INTERNATIONAL WATER RESOURCES ASSOCIATION'S
1st ISLANDS WATER CONGRESS
FAROE ISLANDS - SEPTEMBER 4-6, 2024

International Water Resources Association
IWRA

JARÐFEINGI
Faroese Geological Survey

Designing with Nature:

Stormwater & Aquatic Biodiversity

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envirings

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  - Design, Monitoring, Research
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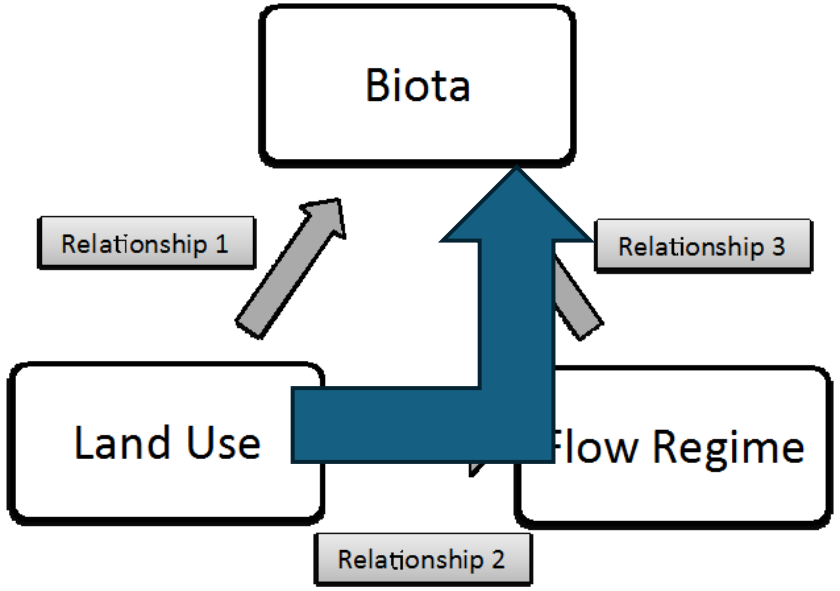
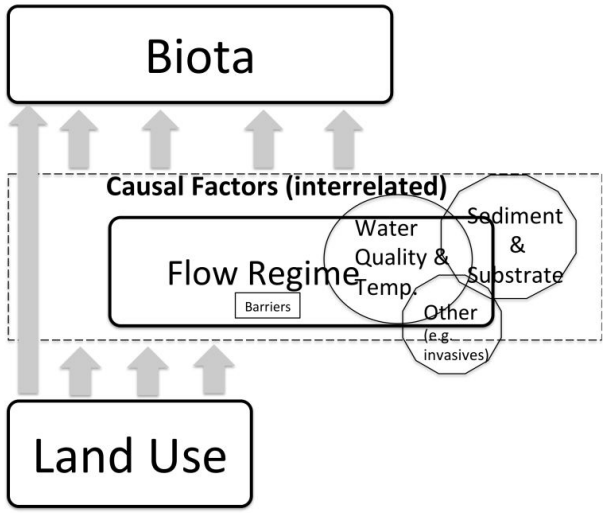
Research Overview

- Aquatic biodiversity is declining – freshwater diversity is especially imperilled
- Massive decline in aquatic biodiversity in urban rivers by 10% watershed urban cover
- Condition known as '*urban stream syndrome*'
- What is the relationship of hydrologic change to fish diversity decline?



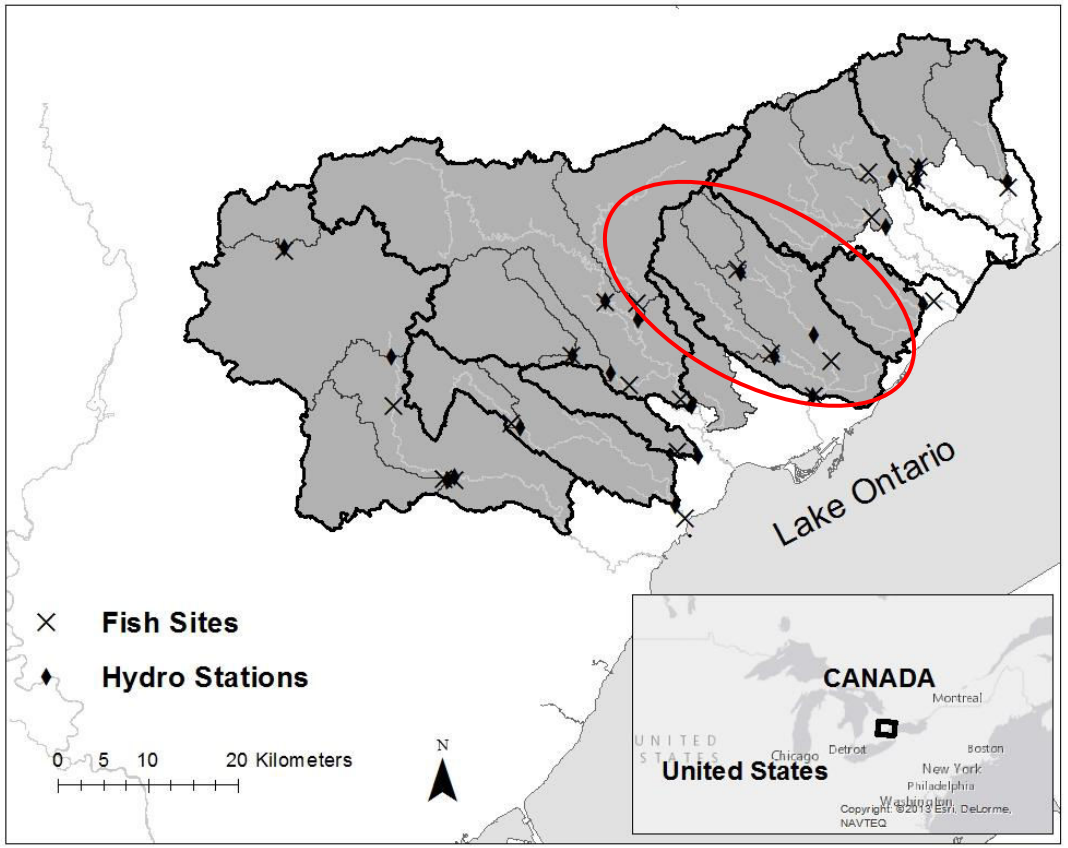
Simplified Model of Relationship



Aquatic systems are not simple

- Empirical study – 42 year period

Research Overview (2)



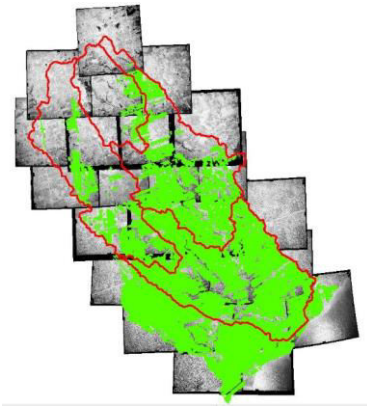
Study Area

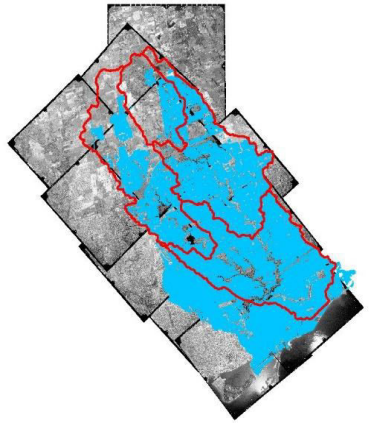
North shore of Lake Ontario

Urbanizing area (Greater Toronto region)

Fish sites: x

Hydrologic stations: ◊ (8 watersheds plus subwatersheds)





Urban land use

Aerial photos and satellite images

- **Don Watershed 1974 (48%) and 1988 (61%)**
- **Other watersheds were less than 1% urban in 1960s**

Hydrologic data

1969 to 2010 in 15-minute increments (May-Nov)

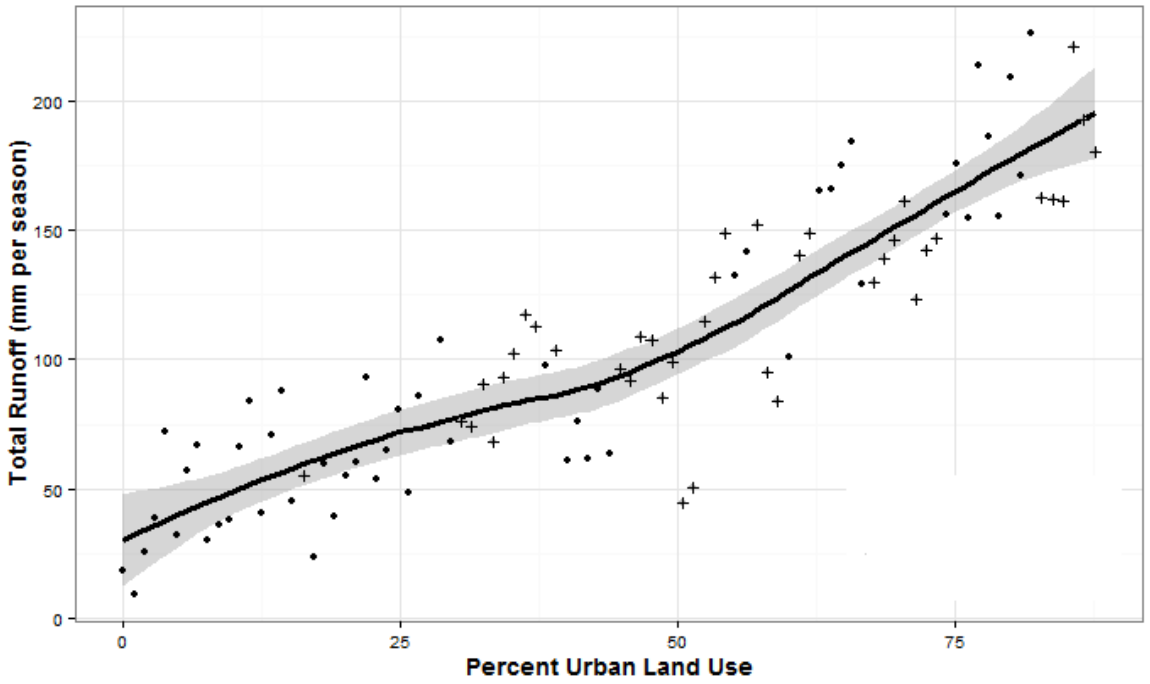
Fish data (# species)

Various research studies 1940s - 2010

Other data

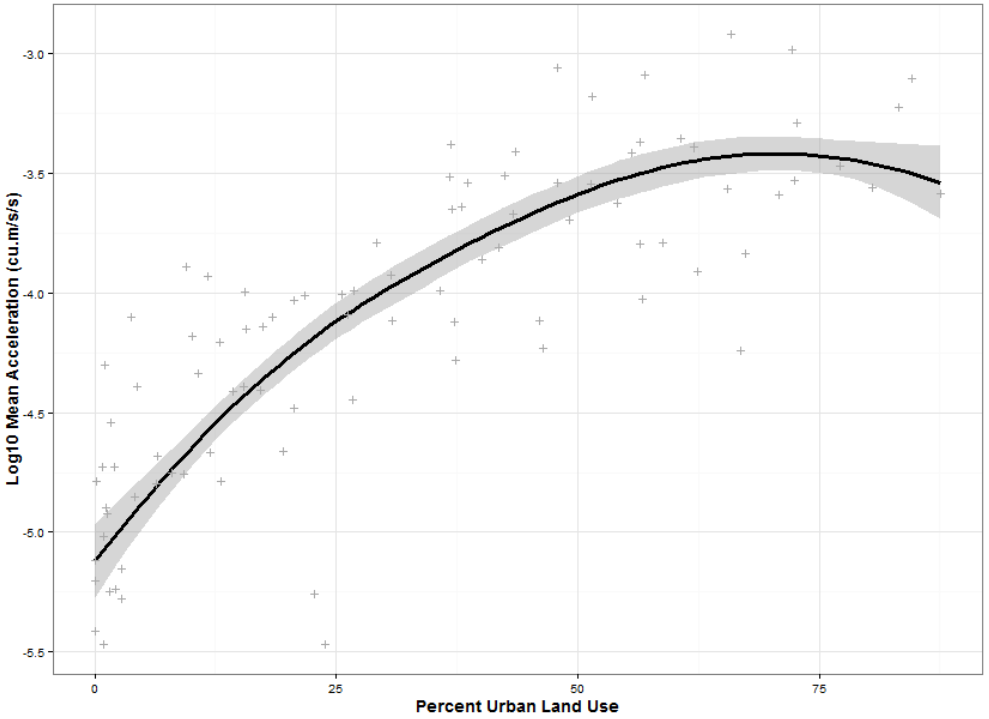
Rainfall, channel slope, Base flow index, dams

Research Results



Total runoff

- Don River runoff increased 45% in 42 years
- No statistical signal for change in rainfall to 2010
- Change in flow detectable at ~4% urban cover



Flow acceleration

- Rate of change in flow (m^3/s^2)
- Explained more variation in fish diversity than any other variable, including urban cover and other flow variables

- Shaded: 95% confidence interval
- Crosses – natural flows; dots flow controls (e.g. dams)

Research Results (2)

Fish Richness Data:

- Positive bias with time!
- Sampling objective (sport fish versus endangered species)
- Classification – differentiation in the 1980s
- Sampling methodologies
- Etc. Etc. Etc.

Decrease in fish richness still evident with:

- **Increased flow acceleration**
- **Increased skew in flow – flashiness in flow**

River Redhorse (Special Concern)

Speckled trout (not present in urban streams)

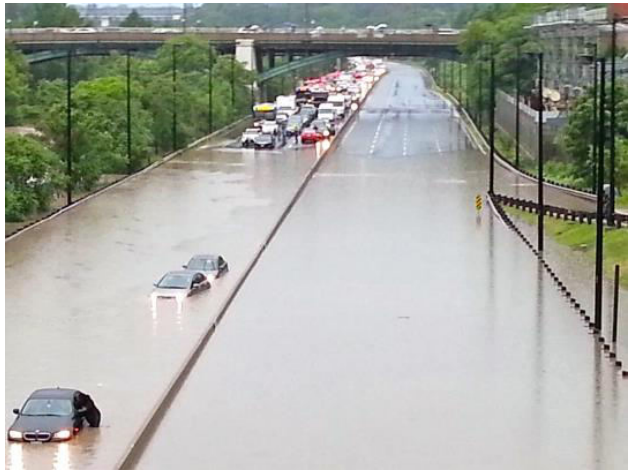
Northern redbelly dace (not present in urban streams)

American Eel

Fish images: Wikipedia

Eel illustration by Duane Raver

Implications



Don Valley Parkway
Toronto
July 2013

July 2024

Photos:
Johnzeus.com
The Canadian Press

Flood risk

- Loss of 'hydrologic stationarity' (predictability of flows) in highly urbanized watersheds was lost before climate change effects detectable
- Form and function of watersheds is important – for aquatic animals and for our own safety – as rainfall intensifies with climate change

Implications (2)

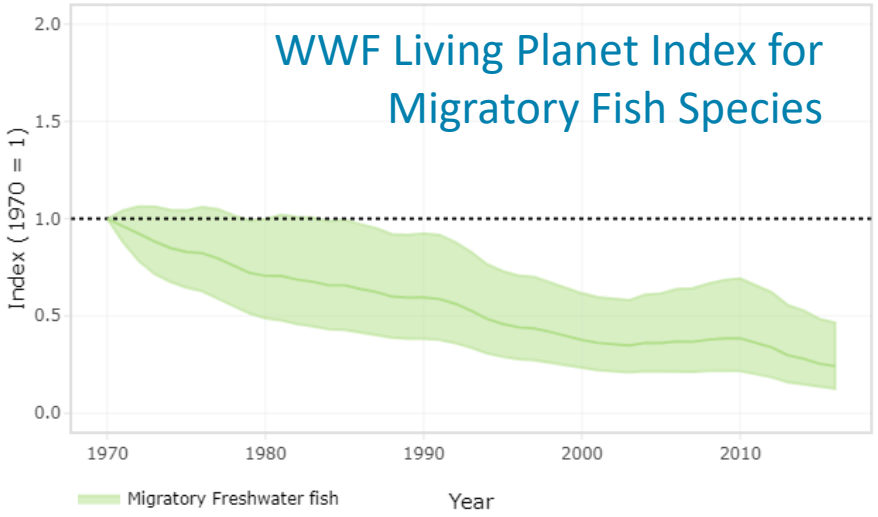
Key Gaps in understanding for stormwater management

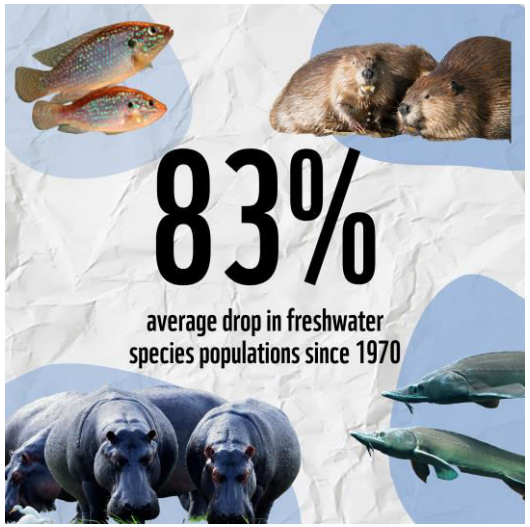
- Flow acceleration is not taken into consideration in urban stormwater infrastructure design & operation
- Flow acceleration is not monitored
- Causal factors for impact are not researched (direct or indirect effects of change in acceleration)

Photo: WaterFunder

Images: Credit Valley Conservation Authority and Toronto and Region Conservation Authority Low Impact Development Handbook

Opportunities





World Wildlife Fund

Islands

- Unique (endemic) fish species due to geographic isolation
- Migratory aquatic species
- Land to sea connectivity
    - Opportunity for public awareness
- Drivers for decisions on urban drainage
    - Cultural norms
    - Risk tolerance and perception
    - Precaution in the face of uncertainty
    - Perceptions and values - nature and humanity's place in it

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Thank you!
Questions of Clarification?

Discussion will follow all presentations

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