

# $\text{AlCl}_3$ -treatment of eutrophic Lake Littoistenjärvi:

## Background and interim results

Heikkilä J. & Vepsäläinen M.

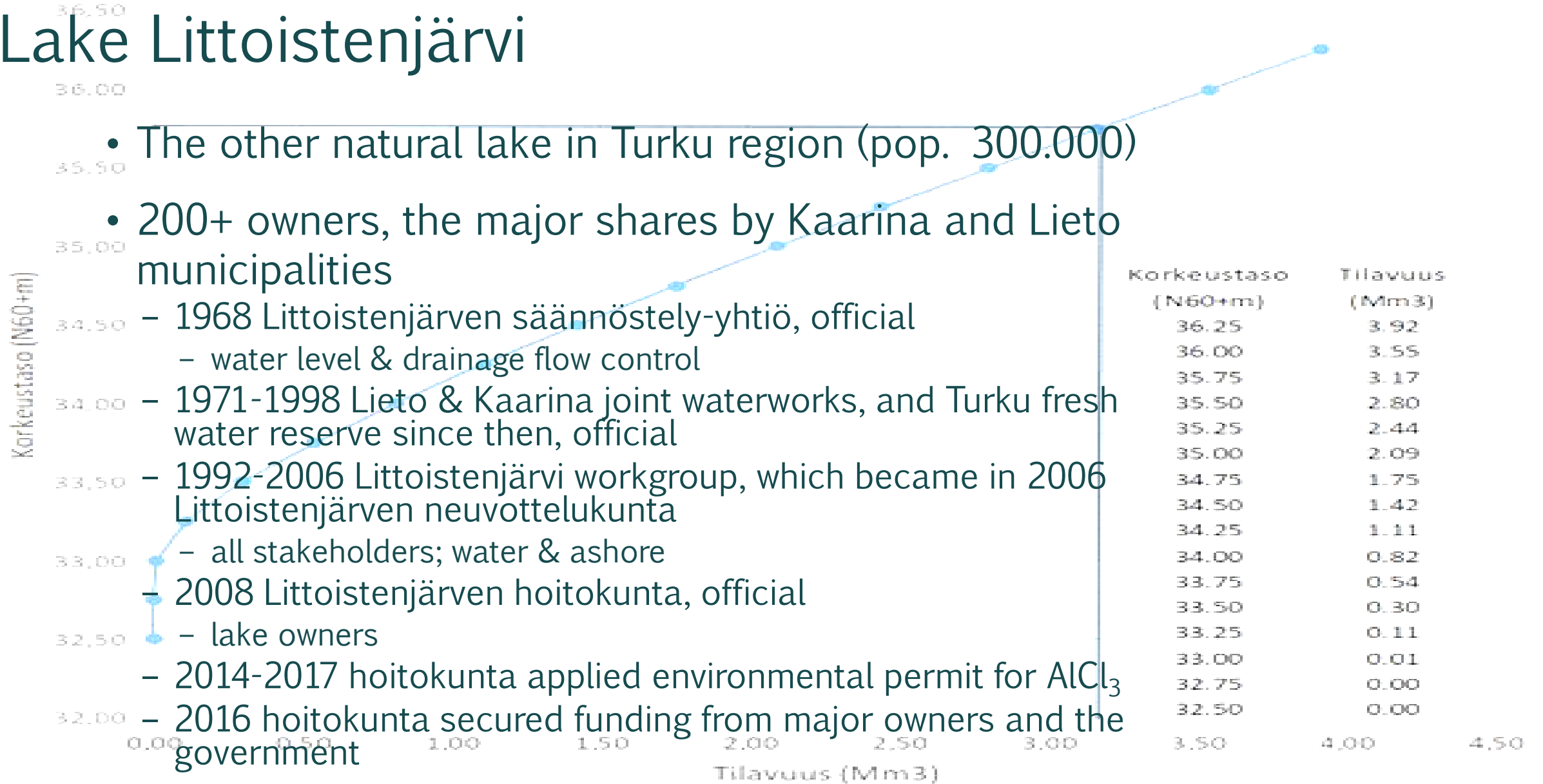
SYKE SEDIMENTTISEMINAARI -Lake restoration using aluminium salts: recent advances, results, and potential hurdles, Helsinki, 5.6.2017, updated 18.8., 13.9., 29.10., 1.11.2017

# Lake Littoistenjärvi

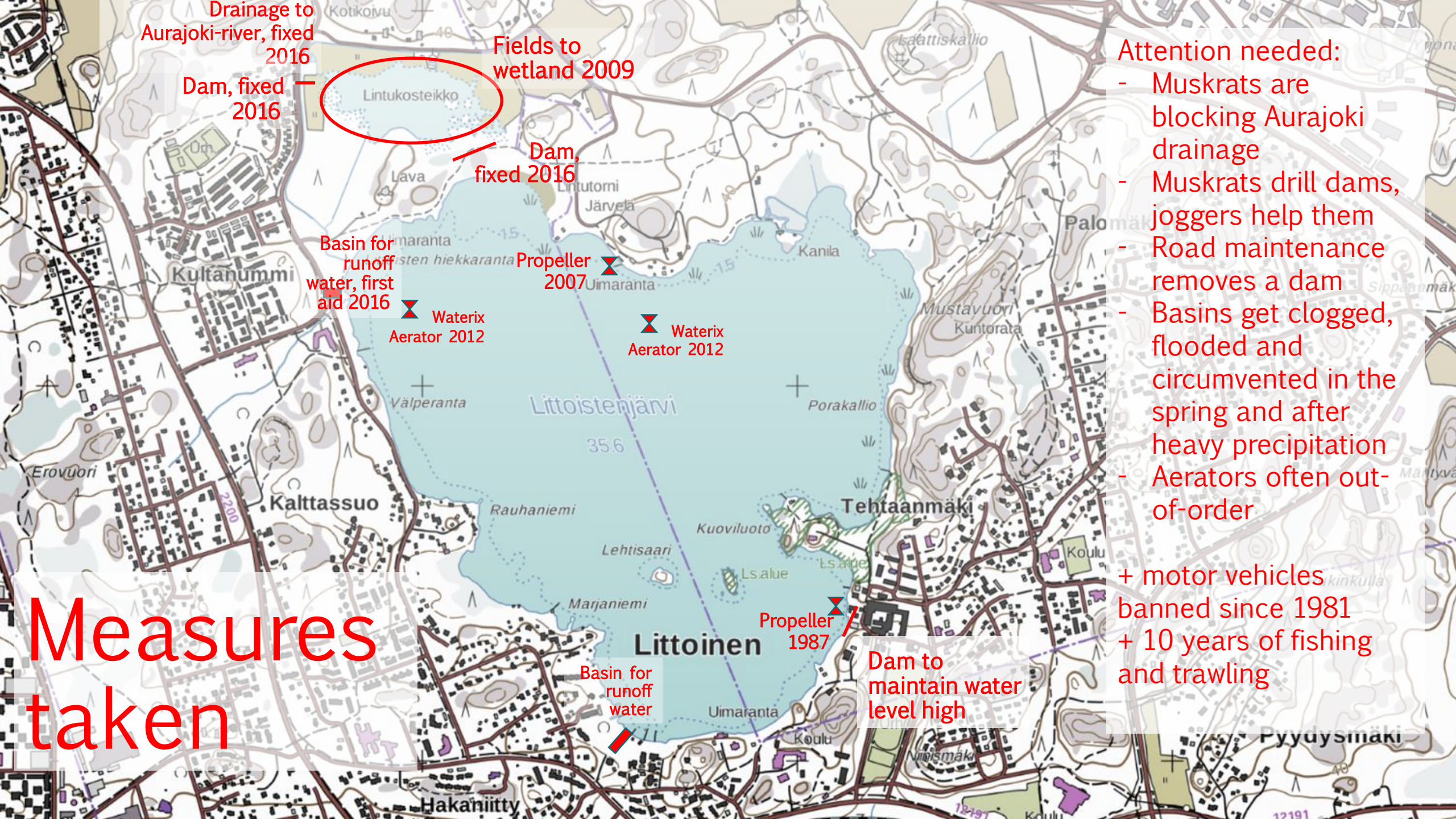
N 60° 27,289' E 22° 23,105' (~WGS84)

- 1,5 km<sup>2</sup>, 3 Mm<sup>3</sup>, 1,7...1,8 years of residence time
- (3)...4,5 km<sup>2</sup> drainage basin
- Regular collection of data for research (and practice)
  - Earliest 18th century records: special, good quality water for frieze manufacturing (est. 1738, later Barker-Littoinen Oy)
  - 1908-1913 First known scientific records
  - 1971-1998 Water quality measurement by waterworks
  - 1983-2013 University of Turku follow-up
  - 1998-present regular follow-up of water quality, zoobentos, phytoplankton, zooplankton
- Canned food factory, laundry, air base, [ice track racing](#), recreational center for swimming, ballroom, beaches, skating, skiing, fishing, wind gliding, bird watching...
- T<sub>0</sub> eutrophic -> oligotrophic - 1900 (?)
- 1986- eutrophic/oligotrophic severe alternating *elodea canadensis* and *ceratophyllum* overgrowth, pH 5,5...11
- 1998-1999 hypoxia, thereafter diminishing *elodea*, strong phytoplankton growth and internal phosphorus-cycles
- ~2010 toxic cyanobacteria appears, zooplankton diminishes, pH 6,5...10
- 2016 worst year ever in terms of water quality; and against Water Framework Directive (2000/60/EC; 1299/2004 Laki vesien ja merenhoidon järjestämisestä)

# Lake Littoistenjärvi



- The other natural lake in Turku region (pop. 300.000)
- 200+ owners, the major shares by Kaarina and Lieto municipalities
  - 1968 Littoistenjärven säännöstely-yhtiö, official
    - water level & drainage flow control
  - 1971-1998 Lieto & Kaarina joint waterworks, and Turku fresh water reserve since then, official
  - 1992-2006 Littoistenjärvi workgroup, which became in 2006 Littoistenjärven neuvottelukunta
    - all stakeholders; water & ashore
  - 2008 Littoistenjärven hoitokunta, official
    - lake owners
  - 2014-2017 hoitokunta applied environmental permit for AlCl<sub>3</sub>
  - 2016 hoitokunta secured funding from major owners and the government



# Measures taken

- Attention needed:
- Muskrats are blocking Aurajoki drainage
  - Muskrats drill dams, joggers help them
  - Road maintenance removes a dam
  - Basins get clogged, flooded and circumvented in the spring and after heavy precipitation
  - Aerators often out-of-order
- + motor vehicles banned since 1981  
 + 10 years of fishing and trawling

# KEMIRA PAX XL-100, i.e., 30-40 % polyaluminiumchloride

(Sheet: Kauko Anttila, Kemira Oyj)

Planned in 2016:

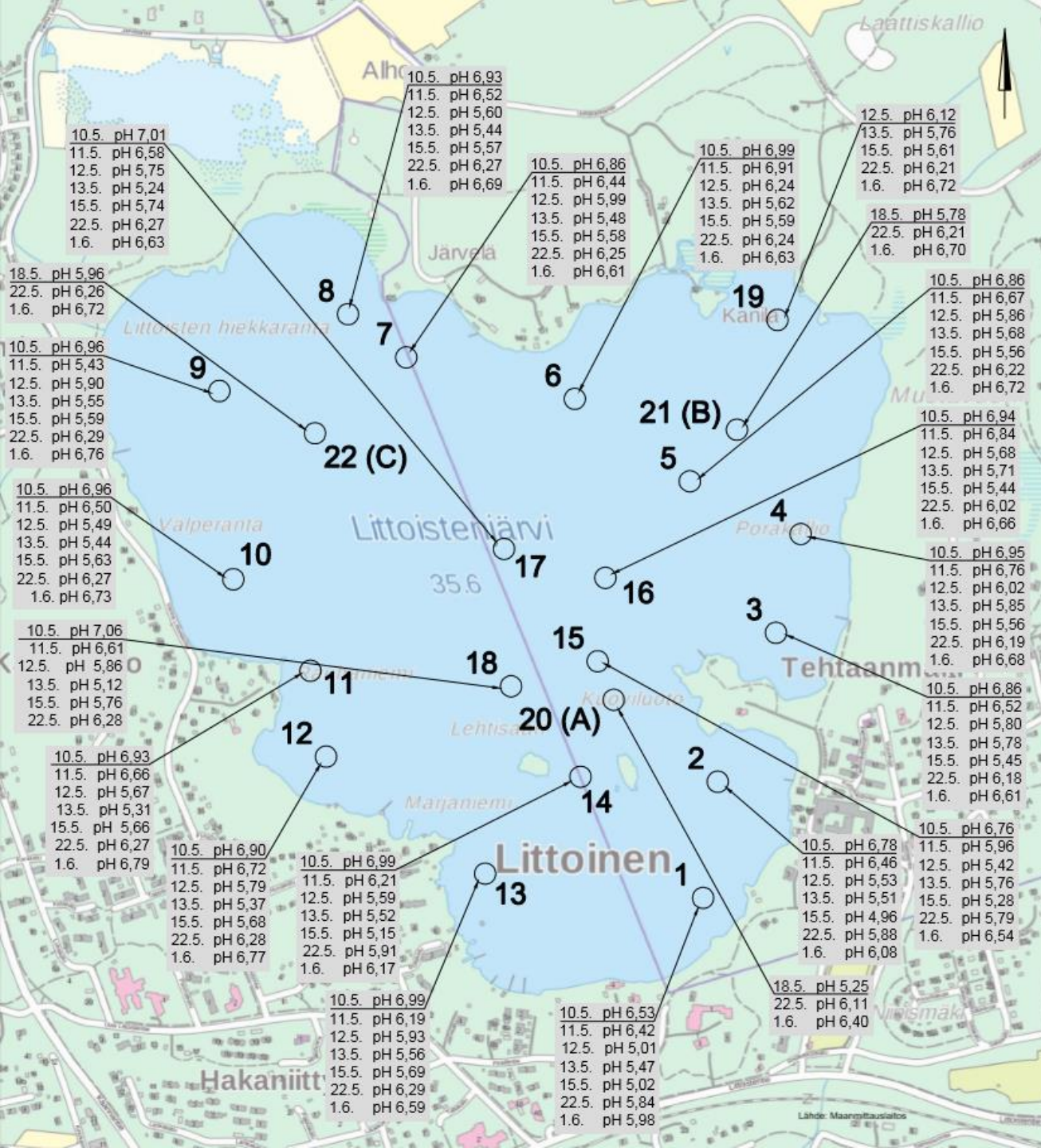
- 40 mg/l, 200-280 t
- Early recommendation in 2017:
  - 50-60 mg/l, 200-260 t
- Water volume estimate:
  - 3,65 MM<sup>3</sup>
- Completed:
  - 44 mg/l, 160 t (20%...40% reduction)
- pH
  - Before ~7
  - Target 6,0...6,3
  - +3d 5,5 (± 0,5)

## LITTOISTEN SAOSTUSKOKEET 04.5.2017 KEMIRA OYJ / K. ANTTILA

Näyte	Kemikaali	Annostus ml/l	Annostus mg/l	pH1	pH2	Sameus
0	PAX-XL100	0	0	7,1	7,1	samea ja väriä
1	"	29	40	6	6,2	kirkkain
2	"	43	60	5,5	5,6	kirkas
3	"	58	80	5	5	kirkas ja vähän väriä

**SEKOITUS 15 SEK**  
**HÄMMENNYS 10 MIN**  
**LASKEUTUS 20 MIN**

HUOM! pH1 mitattu Hyvinkään Veden laboratorion mittarilla ja  
ja pH2 mitattu Kemira Oyj:n kannettavalla mittarilla



# pH details

(Figure: Vahanen Environment Oy; Photo: Janne Jaska Heino)

Short pH spreading time (36 hrs) and gathering daily winds (4 m/s; 8-10 m/s in gusts) mean that solution spreads out unevenly, close follow-up needed.

- On 6.6.2017: pH 6,8...7,0



# Turku

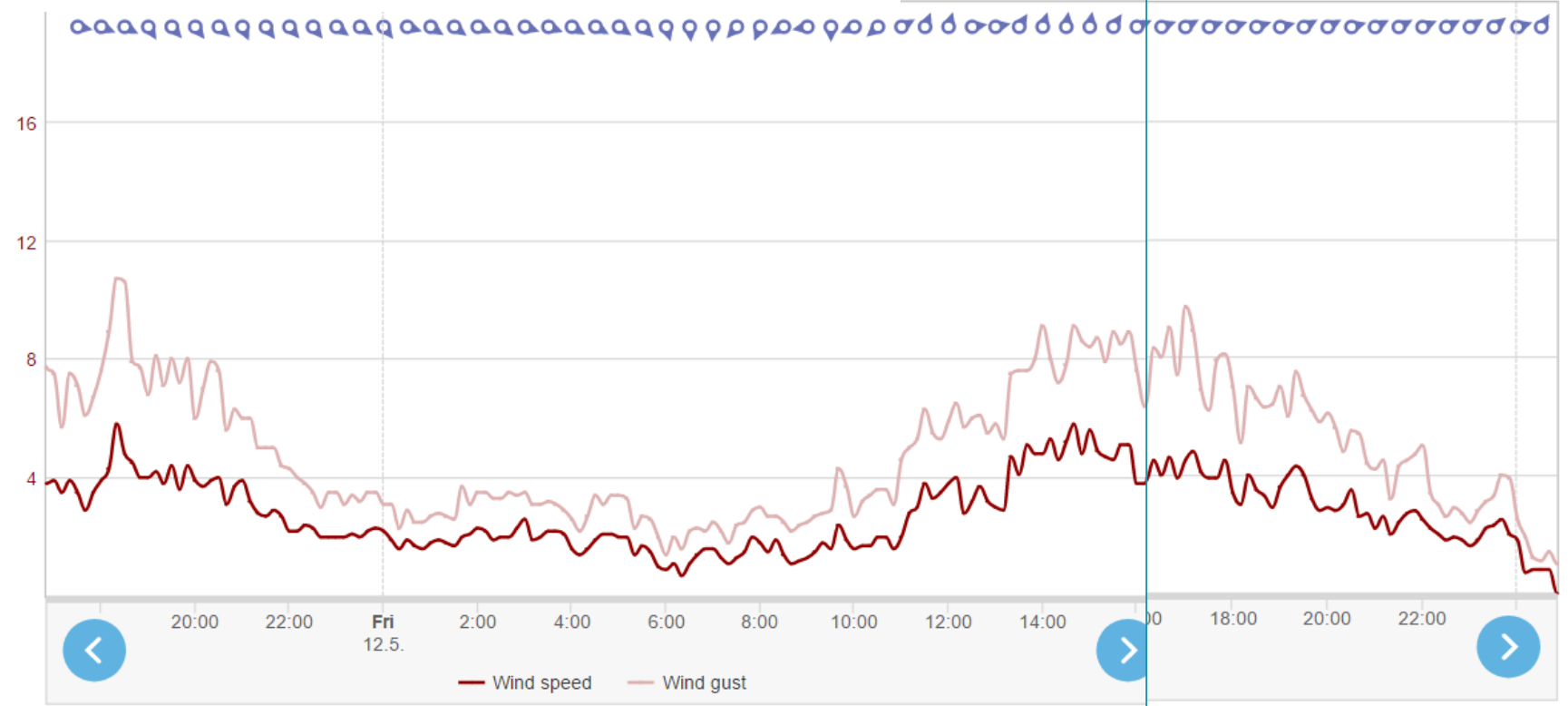
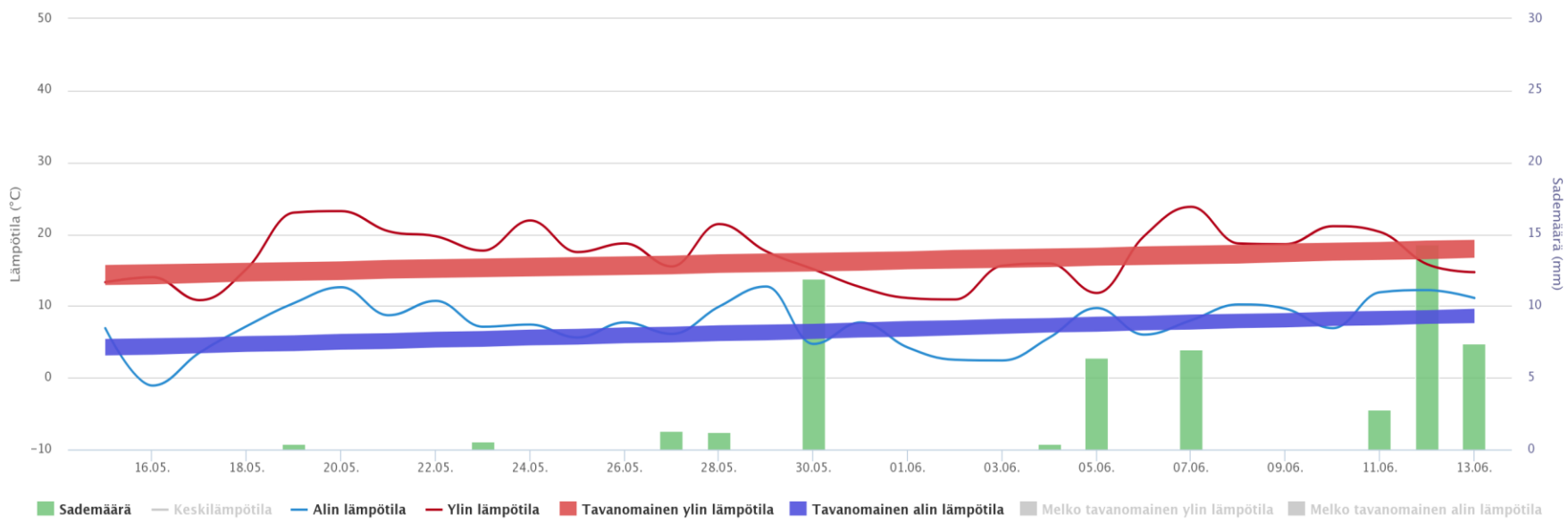
# Weather Artukainen during treatment

(Figures: Finnish Meteorological Institute)

1010-1017 hPa

-3,0...+10 °C

Varying winds 0...10 m/s



# Four months after:

## Average of three samples

(Figure: adapted from Jouko Sarvala, 2016)

### Phosphorus is gone

- Last ten years: 40...160  $\mu\text{g/l}$
- 5  $\mu\text{g/l}$  (total 15.5.2017)  $\rightarrow$  10  $\mu\text{g/l}$  (total 6.6.)...
- < 3 .. 8  $\mu\text{g/l}$  (soluble 5.5 & 6.6.)
- < 3  $\mu\text{g/l}$  (phosphate 6.6.)

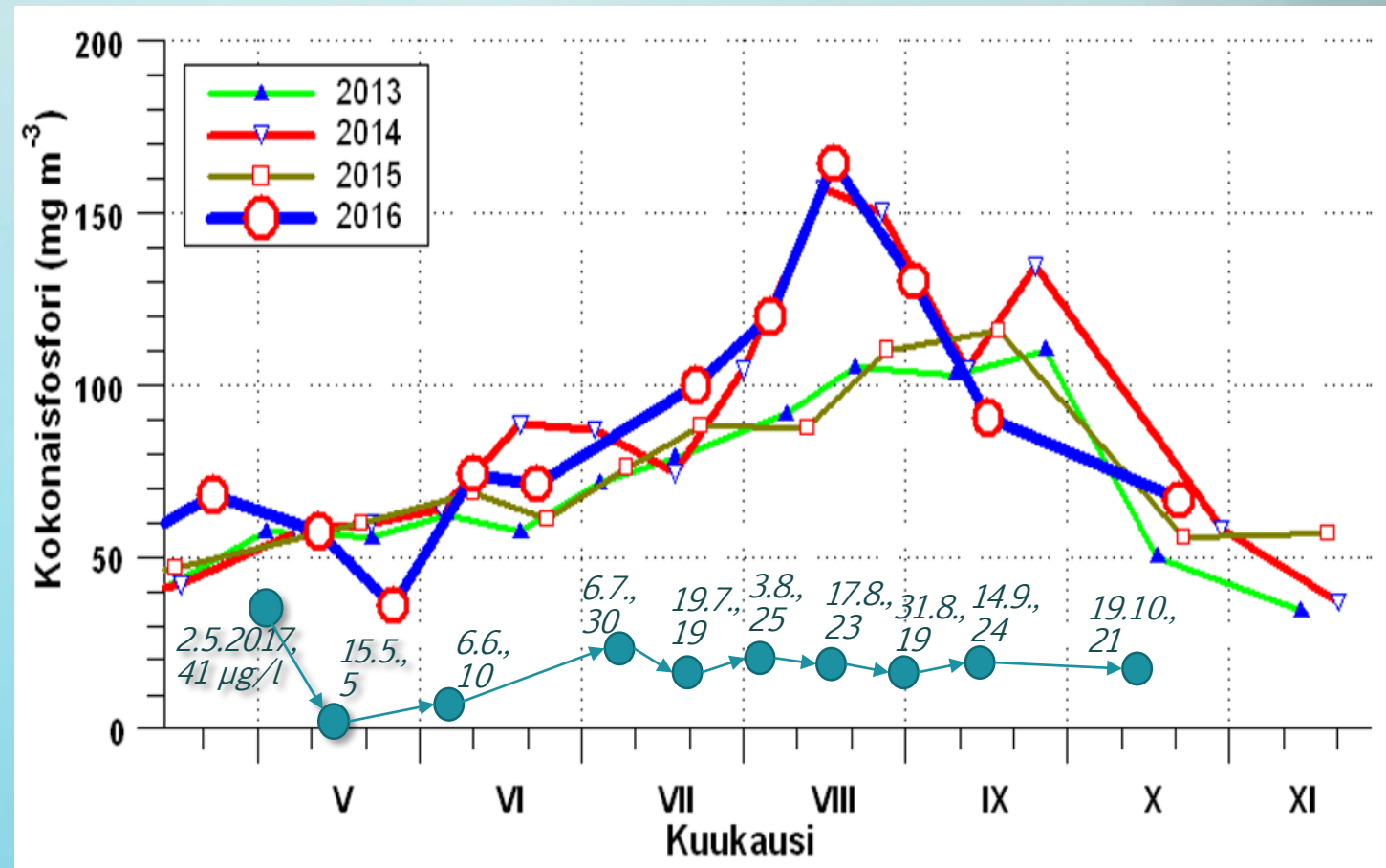
### Aluminium

- Last ten years: 100  $\mu\text{g/l}$
- 630  $\mu\text{g/l}_{15.5.}$   $\rightarrow$  45  $\mu\text{g/l}_{6.6.}$ 
  - 3x drinking water guidance value; below the levels of Finnish acidified lakes, now lowest ever measured.

### Alkalinity very low

- Last ten years: 0,4...0,6 mmol/l
- < 0,04 mmol/l<sub>15.5.</sub>  $\rightarrow$  0,13 mmol/l<sub>6.6.</sub>

For research and open data: Please follow  
<http://www.littoistenjarvi.fi/tutkimustyo/>

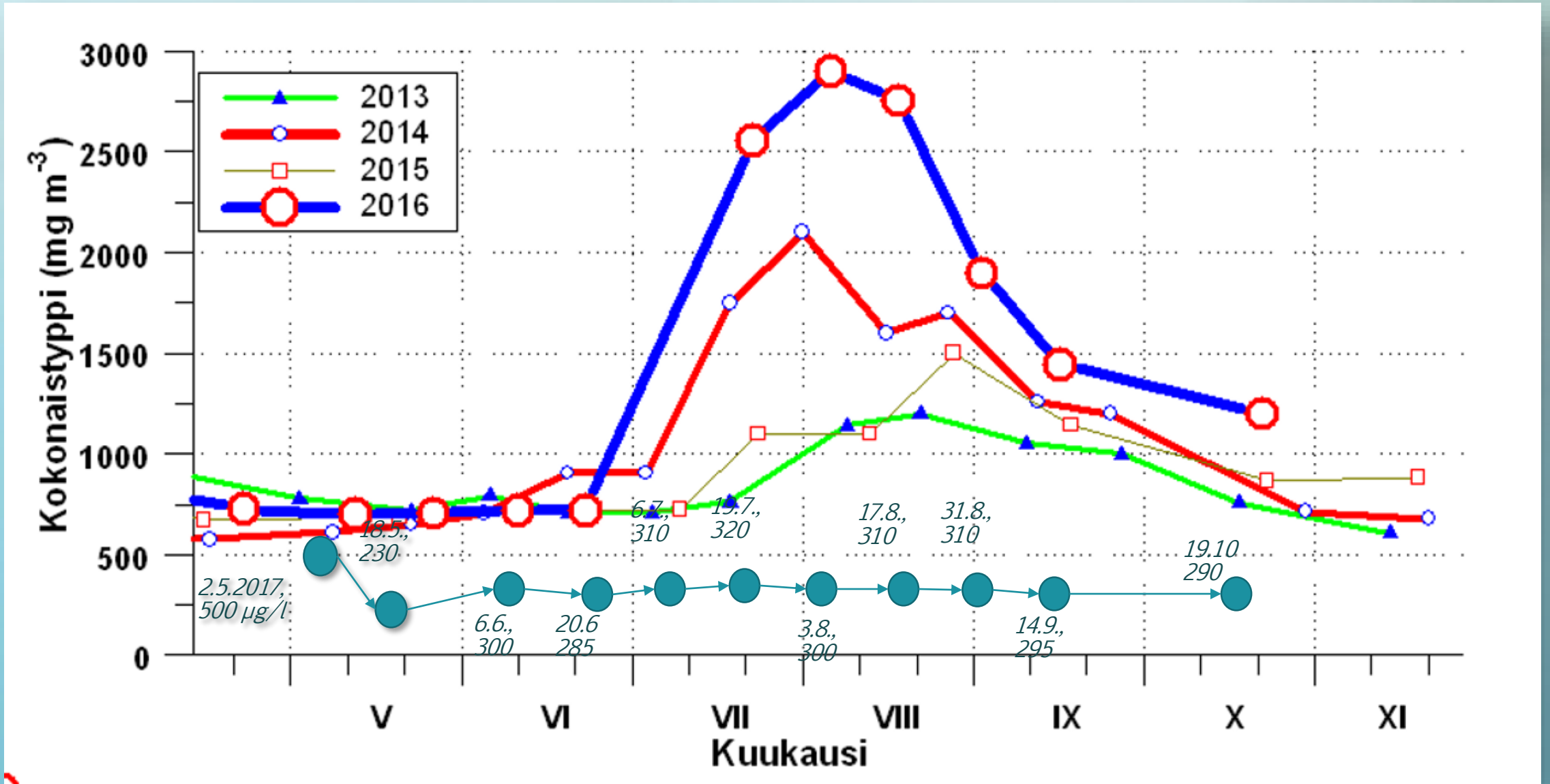




# Four months after:

## Average of three samples

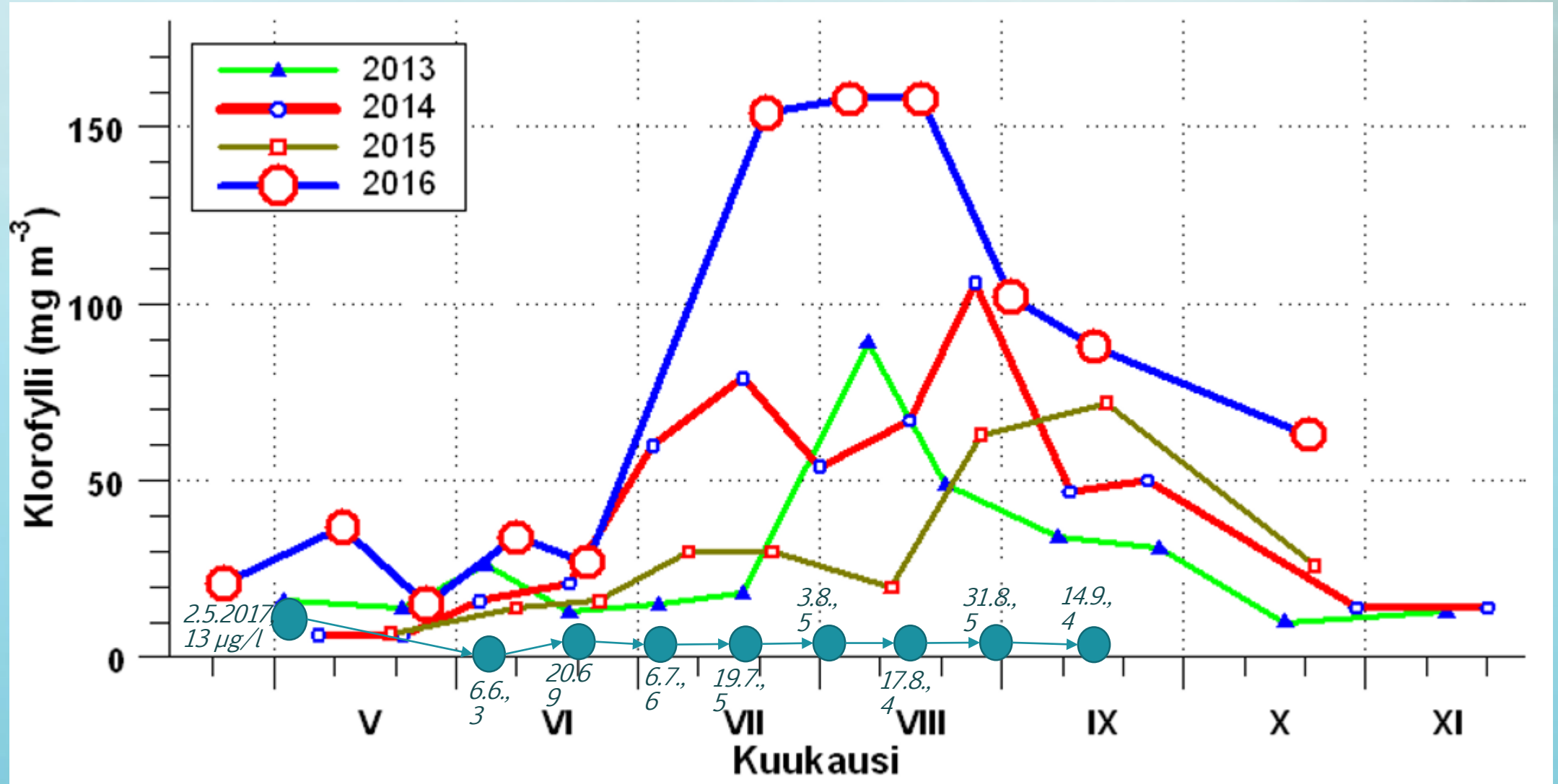
(Figure: adapted from Jouko Sarvala, 2016)



# Four months after:

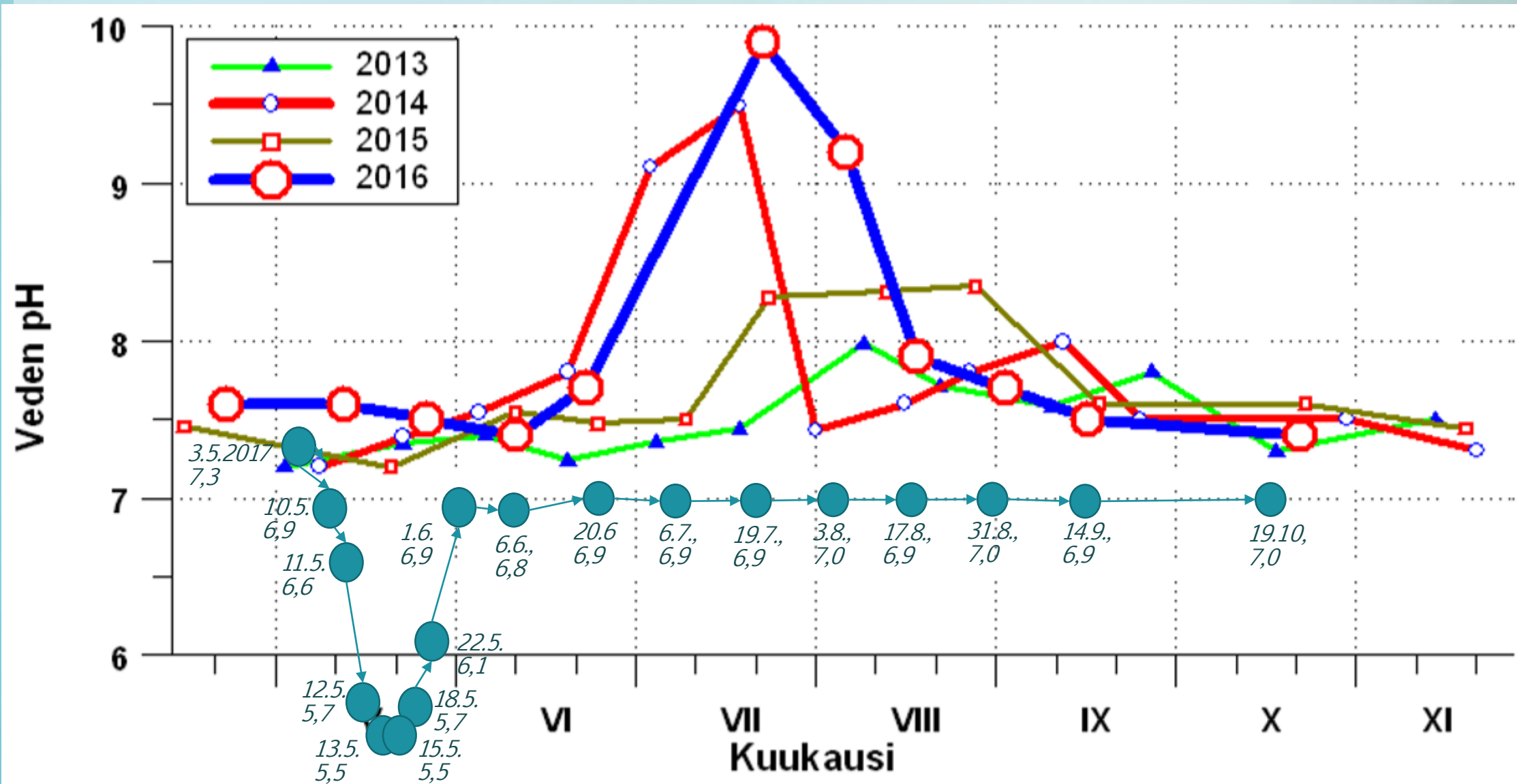
## Average of three samples

(Figure: adapted from Jouko Sarvala, 2016)



# Four months after: Average of available samples

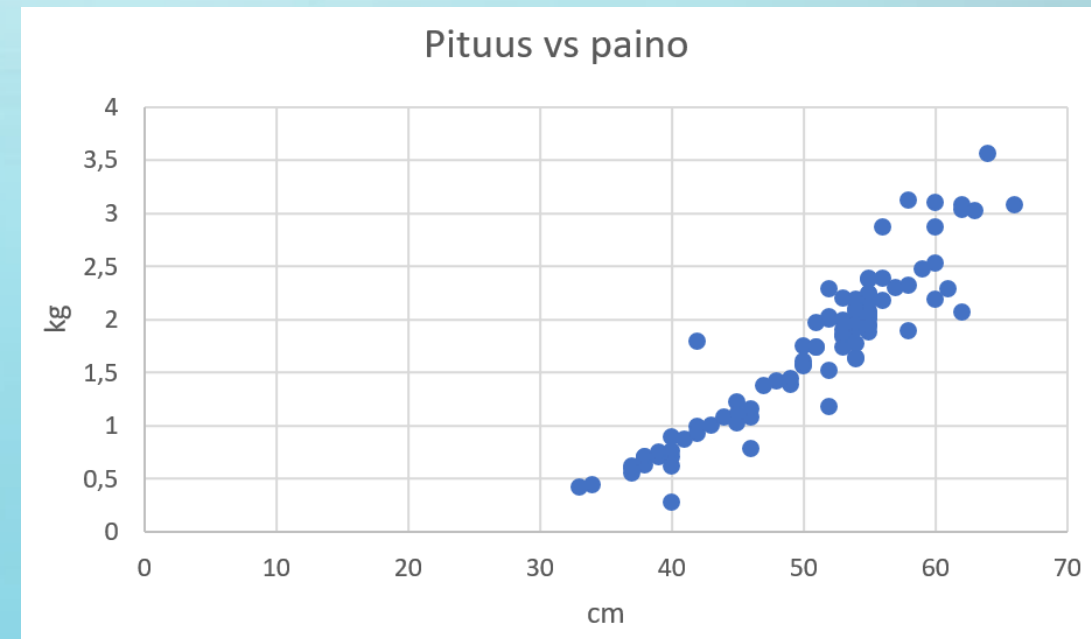
(Figure: adapted from Jouko Sarvala, 2016)



# Changes of animalia

(Photos: Jukka Heikkilä)

- Fish collected
  - Bream (*Abramis brama*), 97 % of collected fish consists of big breams (8-18 years), 5 tons removed (weighed)
    - Harpoon fishing on Sat 20, 19 participants. Focus on large breams, about 230 dead and 100 alive caught (stats on the right)
  - Pike (*Esox lucius*), a few big ones, 20-30 altogether (max 14kg)
  - Roach (*Rutilus rutilus*), many of all ages
  - Perch (*Perca fluviatilis*), some
  - Eurasian ruffe (*Gymnocephalus cernua*), some
  - Crucian carp (*Carassius carassius*), 10 (max 2kg)
- Insects (casual observations)
  - Mayflies (*ephemeroptera*), reduced hatches (not confirmed)
  - Midges (*nematocera, chironomidae*), hatching
  - Caddisflies (*trichoptera*), hatching
- Mussels
  - Duck mussel (*Anodonta piscinalis*), studied in 24.-25.5.2017. Obviously no significant harm, but the population has shrunk to 1/5th of the 1980's population.



# Algae – no algae

(Photos: Jukka Heikkilä, video Vesa Ritvanen)

Before, in August 2015



After, in May 2017  
([https://youtu.be/ow4ud1S\\_Hmg](https://youtu.be/ow4ud1S_Hmg))



# Algae – no algae

(Photos: Janne Jaska Heino, video Kari Koskinen)

Before, May 2017

- visibility 0,3m
- FNU 4,5...5,1



After, May 2017

(<https://youtu.be/KqJzVrBqU8>),

Early June:

- visibility 1-3m,
- FNU 1,3...2,1



# Next steps

- LITSA/PROP project inofficial kick-off on Wed 24.5., starting at 1.7.2017.
  - Measurement of zoobenthos, vegetation, mussels in 2017
  - Intensified measurement of water quality (22 parameters) + phytoplankton and zooplankton in 2017-2018
  - Test fishing in 2017-2019 for deciding about further netting/trawling.
  - Aerial photos & videos
  - Sediment analysis (?)
  - UTU Vehniäinen/Pettersson toxic cyanobacteria/algae follow-up continues.
- Aerators off in 2017-2018
- Contacting with Vesistökunnostusverkosto (water restoration network).

# Some extras

- Elevated media interest in and coverage of Lake Littoistenjärvi and Littoinen village
- Huge increase in use:
  - Requires toilets, bins, parking & hygiene checks
- Some observations made possible by clear water:
  - The strong effect of wind in the lake basin
  - Fish are schooling  
<https://youtu.be/3i0PagxdchA>
- Further development of surface skimming devices

Most important effects:

- People can change their environment to the better
- People learn about caring the nature
- People understand the nature better
- The above is equivalent to €s!



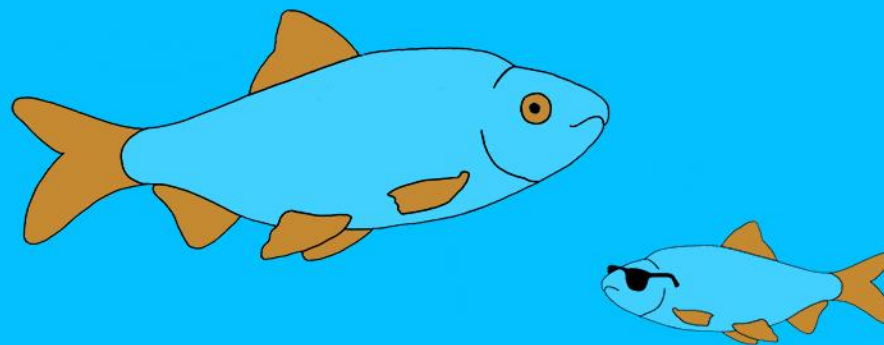


Aerial photo  
and [video](#)  
as of  
11.9.2017  
([all photos](#))



HALLITUKSEN  
KÄRKIHANKE

LITTOISTENJÄRVI



KUNNOSTUS 2017

<http://www.littoistenjarvi.fi>

(Drawings: Pekka Pihlaja, ©Littoistenjärven hoitokunta)