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The optical properties of water in lakes

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Ø Considerably, the penetration of solar energy determines the ***biological productivity*** of aquatic ecosystems, by means of the heat balance and the light availability for autotrophs.

- The optical properties are sensitive both to ***global changes***, such as global warming, and to ***local***, such as deforestation, land-reclamation and other agricultural methods

Ø Decreasing of transparency depth and changing of water color are the ***first indicators*** of water deterioration

The main optical properties of water are:

- ***transparency depth;***
- ***color of water;***
- ***light intensity***

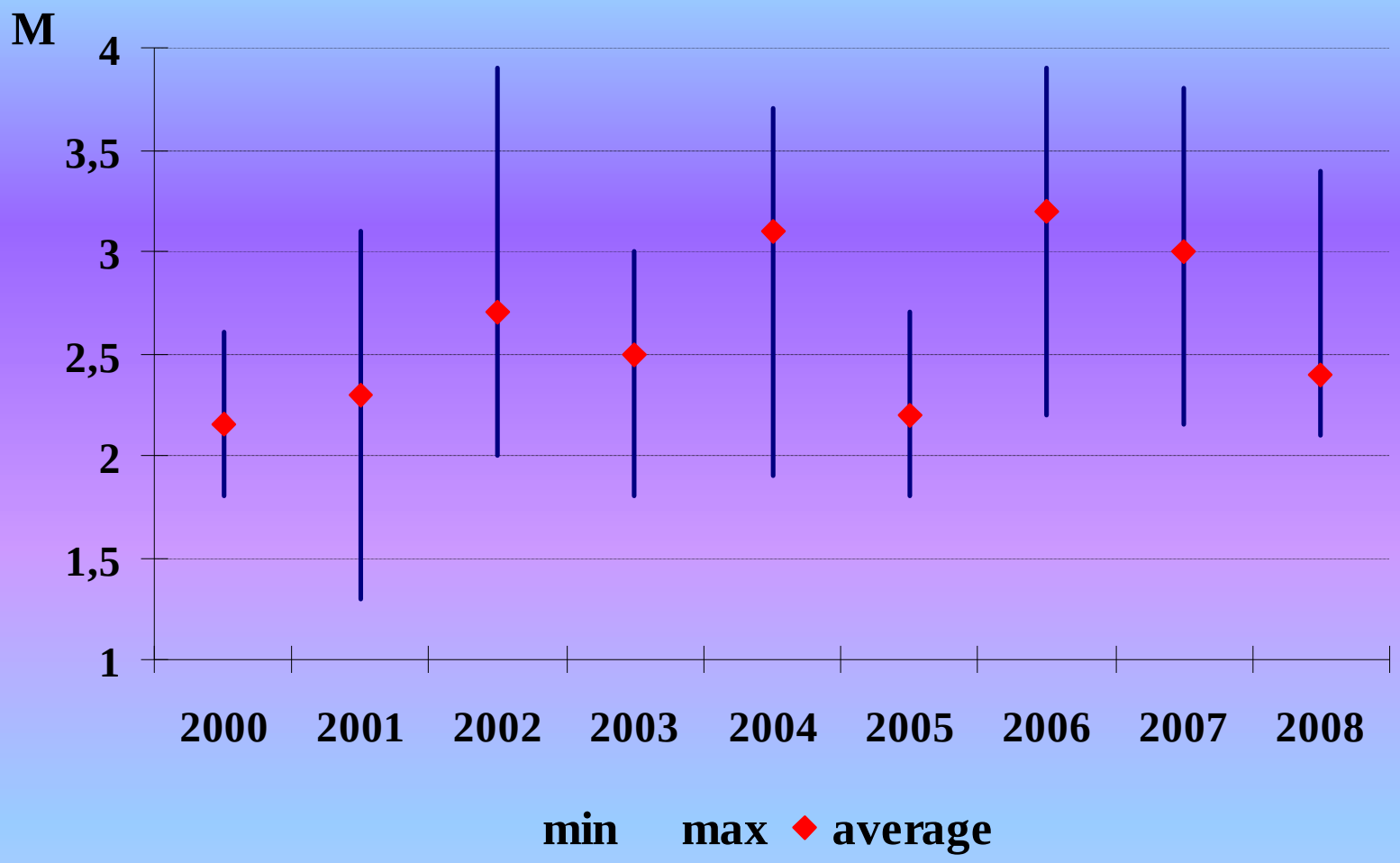
The transparency of water

The differences of transparency is caused by

- ***latitude*** (surface illumination)
- concentration of ***suspended particles***
- content of ***plankton***.

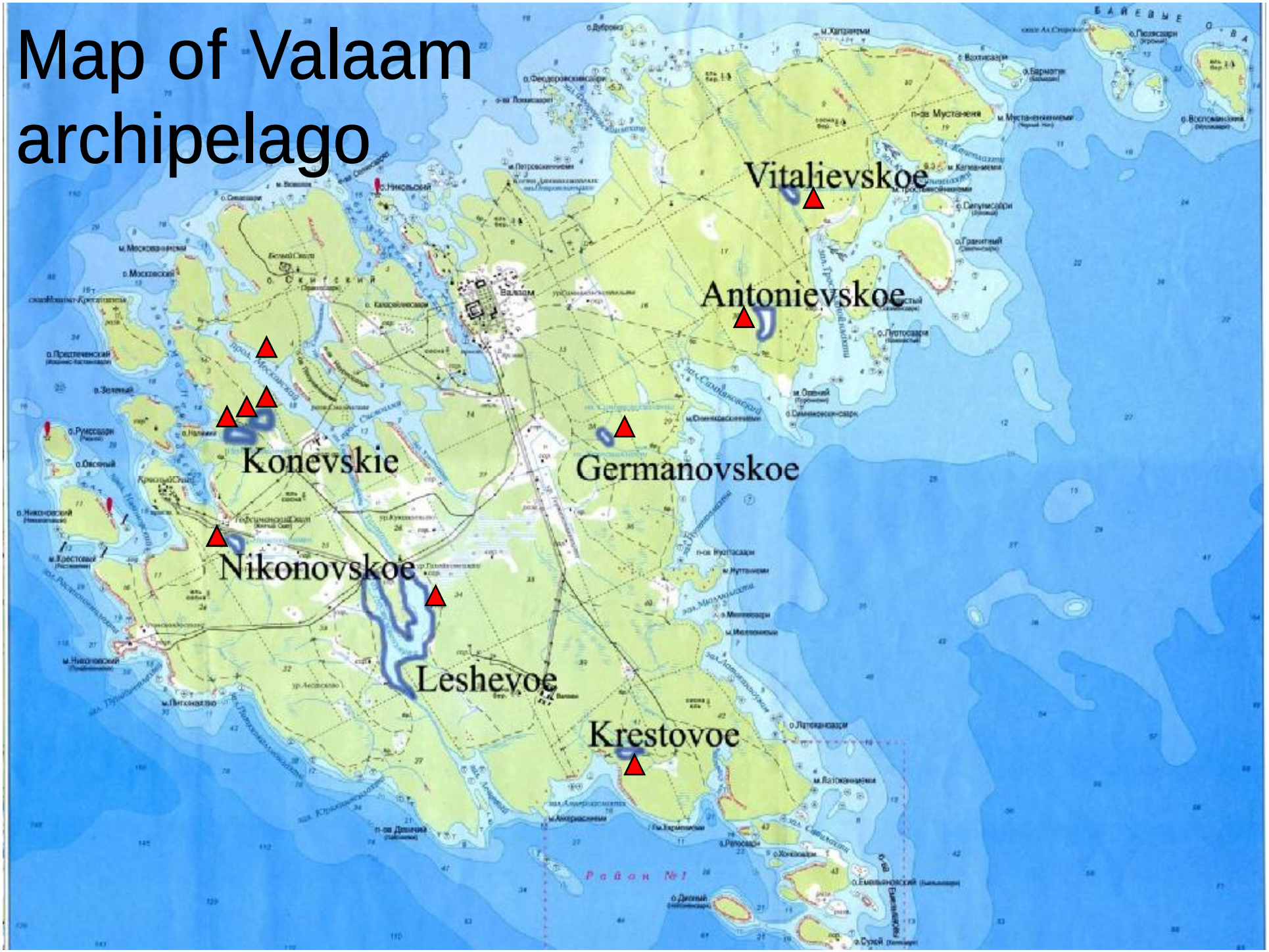

Lake Baikal,
Russia
40 m
© greenpeace.org

The annual variables of Lake Ladoga transparency, n = 130



Average values were changed not considerably from year to year. However the significant data scattering was observed in each year

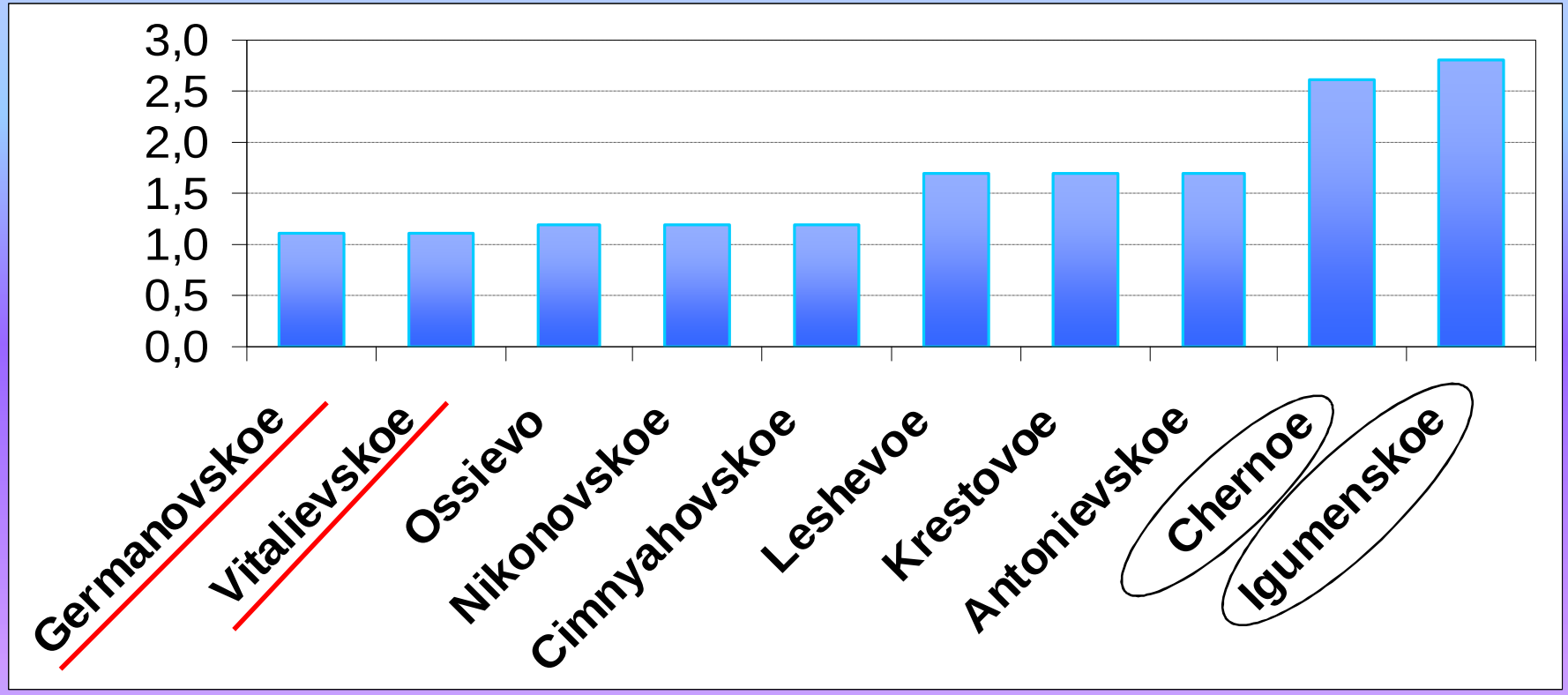
Map of Valaam archipelago



The ranges of transparency depth in small Valaam`s lakes

Lakes	SD, m
Leshevoe	0.8-1.7
Igumenskoe	1.0-**2.8**
Chernoe	1.0-2.6
Ossievo	0.8-1.3
Nikonovskoe	**0.2**-1.2
Krestovoe	0.8-1.7
Germanovskoe	0.4-1.4
Simnjhovskoe	0.3-1.2
Antonevskoe	1.0-1.7
Vitalievskoe	0.4-1.1

Secchi depth values (SD, m)



Igumenskoe Lake	1.0-2.8
Germanovskoe Lake	0.4-1.1
Vitalievskoe Lake	0.7-1.1
common	0.3-2.8

Lake Germanovskoe

Photic zone

is 2 or 2.5 * transparency depth

very impotent parameter for

The macrophytes

The algae

The ratio of chlorophyll-a concentration and transparency depth

$$C_{chl}=57.7*SD^{-2.17}$$

The ratio of suspended matter concentration and transparency depth

$$SD = 3.9 * C_{sm}^{-0.7}$$

The classification of lakes (Kitaev, 1970)

- Very low transparency – less than 1 m,
- Low transparency – 1-2 m,
- Medium transparency – 2-4m,
- High transparency – 4-8 m,
- Very high transparency – more than 8 m

856 lakes of Karelia region (Russia), Finland and Sweden were classified

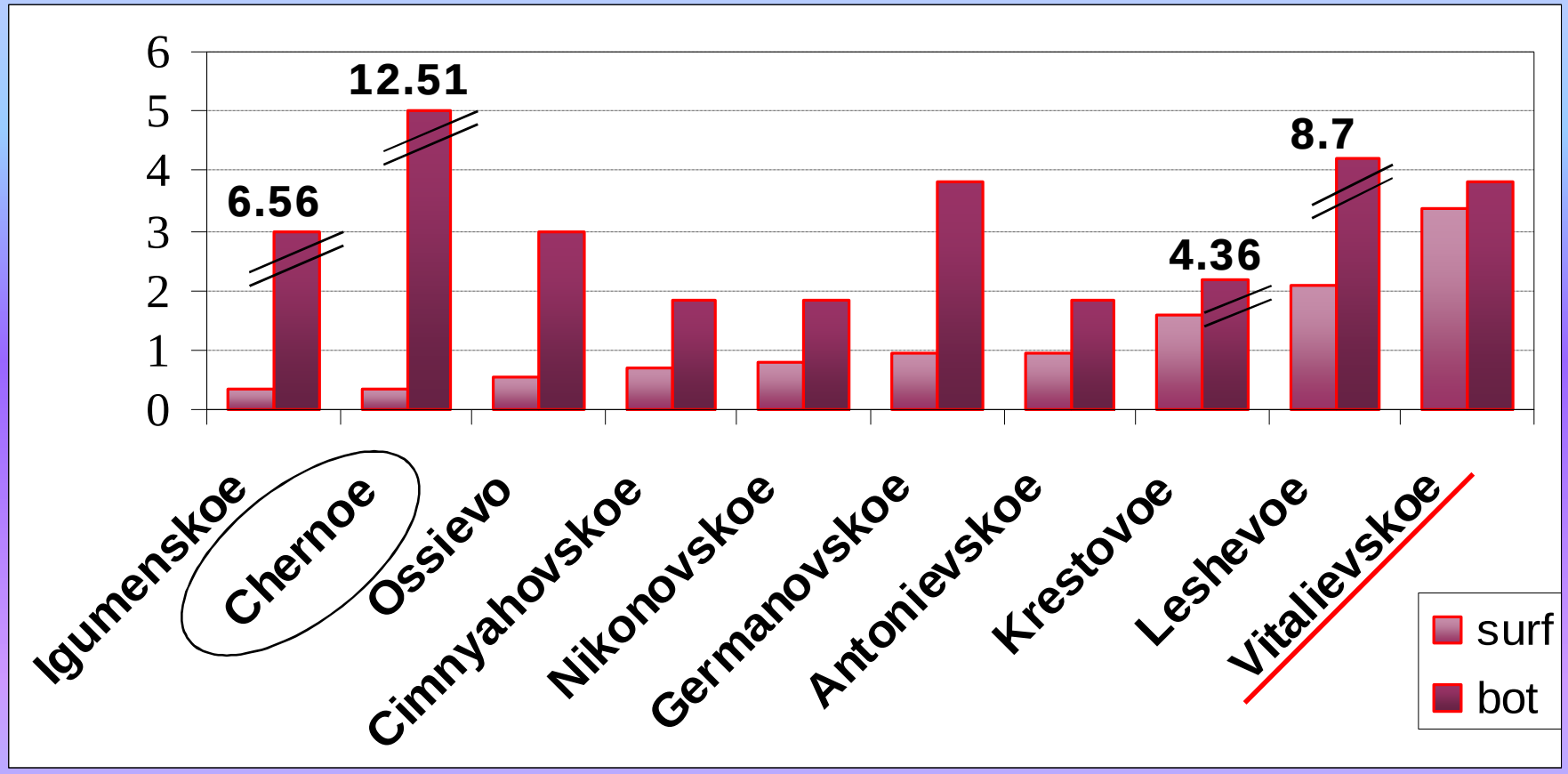

Color of water

The main factors influencing water color

- ***Turbidity*** *green-blue or green* *yellow or brown*
- “***blooms***” *green, blue-green, pink* and others
- ***organic matter*** and ***humic substances*** *brown*

The ***gas bubbles*** and different ***salts*** such as calcium, ferrum and magnesium also influence water color but less.

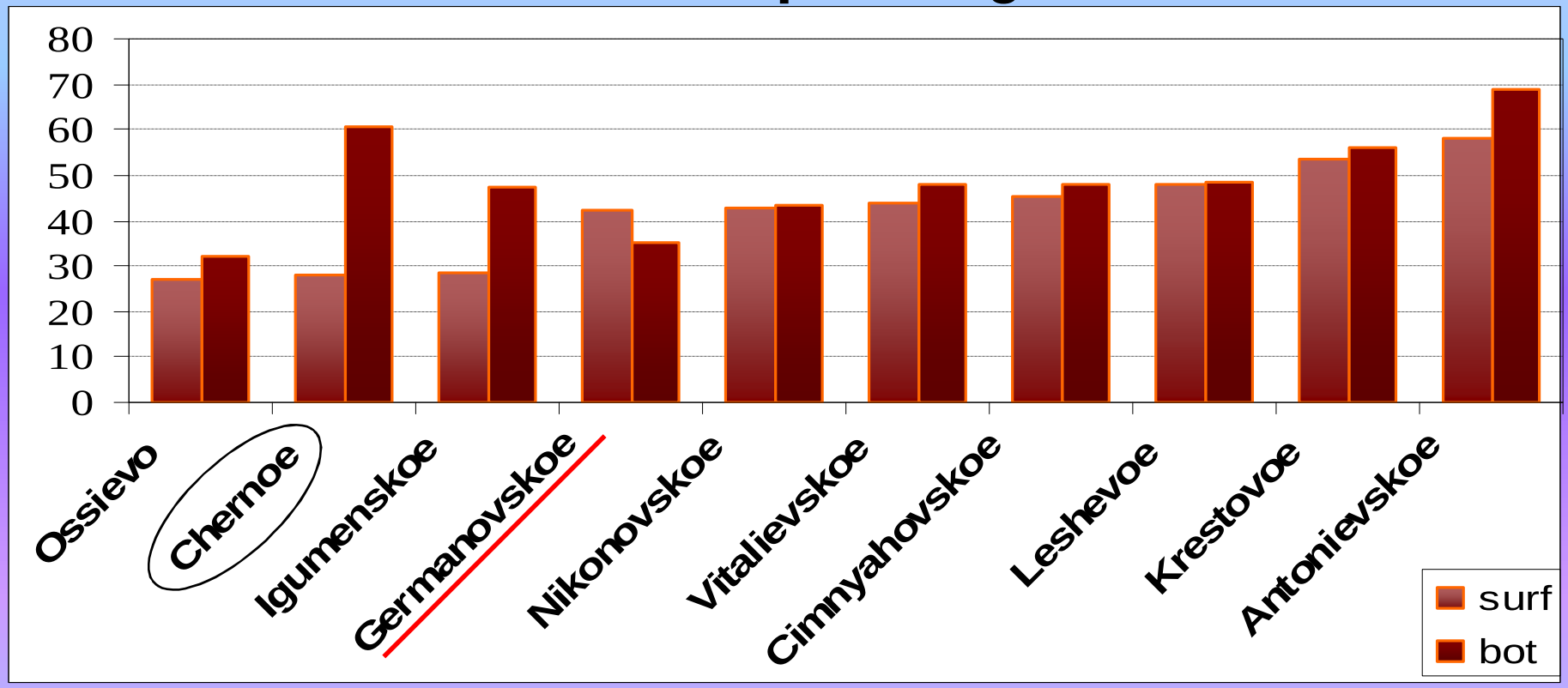
Content of common ferrum ions, mg/l



	surface	bottom
Chernoe Lake	0.03-0.36	0.05-12.51
Vitalievskoe Lake	0.59-3.36	0.88-3.80
common	0.03-3.36	0.05-12.51

Content of organic substance, mgO/l

Estimation method is “permanganate oxidation”



	surface	bottom
Chernoe Lake	8.00-28.19	21.00-60.48
Germanovskoe Lake	17.37-42.47	19.78-35.17
common	6.98-58.19	15.87-68.56

There are a few methods to study degrees of water color

- method of comparison with standard scale;
- titration method;
- spectrophotometric method

The ranges of water color in Valaam`s lakes

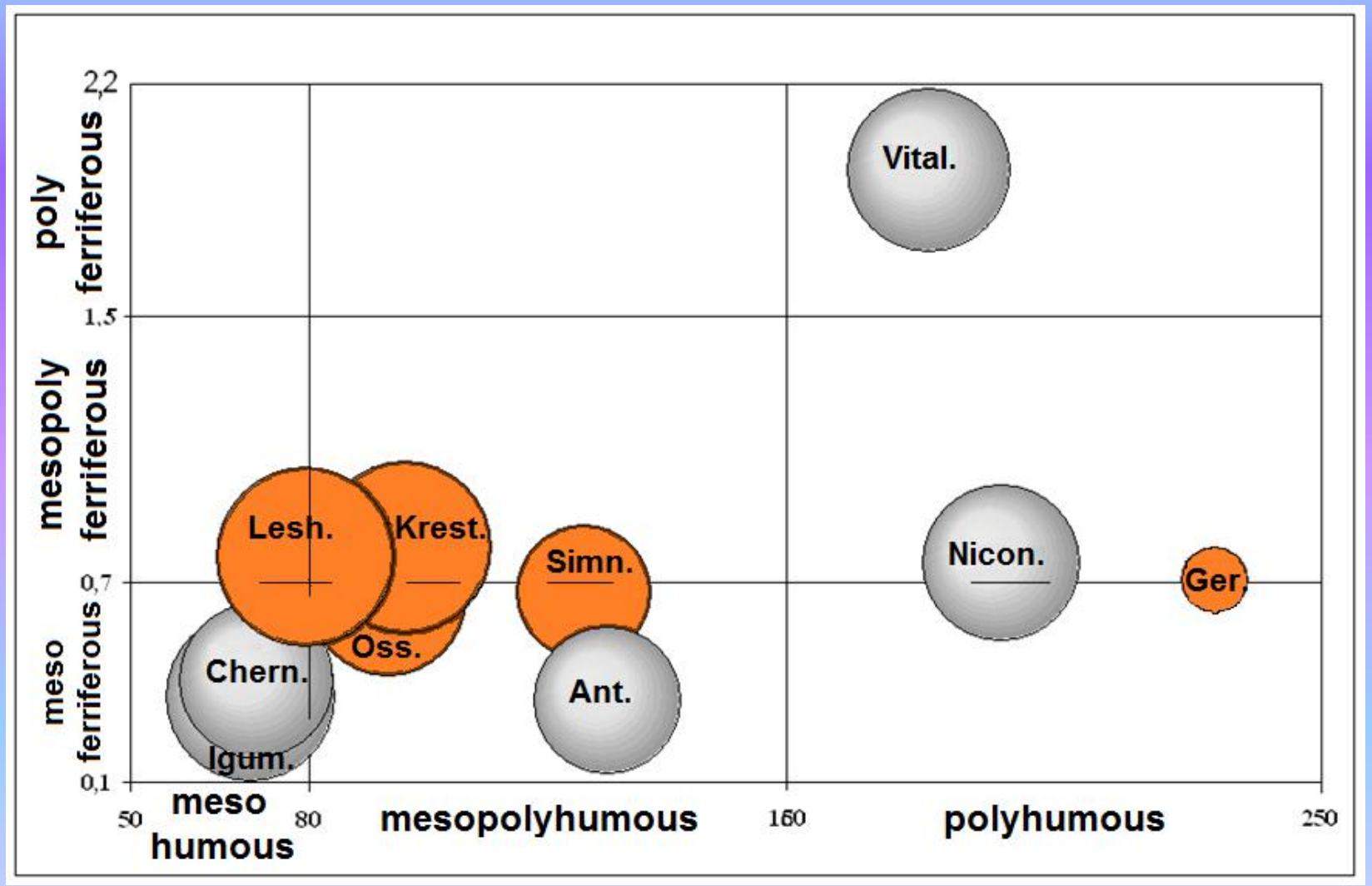
Lakes	Surface layer, □ *Cr-Co scale*	bottom layer, □ *Cr-Co scale*
Leshevoe	40 - 96	42 - 720
Igumenskoe	45 - 90	110 - 600
Chernoe	40 - 106	180 - **900**
Ossievo	50 - 160	60 - 220
Antonevskoe	72 - 180	100 - 252
Nikonovskoe	56 - 260	40 - 360
Krestovoe	70 - 120	80 - 340
Simnjhovskoe	70 - 172	78 - 180
Germanovskoe	180 - **296**	200 - 400
Vitalievskoe	120 - 252	124 - 360
Moskovskii bay	**28** - 50	**34** - 60
Lake Ladoga	30-43	35-45

The classification of lakes by using degrees of chrome-cobalt scales (Kitaev).

- Ultraoligohumous - < 20° Cr-Co scale
- Oligohumous –20-35° Cr-Co scale
- Mesohumous – 35-80° Cr-Co scale
- Mesopolyhumous – 80-160° Cr-Co scale
- Polyhumous – > 140° Cr-Co scale

The distribution of small Valaam`s lakes in area of 3 parameters

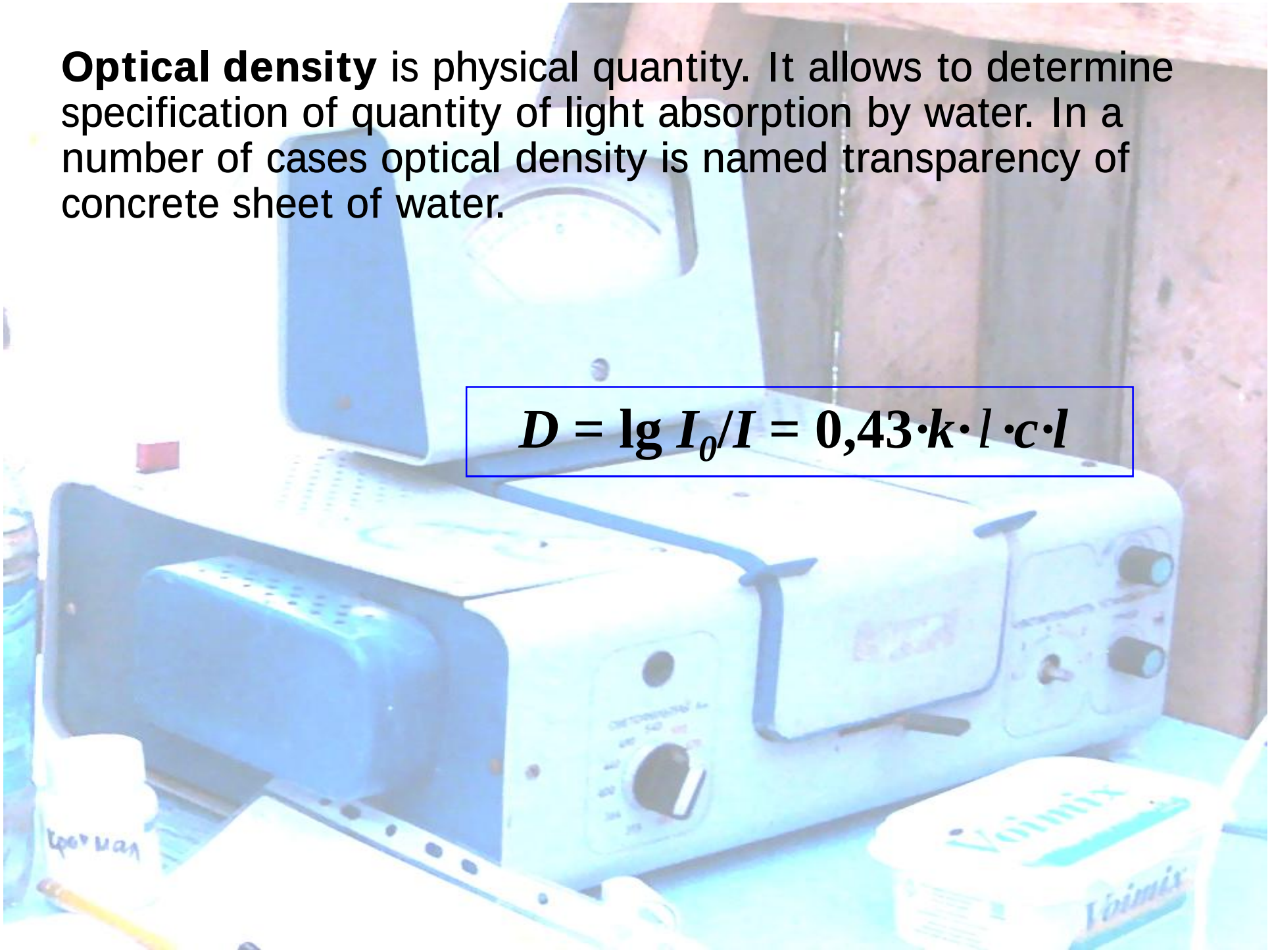
content of ferrum ions, mg/l



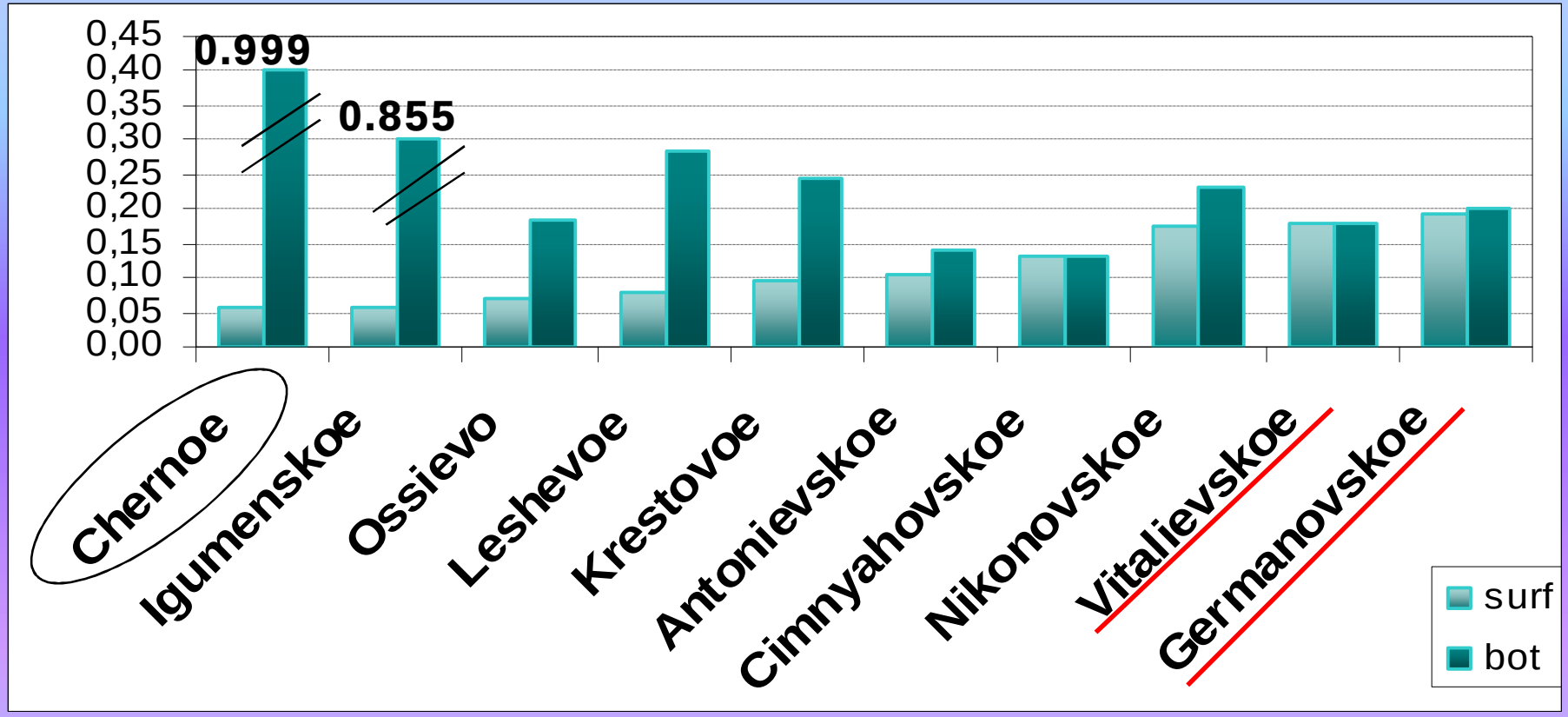
Water color, □ Cr-Co

Optical density is physical quantity. It allows to determine specification of quantity of light absorption by water. In a number of cases optical density is named transparency of concrete sheet of water.

$$D = \lg I_0/I = 0{,}43 \cdot k \cdot l \cdot c \cdot l$$



Optical density values on 400 wave length



	surface	bottom
Chernoe Lake	0.028-0.057	0.054-0.999
Germanovskoe Lake	0.087-0.191	0.103-0.199
common	0.009-0.191	0.036-0.999


Thank
you!