Þingvallavatn

Undesirable changes and nutrient load 2015

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Why is it important to protect Þingvallavatn?

„The Outstanding Universal Value of Þingvellir as a cultural landscape has already been confirmed by the inscription on the World Heritage List in 2004 under criteria III and VI."

The Þingvellir area (lake and catchment) is now on the UNESCO tentative list (http://whc.unesco.org/en/tentativelists/5588), with the justification:
"The Þingvellir area is also a natural wonder on a global scale, with the geologic history and the biota of Lake Þingvallavatn and its catchment area forming a unique entity, a magnificent showcase in geology and biology and an extraordinary ecosystem".

We observe changes in lake physics, biology and chemistry

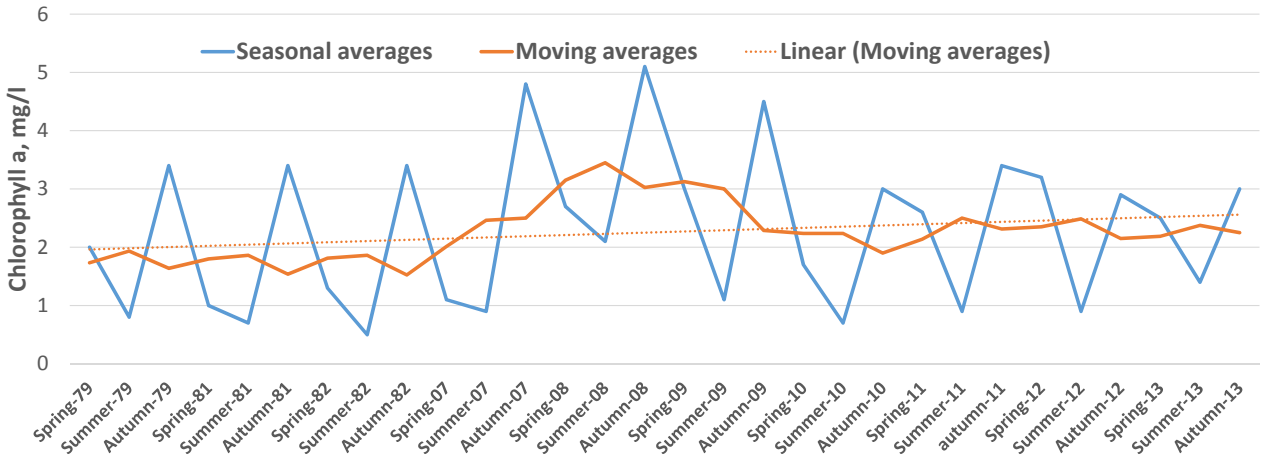
- **In lake physics, related to global warming;**

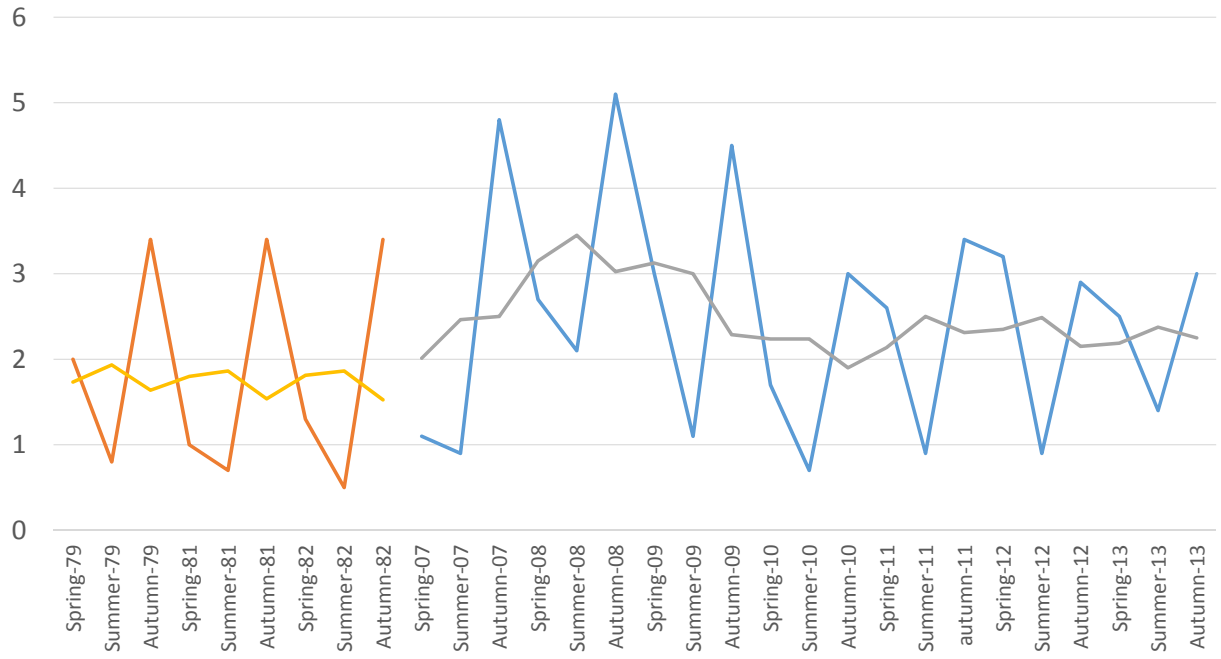
- A) Increased summer water temperatures
- B) Shorter ice periods and ice free winters are more common
- C) Summer *“thermal stratification“, is more stable and lasts longer.

- *Mixed warm layer at the surface, intermediate layer in which temperature decreases rapidly with depth and a cold deep water layer

In lake phytoplankton

Chlorophyll a in Lake Þingvallavatn (Long term seasonal averages)




6
5
4
3
2
1
0
Spring-79
Summer-79
Autumn-79
Spring-81
Summer-81
Autumn-81
Spring-82
Summer-82
Autumn-82
Spring-07
Summer-07
Autumn-07
Spring-08
Summer-08
Autumn-08
Spring-09
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Autumn-09
Spring-10
Summer-10
Autumn-10
Spring-11
Summer-11
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Spring-12
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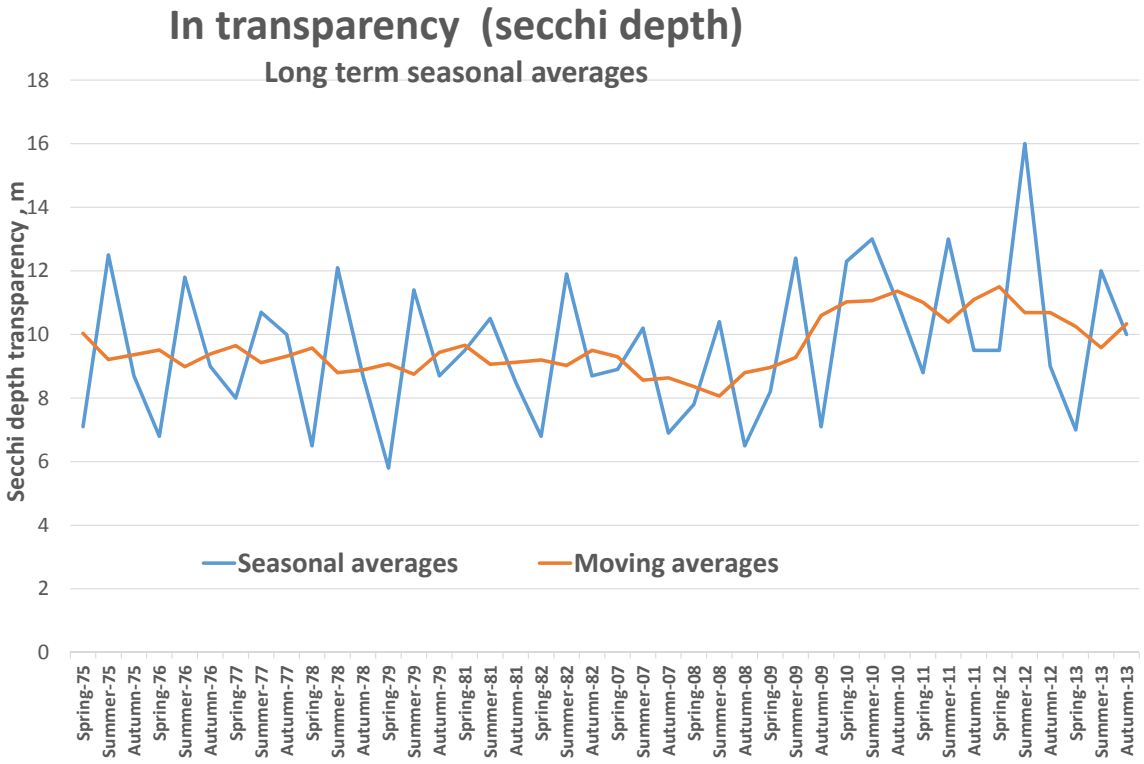
Autumn-12
Spring-13
Summer-13
Autumn-13


In transparency (secchi depth)
Long term seasonal averages
Secchi depth transparency , m
18
16
14
12
10
8
6
4
2
0
Seasonal averages
Moving averages
Spring-75
Summer-75
Autumn-75
Spring-76
Summer-76
Autumn-76
Spring-77
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Summer-78
Autumn-78
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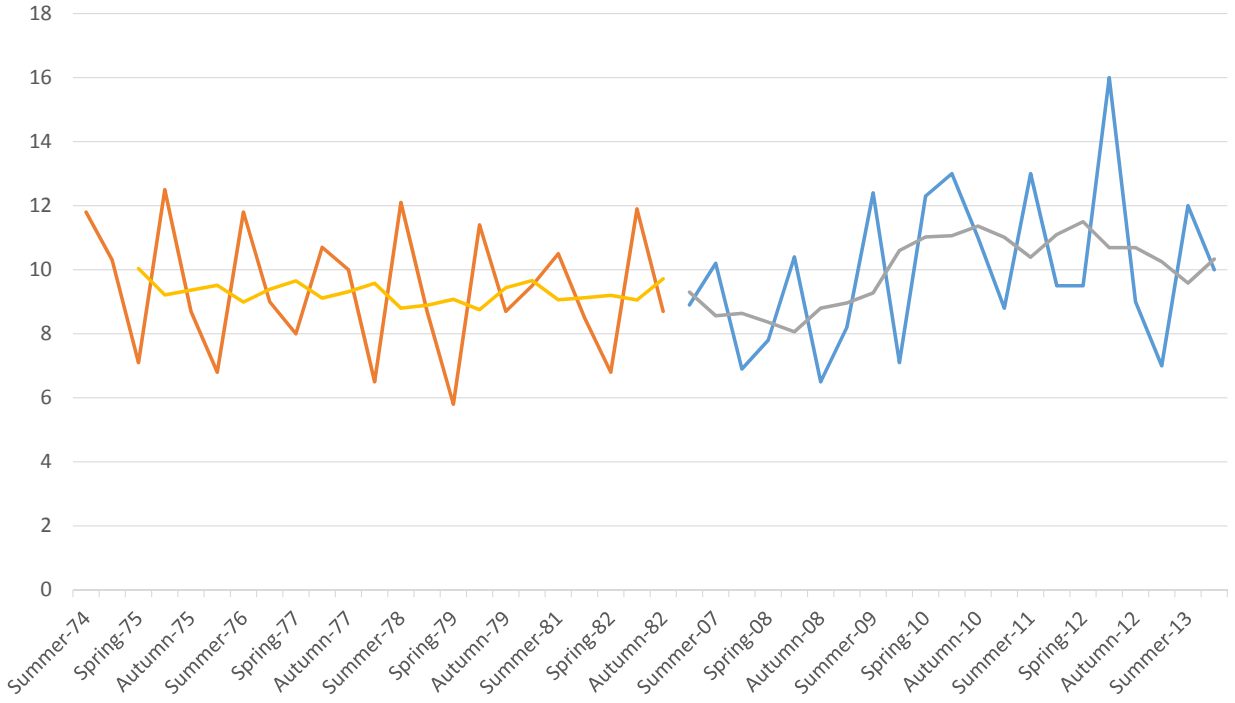
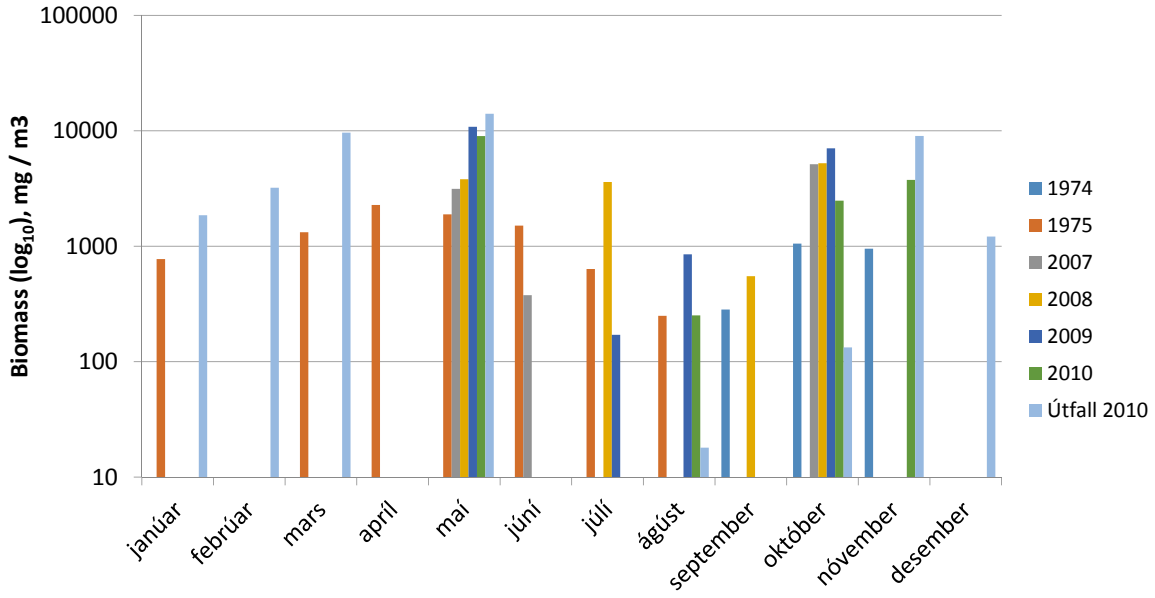


The biomass of the main phytoplankton species Aulacoseira islandica



The in lake chemistry:
Mean inorganic nitrogen and phosphate in the lake water and N:P ratios

Chemical	2007-2013 Stöð 2	1975 Stöðvar 1 og 2
Inorganic soluble N	<5 µg/l-N	2,3 µg/l-N
Posphat PO4-P	9,4 µg/l-P	13,3 µg/l-P

N:P ratio in the lake water in summer 1975 was **0,2:1** by weight and less than **0,5:1** in 2007-2013. These figures are strong indication of nitrogen limitation, and the ratio may be on the way upwards.

Readfield ratio

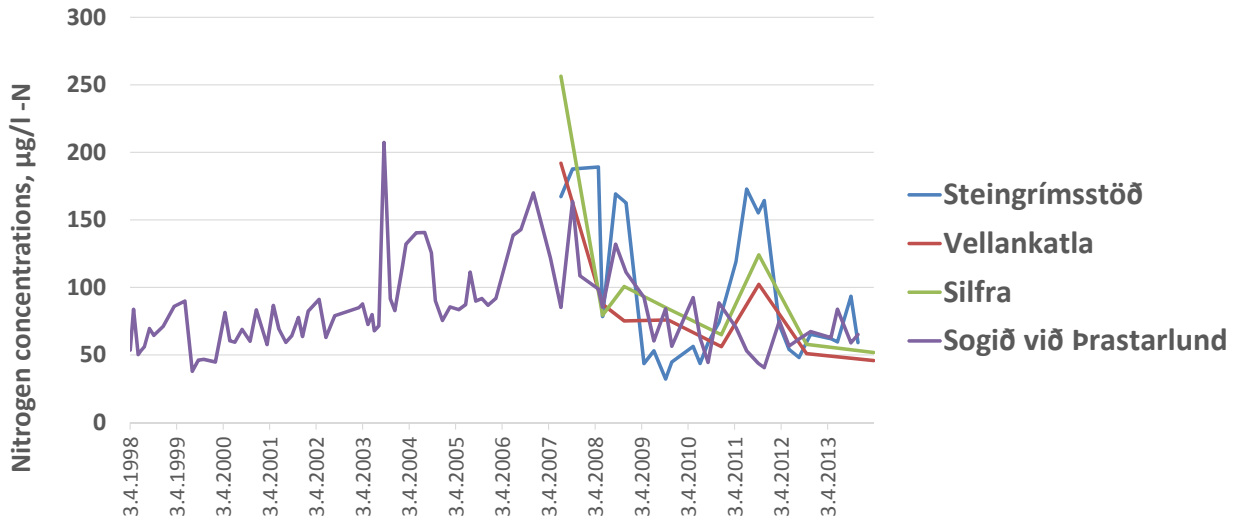
The optimal N/P ratio for phytoplankton growth the „Redfield Ratio“, is 16:1 (based on molecular concentrations) and **7:1 based on weight**. Lower ratios than 16:1 (**7:1 by weight**) can be an indication for potential nitrogen limitation and ratios higher than 16:1 (7:1 by weight) , potential phosphorus limitation of the primary production of phytoplankton.

Analysis of total N, P and C values in Lake water 2007-2013 suggest a ratio: **87 C: 14 N: 1 P** in planktonic organic matter.

Nitrogen – N
Forms of Nitrogen measured in the Lake

<table>
<tr><td colspan="5">Heildar N - Total-N</td></tr>
<tr><td colspan="4">Heildar uppleyst N
Total Dissolved N</td><td>Heildar N í svifögnum
Total Particulate N</td></tr>
<tr><td>Nitrate
NO_3-N</td><td>Nitrite
NO_2-N</td><td>Ammonia
NH_3-N +
Ammonium
NH_4-N</td><td>Uppleyst lífrænt N
Soluble Organic N</td><td>Lífrænt N í svifögnum
PON
Particulate Organic N</td></tr>
<tr><td colspan="3">Heildar ólífrænt N
Total inorganic N, TIN</td><td colspan="2">Heildar lífrænt bundið N
Total organic N, TON</td></tr>
</table>

Nitrogen concentrations (µg/l total dissolved (TDN)-N) in two main springs to Þingvallavatn (Silfra and Vellankatla), total nitrogen (TDN+PON) in the outlet at Steingrímsstöð and in River Sog at Þrastarlundur (data: Eydís Salome Eiríksdóttir og Sigurður Reynir Gíslason, 2014).



Estimated Nitrogen budget in Lake Thingvallavatn

	Into the Lake	Out of the Lake
With rivers and springs	284 tons	
Nitrogen fixation	Not known	
Precipitation directly on the lake	19 tons	
Thereof EMEP estimated airpollution directly on the lake	7 tons wet- and 1 ton dry deposition	
Aerosion and air transport	Not known	
Industry	1 ton	
Agriculture	5,5 tons	
Sewage; Tourism/settlement /sommerhouses	5,5 tons	
At the outlet of the Lake		300 tons
Sedimentation to the bottom		41,5 tons
Total:	~320 tons N in	~340 tons N out

Runoff and leaching of total nitrogen (PON+TDN) from some river catchment basins

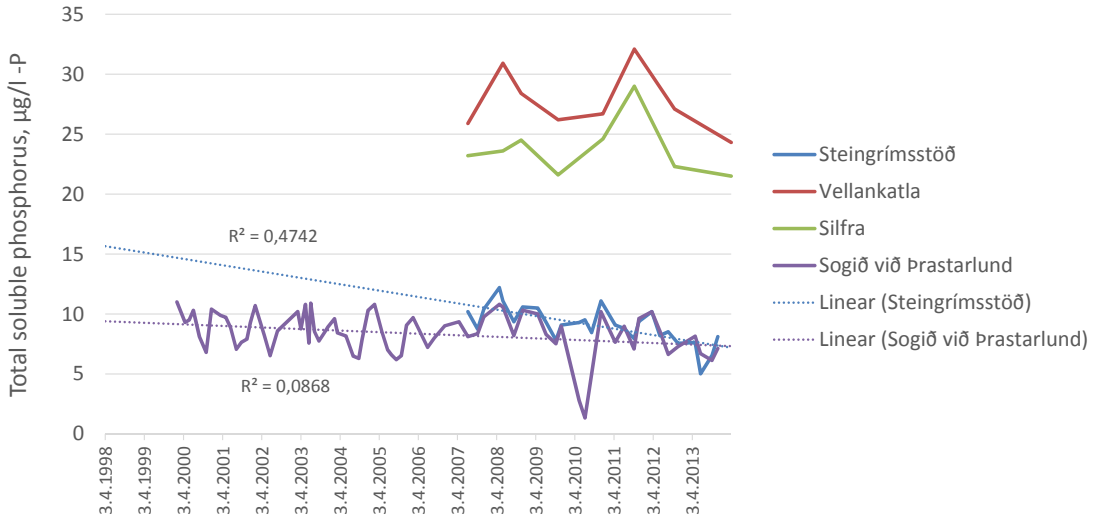
River / Catchment-basin	Water Runoff mm / year	Discharge N-total Tons / year	Leaching N-total kg /km^2/year	Concentration N-total µg / l
Sogið	2600	285	219	83±31
Fjarðará	2400	7	156	104±38
Grímsá	2300	48	144	68±22
Ölfusá	2200	1799	317	130±71
Hvítá Borg.	1700	283	170	101±32
Andakílsá	1700	25	171	104±38
Þjórsá	1500	1076	146	94±37
Norðurá	900	43	85	79±28
Vatnsdalsá	700	46	94	141±37
Víðidalsá	600	29	73	120±33

Phosphorus – P

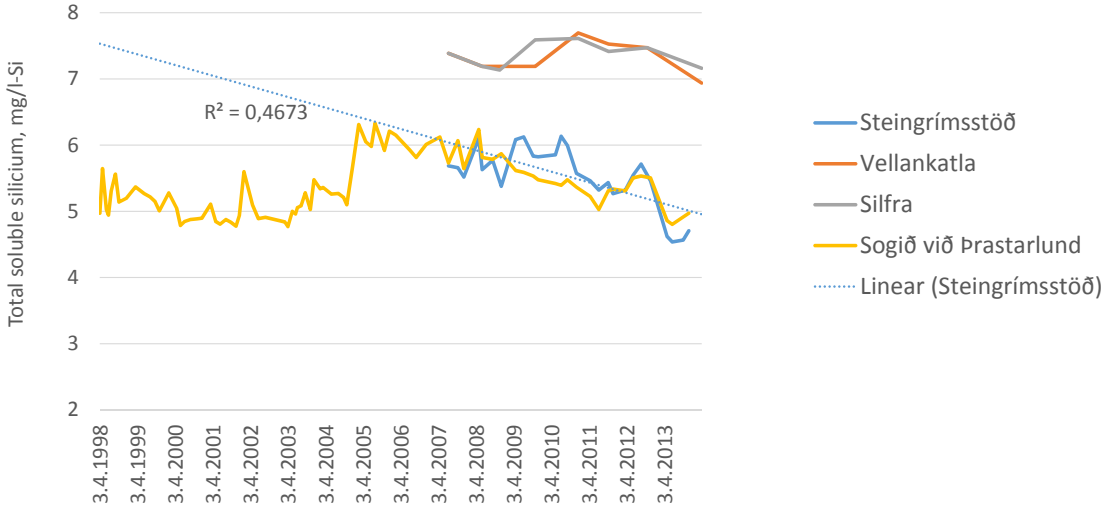
Forms of phosphorus, measured (or not) in the Lake

<table>
<tr><td colspan="3">Heildar P (Total-P)</td></tr>
<tr><td colspan="2">Heildar uppleyst P (TSP)
(Total Soluble P)</td><td>P bundið í svifögnum TPP
(Total Particulate P)</td></tr>
<tr><td>Fosfat PO_4-P
Soluble Reactive P</td><td>Uppleyst P (lífrænt)
(Soluble Unreactive)</td><td>P bundið í (lífrænum) svifögnum
(Particulate Organic P)</td></tr>
</table>

Concentrations of total soluble phosphorus (µg/l TSP-P) in two main springs to Þingvallavatn (Silfra and Vellankatla), at the outlet at Steingrímsstöð and in River Sog at Þrastarlundur (data: Eydís Salome Eiríksdóttir og Sigurður Reynir Gíslason, 2014).



Concentrations of total soluble silicium (mg/l -Si) in two main springs to Þingvallavatn (Silfra and Vellankatla), in the outlet at Steingrímsstöð and in River Sog at Þrastarlundur (data: Eydís Salome Eiríksdóttir og Sigurður Reynir Gíslason, 2014).



An increased nitrogen load to Þingvallavatn will increase phytoplankton growth which is a threath to the lake

Eutrophication - "The term 'eutrophic' means well-nourished; thus, 'eutrophication' refers to natural or artificial addition of nutrients to bodies of water and to the effects of the added nutrients….When the effects are undesirable, eutrophication may be considered a form of pollution." - National Academy of Sciences, 1969

The lake clarity and blue color is under threath as in some other nutrient poor deep lakes

- On the left is a slogan to **keep Flathead lake**, Montana**, blue**.
- **Keep Tahoe Blue** is old slogan of The League to Save Lake Tahoe (**Keep Tahoe Blue**). The league has been advocating for the protection of Lake Tahoe California for 50 years.

Lake Þingvallavatn

Keep it blue