Global Center for Understanding Climate Change Impacts on Transboundary Waters

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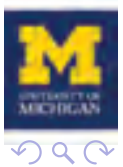
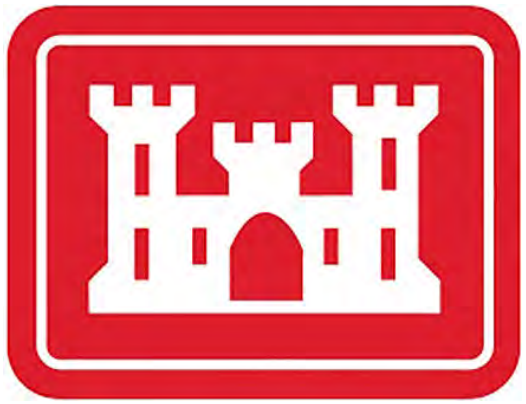
University of Michigan
School for Environment and Sustainability
Department of Civil and Environmental Engineering
Department of Earth and Environmental Sciences

Presented to GLSLCC Science Team
January 2024



Outline

Outline

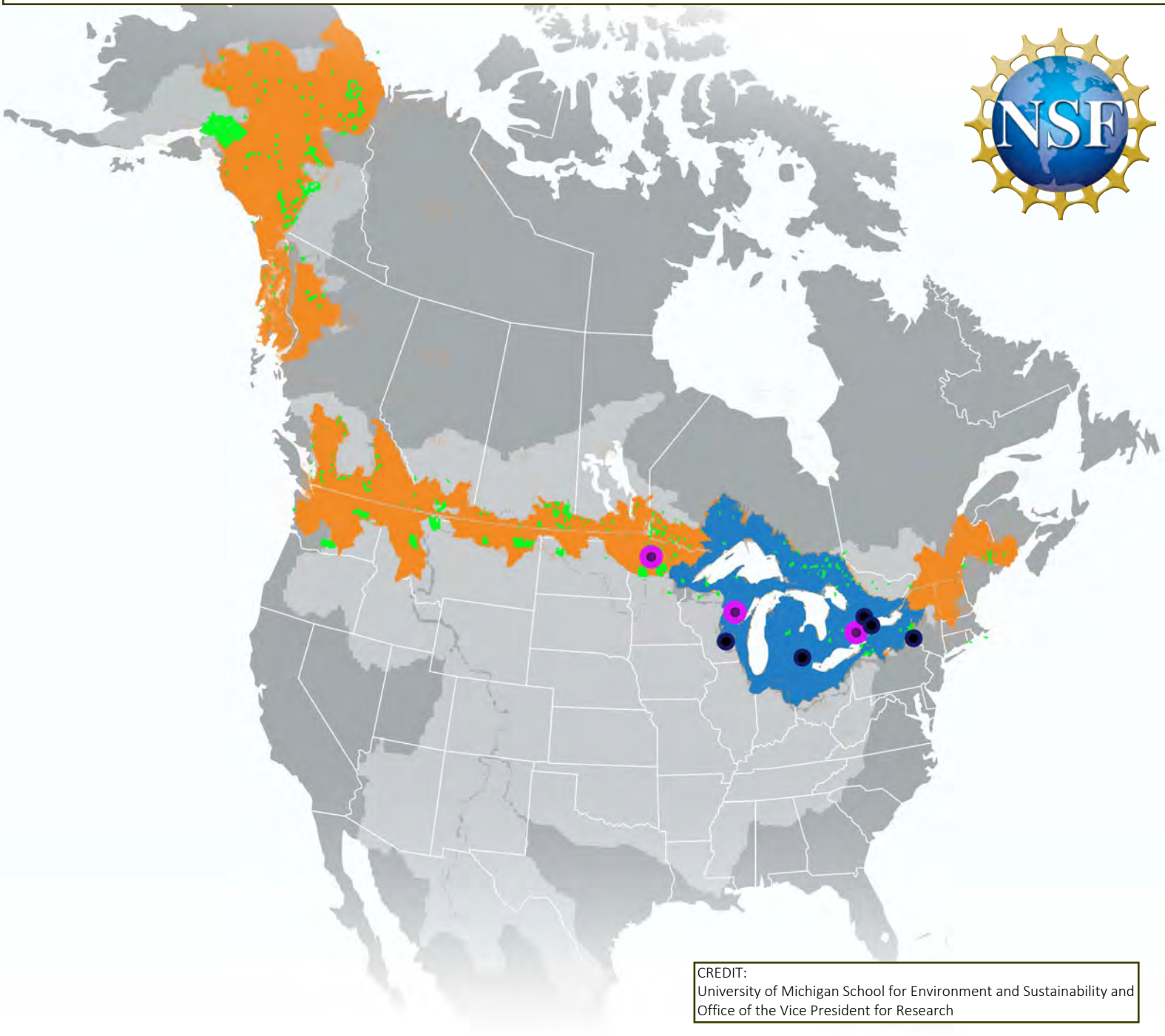


GREAT LAKES
ST. LAWRENCE
GOVERNORS
& PREMIERS

BOLD CHALLENGES

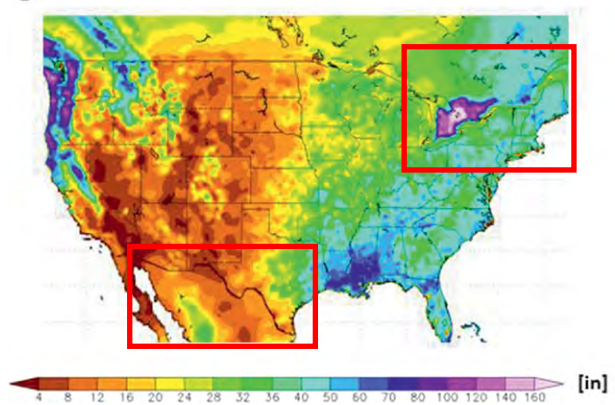
Working together in new ways, research can change the world. Now is the time to be BOLD.

Global Center for Climate Change and Transboundary Waters



CREDIT:
University of Michigan School for Environment and Sustainability and Office of the Vice President for Research

Outline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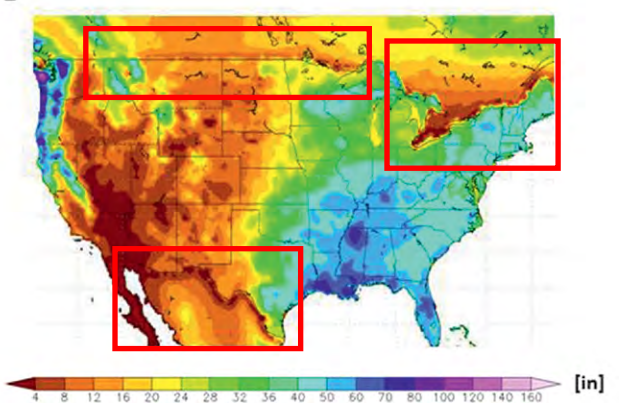
[in]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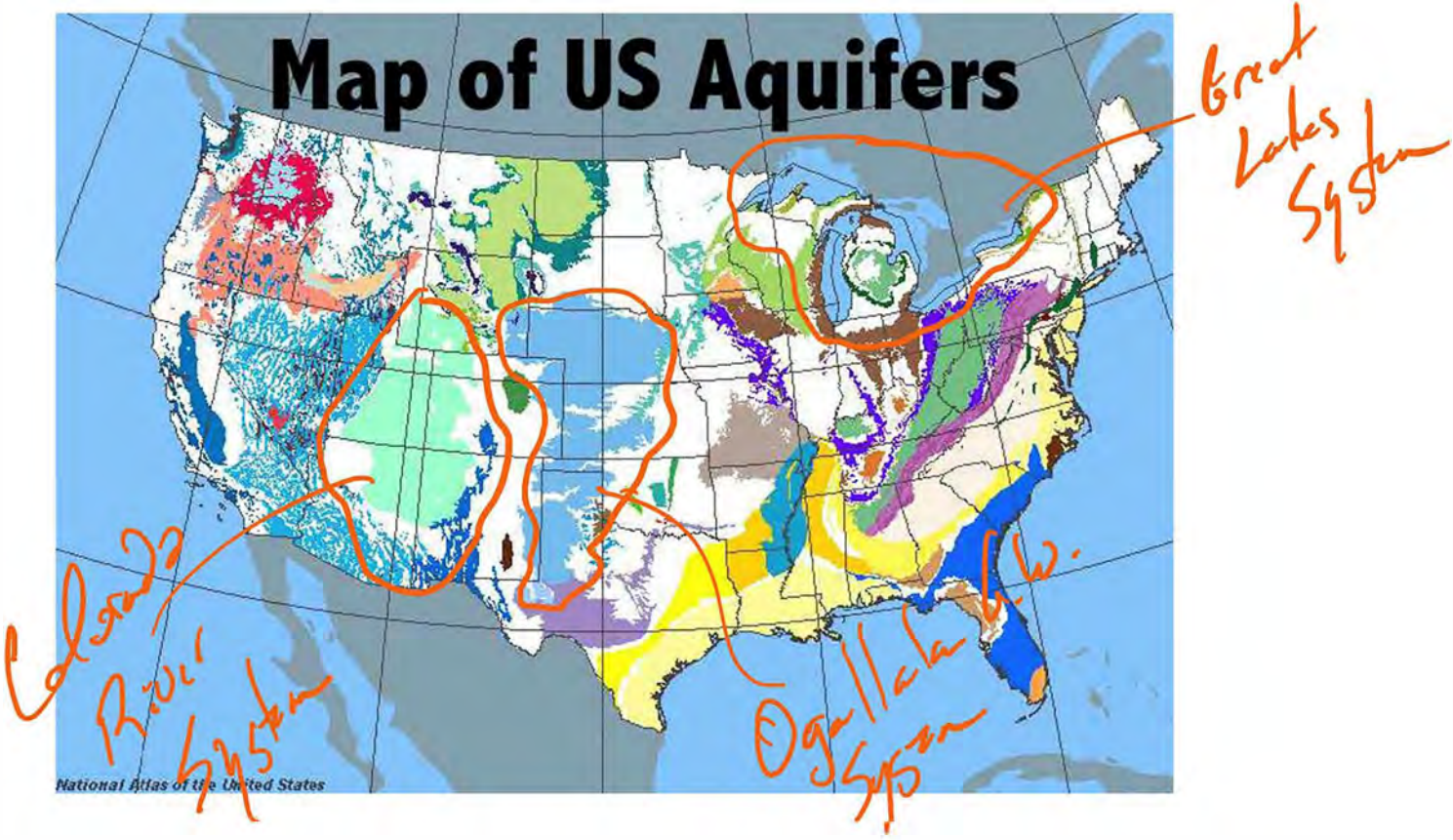
Map of US Aquifers
Great Lakes System
Colorado River System
Ogallala A.
System
National Atlas of the United States

Outline

500 km
300 mi

at 45°N 100°W.
ntrado en 45°N 100°O.
100°O.

BASSINS HYDROGRAPHIQUES OCÉANIQUES

Océan Arctique
Littoral
Fleuve Mackenzie

Océan Atlantique
Littoral
Fleuve Saint-Laurent

Golfe du Mexique
Littoral
Réseau hydrographique du Mississippi
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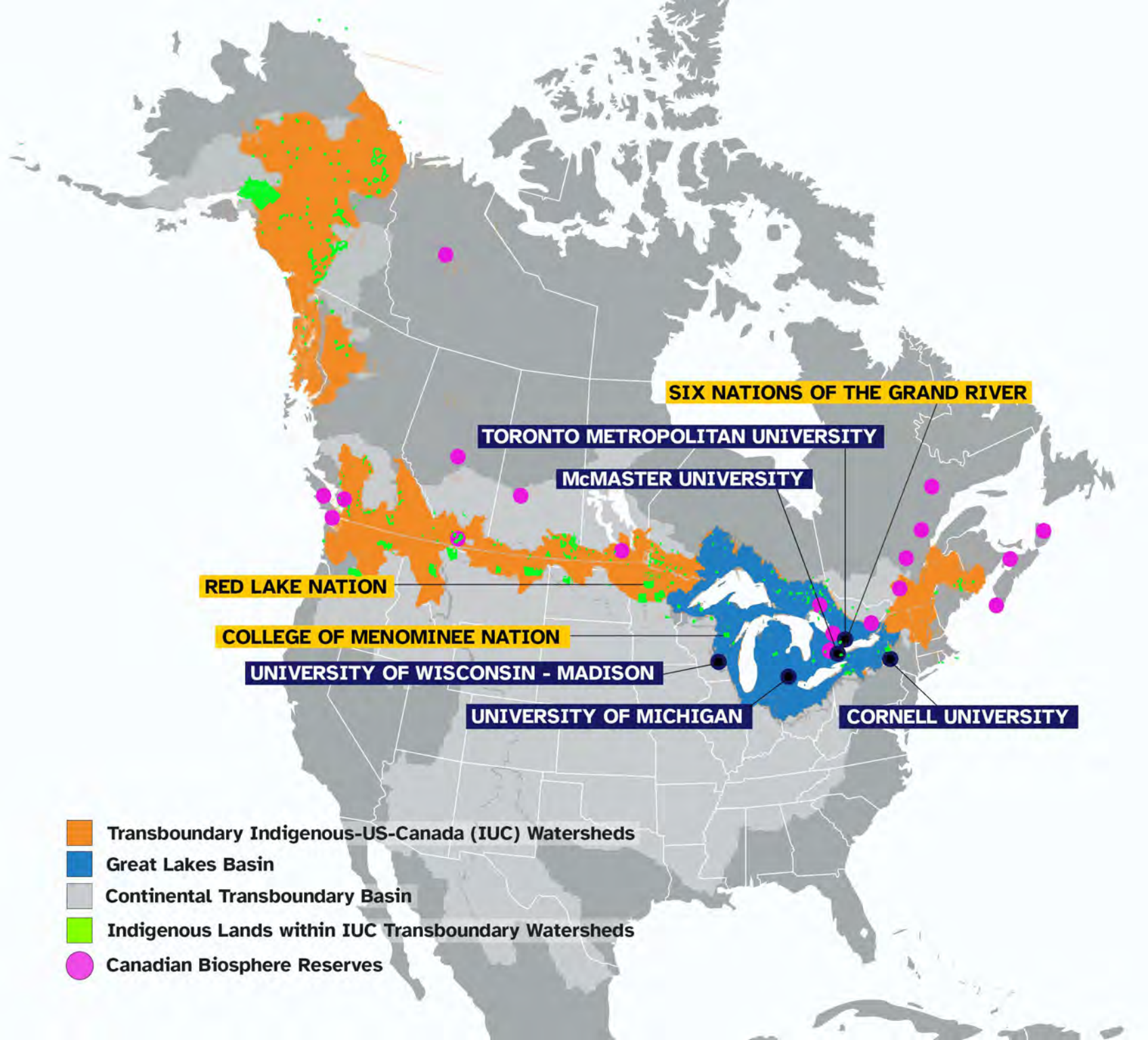
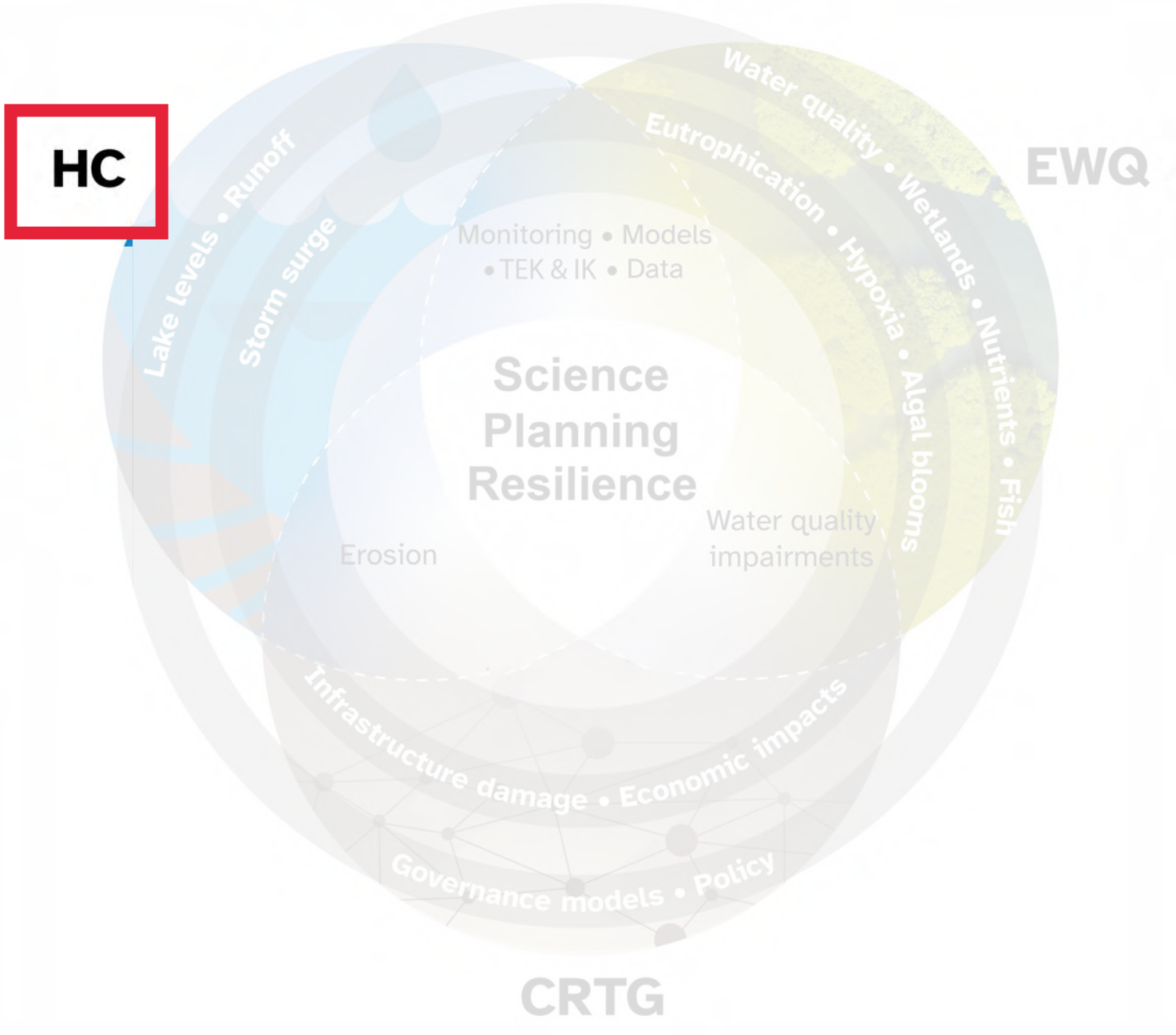
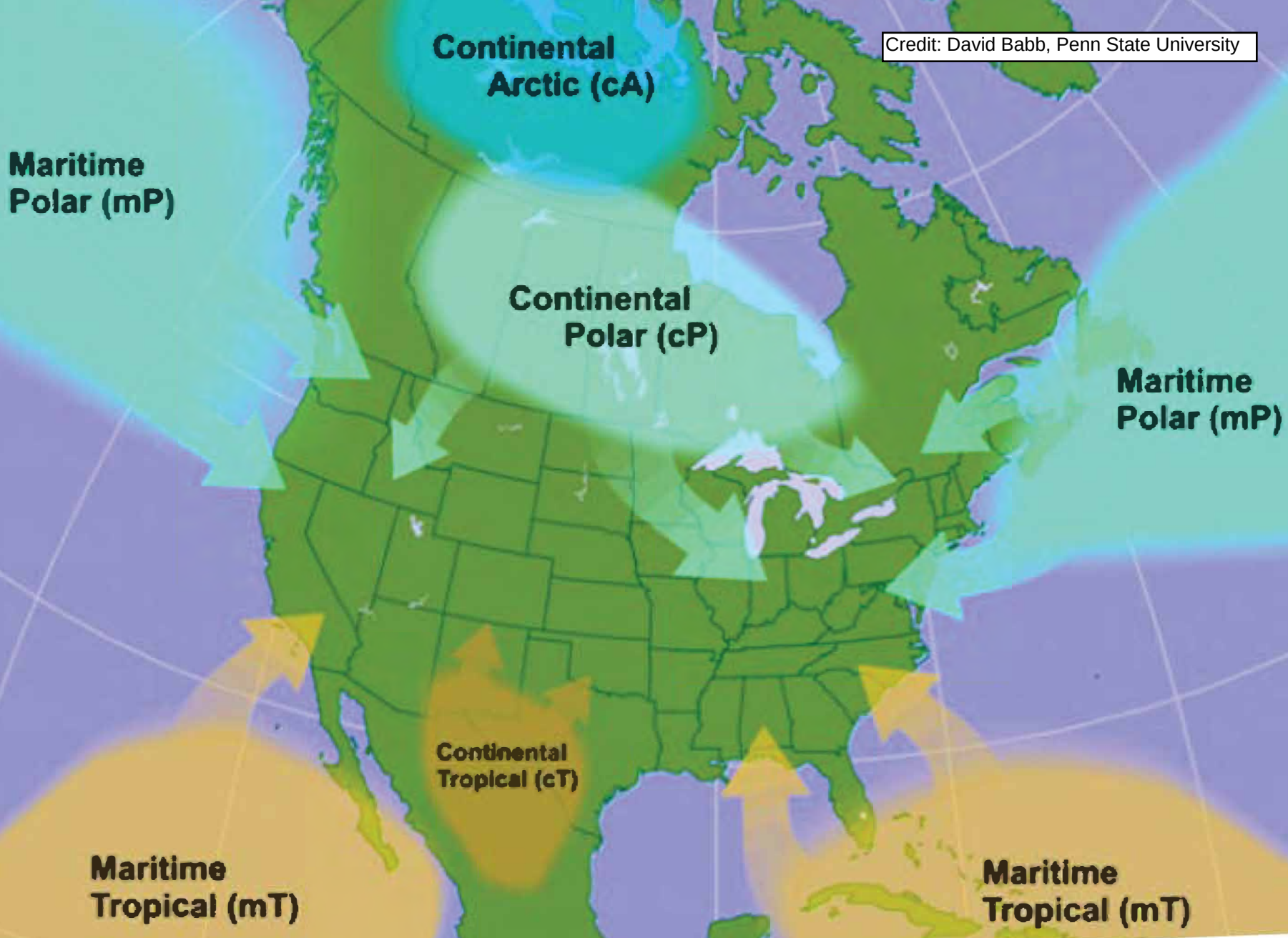
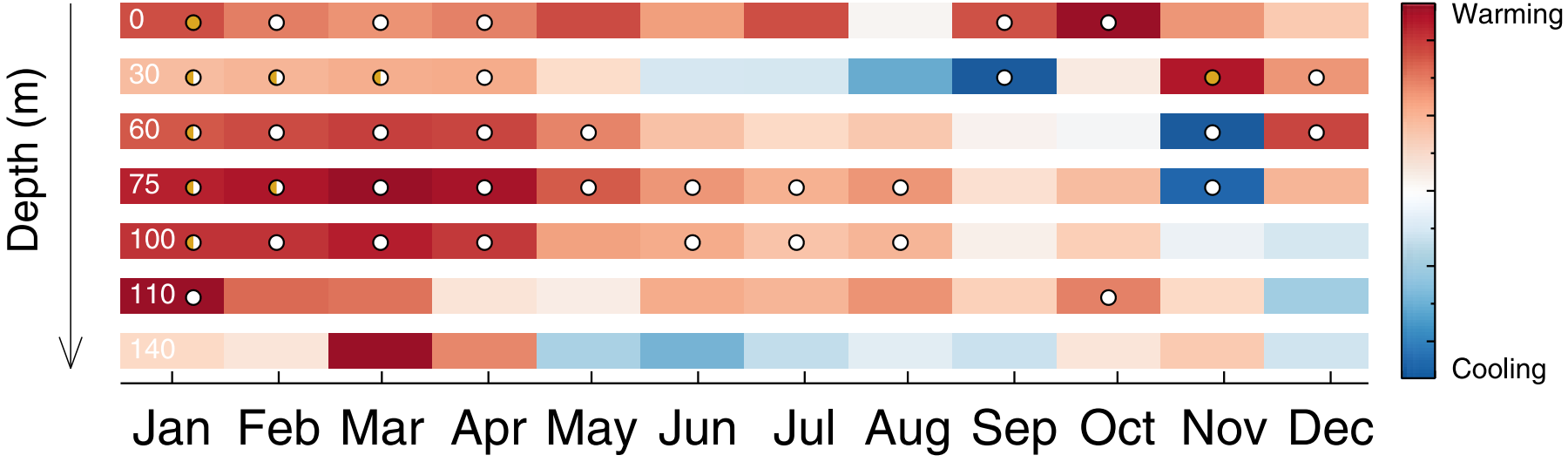
Rivière Missouri
Rivière Ohio

Mexican States
Estados Mexicanos
États mexicains


SIX NATIONS OF THE GRAND RIVER
TORONTO METROPOLITAN UNIVERSITY
McMASTER UNIVERSITY
RED LAKE NATION
COLLEGE OF MENOMINEE NATION
UNIVERSITY OF WISCONSIN - MADISON
UNIVERSITY OF MICHIGAN
CORNELL UNIVERSITY
Transboundary Indigenous-US-Canada (IUC) Watersheds
Great Lakes Basin
Continental Transboundary Basin
Indigenous Lands within IUC Transboundary Watersheds
Canadian Biosphere Reserves


HC
Lake levels • Runoff
Storm surge
Water quality • Wetlands • Nutrients • Fish
Eutrophication • Hypoxia • Algal blooms
EWQ
Monitoring • Models
• TEK & IK • Data
Science
Planning
Resilience
Erosion
Water quality
impairments
Infrastructure damage • Economic impacts
Governance models • Policy
CRTG


Credit: David Babb, Penn State University
Continental Arctic (cA)
Maritime Polar (mP)
Continental Polar (cP)
Maritime Polar (mP)
Continental Tropical (cT)
Maritime Tropical (mT)
Maritime Tropical (mT)


Depth (m)
0
30
60
75
100
110
140
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Warming
Cooling

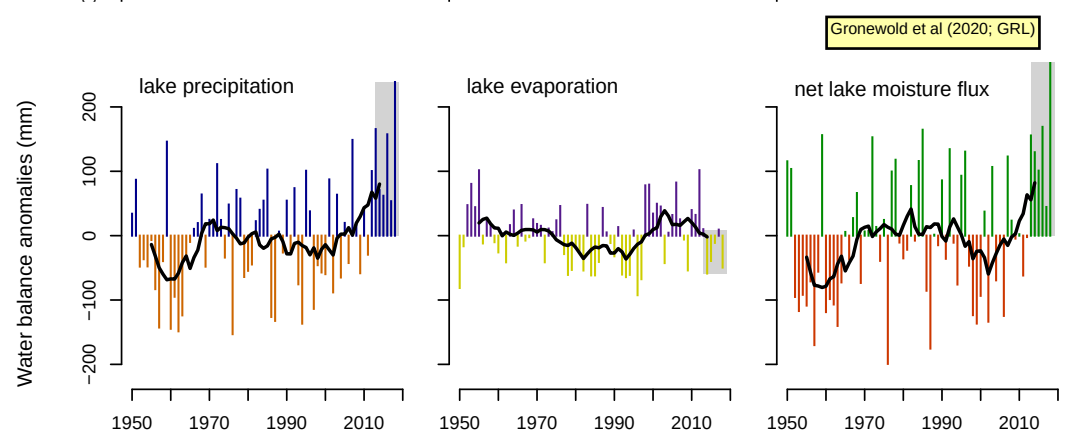
nature COMMUNICATIONS

ARTICLE

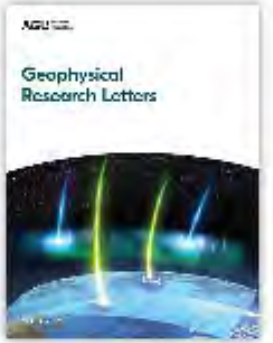
https://doi.org/10.1038/s41467-021-21971-1 OPEN

Seasonal overturn and stratification changes drive deep-water warming in one of Earth's largest lakes

Eric J. Anderson[1✉], Craig A. Stow[1], Andrew D. Gronewold[2], Lacey A. Mason[1], Michael J. McCormick[1], Song S. Qian[3], Steven A. Ruberg[1], Kyle Beadle[1], Stephen A. Constant[1] & Nathan Hawley[1]


Gronewold et al (2020; GRL)
lake precipitation
lake evaporation
net lake moisture flux
Water balance anomalies (mm)
200
100
0
−100
−200
1950
1970
1990
2010

Geophysical Research Letters



Research Letter

A tug-of-war within the hydrologic cycle of a continental freshwater basin

A. D. Gronewold ✉, H. X. Do, Y. Mei, C. A. Stow

First published: 04 January 2021 | https://doi.org/10.1029/2020GL090374

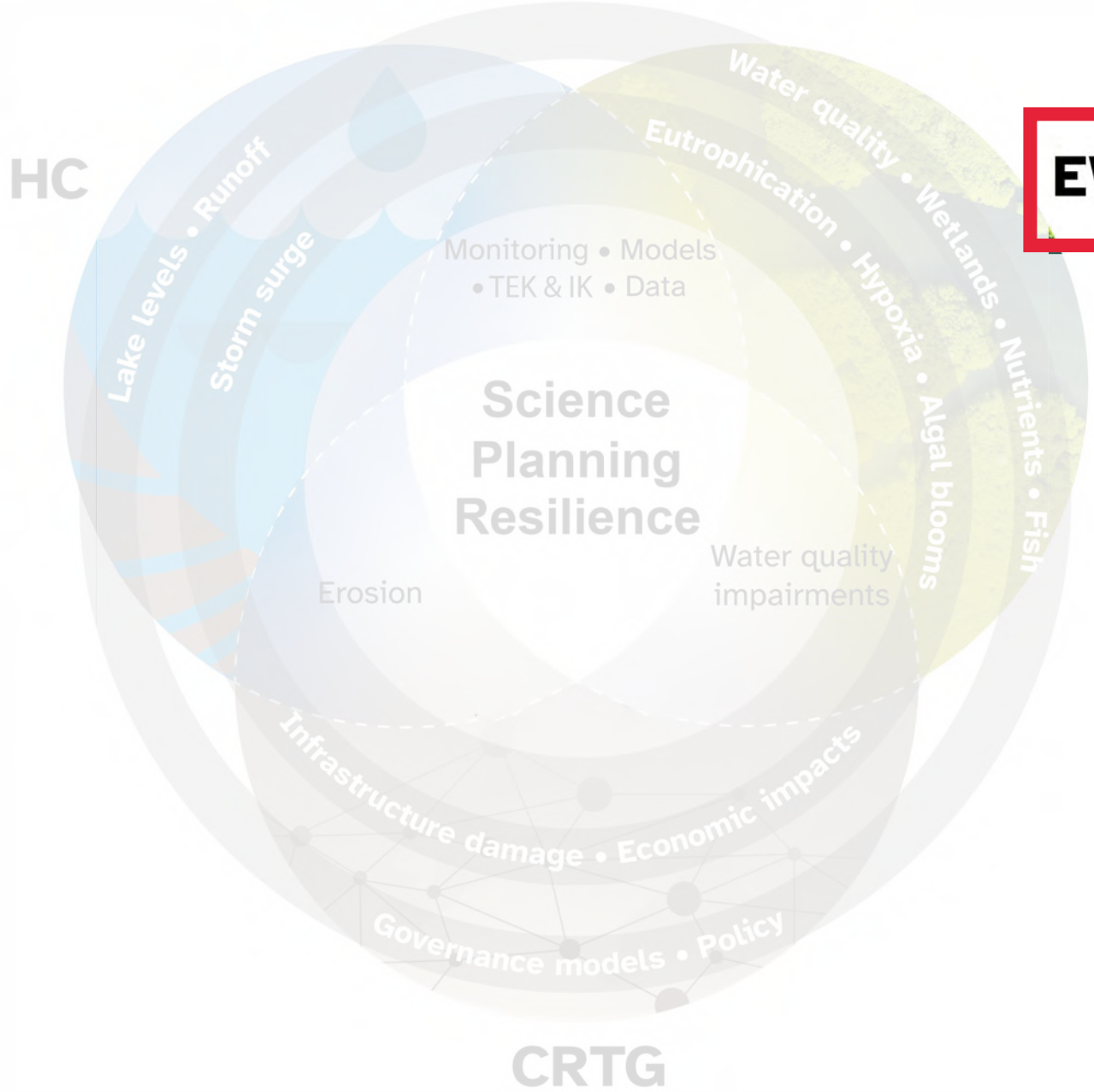
frontiers | Frontiers in Water

ORIGINAL RESEARCH
published: 13 April 2022
doi: 10.3389/frwa.2022.805143

Changes in Large Lake Water Level Dynamics in Response to Climate Change

Alexander VanDeWeghe[1], *Victor Lin*[2], *Jennani Jayaram*[3] *and Andrew D. Gronewold*[1,4]*

[1] *Department of Civil and Environmental Engineering, College of Engineering, University of Michigan, Ann Arbor, MI, United States,* [2] *Department of Electrical Engineering and Computer Science, College of Engineering, University of Michigan, Ann Arbor, MI, United States,* [3] *Department of Mathematics, College of Literature, Science, and the Arts, Ann Arbor, MI, United States,* [4] *School for Environment and Sustainability, University of Michigan, Ann Arbor, MI, United States*


HC
EWQ
Lake levels • Runoff
Storm surge
Water quality • Wetlands • Nutrients • Fish
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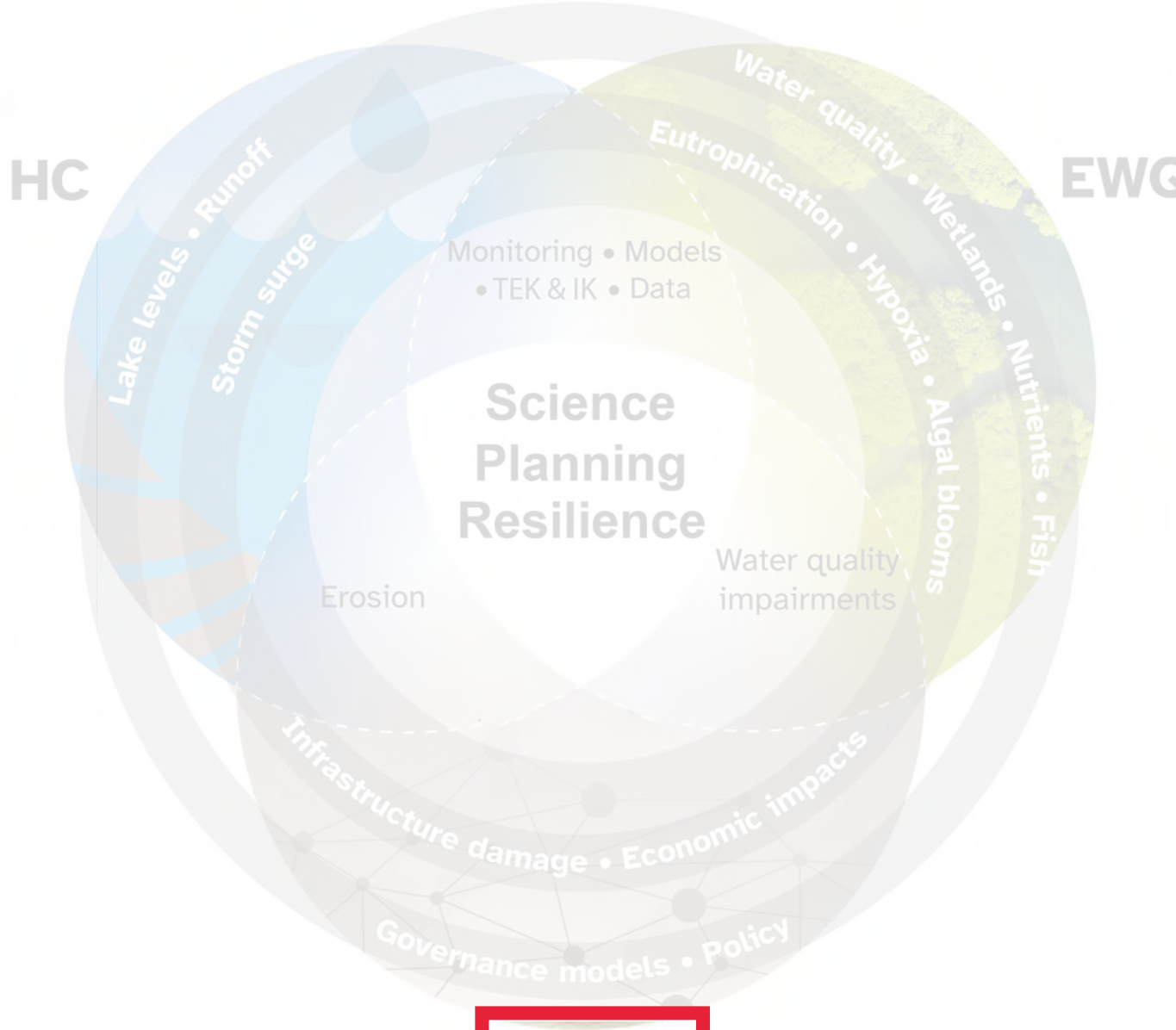
• TEK & IK • Data
Science
Planning
Resilience
Erosion
Water quality
impairments
Infrastructure damage • Economic impacts
Governance models • Policy
CRTG

Record-setting algal bloom in Lake Erie caused by agricultural and meteorological trends consistent with expected future conditions

Anna M. Michalak[a,1], Eric J. Anderson[b], Dmitry Beletsky[c], Steven Boland[d], Nathan S. Bosch[e], Thomas B. Bridgeman[f], Justin D. Chaffin[f], Kyunghwa Cho[g,2], Rem Confesor[h], Irem Daloğlu[g], Joseph V. DePinto[i], Mary Anne Evans[g,3], Gary L. Fahnenstiel[j], Lingli He[k], Jeff C. Ho[l], Liza Jenkins[g,j], Thomas H. Johengen[c], Kevin C. Kuo[d,m], Elizabeth LaPorte[n], Xiaojian Liu[d], Michael R. McWilliams[o], Michael R. Moore[g], Derek J. Posselt[d], R. Peter Richards[h], Donald Scavia[g], Allison L. Steiner[d], Ed Verhamme[i], David M. Wright[d], and Melissa A. Zagorski[d]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CRTG

Canadian Foreign Policy Journal

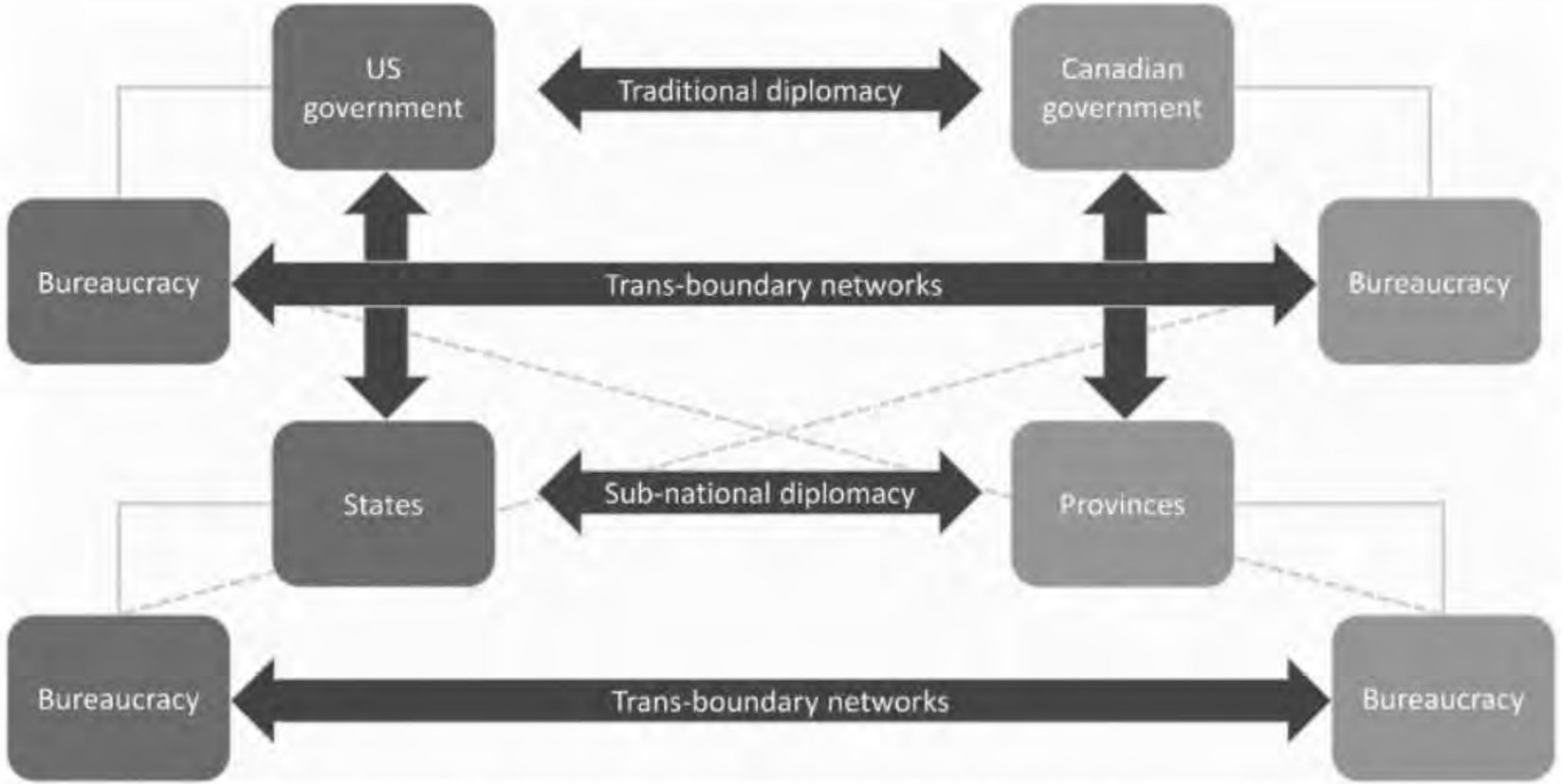
ISSN: 1192-6422 (Print) 2157-0817 (Online) Journal homepage: https://www.tandfonline.com/loi/rcfp20

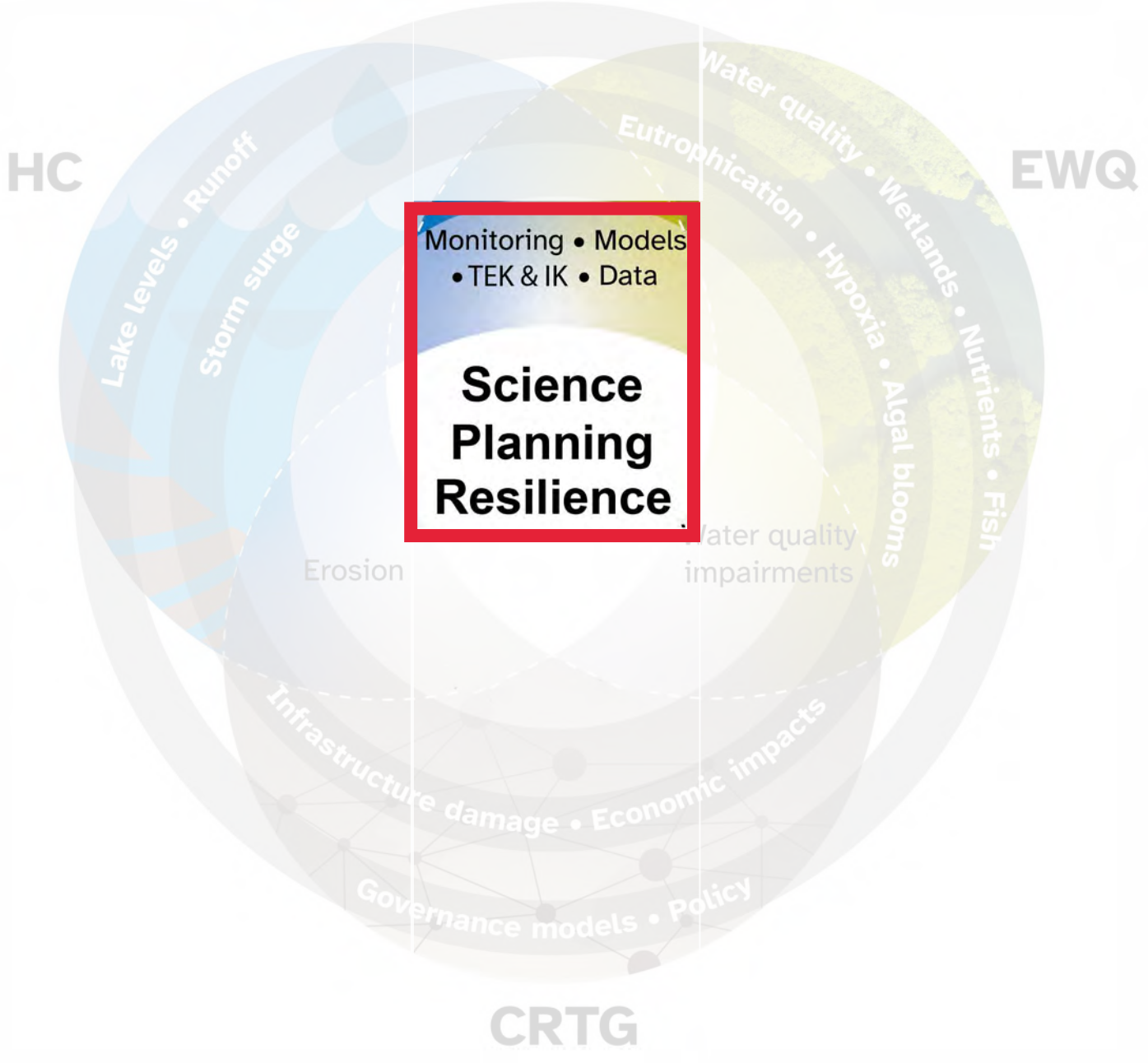
Subnational diplomacy in the Great Lakes region: toward explaining variation between water quality and quantity regimes

Carolyn M. Johns & Adam Thorn

Figure 1 of 1

Figure 1. Levels of US–Canadian subnational engagement in foreign policy.

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Outline

	Name	Institution	Role	Capacity building	Indigenous rights and perspectives	Future climate scenarios (HC)	Hydrological impacts (HC)	Ecosystem modeling and function (EWQ)	Water quality monitoring (EWQ)	Community decision making (CRTG)	Mixed social science methods (CRTG)	Transboundary water governance (CRTG)	Growth and broader impacts	Evaluation and integration
a	**Andrew Gronewold**	University of Michigan	**PI**	x		x	x	x	x			x	x	
b	**Gail Krantzberg**	McMaster University	**Canadian PI (Applicant)**	x					x	x		x		
c	**Kyle Whyte**	University of Michigan	**Co-PI**	x	x	x			x	x		x	x	
d	**Dawn Martin-Hill**	McMaster University	**Canadian Co-PI (Co-Applicant)**	x	x					x				
e	**Rebecca Edler**	College of Menominee Nation	**Co-PI**	x	x								x	
f	**Paulin Coulibaly**	McMaster University	**Canadian Co-PI (Co-Applicant)**			x	x	x						
g	**Altaf Arain**	McMaster University	**Canadian Co-PI (Co-Applicant)**				x	x						
h	**Scott Steinschneider**	Cornell University	**Co-PI**			x	x							
i	**Shane Bowe**	Red Lakes Dept. Natural Resources	**Senior Personnel**	x	x				x				x	
j	**Carolyn Johns**	Toronto Metropolitan University	**Canadian Co-PI (Co-Applicant)**	x						x	x	x		
k	**Richard Norton**	University of Michigan	**Co-PI**	x						x	x	x		
l	**Deb VanNijnatten**	Wilfred Laurier University	**Canadian Senior Personnel**							x	x	x		
m	**Julia Baird**	Brock University	**Canadian Senior Personnel**					x		x	x	x		
n	**Jon Allan**	University of Michigan	**Senior Personnel**	x					x			x	x	x
o	**Chris McClaughlin**	McMaster University	**Canadian Senior Personnel**	x							x	x	x	x
p	**Samuel Pratsch**	University of Wisconsin - Madison	**Evaluator**											x

Name	Organization	Title	Geographic Base
Dr. Rebecca Turpin	Climate Change Secretariet, Government of Yukon	Director	Whitehorse, Yukon
Dr. Edda Mutter	Yukon River Inter-Tribal Watershed Council	Science Director	Anchorage, Alaska
Dr. Aaron T. Wolf	Program in Water Conflict Mgmt. and Transformation, OSU	Co-Director	Corvalis, Oregon
Dr. Gary Tabor	Center for Large Landscape Conservation	Founder and Executive Director	Bozeman, Montana
Mr. Rob Sisson	IJC and ConservAmerica	Commisioner and former Direector	Wyoming
Dr. Roger Pulwarty	NOAA Physical Sciences Laboratory	Senior Scientist	Boulder, Colorado
Peter Johnson, esq	Conference of GLSL Governors and Premiers	Deputy Director	Chicago, Illinois
Ms. Erika Jensen	Great Lakes Commission	Executive Director	Ann Arbor, Michigan
Ms. Heather Stirratt	IJC, Director of IJC Great Lakes Regional Office	Director	Windsor, Ontario
Mr. Mike Goffin	Environment and Climate Change Canada (ECCC)	Regional Director General	Toronto, Ontario
Dr. Henry Lickers	IJC and Mohawk Council	Commissioner and Director	Akwesasne, Ontario
Dr. Jeff Ridal	The River Institute	Exec. Dir. and Chief Research Scientist	Toronto, Ontario
Paul Muldoon, esq	University of Toronto - School of the Environment	Adjunct Professor	Toronto, Ontario
Dr. Asim Zia	Transboundary Water In-Cooperation Network and U. Vermont	Panelist at COP26 and Profssor	Burlington, Vermont
Mr. Cliff McCreedy	National Park Service and US Biosphere Network	Science and Stewardship Coordinator	Arlington, Virginia

Names listed geographically from northwestern to eastern North America
OSU - Oregon State University; IJC - International Joint Commission; GLSL - Great Lakes and St. Lawrence

Outline

500 km
300 mi

at 45°N 100°W.
ntrado en 45°N 100°O.
100°O.

BASSINS HYDROGRAPHIQUES OCÉANIQUES

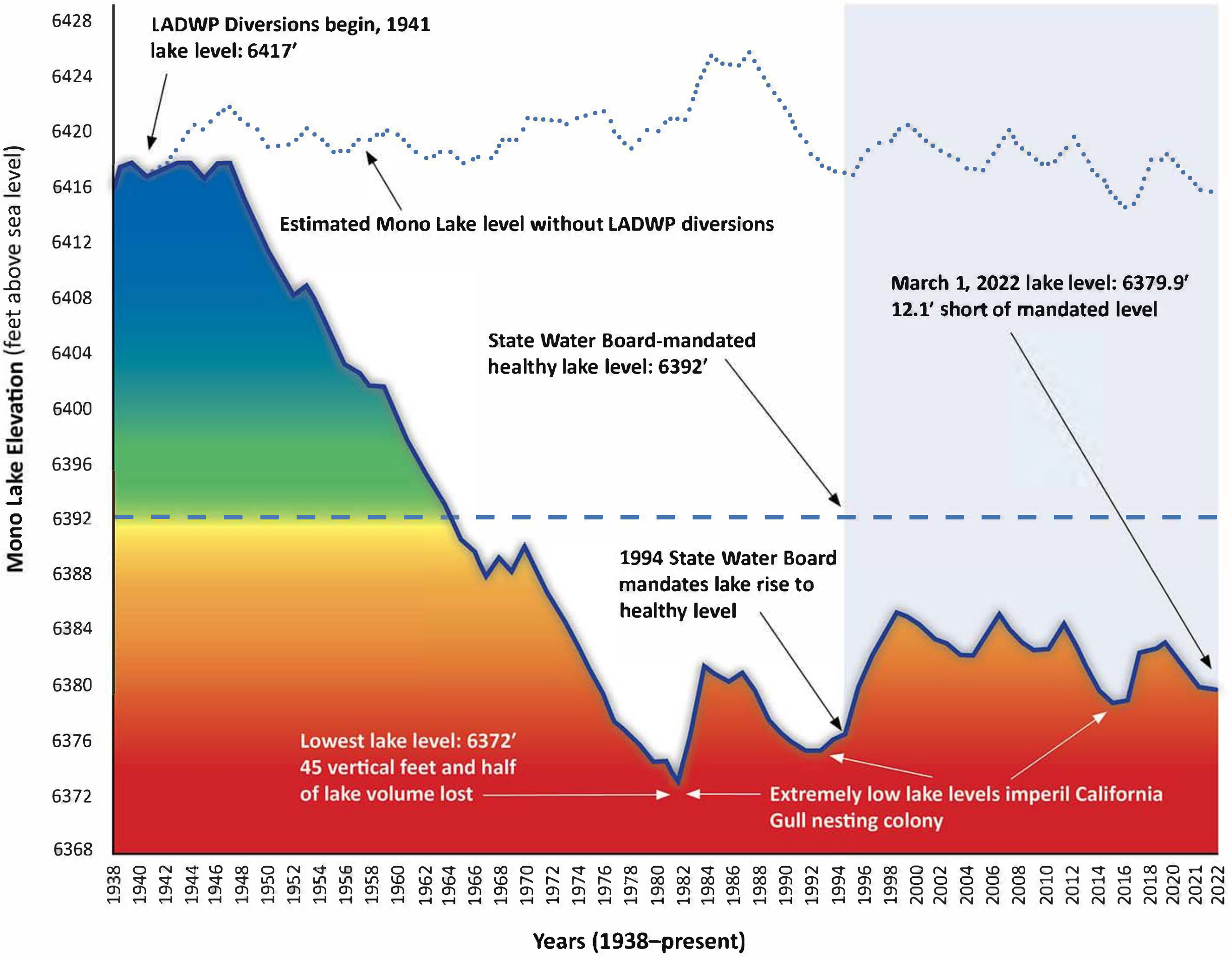
Océan Arctique
Littoral
Fleuve Mackenzie

Océan Atlantique
Littoral
Fleuve Saint-Laurent

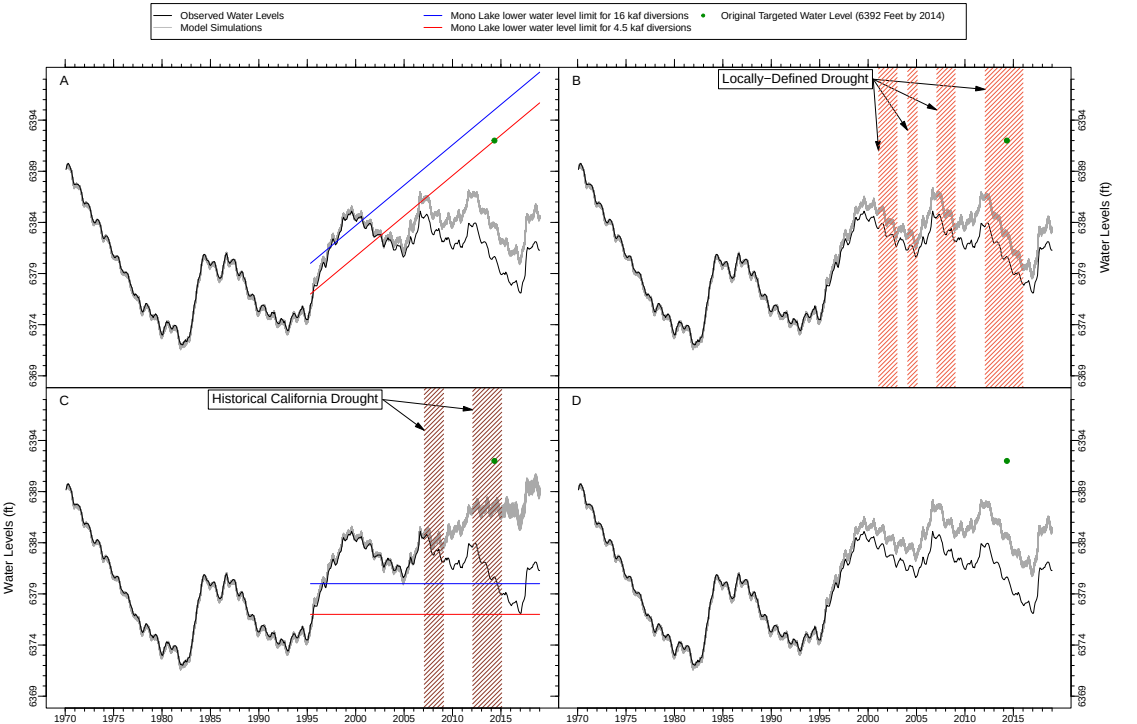
Golfe du Mexique
Littoral
Réseau hydrographique du Mississippi
Fleuve Mississippi
Rivière Missouri
Rivière Ohio

Mexican States
Estados Mexicanos
États mexicains

Mono Lake Surface Elevation



Gossard et al (Submitted)



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Réseau hydrographique du Mississippi
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Rivière Ohio

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États mexicains

TREATY SERIES 994

UTILIZATION OF WATERS OF THE COLORADO AND TIJUANA RIVERS AND OF THE RIO GRANDE

✦

TREATY BETWEEN THE UNITED STATES OF AMERICA AND MEXICO

Signed at Washington February 3, 1944.

AND

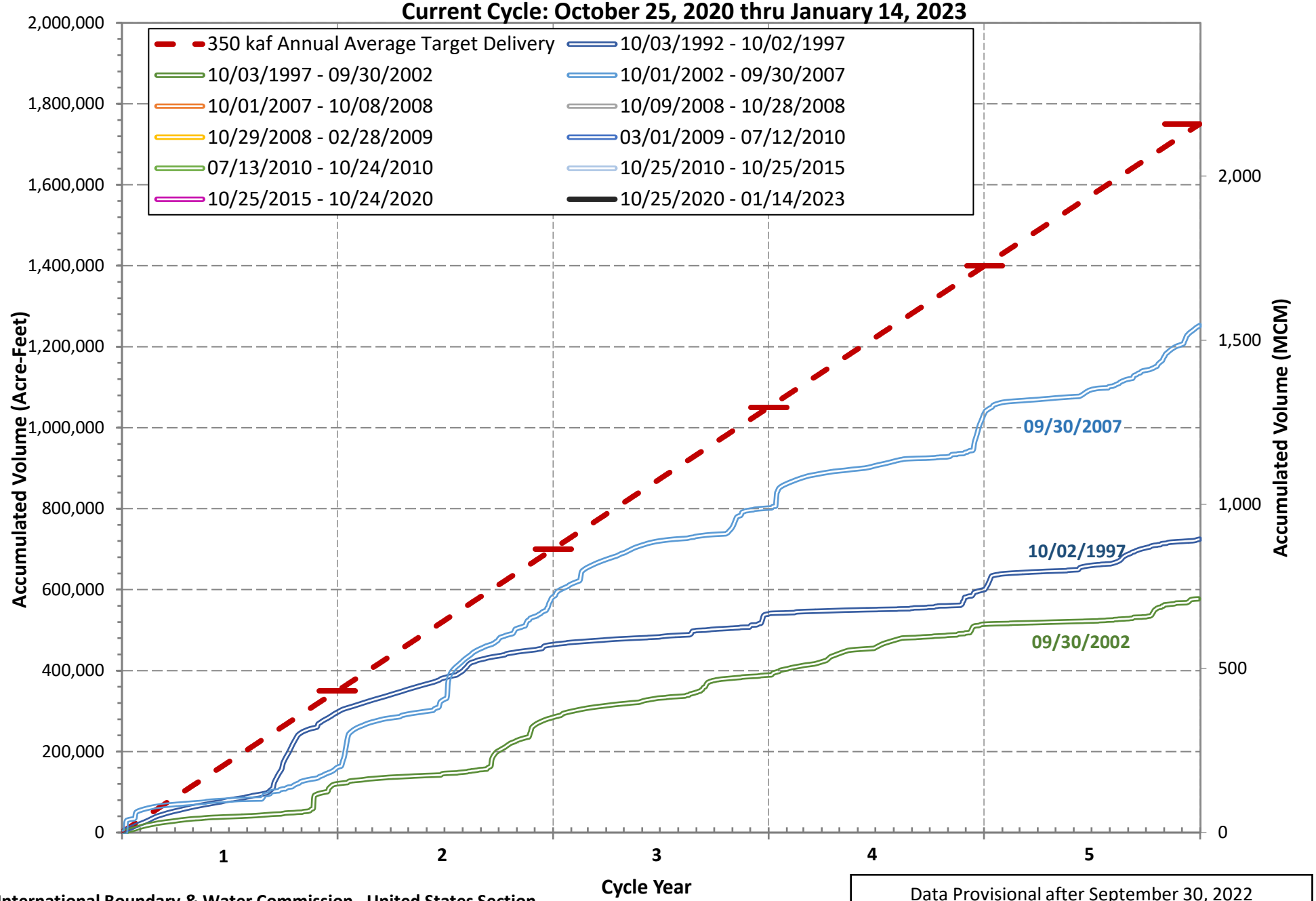
PROTOCOL

Signed at Washington November 14, 1944.

Ratification advised by the Senate of the United States of America April 18, 1945, subject to certain understandings.
Ratified by the President of the United States of America November 1, 1945, subject to said understandings.
Ratified by Mexico October 16, 1945.
Ratifications exchanged at Washington November 8, 1945.
Proclaimed by the President of the United States of America November 27, 1945, subject to said understandings.
Effective November 8, 1945.

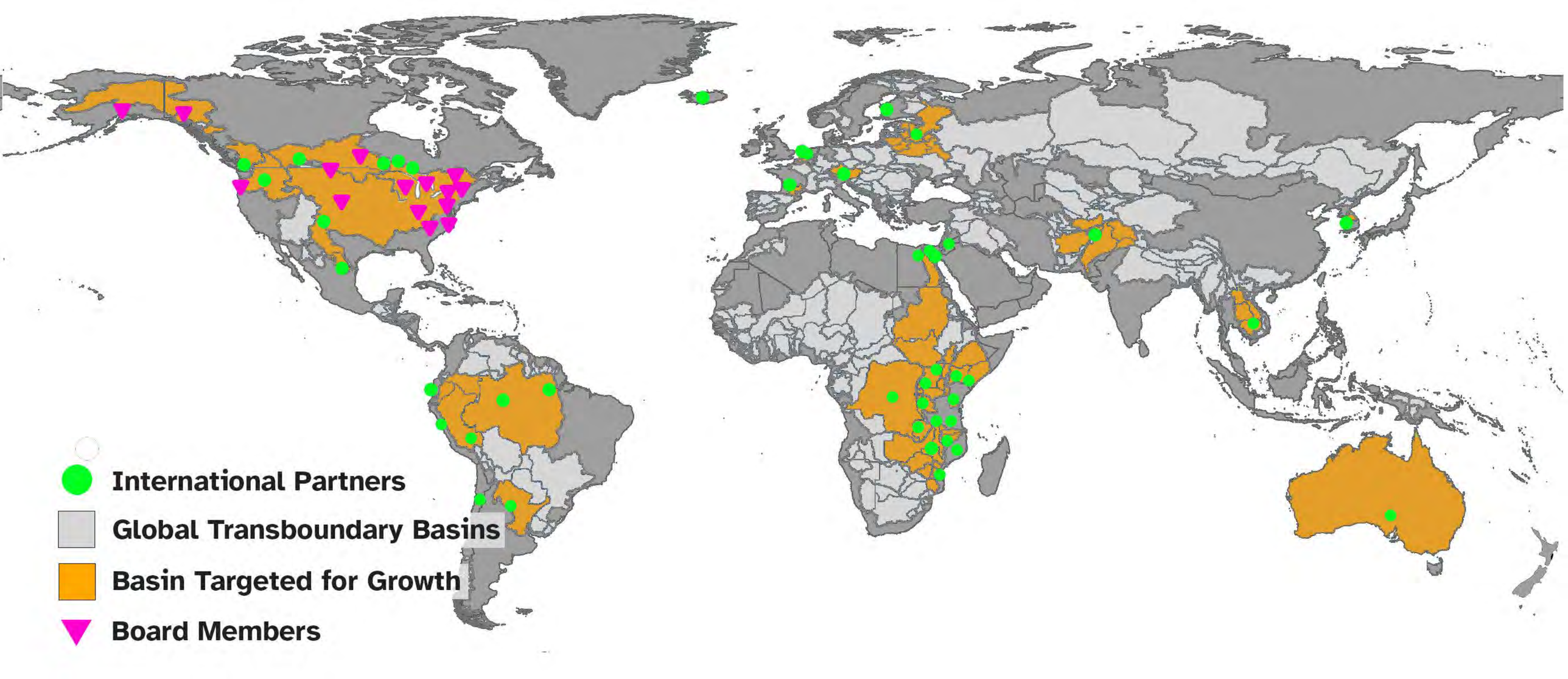
UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1946

Rio Grande River Basin
Estimated Volumes Allotted to the United States by Mexico from Six Named Mexican Tributaries and Other Accepted Sources under the 1944 Water Treaty
Current Cycle: October 25, 2020 thru January 14, 2023



International Boundary & Water Commission - United States Section

Data Provisional after September 30, 2022


International Partners
Global Transboundary Basins
Basin Targeted for Growth
Board Members

Global Center for Understanding Climate Change Impacts on Transboundary Waters

Andrew Gronewold, Ph.D., P.E.
drewgron@umich.edu

University of Michigan
School for Environment and Sustainability
Department of Civil and Environmental Engineering
Department of Earth and Environmental Sciences

Presented to GLSLCC Science Team
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