Can climate change make the aquatic invasive species problems in the Great Lakes any worse than they already have been?

Is more needed from science?

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What I will present:

- Evidence that climate warming in the Great Lakes region has been ongoing.
- Examples of aquatic invasive species probably already benefitted by ongoing climate change
- Questions about implications for AIS science in the Great Lakes

Bryson, R. A. 2006. The Volcanic Record and Climatic Cycles. CCNet 169(06):7.

The Volcanic Record and Climatic Cycles

R.A. Bryson

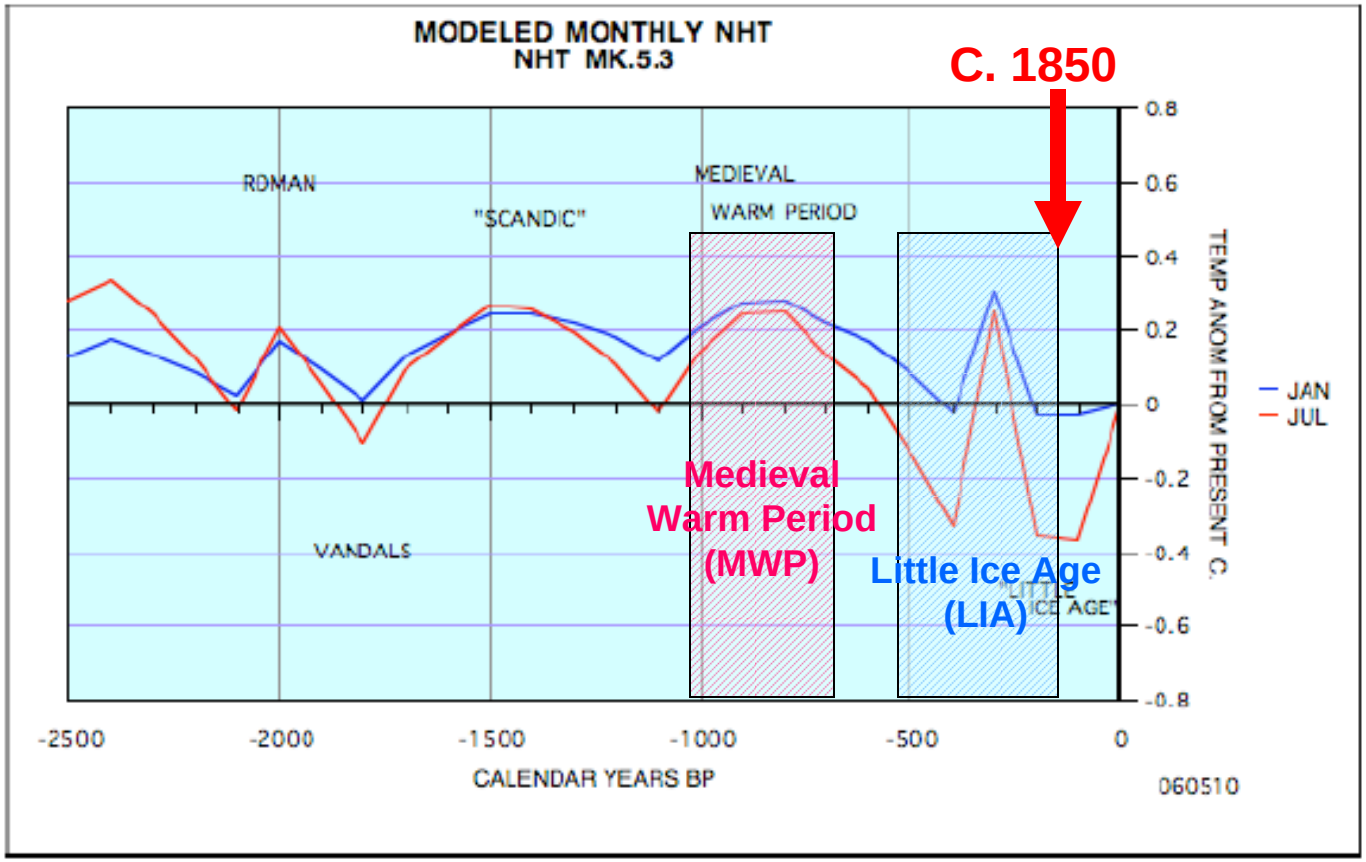
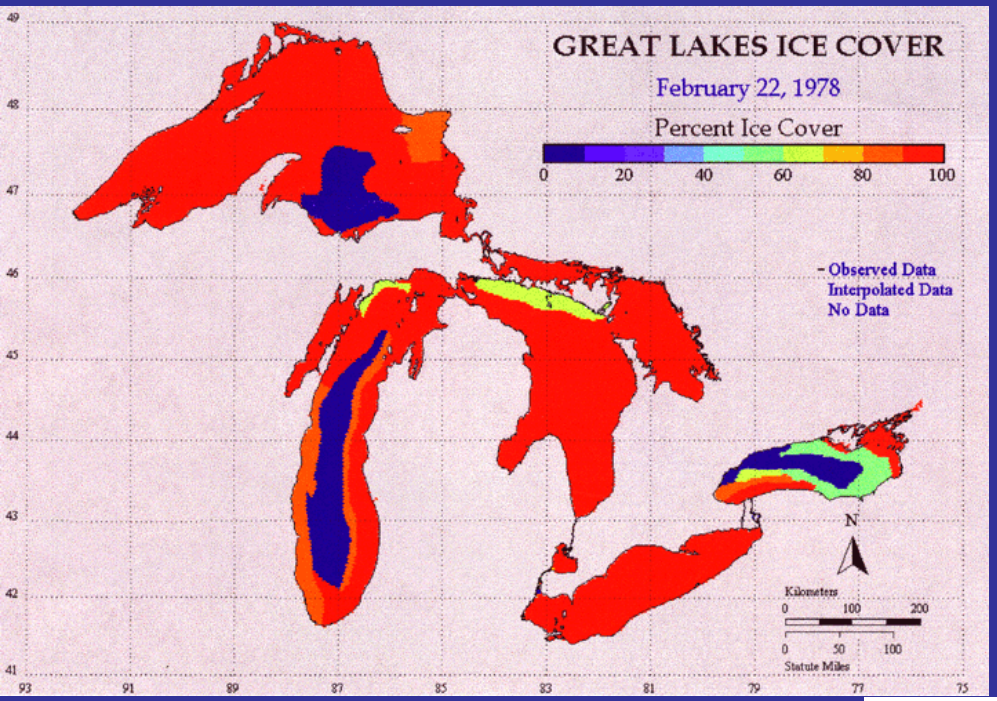


Fig. 3 Modeled mean surface temperature of the most recent 2.5 millennia with the transparency of the atmosphere determined by the volcanic aerosol content. The "present" or zero time on this diagram is 1955 AD.

Evidence of long-term climate warming in the Great Lakes region:

Observations from 1853-2001 indicate significantly earlier break up dates and longer ice free seasons across the entire series and in the last 30 years; long-term trend may be associated with the end of the Little Ice Age.

Documented changes in Ice Cover of Great Lakes – recognized 16 years ago



Earlier end of ice season: 10-15 days <u>over 30 years</u> at some stations.

Also increasing average springtime (March-May) temperatures.

Hanson, H.P., C.S. Hanson, and B.H. Yoo. 1992. Recent Great Lakes Ice Trends. Bulletin American Meteorolgical Society 73: 577-584.

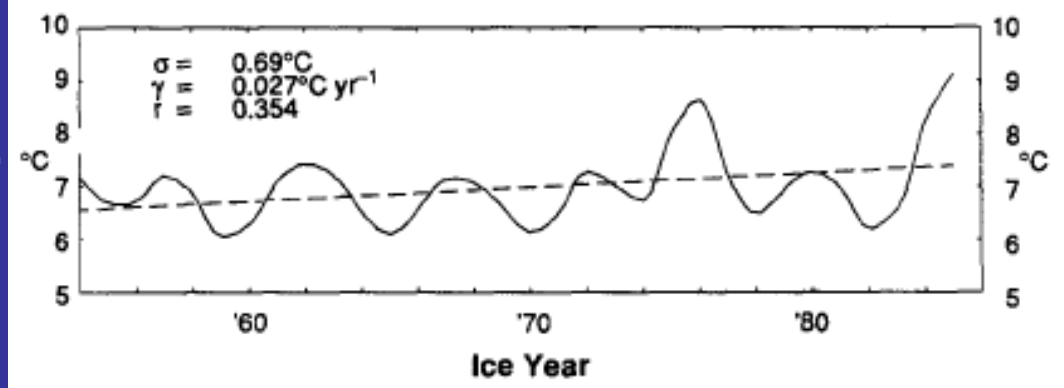


FIG. 5. Time series of average springtime (March–May) temperatures for stations in the hatched region of Fig. 1. Statistics are the same as those shown in Fig. 3: the trend is significant at greater than the 90% level by the same tests used previously.

Summer stratification

Increased duration of summer stratification 14-18 days from 1910-1990

McCormick, M.J. and G.L. Fahnenstiel. 1999. Recent climatic trends in nearshore water temperatures in the St. Lawrence Great Lakes. Limnology & Oceanography 44: 530-540.

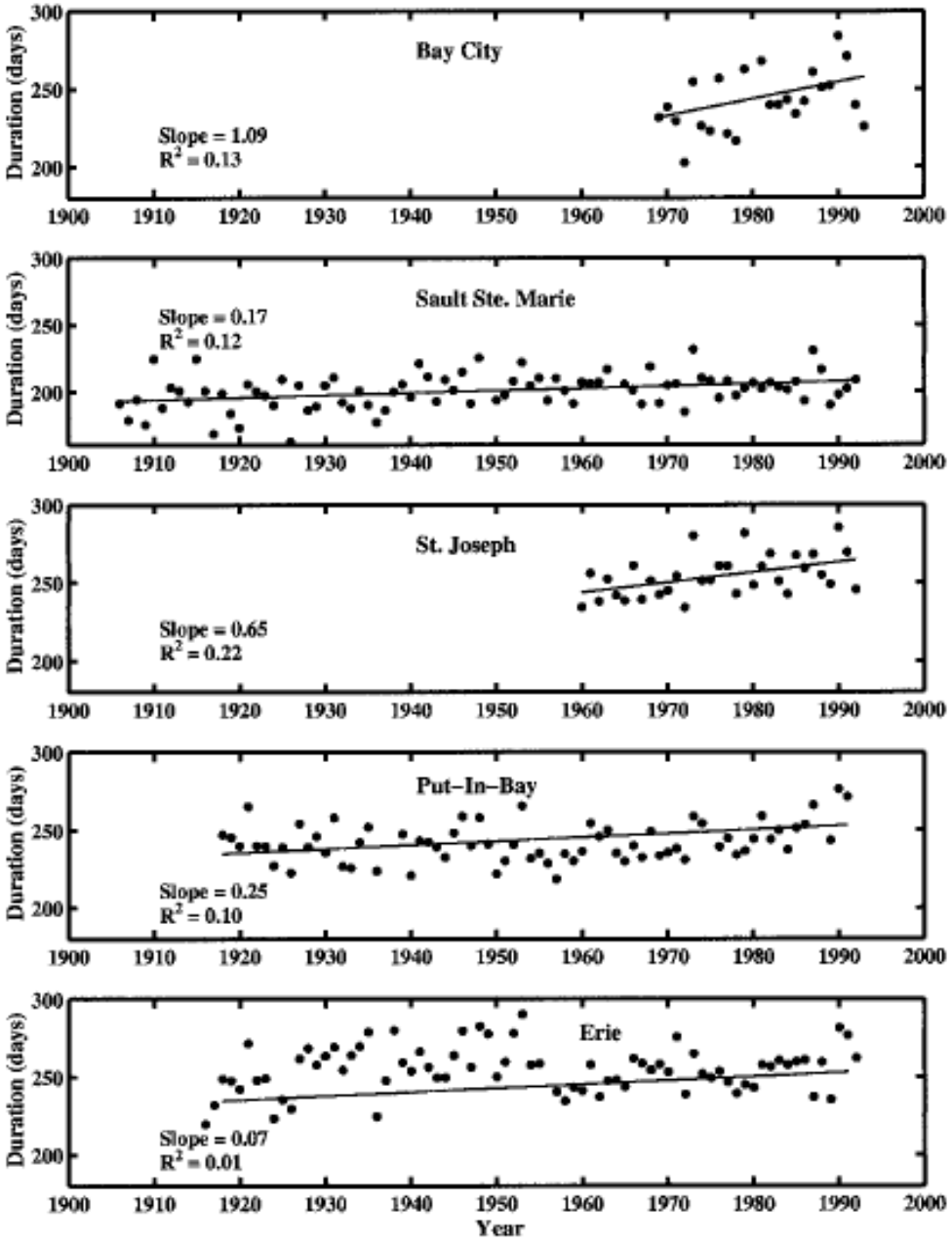


Fig. 7. Plot of maximum potential DSS data from sites showing significant trends over their entire data set (Table 2).

Changes in annual seasonal pattern of lake level fluctuation from1860-1998

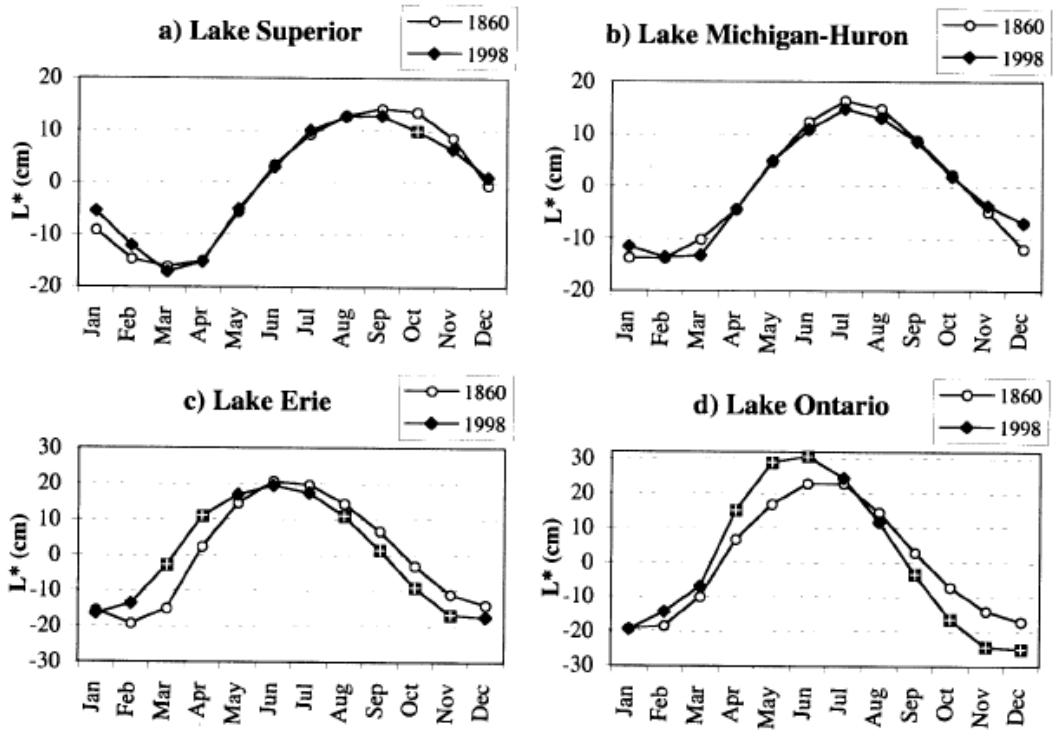


FIG. 6. Reconstructed lake level anomalies (in cm) for 1860 (open circles) and 1998 (closed diamonds or "+" symbol) based on the endpoints of the linear regression of L vs. time. Months for which the linear trend in L* is statistically significant (at at least the 90% level) are denoted by the "+" symbol.*

Lake Erie rising and falling one month earlier in 1998 than in 1860.

Lake Superior max. levels reached earlier in year.

Lenters, J.D. 2001. Long-term trends in the Seasonal cycle of Great Lakes water levels. Journal of Great Lakes Research 27:342-353.

AIS likely already benefitted from long-term climate change:

Sea lamprey possibly benefitted from climate warming after the Little Ice Age.

Declines of cold water fishes related to thermal changes (Atlantic Salmon and stream temps)

Sea lamprey

The general climatic cool period in the Northern Hemisphere from the late 1500s to 1900 could have suppressed sea lamprey reproduction. The sharp warming after 1920 (Bryson 1974) may have enhanced it throughout the Great Lakes drainage in recent decades. This climatic change could, in part, explain why lake trout did not become extinct in Lake Ontario and the Finger Lakes in the early part of this century, even though they have had greater difficulty surviving to maturity after sea lampreys became abundant in Lakes Superior, Michigan, Huron, and Ontario in recent years-prior to implementation of sea lamprey control.

Smith, S. 1995. Early changes in the fish community of Lake Ontario. Great Lakes Fishery Commission Technical Report 60.

Alewife

Slow spread from southern Lake Huron to Lakes Michigan and Superior

Inability to tolerate colder temperatures impeded invasion.

Adapted to milder, more stable temperatures – susceptible to die-offs due to thermal shock associated with temperature "inversions."

Round goby

Confirmed round goby sightings as of 2002

PA Sea Grant/ Penn State Erie map

Gobies are multiple spawners, producing up to 6 broods per year as long as temperatures are between 9 – 26 C^{o}

Shorter time between successive spawning intervals at temperatures above 20° C

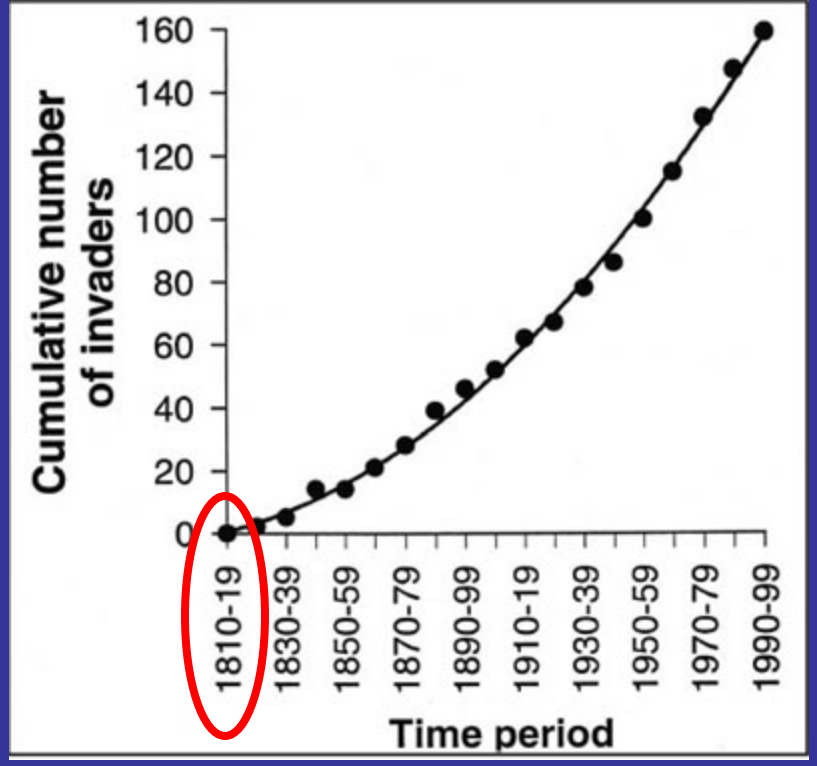
Population growth benefitted from longer period of elevated temperatures in nearshore areas

So what?

Assuming that past invasions were already benefactors of ongoing climate warming, what are possible Implications for science today?

One possibility: The future challenges may be no greater than the challenges we have already faced. The scientific community is already "adapted" to deal with future invasive species problems (best case scenario).

Another possibility: The invasion problems will get worse or more frequent, and the scientific community will be required to do more to meet future challenges (worst case scenario).



Long-term perspective on rate of invasion in Great Lakes

NOAA-GLERL: Aquatic Invasive Species (AIS) and the Great Lakes: Simple Questions, Complex Answers (usually)

Letters

When did the discovery rate for invasive species in the North American Great Lakes accelerate?

Answer: 1982

Holeck and colleagues (2004) rightly draw attention to transoceanic ships as a source of nonindigenous species (NIS) in the North American Great Lakes. We agree that "management strategies aimed at preventing new invasions must consider the linkages between NIS and vectors" (p. 927), and that invasive species from anthropogenic sources will be a growing problem as global trade in-

Moreover, even under the assumption that there is no lag between introduction and discovery, the conclusion that BWE is associated with accelerated introductions is not supported. Visual inspection of the discovery record suggests that if there is a break point separating two periods that differ in discovery rate, it predates the 1989 policy. Using break-point regression

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References cited

Costello C, Solow A. 2003. On the pattern of discovery of introduced species. Proceedings of the National Academy of Sciences 100: 3321–3323.

2005
BioScience 55:4

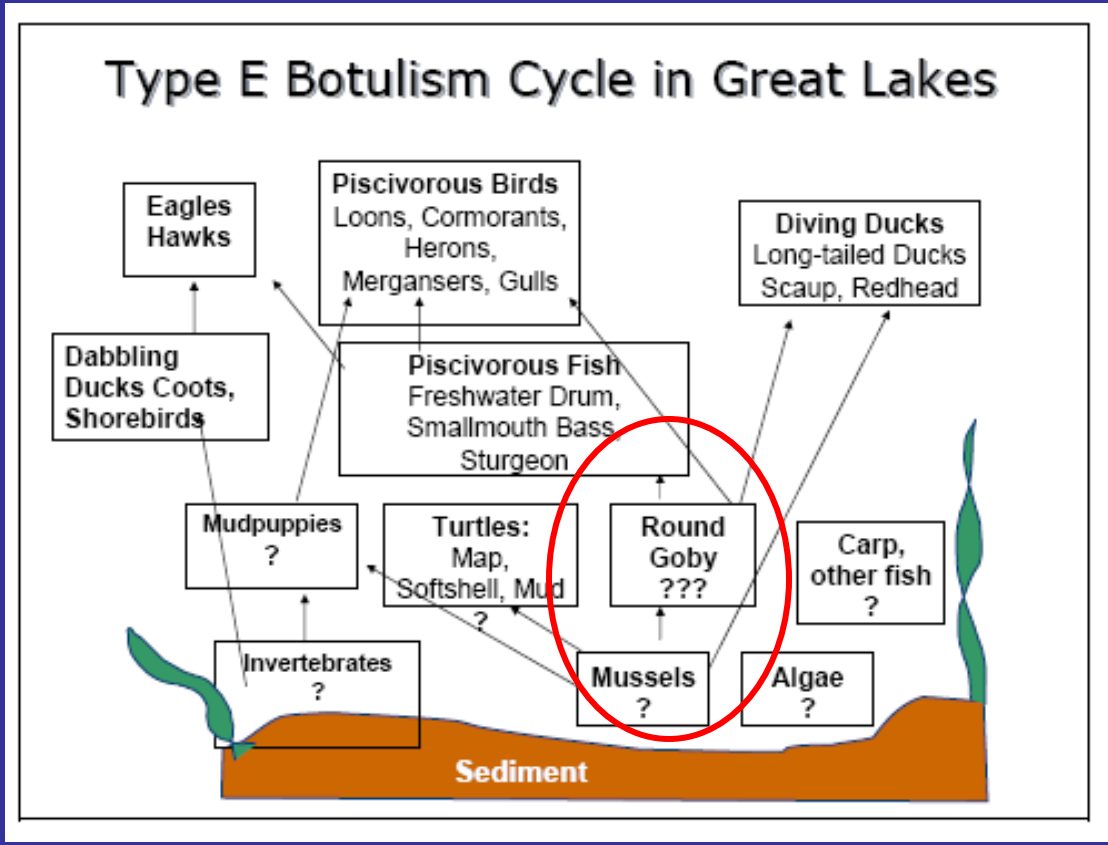
Discovery rate tripled after 1982 – <u>not</u> likely due to "investigation bias"

Invasive meltdown scenario:

Anthony Ricciardi. 2001. Facilitative interactions among aquatic invaders: is an "invasional meltdown" occurring in the Great Lakes? Can. J. Fish. Aquat. Sci. 58(12): 2513–2525.

More “positive” interactions among new invasive species than “negative,” and exploitative (predator-prey) interactions may benefit one invading species at a negligible cost to another.

Meltdown already commencing?



Invasive mussel and round goby links in avian botulism outbreaks – associated with low lake levels and warmer conditions….

Is the AIS scientific community of the Great Lakes equipped to predict potential consequences of complex interactions among new invasives and the changing physical environment associated with climate change?