

Relevant Information from Recent International Great Lakes Water Level Management Studies

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Great Lakes Coastal Infrastructure
Scoping Workshop – Oct. 10-11, 2007



Changing Great Lakes Water Levels

■ Water Level Shifts

- Highs - 70s-90's
- Lows - 20-30's, 60's, 1998-present

■ Impacts

■ High Levels

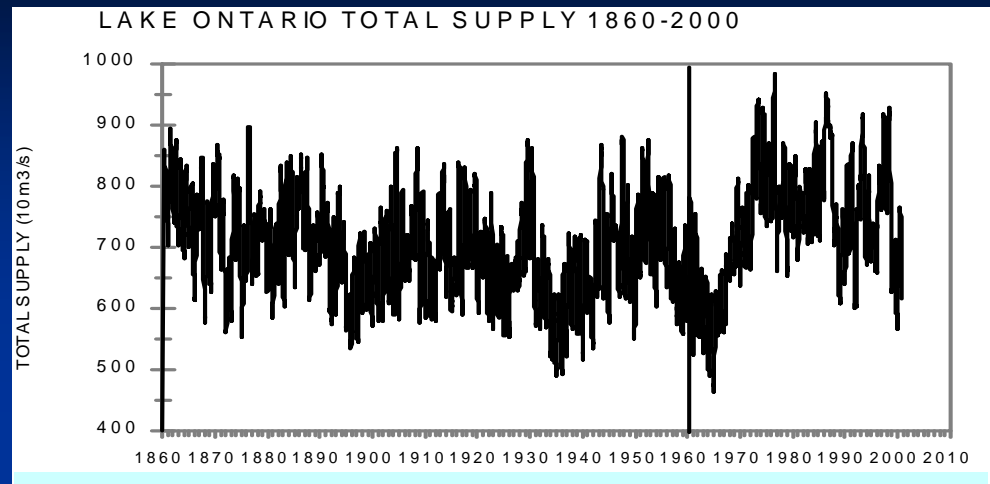
- Erosion – Flooding – Damage to coastal infrastructure

■ Low Levels

- Hydropower - Navigation - Recreational Boating – Environment – Impacts to water intakes and wastewater outfalls

■ Actions - Review of IJC Orders

- \$20 M Lake Ontario-St. Lawrence River Study (completed)
- \$15 M Upper Great Lakes Study (2007-2012)



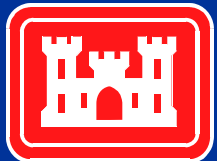
Climate Change – beginnings of long-term change or climatic variability?

IJC Studies considering climate change:

- International Levels Reference Study (1986-1993)
- International Lake Ontario-St. Lawrence River Study (2001-06)
- International Upper Great Lakes Study (On-going)



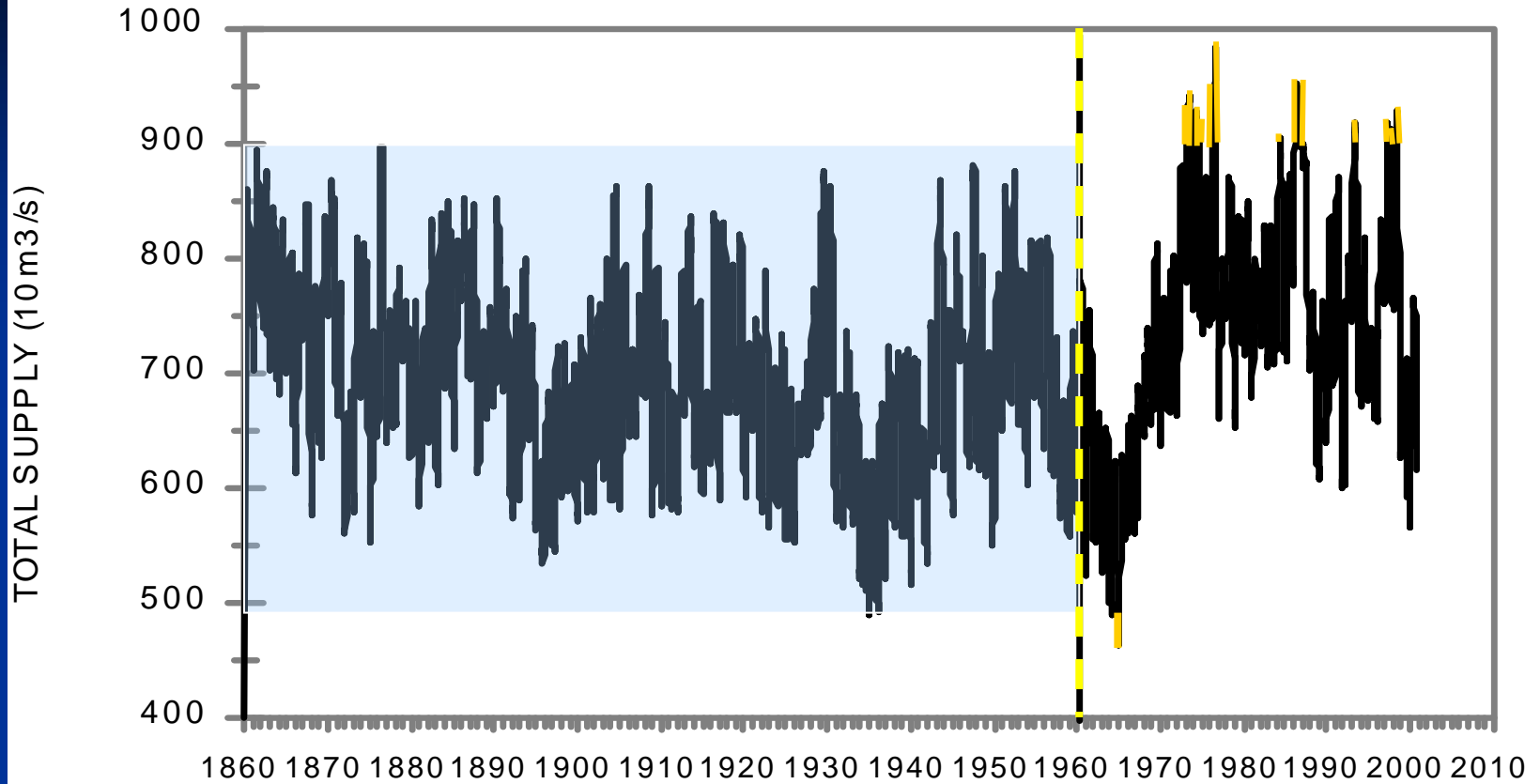
International Lake Ontario-St. Lawrence River Study



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LAKE ONTARIO TOTAL SUPPLY 1860-2000



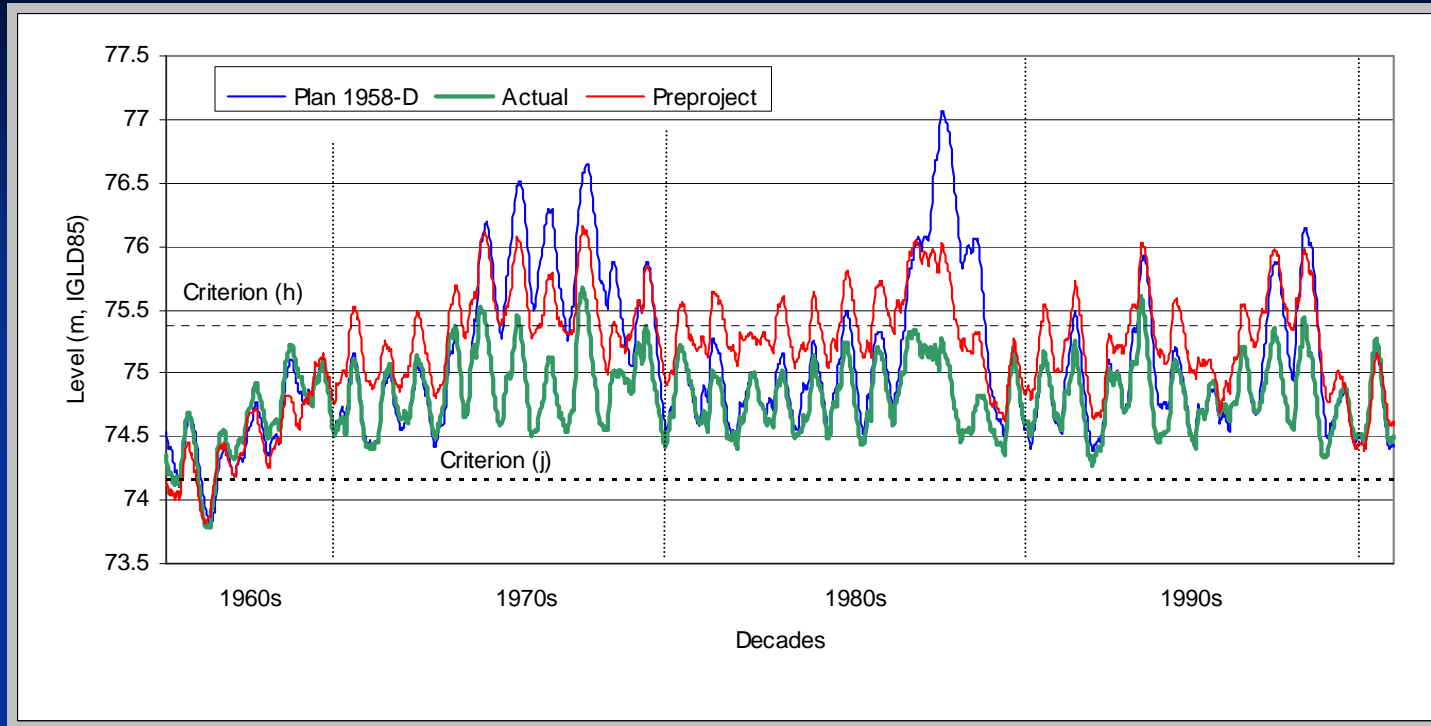
Current Plan 1958-D was not designed to handle the extreme low water of the 1960s or the high water of the 70s, 80s and 90s



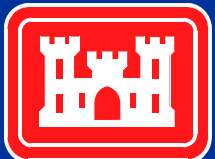
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Outflow Management by the International St. Lawrence River Board of Control



- Average \$46.66M and \$2.51M in annual benefits in terms of reduced flooding and erosion, and enhanced recreational boating, respectively, on the lake and the St. Lawrence River
- \$40.91M when all interests are considered, including losses of \$2.97, \$5.09 and \$0.2M annually to commercial navigation, hydropower, and domestic, municipal and industrial water uses, respectively
- Under the driest climate change scenario – Plan 1958-D would fail



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International Lake Ontario - St. Lawrence River Study

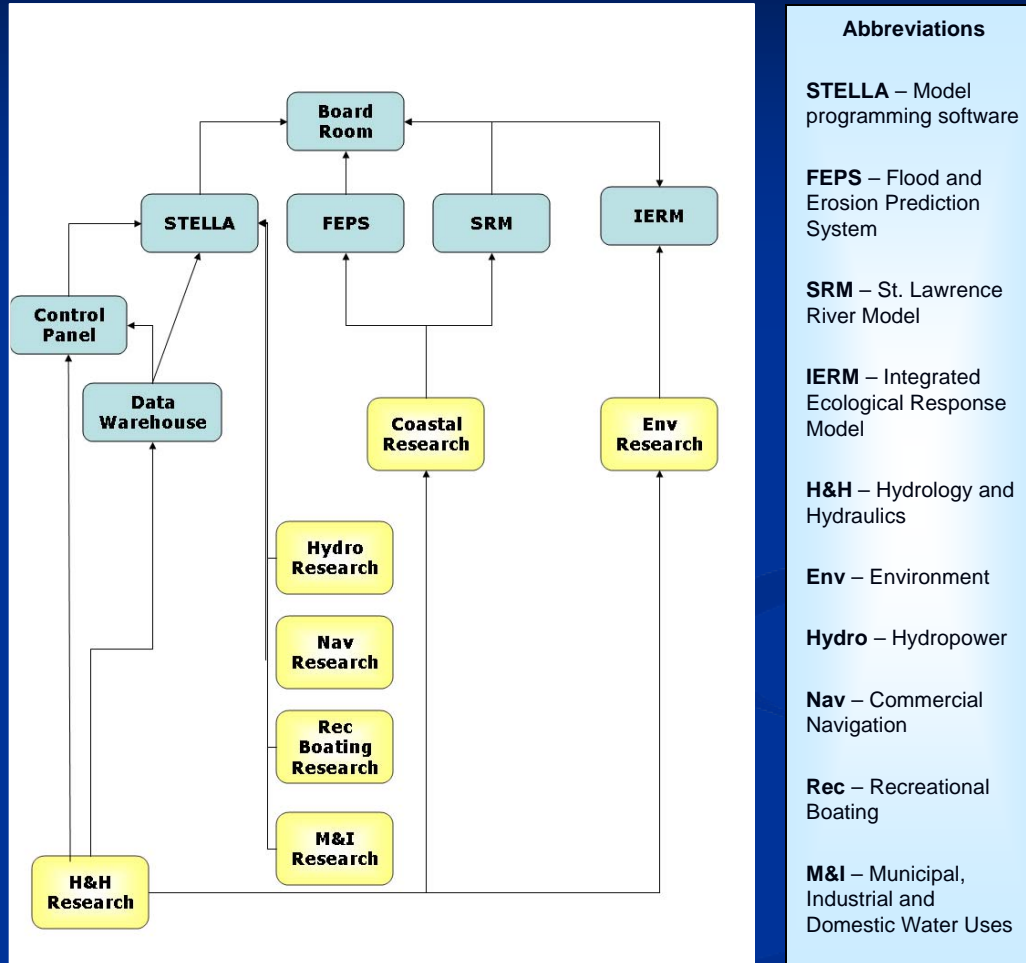
Purpose:

- **Assessment of how water level fluctuations affect all interests**
 - Emphasis on environmental, recreational boating and shoreline property
 - Needs of all interests will be determined
 - **Climate change will be assessed**
- **Within the bounds of Article VIII of the Boundary Waters Treaty considering**
 - Domestic and sanitary purposes
 - Commercial navigation
 - Hydropower and irrigation
- **Completed in March 2006**



International Lake Ontario - St. Lawrence River Study

Shared Vision Planning Framework



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International Lake Ontario - St. Lawrence River Study

Metrics of Performance Indicators:

■ Economic PI:

- Coastal processes – flooding & erosion
- Recreational boating & tourism
- Hydroelectric power generation
- Commercial shipping
- Municipal, industrial & domestic water uses

■ Environmental PI:

- Over 400 for six indicator groups (wetland vegetation, fish species/ guilds, wetland birds, herptiles (amphibians & reptiles), mammals, species-at-risk)
- Integrated Ecological Response Model – 32 key indicators



International Lake Ontario - St. Lawrence River Study

Three alternative plans

Plan A+ - highest economic benefits

Plan B+ - overall environmental improvements

Plan D+ - no disproportionate losses

Based on:

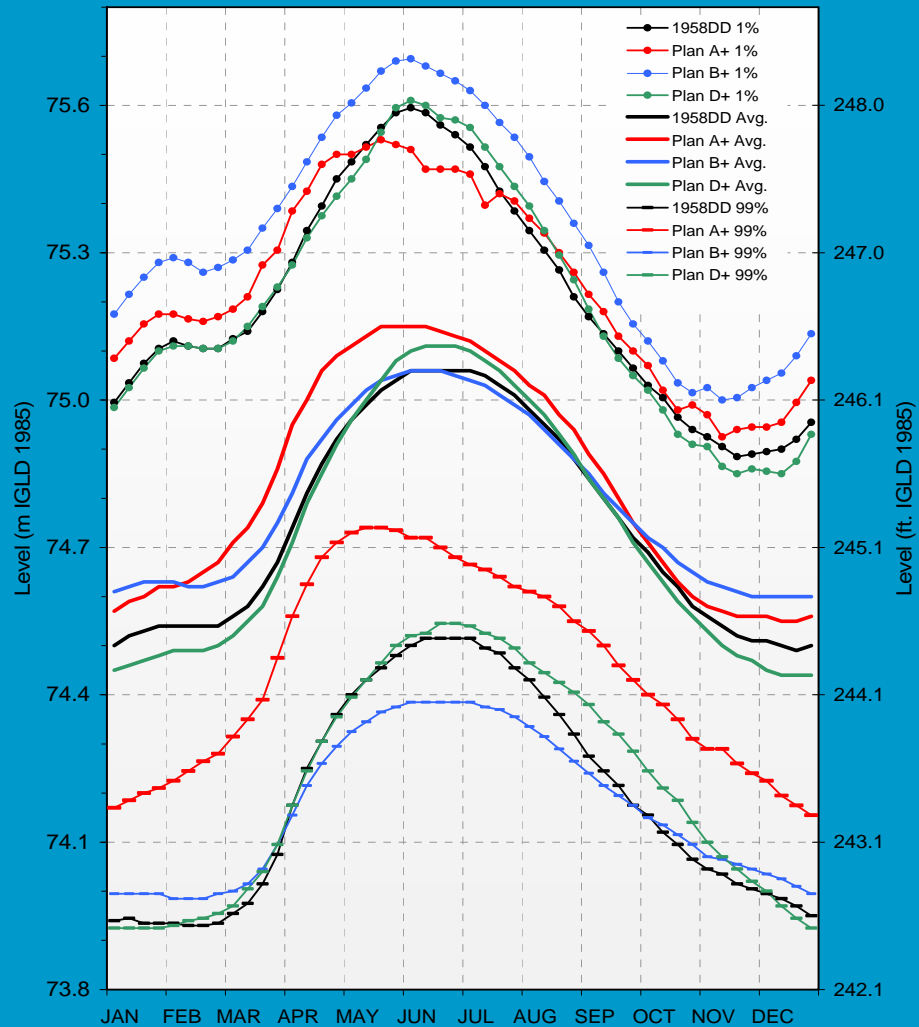
1900 through 2001 historic supplies

50,000 years of simulated supplies

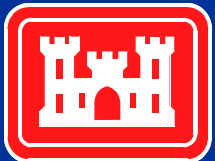
Four climate change scenarios



Lake Ontario Water Levels: Average, 1% and 99% probability of exceedence



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	Alternative Plans			E
	A ⁺	B ⁺	D ⁺	
Economic Results- Average Annual Net Benefits (\$ Million)				
Coastal - Lake Ontario	-\$0.36	-\$0.60	\$0.25	-\$23.12
Coastal - Upper St. Law.	0.00	0.00	0.00	-\$1.56
Coastal - Lower St. Law.	-\$0.25	-\$0.51	\$0.07	-\$1.27
Commercial Navigation	\$0.41	\$2.20	\$2.31	\$4.13
Hydropower	\$3.50	\$5.97	\$1.82	\$14.16
Rec. Boating -Above Dam	\$2.21	-\$0.62	\$0.52	-\$5.91
Rec. Boating -Below Dam	\$2.02	\$0.04	\$1.53	\$1.27
Water Uses	0.00	0.00	0.00	0.00
Total	\$7.52	\$6.48	\$6.52	-\$12.30
Overall Environmental Index	1.06	1.35	1.10	4.04



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International Lake Ontario - St. Lawrence River Study

Climate work for the Study led by Dr. Tom Croley of GLERL, using meteorological time series over each of 121 sub-basins & 7 lakes



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International Lake Ontario - St. Lawrence River Study

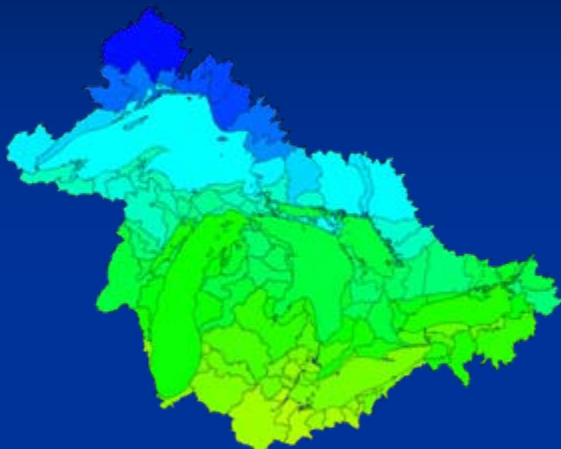
Climate Change Scenarios:

- Focused on a future 20 year window (2040-60)
- Second generation Canadian CC:
 - CGCM2a – Warm and Dry
 - CGCM2b – Not So Warm and Dry
- Third generation UK Hadley:
 - HadCM3a – Warm and Wet
 - HadCM3b – Not So Warm and Wet

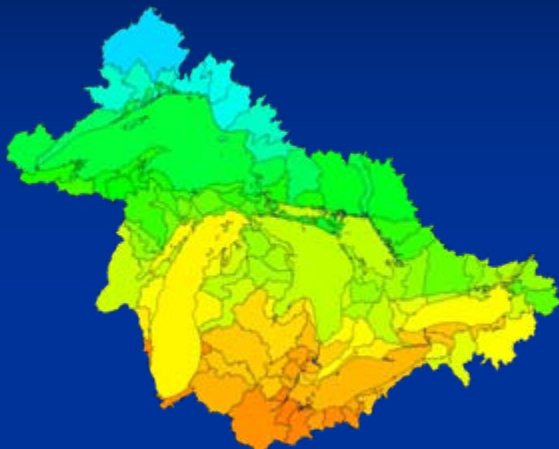


Climate Scenarios (Average Air Temperature, 0–15°C)

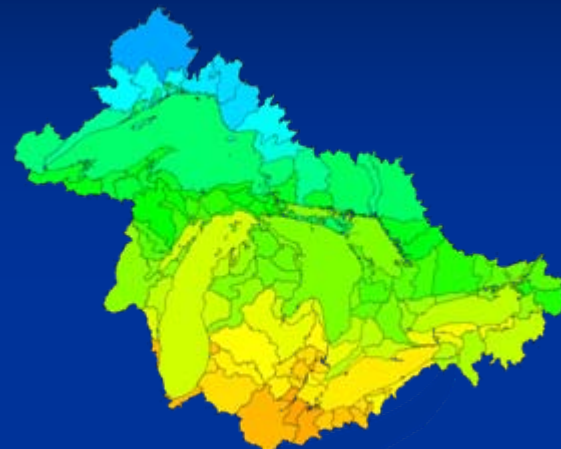
Base Case



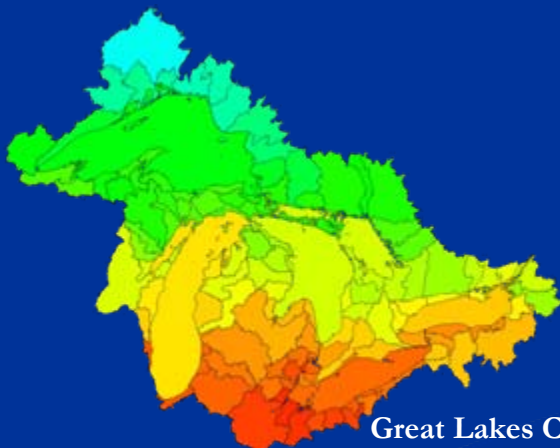
Warm & Dry



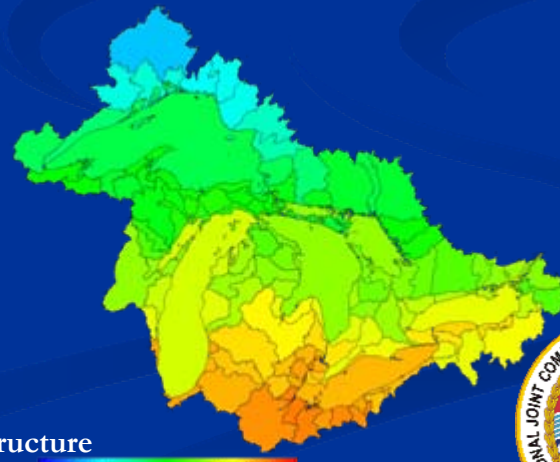
Cool & Dry



Warm & Wet



Cool & Wet

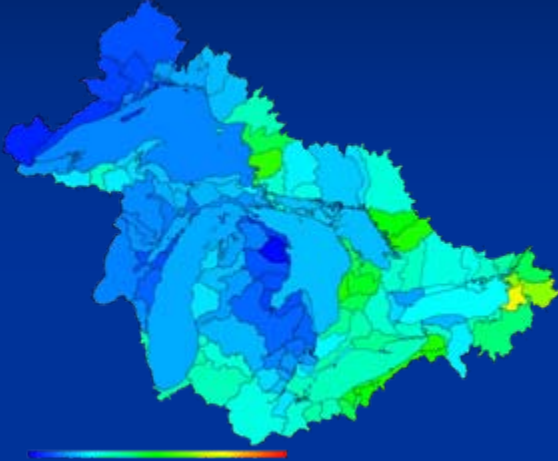


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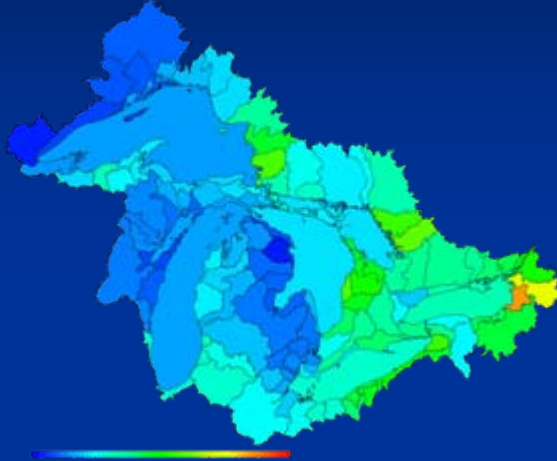


Climate Scenarios (Average Annual Precipitation, 0.7–1.4 m)

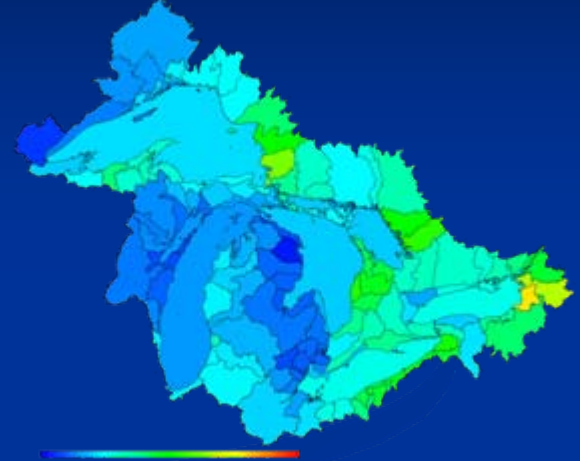
Base Case



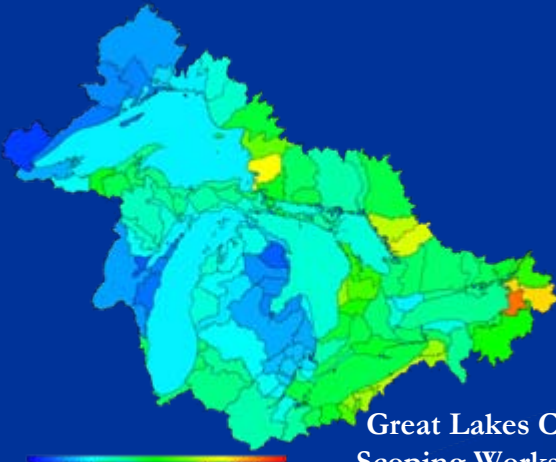
Warm & Dry



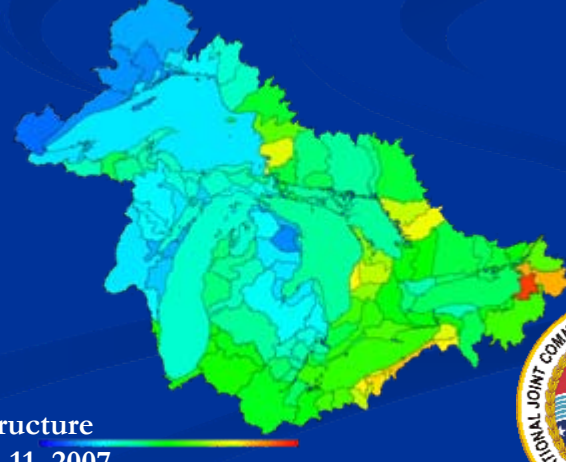
Cool & Dry



Warm & Wet



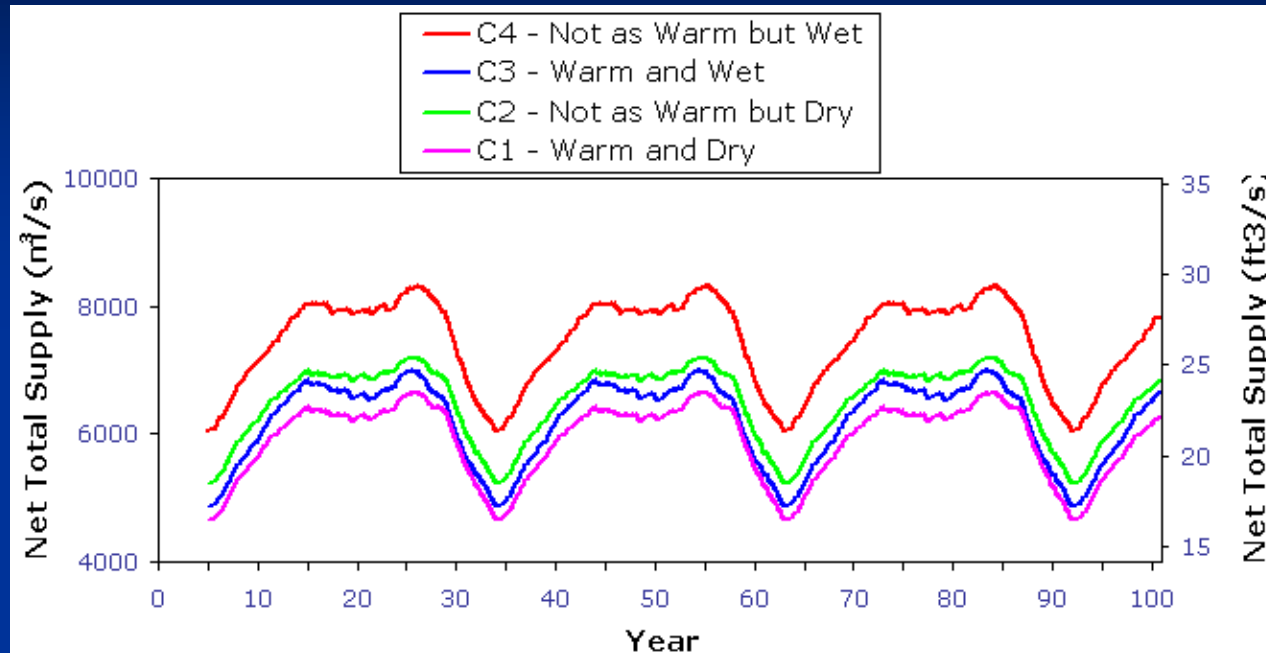
Cool & Wet



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Five-year moving average of the net total supply (NTS) sequences for the four climate change scenarios (C1-C4)

Repetition of 29-year sequences due to limited available recorded values in parts of the Study area



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International Lake Ontario - St. Lawrence River Study

Economic Robustness of Plans:

Avg. ann.

net benefits

(\$US million)

	Plan 1958D	Plan A	Plan B	Plan D	Plan E
Plan 1958DD	0	7.52	6.48	6.52	-12.30
C1- Warm/Dry	-115.65	34.89	-1.42	20.09	-4.91
C2 – Not as Warm/Dry	-49.52	9.85	4.89	5.25	-34.03
C3 - Warm/Wet	-81.69	21.53	2.61	17.77	-2.46
C4 – Not as Warm/Wet	13.98	8.33	11.78	9.65	-21.38

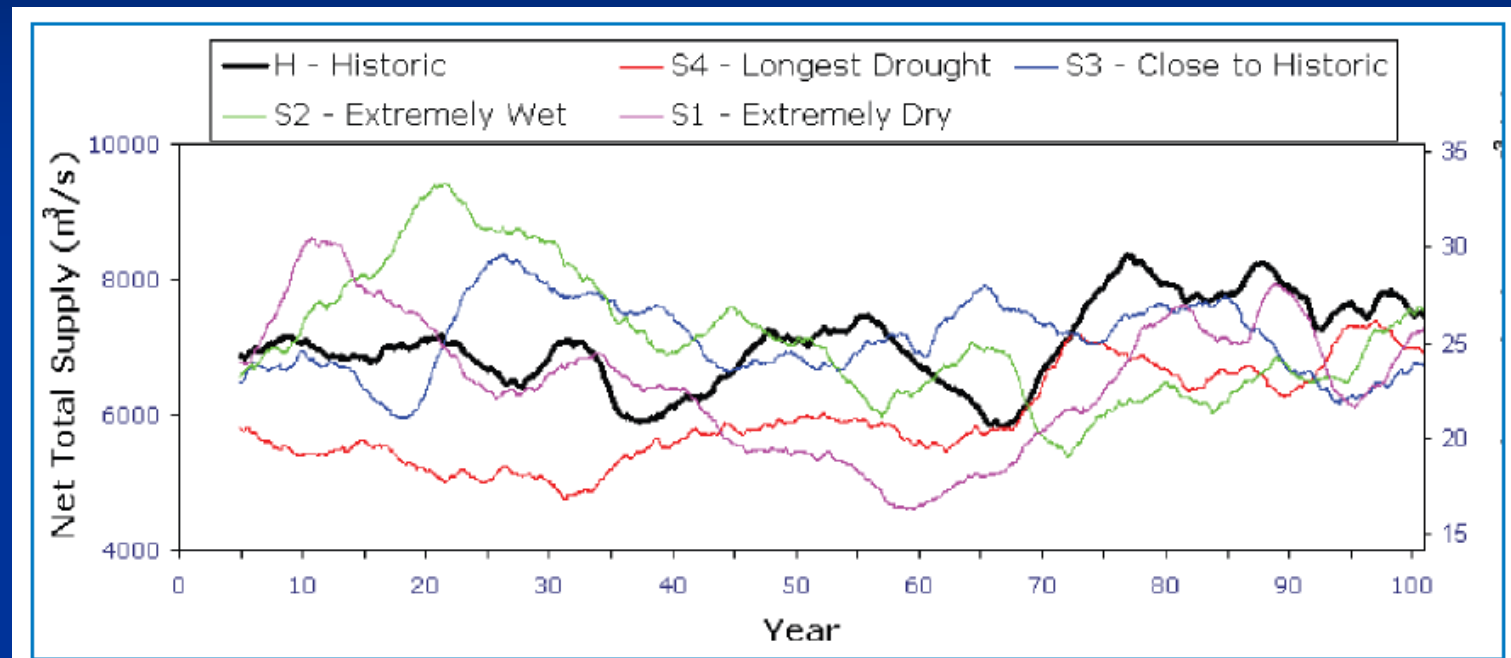


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Five-year moving average of the NTS for four stochastic (S1-S4) centuries and the historical



Important: to assess the robustness of a management plan, but not necessarily relevant from an infrastructure design or evaluation standpoint



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International Upper Great Lakes Study



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International Upper Great Lakes Study

Understanding the St. Clair-Detroit River System:

- Investigate the factors affecting Great Lakes levels and flows, including physical changes in the St. Clair River related to:
 - Basin water supplies,
 - Diversions and consumptive uses,
 - Glacial rebound and subsidence,
 - St. Clair – Detroit River flow conveyance capacity.



International Upper Great Lakes Study

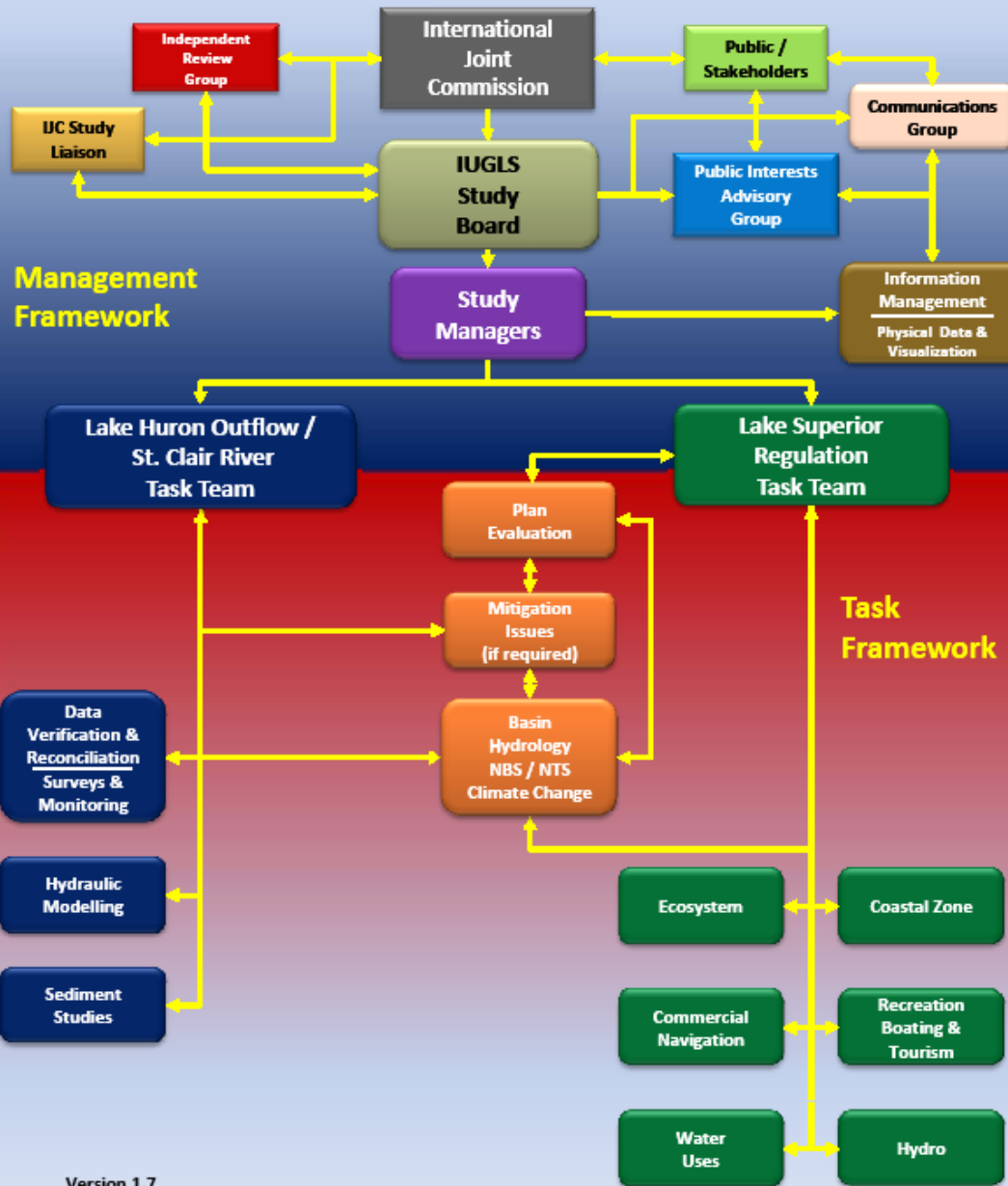
Improving Lake Superior Outflow Regulation:

- Review how the present management plan, Plan 1977-A, and the operation of the control structures affect water levels and flows.
- Identify potential updates and improvements to Plan 1977-A criteria, requirements, operating rules and outflow limits and incorporating operational experience.
- Review institutional arrangements.
- Test plan performance under **climate variability and climate change scenarios.**



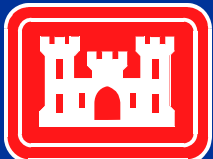
Org. Chart

IUGLS Study Organization



Version 1.7
June 7, 2007

International Upper Great Lakes Study



Hydroclimatic Impacts on the Great Lakes Workshop

1-2 November 2007 - Toronto

Objectives:

- Determine recent changes in climate related factors that influence components of net basin supply, evaporation, precipitation on lakes and runoff to Lake Superior, Michigan-Huron and Erie with a view to:
 - assess the extent to which such changes have contributed to the observed reduction in level differences between Huron and Erie, and
 - assess the main factors affecting the current low levels of Lake Superior.
- The workshop is to determine what is known and what further work must be undertaken to quantify the effects and assess whether recently observed trends are likely to continue.



Hydroclimatic Assessment Workshop

February 2008

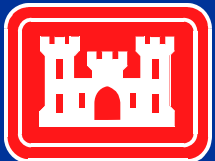
Objectives:

- Determine how best to consider climate change and variability based on findings of the first (November 2007) workshop.
- Possible alternatives:
 - Use the results of the International Lake Ontario – St. Lawrence River Study.
 - Use methodology used in the International Lake Ontario – St. Lawrence River Study but using updated GCM predictions
 - Use latest GCM and new methodology



*International Lake Ontario-
St. Lawrence River Study*
(www.losl.org)

*International Upper Great
Lakes Study (www.ugls.org)*



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Recent Policy Guidance

ASA(CW) Woodley Testimony to Congress, April 2007

- ❖ Historically, adaptation to climate variability has been basis of water management programs
- ❖ Corps is working with other agencies (USGS, NOAA, EPA, NRCS) & international entities (UNESCO, World Bank) to develop new climate change guidelines and impact procedures
- ❖ Focus is on hydrologic and risk analysis procedures for planning, design and operations
- ❖ ‘Proactive adaptive management’
- ❖ Dr. Rolf Olson, (IWR) is Corps PM for Climate Change Program.



An aerial photograph of the Great Lakes basin in North America, overlaid with a semi-transparent green filter. The water bodies are dark, and the surrounding land is a lighter green. The text is overlaid on the top left and center of the image.

Relevant Information from
Recent International Great Lakes
Water Level Management Studies

Questions?