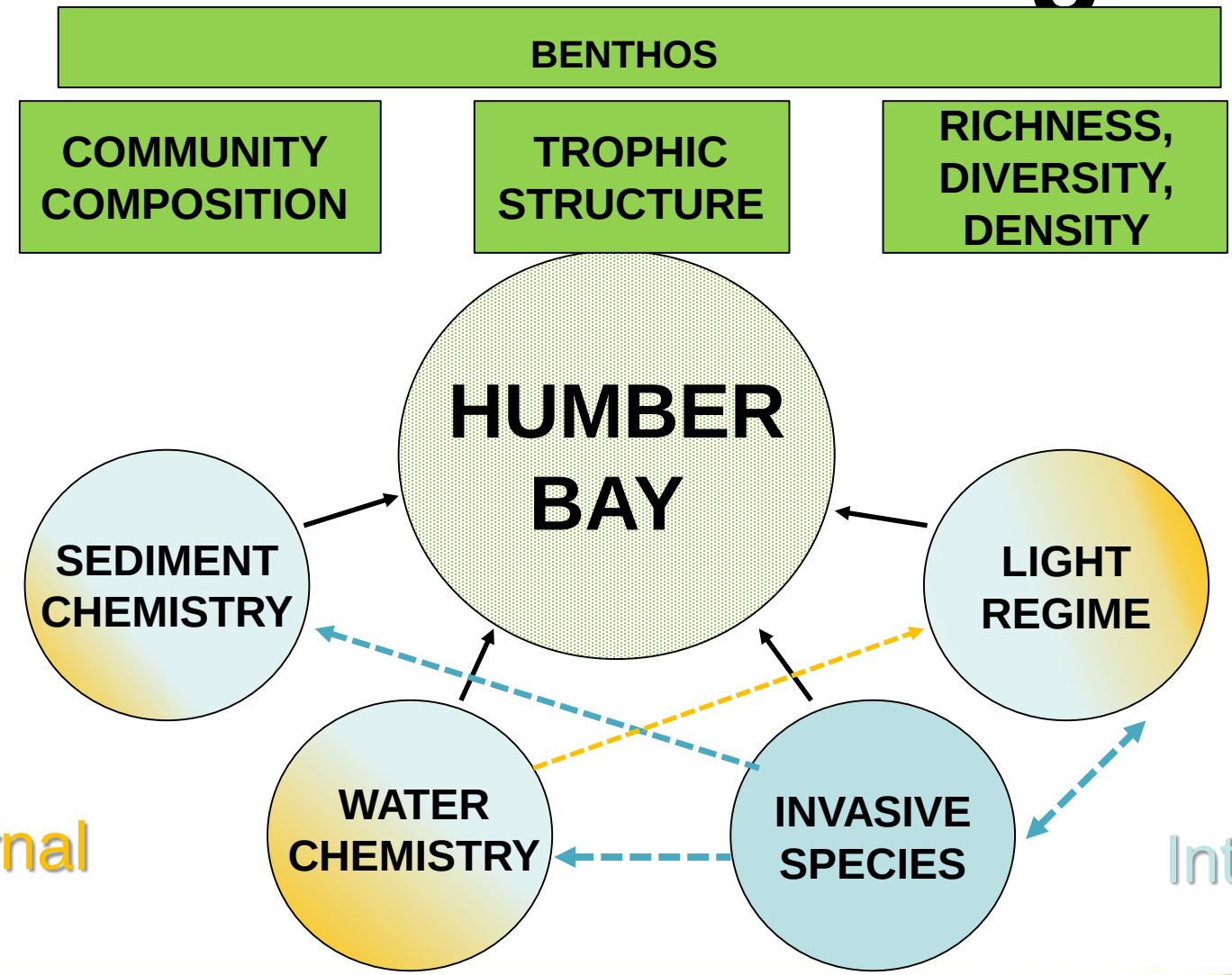
Drivers of Change:



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Summary

- Benthos are food for fish, indicators of ecosystem function and biological indicators of the effectiveness of management actions/decisions.

- Even in highly urbanized and urbanizing areas of the lake invasive species have been found to be the major driver in nearshore benthic community diversity and trophic structure

So What?

- Complexity of changes and stressors on urban coastlines make environmental protection highly complicated.
- Going forward it is recommended that monitoring of biological end points such as benthos is used together with sediment and water chemistry data to assist with management decisions in the Great Lakes nearshore.

Thank You!

Acknowledgements:

- MECP Great Lakes Unit
- MECP Laboratory Services Branch
- Toronto Region Conservation Authority staff (esp. Brian Graham)
- Praneeta Moti, Humber Bay WWTP
- Bill Snodgrass, City of Toronto

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