

AlCl₃-treatment of eutrophic Lake Littoistenjärvi:

Background and interim results

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

Lake Littoistenjärvi

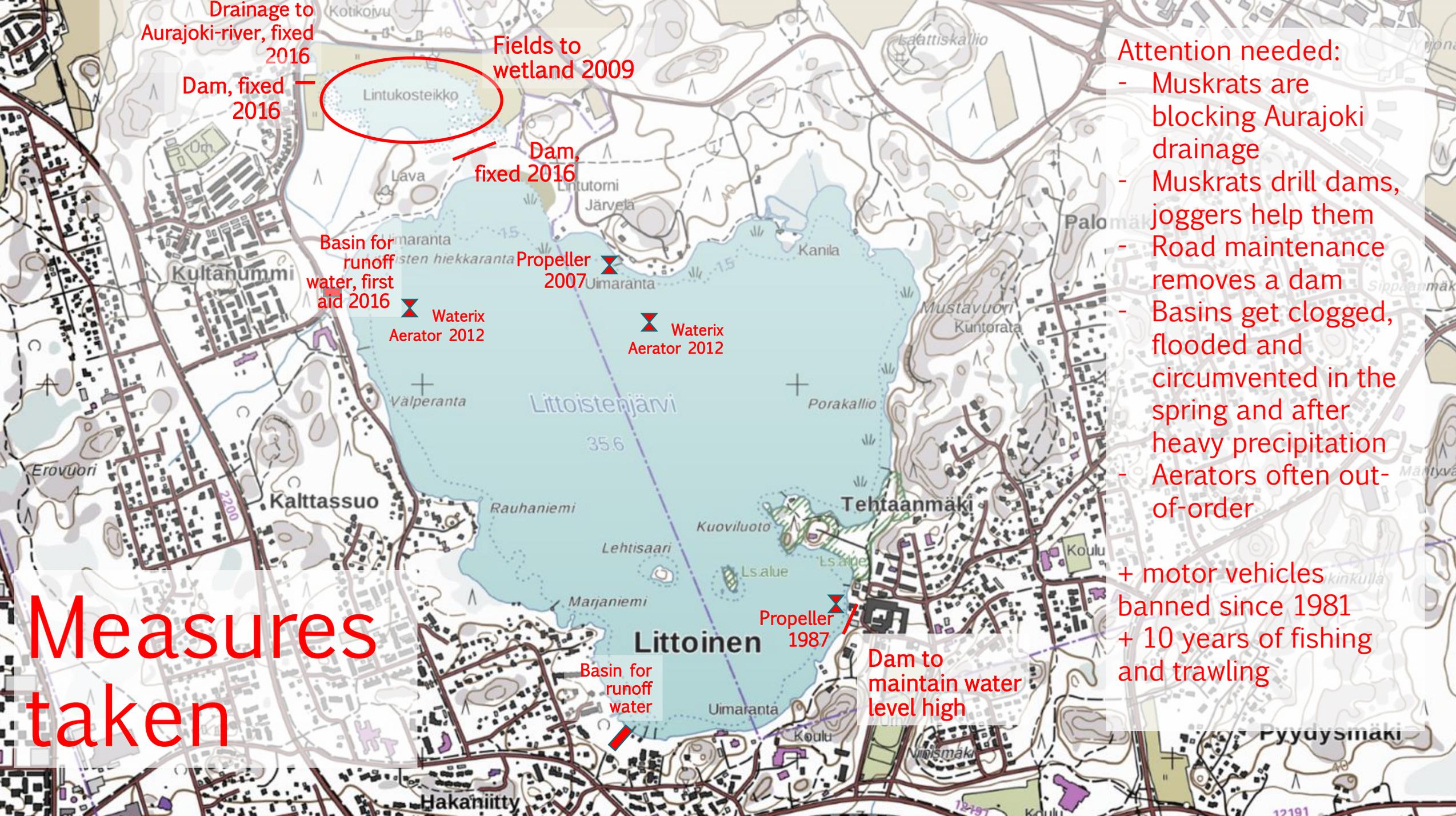
N 60° 27,289' E 22° 23,105' (~WGS84)

- 1,5 km², 3 Mm³, 1,7...1,8 years of residence time
- (3)...4,5 km² 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...
- T₀ 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 $AlCl_3$
 - 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:

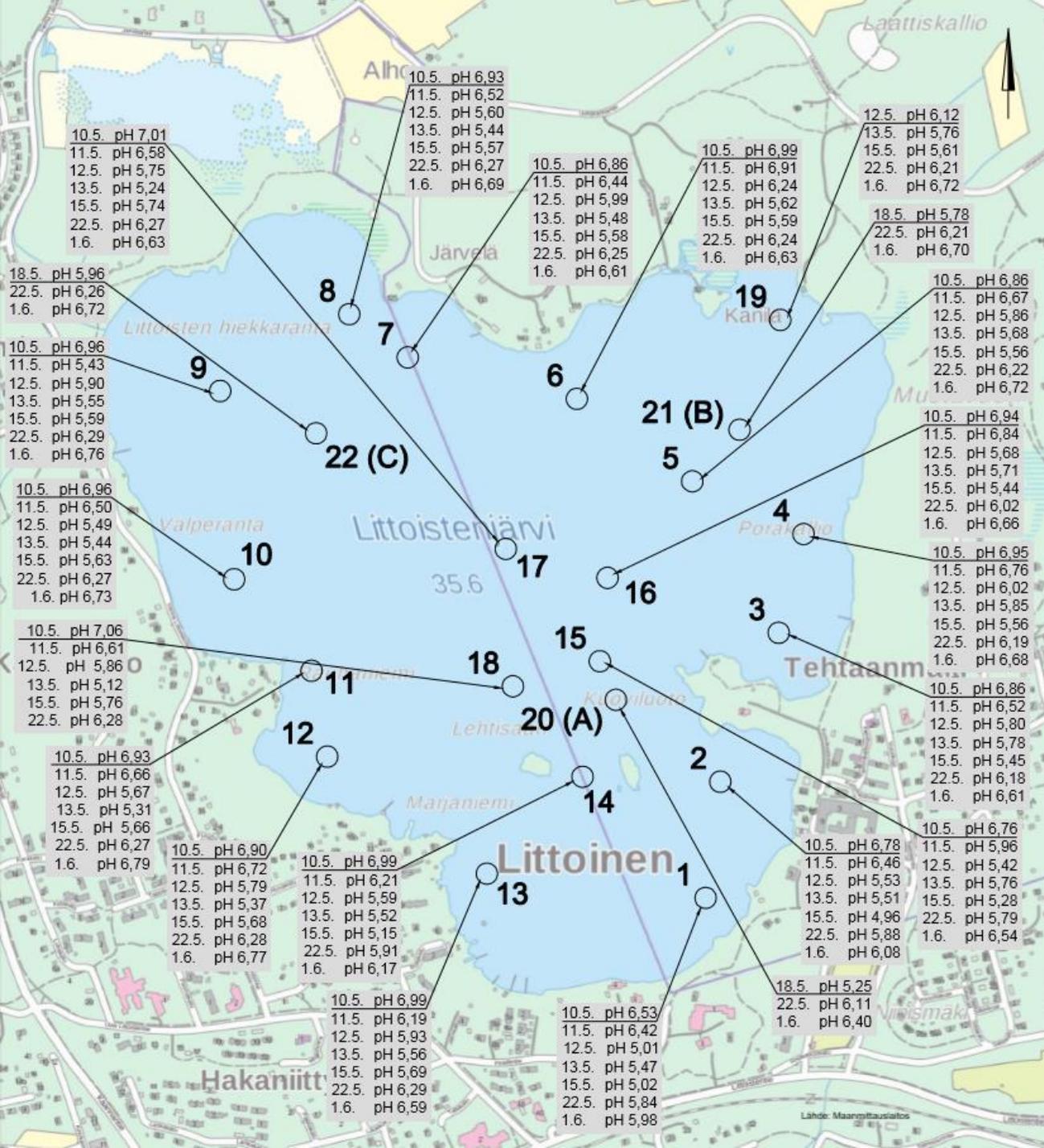
- 40 mg/l, 200-280 t
- Early recommendation in 2017:
 - 50-60 mg/l, 200-260 t
- Water volume estimate:
 - 3,65 MM³
- Completed:
 - 44 mg/l, 160 t (20%...40% reduction)
- pH
 - Before ~7
 - Target 6,0...6,3
 - +3d 5,5 (± 0,5)

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

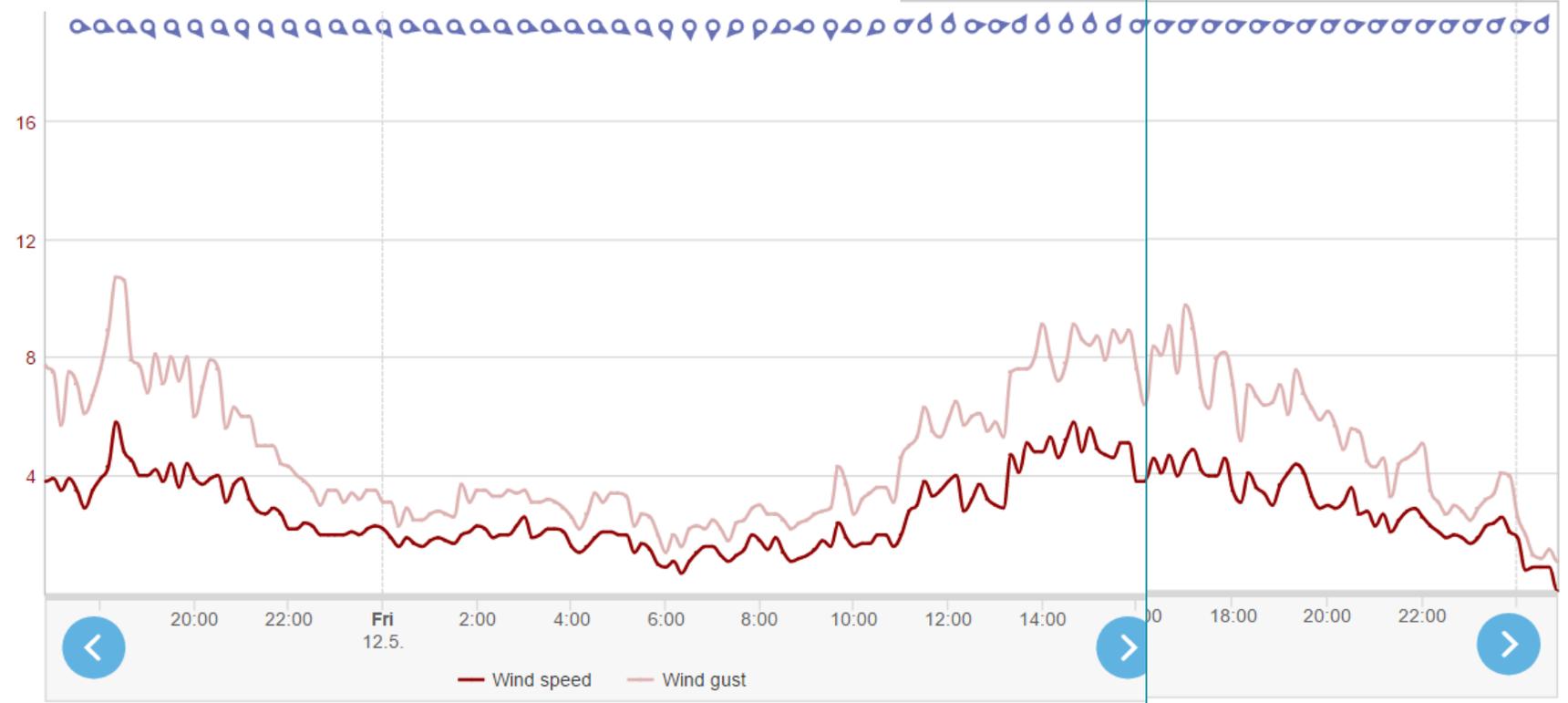
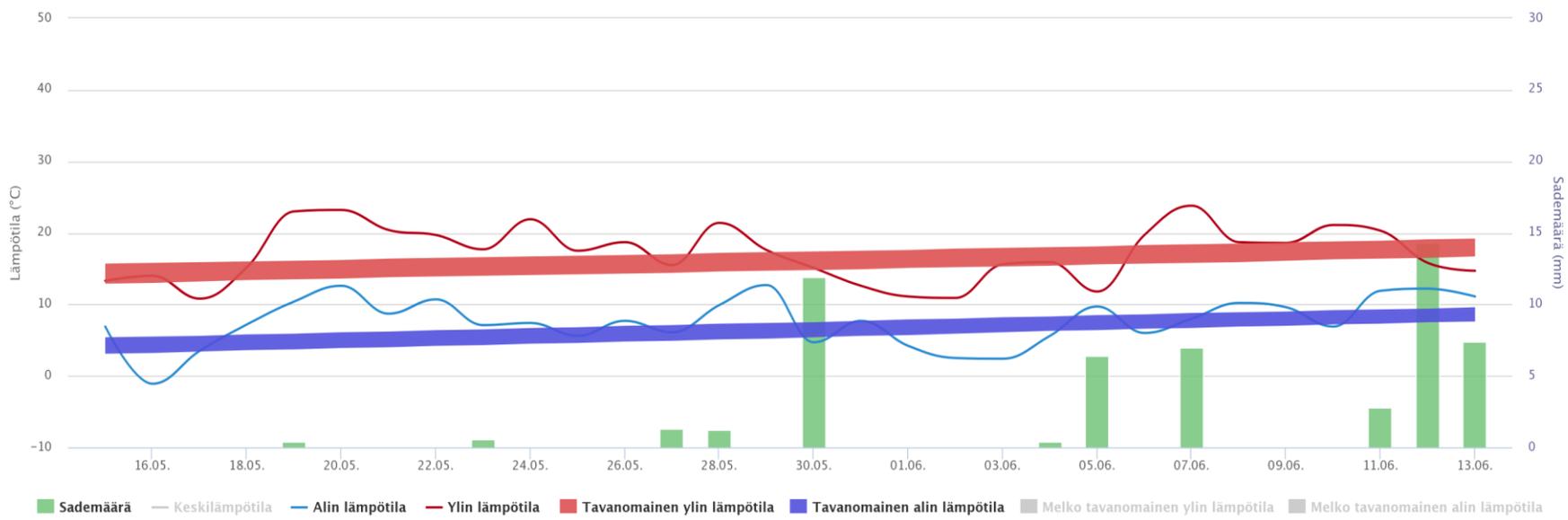
Weather Artukainen during treatment

(Figures: Finnish Meteorological Institute)

1010-1017 hPa

-3,0...+10 °C

Varying winds 0...10 m/s



Three days vs. three weeks after: Average of three samples

(Figure: adapted from Jouko Sarvala)

Phosphorus is gone

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

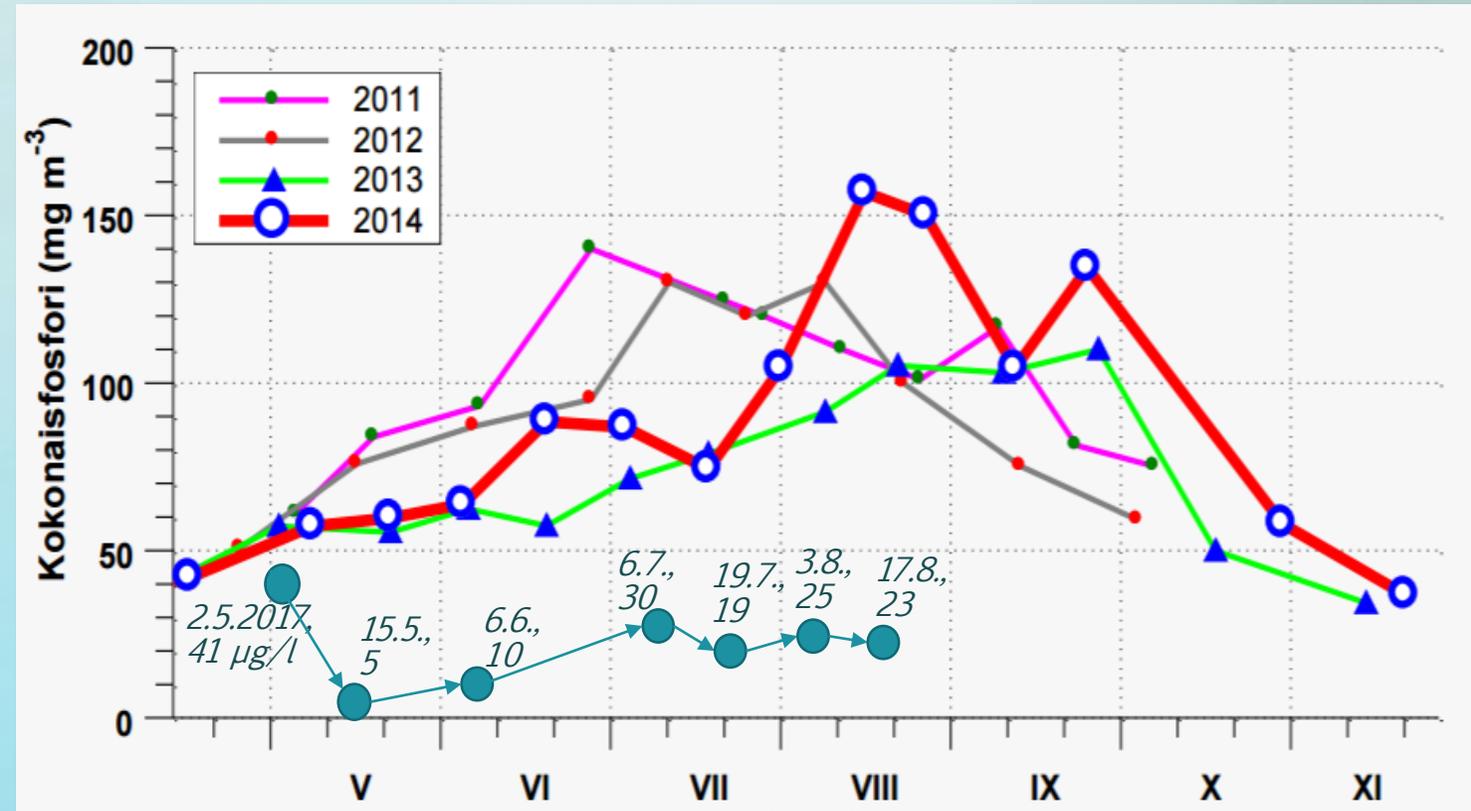
Aluminium

- Last ten years: 100 $\mu\text{g}/\text{l}$
- 630 $\mu\text{g}/\text{l}_{15.5.}$ \rightarrow 45 $\mu\text{g}/\text{l}_{6.6.}$
 - 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_{15.5.} \rightarrow 0,13 mmol/l_{6.6.}

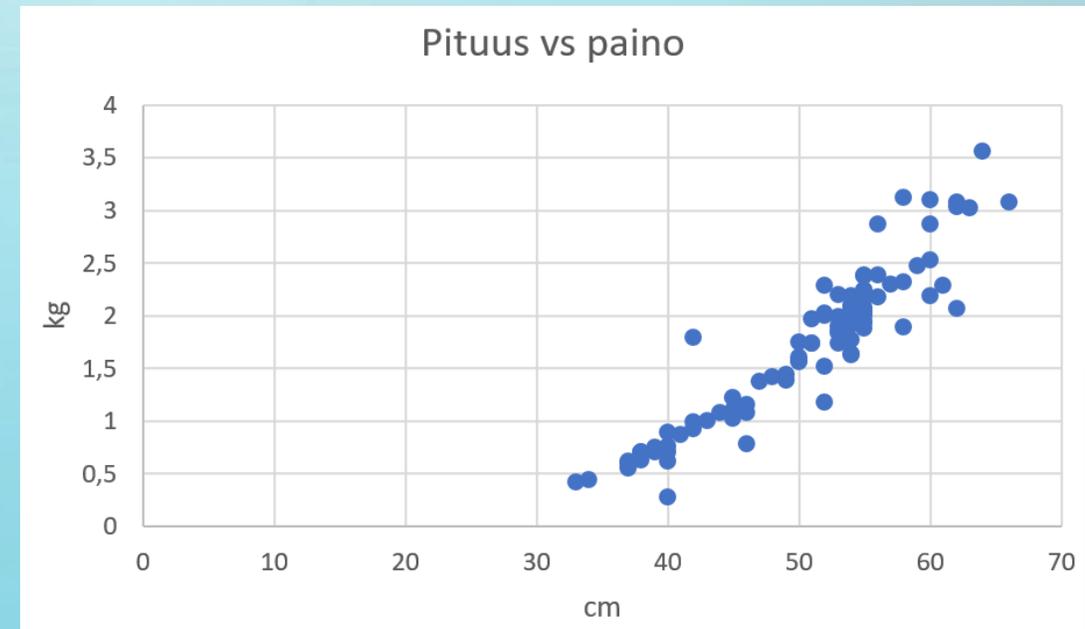
For research and open data: Please follow
<http://www.littoistenjarvi.fi/tutkimustyo/>



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)



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

- Intensified measurement of water quality (22 parameters), phytoplankton, zooplankton and zoobenthos.
 - Aerial photos & videos
- Test fishing in Autumn. Deciding for further netting/trawling.
- Aerator redesign?
(<https://youtu.be/giEqxkClTe8?t=1m54s>)
- UTU Vehniäinen/Pettersson toxic algae follow-up continues.
- Contacting with Vesistökunnostusverkosto (water restoration network).
- Further development of surface skimming devices
- LITSA/PROP project inofficial kick-off on Wed 24.5., starting at 1.7.2017.

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:
 - The strong effect of wind in the lake basin
 - Fish are schooling
<https://youtu.be/3i0Pagxdc hA>

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](#))



<http://www.littoistenjarvi.fi>
(Drawings: Pekka Pihlaja, ©Littoistenjärven hoitokunta)

