

AlCl_3 -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

Lake Littoistenjärvi

N 60° 27,289' E 22° 23,105' (~WGS84)

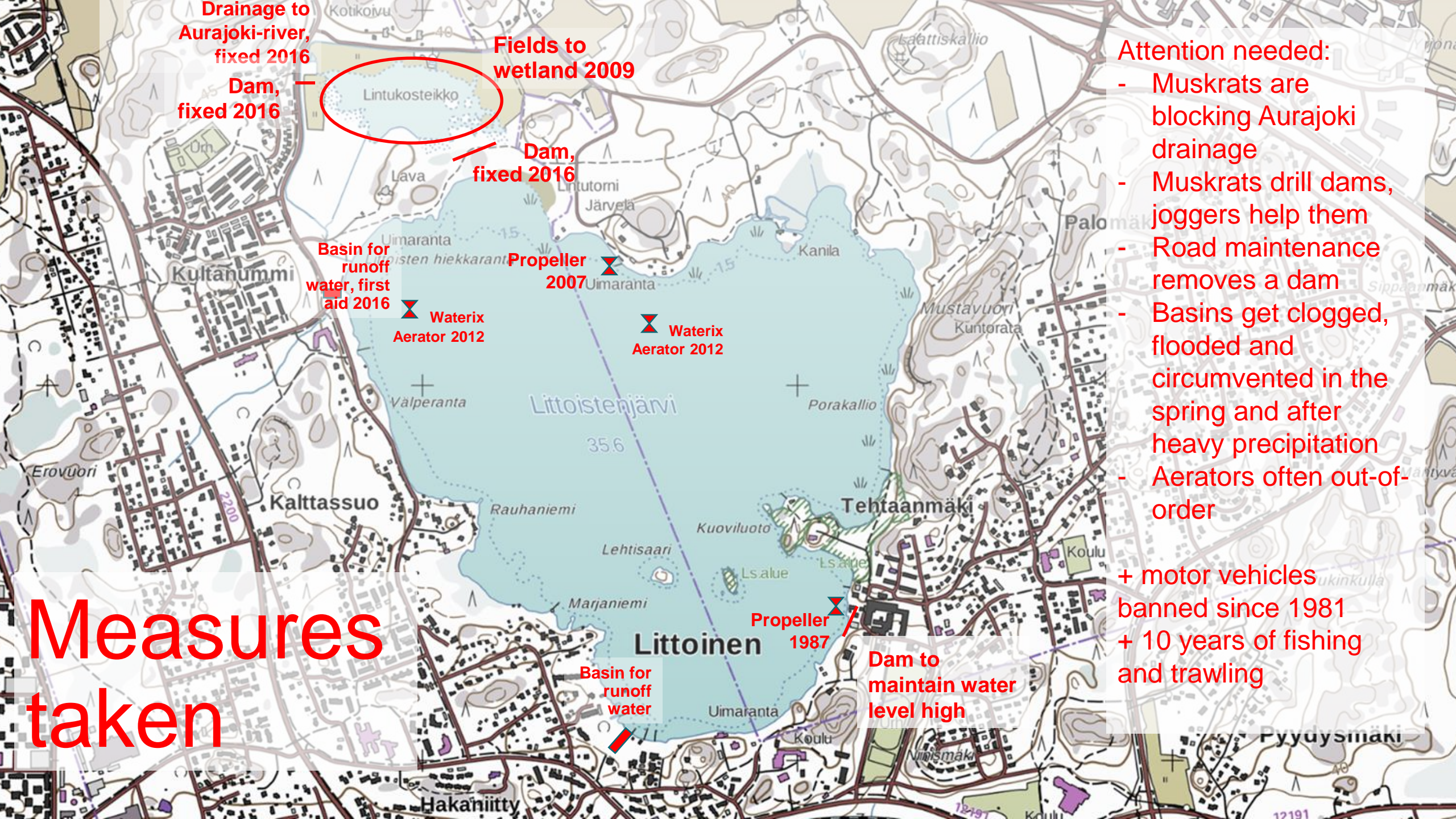
- 1,5 km², 3 Mm³, 1,7...1,8 years of residence time
- (3)...4,5 km² drainage basin
- Regular collection of data for research (and practice)
 - Earliest 18th century records: special, good quality water for frieze manufacturing (est. 1738, later Barker-Littoinen Oy)
 - 1908-1913 First known scientific 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
- 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 AlCl₃
 - 2016 hoitokunta secured funding from major owners and the government

Kuva 2. Littoistenjärven tilavuuskäyrä.



Drainage to Aurajoki-river, fixed 2016
 Dam, fixed 2016

Fields to wetland 2009



Dam, fixed 2016

Basin for runoff water, first aid 2016

Propeller 2007

Waterix Aerator 2012

Waterix Aerator 2012

Measures taken

Propeller 1987

Basin for runoff water

Dam to maintain water level high

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

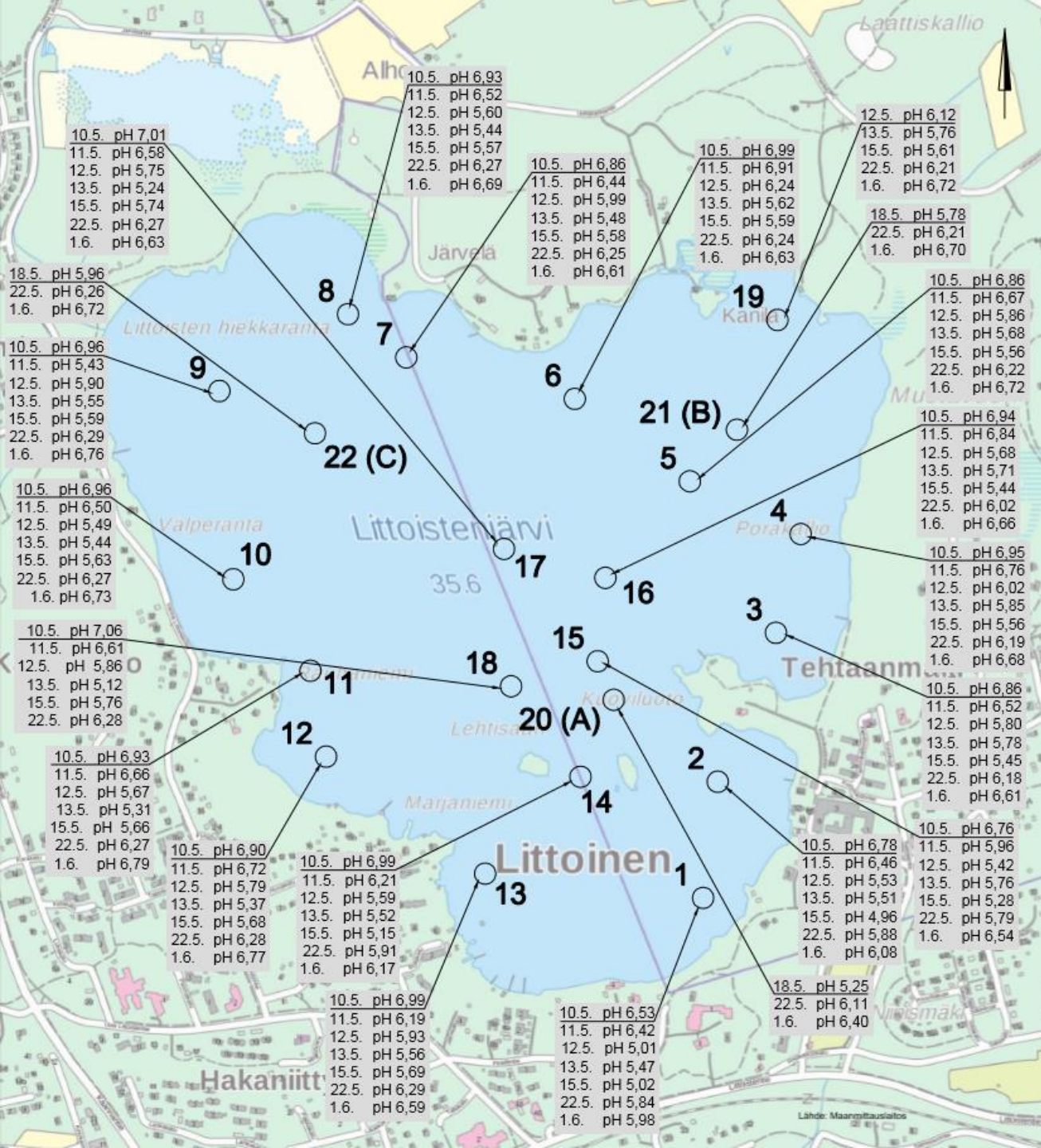
Näyte	Kemikaali	Annostus ml/l	Annostus mg/l	pH1	pH2	Sameus
0	PAX-XL100	0	0	7,1	7,1	samea ja väriä
1	"	29	40	6	6,2	kirkkain
2	"	43	60	5,5	5,6	kirkas
3	"	58	80	5	5	kirkas ja vähän väriä

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 spreading time (20 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

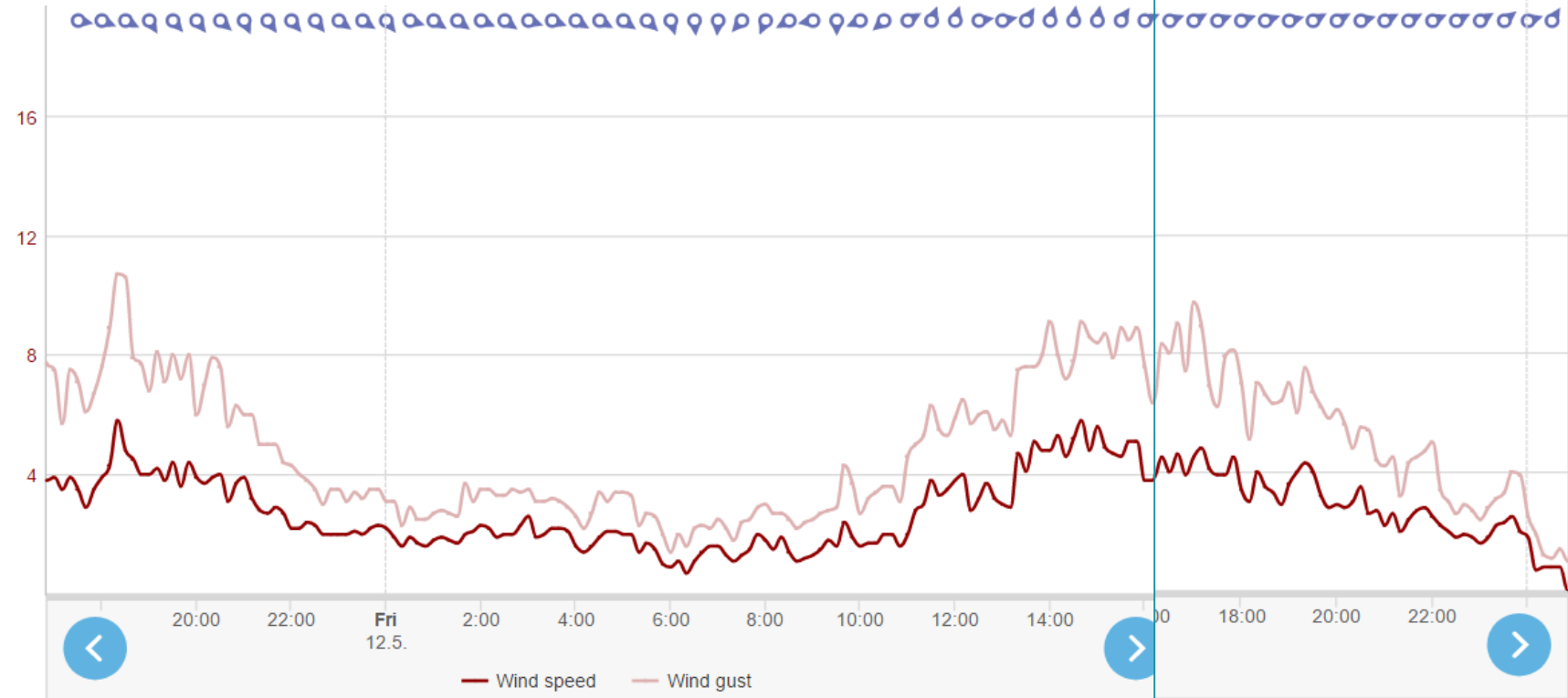
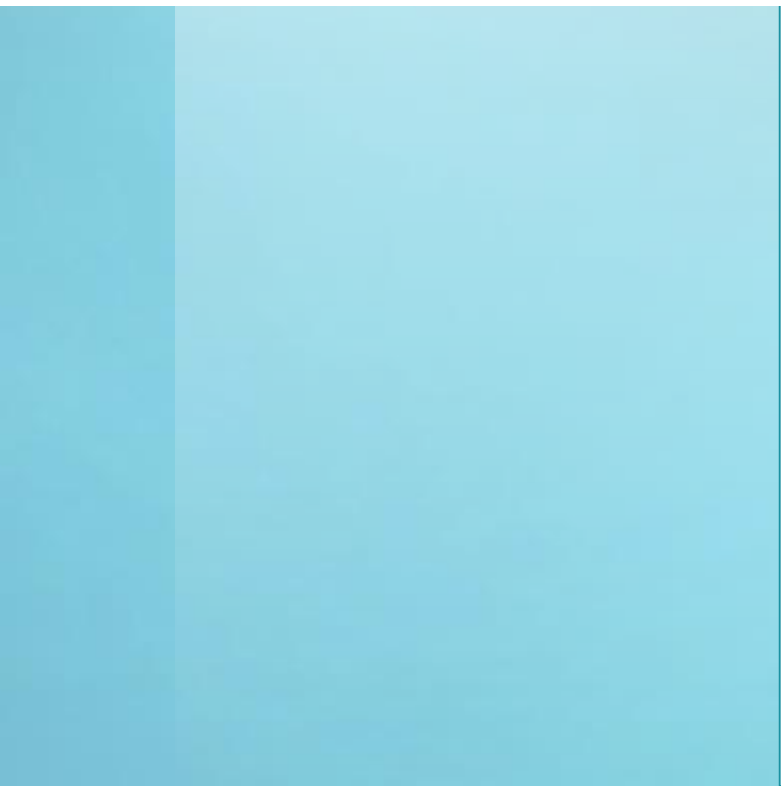
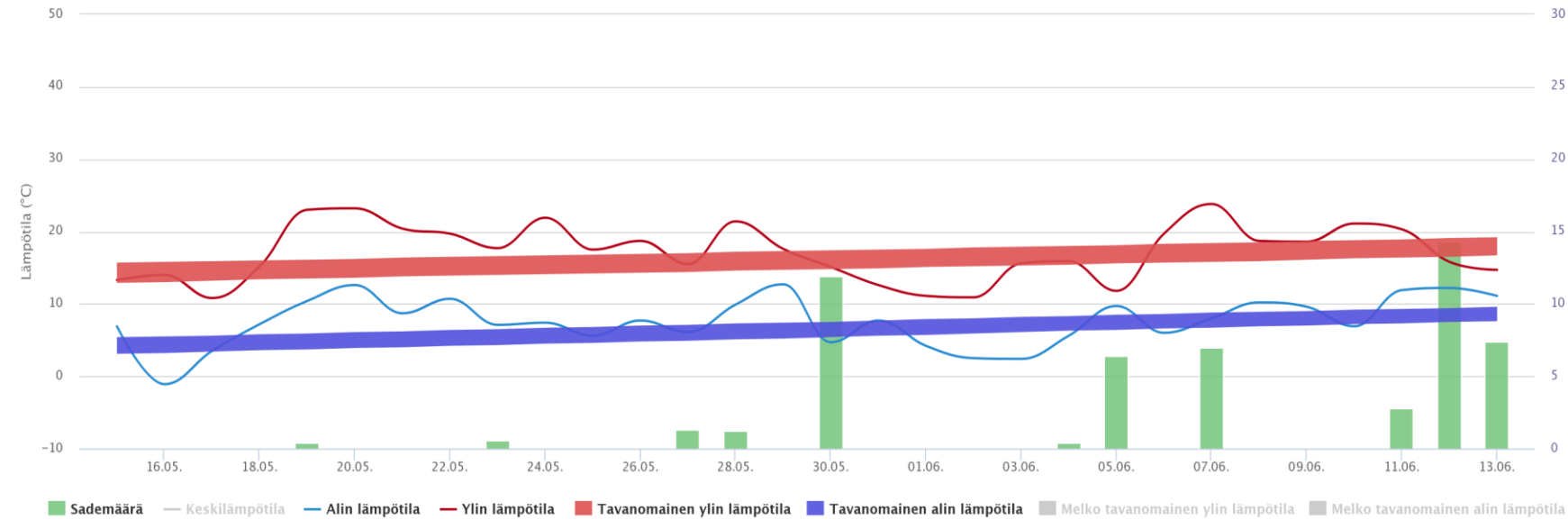
Weather Artukainen during treatment

(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 $\mu\text{g/l}$
- 5 $\mu\text{g/l}$ (total 15.5) -> 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)

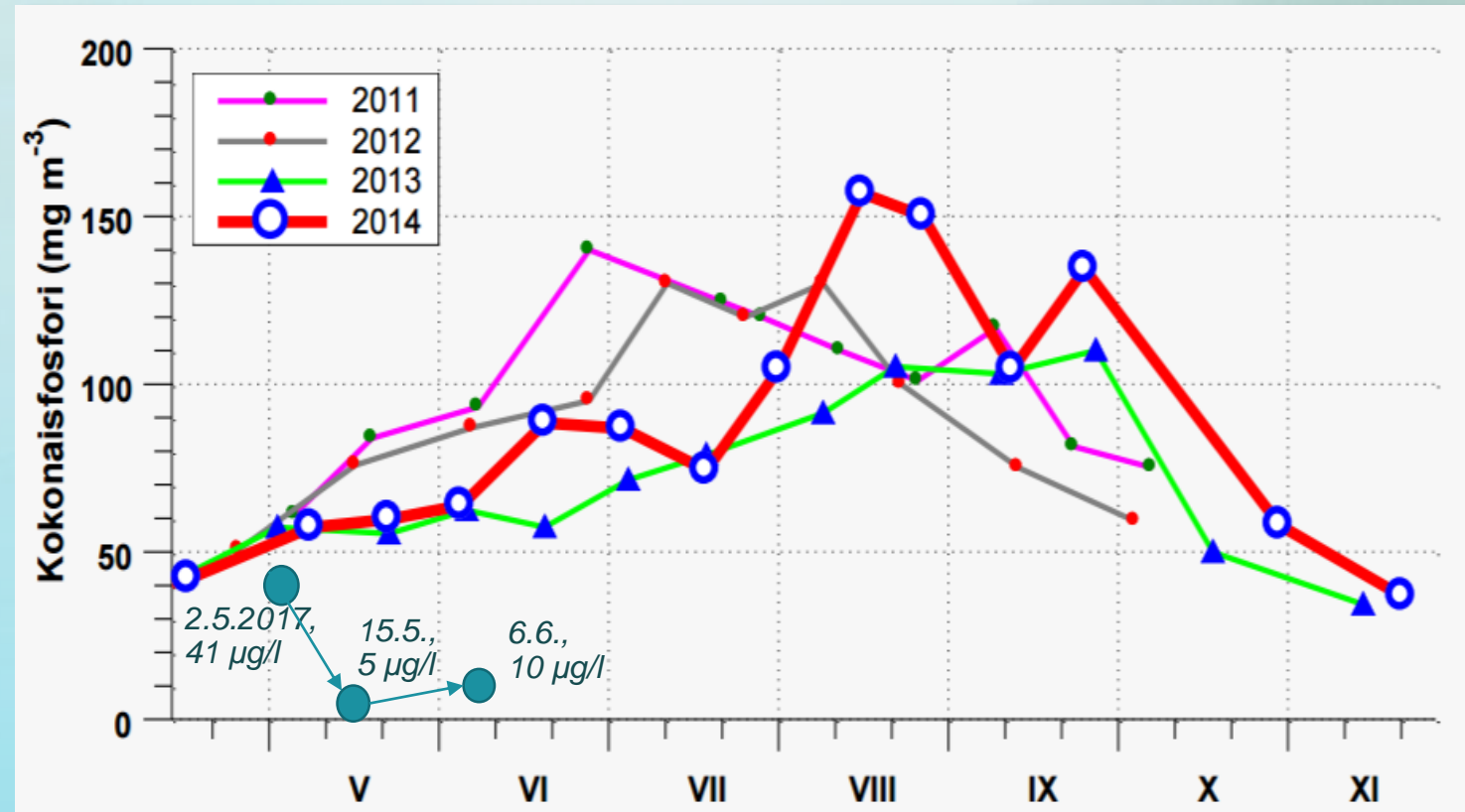
Aluminium

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

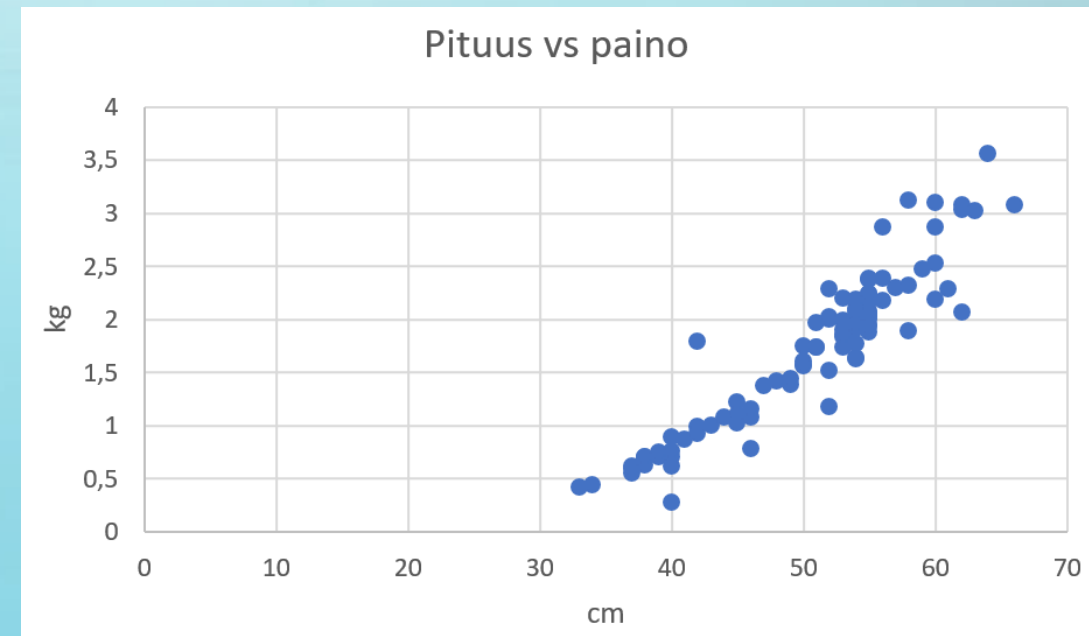
For research and open data: Please follow
<http://www.littoistenjarvi.fi/tutkimustyo/>



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/giEqxkCITe8?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/3i0PagxdchA>

<http://www.littoistenjarvi.fi>

(Drawings: Pekka Pihlaja, ©Littoistenjärven hoitokunta)

