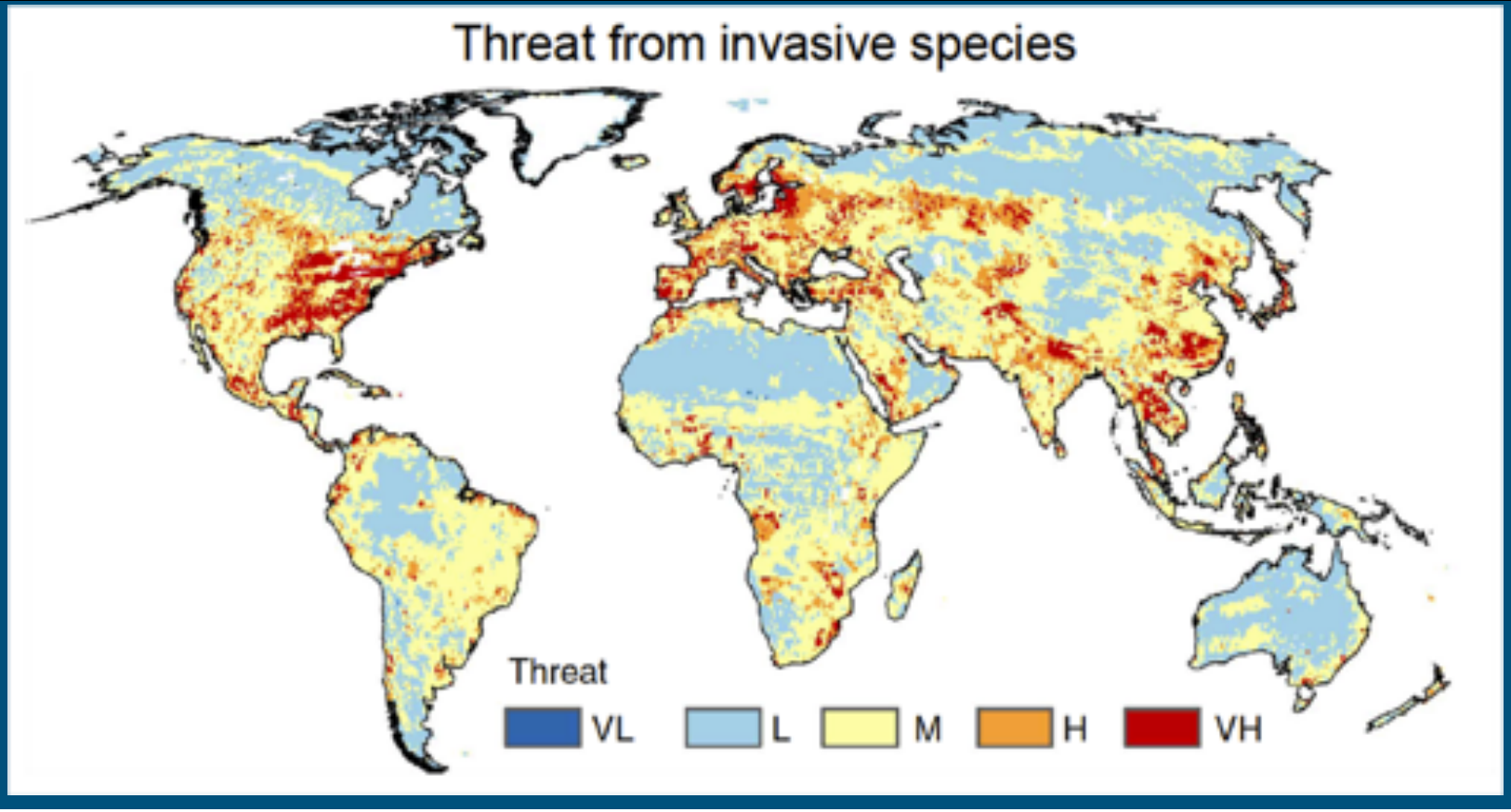
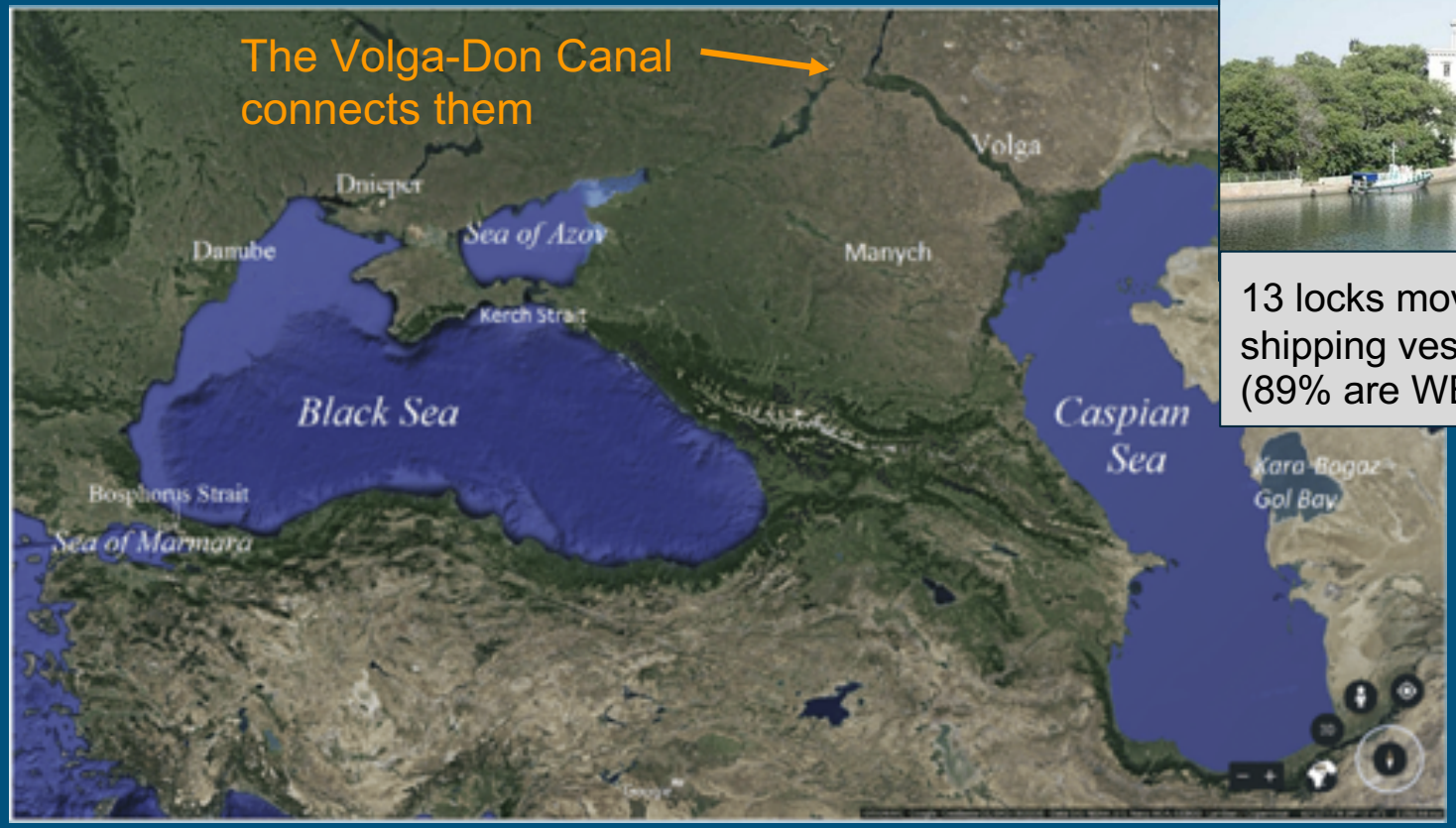
Be AIS AWARE: Mapping AIS Mayhem



FLATHEAD LAKE BIO STATION
UNIVERSITY OF MONTANA

WHERE are zebra and quagga mussels native?

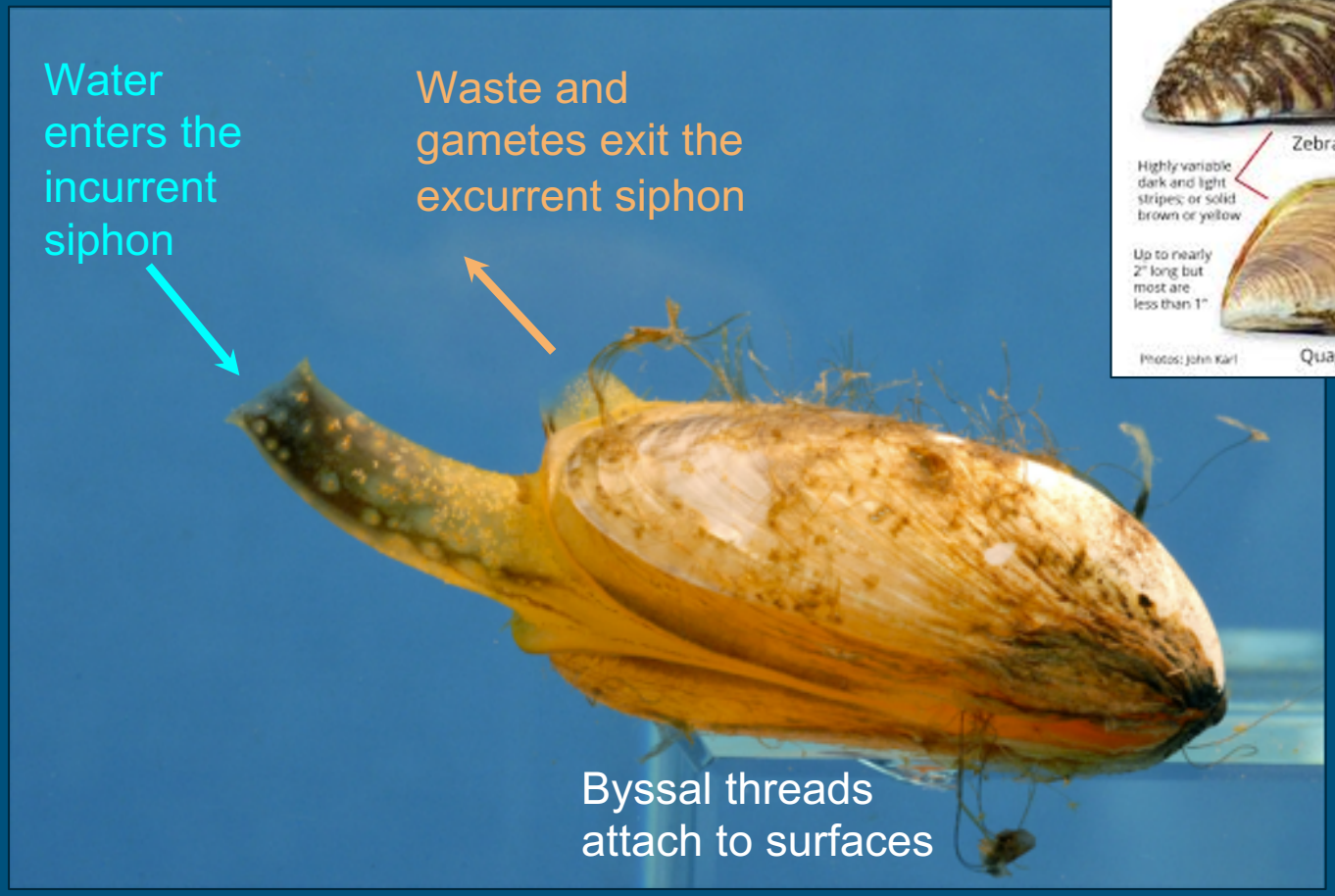
Zebra mussels are native to the Black, Caspian, and Azov Seas

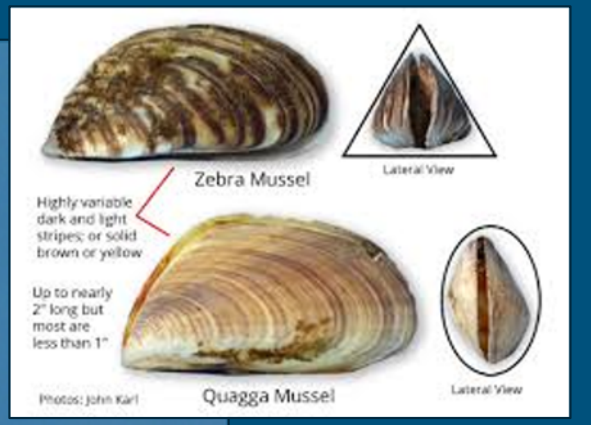


13 locks move the shipping vessels (89% are WESTWARD)

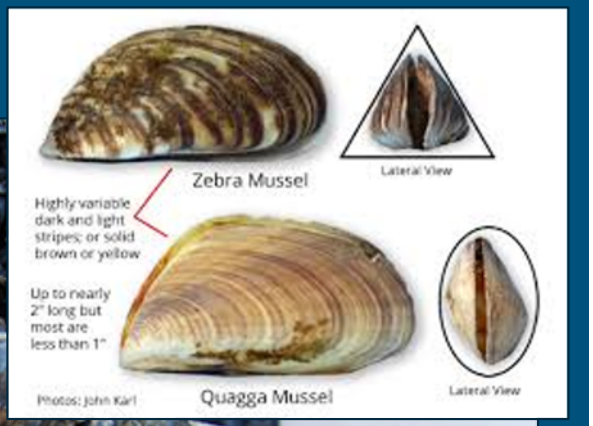
Quagga mussels are native to the Dneiper River

WHAT makes these mussels so invasive?





WHAT makes these mussels so invasive?



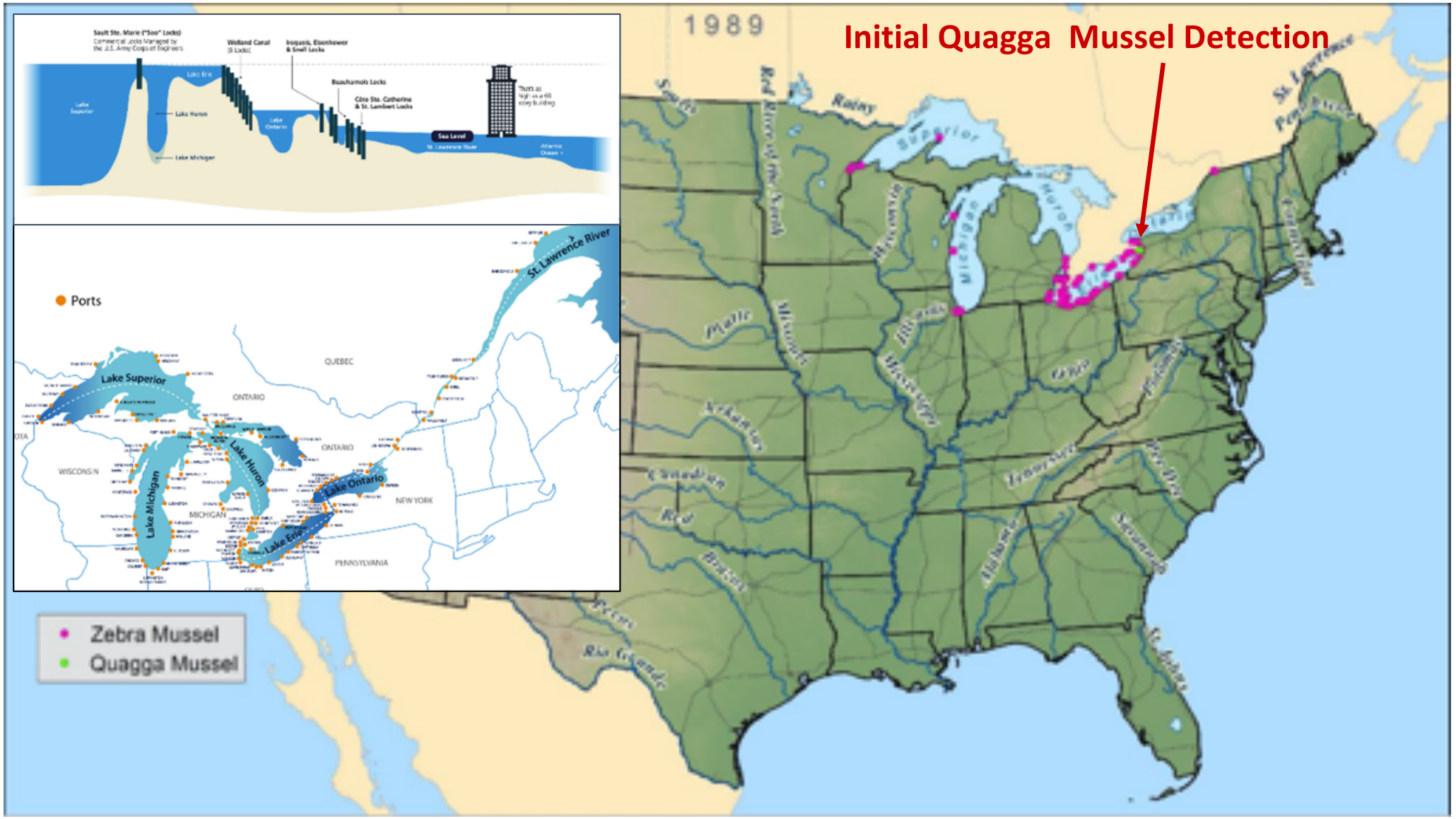
How did the invasive mussels get to the United States?

Cargo ships released contaminated ballast water into the Great Lakes!


1986
Initial Zebra Mussel Detections
Hudson Bay
Ontario
Québec
Minnesota
Lake Superior
Nipigon River
Thunder Bay
Duluth
Sault Ste. Marie
St. Marys River
Wisconsin
Michigan
Lake Michigan
Lake Huron
Green Bay
Milwaukee
Bay City
St. Clair River
Lake St. Clair
Detroit River
Chicago
Illinois
Indiana
Ohio
Lake Erie
Cleveland
Pennsylvania
Toronto
Lake Ontario
Niagara River
Buffalo
Rochester
Oswego
Cape Vincent
New York
St. Lawrence River
Kingston
Ottawa
Montreal
Zebra Mussel
Quagga Mussel
Make a prediction:
Where do you think the zebra mussels spread to first?


1987
Zebra Mussel
Quagga Mussel


1988
Zebra Mussel
Quagga Mussel


1989
Initial Quagga Mussel Detection
Sault Ste. Marie ("Soo" Locks)
Welland Canal
Iroquois, Eisenhower & Snell Locks
Beauharnois Locks
Côte Ste. Catherine & St. Lambert Locks
Lake Erie
Lake Huron
Lake Michigan
Lake Ontario
Sea Level
Ports
St. Lawrence River
Lake Superior
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
QUEBEC
ONTARIO
WISCONSIN
MICHIGAN
NEW YORK
PENNSYLVANIA
Zebra Mussel
Quagga Mussel


1990
Zebra Mussel
Quagga Mussel
Where did the invasive mussels actually spread to initially?


1991
5 years later...
Zebra Mussel
Quagga Mussel


1992
Zebra Mussel
Quagga Mussel


1993
Zebra Mussel
Quagga Mussel


1994
Zebra Mussel
Quagga Mussel


1995
Zebra Mussel
Quagga Mussel


1996
10 years later...
Zebra Mussel
Quagga Mussel
They quickly spread by traveling
_____
from their points of origin and by
_____
a ride.

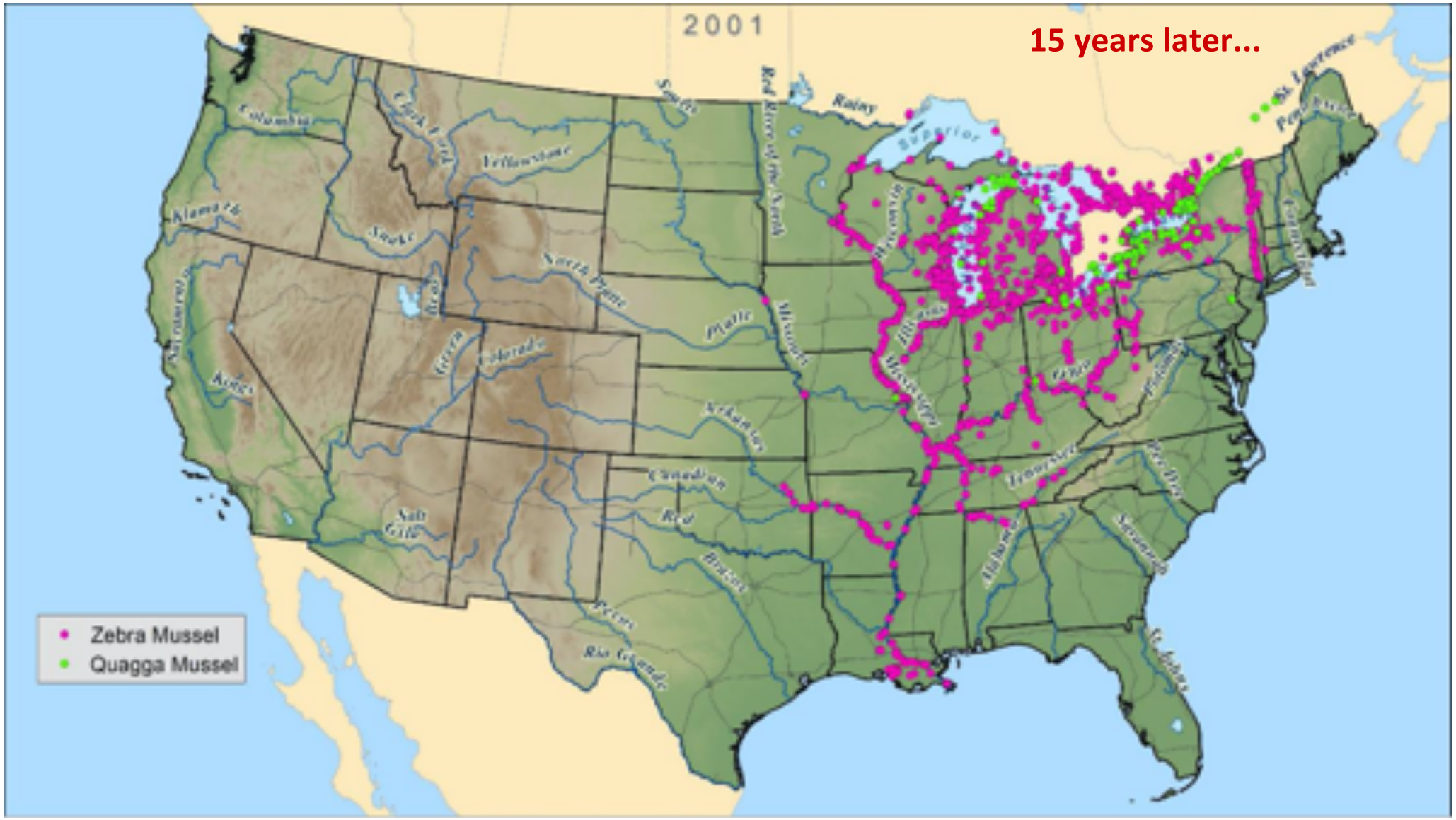

1996
10 years later...
Zebra Mussel
Quagga Mussel
They quickly spread by traveling DOWNSTREAM from their points of origin and by HITCHHIKING a ride.

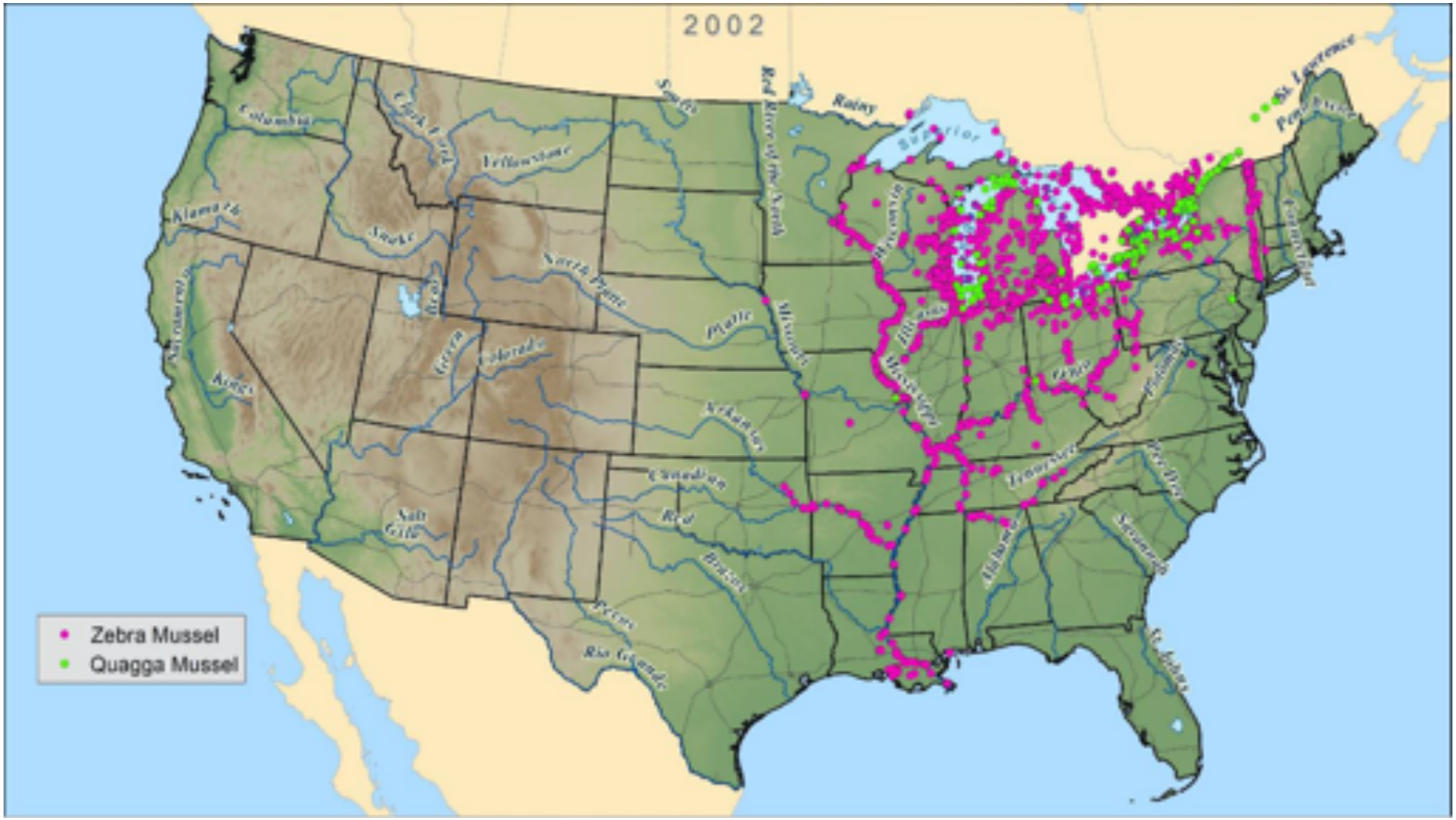

1997
Zebra Mussel
Quagga Mussel

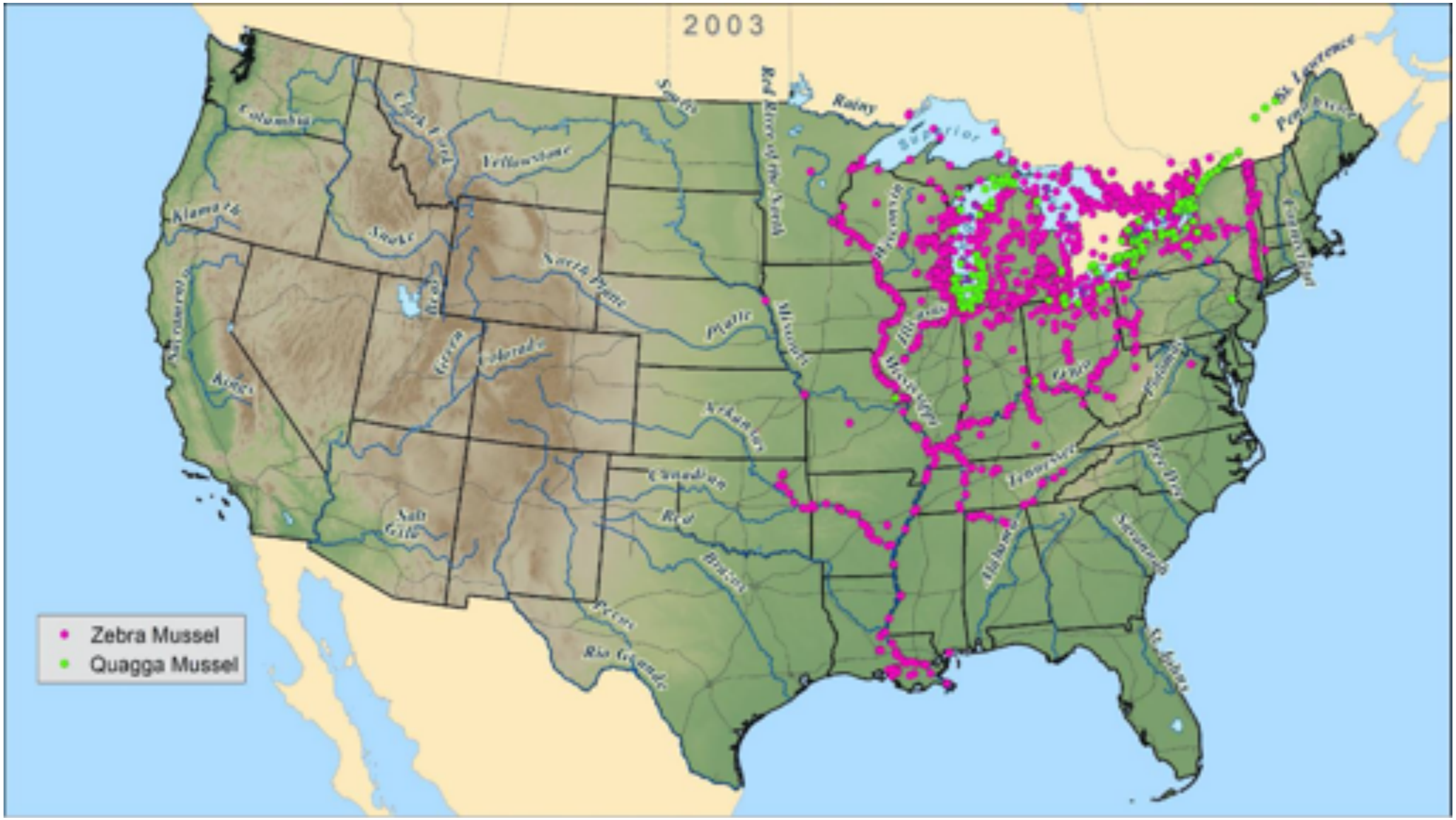

1998
Zebra Mussel
Quagga Mussel

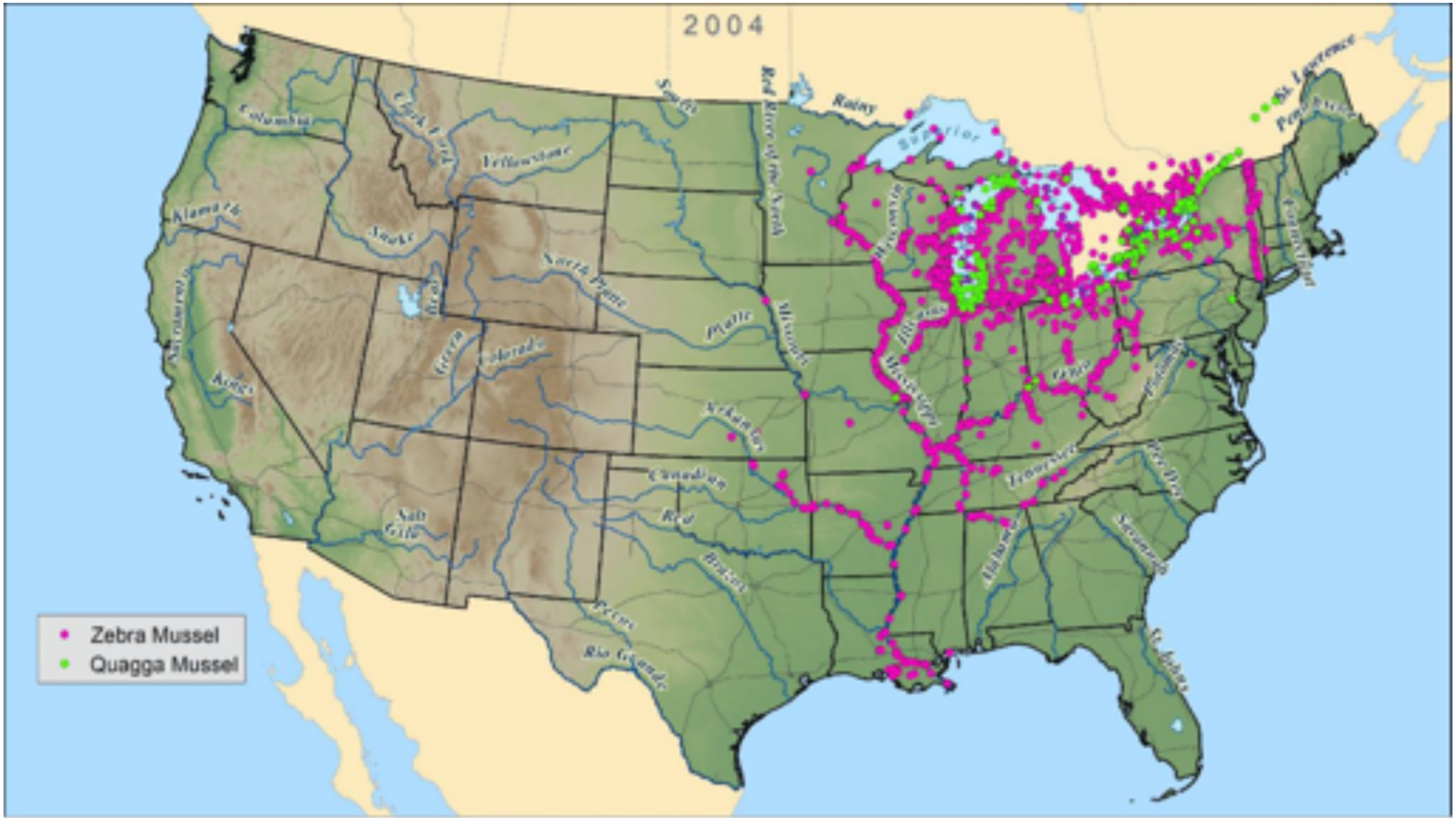

1999
Zebra Mussel
Quagga Mussel

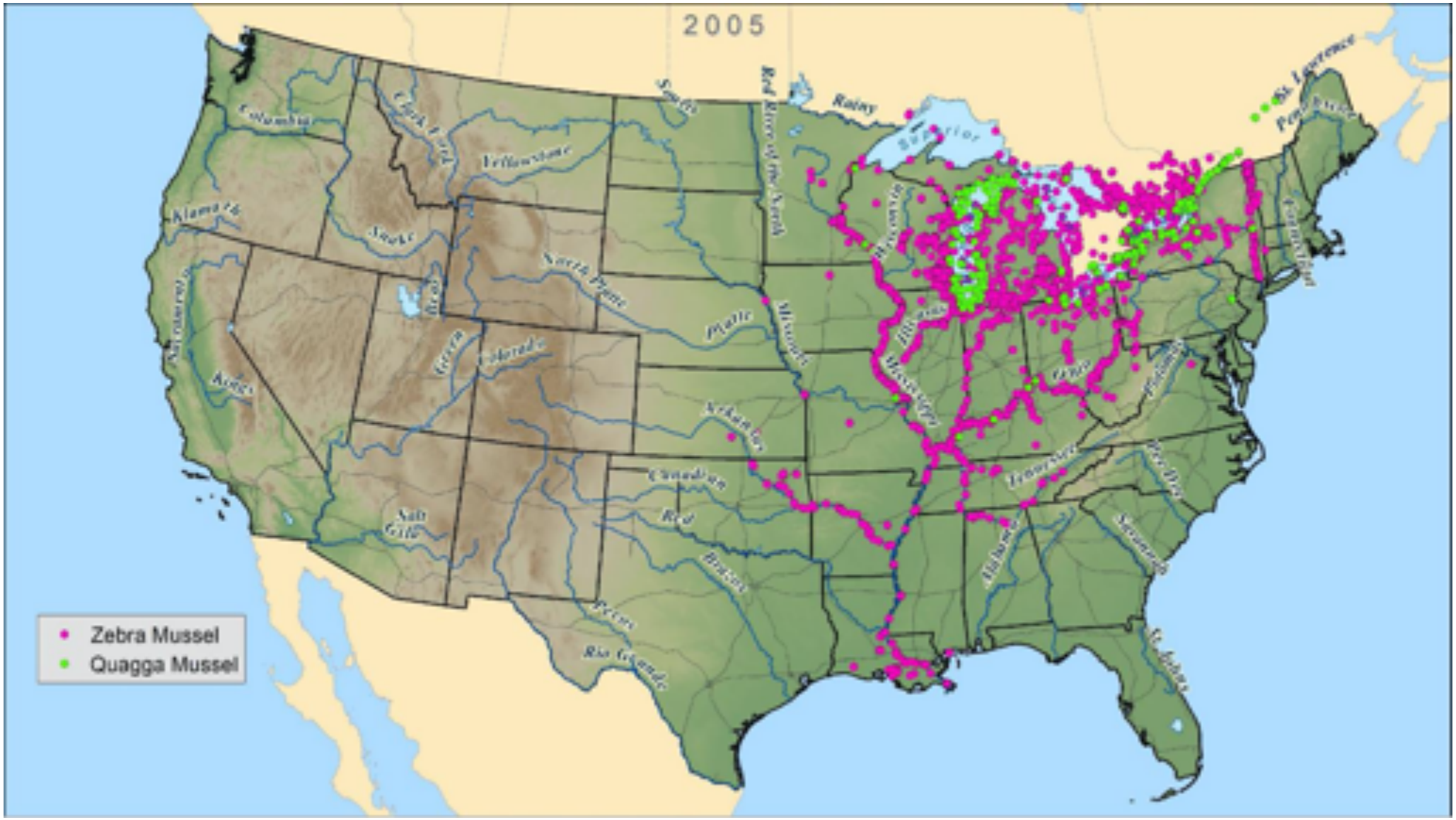

2000
Zebra Mussel
Quagga Mussel

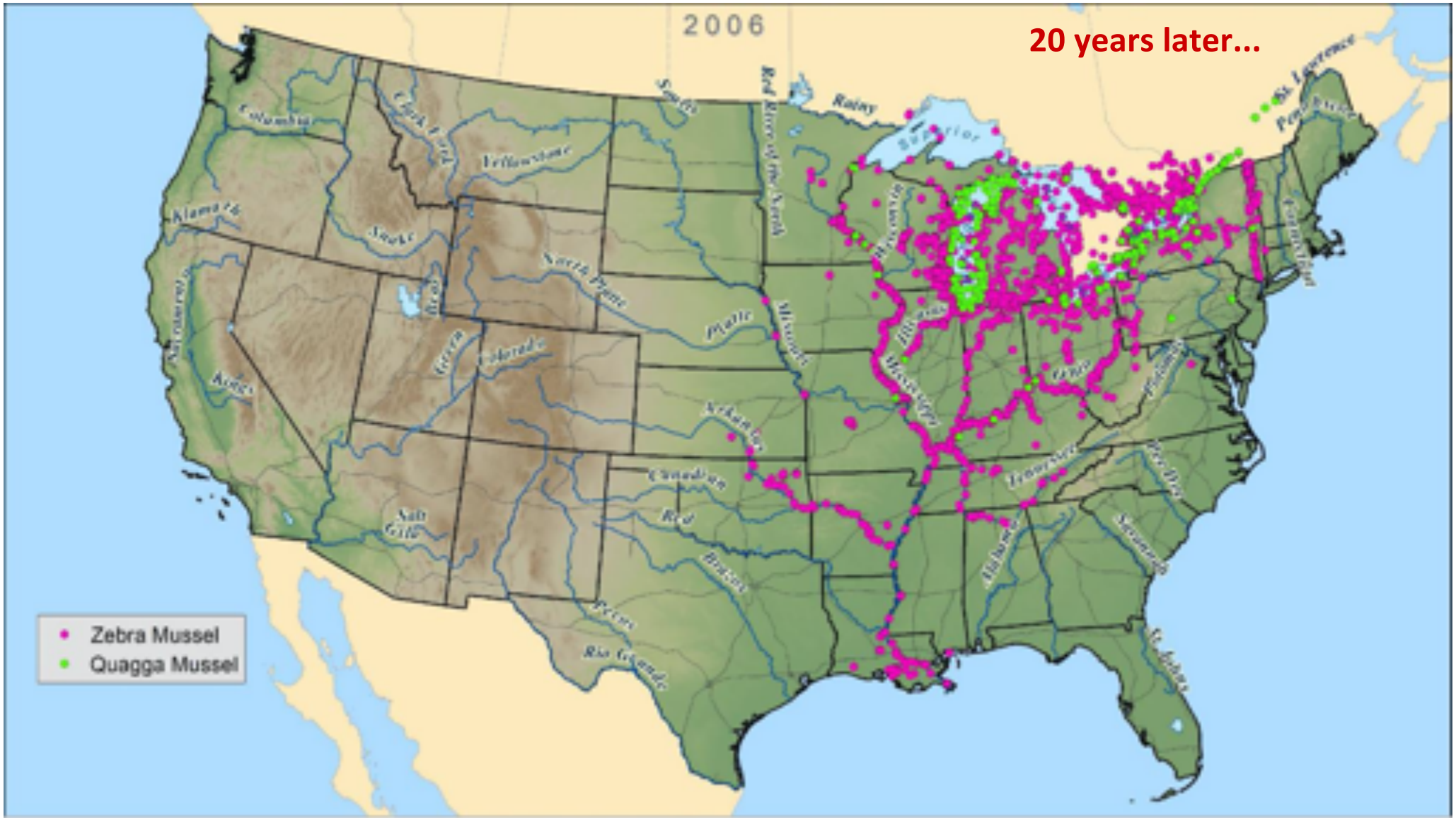

2001
15 years later...
Zebra Mussel
Quagga Mussel

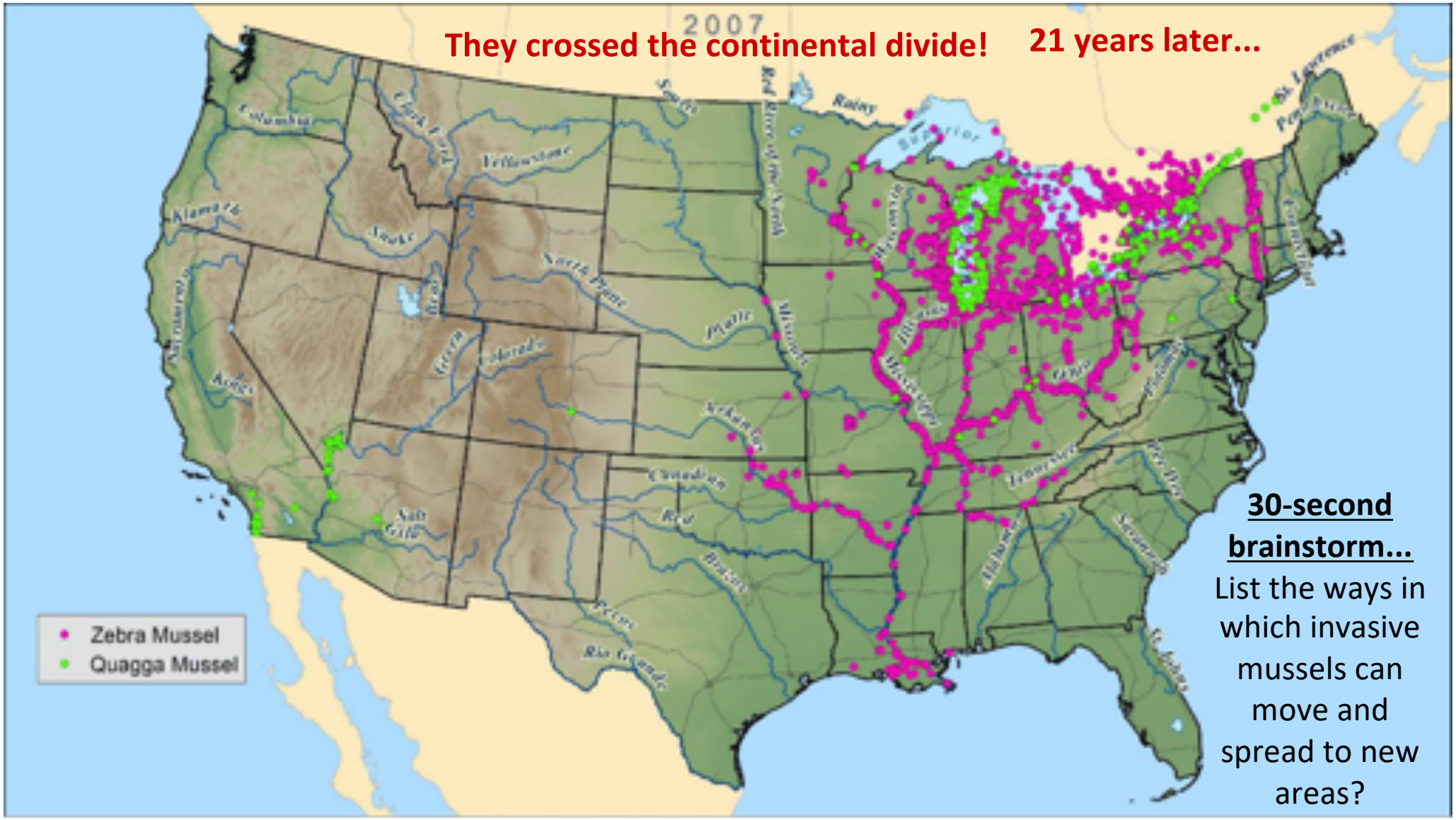

2002
Zebra Mussel
Quagga Mussel


2003
Zebra Mussel
Quagga Mussel


2004
Zebra Mussel
Quagga Mussel

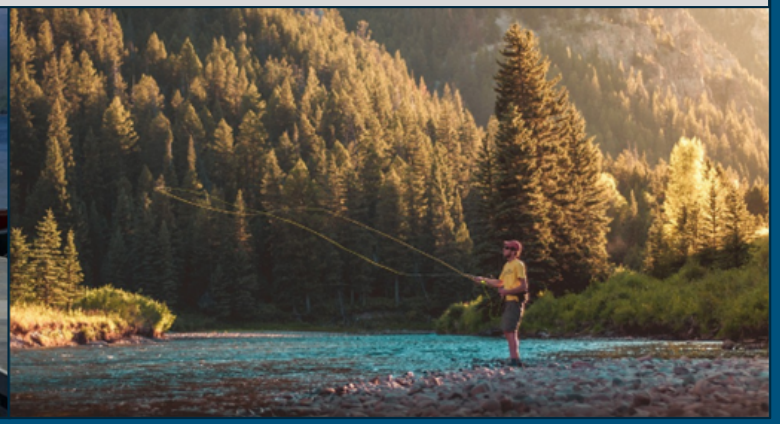

2005
Zebra Mussel
Quagga Mussel

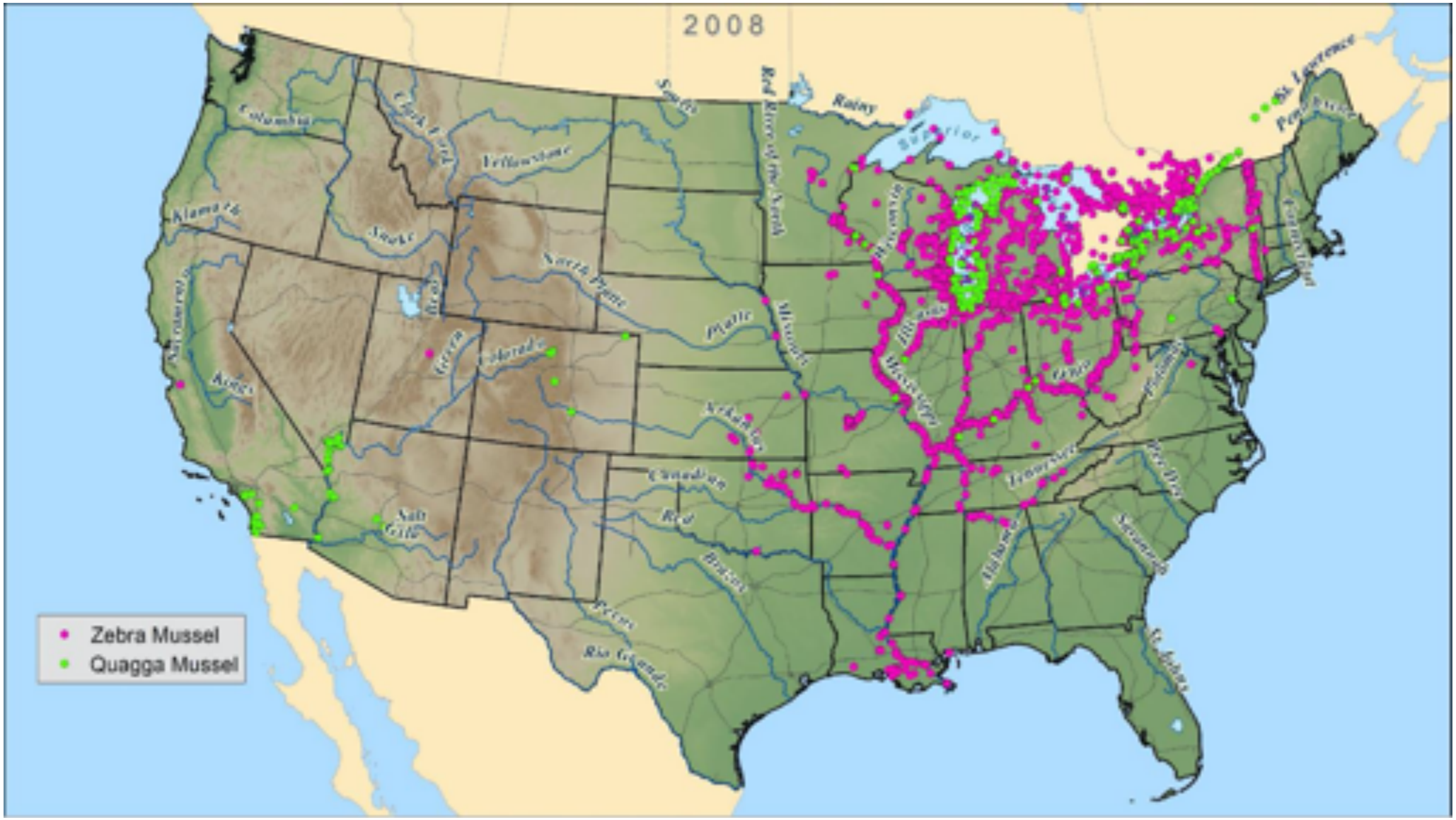

2006
20 years later...
Zebra Mussel
Quagga Mussel

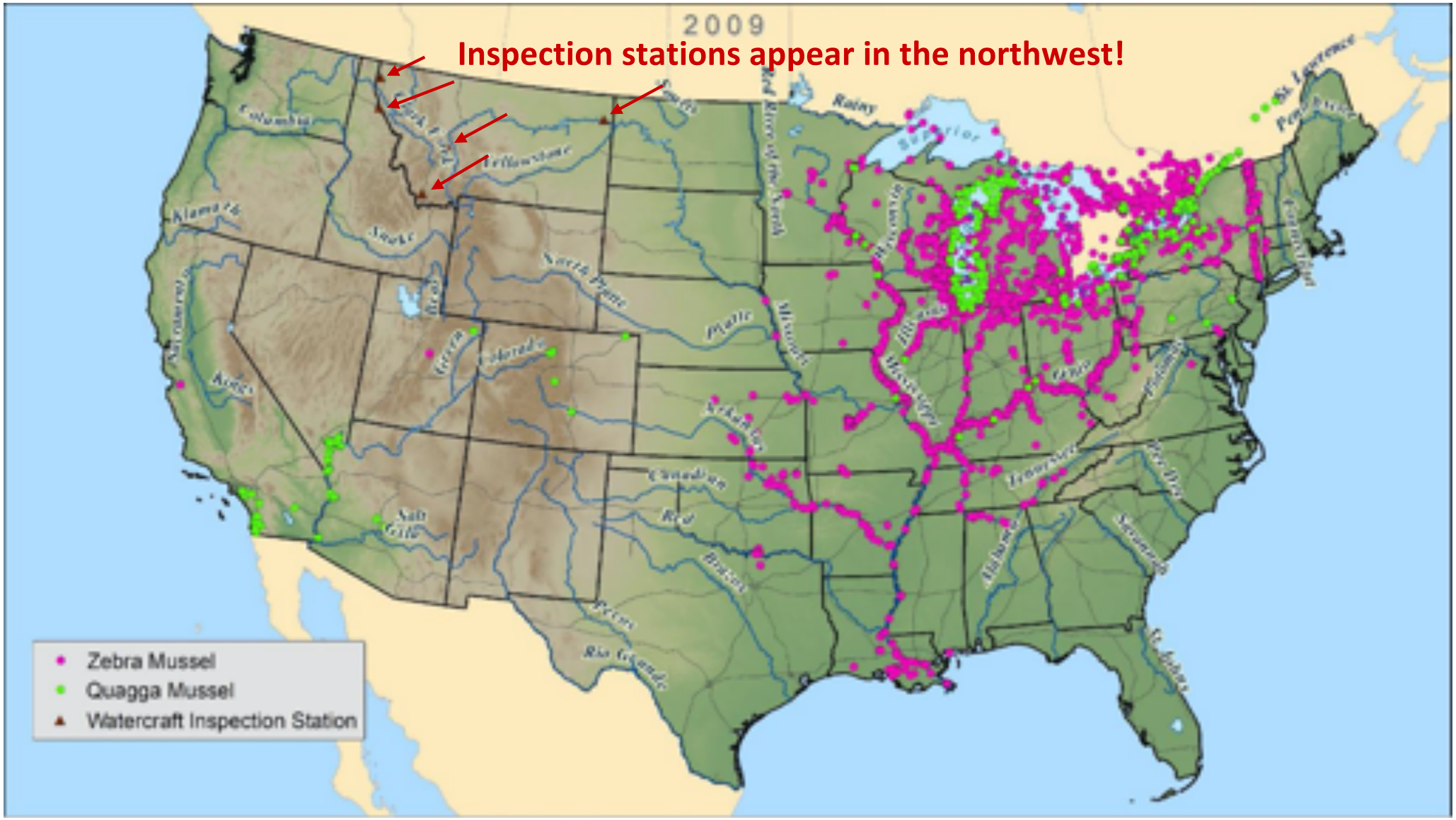

2007
They crossed the continental divide!
21 years later...
Zebra Mussel
Quagga Mussel
30-second brainstorm...
List the ways in which invasive mussels can move and spread to new areas?

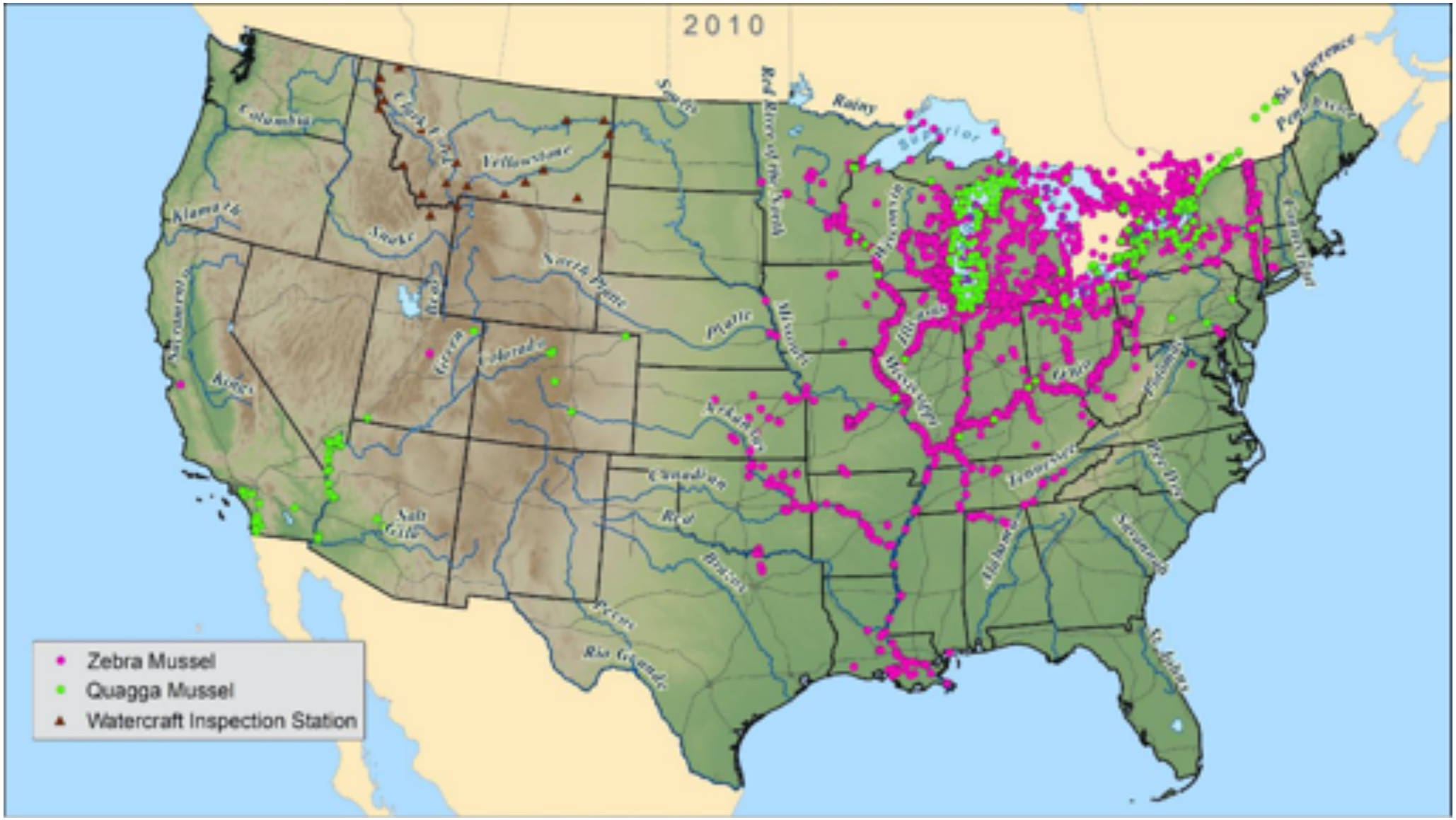
How Do Invasive Mussels Spread?

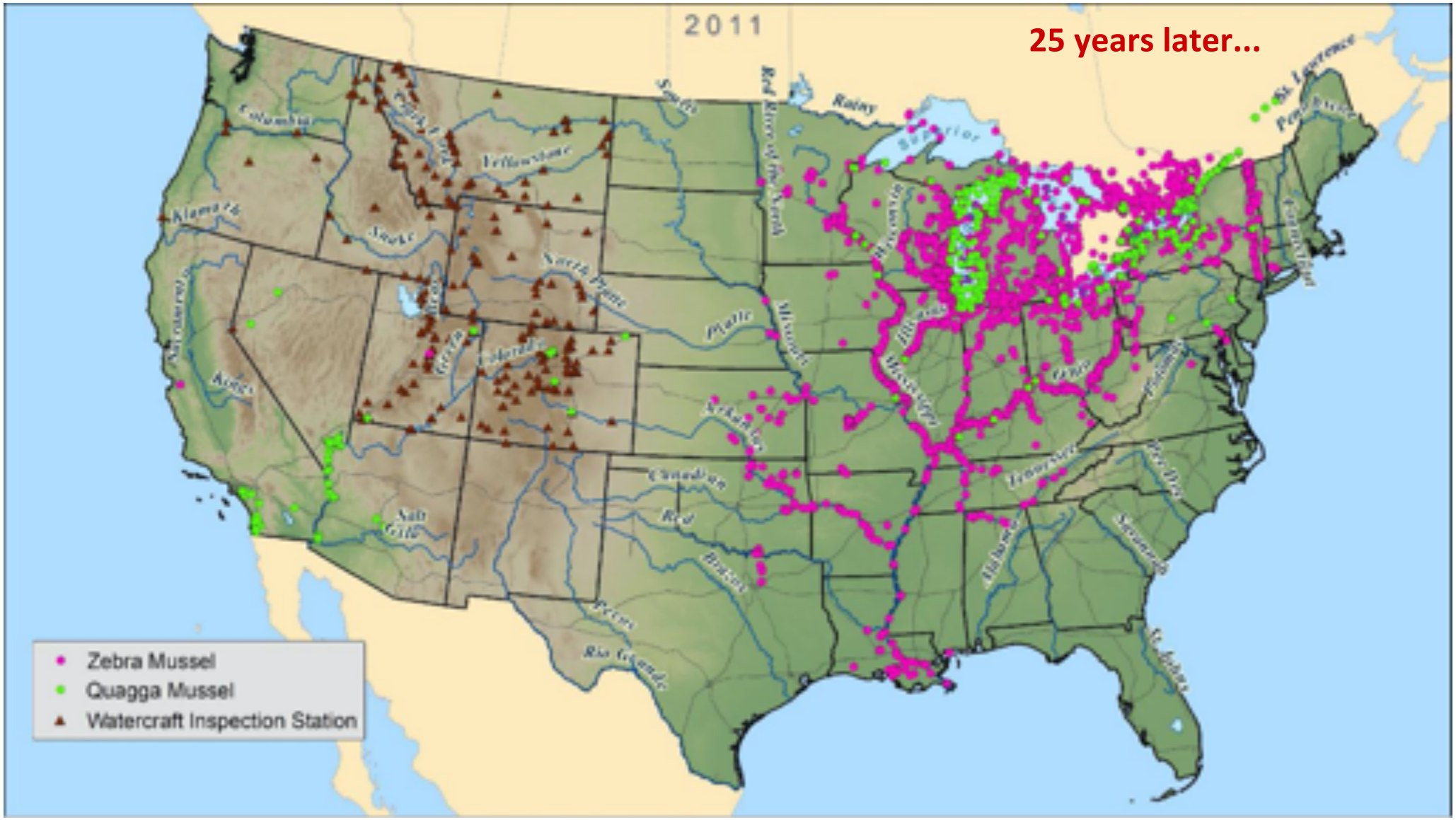
What do all of these photos have in common?

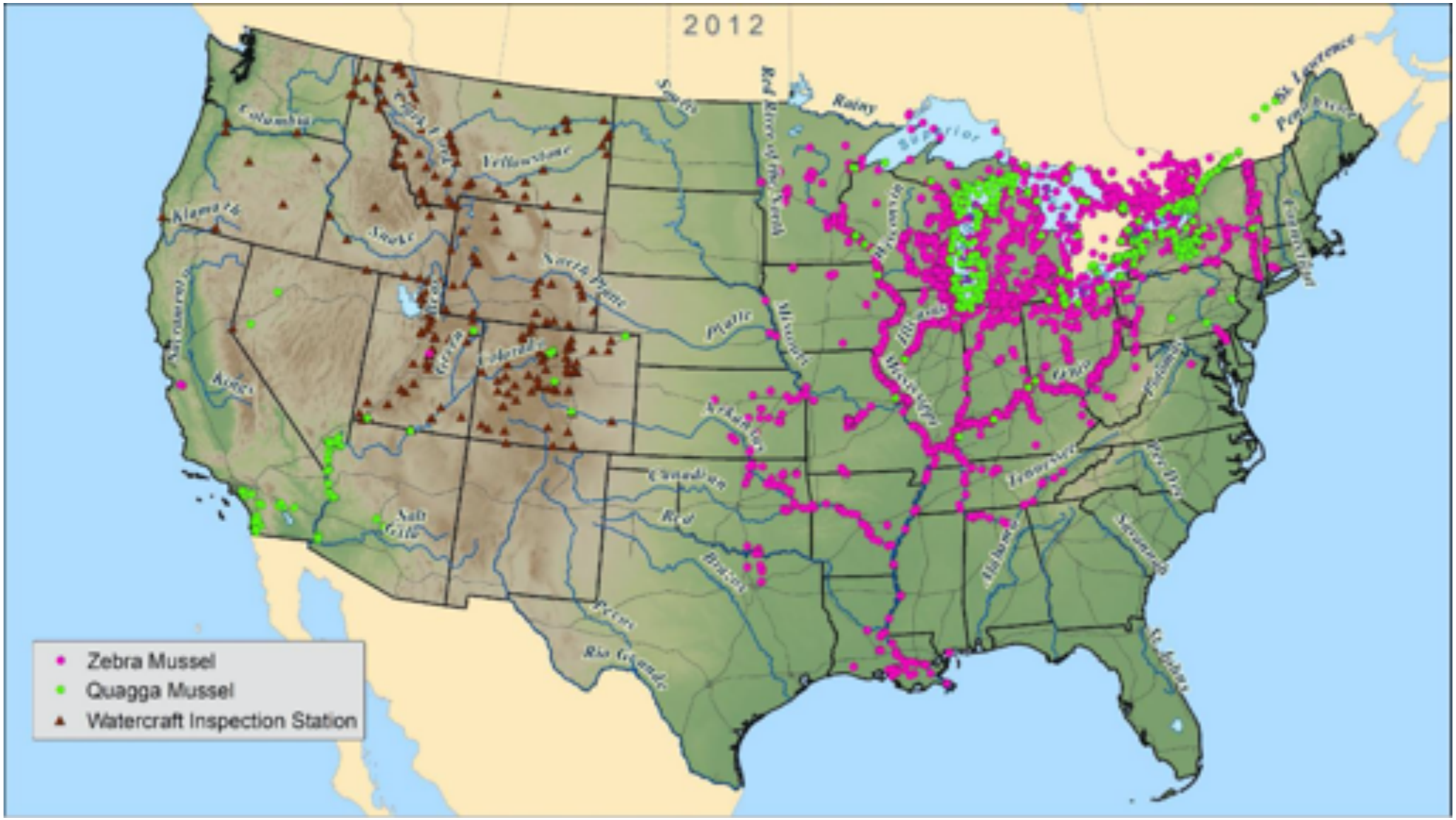


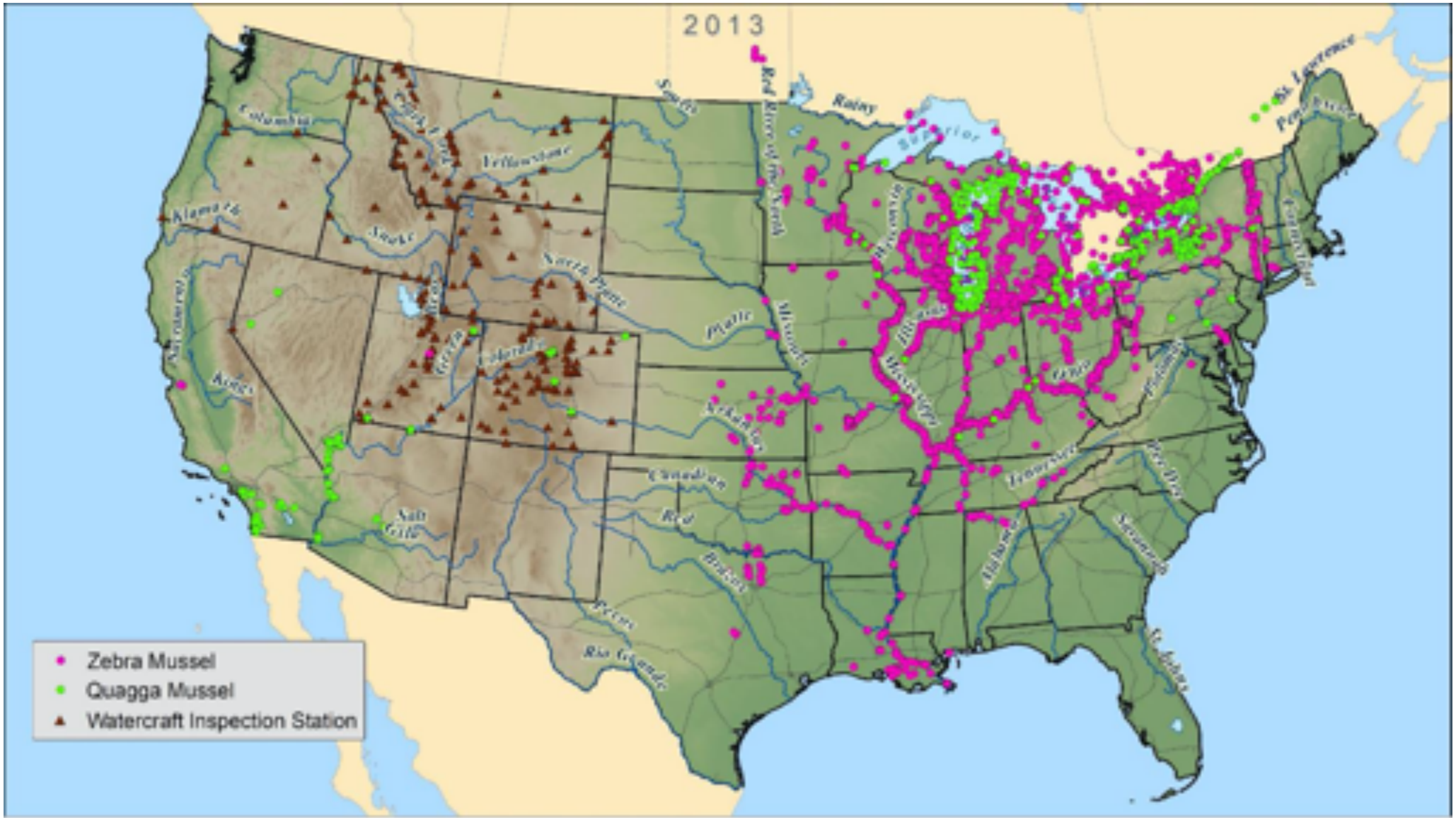

2008
Zebra Mussel
Quagga Mussel

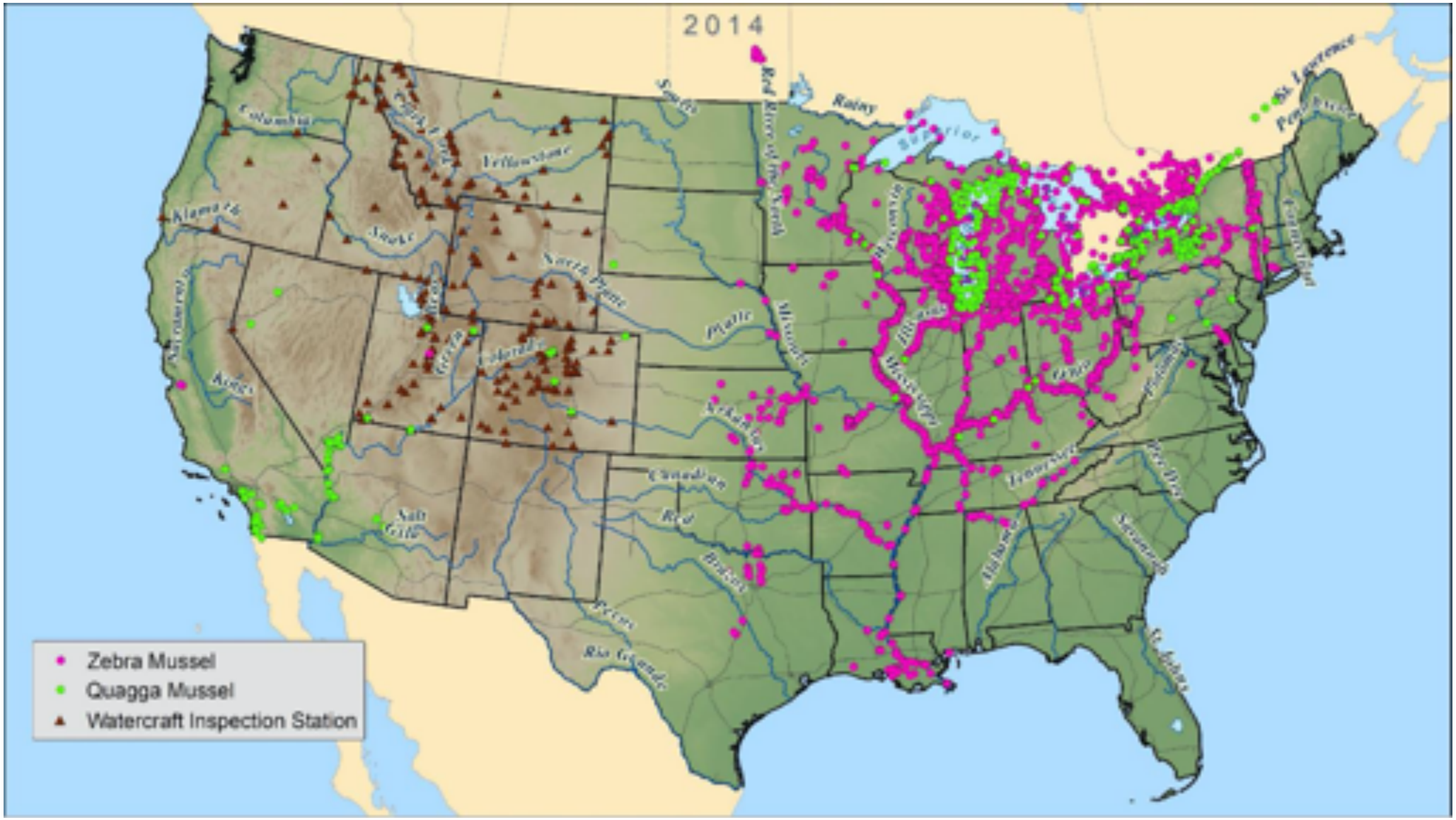

2009
Inspection stations appear in the northwest!
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station

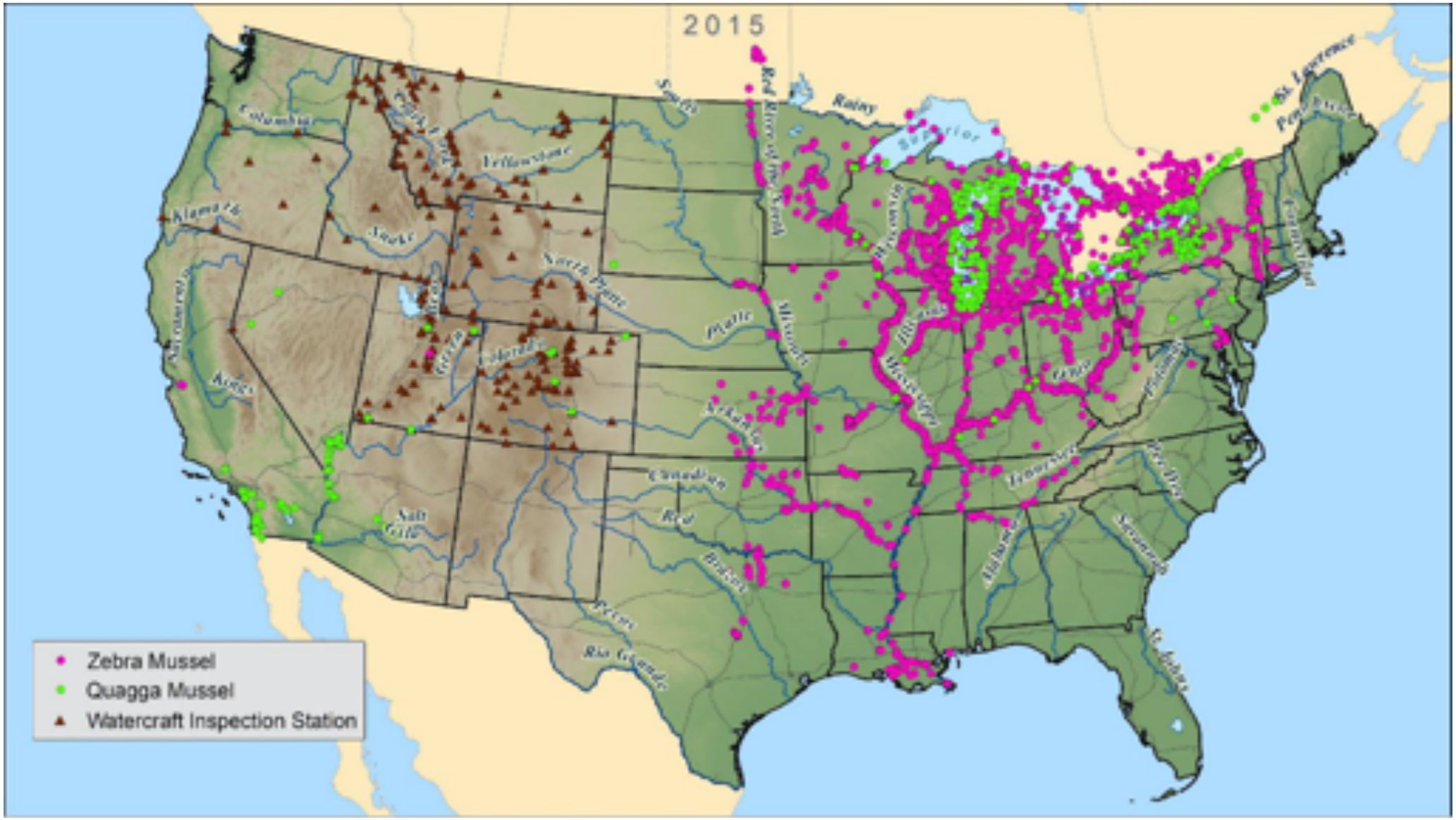

2010
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station

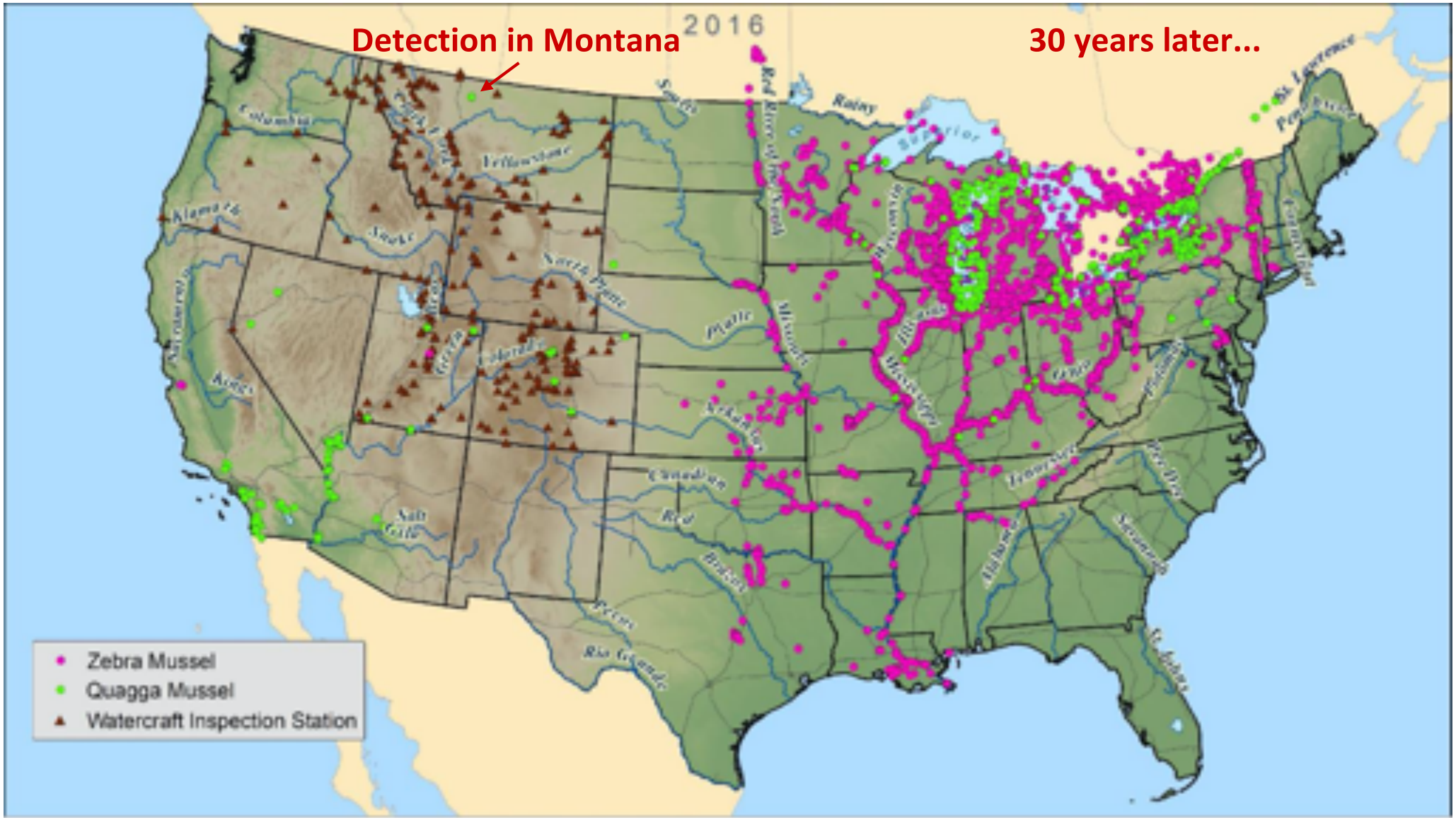

2011
25 years later...
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station

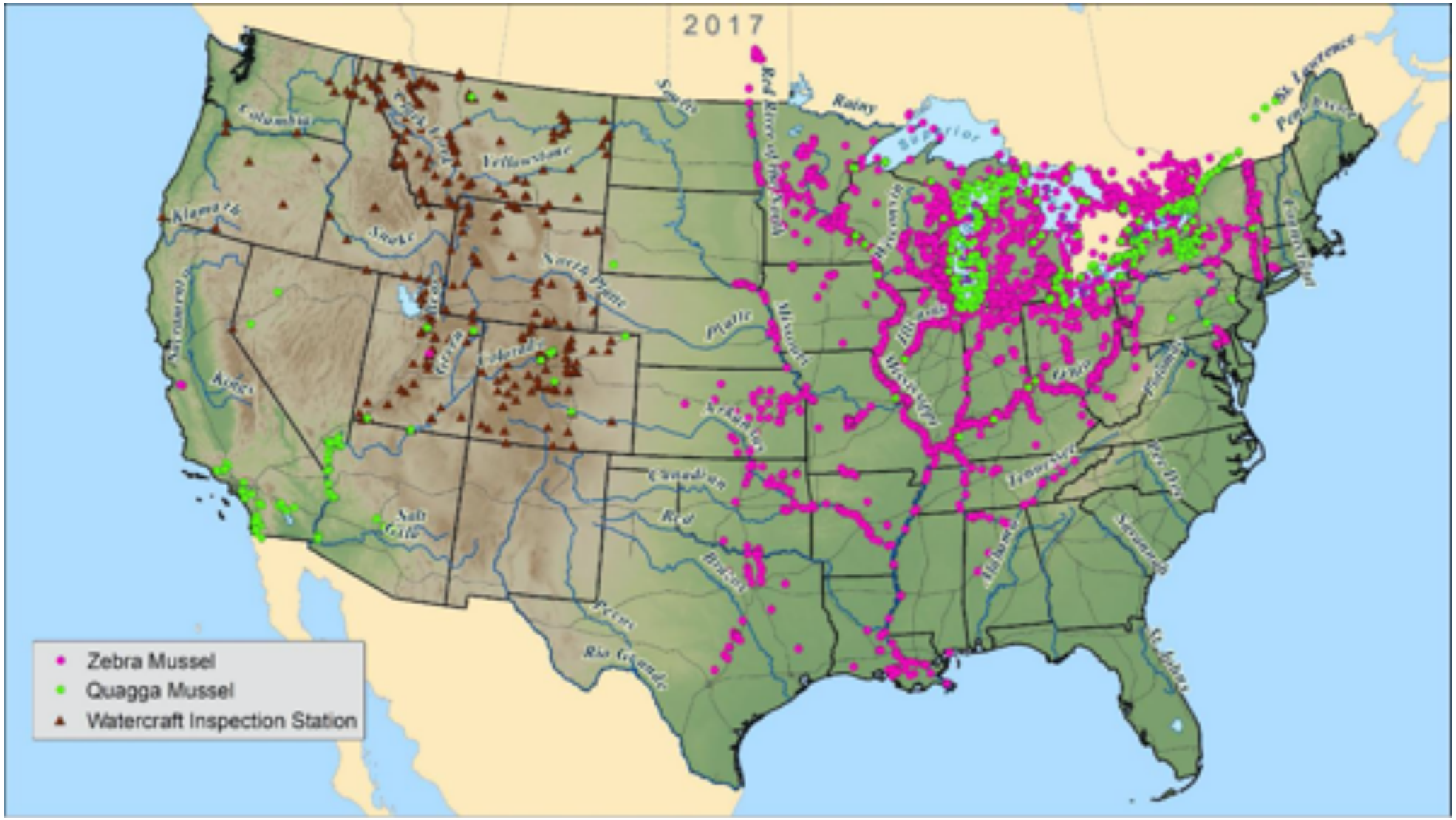

2012
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station

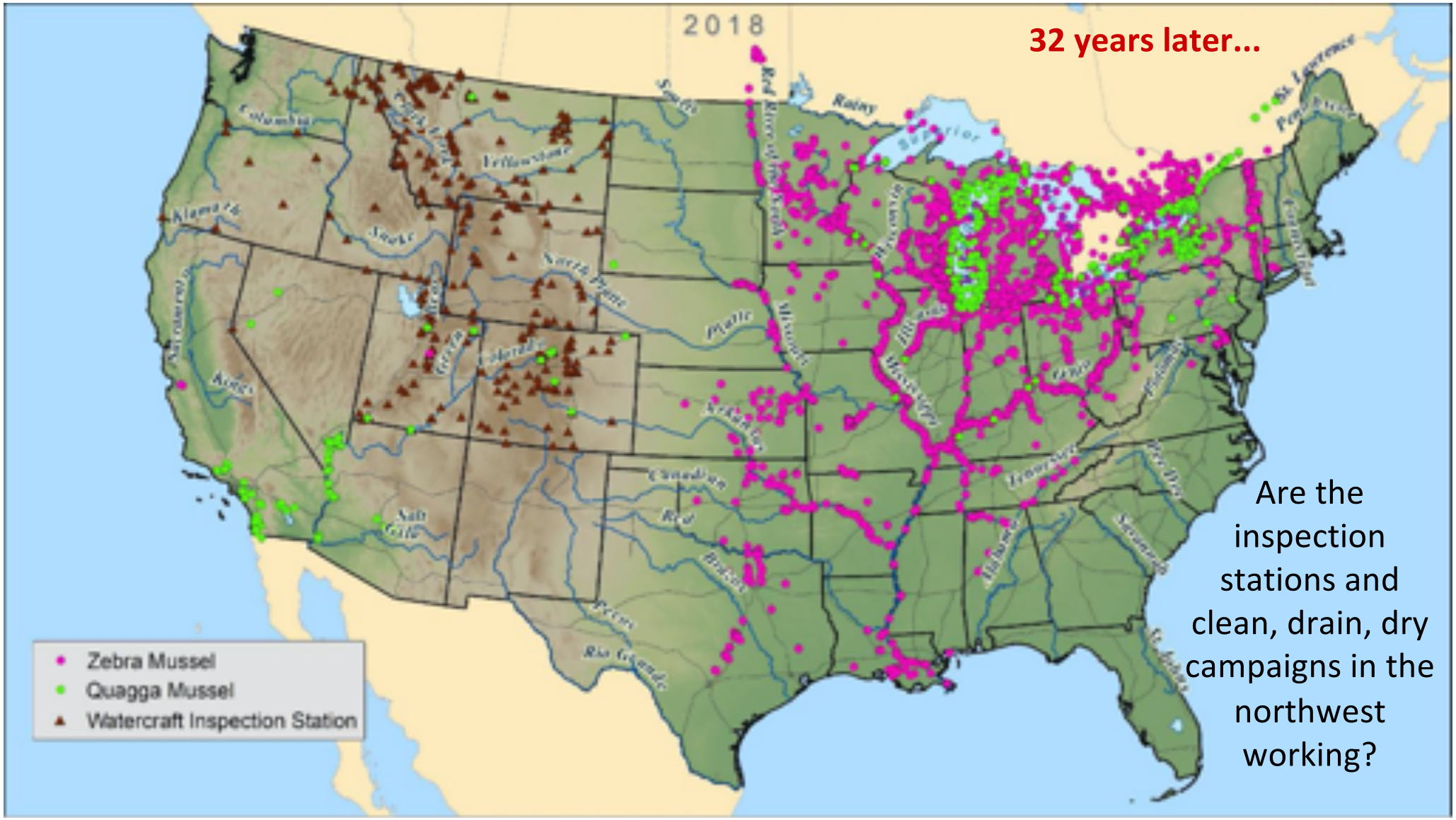

2013
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station

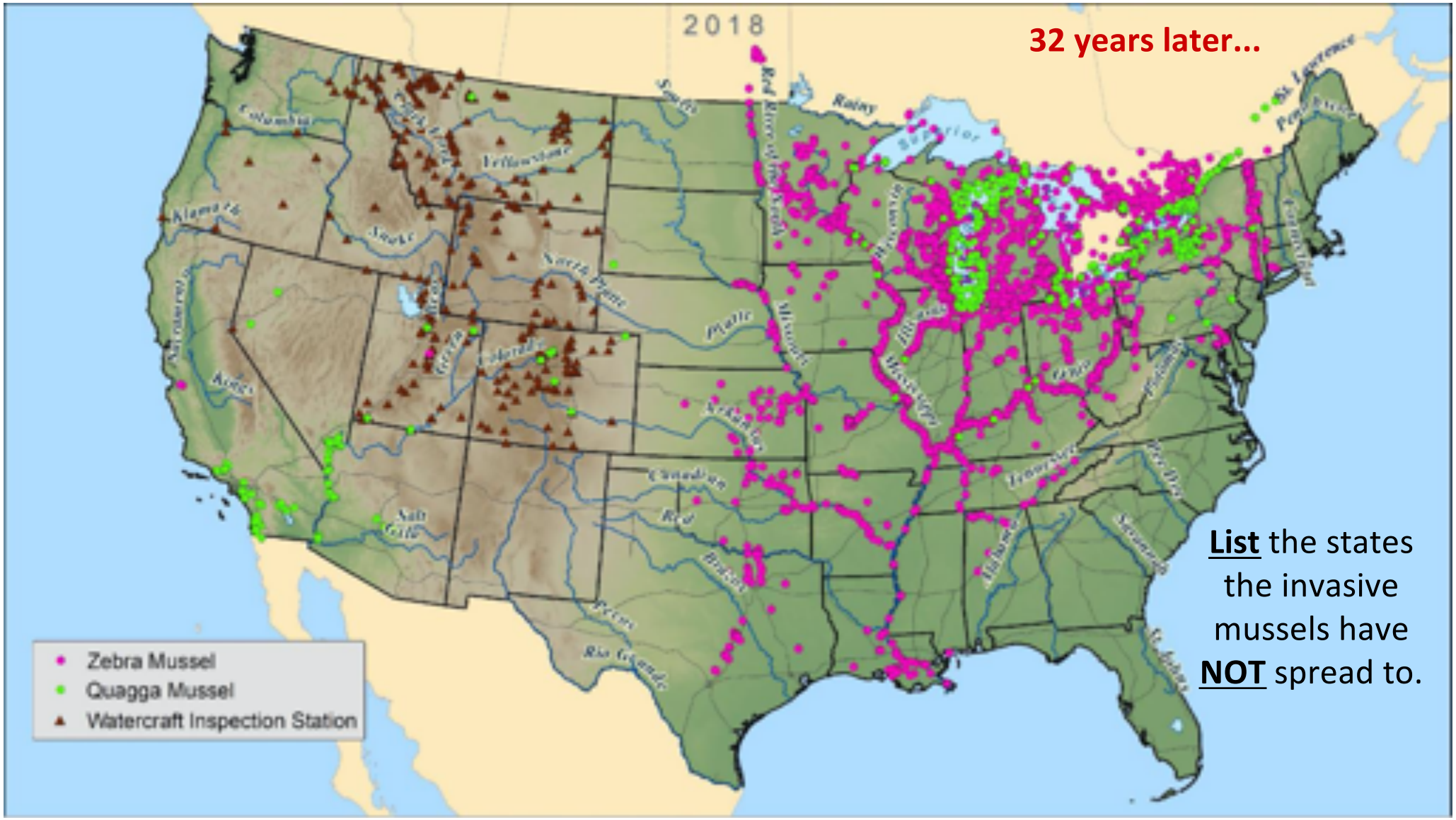

2014
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station


2015
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station


Detection in Montana
2016
30 years later...
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station


2017
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station


2018
32 years later...
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station
Are the inspection stations and clean, drain, dry campaigns in the northwest working?

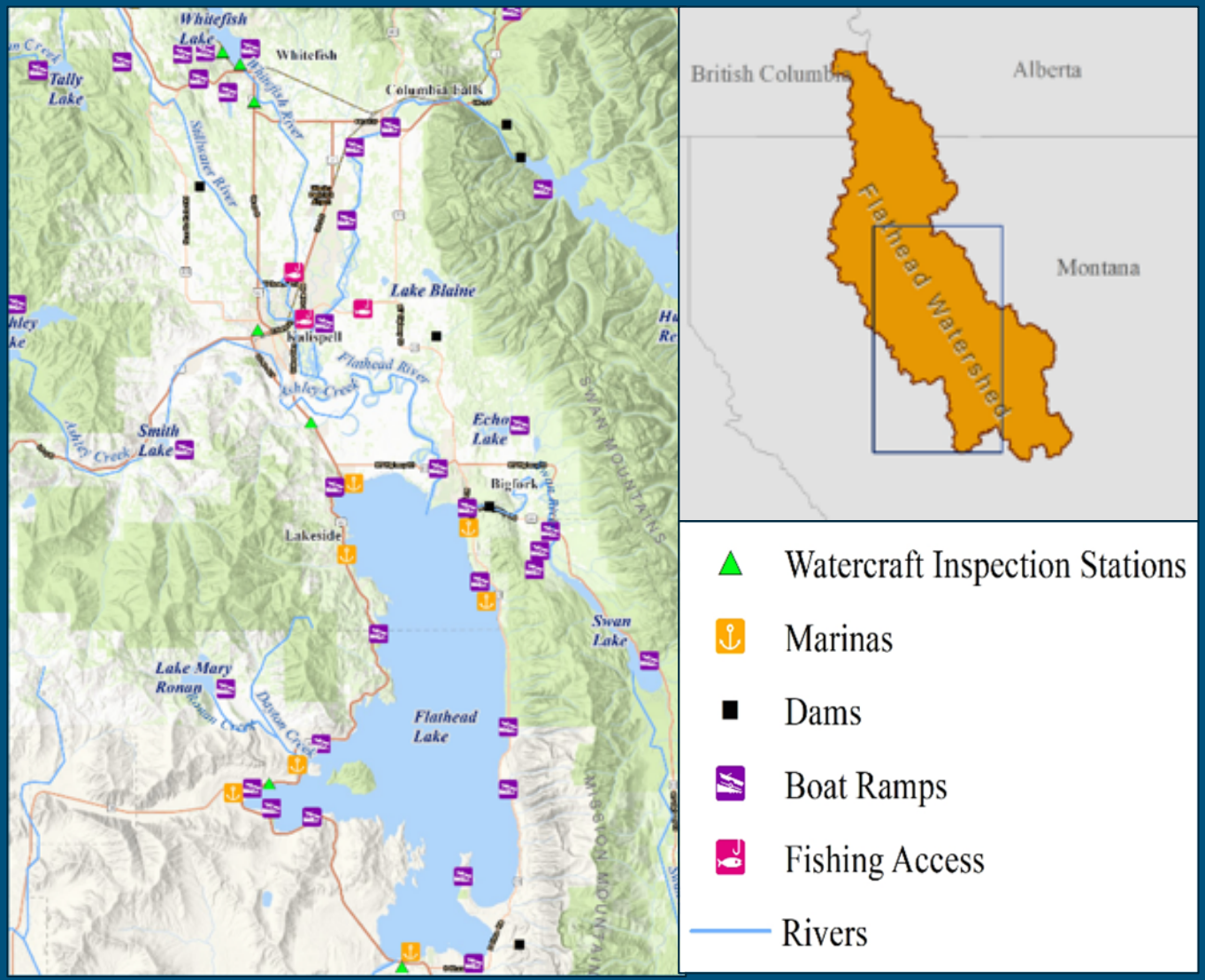

2018
32 years later...
Zebra Mussel
Quagga Mussel
Watercraft Inspection Station
List the states the invasive mussels have NOT spread to.


32 years later...
Mussels Eradicated
Mussels Failed
What are some **invasion barriers** that could cause a mussel invasion to fail?

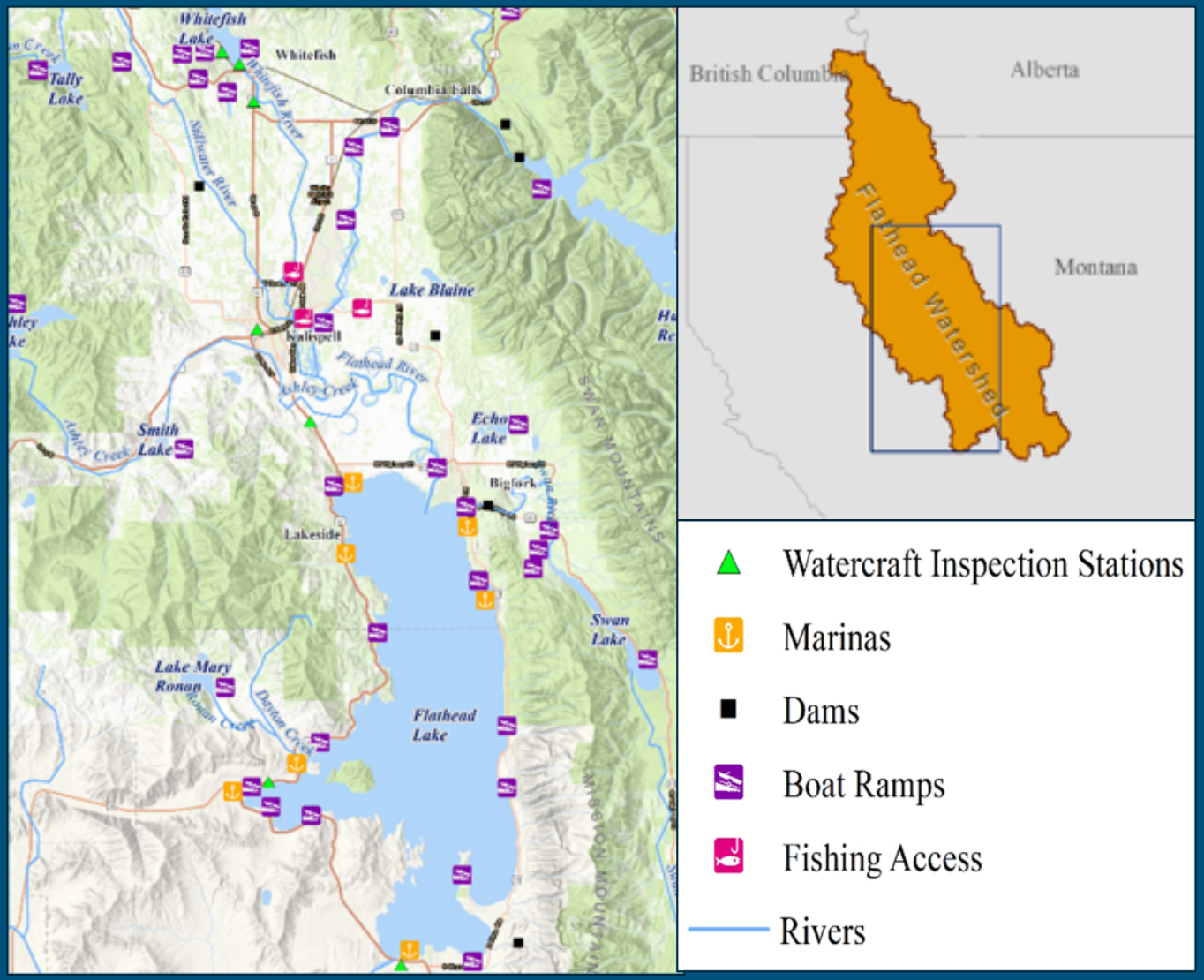
The Columbia River Basin is the last major watershed without invasive mussels!

A **river basin** or **watershed** is an area of land drained by a river and its tributaries to a common outlet.

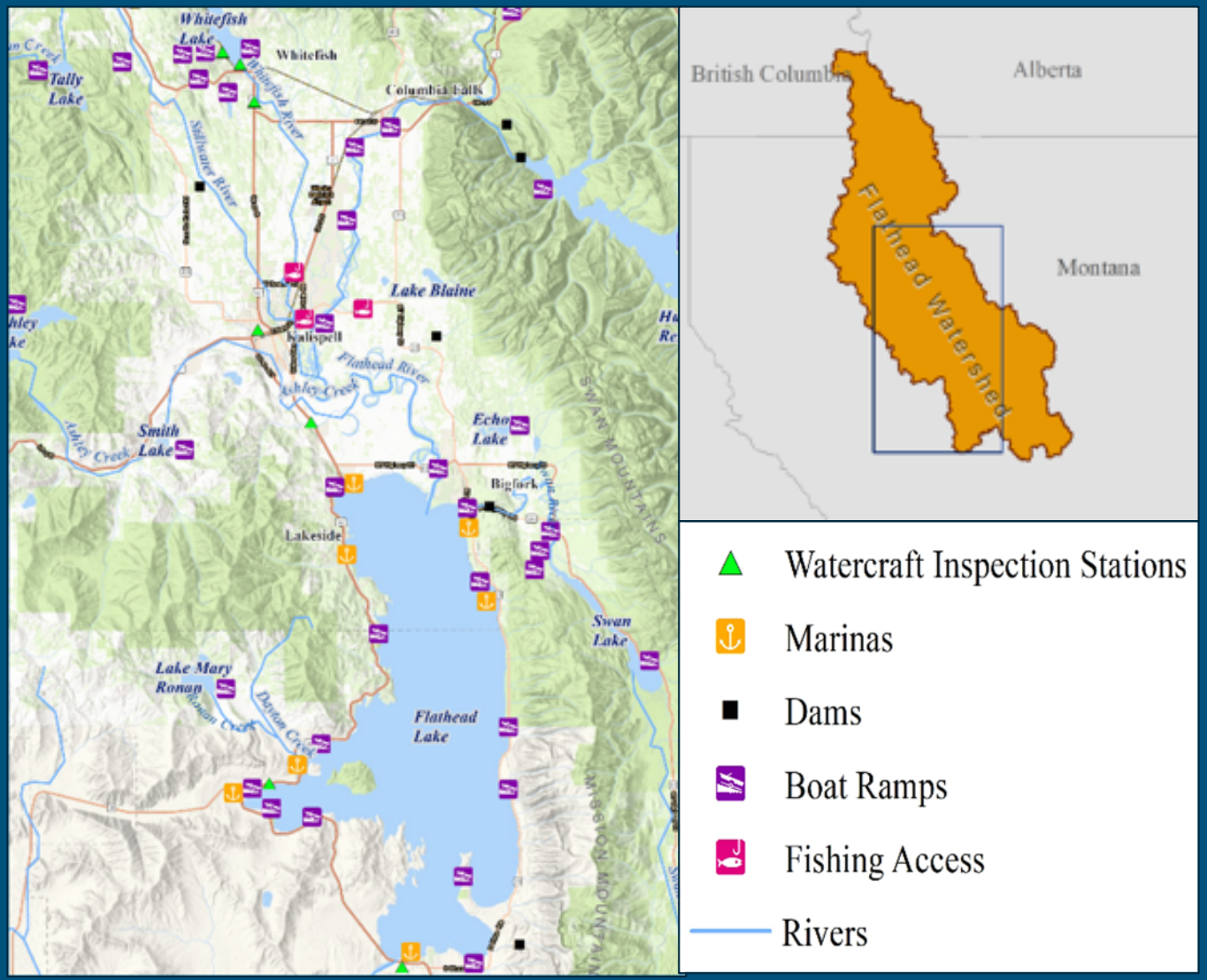
Select a **point of introduction** on the Flathead Region Map



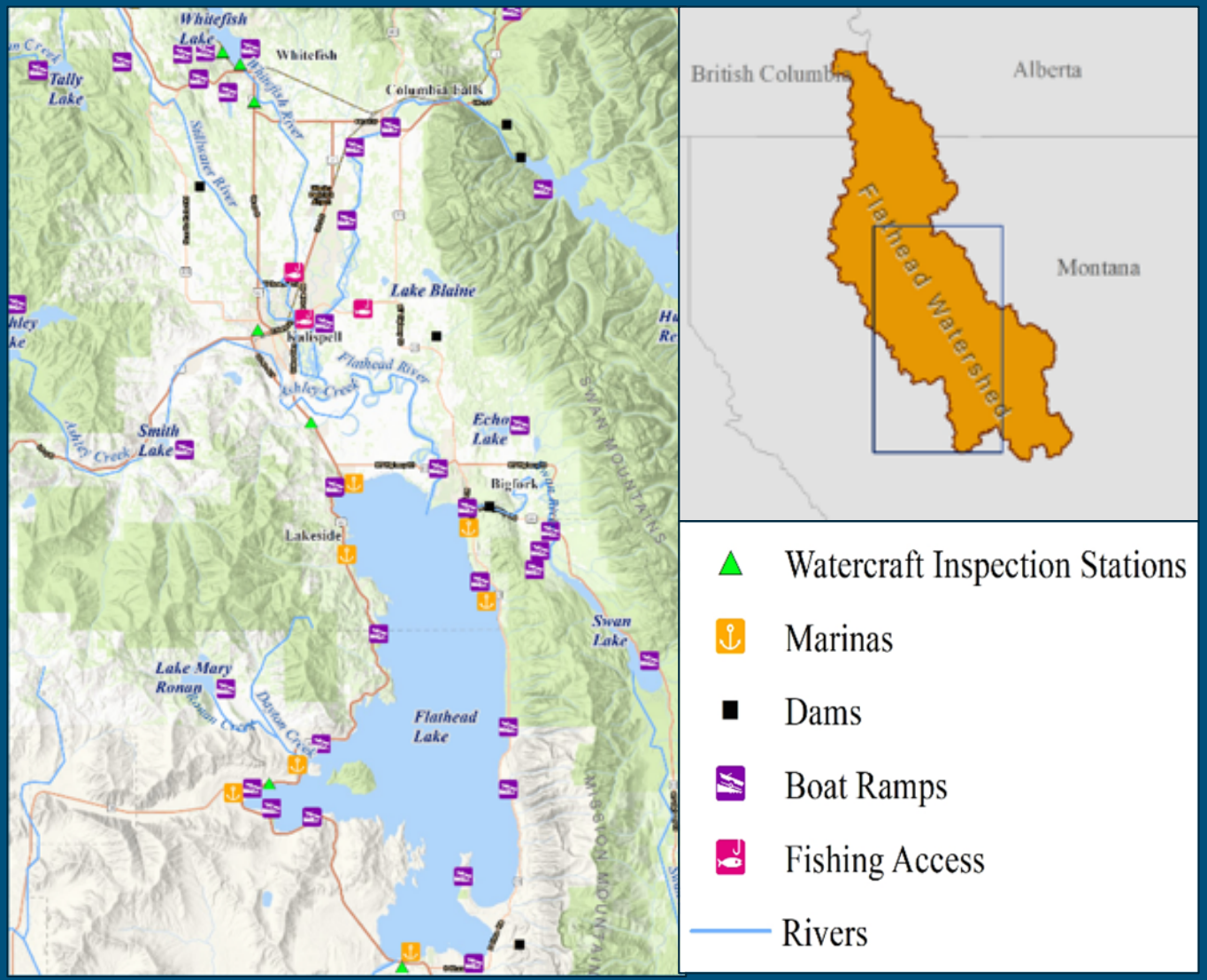
Describe **where** the mussels would disperse from that location.



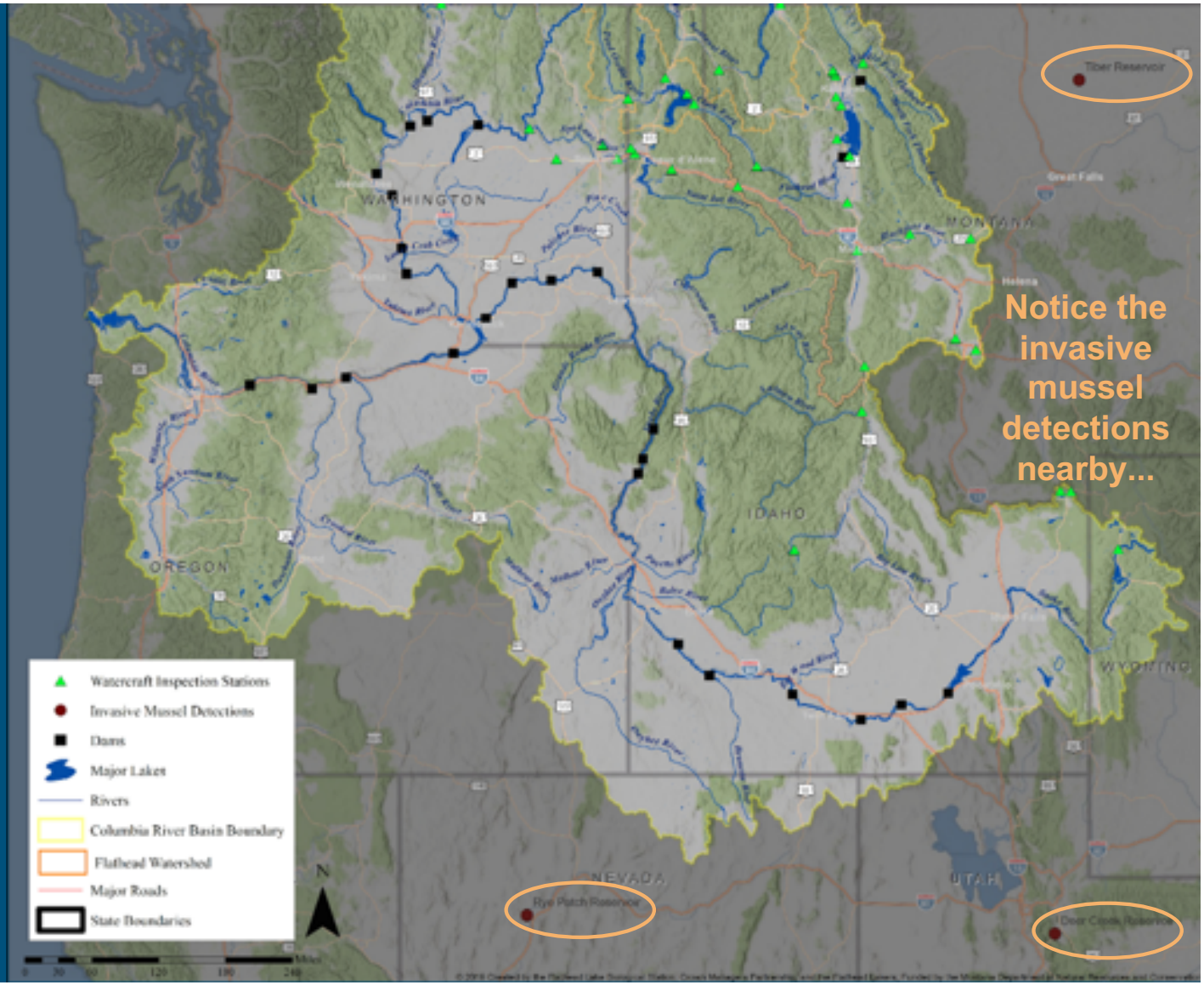
How could the **aquatic environment** of the Flathead Watershed be impacted by a mussel invasion?



Think of a **personal connection**… How could a mussel invasion impact someone you know?



Select a topic. Use the map to explain how the Columbia River Basin **economy** could be impacted by a mussel invasion?



We live near the headwaters of the Columbia River Basin...

Why should we care about a potential mussel invasion?

References

Slide #1: Map of invasive species threat by Jeffrey Dukes at Purdue University

Slide #2: Photo of zebra mussels on shell by Randy Westbrooks (Bugwood.org / Public Domain)

Slides #3-4: Photo of Black and Caspian Seas by Google Earth
Photo of Volga-Don Canal by Дмитрий Николенко (public domain)

Slide #5: Photo of quagga mussels by Great Lakes Environmental Research Laboratory (CC BY-SA 2.0)

Slide #6: Photo of zebra mussels on posts by thirdwavephoto (Wikimedia Commons / CC BY 4.0)
Photo of mussels on propeller by NPS (public domain)
Diagram of zebra vs. quagga mussels by Minnesota Sea Grant (photos by John Karl)

Slide #7: Drawing of cargo ship by Holly Church at FLBS (2019)
Slide #8: Diagram of Great Lakes by On The World Maps
Slide #11: Diagrams of the ports along the Great Lakes by the Chamber of Marine Commerce

References

Slide #31: Photo of paddle boarder by U.S. Dept. of Agriculture (Wikimedia Commons)
Photo of water skier by Isiwal (Wikimedia Commons / CC BY-SA 4.0)
Photo of boats at Lake McDonald by David Restivo (Wikimedia Commons / CC BY-2.0)
Photo of fly fisherman by Paul Nute (Wikimedia Commons / CC0 1.0)

Slides #8-30/32-44: Mussel detection maps by Natalie Poremba/FLB

Slide #45: Photo of Columbia River by U.S. Forest Service (Wikipedia Commons)

Slides #46-49: Flathead Lake Region map by Natalie Poremba/FLBS

Slide #50: Columbia River Basin map by Natalie Poremba/FLBS

Slide #51: Photo of zebra mussels on shell by Randy Westbrooks (Bugwood.org / Public Domain)