

# **The possible effects of invasive freshwater species on fish and fisheries in Iceland**

**Ingi Rúnar Jónsson**

Marine and Freshwater Research Institute, Reykjavik, Iceland

[ingi.runar.jonsson@hafogvatn.is](mailto:ingi.runar.jonsson@hafogvatn.is)

## Overview

Fish species in freshwater in Iceland. Value of sport fisheries

The diatom *Didymosphenia geminata* in Iceland

New fish species. Potential threats

Iceland is a young volcanic island (103.000 km<sup>2</sup>) in the North Atlantic Ocean.

Between 63° and 67° N latitude and 13° and 25° W longitude - close to the Arctic Circle.

Iceland has a relatively mild coastal climate.



Nearest neighbours:

- Greenland ~280 km
- Norway ~950 km
- Faroye Islands ~400 km

# 5 native species of freshwater fish in Iceland



Atlantic salmon (*Salmo salar*)



Arctic charr (Arctic charr) (searun and resident)



Brown trout (*Salmo trutta*) (searun and resident)



Eel (European eel (*Anguilla anguilla*), American eel (*Anguilla rostrata*))



Sticklebacks (*Gasterosteus aculeatus*)

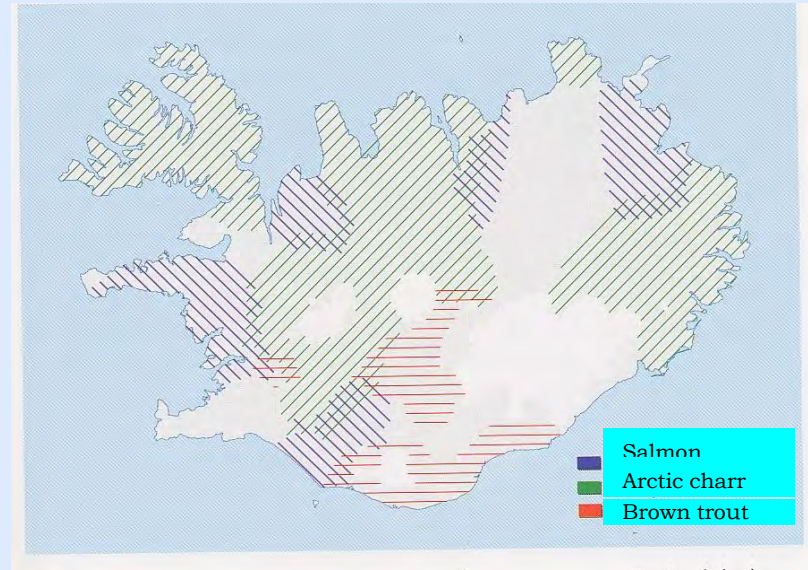
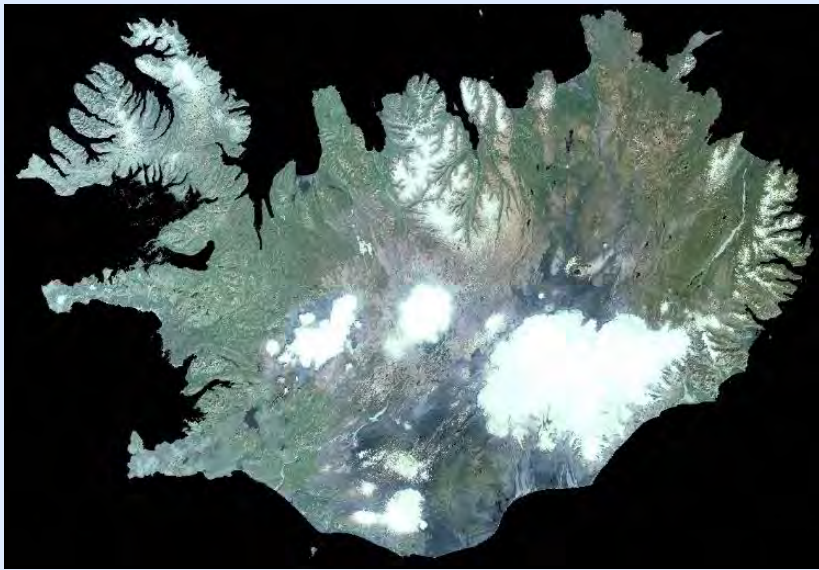


Rainbow trout (*Oncorhynchus mykiss*) imported for aquaculture

- **Brown trout and Arctic charr can have both resident and sea-migrating populations.**
- **Unlike the Atlantic salmon they have limited seawater tolerance. Sea migration lasts 5-10 weeks and stay in freshwater during winter time**
- **Eel is catadromous, i.e. spawns in the sea and feed in freshwater.**

# Management structure of freshwater fisheries in Iceland

- Salmon fishery has been of high value in Iceland since the first settlement.
- The first complete written law (year about 1245) states how a landowner were allowed to fish. Part of the river had to be open to allow fish to pass through the whole river system from the ocean to the upper regions.
- Fishing rights in freshwater are privately owned.
- Close to 1800 farms in Iceland have income from salmon fishery
- Fishing rights go with adjacent land, can not be sold separately.
- Landowners (farmers) have (by law) to form a Fisheries Association that manages the fishing rights.
- Fishing rights are usually leased for rod and line fishery. Decided by the majority of the Landowner Fisheries Association.



The dominant salmonid species in different parts of Iceland

Salmon rivers - average rod catch:

1000-2000	salmon	12	rivers
300-1000	salmon	19	rivers
100-300	salmon	32	rivers
< 100	salmon	47	rivers
	Total	110	rivers

(Guðbergsson & Antonsson 1996)

# Economic value of sport fishery in Iceland

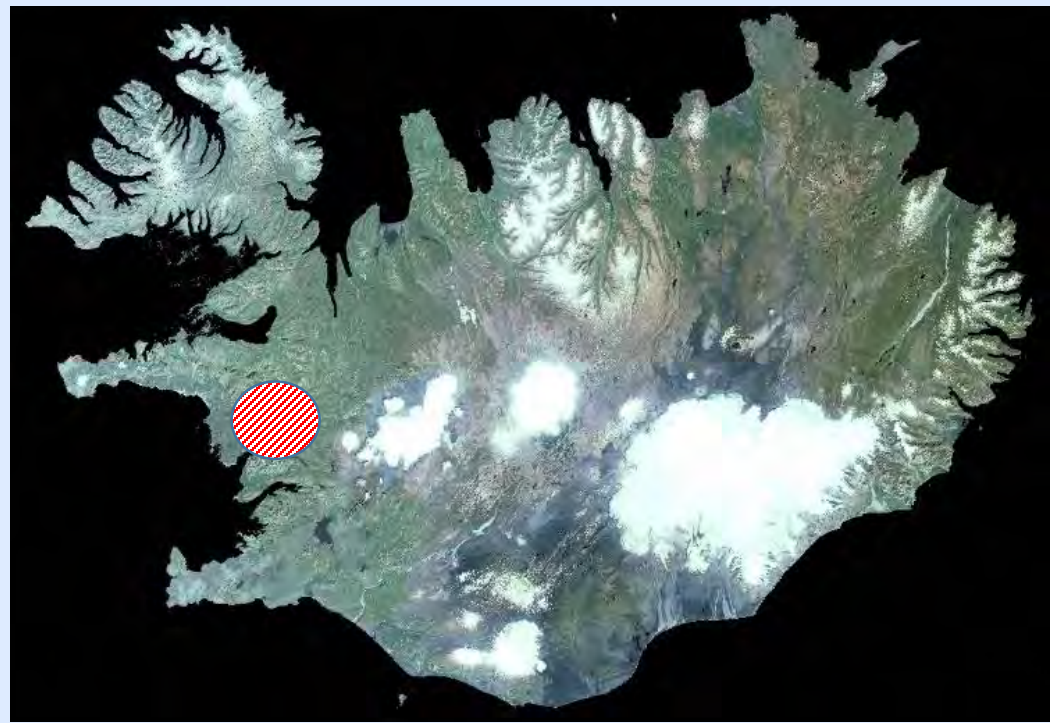
- 31,5% of the people in Iceland (18-69) are sport fishermen, close to 60.000 people
- They fish for 7,9 days/year
- Angling is a very popular sport in Iceland

(Toivonen et al. 2000. Economic value of recreational fisheries in the Nordic countries)

In 1994 there was reported unusual amount of algal growth in the River Hvita, in the Borgarfjordur area in west Iceland. Reported by local fishermen.

According to local farmers the algae growth was first noticed in 1992 and increased the following years, causing nuisance in net-fisheries.

In the Borgarfjordur area there are found many of the most valuable sport fishing rivers in Iceland







# *Didymosphenia geminata* (Lyngbye) Schmidt

- a diatom
- native to the cool temperate regions of the northern hemisphere
- originally described from the Faroe Islands
- common in Scotland, Sweden, Finland, etc.
- was restricted to low nutrients water
- massive production of extracellular stalks create nuisance build-up



Photo: Sara Spaulding

# ¡NIÑOS! PARA EVITAR LA PROPAGACIÓN DEL DIDYMO DEBEMOS CUMPLIR CON LAS SIGUIENTES REGLAS

## DIDYMO

### REMOVER

Antes de dejar el río, saca a largo todo y arranca toda la planta visible que se de su caballo, saca el agua de piscas y canchales. Llévala todo lo removido a un lugar lejano que permita llevar a la basura.

### LAVAR

• Siempre con un sec de limpieza: un cubo grande, desinfectante (solamente cloro para el uso doméstico), agua sal, alcohol y frotas desechables.  
• Limpia con frotas con frotis y alcohol o alcohol desinfectante de piscas.  
• Después de utilizarlo, sumerge los implementos de protección personal y desinfecta en un cubo con un litro de agua y una taza de lejía por 10 minutos.  
• Después de utilizarlo, sumerge los implementos de protección personal en un cubo con un litro de agua y una taza de lejía por 10 minutos.  
• Limpia los implementos que entran en contacto con el agua, como los zapatos, con una solución desinfectante.  
• Limpia los implementos que entran en contacto con el agua, como los zapatos, con una solución desinfectante.  
• Limpia los implementos que entran en contacto con el agua, como los zapatos, con una solución desinfectante.  
• Limpia los implementos que entran en contacto con el agua, como los zapatos, con una solución desinfectante.

### SECAR

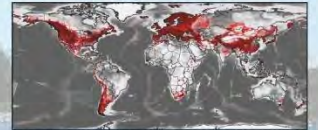
• Los implementos sacos mojados al Didymo pueden ser secados al sol por 72 horas en ambientes bien ventilados.  
• Evita usar sus aparatos de pesca a la vez que otros sacos.

Proyecto P1 y 2012 "Control Masivo de Didymo: Monitoreo de ríos y lagos" Código RP 3013772-0.

<http://www.programadidymomagallanes.cl>

# DIDYMO: a nuisance and invasive freshwater alga

**THE THREAT:** Didymo is an invasive freshwater alga that can form massive blooms. Didymo can smother streambeds and adversely affect freshwater fish, plant and invertebrate species by depriving them of habitat, and also impact recreational opportunities. It is not considered a significant human health risk, but in recent years has been spreading to previously unaffected areas in North America, Europe and Asia, and has been detected in New Zealand. This species historically formed blooms in fast-flowing, cold, clean waters but now didymo is increasing its ecological range. Recent research shows that many countries across the globe provide suitable habitat for didymo to thrive.



Map of the world showing regions where suitable stream habitats for didymo are located. Results for Australia are preliminary (McIhse, US Environmental Protection Agency)

**DESCRIPTION:** Didymo is a freshwater diatom (type of alga) that uses stalks to attach to streambed material. It forms a thick mat which smothers rocks, submerged plants and other materials. As the stalks lengthen, the beige/brown mats shred into the stream and are sometimes washed white at the ends, looking similar to tissue paper. Although they appear slimy, didymo mats feel like wet wool.

**RISK OF SPREAD:** Recreational equipment, including boats, kayaks, lifejackets and fishing gear (particularly waders) is the most likely way for didymo to spread. Didymo can remain viable for several days if kept moist, and can be transferred in microscopic form on equipment to new waterways. Infection may only need a single cell. This means fishermen travelling internationally contribute to the risk of spread. It is not possible to eliminate didymo from a waterway once it has become affected. Decontaminating equipment between use in different freshwater systems is the key to preventing further spread and leaving an environment for all to enjoy. **DON'T SPREAD DIDYMO:** Where possible, equipment should be restricted to use in a single waterway. If this is not feasible, we suggest the decontamination methods of CHECK, CLEAN, DRY.

- CHECK:** Before leaving a river's edge, look for clumps of algae and sediment and remove them. Leave them at the site.
- CLEAN:** Soak all gear for at least one minute in a 2% (by volume) solution of household bleach, or a 5% (by volume) solution of dishwashing detergent or salt. All surfaces must be in contact with the cleaning solution for a full minute. Water-absorbent equipment (lifejackets, waders) should be soaked thoroughly to ensure complete contact.
- DRY:** If cleaning is not practical, after the item is dry to the touch, leave it to dry for at least another 48 hours before using in another freshwater system.



Fish and Game New Zealand



MORE INFORMATION:  
[www.epa.gov/region8/water/monitoring/didymosphenia.html](http://www.epa.gov/region8/water/monitoring/didymosphenia.html)  
[www.fedflyfishers.org/conDidymo.php](http://www.fedflyfishers.org/conDidymo.php)

## WARNING

The invasive algae "didymo" is present in this river

### STOP ROCK SNOT

After leaving this water:

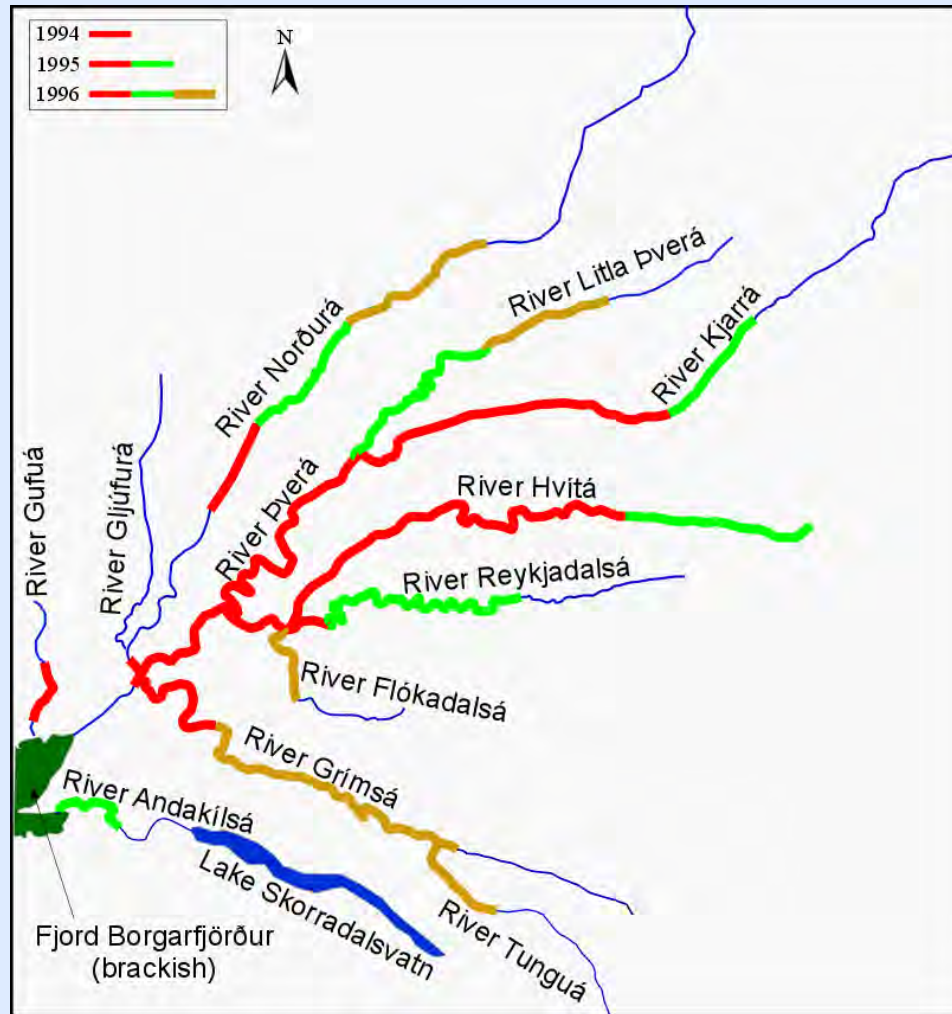
**CHECK** - Remove all visible clumps of algae and plant material from fishing gear, waders, clothing, water shoes and sandals, canoes and kayaks, **and anything else** that has been in the water.

**CLEAN** - Using HOT tap water and lots of soap; **Scrub** boats and other "hard" items thoroughly; **Soak** clothes, felt-sole waders and other "soft" items for **30 minutes!!!!**

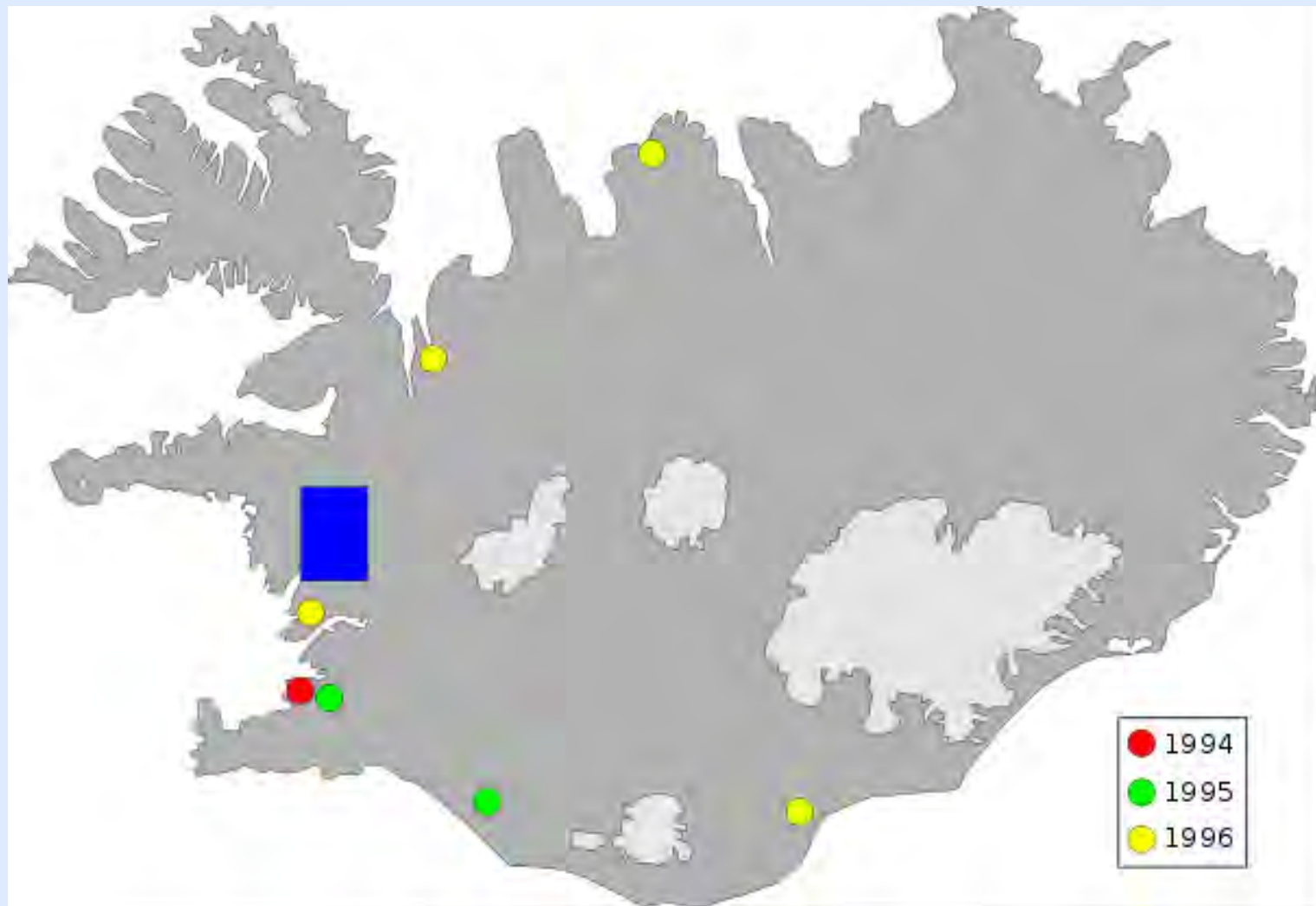
Get more information:  
 In Vermont, contact the VT DEC at 802-241-3777 or visit [www.nmr.state.vt.us/dec](http://www.nmr.state.vt.us/dec)  
 In New Hampshire, contact the NH DEC at 603-375-2248 or visit [www.dss.state.nh.us/wmb/evoltisspecies](http://www.dss.state.nh.us/wmb/evoltisspecies)

Please do your part - Don't Spread Didymo!

# Distribution of *Didymosphenia geminata* in the Borgarfjörður rivers in 1994-1996



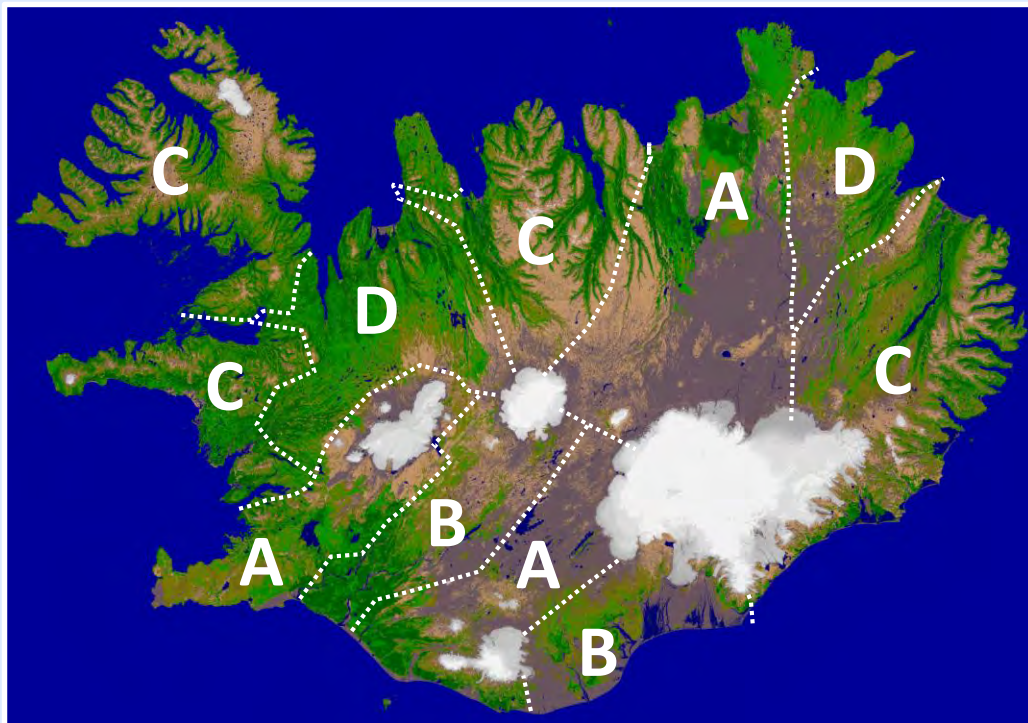
The rivers in Iceland where *D. geminata* was identified in 1994-1996. The blue box is the Borgarfjordur area.



A national survey, carried out in 1997 in Iceland, for mapping the total distribution of Didymo.

Samples were obtained from 117 rivers all over Iceland.

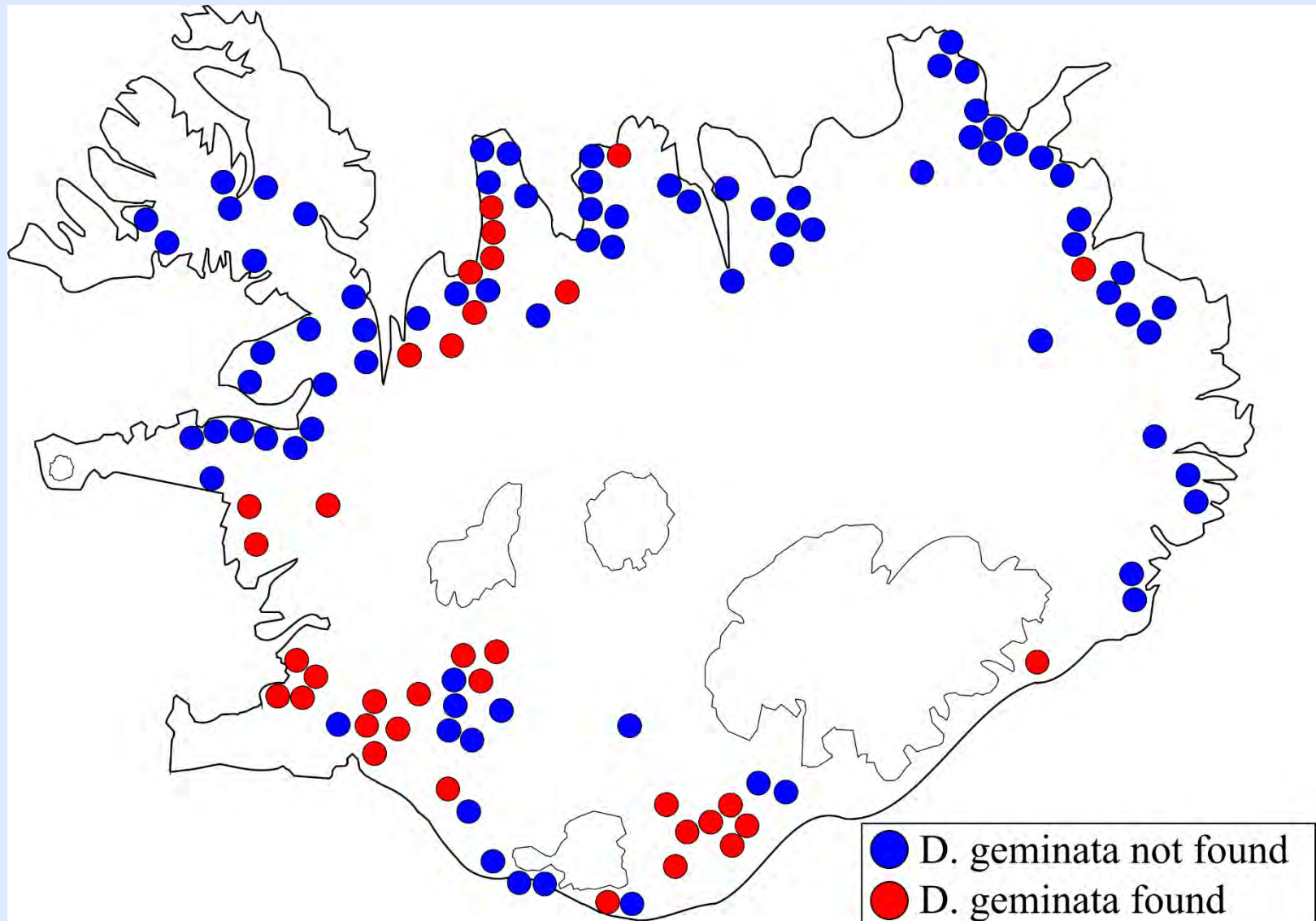
Second national survey was carried out in 2006 and samples obtained from 133 rivers, mainly in the northwest and eastern part of the country.



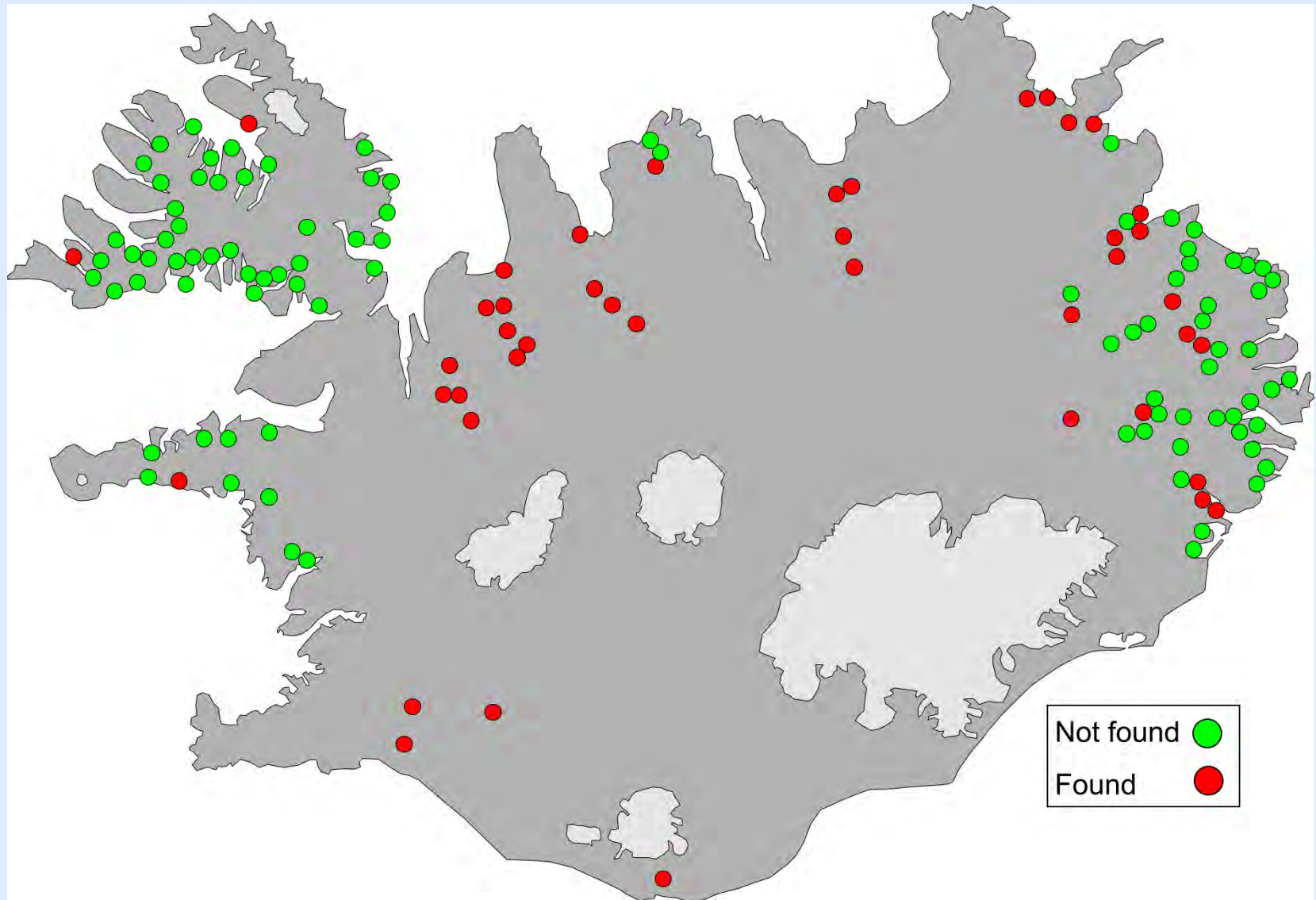
- (A) Spring-fed waters at the neovolcanic zone
- (B) Direct run-off waters at the neovolcanic zone
- (C) Short direct run-off waters of the Tertiary basalt formation
- (D) Long direct run-off waters of the Tertiary basalt formation and waters originating from lakes or wetland heaths

Based on Gudjonsson 1990.

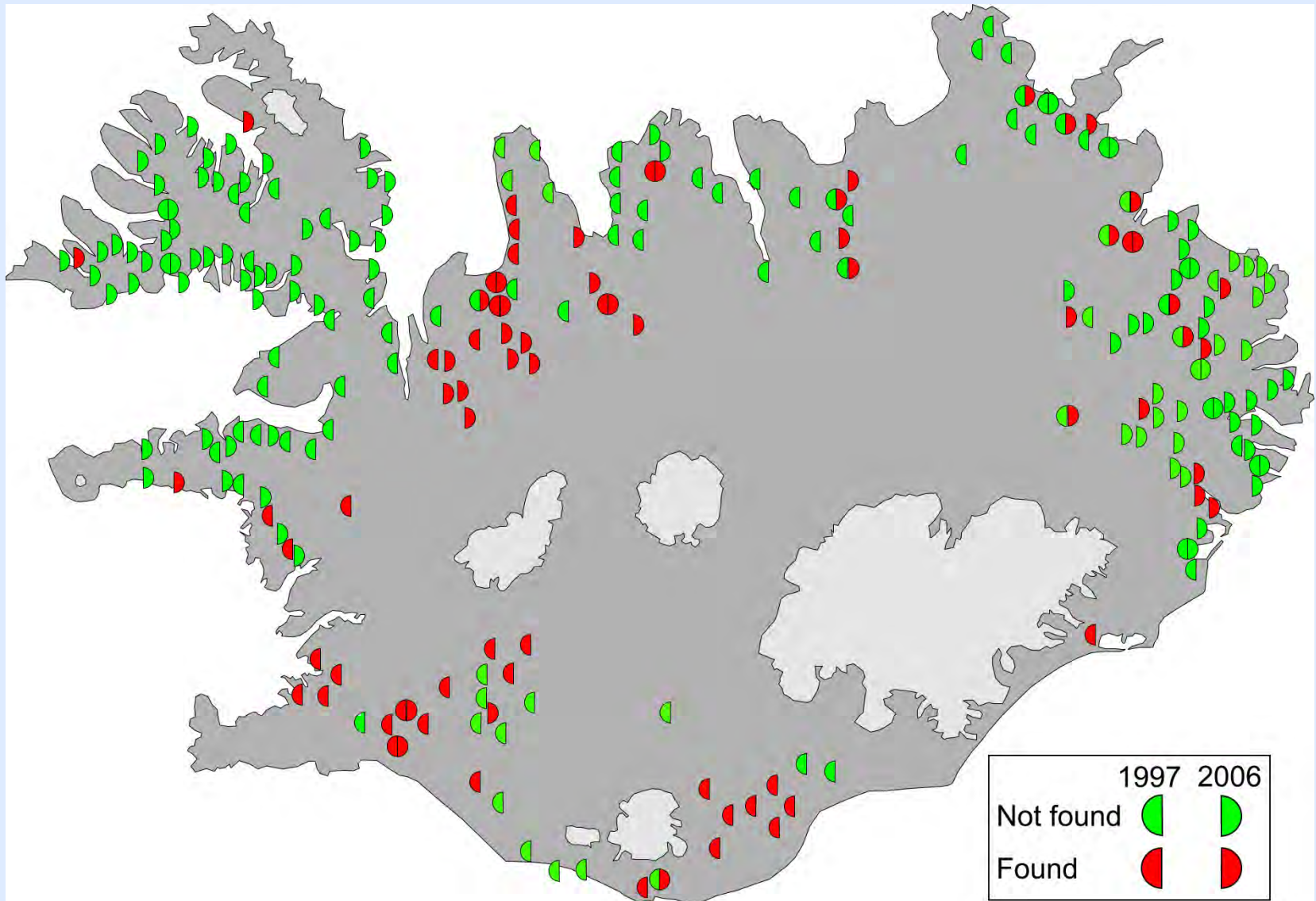
## The occurrence of *D. geminata* in the 1997 survey



# Rivers in Iceland where Didymo was found (red) and not found (green) in the survey in 2006



# Distribution of *Didymosphenia geminata* in Iceland in 1994 and 2006



## References:

Jonsson, G.S., I.R. Jonsson, M. Björnsson & S.M. Einarsson. 2000. Using regionalization in mapping the distribution of the diatom species *Didymosphenia geminata* (Lyngb.) M. Smith in Icelandic rivers. *Verh. Internat. Verein. Limnol.* 27: 340–343.

Jónsson, I.R., G.S. Jónsson, J.S. Ólafsson, S.M. Einarsson and P. Antonsson. 2010. The colonization of the invasive diatom *Didymosphenia geminata* in Icelandic rivers. *Verh. Internat. Verein. Limnol.* 30: 1349–1352.

Spaulding, S.A. and Elwell, L., 2007, Increase in nuisance blooms and geographic expansion of the freshwater diatom *Didymosphenia geminata*: U.S. Geological Survey Open-File Report 2007-1425, 38 p.

# New fish species



European flounder  
(*Platichthys flesus*)



<http://www2.dnr.cornell.edu/cek7/nyfish/>



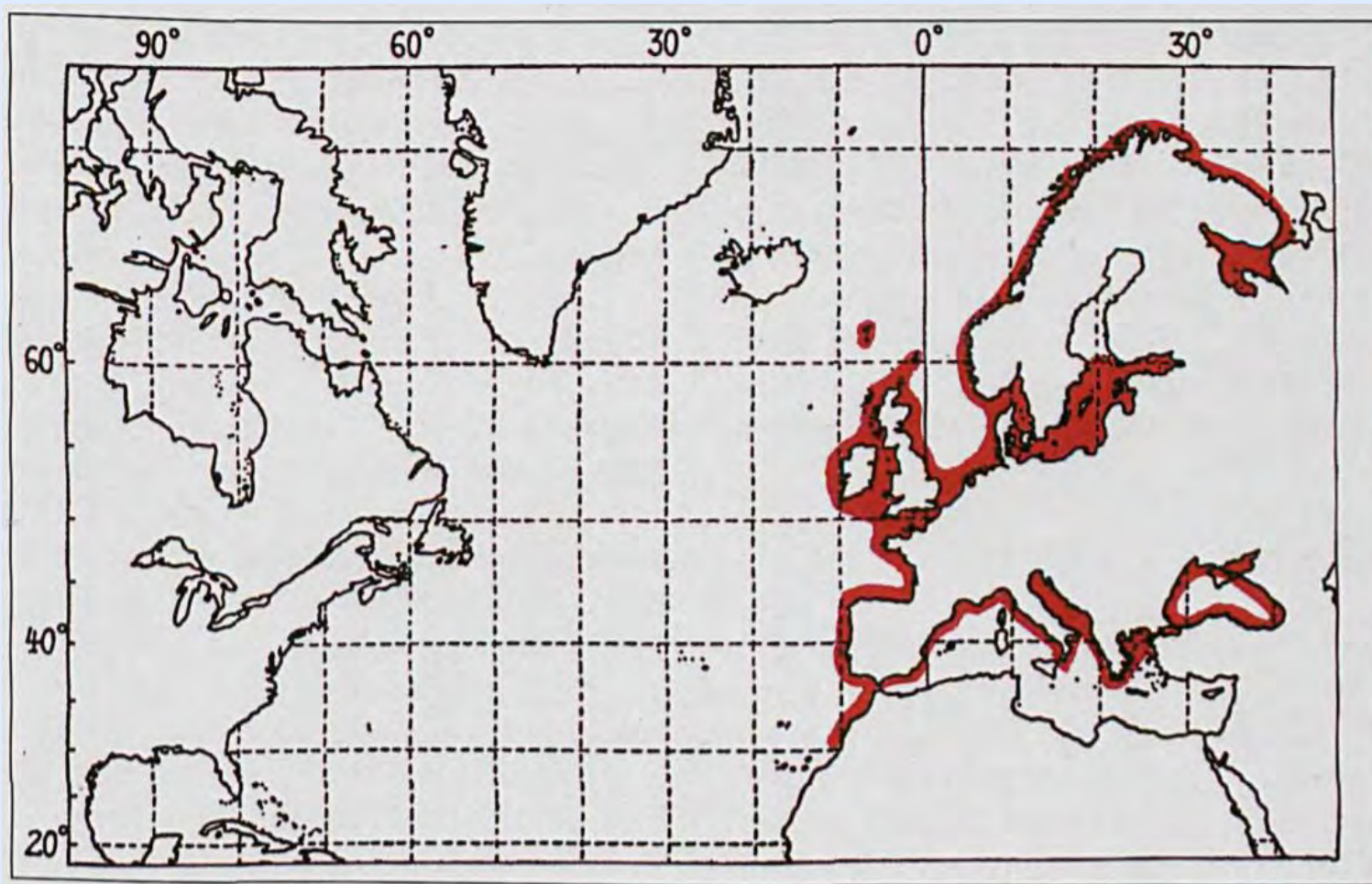
[www.visir.is](http://www.visir.is)



Stefán H. Jónsson

Sea lamprey  
(*Petromyzon marinus*)

# Geographical distribution of flounder



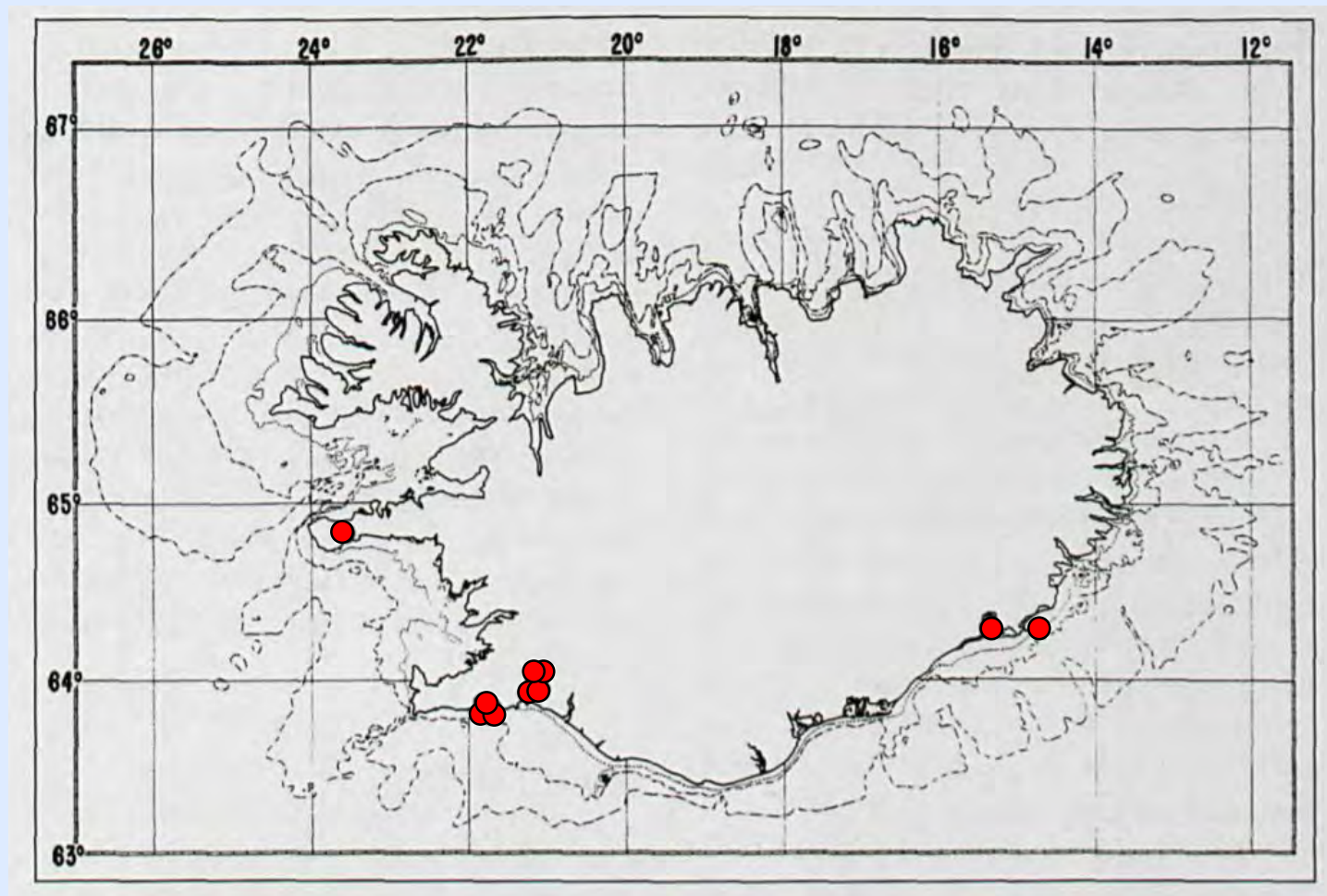
Jonsson G, Palsson J & Johannsson M. 2001 First record of flounder, *Platichthys flesus* (Linnaeus, 1758) at Iceland

# Flounder

- found in estuaries most of the year
- adults occur on mud and sand bottom in shallow water, at sea and brackish
- often entering freshwaters
- adults retreat to deeper, warmer waters during winter, where they spawn in spring
- the growing larvae moving to the coast
- larvae and early juveniles use selective tidal transport to migrate upstream rivers
- juveniles live in shallow coastal waters and estuaries, which are also the summer feeding grounds for the adults
- juveniles of less than a year old feed on plankton and larvae of insects, juveniles of more than a year and adults feed on benthic fauna, including small fishes and invertebrates

*[www.fishbase.org](http://www.fishbase.org)*





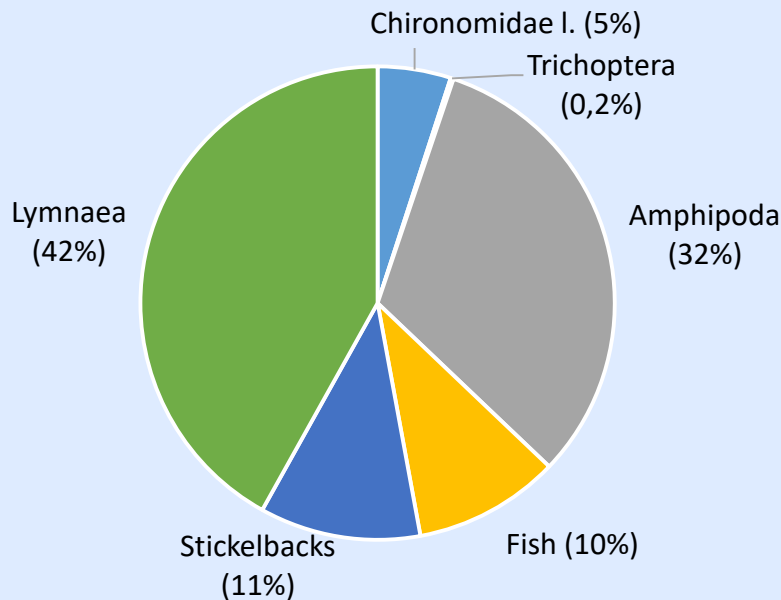
## Localities of the flounders caught in Iceland 1999 - April 2001

(Jonsson G, Palsson J & Johannsson M. 2001. First record of flounder, *Platichthys flesus* (Linnaeus, 1758) at Iceland)



## „Current“ distribution of flounder in Iceland

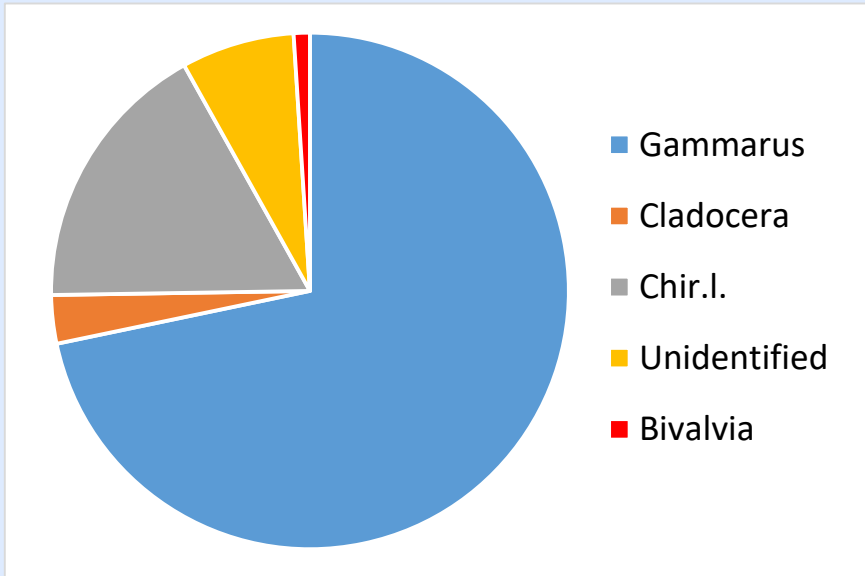
# Stomach contents of flounder



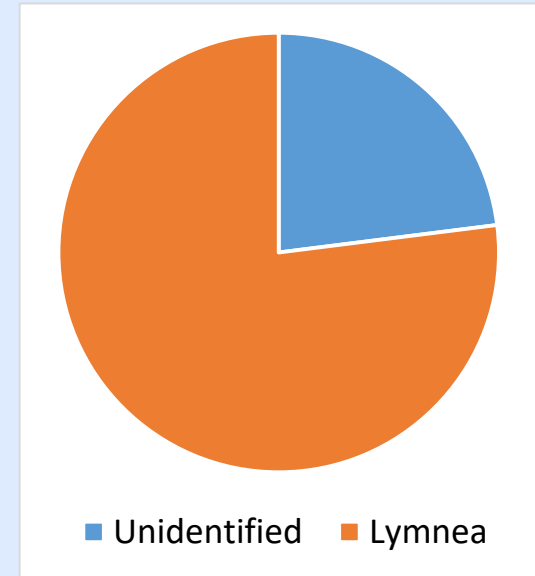
Stomach content of flounder caught in Lake Hlidarvatn South Iceland in 2006 (Johannsson & Jonsson 2007)

- Fish
- Amphipods
- Mysidae
- Bivalvia
- Annelids
- ...
- Competition between flounder and salmonids.

Stomach content of flounder caught in Borgarfjordur SW Iceland (Hlinason 2013)



Stomach content of flounder caught in Lake Hunavatn N Iceland in 2011 (Kristinsson 2013)



Stomach content of flounder caught in Lake Hop N Iceland in 2011 (Kristinsson 2013)

# Sea lamprey (*Petromyzon marinus*)

- a parasitic lamprey - native to the Northern Hemisphere.
  - migrate up rivers to spawn
  - larvae burrow in the bottom in quiet water - filter-feed on plankton and detritus
- 
- The image is a world map with a focus on the Northern Hemisphere. It shows the distribution of sea lampreys, with red and yellow areas indicating their range. The distribution is concentrated in North America (USA and Canada), Europe, and parts of Asia and Africa. The map uses a color gradient from green to red to represent the density or presence of the species.
- metamorphosis after several years in freshwater - migrate to the sea or lakes
  - uses suction cup-like mouth to attach itself to the skin of a fish
  - victims typically die from excessive blood loss or infection.
  - after one year of hematophagous feeding, return to the river to spawn and die

[www.wikipedia.org](http://www.wikipedia.org)

# Sea lamprey

- found occasionally in seawater around Iceland
- in 2006, anglers reported wounded sea run brown trout caught in rivers in South Iceland
- almost all incidence on sea run brown trout, a few on Atlantic salmon and one on Arctic char.
- sea lamprey larvae not been found in rivers in Iceland
- increased frequency in seawater in Iceland

(Jonsson & Johannsson 2008)

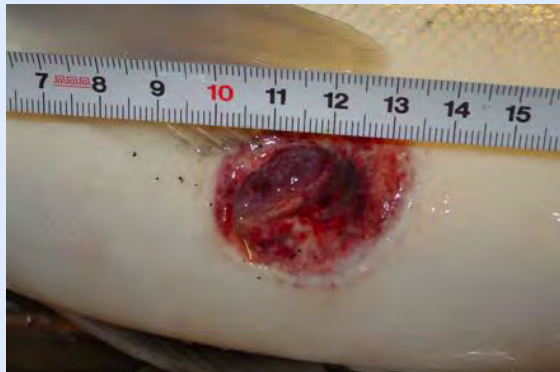


Photo: Elias Baldursson



Photo: Arnar Oskarsson



[www.visir.is](http://www.visir.is)

# Pathways

- Ships (ballast water)
- Import
- Tourists
- Travelling on its own
- By other organisms
- ...



# Potential threats

Species imported for aquariums and garden ponds (intentionally and unintentionally)

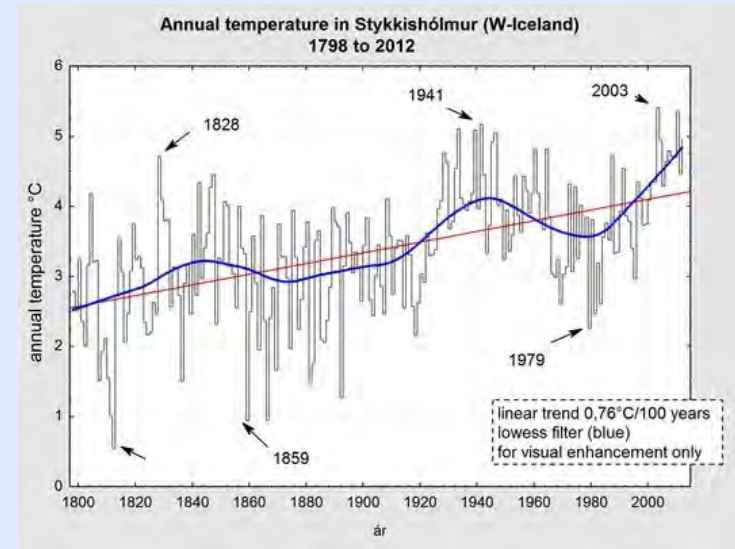
- Koi fish
- Sturgeon
- Plants/algae

...



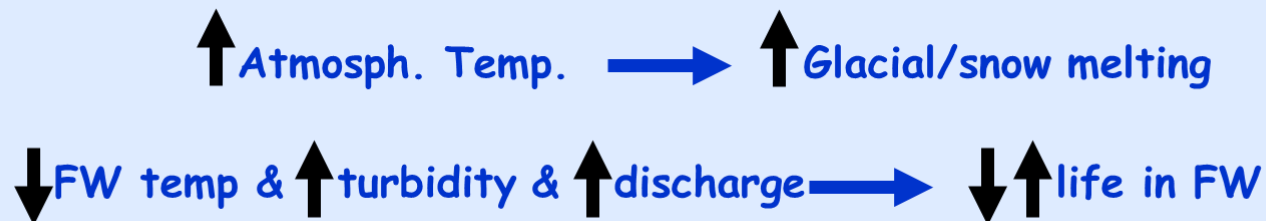
# Diverse environmental changes

- Increased temperature
- Arctic sea ice decline
- Glaciers declining
- Ocean salinity changing
- Affecting ocean currents
- ...



Trausti Jonsson, [www.vedur.is](http://www.vedur.is)

Local effects of increased global temperature  
not always easily predictable



Thank you

