Restoration problems in coastal lagoon lakes

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Euroopa Liit
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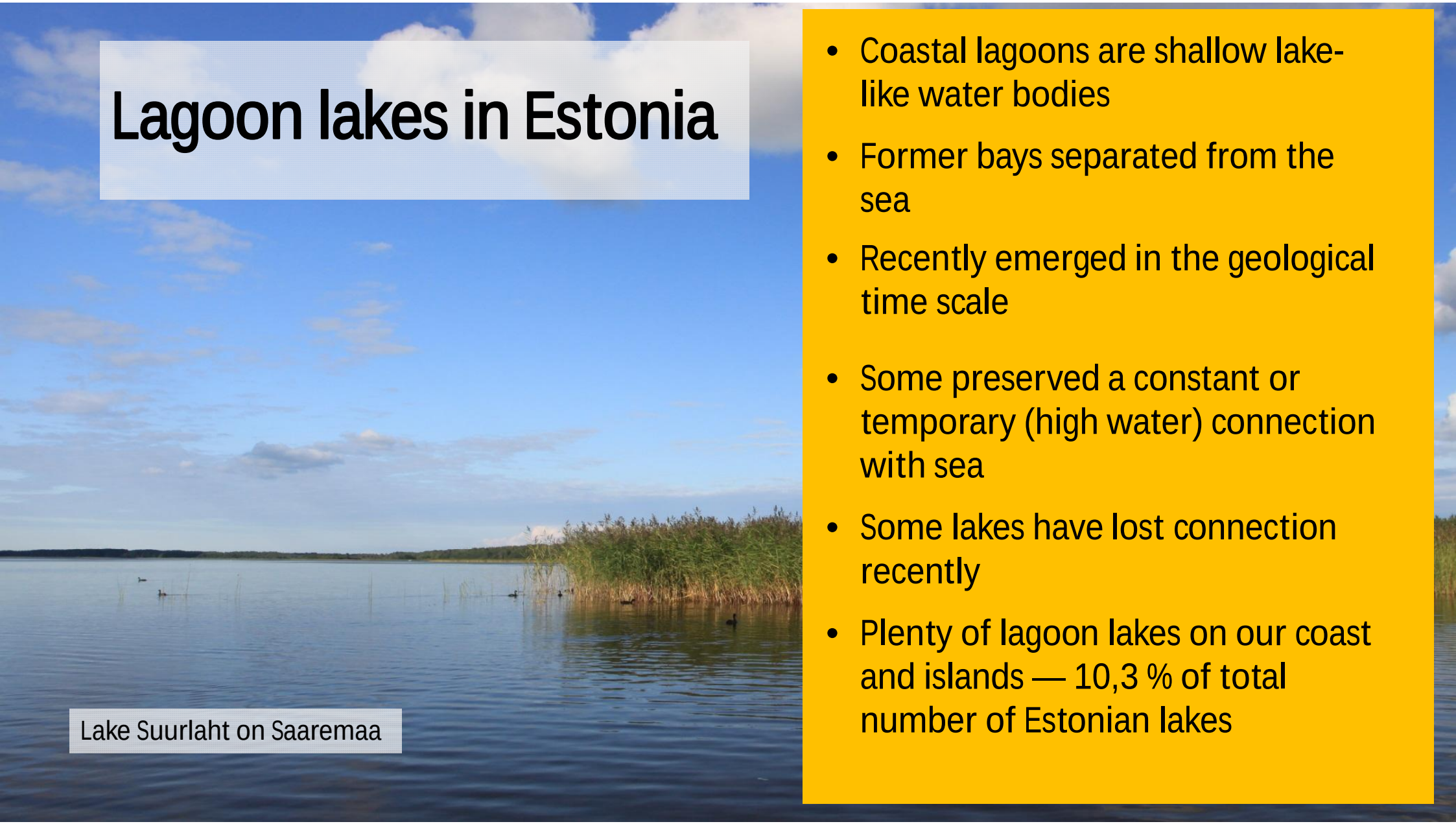
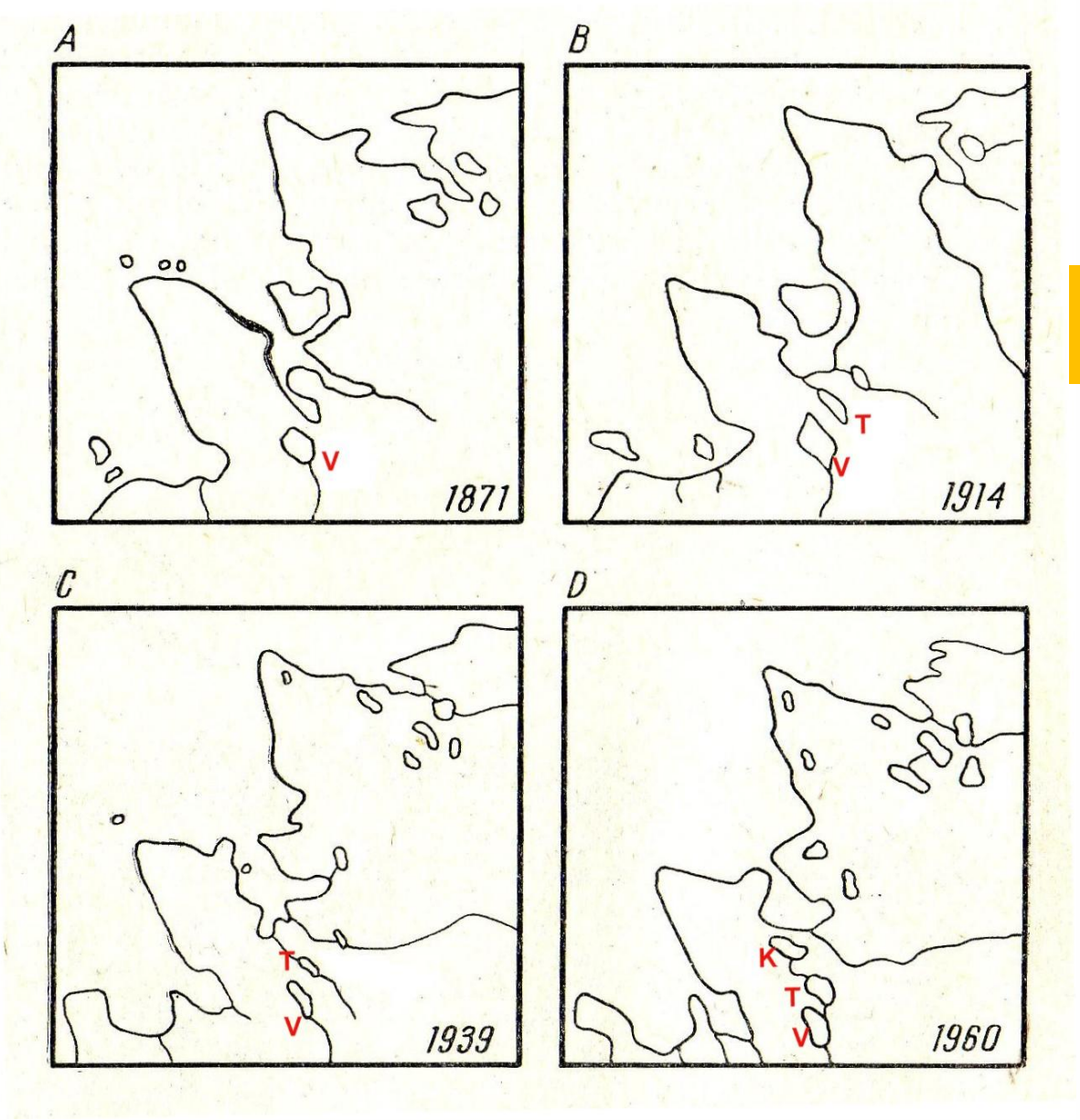
Lagoon lakes in Estonia



Lake Suurlaht on Saaremaa

- Coastal lagoons are shallow lake-like water bodies
- Former bays separated from the sea
- Recently emerged in the geological time scale
- Some preserved a constant or temporary (high water) connection with sea
- Some lakes have lost connection recently
- Plenty of lagoon lakes on our coast and islands — 10,3 % of total number of Estonian lakes



Changes in North-West of Hiiumaa between 1871-1960

V – Veskilais

T – Tammelais

K – Künaauk

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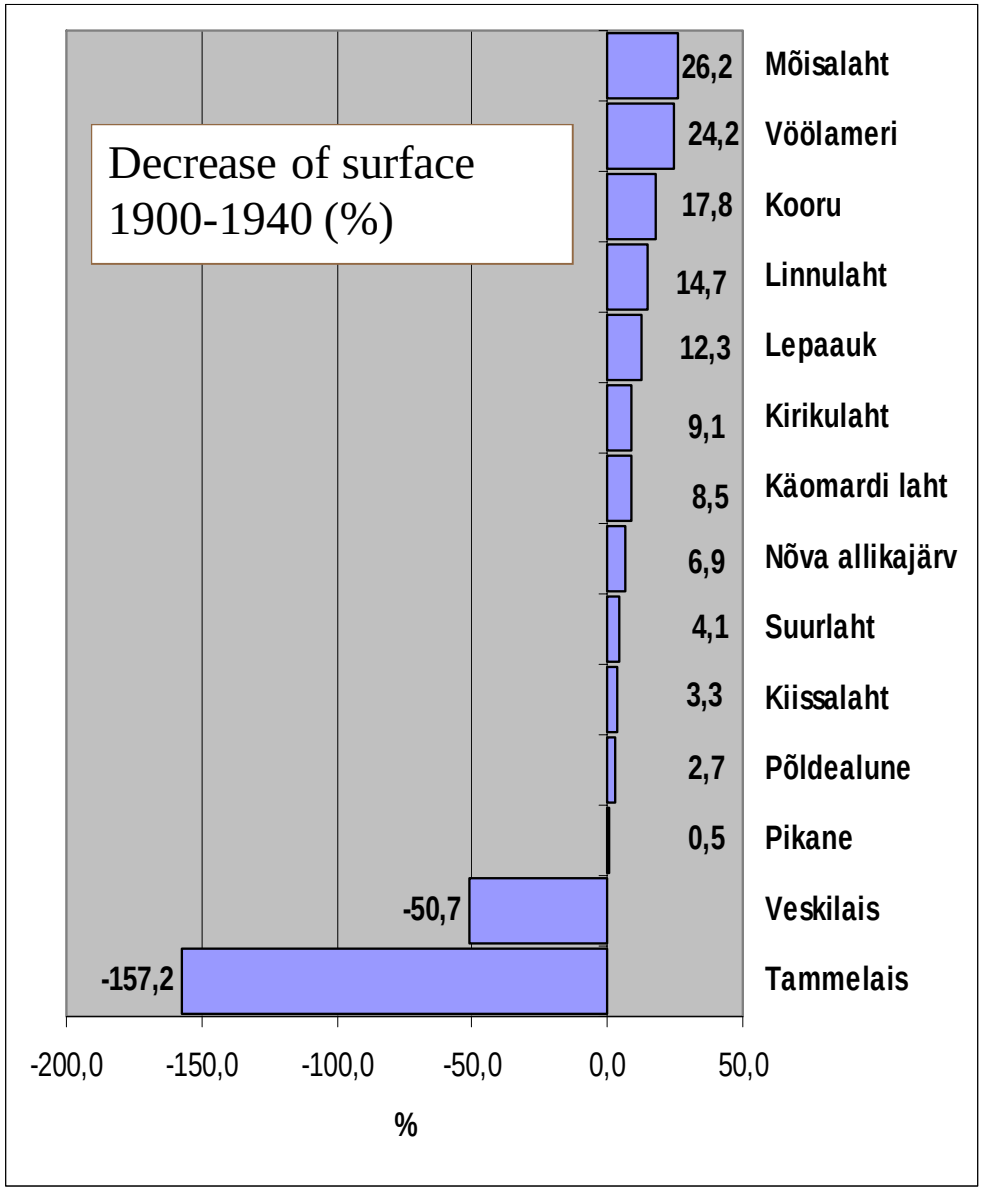
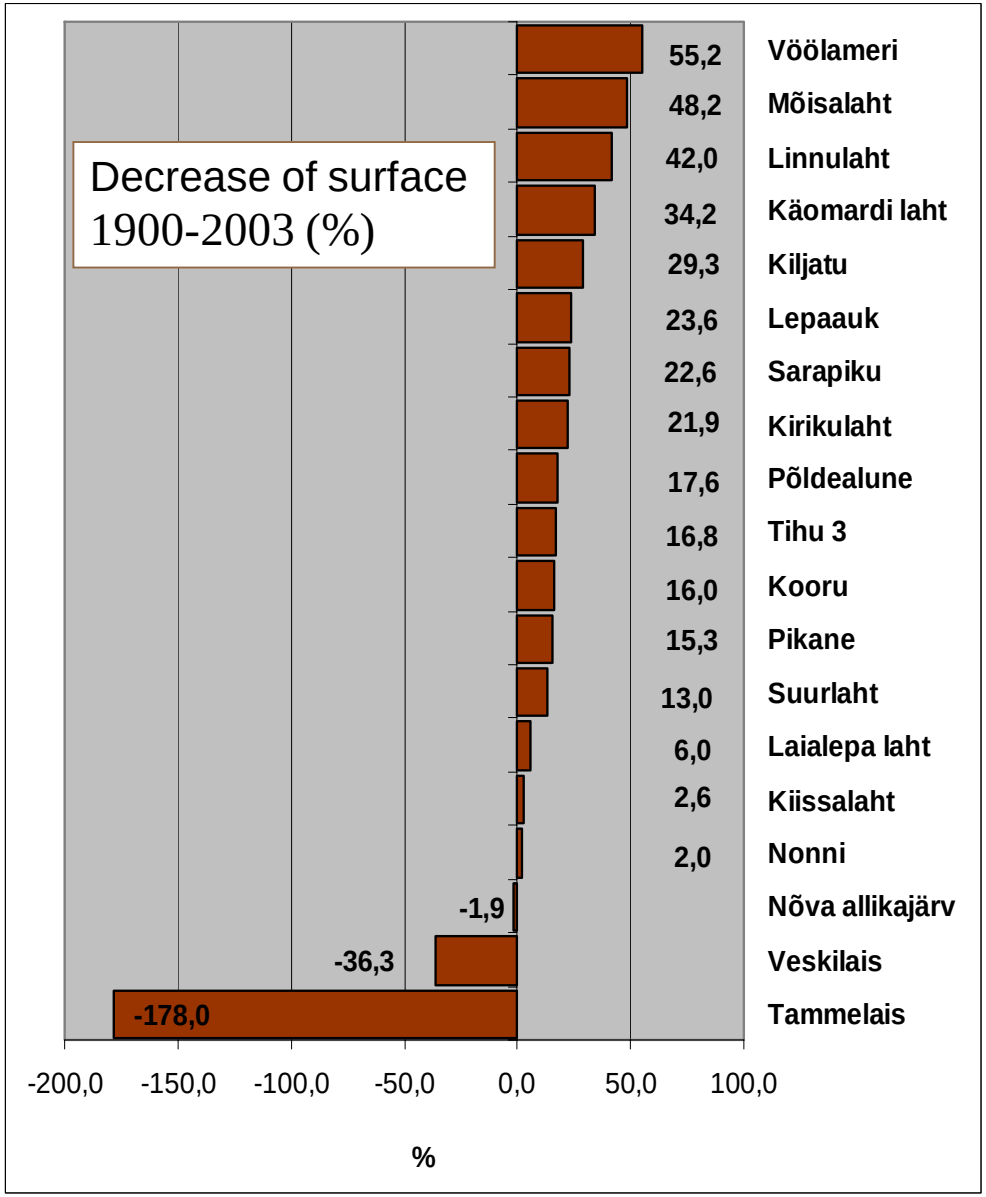
Extinction of coastal lakes

- Causes:
- Eutrophication
- Lowering of water table
- Uprise of lithosphere 2-3 mm/per year

- Rapidly changing from marine communities to brackish, then to freshwater systems and eventually to meadows.


Decrease of surface
1900-1940 (%)
26,2
Mõisalaht
24,2
Vöölameri
17,8
Kooru
14,7
Linnulaht
12,3
Lepaauk
9,1
Kirikulaht
8,5
Käomardi laht
6,9
Nõva allikajärv
4,1
Suurlaht
3,3
Kiissalaht
2,7
Põldealune
0,5
Pikane
-50,7
Veskilais
-157,2
Tammelais
-200,0
-150,0
-100,0
-50,0
0,0
50,0
%

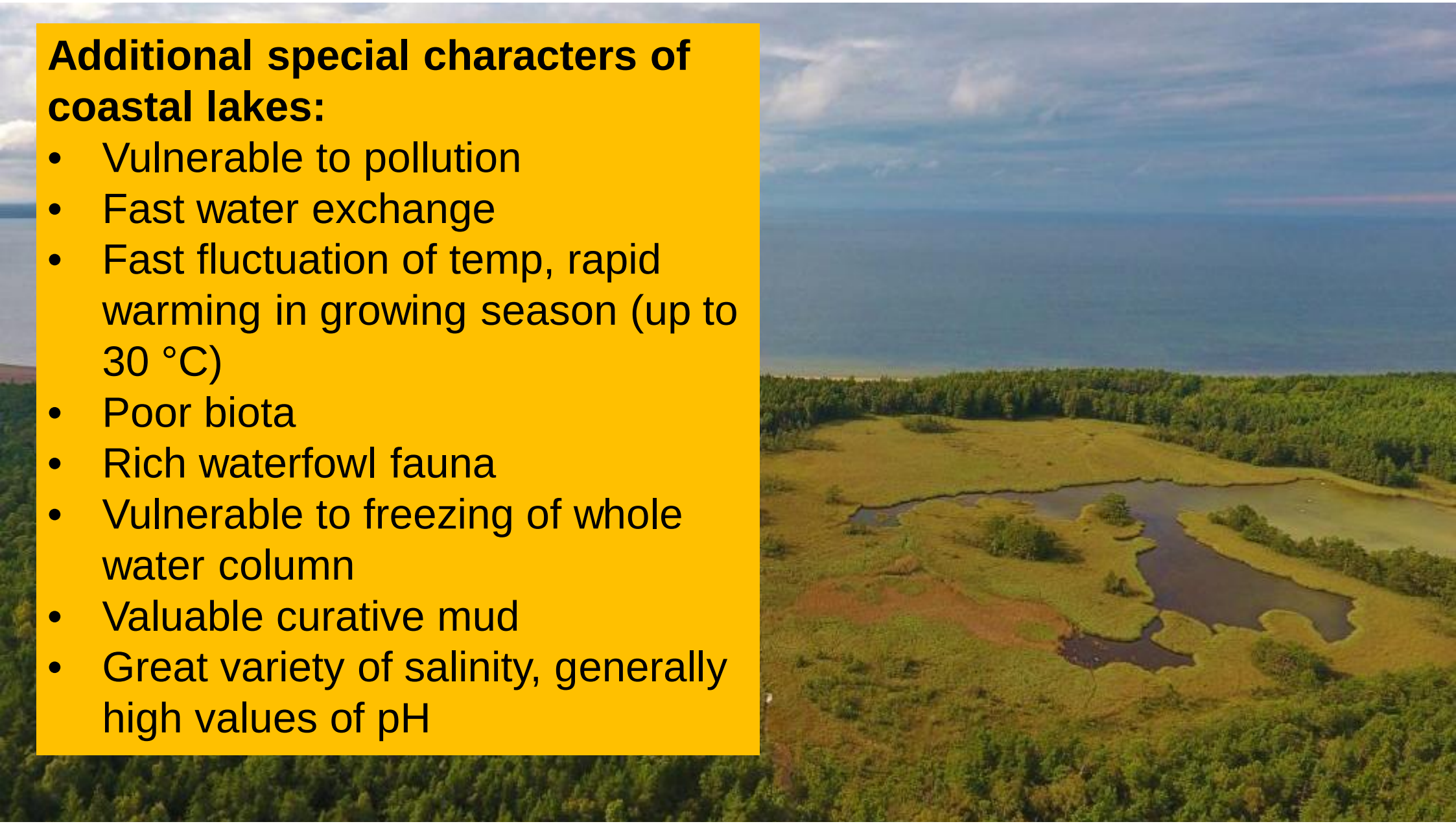

Decrease of surface
1900-2003 (%)
55,2
Vöölameri
48,2
Mõisalaht
42,0
Linnulaht
34,2
Käomardi laht
29,3
Kiljatu
23,6
Lepaauk
22,6
Sarapiku
21,9
Kirikulaht
17,6
Põldealune
16,8
Tihu 3
16,0
Kooru
15,3
Pikane
13,0
Suurlaht
6,0
Laialepa laht
2,6
Kiissalaht
2,0
Nonni
-1,9
Nõva allikajärv
-36,3
Veskilais
-178,0
Tammelais
-200,0
-150,0
-100,0
-50,0
0,0
50,0
100,0
%

General info about lagoon lakes in Estonia

- Highly heterogeneous systems
- Rapidly alternating or changing ecologic conditions
- The ecological status depends on the influx of seawater
- Shallow water level makes these ecosystems weak and sensitive to pressures
- Sediment is easily resuspendable
- In some lakes, considerable amount of nutrients can be accumulated in sediment

Lake Kooru on Saaremaa

- Diversity of ecosystems of coastal lakes depends (Estonian conditions) on:
  - Age of the water body
  - Connection with sea
  - Water exchange time
  - Prevailing sediments (solid minerals, soft minerals, organic sediments)
  - Water volume
  - Morphometry



Additional special characters of coastal lakes:

- Vulnerable to pollution
- Fast water exchange
- Fast fluctuation of temp, rapid warming in growing season (up to 30 °C)
- Poor biota
- Rich waterfowl fauna
- Vulnerable to freezing of whole water column
- Valuable curative mud
- Great variety of salinity, generally high values of pH

Where is Lake Vööla meri?

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Inflow from the sea (Hara Bay)

Inflow before reconstruction

After reconstruction in 2011

Water exchange has been intensified a lot. Water level depends much more from sea level than before.

Ecological status of Lake Vööla meri

- Investigated more than 10 years
- Always moderate or bad ecological status
- Shallow, low water volume
- Naturally overgrowing
- Extensive reed areas
- Low biodiversity
- One rare macrophyte –

spiny water nymph (*Najas marina)*

To restore or not to restore... that is the question?

- Should we maintain these lakes as aquatic ecosystems or allow them to naturally overgrow and become wetlands?
- Since it is larger than 50 ha, WFD states that we need to achieve good ecological status.
- If the sea level rises (global change) then the lake will last for a long time.
- If we improve water exchange with the sea, increase the water volume, would we be able to return to the former situation with a beautiful water body with sandy beaches?

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Sediment analysis

- Sediment sampling in seven points:
  - Sediment characteristics
  - Phosphorus fractionations
  - Incubation experiments

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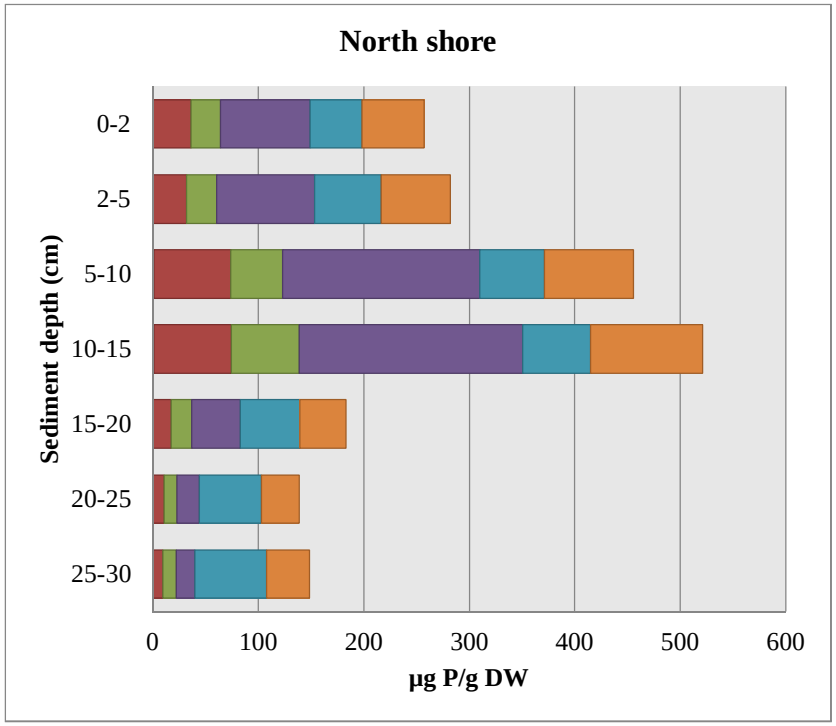
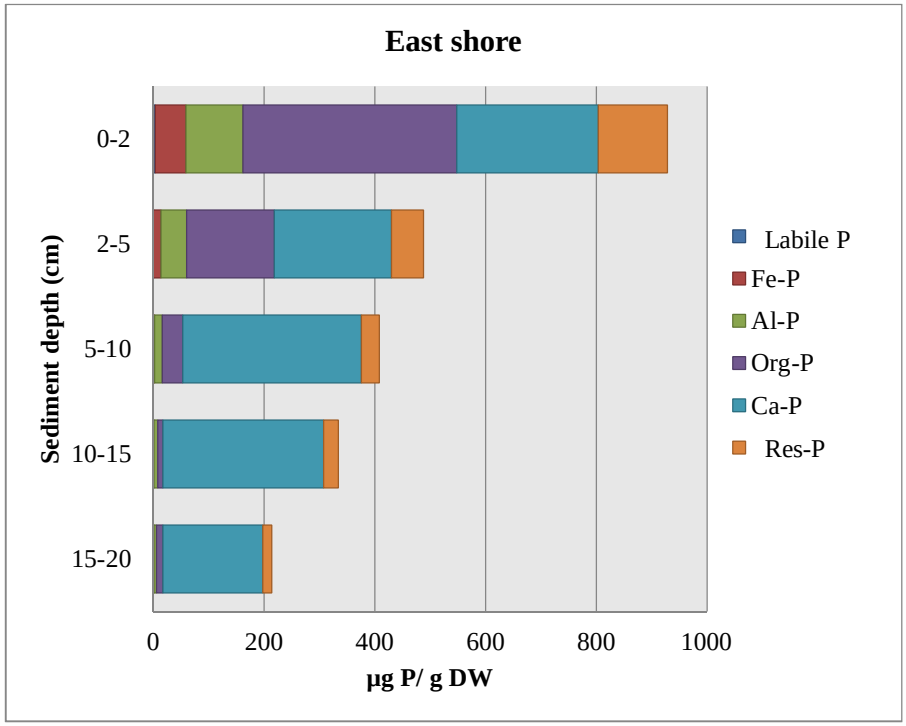
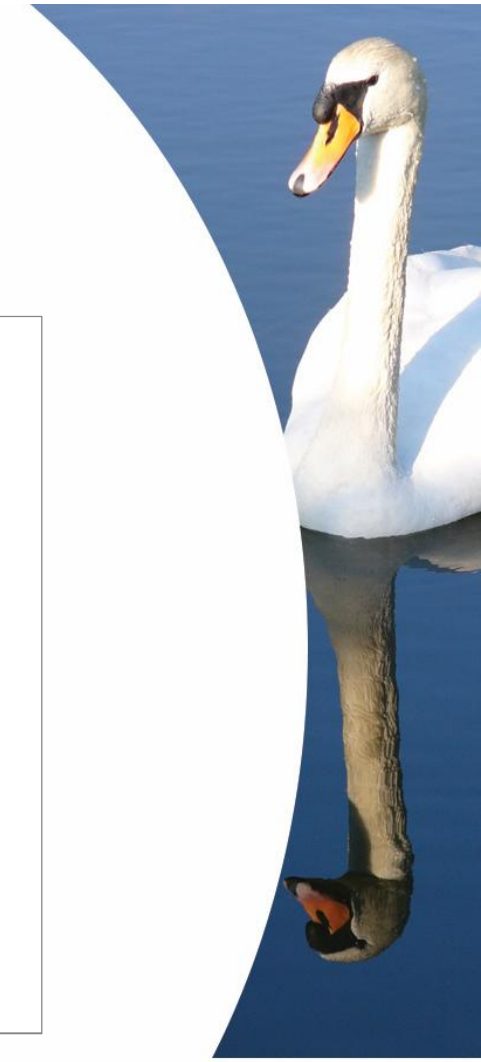
Sediment phosphorus fractionation







High sediment P content for lagoon lake. In surface layer, most P in mobile forms.
In north shore sediment higher amount of P in deeper layers. Probably accumulation due to dam.

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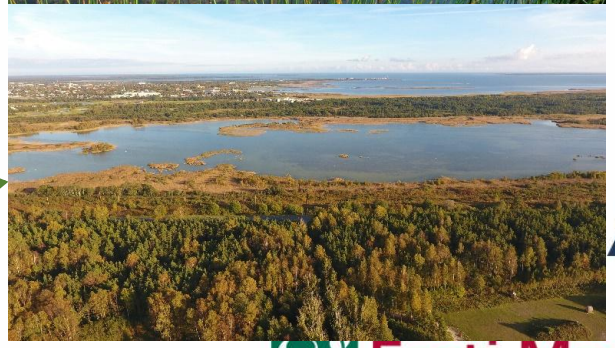
Lake Vööla meri compared to other Estonian lagoon lakes

Lake	Sampling point	Sum of sediment fractions (µg P/g KA)	Ecol. status
Lake Vööla meri	East shore	929	moderate
	North shore	257	
Lake Oessaare		300	moderate
Lake Käomardi		335	moderate
Lake Linnulaht		2500	moderate



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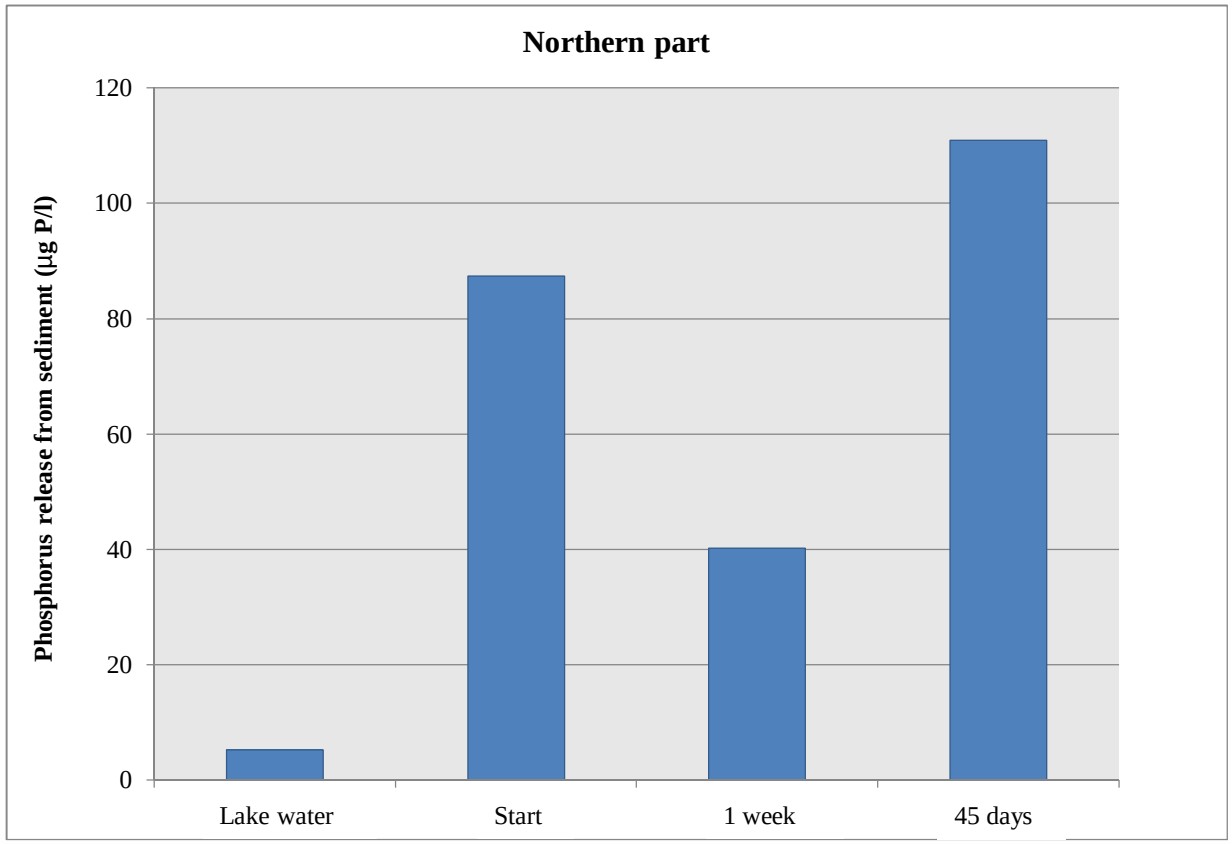
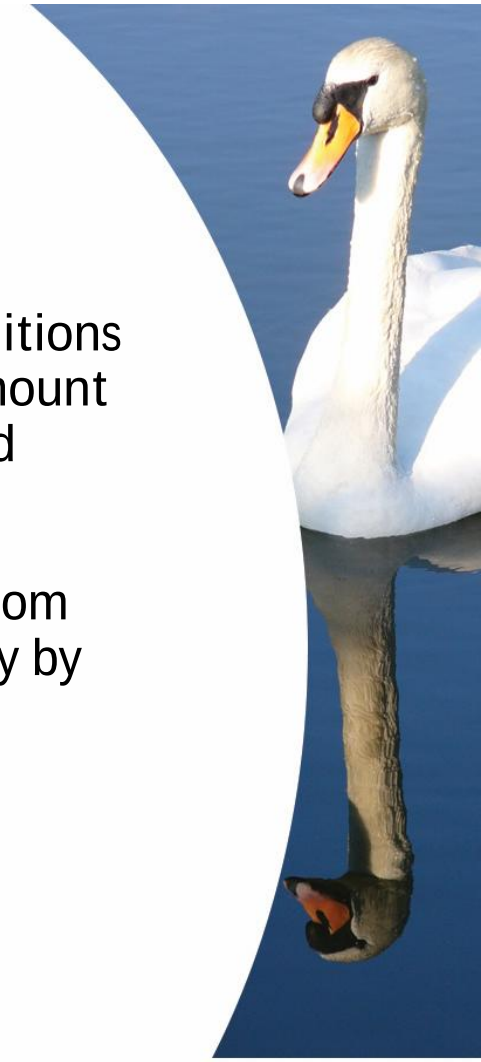
Phosphorus incubation experiments



- In anoxic conditions substantial amount of P is released
- P is released from sediment easily by resuspension



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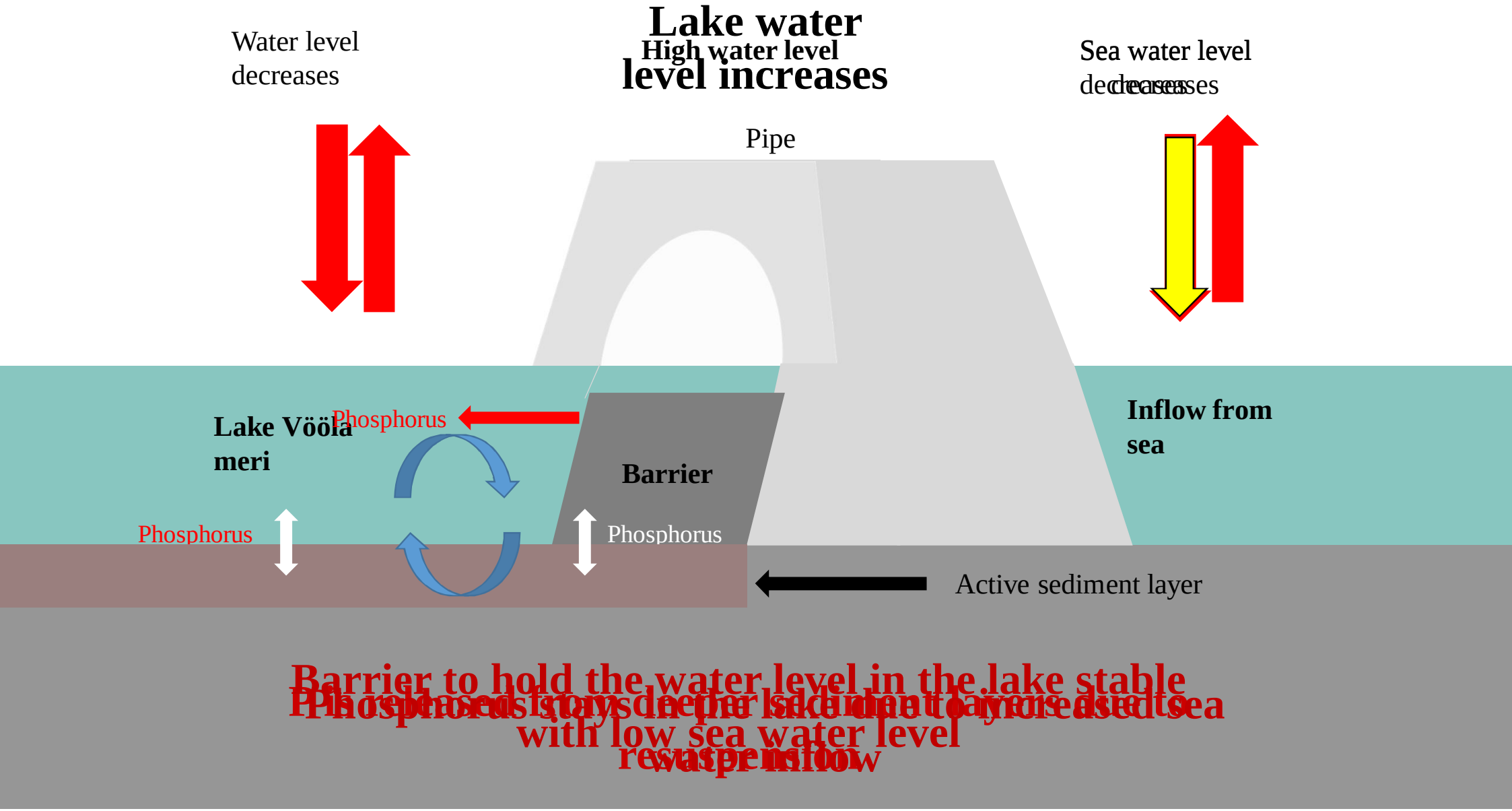

Lake water
level increases
High water level
Water level
decreases
Sea water level
decreases
Pipe
Lake Vööla
meri
Phosphorus
Barrier
Inflow from
sea
Phosphorus
Phosphorus
Active sediment layer
Barrier to hold the water level in the lake stable
with low sea water level
Phosphorus stays in the lake due to increased sea
water inflow

How will the seawater continue to affect the lake?

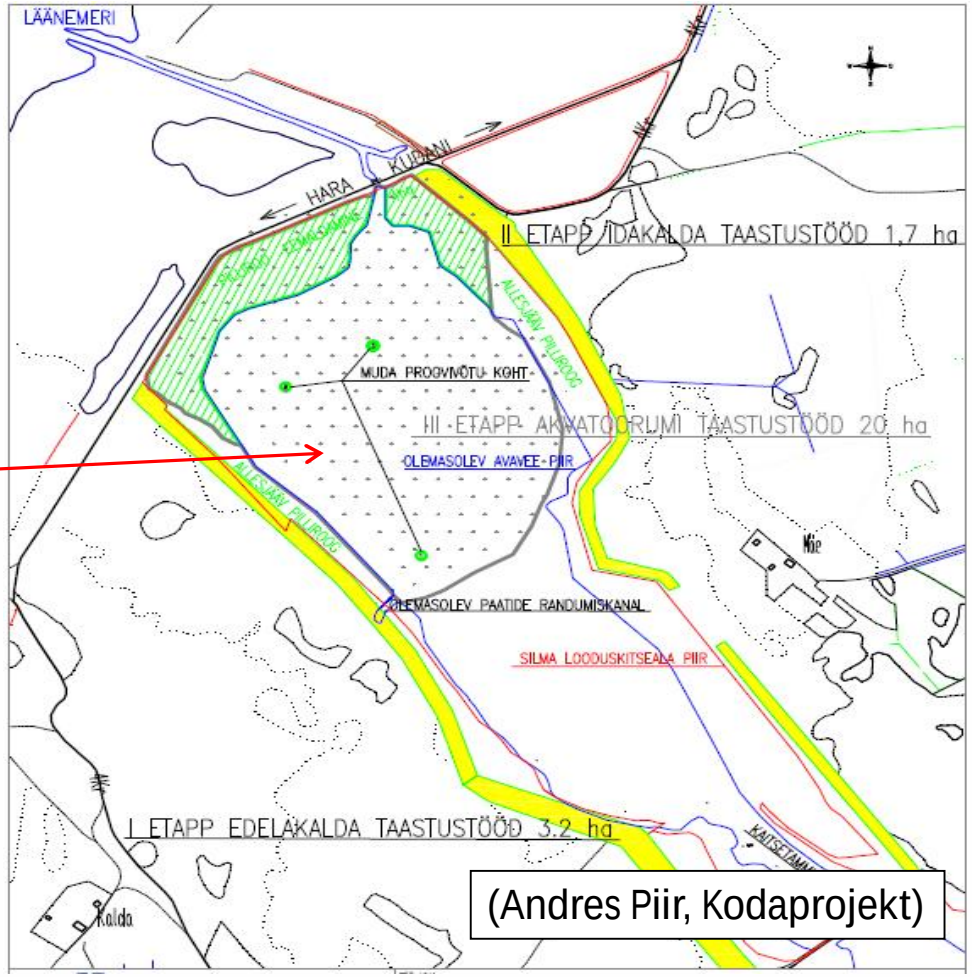
- If phosphorus will continue to be released from the sediment due to resuspension, a large amount of P will be carried to the sea.
- This way the lake is restoring itself.
- Hard to predict its duration.
- The sediment will remain in the lake and the water volume in the lake will keep decreasing because of the land rising.

How about lake Vööla meri? To restore or not?

- Due to the climate change these lakes could be considered as one of the most endangered water habitats of the world.
- Natural conservation and environmental management will inevitably have to address issues arisen with these water bodies
- We need to evaluate by site if to maintain them as aquatic ecosystems or to allow these lakes to naturally overgrow and become wetlands.

Restoration plan

- Sediment removal from the northern part of the lake.
- Restored area ca 20 ha.
- Sediment dredging volume ca 150 000 m³ (calculations according to Jüri Kask, Geological Agency, 2002).
- Increase the water depth 0,7 m.



(Andres Piir, Kodaprojekt)

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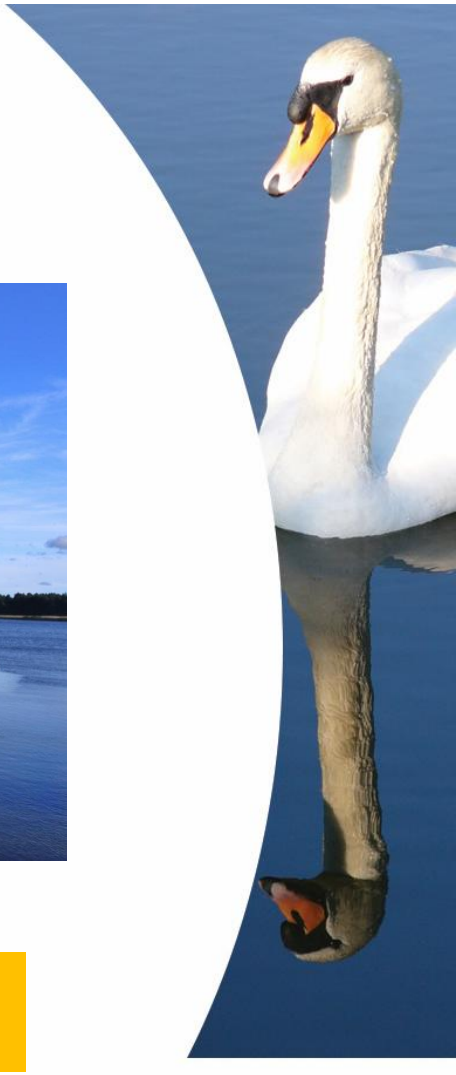
Water volume and emergent plants

Increase the water volume by restricting the inflow

Decrease the reed areas in some parts of the lake



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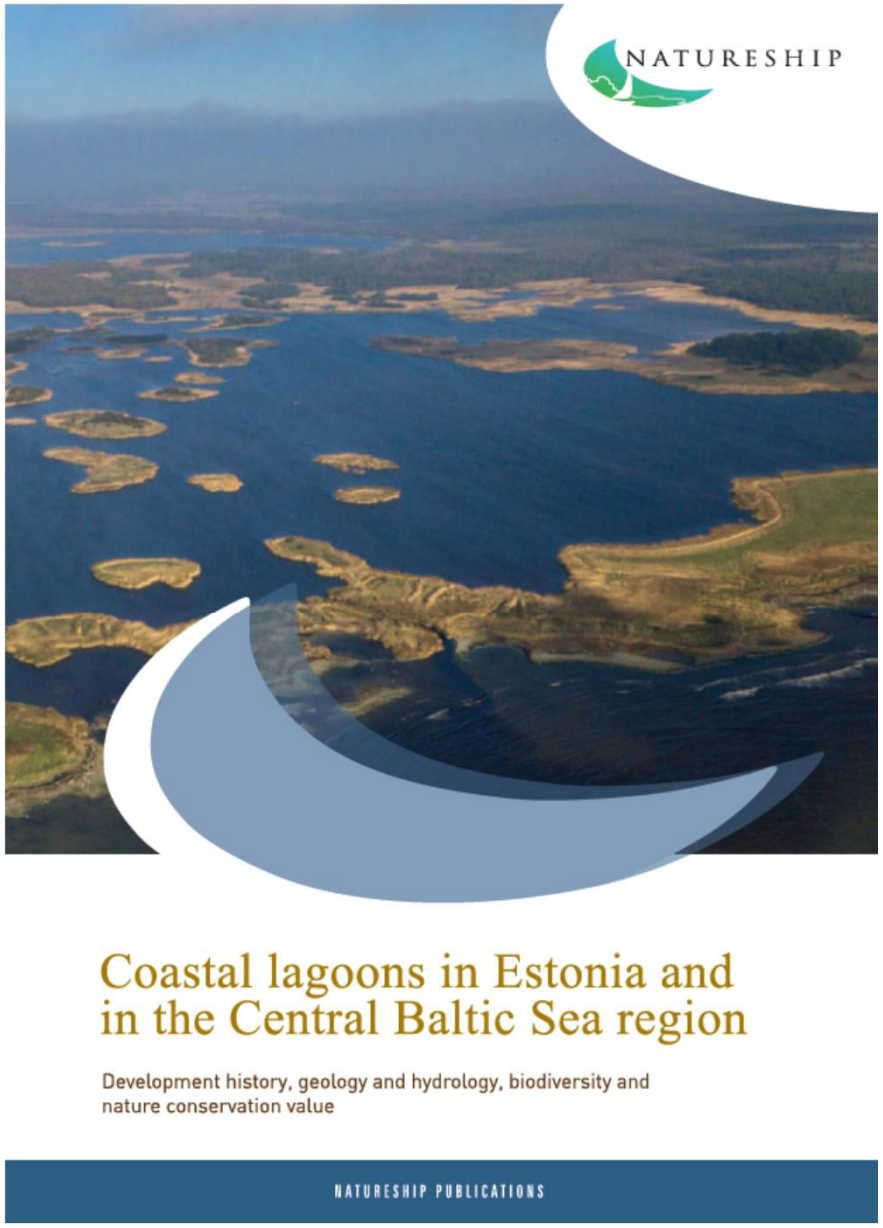
Conclusion

- In case of Lake Vööla meri we decided to do the restoration
- More information on coastal lagoon lakes
- Available online for free



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Thank You!