RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

RU Life Science 2U: Fish Data and NGSS Science Practices in Your Classroom

Chris Free
Kristin Hunter-Thomson

New Jersey Science Convention
October 15, 2014

Mongolia: Confronting change in the 21st century

- Christopher Free
- PhD Student, Rutgers University

NJ Science Convention | Princeton, NJ | October 15, 2014

The Asian Continent
Iceland
United States
Norwegian Sea
U.K.
Bering Sea
East Siberian Sea
Barents Sea
Norway
Denmark
Sweden
Laptev Sea
Kara Sea
North Pacific Ocean
Germany
Finland
Estonia
Poland
Lith.
Lat.
Belarus
Rom.
Ukraine
Moldova
Sea of Okhotsk
Russia
Turkey
Georgia
Armenia
Kazakhstan
Azerbaijan
Uzbekistan
Mongolia
Sea of Japan
North Korea
Japan
Iraq
Turkmenistan
Kyrgyzstan
South Korea
Iran
Tajikistan
Afghanistan
East China Sea
China
UAE
Pakistan
Saudi Arabia
Nepal
Taiwan
Bhutan
Oman
Philippine Sea
India
Bangladesh
Myanmar
Arabian Sea
Laos
South China Sea
Thailand
Philippines
Bay of Bengal
Cambodia
Vietnam
Andaman Sea
Brunei
Sri Lanka
Maldives
Malaysia
Singapore
Indian Ocean
Indonesia
©1999 MAGELLAN Geographix℠ (805) 685-3100 www.maps.com

Democratization

Development

Mining

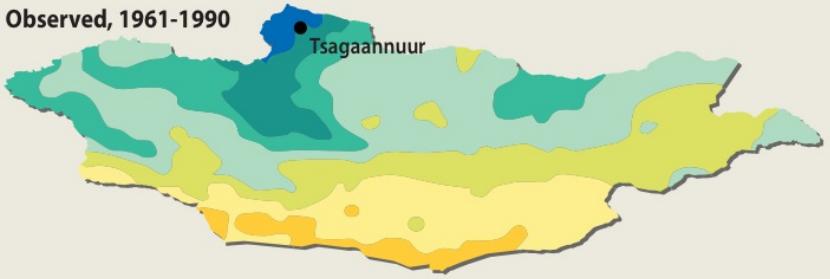
Globalization

Access to technology

Climate change in Mongolia

Annual mean temperature

Observed, 1961-1990



Projected, 2070-2100

Temperature, °C

-12 -9 -6 -3 0 3 6

Frequency of *dzud* events

Modelled, 1961-1990

Projected, 2070-2100

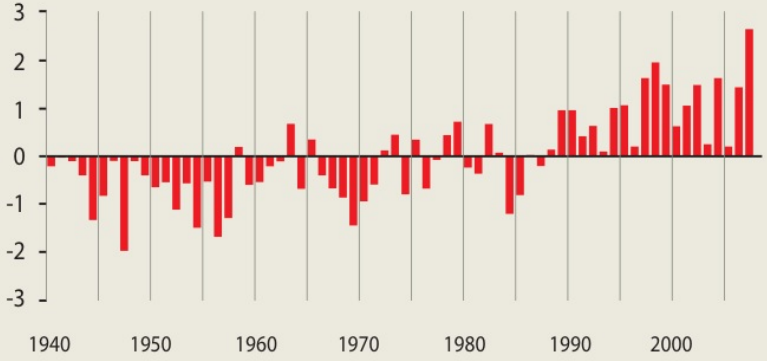
Frequency

0 10 20 40 50 100

Dzud is a Mongolian term that refers to a multiple natural disaster consisting of a summer drought resulting in inadequate pasture and production of hay, followed by very heavy winter snow, winds and lower-than-normal temperatures.

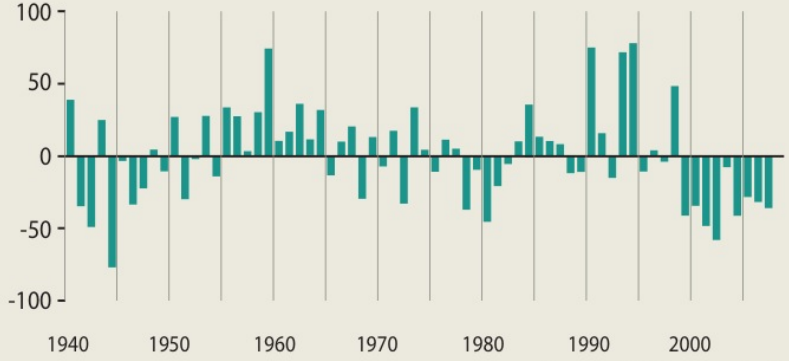
Annual mean temperature anomaly

°C

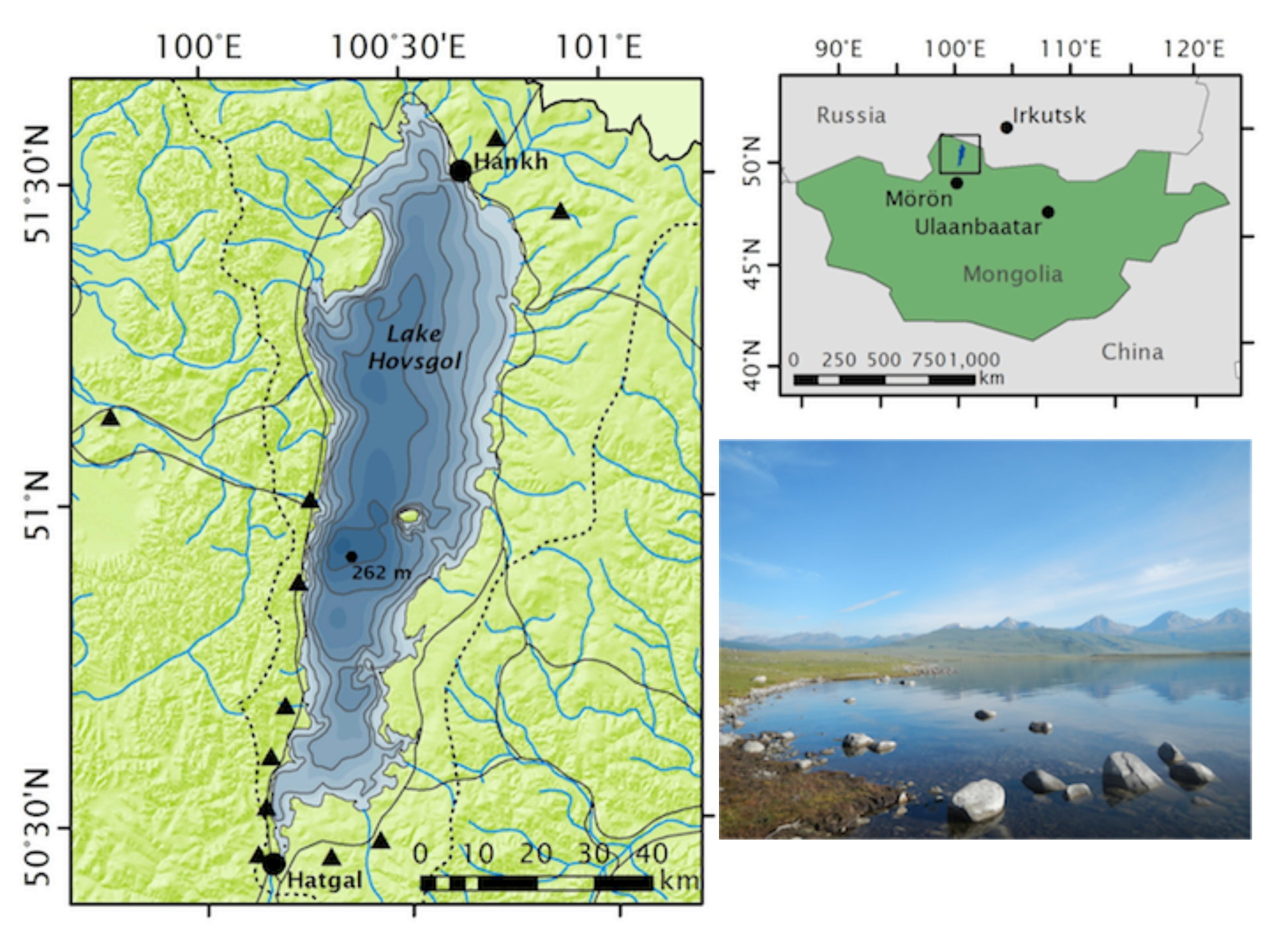


Annual total rainfall anomaly

Millimetres



Source: Mongolia NCAP Project, weADAPT; World Bank.


100°E
100°30'E
101°E
51°30'N
51°N
50°30'N
Hankh
Lake
Hovsgol
262 m
Hatgal
0 10 20 30 40
km
90°E
100°E
110°E
120°E
50°N
45°N
40°N
Russia
Irkutsk
Mörön
Ulaanbaatar
Mongolia
China
0 250 500 750 1,000
km

What variables or relationships could we investigate to learn about illegal fishing on Lake Hovsgol? Develop a question to investigate the problem further.

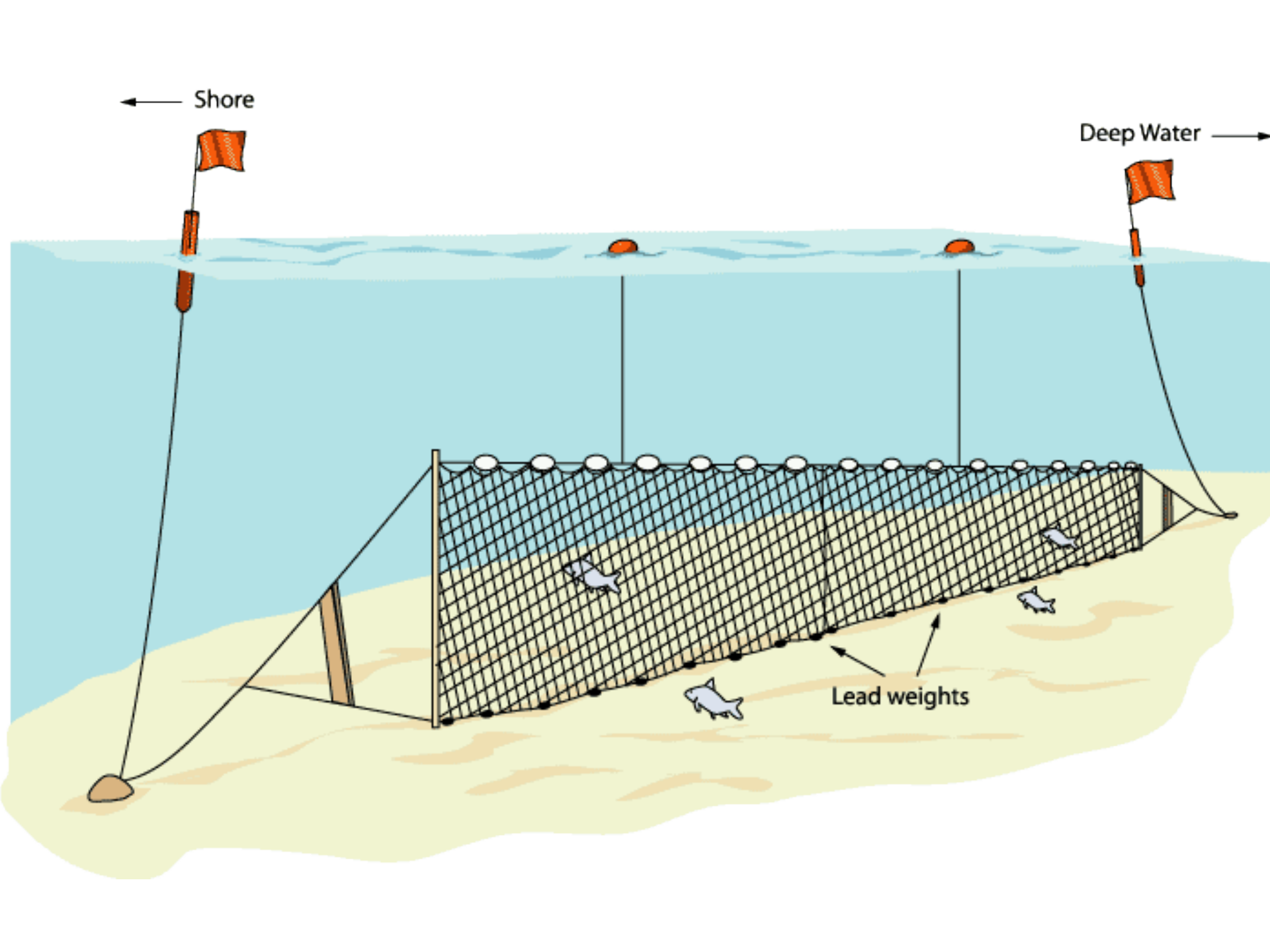
SEP 1: Asking Questions and Defining Problems - Scientific questions are distinguished from other types of questions in that the answers lie in explanations supported by empirical evidence, including evidence gathered by others or through investigation.

Asking questions also involves asking questions about data, claims that are made, and proposed designs.

Illegal fishing for the endangered endemic Hovsgol grayling

Christopher Free, Olaf Jensen, Bud Mendsaikhan

In prep for
Conservation Biology


Shore
Deep Water
Lead weights

Interviews

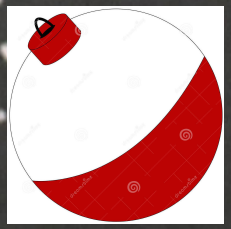
10 herding families
7 national park rangers

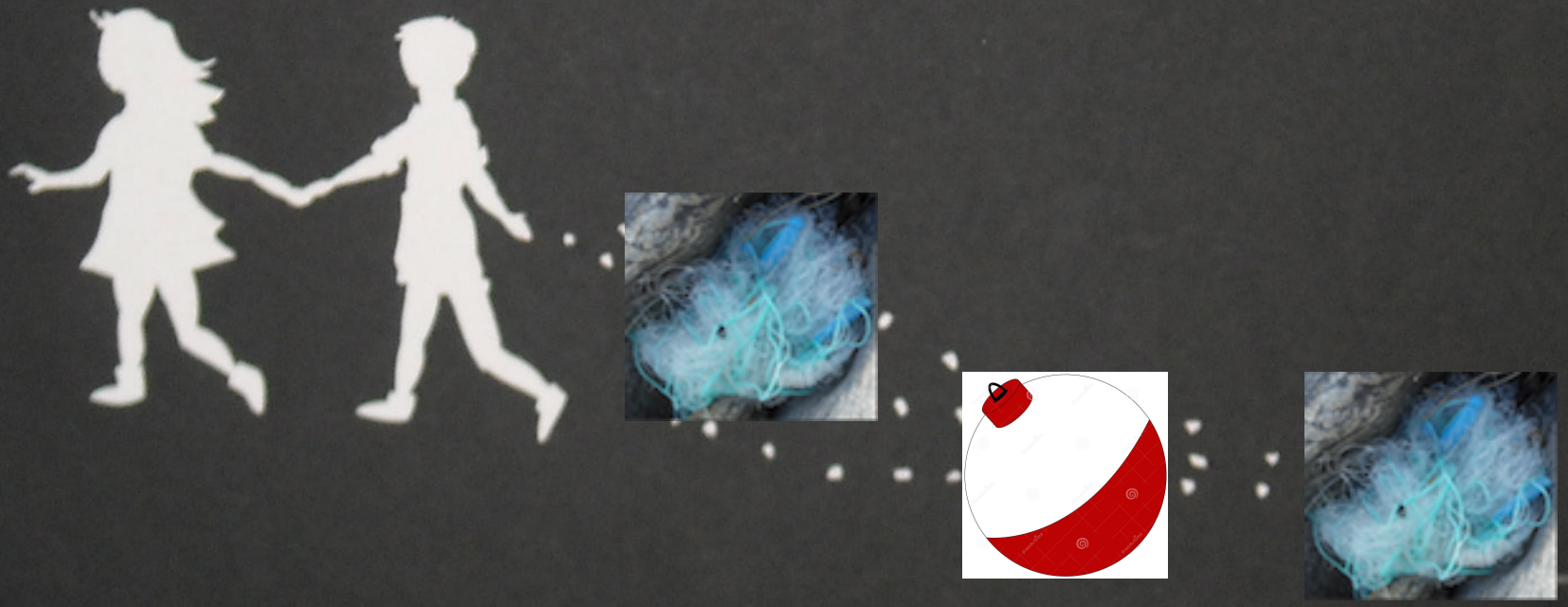
Personal and observed fishing habits

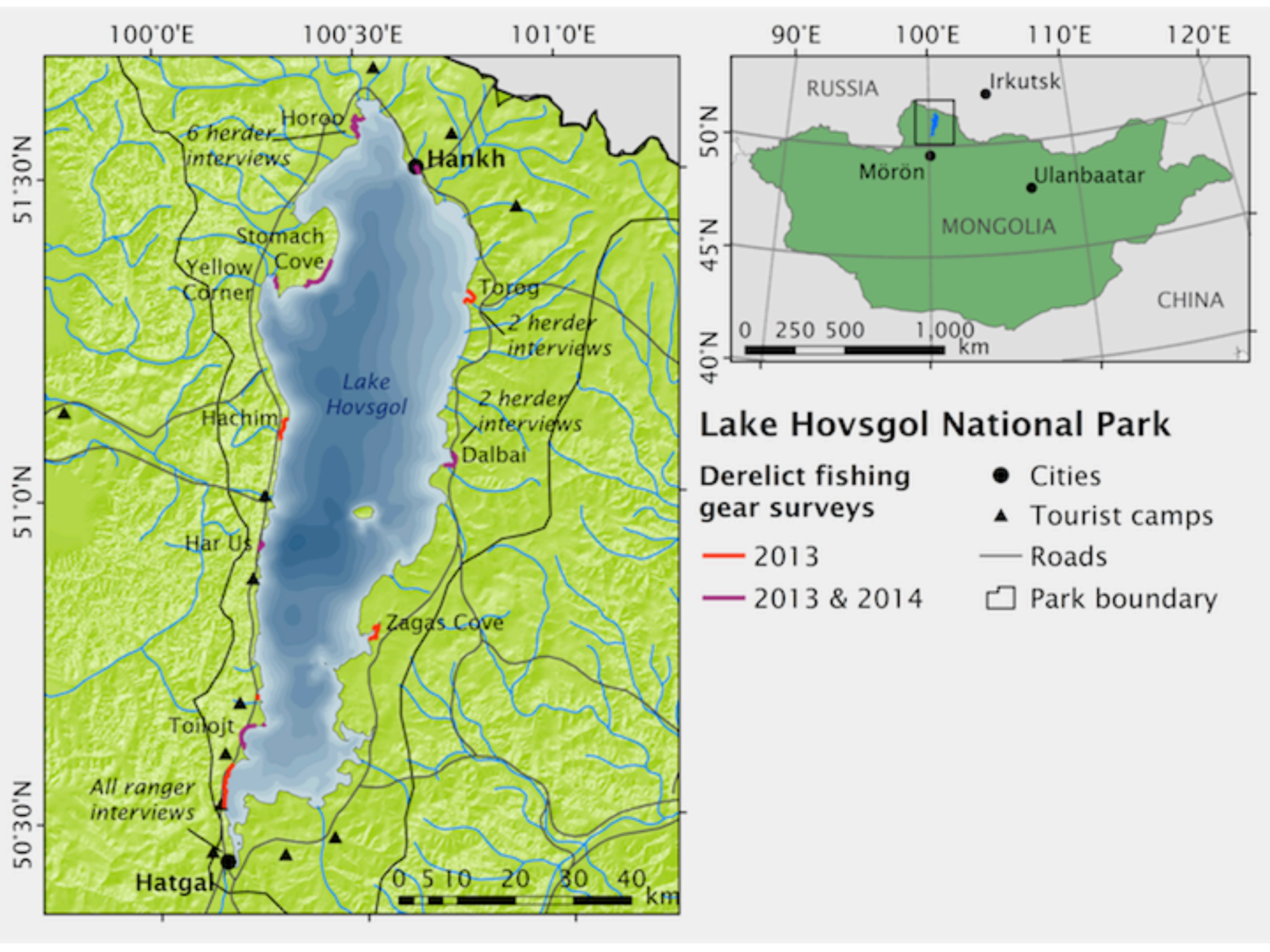
Derelict gillnet surveys

2013: 10 sites, 53.6 km
2014: 7 sites, 31.9 km resurveyed

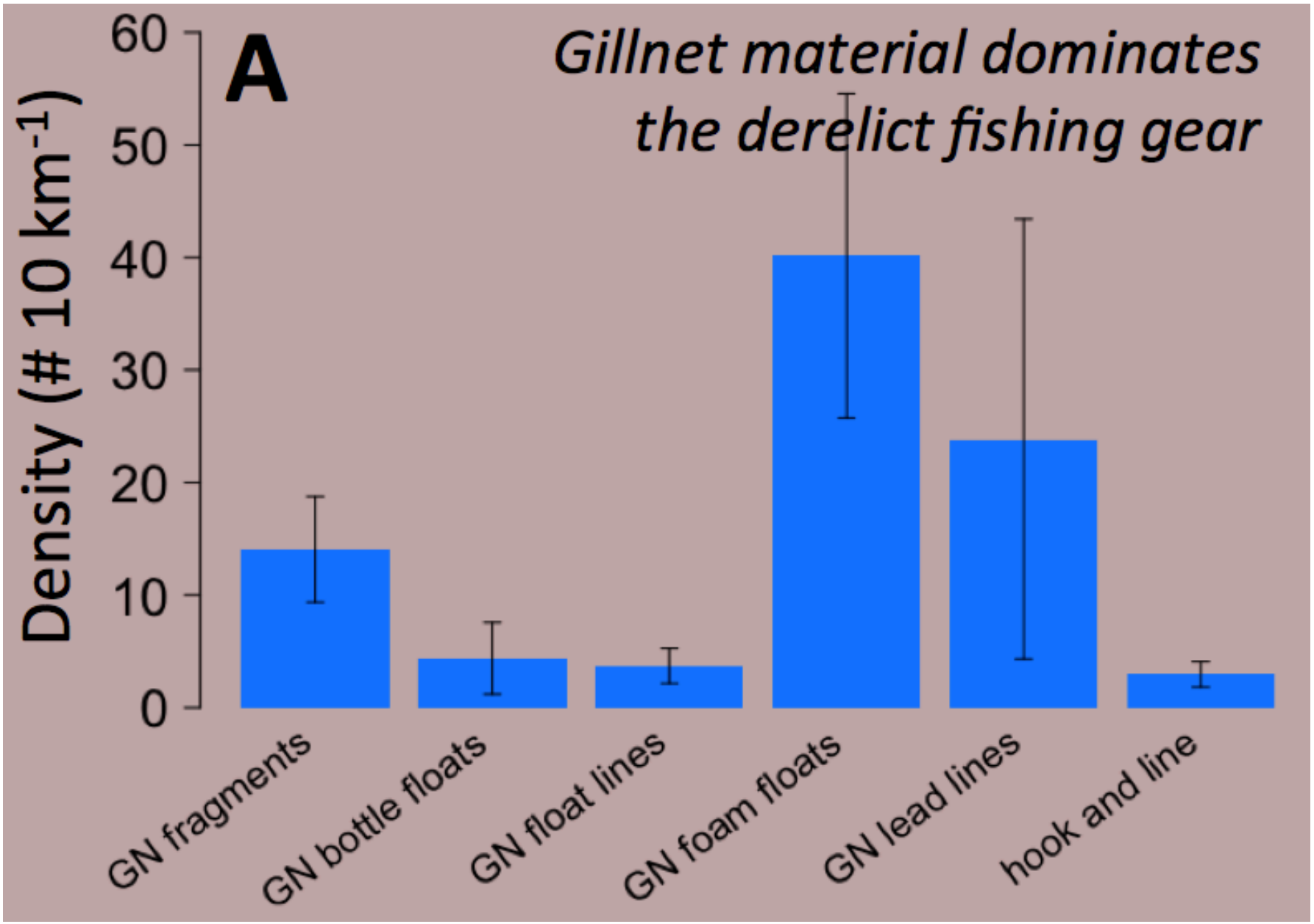
Location, mesh size, weight, etc.



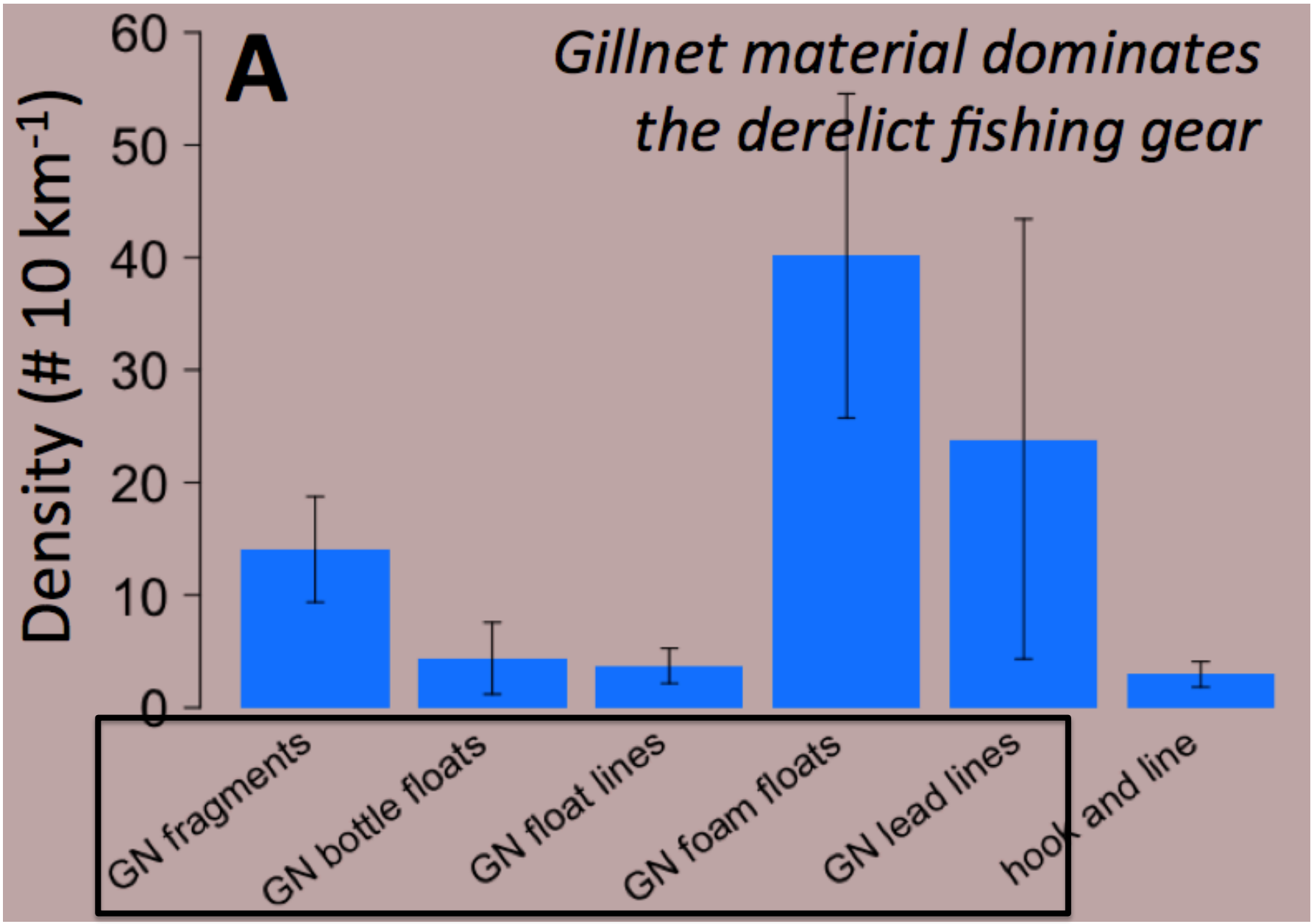



100°0'E
100°30'E
101°0'E
51°30'N
51°0'N
50°30'N
Horoo
6 herder interviews
Hankh
Stomach Cove
Yellow Corner
Torog
2 herder interviews
Lake Hovsgol
2 herder interviews
Hachim
Dalbai
Har Us
Zagas Cove
Toilojt
All ranger interviews
Hatgal
0 5 10 20 30 40 km
90°E
100°E
110°E
120°E
50°N
45°N
40°N
RUSSIA
Irkutsk
Mörön
Ulanbaatar
MONGOLIA
CHINA
0 250 500 1,000 km
Lake Hovsgol National Park
Derelict fishing gear surveys
2013
2013 & 2014
Cities
Tourist camps
Roads
Park boundary

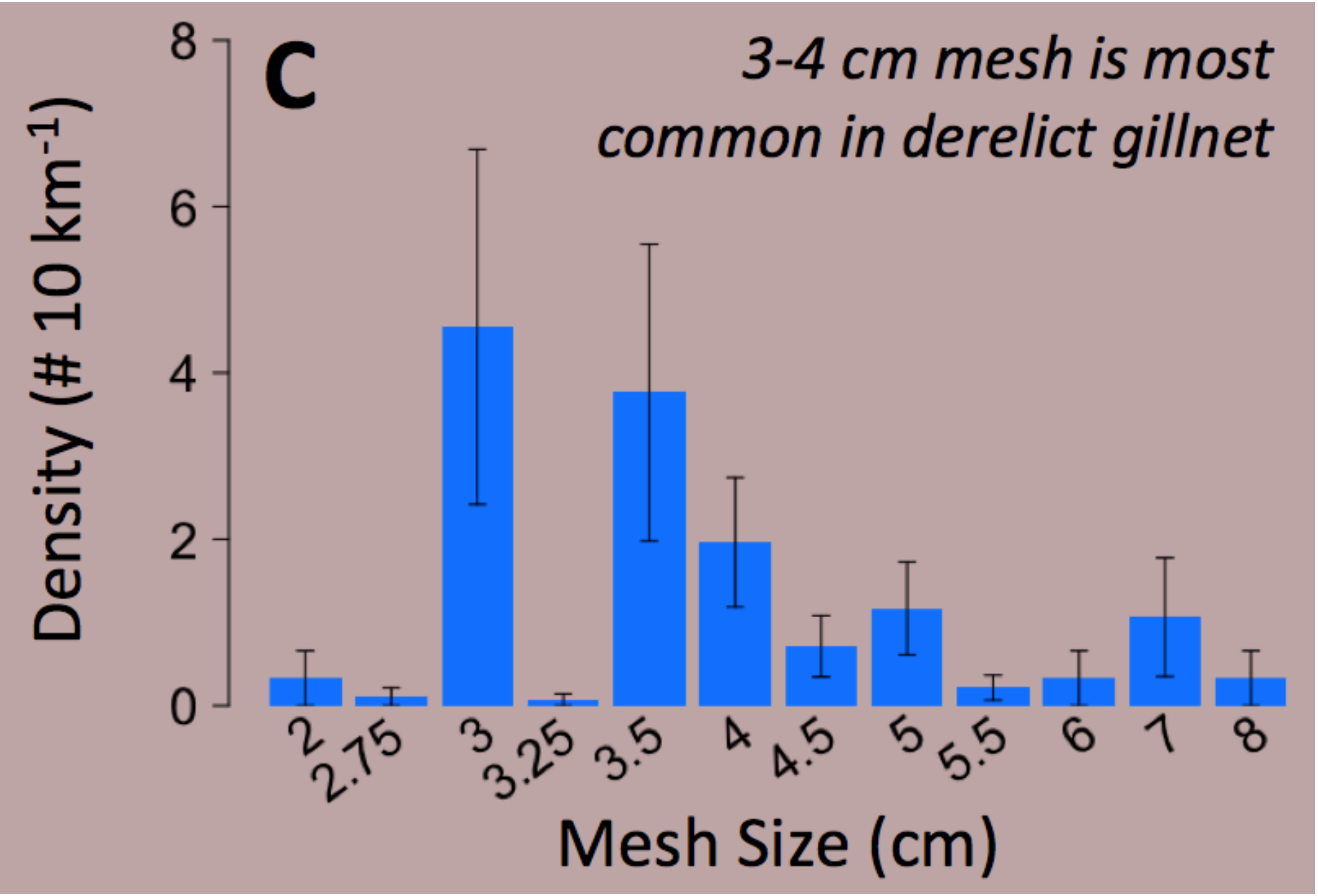
How do people fish?

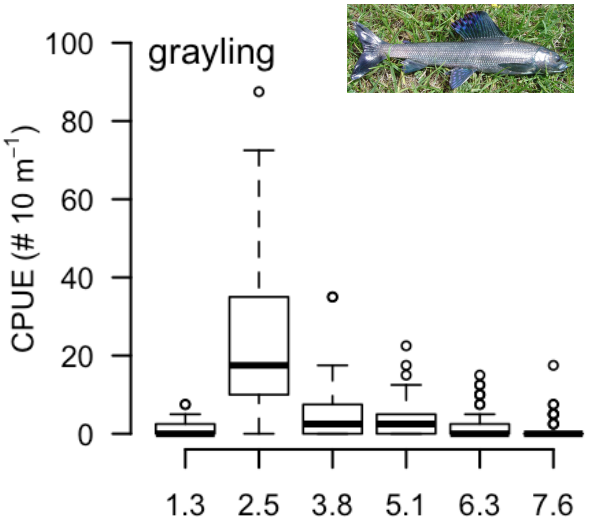


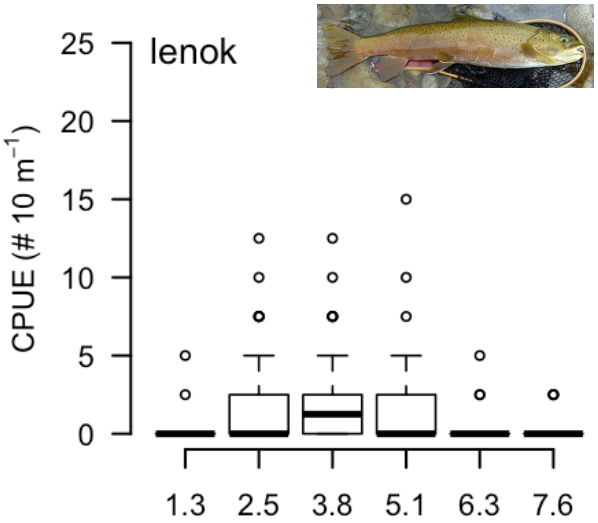
How do people fish?

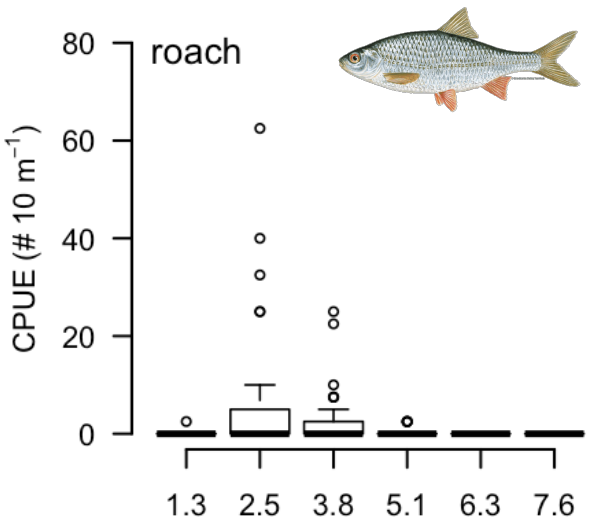


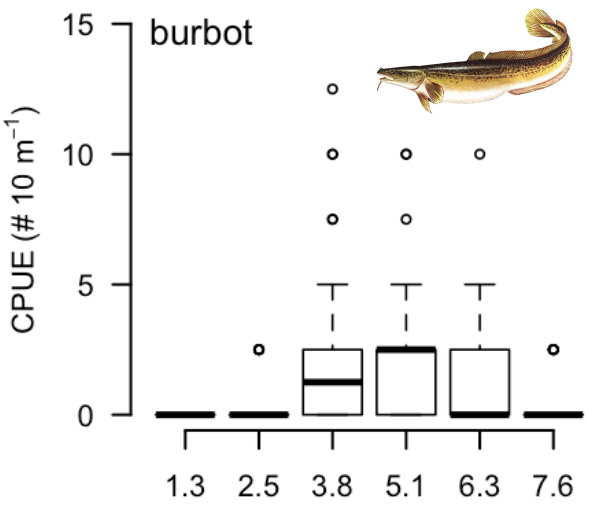
How do people fish?

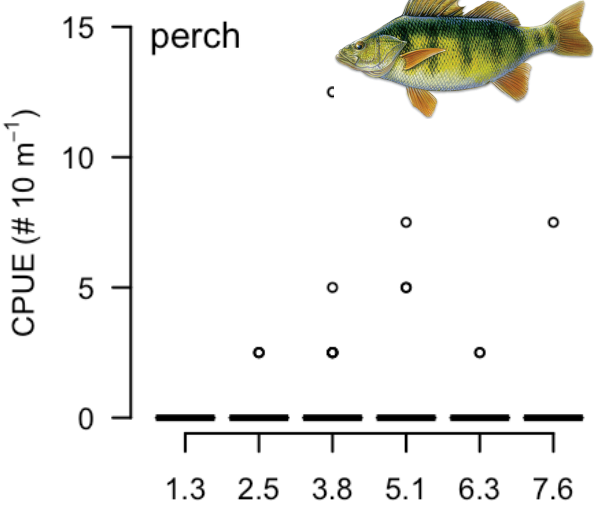


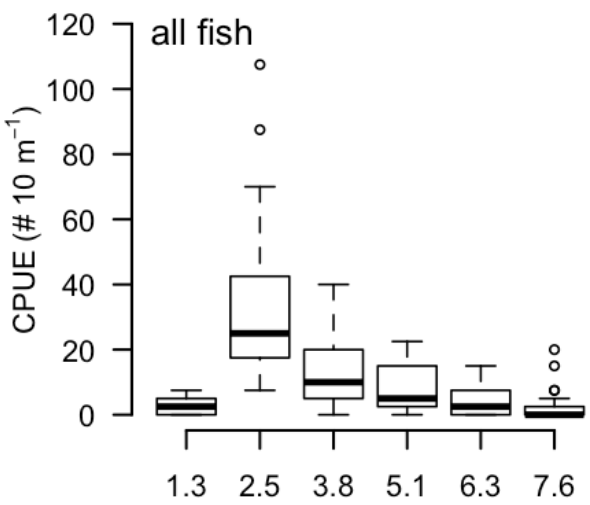

grayling
CPUE (# 10 m^{-1})
0
20
40
60
80
100
1.3
2.5
3.8
5.1
6.3
7.6


lenok
CPUE (# 10 m^{-1})
0
5
10
15
20
25
1.3
2.5
3.8
5.1
6.3
7.6


roach
CPUE (# 10 m^{-1})
0
20
40
60
80
1.3
2.5
3.8
5.1
6.3
7.6

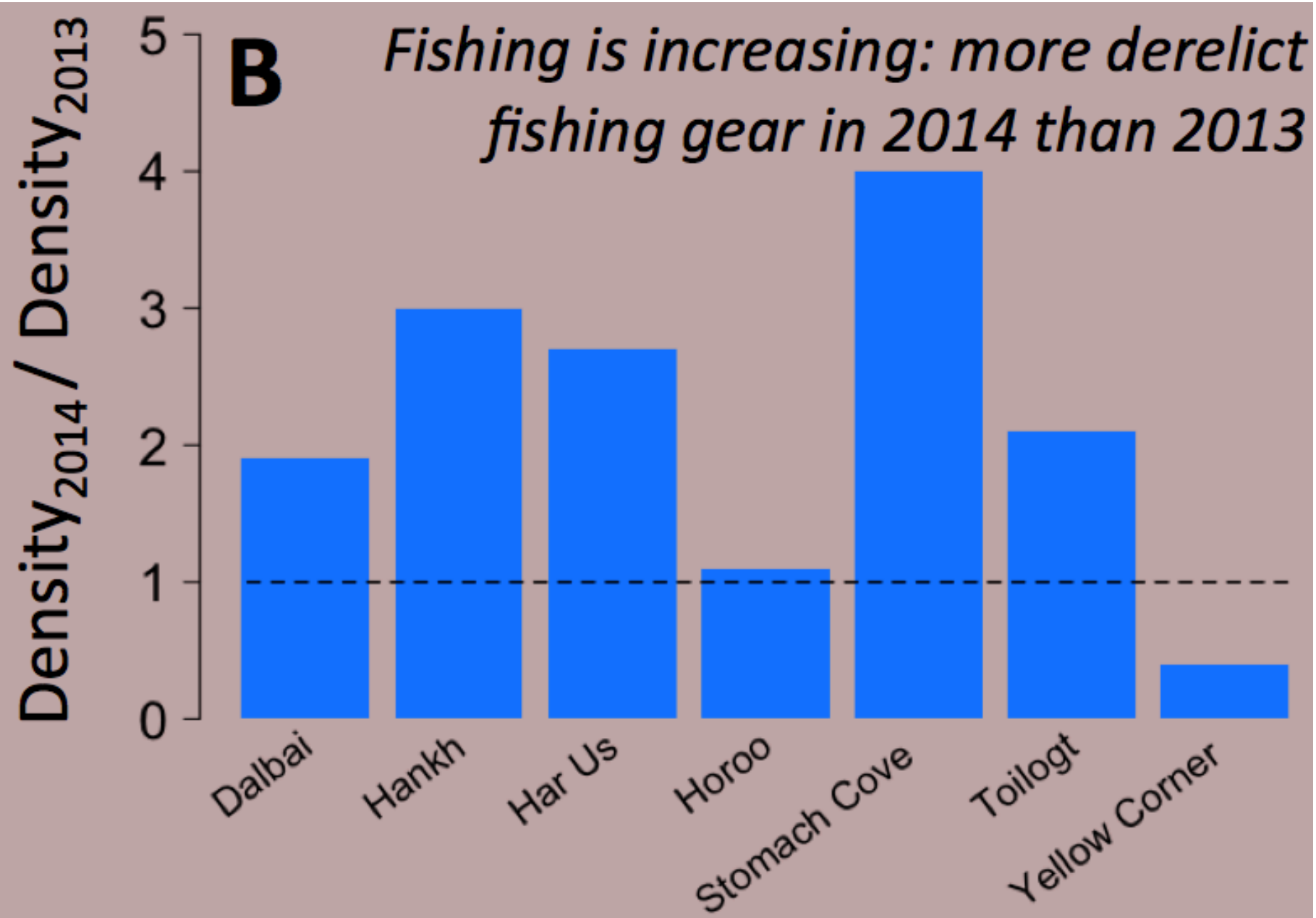

burbot
CPUE (# 10 m^{-1})
0
5
10
15
1.3
2.5
3.8
5.1
6.3
7.6


perch
CPUE (# 10 m^{-1})
0
5
10
15
1.3
2.5
3.8
5.1
6.3
7.6


all fish
CPUE (# 10 m^{-1})
0
20
40
60
80
100
120
1.3
2.5
3.8
5.1
6.3
7.6

Where/when do people fish?

How much fishing is there?



Who fishes and why?

Conclusions

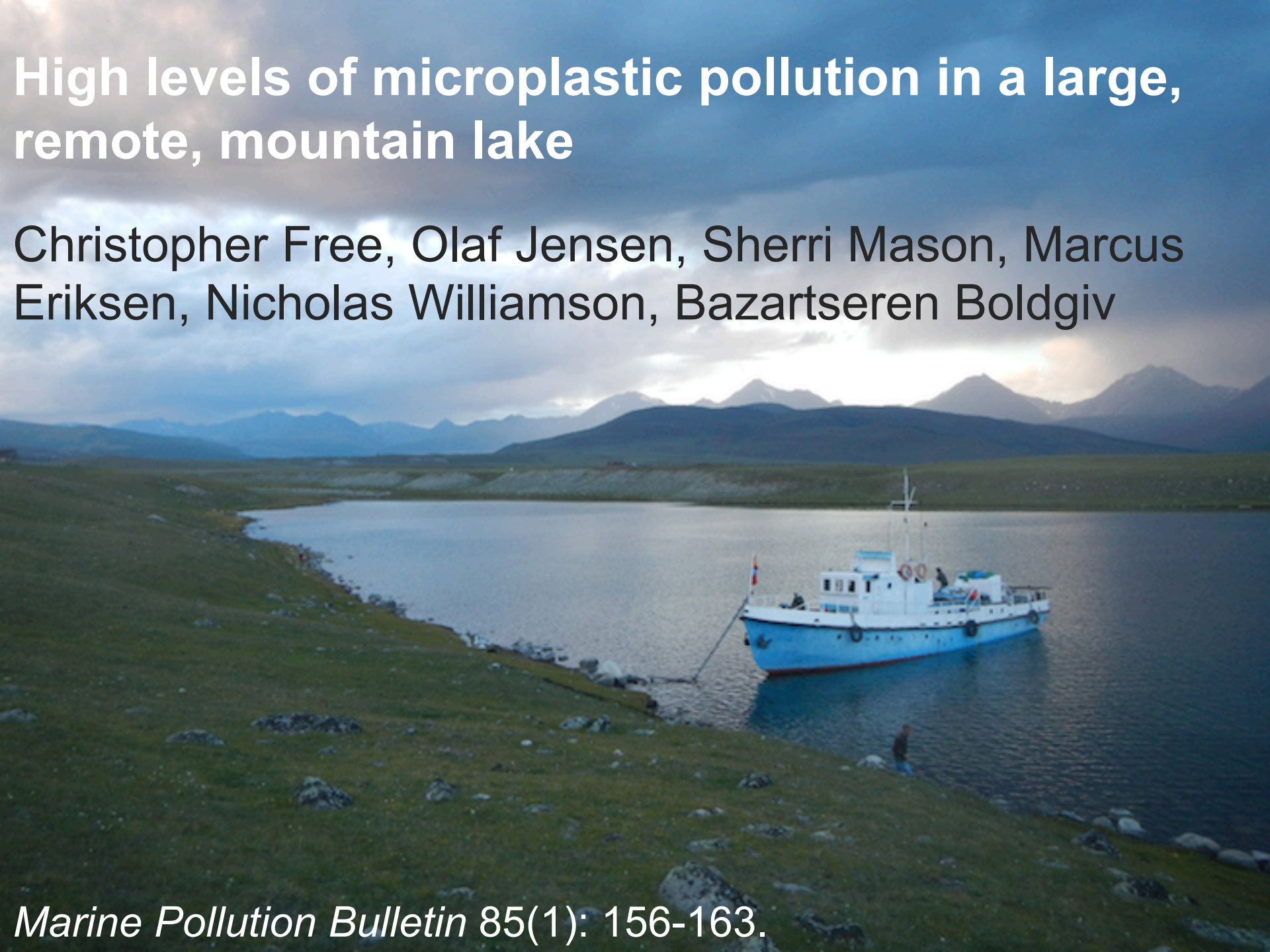
- Gillnet fishing is widespread, efficiently targets grayling when they are most vulnerable, and is a likely threat to the Hovsgol grayling population

- Park management denies the occurrence and threat of illegal fishing and rangers are powerless to enforce the law

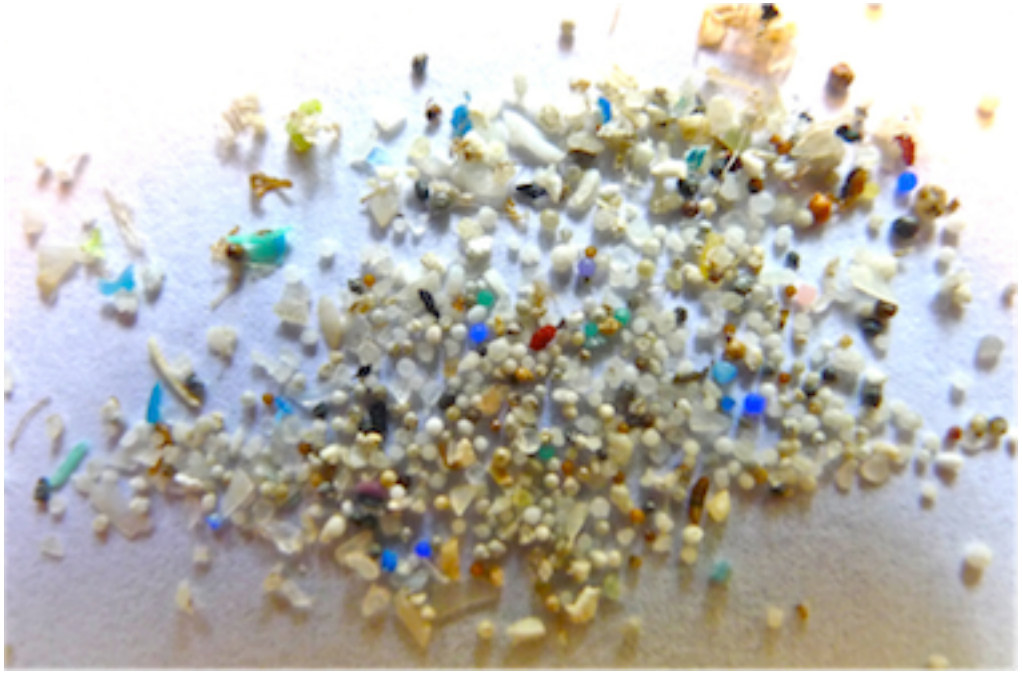
- Education and outreach are necessary to promote grayling conservation. If local people have pride in their endemic species, they will reduce fishing during spawning and empower rangers in enforcement against non-locals.

High levels of microplastic pollution in a large, remote, mountain lake

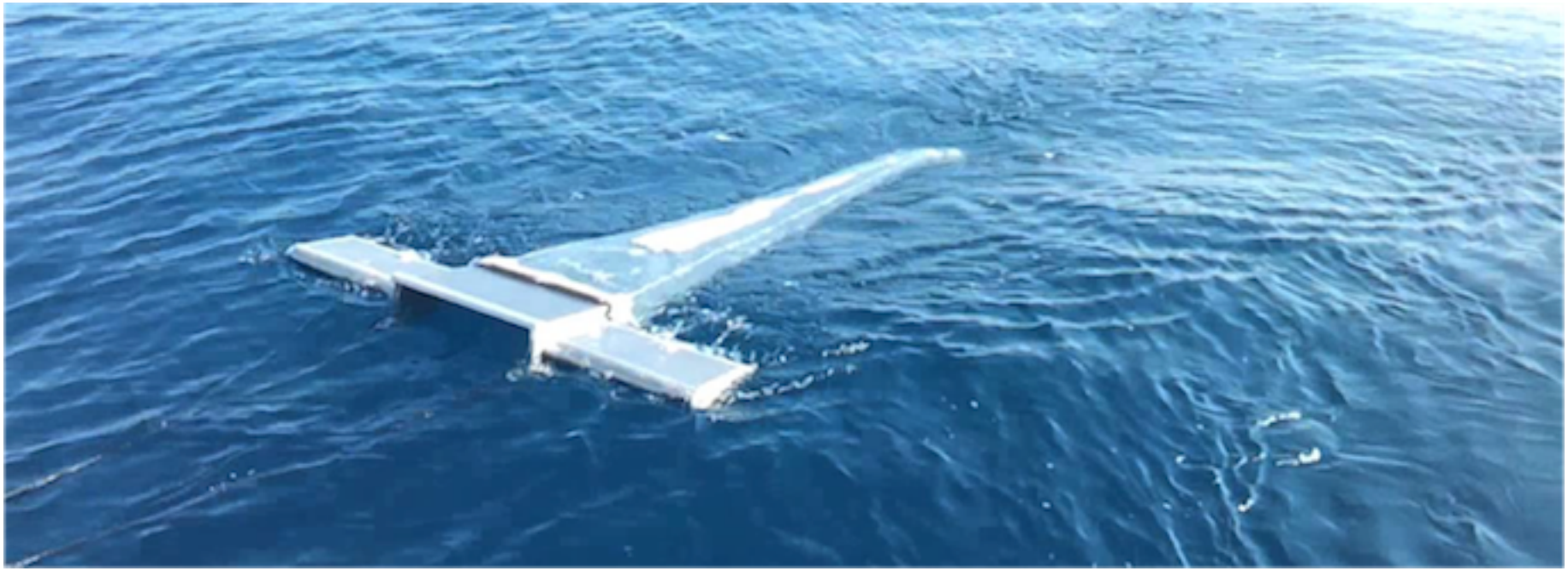
Christopher Free, Olaf Jensen, Sherri Mason, Marcus Eriksen, Nicholas Williamson, Bazartseren Boldgiv

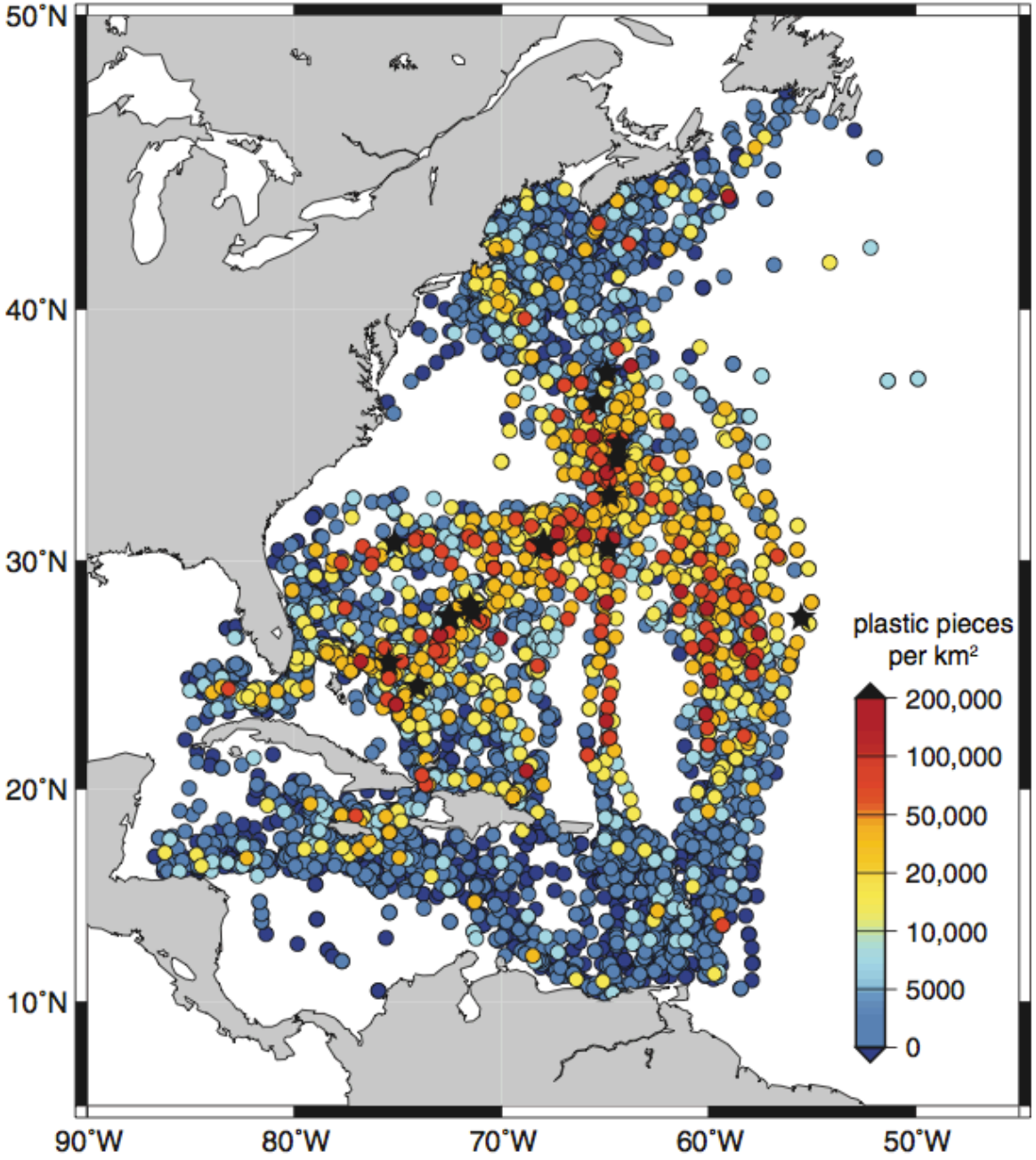


Marine Pollution Bulletin 85(1): 156-163.

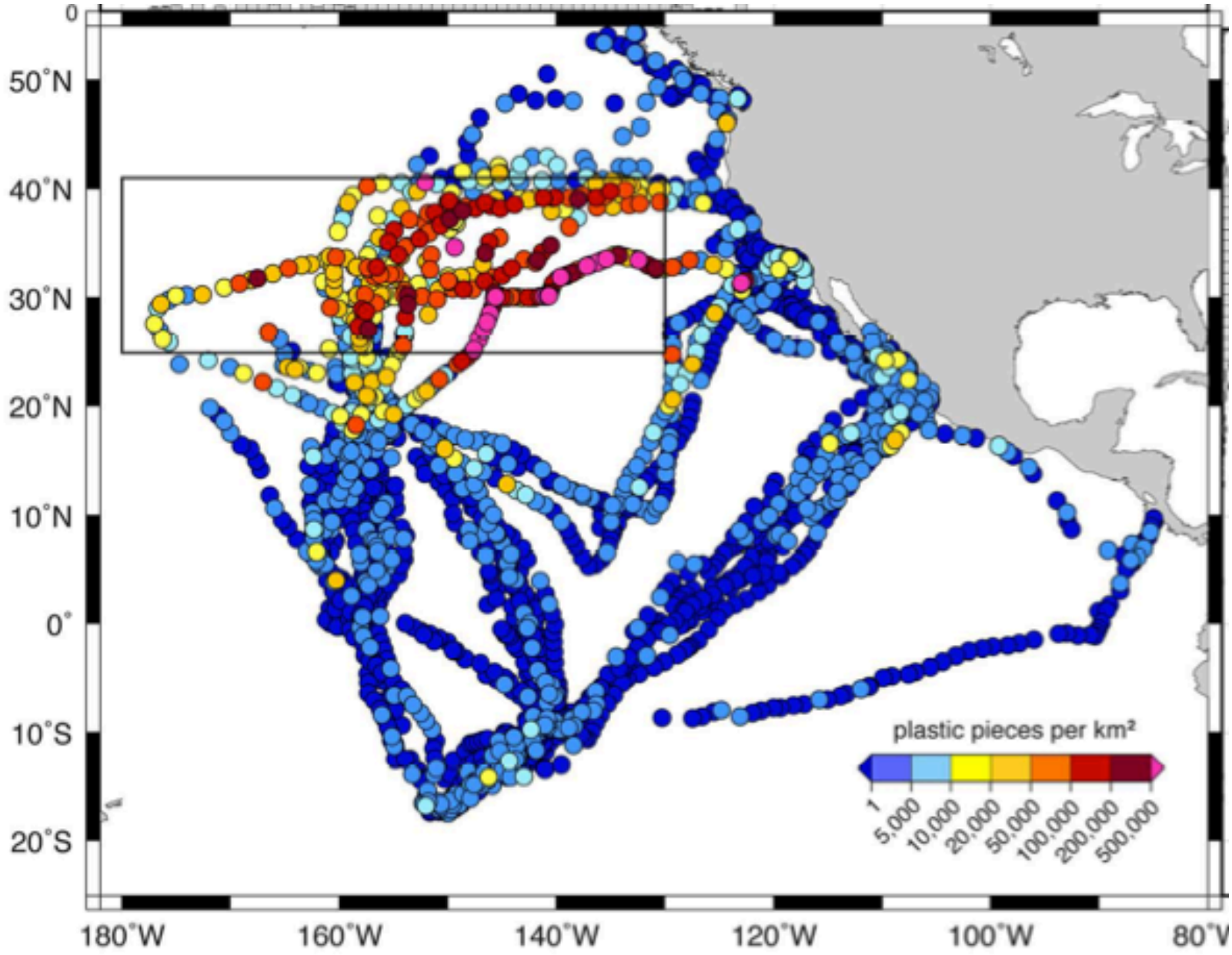


TRUST
LIBERTY
2004

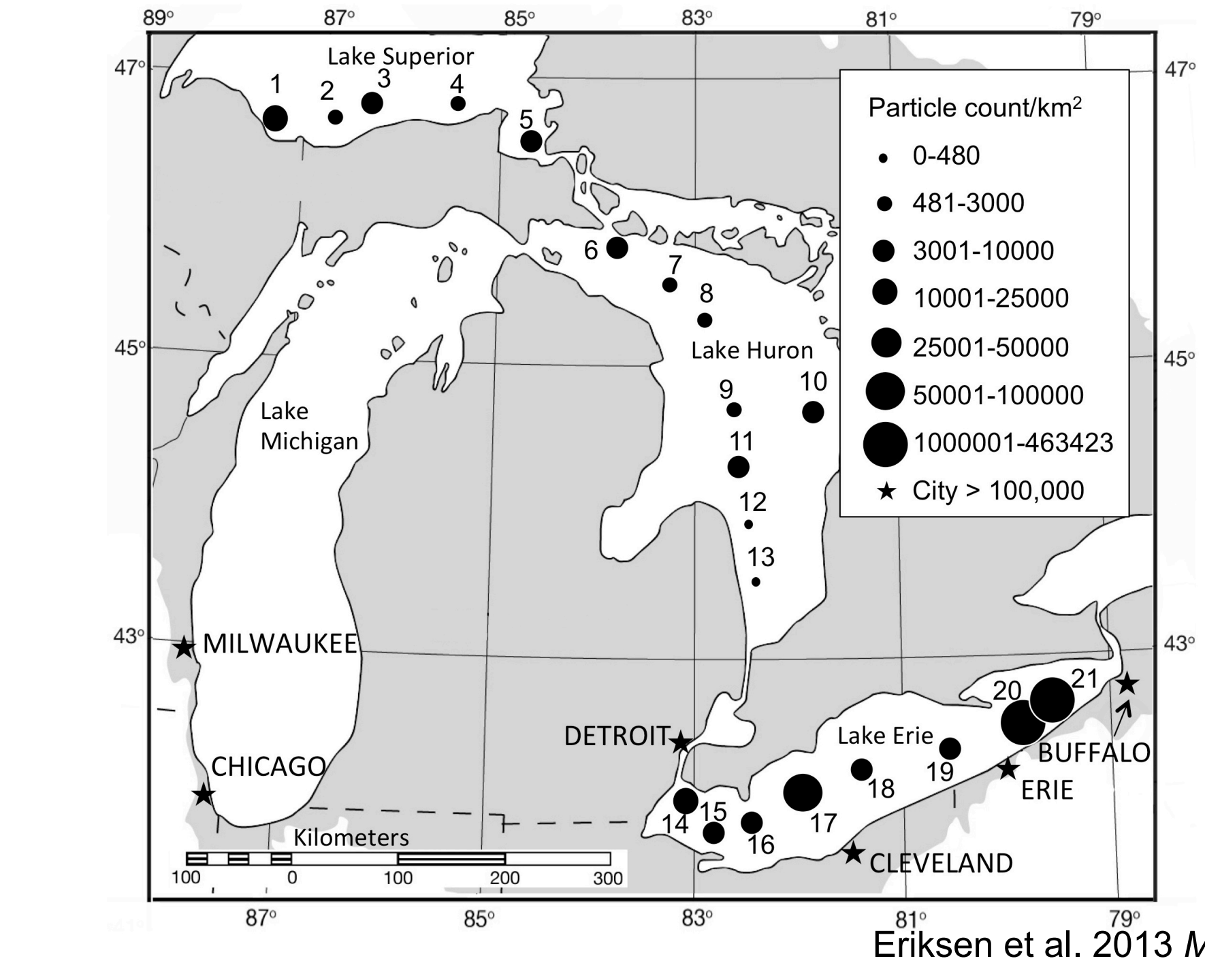




Law et al. 2010 *Science*

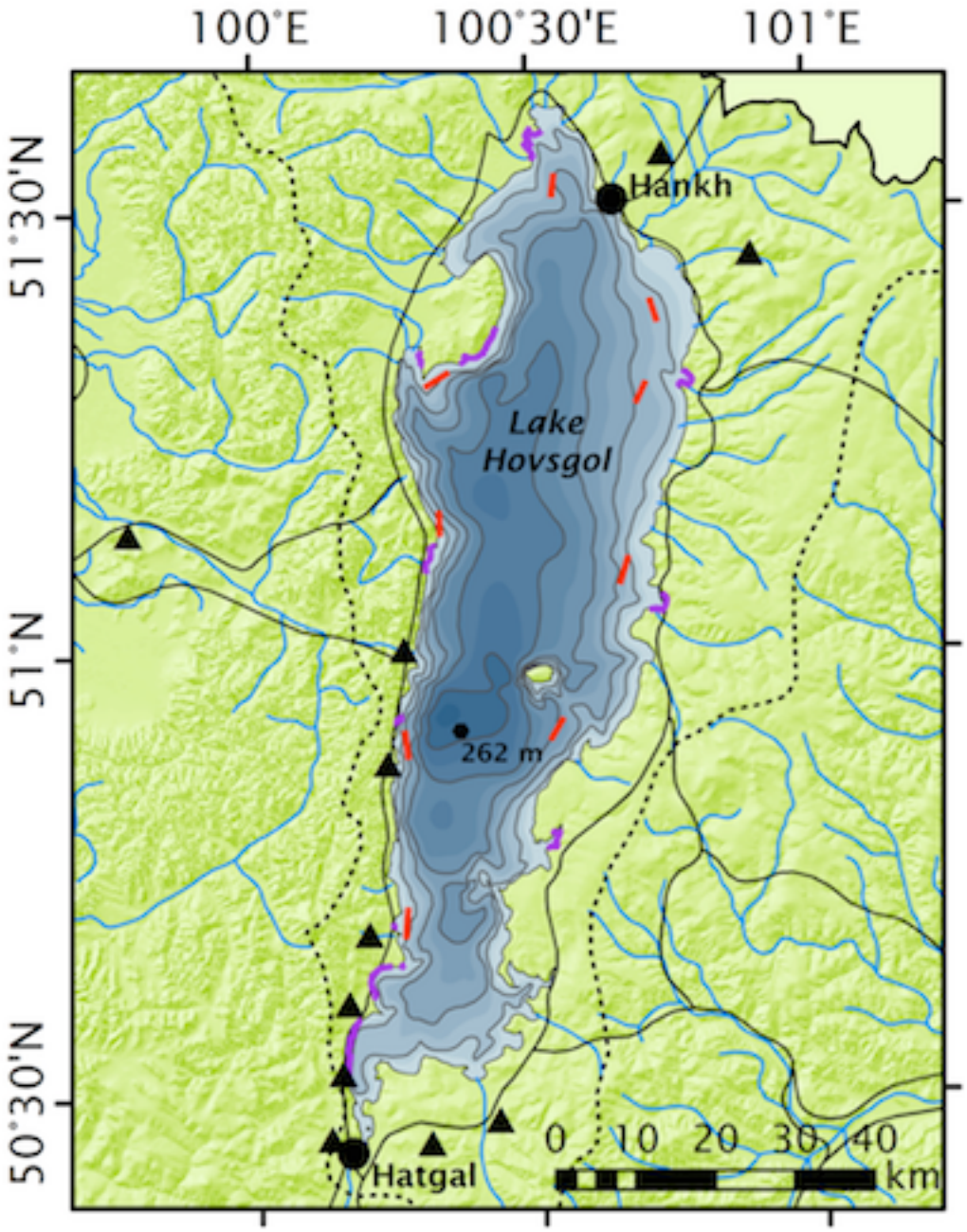


Law et al. 2014 *ES&T*



Eriksen et al. 2013 *MPB*

Photo: M. Eriksen
NEUTROGENA
DEEP CLEAN
GENTLE
SCRUB
oil free
Neutrogena
Clean & Clear
daily pore
cleanser
Johnson & Johnson
NET WT. 5.5 OZ. (156g)
new look
Aveeno
ACTIVE NATURALS
positively radiant
skin brightening
daily scrub
gently exfoliates for
even tone and texture


100°E
100°30'E
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51°30'N
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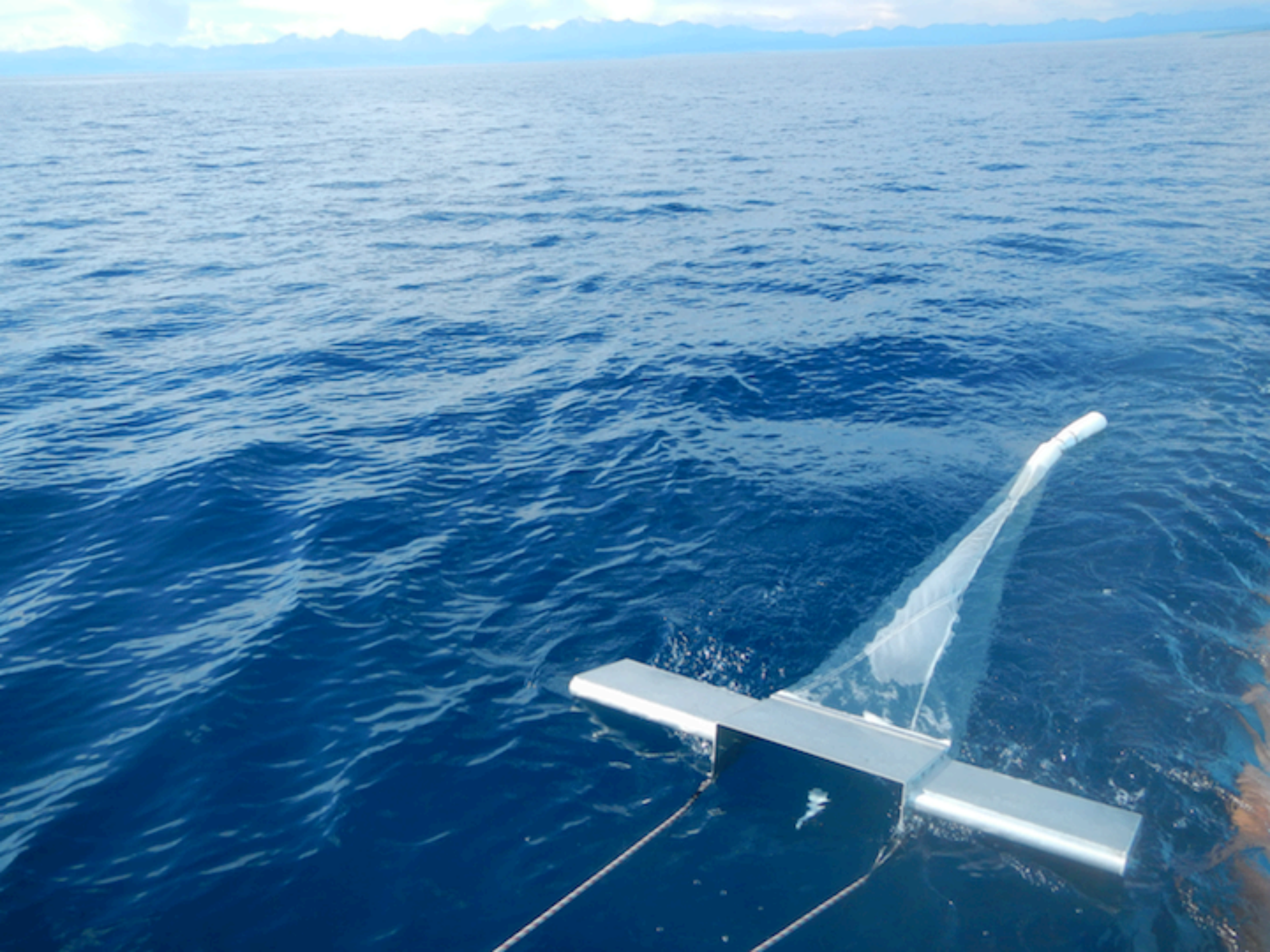
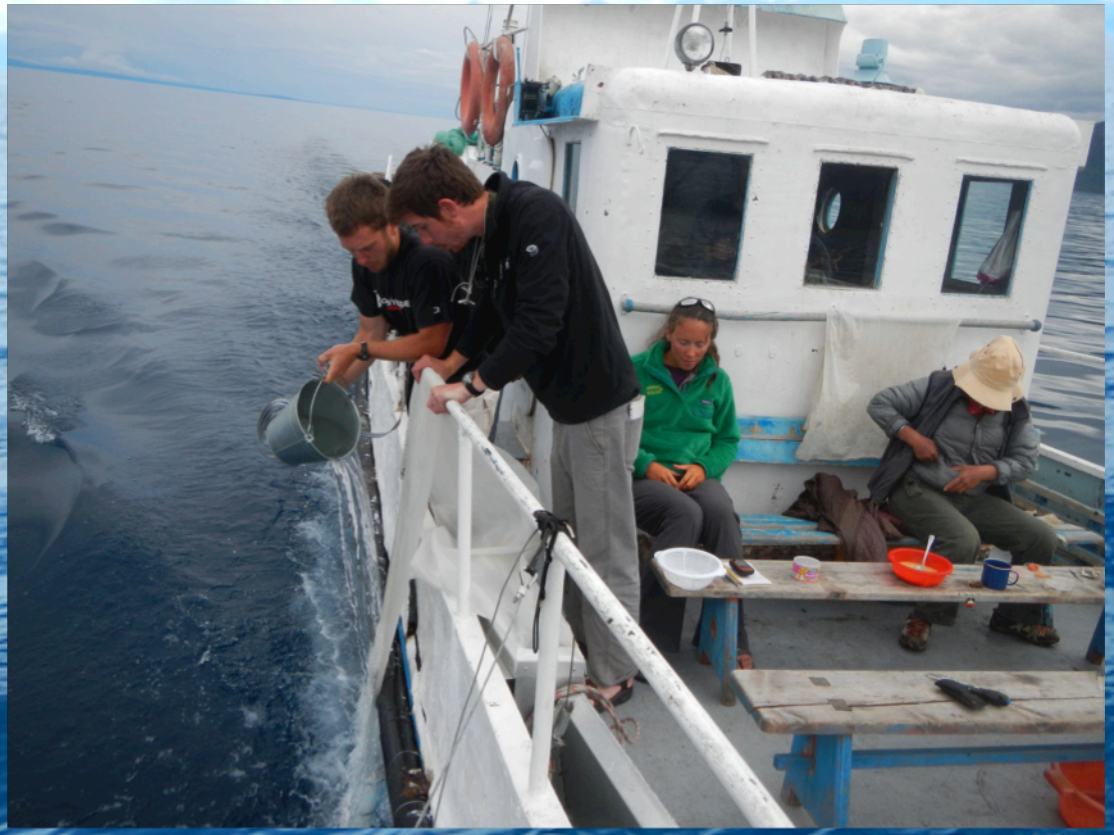
Hankh
Lake
Hovsgol
262 m
Hatgal
0 10 20 30 40
km

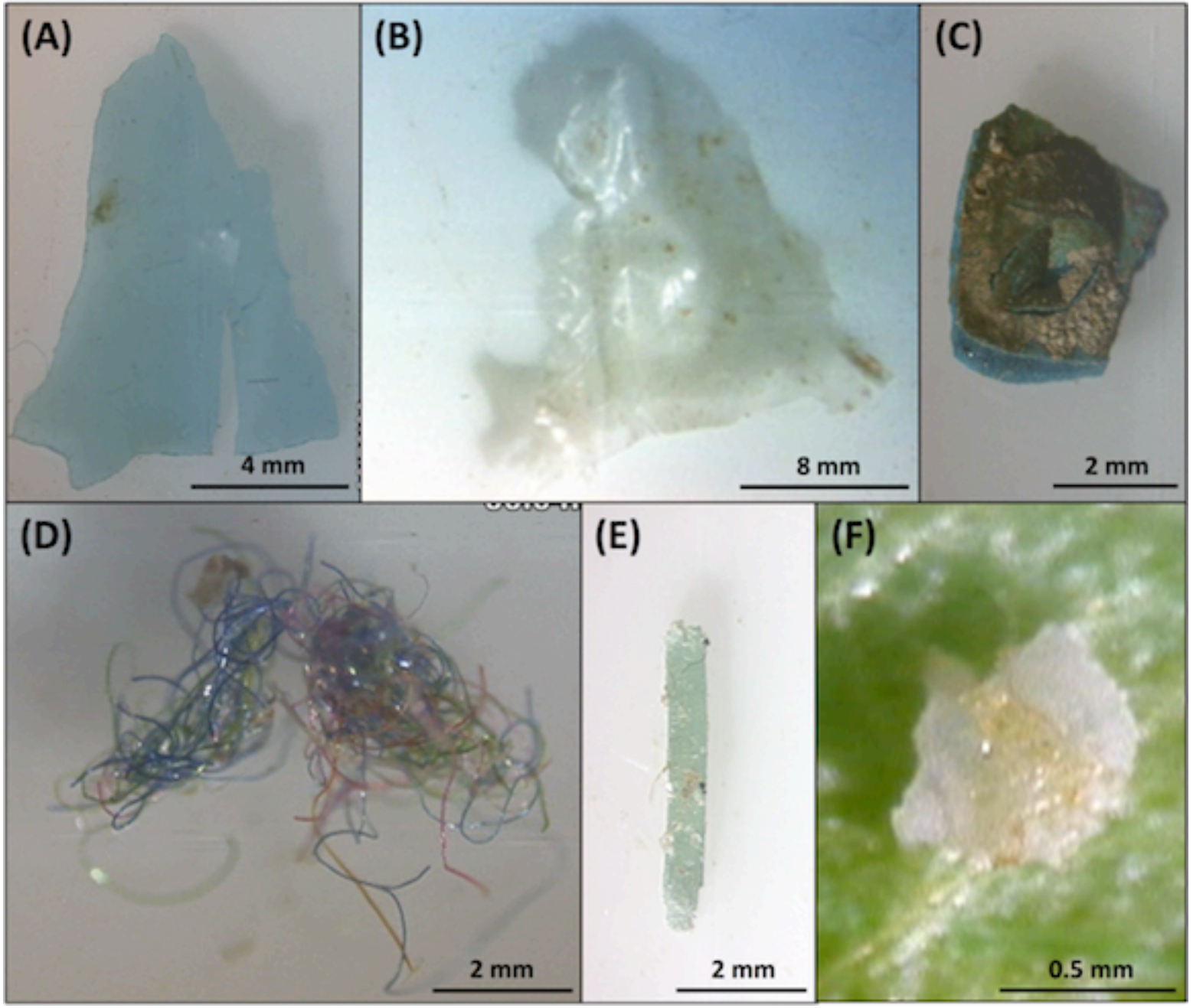
90°E
100°E
110°E
120°E
50°N
45°N
40°N
RUSSIA
Irkutsk
Mörön
Ulanbaatar
MONGOLIA
CHINA
0 250 500 1,000
km

Photo: Mongol Ecology Cent





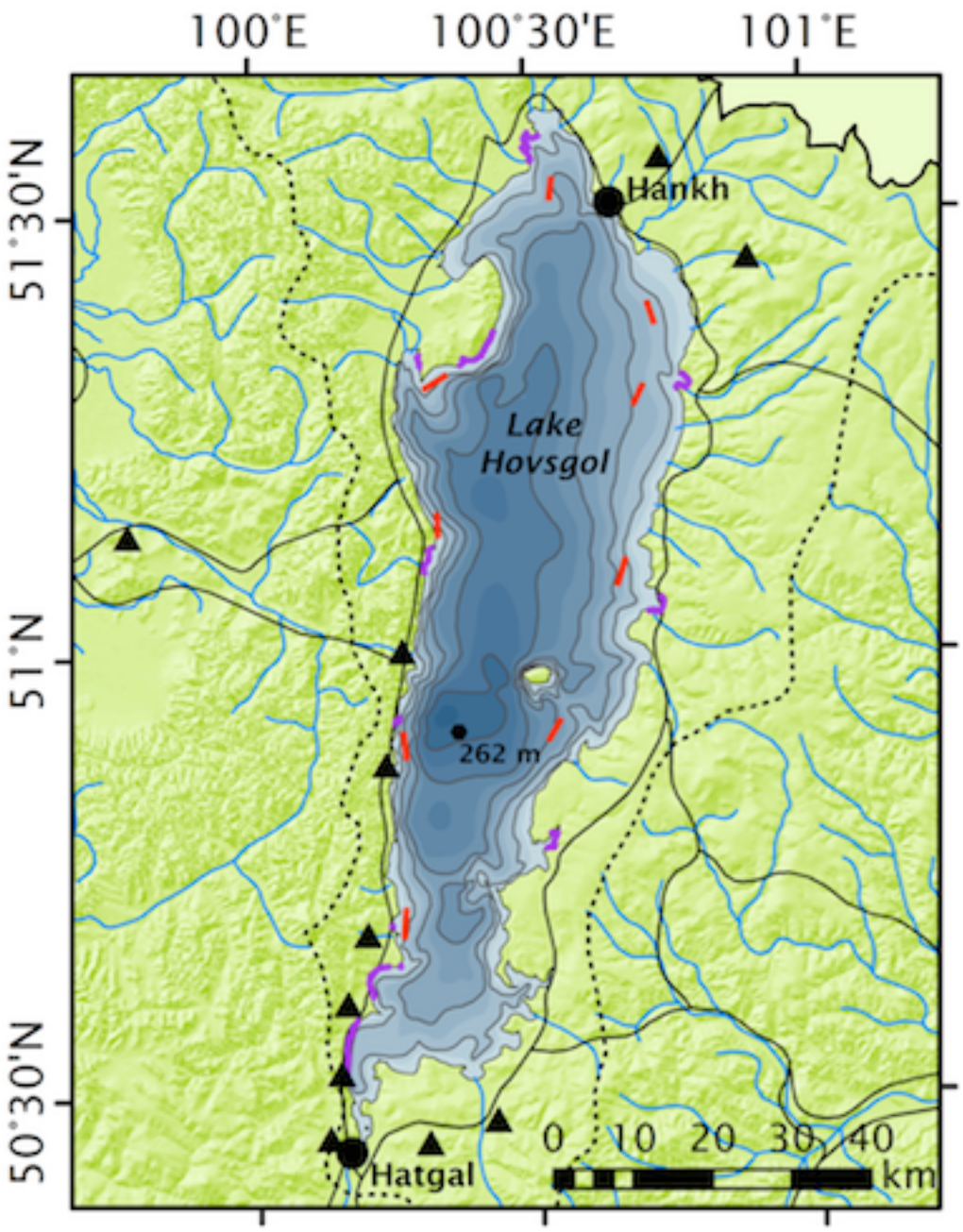
Boathouse
SPORTS



Free et al. 2014

Construct an explanation that predicts the spatial distribution of macroplastic density in Lake Hovsgol.

SEP 6: Constructing Explanations and Designing Solutions - The goal of science is to construct explanations for the causes of phenomena. Students are expected to construct their own explanations.


100°E
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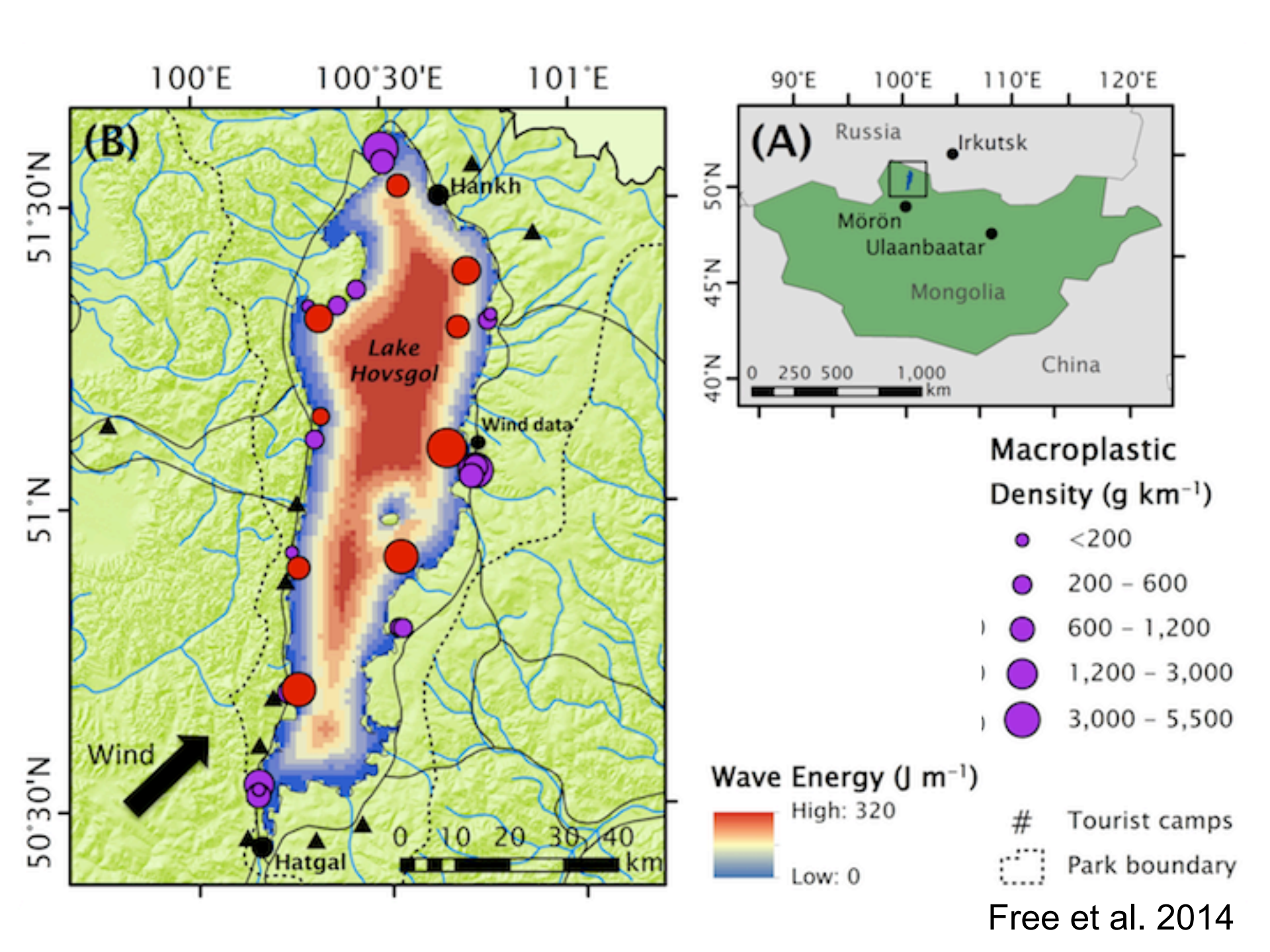
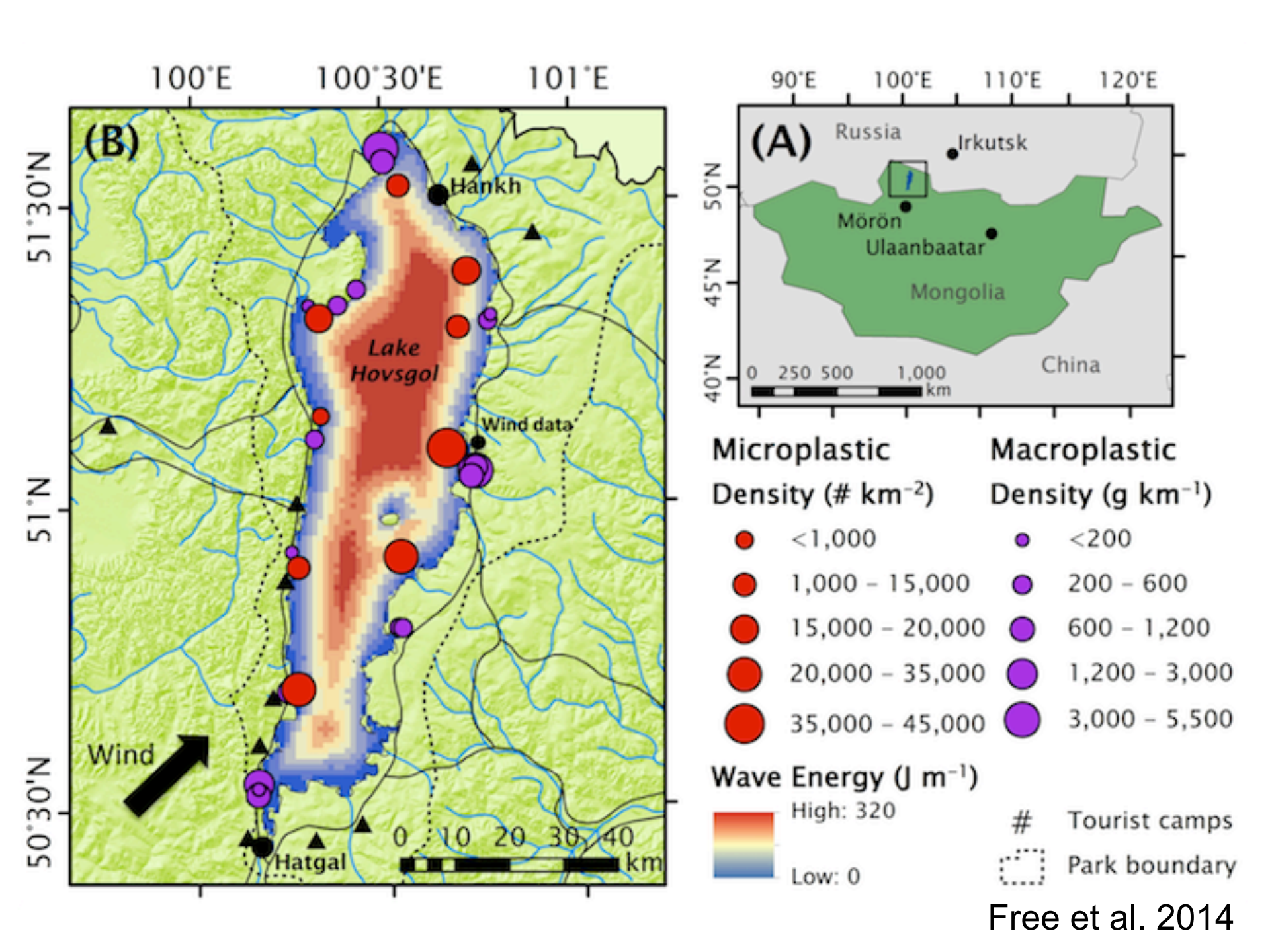
120°E
50°N
45°N
40°N
RUSSIA
Irkutsk
Mörön
Ulanbaatar
MONGOLIA
CHINA
0 250 500 1,000
km

Construct an explanation that describes the relationship between macroplastic density and wave direction in Lake Hovsgol.

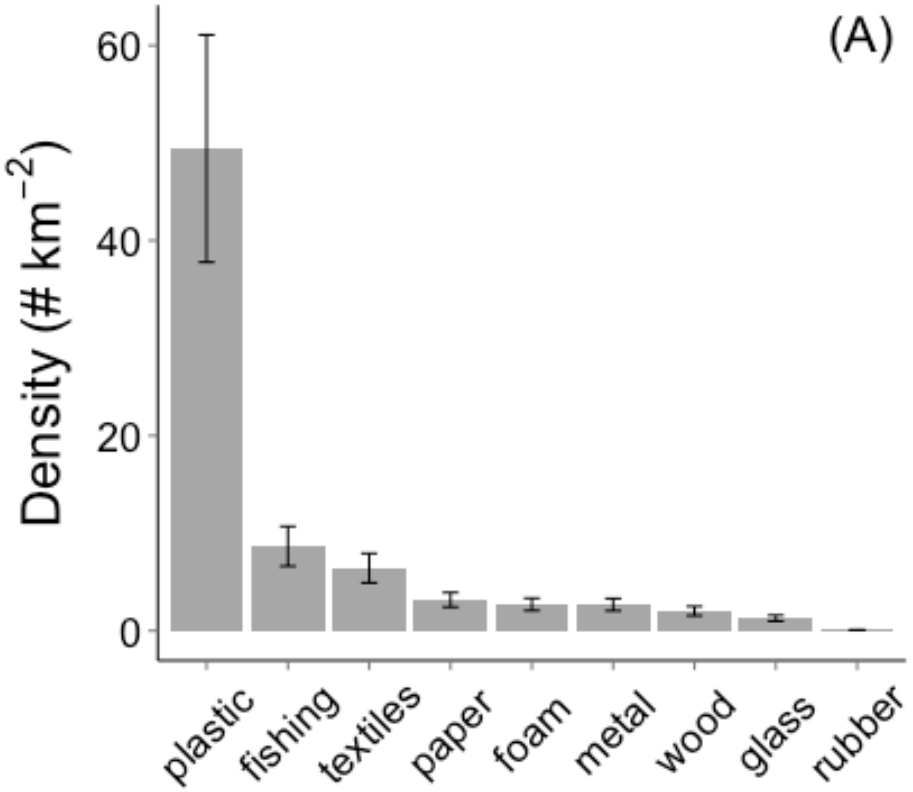
SEP 6: Constructing Explanations and Designing Solutions - The goal of science is to construct explanations for the causes of phenomena. An explanation includes a claim that relates how a variable or variables relate to another variable or a set of variables. A claim is often made in response to a question and in the process of answering the question, scientists often design investigations to generate data.

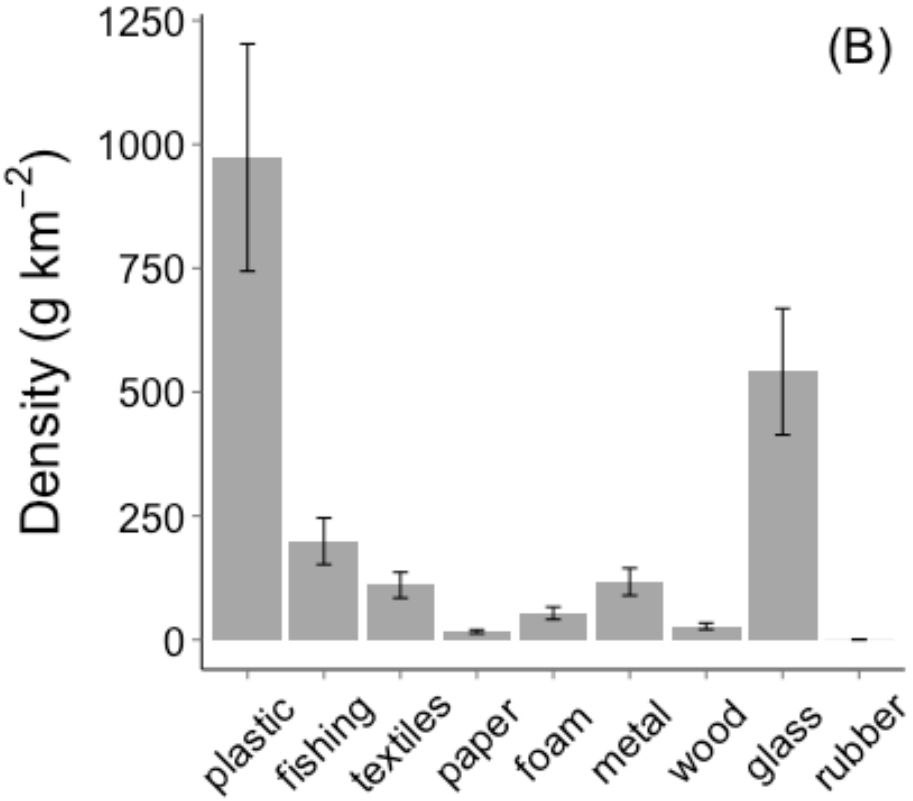


Free et al. 2014



Free et al. 2014





37% 25% 16% 22%

bottles fishing gear bags miscellaneous

	Average Microplastic Density (particles/km²)				
Plastic Type	**0.333-0.999 mm**	**1.000-4.749 mm**	**>4.75 mm**	**Total**	**Percent**
Fragment	5,950	1,876	335	8,160	40%
Film	881	4,164	2,740	7,786	38%
Line/fiber	1,237	2,044	702	3,984	20%
Foam	219	0	0	219	1%
Pellet	0	58	57	115	1%
Total	8,287	8,142	3,834	**20,264**	
Percent	41%	40%	19%		

Free et al. 2014

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Percent	41%	40%	19%		

Potential sources of microplastics…

fragments

films

fibers

lines

Free et al. 2014

Lake, Country[1]	Lake Area (km²)	Watershed Population	Residence Time (yr)	# Tows	Plastic Density (particles/km²) Average	Maximum	Dominant Type
Lake Geneva, Switzerland[41]	584	950,000	11.8	3	51,556	82,713	fragments/films
Lake Superior, USA[43]	82,097	673,000	173.0	5	5,391	12,645	pellets/fragments
Lake Huron, USA[43]	59,565	3,000,000	21.0	8	2,779	6,541	pellets/fragments
Lake Erie, USA[43]	25,655	12,400,000	2.7	8	105,503	466,305	pellets/fragments
Lake Hovsgol, Mongolia	2,760	6,000	300-600	9	20,264	44,435	fragments/films

[1] Lake characteristics for the US Great Lakes are from the NOAA Great Lakes Environmental Research Laboratory [96] and lake characteristics of Lakes Geneva and Hovsgol are from the ILEC World Lakes Database [97].

Free et al. 2014

CoSEE
CENTERS FOR OCEAN SCIENCES EDUCATION EXCELLENCE

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Scientist Resources | Education Resources | NOW Legacy | Online Community | NOW Research | Contact Us

K-12 Lesson Plans:

Sea Level Trends – This activity explores one facet of climate change — sea level change. Investigate and compare long-term changes in sea level from different coastal locations around the United States.

Heat Capacity – Students use ocean observing system data to investigate the concept of heat capacity and find out why water acts as a thermal buffer and the practical applications this has.

To see other Lesson Plans visit the Lesson Plans & Activities page.

http://coseenow.net/

Teacher Appreciation Event

- Come share your thoughts, suggestions, and opinions!
- Tuesday October 28th 5-7pm
- Marine Science Building (71DudleyRd., New Brunswick, NJ)
- We will provide appetizers, capture your feedback, and give tours of the Rutgers Glider Lab
- https://rutgers.qualtrics.com/SE/?SID=SV_4JASiwaDodvIcl

Questions?