# A Bold New Research Path to Controlling Dreissenids throughout Entire Water Bodies

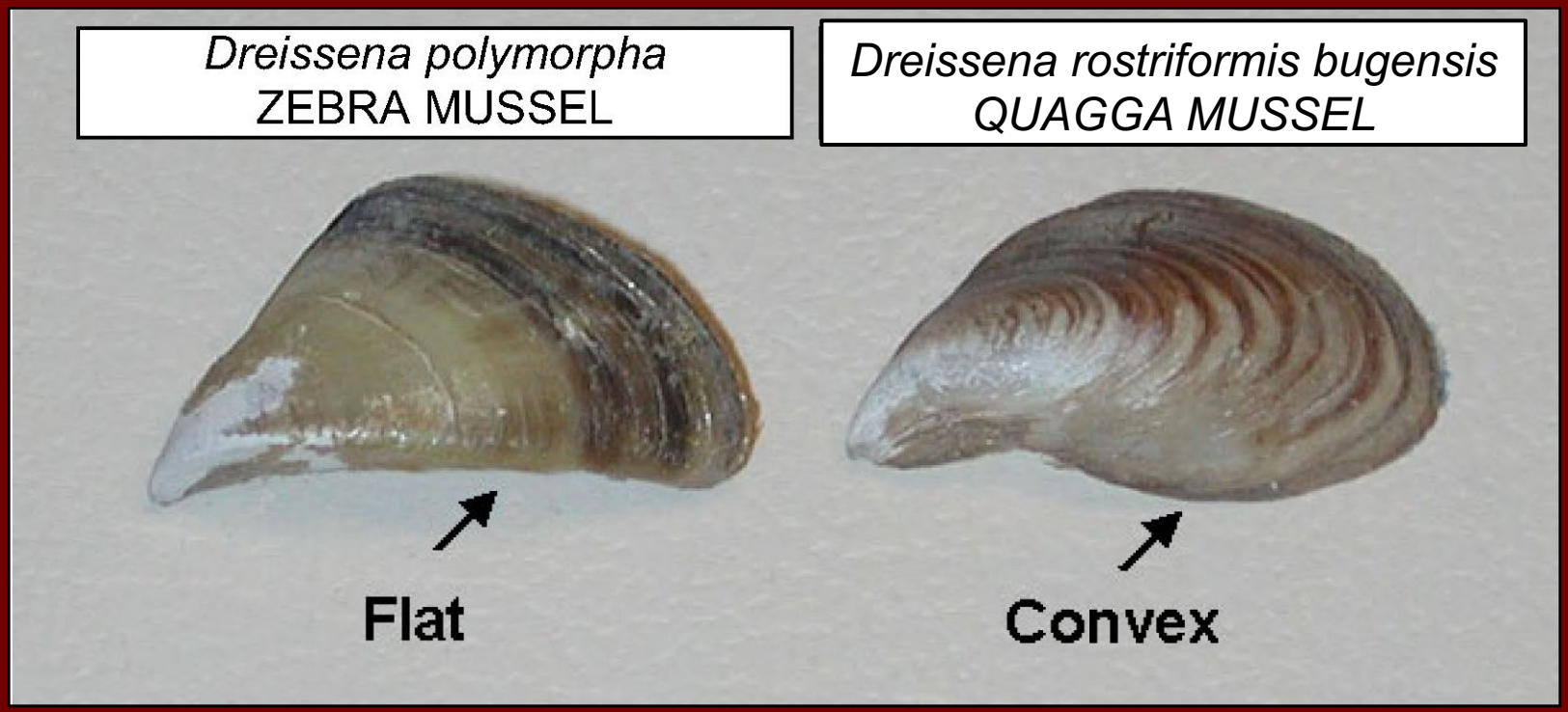
**Daniel P. Molloy, PhD**

**University of Illinois – Natural History Survey**
**State University of New York – Great Lakes Center at Buffalo**
**Molloy & Associates, LLC**

**January 22, 2020**
**Columbia River Basin Team Meeting**
**Portland, Oregon**

# Project Funding Acknowledgement

# Bold, unconventional, outside the box" approach for controlling dreissenids lake-wide



# We envision a control approach that will work not only in small lakes…..

# ….but also even throughout the Great Lakes *!!*

….but also even throughout the Great Lakes *!!*

Yes, if our research is successful, its impact could be that huge

# ……. throughout the entire Columbia River Basin


Developed for the exhibit *River of Memory: The Everlasting Columbia 2006-2008* by the King County GIS Center. ©2006 Wenatchee Valley Museum & Cultural Center, Wenatchee, Washington.

Did you ever wonder …

Did you ever wonder …

*“Why aren’t lake associations across North America treating their lakes for Dreissena mussel control ?”*

Did you ever wonder …

*“Why aren’t lake associations across North America treating their lakes for Dreissena mussel control ?”*

Here’s why…..

Treating an entire large water body is currently:

- Too expensive

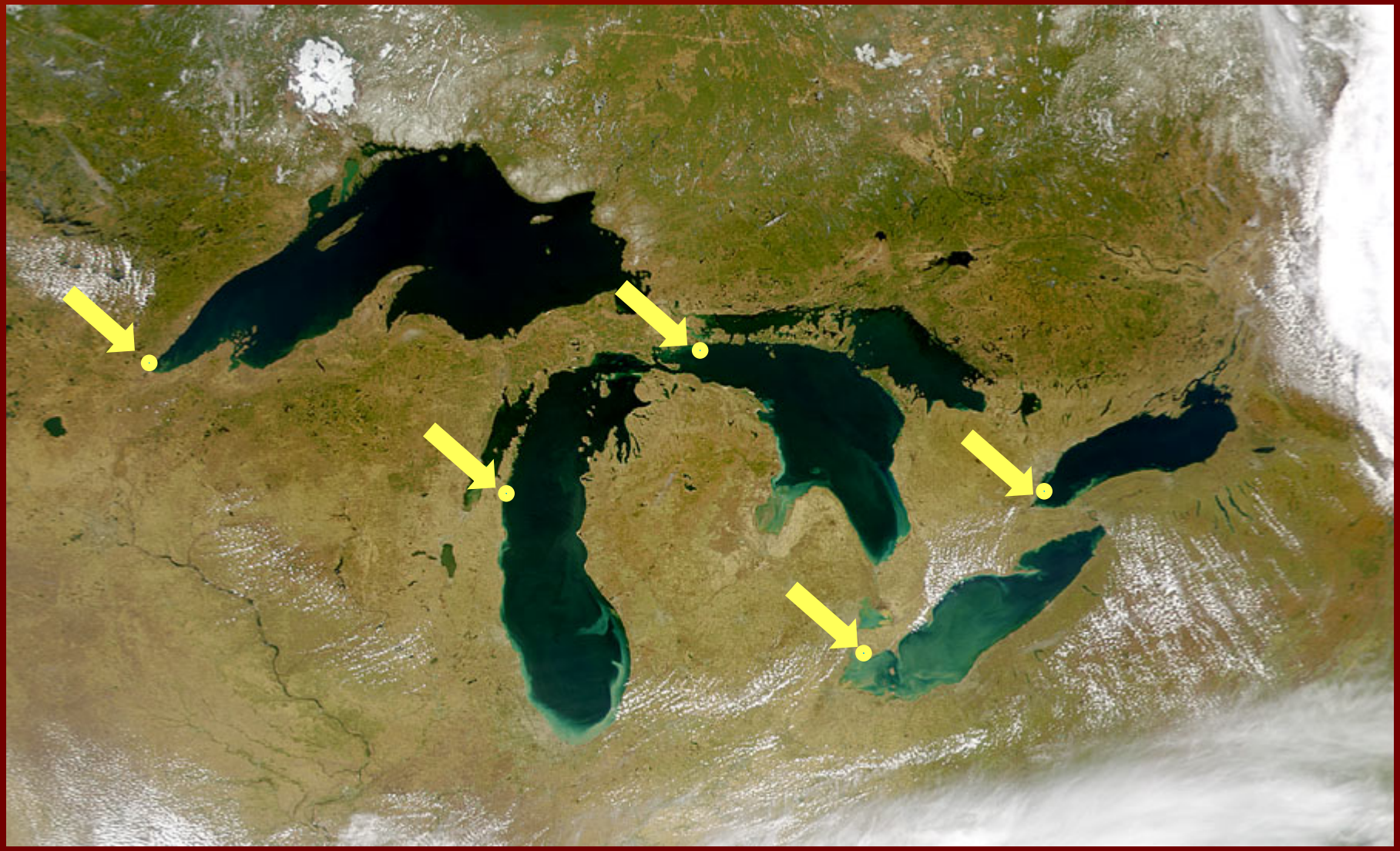
and/or

- Too environmentally degrading

To be economically feasible a control agent ideally must be:

To be economically feasible a control agent ideally must be:

-- applied only in a small part of the water body

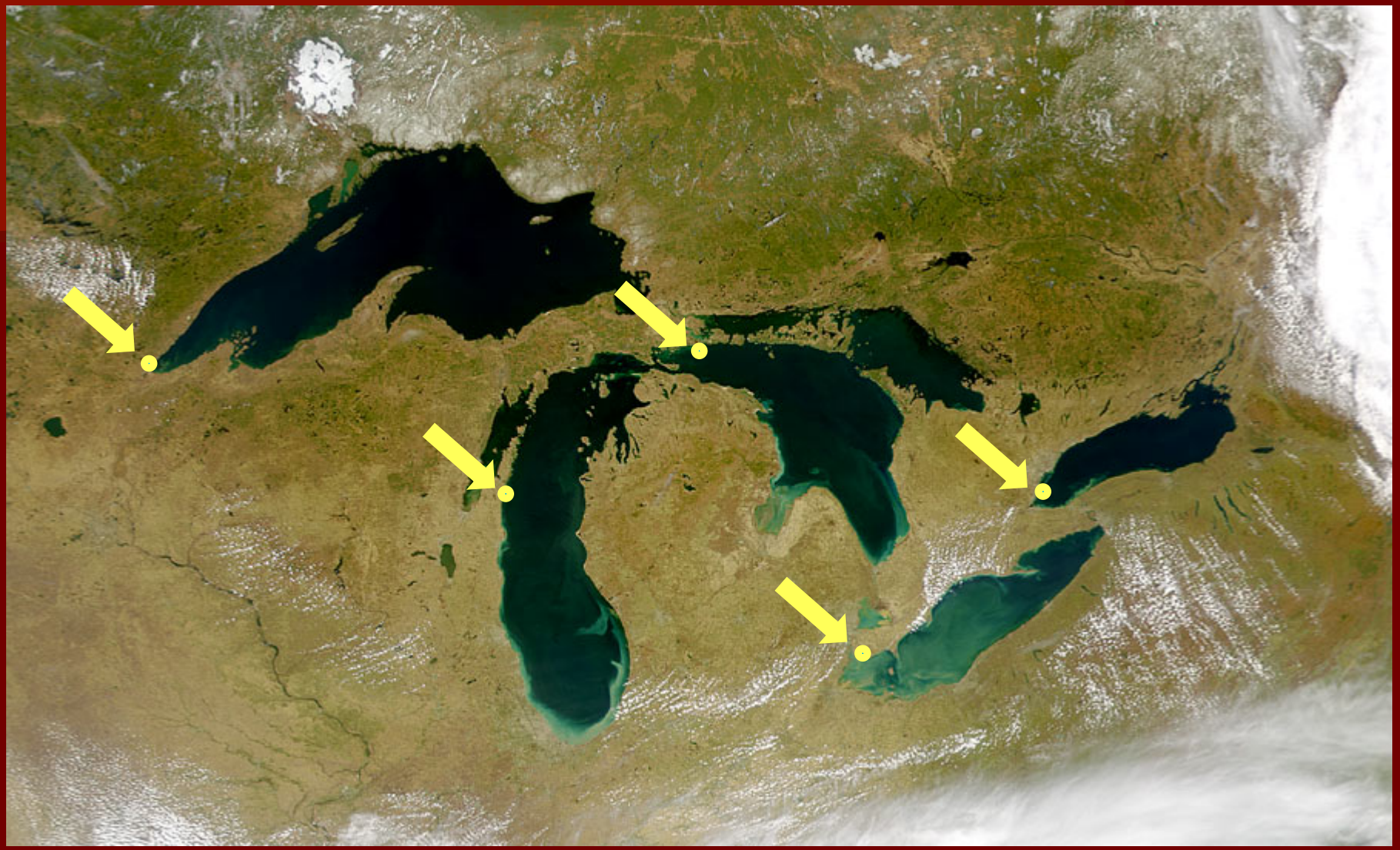


Our control agent will be applied to only a **small** part of a (not the entire) water body, resulting in significant savings

To be economically feasible a control agent ideally must be:

-- applied only in a small part of the water body

-- self-perpetuating



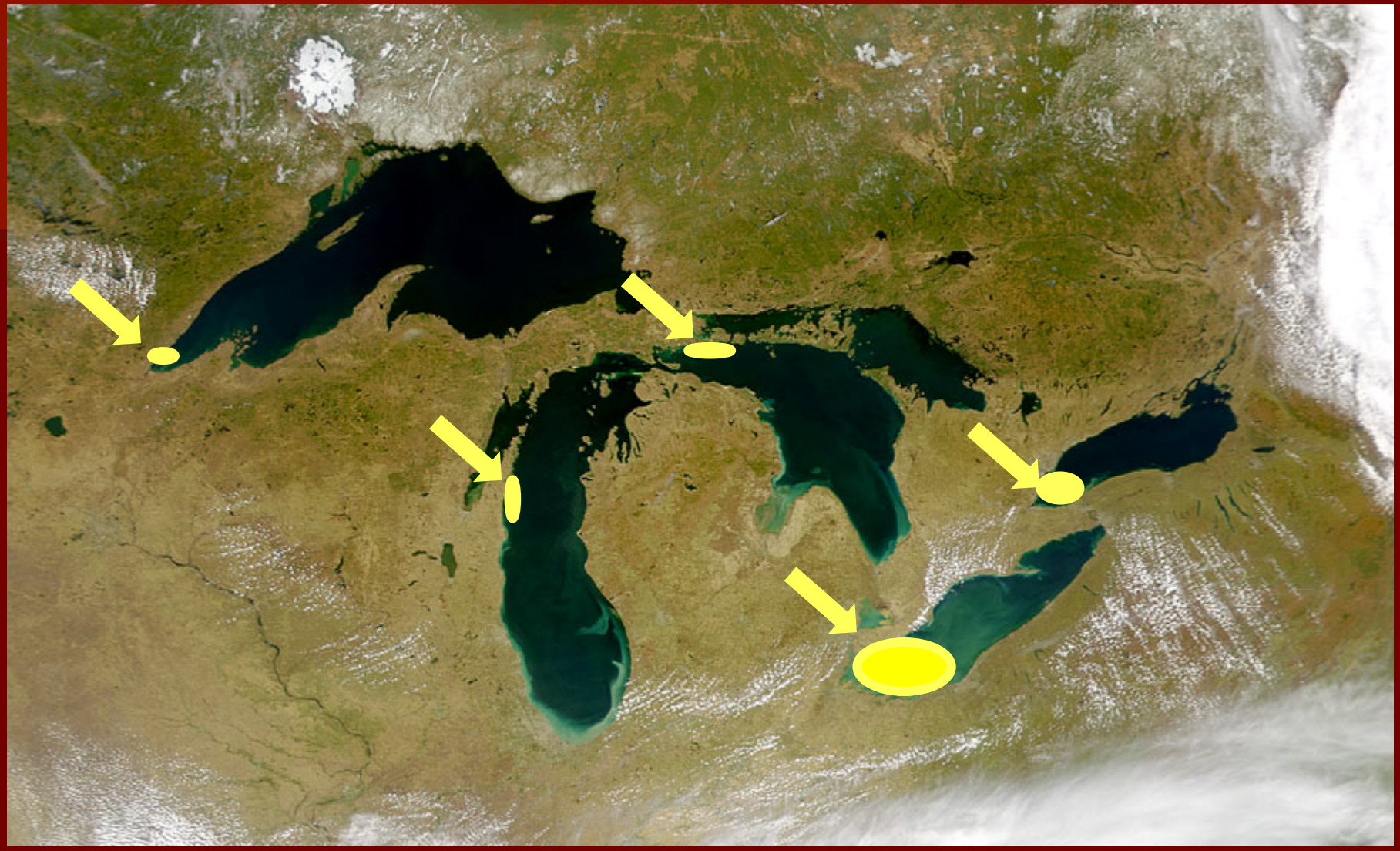
Our control agent will be **self-perpetuating** -- killing mussels from year to year and not requiring reapplications, resulting in significant savings

To be economically feasible a control agent ideally must be:

-- applied only in a **small part of the water body**

-- **self-perpetuating**

-- self-spreading



Our control agent will be **self-spreading** -- killing mussels elsewhere throughout the lake on its own, resulting in significant savings

To be economically feasible a control agent ideally must be:

-- applied only in a small part of the water body

-- self-perpetuating

-- self-spreading

Our control agent will be **LIVE** – the only kind of control agent capable of self-perpetuating and self-spreading

To be economically feasible a control agent ideally must be:
-- applied only in a small part of the water body
-- self-perpetuating
-- self-spreading

Our control agent will be **LIVE** – the only kind of control agent capable of self-perpetuating and self-spreading

Since it's **LIVE**, it's a **BIOCONTROL** agent…
……but what kind of biocontrol agent…???

The biocontrol agent will be a **PARASITE**

## The biocontrol agent will be a **PARASITE**

…. because among all types of natural enemies,

parasites are the most host-specific killing agents

The biocontrol agent will be a **PARASITE**

…. because among all types of natural enemies,

parasites are the most host-specific killing agents

…. and HOST-SPECIFICITY is the MOST IMPORTANT

characteristic of any candidate biocontrol agent

This project is an extremely ambitious one

This project is an extremely ambitious one

This project is an extremely challenging one

This project is an extremely ambitious one

This project is an extremely challenging one

But I am confident there is a parasite already existing in nature that could be this future biocontrol agent

This project is an extremely ambitious one

This project is an extremely challenging one

But I am confident there is a parasite already existing in nature that could be this future biocontrol agent

But will we be able to find it?

That is our greatest challenge *!*

So where have we concentrated on looking to find this parasite…. this potentially extraordinary control agent?


Area in past that we have focused on looking for parasites in the same two *Dreissena* spp. as we have in North America:
- *D. polymorpha* (zebra)
- *D. rostriformis* (quagga)
United Kingdom
Ireland
France
Spain
Portugal
Germany
Poland
Belarus
Ukraine
Lithuania
Latvia
Estonia
Italy
Romania
Greece
Turkey
Bulgaria
Hungary
Slovakia
Czech Republic
Austria
Switzerland
Netherlands
Belgium
Denmark
Georgia
Armenia
Azerbaijan
Uzbekistan
Turkmenistan
Afghanistan
Iran
Iraq
Syria
Lebanon
Cyprus
Tunisia
Morocco
Malta
Albania
Serbia
Bosnia and Herzegovina
Croatia
Slovenia
Moldova
Monaco
Andorra
Gibraltar


Area in past that we have focused on looking for parasites in the same two *Dreissena* spp. as we have in North America:
- *D. polymorpha* (zebra)
- *D. rostriformis* (quagga)
United Kingdom
Ireland
France
Spain
Portugal
Germany
Poland
Ukraine
Belarus
Lithuania
Latvia
Estonia
Romania
Italy
Greece
Turkey
Bulgaria
Hungary
Slovakia
Czech Republic
Austria
Switzerland
Netherlands
Belgium
Denmark
Moldova
Georgia
Armenia
Azerbaijan
Uzbekistan
Turkmenistan
Afghanistan
Iran
Iraq
Syria
Lebanon
Cyprus
Tunisia
Morocco
Malta
Albania
Serbia
Bosnia and Herzegovina
Croatia
Slovenia
Kosovo
Macedonia (FYROM)

# What happened to American chestnut trees?

# What happened to American chestnut trees?

A fungus from an Asian “cousin” chestnut tree eliminated this tree species from North America

# What happened to elm trees?

# What happened to elm trees?

A fungus from an Asian “cousin” elm tree has devastated North American elm populations

# What happened to eastern oysters?

# Up until the 1950s, eastern oyster populations were abundant and the industry thrived

Up until the 1950s, eastern oyster populations were abundant and the industry thrived


Until a parasite killed 95% of these oysters

Up until the 1950s, eastern oyster populations were abundant and the industry thrived


Until a parasite killed 95% of these oysters
…and guess what?

Up until the 1950s, eastern oyster populations were abundant and the industry thrived


Until a parasite killed 95% of these oysters
…and guess what?

That killer parasite was from a “cousin” species, the Pacific oyster *!!*

So that's a few examples of "novel" parasites from "cousins" killing off "naïve" species

…and there are many other such "bad news" examples as those I've given you *!*

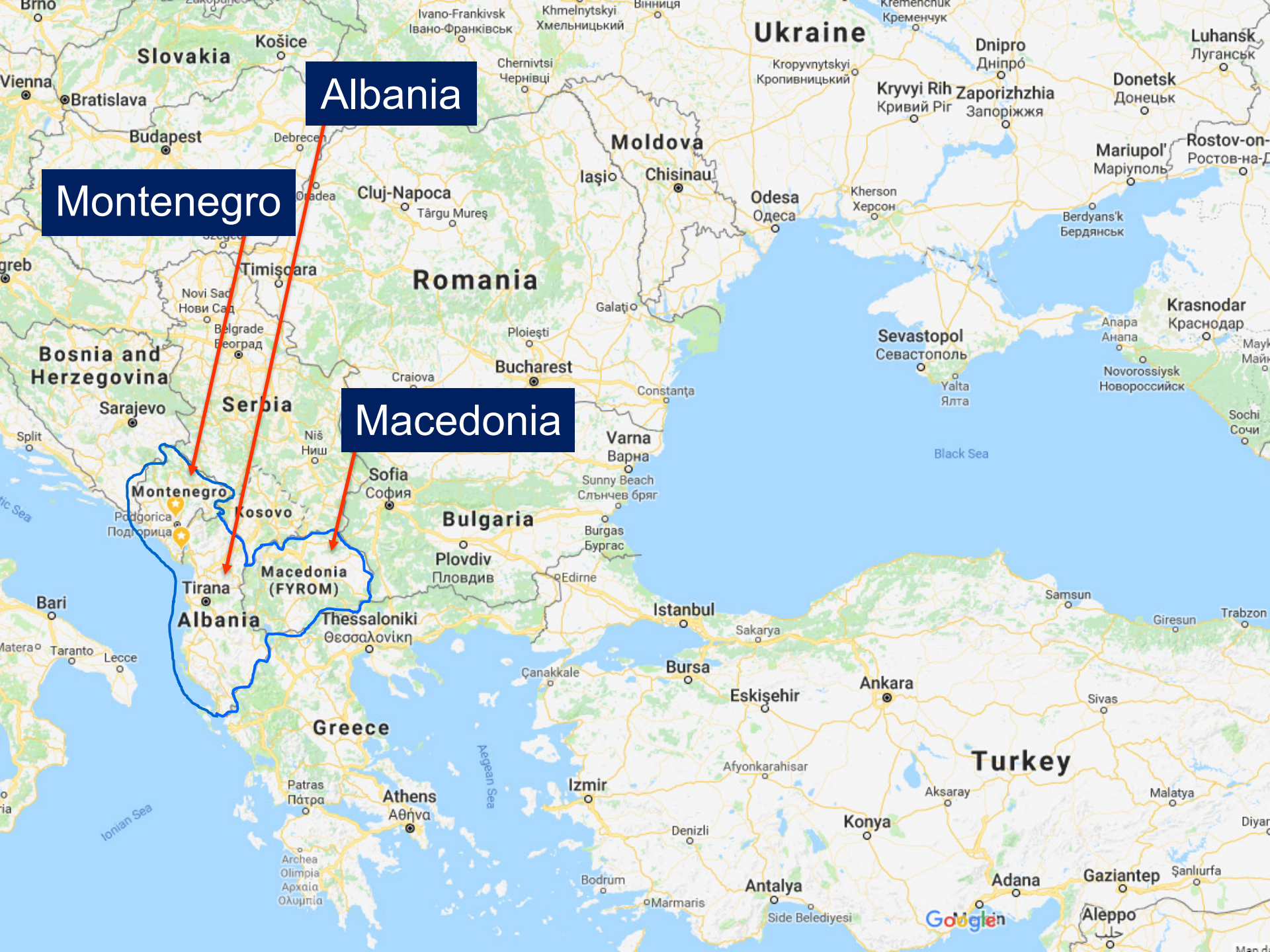
But what if we took advantage of this novel-naïve phenomenon and used it to our advantage?

But what if we took advantage of this novel-naïve phenomenon and used it to our advantage?

What if we used it to control zebra and quagga mussels *!*


Here is the area we have now switched to… in our search for parasites……
An area where “cousin” *Dreissena* species live…
Oslo
Stockholm
Edinburgh
United Kingdom
Ireland
Denmark
Poland
Hamburg
Berlin
Amsterdam
Netherlands
London
Germany
Brussels
Belgium
Cologne
Frankfurt
Prague
Czech Republic
Paris
France
Munich
Vienna
Slovakia
Austria
Budapest
Hungary
Switzerland
Milan
Slovenia
Zagreb
Croatia
Bosnia and Herzegovina
Serbia
Sarajevo
Belgrade
Romania
Bucharest
Ukraine
Kiev
Kharkiv
Moldova
Chisinau
Odessa
Volgograd
Rostov-on-Don
Kazakhstan
Krasnodar
Black Sea
Sofia
Bulgaria
Italy
Rome
Monaco
Andorra
Barcelona
Madrid
Portugal
Spain
Valencia
Lisbon
Porto
Seville
Granada
Málaga
Gibraltar
Algiers
Tunis
Malta
Tunisia
Tripoli
Rabat
Casablanca
Morocco
Mediterranean Sea
Tyrrhenian Sea
Albania
Tirana
Macedonia (FYROM)
Kosovo
Greece
Athens
Izmir
Istanbul
Bursa
Ankara
Turkey
Antalya
Adana
Cyprus
Syria
Lebanon
Beirut
Damascus
Iraq
Baghdad
Jordan
Jerusalem
Alexandria
Iran
Georgia
Tbilisi
Armenia
Azerbaijan
Baku
Caspian Sea
Makhachkala
Uzbekistan
Turkmenistan
Ashgabat
Tehran
Afghanistan
Kabul
Tajikistan
Dushanbe
Shymkent
Tashkent
Volgograd
Krasnodar
Bay of Biscay
North Sea
Baltic Sea


… and in 2019 we concentrated on examining “cousin” species in the <u>Balkans and Turkey</u>

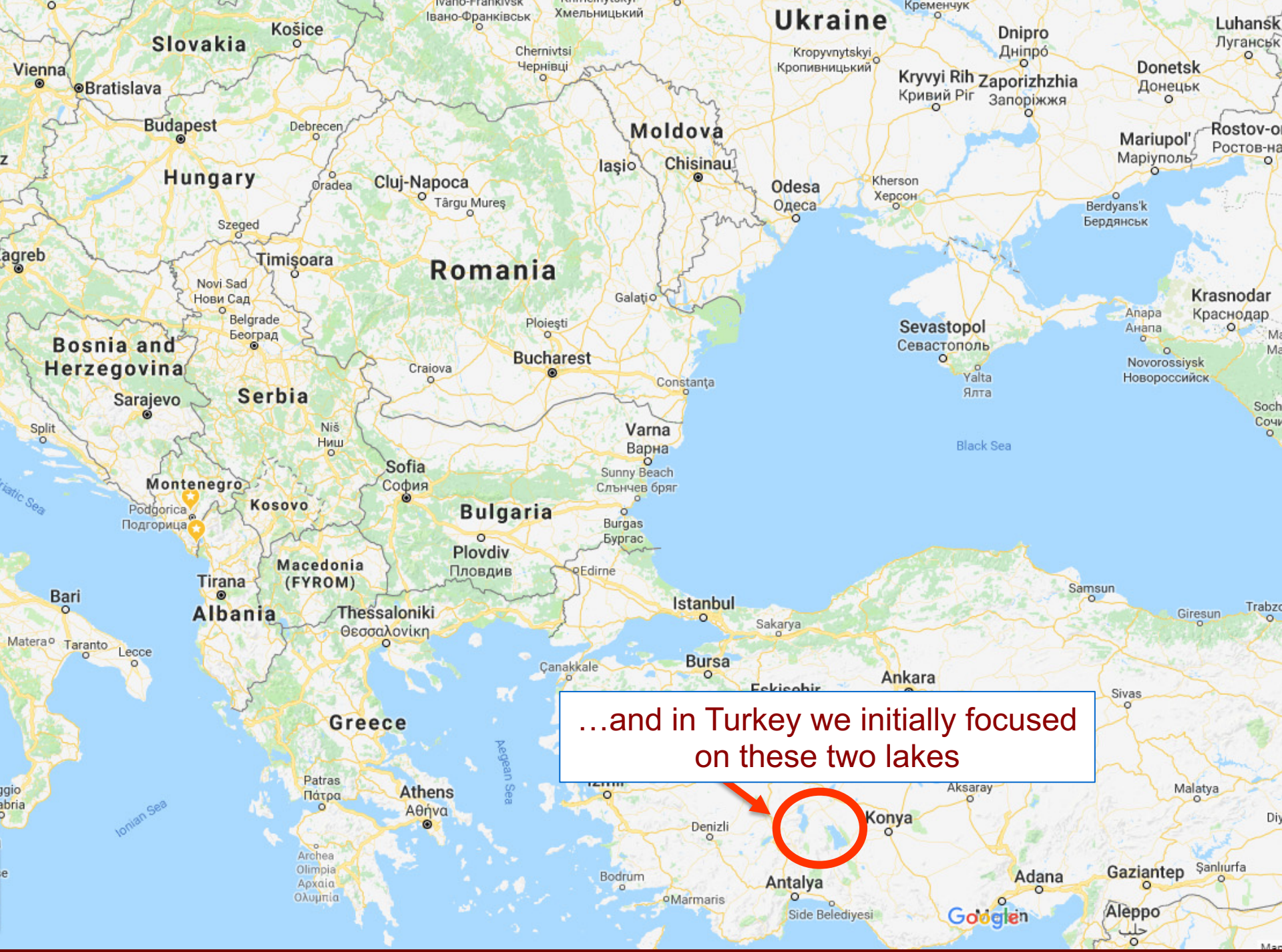

Albania
Montenegro
Macedonia
Ukraine
Slovakia
Moldova
Romania
Bosnia and Herzegovina
Serbia
Bulgaria
Greece
Turkey
Kosovo
Macedonia (FYROM)
Black Sea
Aegean Sea
Ionian Sea
Budapest
Bratislava
Vienna
Košice
Debrecen
Cluj-Napoca
Târgu Mureş
Timişoara
Novi Sad
Belgrade
Sarajevo
Split
Niš
Craiova
Bucharest
Ploieşti
Galaţi
Iaşi
Chisinau
Odesa
Kherson
Sevastopol
Krasnodar
Anapa
Novorossiysk
Yalta
Constanţa
Varna
Sunny Beach
Burgas
Sofia
Plovdiv
Edirne
Istanbul
Samsun
Trabzon
Giresun
Sakarya
Bursa
Çanakkale
Eskişehir
Ankara
Sivas
Afyonkarahisar
Izmir
Aksaray
Konya
Malatya
Denizli
Bodrum
Antalya
Marmaris
Side Belediyesi
Adana
Gaziantep
Şanlıurfa
Aleppo
Podgorica
Tirana
Thessaloniki
Patras
Athens
Archea Olimpia
Taranto
Bari
Lecce
Matera
Dnipro
Kryvyi Rih
Zaporizhzhia
Donetsk
Luhansk
Mariupol'
Rostov-on-
Berdyans'k
Chernivtsi
Ivano-Frankivsk
Khmelnytskyi
Kropyvnytskyi
Sochi
Google

# Balkans
# Montenegro, Albania & Macedonia

Lake Ohrid
Macedonia/Albania

Skadar Lake
Montenegro/Albania

…and we have focused on examining the parasites of the only *Dreissena* species that is in these two lakes:
"Cousin" *Dreissena carinata*


…and in Turkey we initially focused on these two lakes
Ukraine
Slovakia
Hungary
Moldova
Romania
Bulgaria
Serbia
Bosnia and Herzegovina
Montenegro
Kosovo
Macedonia (FYROM)
Albania
Greece
Vienna
Bratislava
Budapest
Košice
Debrecen
Oradea
Cluj-Napoca
Târgu Mureş
Szeged
Timişoara
Novi Sad
Нови Сад
Belgrade
Београд
Zagreb
Split
Sarajevo
Niš
Ниш
Craiova
Bucharest
Ploieşti
Galaţi
Iaşi
Chisinau
Odesa
Одеса
Constanţa
Varna
Варна
Sunny Beach
Слънчев бряг
Burgas
Бургас
Sofia
София
Plovdiv
Пловдив
Edirne
Tirana
Bari
Matera
Taranto
Lecce
Thessaloniki
Θεσσαλονίκη
Patras
Πάτρα
Athens
Αθήνα
Archea Olimpia
Αρχαία Ολυμπία
Ionian Sea
Aegean Sea
Black Sea
Sea of Marmara
Istanbul
Çanakkale
Bursa
Sakarya
Ankara
Eskişehir
Samsun
Giresun
Trabzon
Sivas
Malatya
Aksaray
Konya
Denizli
Bodrum
Marmaris
Antalya
Side Belediyesi
Adana
Gaziantep
Şanlıurfa
Aleppo
حلب
Dnipro
Дніпро
Kryvyi Rih
Кривий Ріг
Zaporizhzhia
Запоріжжя
Donetsk
Донецьк
Luhansk
Луганськ
Mariupol'
Маріуполь
Rostov-on-Don
Ростов-на-Дону
Kherson
Херсон
Berdyans'k
Бердянськ
Sevastopol
Севастополь
Yalta
Ялта
Krasnodar
Краснодар
Anapa
Анапа
Novorossiysk
Новороссийск
Sochi
Сочи
Kropyvnytskyi
Кропивницький
Chernivtsi
Чернівці
Ivano-Frankivsk
Івано-Франківськ
Khmelnytskyi
Хмельницький
Kremenchuk
Кременчук
Google


Eğirdir Lake
&
Beyşehir Lake
Black Sea
Varna
Варна
Sunny Beach
Слънчев бряг
Bulgaria
Burgas
Бургас
Plovdiv
Пловдив
Edirne
Istanbul
Sakarya
Samsun
Giresun
Trabzon
Çanakkale
Bursa
Ankara
Eskişehir
Sivas
Turkey
Aegean Sea
Izmir
Aksaray
Malatya
Konya
Denizli
Bodrum
Antalya
Marmaris
Side Belediyesi
Adana
Gaziantep
Şanlıurfa
Aleppo
حلب
Google

# Turkey

Eğirdir Lake
"Cousin" *Dreissena anatolica*

Beyşehir Lake
"Cousin" *Dreissena anatolica*

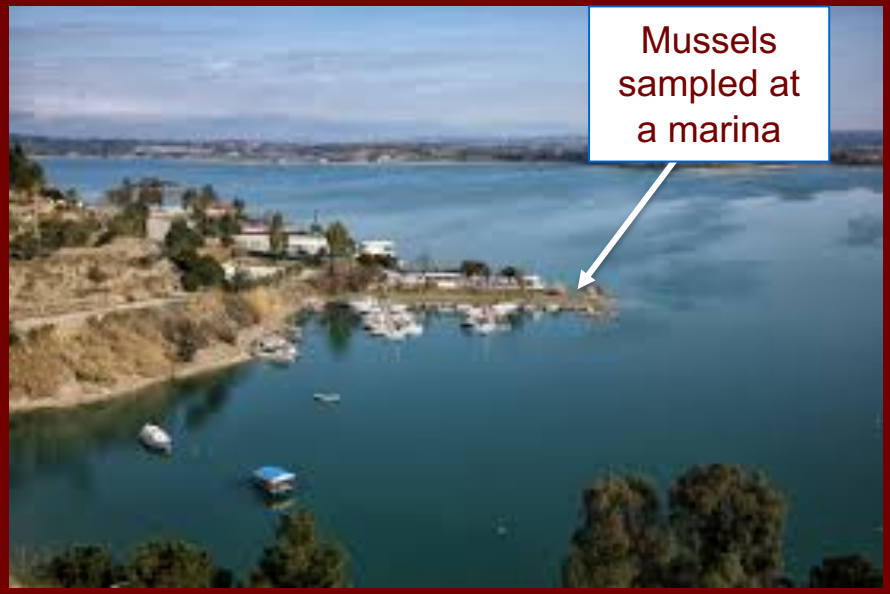


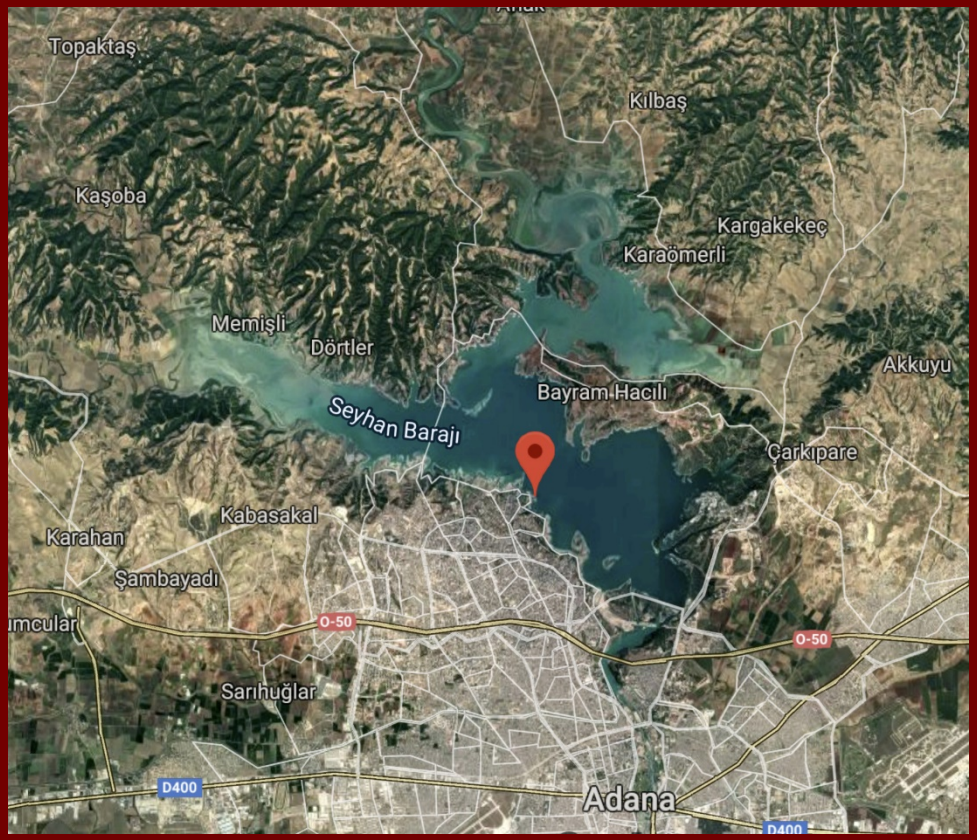
Black Sea
Сочи
Batumi
Samsun
Giresun
Trabzon
Rize
Sakarya
Bursa
Ankara
Eskişehir
Sivas
Erzurum
Turkey
Afyonkarahisar
…and we also sampled at a dam reservoir at Adana
Malatya
Konya
Denizli
Diyarbakır
Batman
Mardin
Şanlıurfa
Gaziantep
Adana
Antalya
Side Belediyesi
Aleppo
Google

# Turkey

## Seyhan Dam Reservoir at Adana

## "Cousins" *Dreissena anatolica* and *Dreissena caputlacus*



OK,  we collected these Balkan and Turkish mussels…

But what did we do next with them?

We brought them back to our field lab in Montenegro….


Montenegro
Slovakia
Košice
Vienna
Bratislava
Budapest
Debrecen
Oradea
Cluj-Napoca
Târgu Mureș
Timișoara
Romania
Novi Sad
Нови Сад
Belgrade
Београд
Bosnia and Herzegovina
Sarajevo
Serbia
Split
Niš
Ниш
Montenegro
Podgorica
Подгорица
Kosovo
Sofia
София
Bulgaria
Plovdiv
Пловдив
Macedonia (FYROM)
Tirana
Albania
Bari
Taranto
Lecce
Thessaloniki
Θεσσαλονίκη
Greece
Patras
Πάτρα
Athens
Αθήνα
Ionian Sea
Aegean Sea
Archea Olimpia
Αρχαία Ολυμπία
Ivano-Frankivsk
Івано-Франківськ
Khmelnytskyi
Хмельницький
Chernivtsi
Чернівці
Ukraine
Kremenchuk
Кременчук
Kropyvnytskyi
Кропивницький
Dnipro
Дніпро
Luhansk
Луганськ
Kryvyi Rih
Кривий Ріг
Zaporizhzhia
Запоріжжя
Donetsk
Донецьк
Moldova
Iași
Chisinau
Mariupol'
Маріуполь
Rostov-on-
Ростов-на-Д
Odesa
Одеса
Kherson
Херсон
Berdyans'k
Бердянськ
Galați
Ploiești
Bucharest
Craiova
Constanța
Varna
Варна
Sunny Beach
Слънчев бряг
Burgas
Бургас
Edirne
Black Sea
Sevastopol
Севастополь
Yalta
Ялта
Krasnodar
Краснодар
Anapa
Анапа
Novorossiysk
Новороссийск
Sochi
Сочи
Istanbul
Samsun
Giresun
Trabzon
Sakarya
Çanakkale
Bursa
Eskişehir
Ankara
Sivas
Turkey
Afyonkarahisar
Izmir
Aksaray
Malatya
Konya
Denizli
Bodrum
Antalya
Marmaris
Side Belediyesi
Adana
Gaziantep
Şanlıurfa
Aleppo
Google

This field lab that we established in Montenegro has proven to be a critically important asset to the project

This field lab that we established in Montenegro has proven to be a critically important asset to the project

…and although it's a just a relatively small trailer,…

… it's packed with aquaria and other scientific equipment for rearing mussels & doing experiments…

… it's packed with aquaria and other scientific equipment for rearing mussels & doing experiments…


…with mussels held inside clear acrylic pipes in the aquaria

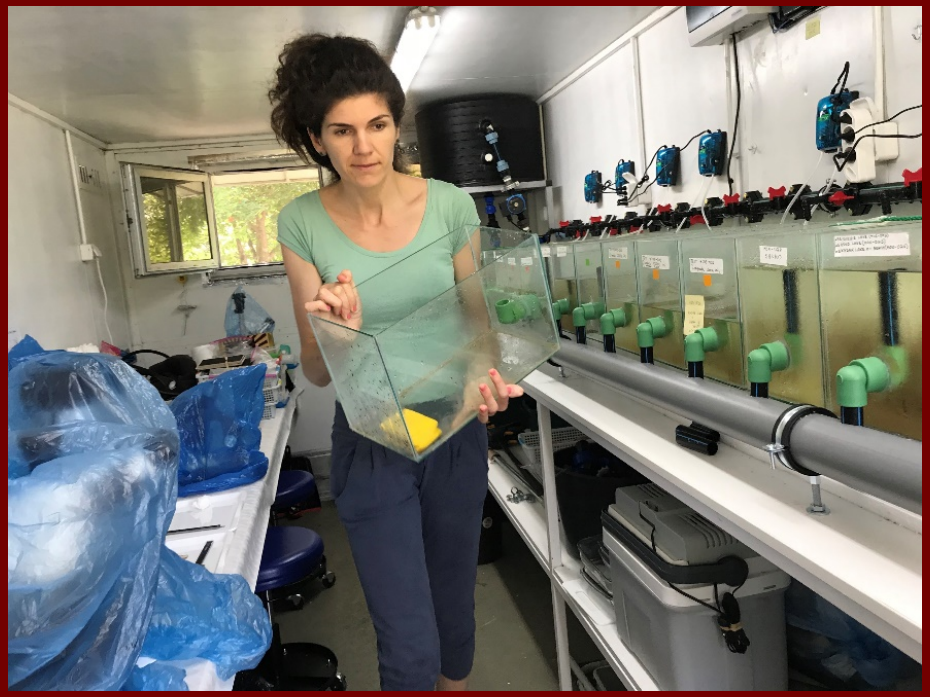
… and my research in the trailer is assisted by the following two key Montenegrin scientists…

# Fieldwork

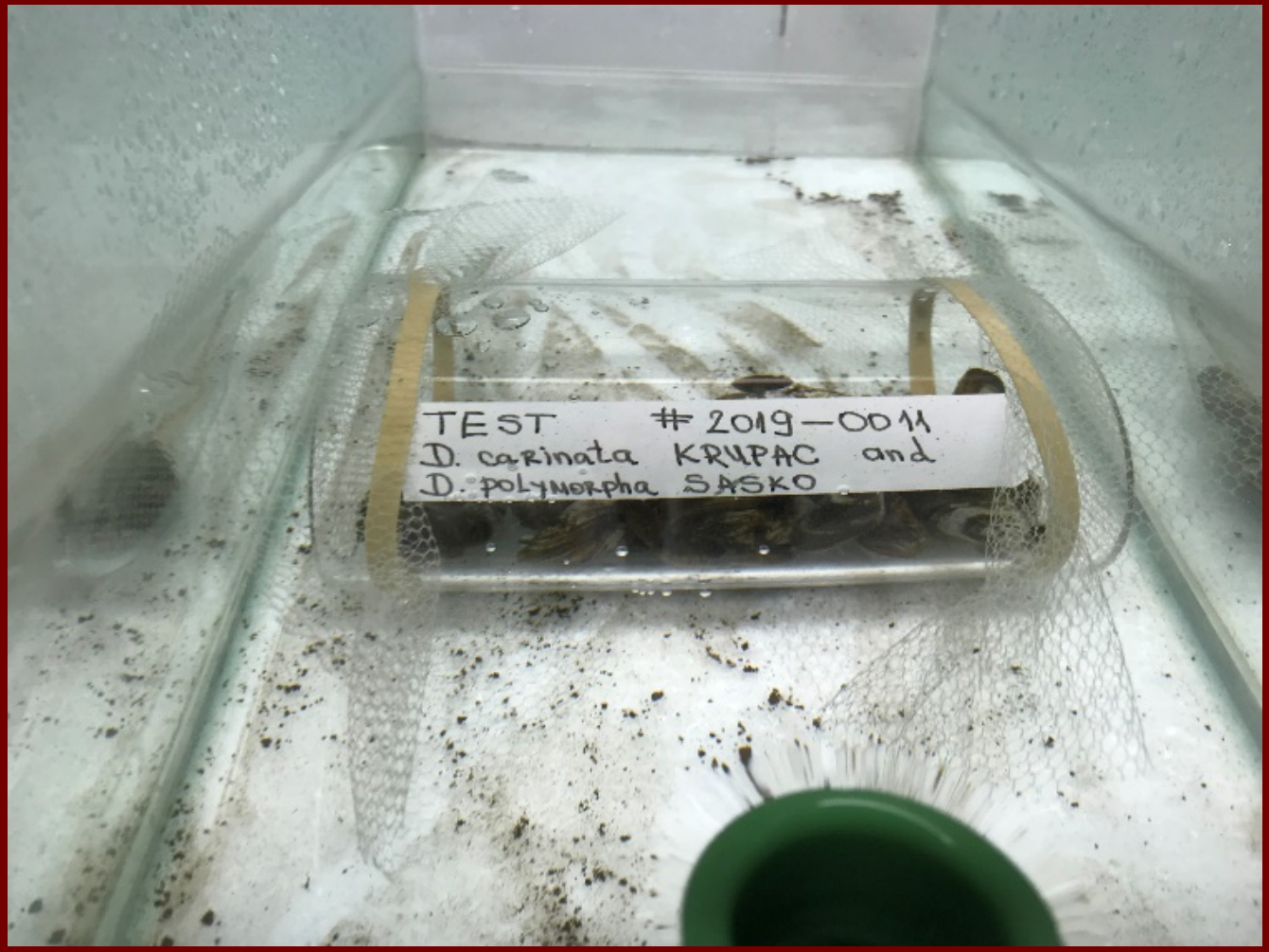
Mihailo Jovićević

# Labwork

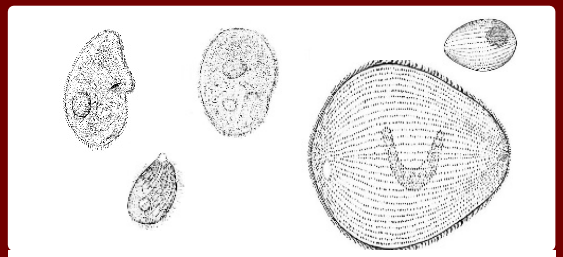
Milena Iković



….and in 2019 we started doing experiments in the research trailer trying to transmit parasites from “cousin” *D. carinata* into *D. polymorpha* -- to our knowledge, something never before ever attempted in science …



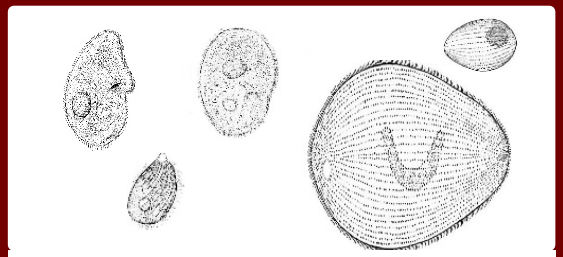
…and these experiments succeeded in transmitting all 5 species of ciliate parasites present in “cousin” *D. carinata* into *D. polymorpha* -- a **major milestone achievement** for the project *!!*



Enlarged drawings (>100X) of the 5 parasite species transmitted into *D. polymorpha*

*“Cousin” D. carinata* → *D. polymorpha*

…and these experiments succeeded in transmitting all 5 species of ciliate parasites present in “cousin” *D. carinata* into *D. polymorpha* -- a **major milestone achievement** for the project *!!*



Enlarged drawings (>100X) of the 5 parasite species transmitted into *D. polymorpha*

*“Cousin” D. carinata* → *D. polymorpha*

**Longer-term** experiments are critically needed now

The research trailer needs to be kept operating **year round**

# Plans for 2020

# Plans for 2020

-- Focus on collecting **more mussels and their parasites from Turkey** where there is a relatively high diversity of "cousin" *Dreissena* populations…

# Plans for 2020

-- Focus on collecting **more mussels and their parasites from Turkey** where there is a relatively high diversity of "cousin" *Dreissena* populations…

-- Obtain more funding to keep the research trailer in Montenegro **open year round** (not for only 5 months as in 2019). This would significantly accelerate project momentum by allowing:

# Plans for 2020

-- Focus on collecting **more mussels and their parasites from Turkey** where there is a relatively high diversity of "cousin" *Dreissena* populations…

-- Obtain more funding to keep the research trailer in Montenegro **open year round** (not for only 5 months as in 2019). This would significantly accelerate project momentum by allowing:

- **Year-round collection-dissection of "cousin" *Dreissena* species** in search of their most "novel" (i.e., lethal) parasites

# Plans for 2020

-- Focus on collecting **more mussels and their parasites from Turkey** where there is a relatively high diversity of "cousin" *Dreissena* populations…

-- Obtain more funding to keep the research trailer in Montenegro **open year round** (not for only 5 months as in 2019). This would significantly accelerate project momentum by allowing:

- **Year-round collection-dissection of "cousin" *Dreissena* species** in search of their most "novel" (i.e., lethal) parasites
- **Year-round conduct of long-term infection trials** (against both zebra and quagga mussels) using "novel" parasites from "cousin" *Dreissena* species

# Take Home Messages

# Take Home Messages

Will there ever be a **lake-wide** control method to combat these mussels? Might it be really possible some day?

# Take Home Messages

Will there ever be a **lake-wide** control method to combat these mussels? Might it be really possible some day?

Please don't give up hope. I haven't.

# Take Home Messages

Will there ever be a **lake-wide** control method to combat these mussels? Might it be really possible some day?

Please don't give up hope. I haven't.

…and I predict that if a control agent is ever **widely** adopted for use throughout North American lakes, it will be a **LIVE** control agent…. as no other type of control agent could ever be **economical enough** to see **widespread** use by lake associations and other entities to achieve control throughout **entire lakes**

# Take Home Messages

Will there ever be a **lake-wide** control method to combat these mussels? Might it be really possible some day?

Please don't give up hope. I haven't.

…and I predict that if a control agent is ever **widely** adopted for use throughout North American lakes, it will be a **LIVE** control agent…. as no other type of control agent could ever be **economical enough** to see **widespread** use by lake associations and other entities to achieve control throughout **entire lakes**

…and finally ….don't be surprised if…

# Take Home Messages

Will there ever be a **lake-wide** control method to combat these mussels? Might it be really possible some day?

Please don't give up hope. I haven't.

…and I predict that if a control agent is ever **widely** adopted for use throughout North American lakes, it will be a **LIVE** control agent…. as no other type of control agent could ever be **economical enough** to see **widespread** use by lake associations and other entities to achieve control throughout **entire lakes**

…and finally ….don't be surprised if…

…. some "novel", inexpensive, environmentally-safe, **parasite discovered by this project** proves to be that above-mentioned **LIVE** control agent used throughout North America *!!*

# International Team of Collaborating Scientists


NORTH MACEDONIA
Sasho Trajanovski


NORTH MACEDONIA
Tino Zdraveski


ALBANIA
Spase Shumka


ITALY
Sergei Fokin


ITALY
Wanying Liao


ITALY
Mahesh Nitla


MONTENEGRO
Mihailo Jovićević


MONTENEGRO
Vladimir Pešić


MONTENEGRO
Milena Iković


USA
Jacque Keele


USA
Yale Passamaneck


USA
Sherri Pucherelli

**Special thanks !!**


FINLAND
Jouni Taskinen


BULGARIA
Teodora Trichkova


TURKEY
Zeki Yildirim


FRANCE
Laure Giamberini

*Thank you very much for your attention!*