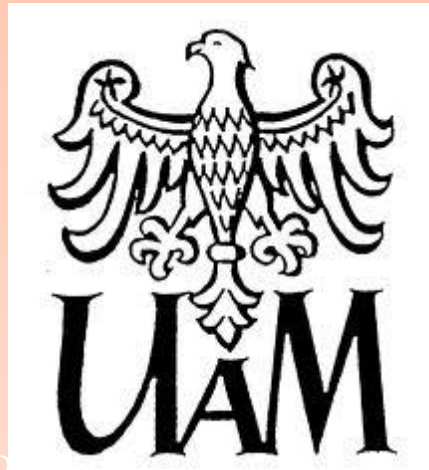
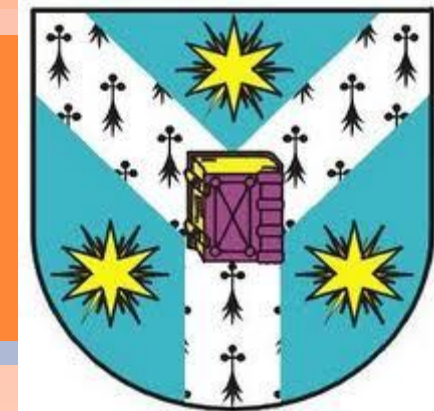


Ecological state of the lake during restoration measures using macro-invertebrates.



Presented by

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Structure

- *Introduction*
- *Methodology*
- *Results*
- *Conclusions*

Introduction

Restoration can be defined as “a complete structural and functional return to a pre-disturbance state” (Cairns, 1991). Pre-restoration monitoring is necessary to define the correct restoration project design and the desired state after restoration.

Benthic macroinvertebrates, especially aquatic insects, have been traditionally used in the biomonitoring of stream and river ecosystems for various environmental stress

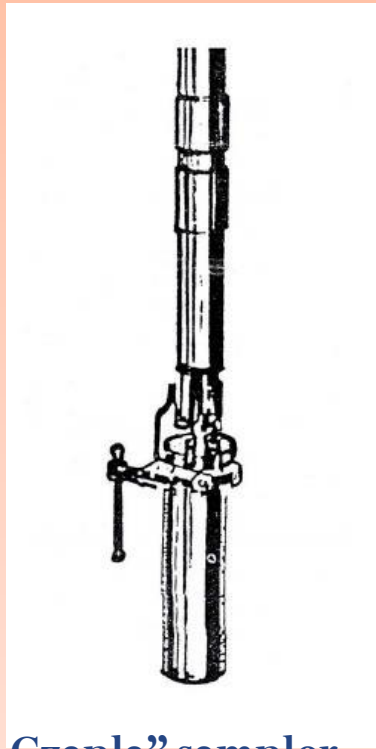
Macroinvertebrates, or more simply
“zoobenthos“ are animals without
backbones. They are bottom dweller’s.

- They generally have limited mobility and reflect local environmental conditions
- Some of the organisms are long-lived, so they are integrated for both a long period and short-term environmental variables

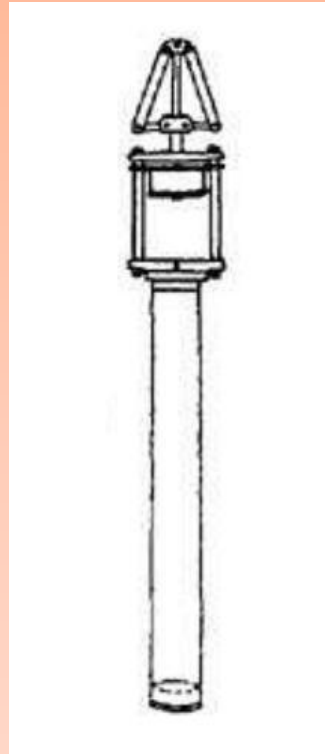
- They are good indicator species for pollution studies
- They include: Annelida, Crustacea, Insecta, Mollusca and many other.



Methodology



Czapla" sampler



Kajak" sampler

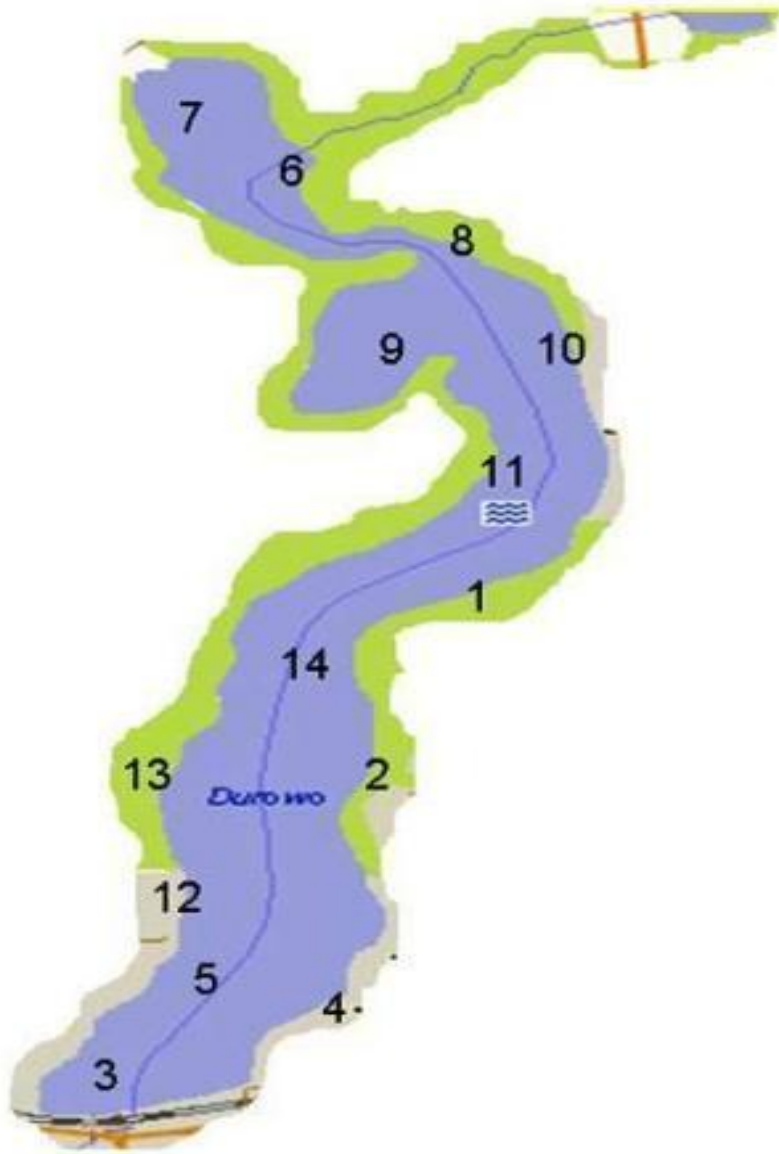


Compound Microscope

Study Area

Lake Durowskie is located in Wągrowiec, Poland. The lake is in a chain of lakes connected by the river Struga Gołaniecka. These rivers and lakes are at the exposure of nutrients and pollutant.

Sampling Locations



| Number of sites | Sites description |
|-----------------|---------------------------------------|
| 1 | Littoral with reeds near forest cover |
| 2 | Littoral near urban area |
| 3 | Pelagial near dam |
| 4 | Littoral near urban area |
| 5 | Pelagial (aerator 1) |
| 6 | Littoral near Struga Golaniecka River |
| 7 | Pelagial |
| 8 | Littoral (bulrush near forest cover) |
| 9 | Pelagial |
| 10 | Pelagial (aerator 2) |
| 11 | Littoral with reeds |
| 12 | Littoral near urban area |
| 13 | Littoral with reeds near forest cover |
| 14 | Pelagial |

Sampling Sites

The 14 sampling sites of the lakes were assigned to 6 different groups: These includes:

- Pelagial – 4 samples
- Aerators I & II – 1 sample each
- Litoral (forest)– 5 samples
- Litoral (urban) – 3 samples

• Sampling Durations: 4th - 9th July, 2011

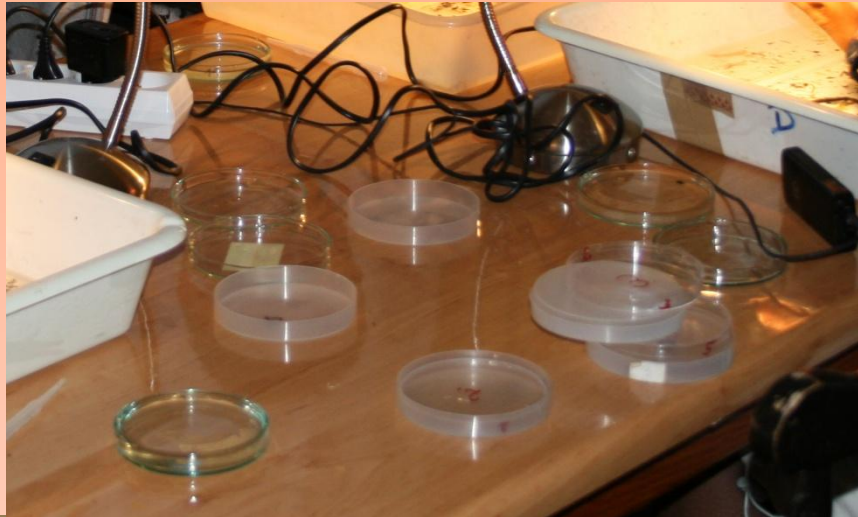
Sampling of Macroinvertebrate



Sieving of Macroinvertebrate



Sorting of Macroinvertebrate



Identification of Macroinvertebrate



Data analysis

Indices used to measure the diversity

Shannon-Wiener Index

Equitability (E) or evenness Index

Margalef Index

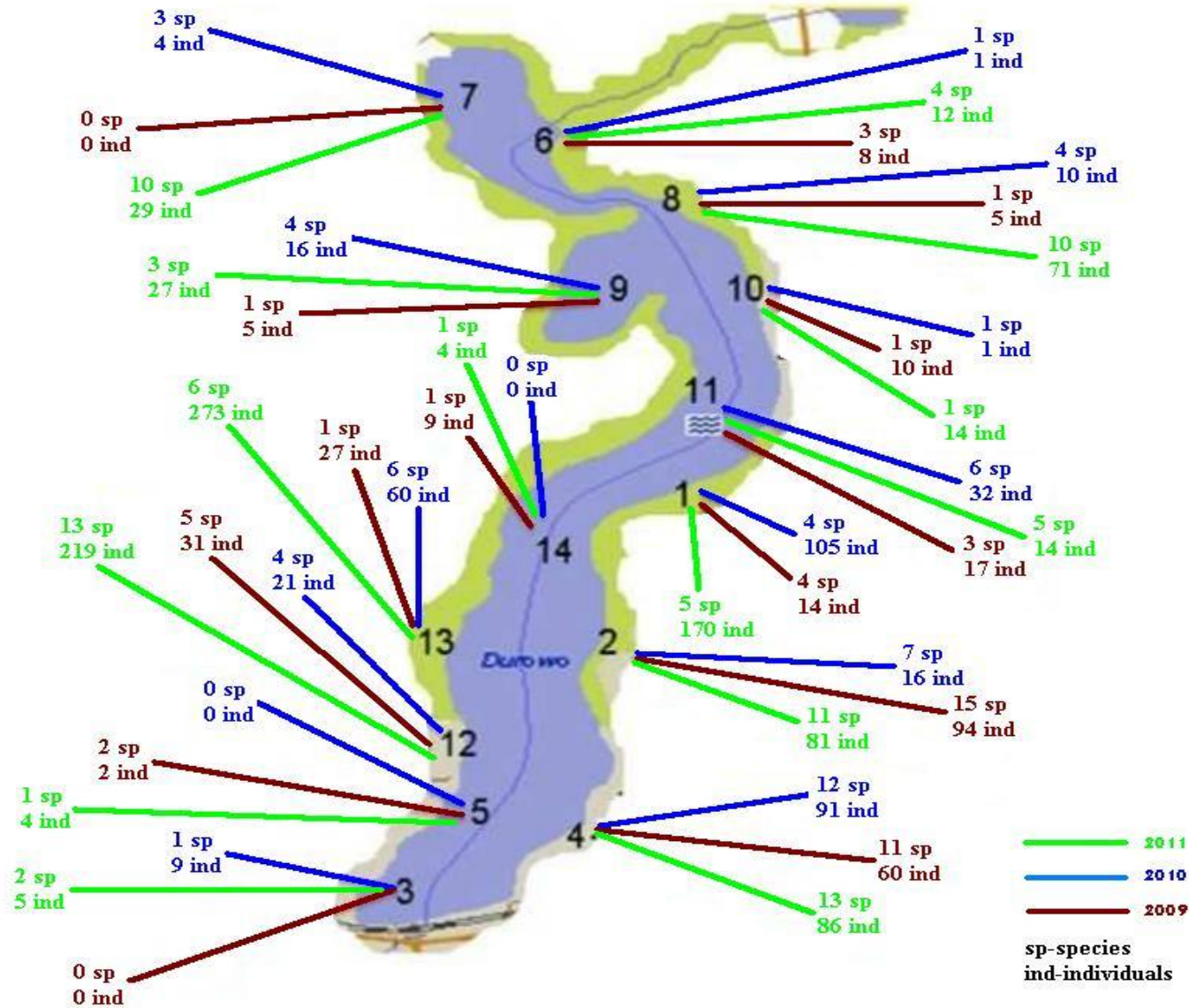
Simpson Index

- **The EPT Index** is named for three orders of aquatic insects that are common in the benthic macroinvertebrate community: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). The greater the pollution, the lower the species richness expected, as only a few species are pollutant tolerant.
- **Ratio of EPT and Chironomidae:** The EPT / Chironomidae Index is calculated by dividing the sum of the total number of individuals classified as *Ephemeroptera*, *Plecoptera*, and *Trichoptera* by the total number of individuals classified as *Chironomidae*.

- The biological monitoring working party (BMWP) is a procedure for measuring water quality using species of macroinvertebrates as biological indicators.
- The WFD classification scheme for water quality includes five status classes: high, good, moderate, poor and bad.
- ‘High status’ is defined as the biological, chemical and morphological conditions associated with **no** or **very low** human pressure.

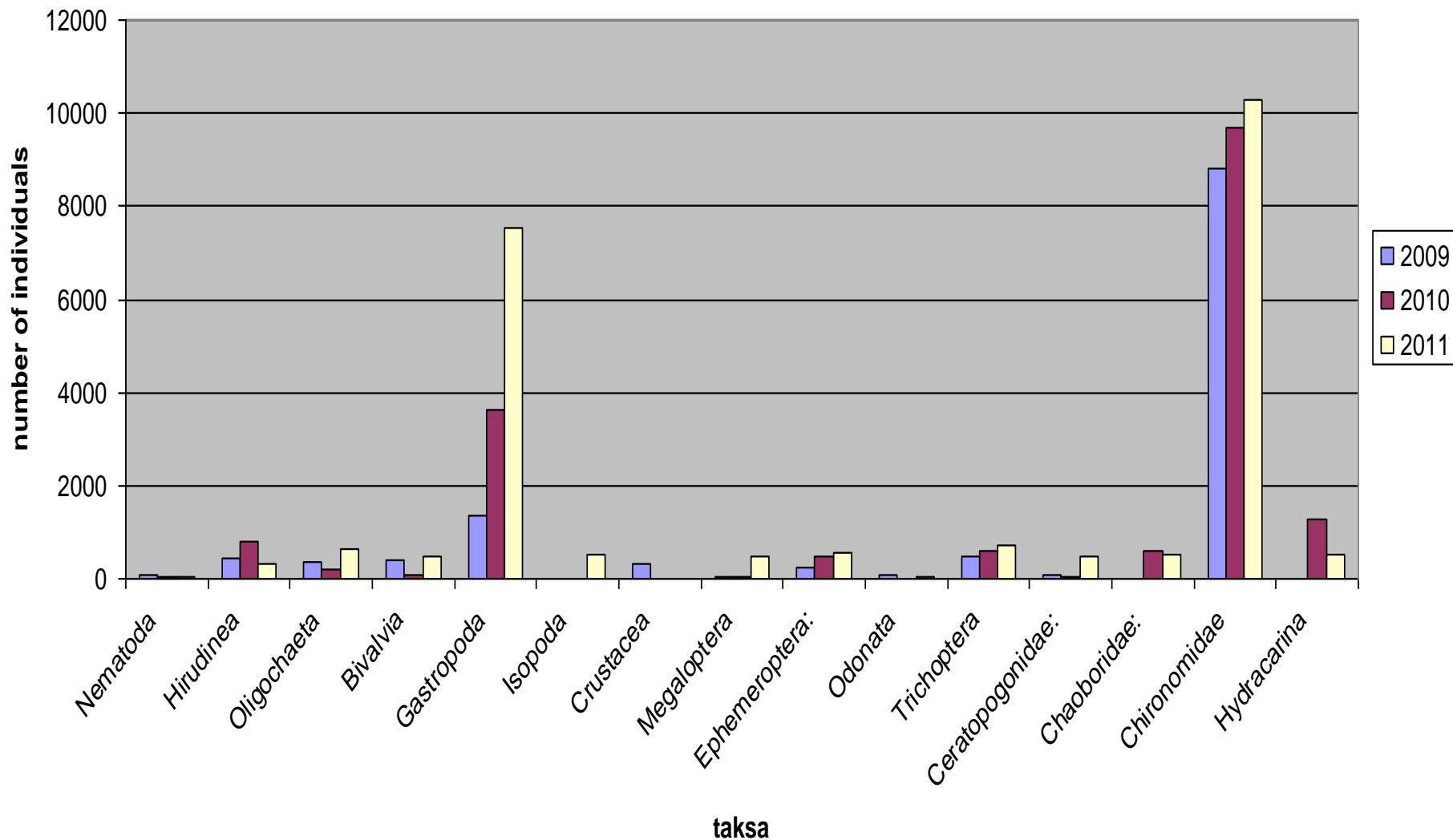
| Families | | Score |
|--|--|-------|
| Ephemeroptera Trichoptera Diptera | <i>Ameletidae</i> <i>Glossosomatidae, Molannidae, Beraeidae, Odontoceridae,</i> <i>Leptoceridae</i> <i>Blephariceridae, Thaumaleidae</i> | 10 |
| Ephemeroptera Plecoptera Odonata Trichoptera | <i>Behningiidae</i> <i>Taeniopterygidae</i> <i>Cordulegastridae</i> <i>Goeridae, Lepidostomatidae</i> | 9 |
| Crustacea Ephemeroptera Plecoptera Trichoptera Diptera | <i>Astacidae</i> <i>Oligoneuridae, Heptageniidae (only genus Epeorus and</i> <i>Rhithrogena)</i> <i>Capniidae, Perlidae, Chloroperlidae</i> <i>Philopotamidae</i> <i>Athericidae</i> | 8 |
| Ephemeroptera Plecoptera Odonata Trichoptera Coleoptera Heteroptera Gastropoda Bivalvia | <i>Siphonuridae, Leptophlebiidae, Potamanthidae, Ephemerellidae,</i> <i>Ephemeridae, Caenidae,</i> <i>Perlodidae, Leuctridae</i> <i>Calopterygidae, Gomphidae,</i> <i>Rhyacophilidae, Brachycentridae, Sericostomatidae, Limnephilidae</i> <i>Elmidae</i> <i>Aphelocheiridae</i> <i>Viviparidae</i> <i>Unionidae, Dreissenidae</i> | 7 |
| Hirudinea Crustacea Ephemeroptera) Plecoptera Odonata Trichoptera Diptera Gastropoda | <i>Piscicolidae</i> <i>Gammaridae, Corophiidae</i> <i>Baetidae, Heptageniidae (except for genus Epeorus and Rhitrogena)</i> <i>Nemouridae</i> <i>Platycnemididae, Coenagrionidae</i> <i>Hydroptilidae, Polycentropodidae, Ecnomidae</i> <i>Limoniidae, Simuliidae, Empididae</i> <i>Neritidae, Bithyniidae</i> | 6 |
| Crustacea Trichoptera Coleoptera Heteropera Diptera Gastropoda | <i>Cambaridae</i> <i>Hydropsychidae, Psychomyidae</i> <i>Gyrinidae, Dytiscidae, Haliplidae, Hydrophilidae</i> <i>Mesoveliidae, Veliidae, Nepidae, Naucoridae, Notonectidae, Pleidae,</i> <i>Corixidae</i> <i>Tipuliidae</i> <i>Hydrobiidae</i> | 5 |
| Diptera Gastropoda Bivalvia | <i>Ceratopogonidae</i> <i>Valvatidae, Planorbidae</i> <i>Sphaeriidae</i> | 4 |
| Hirudinea Crustacea Megaloptera Diptera Gastropoda | <i>Glossiphonidae, Erpobdellidae, Hirudinidae</i> <i>Asellidae</i> <i>Sialidae</i> <i>Chironomidae</i> <i>Ancylidae, Physidae, Lymnaeidae</i> | 3 |
| Oligochaeta Diptera | All Oligochaeta <i>Culicidae</i> | 2 |
| Diptera | <i>Syrphidae, Psychodidae</i> | 1 |

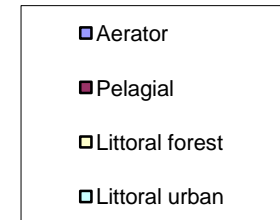
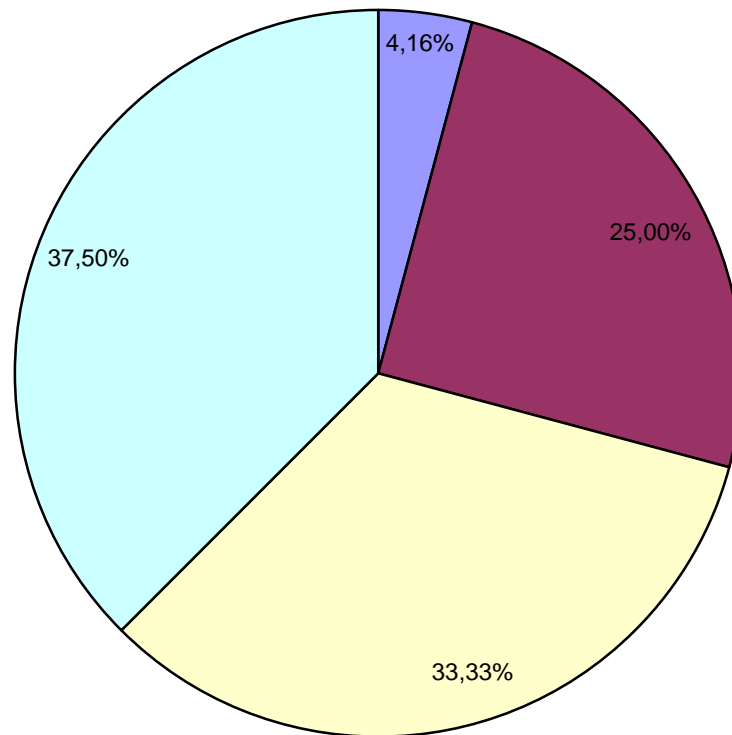
Results and discussions



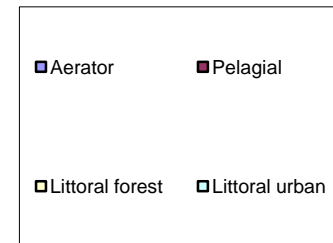
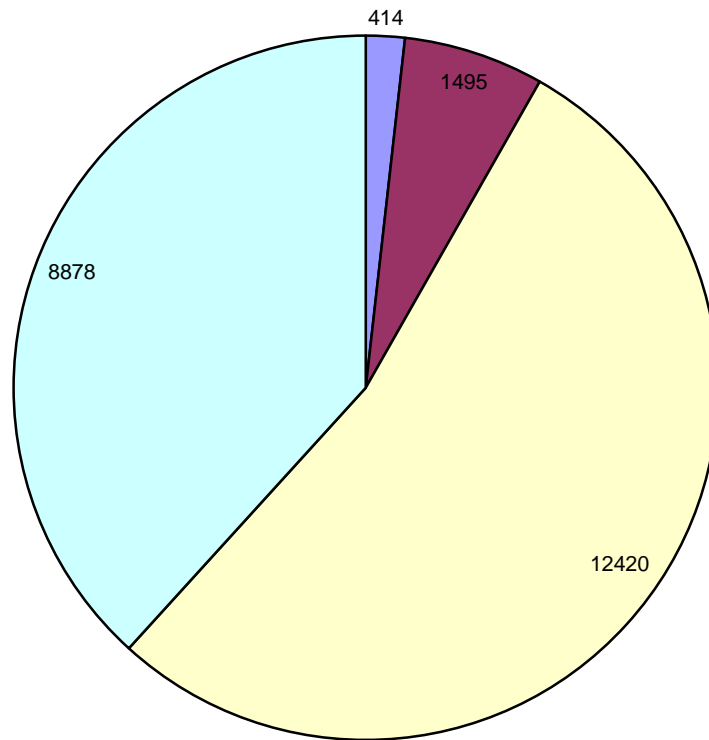
Total number of species and individuals identified in 2009, 2010 and 2011 sampling season in Lake Durowskie

Macroinvertebrates taxa identified in 2009, 2010 and 2011 sampling season in Lake Durowskie





The distribution of species in the 4 different zones of Lake Durowskie

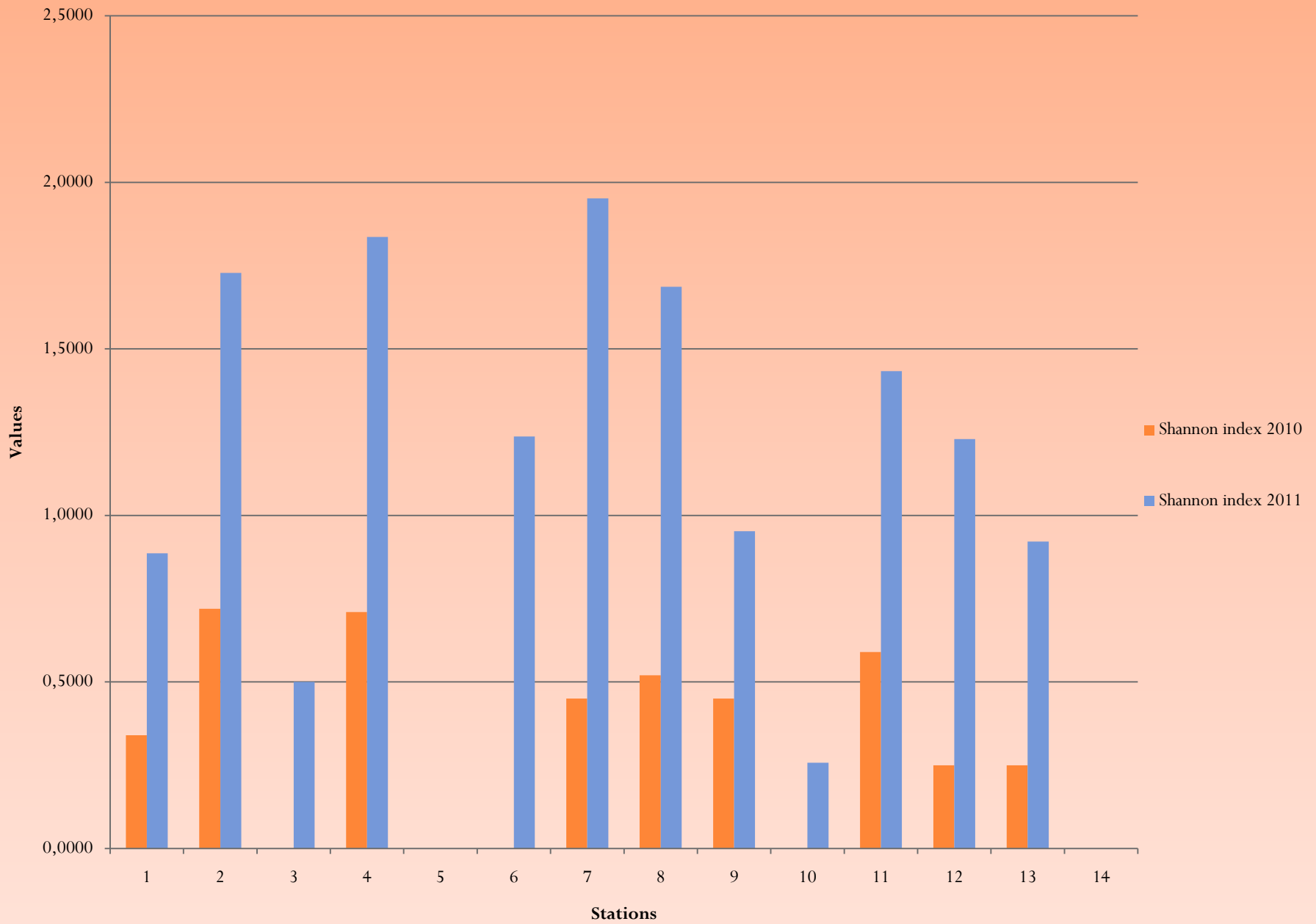


Total number of individuals collected/m² at the four different sampling zones of Lake Durowskie.

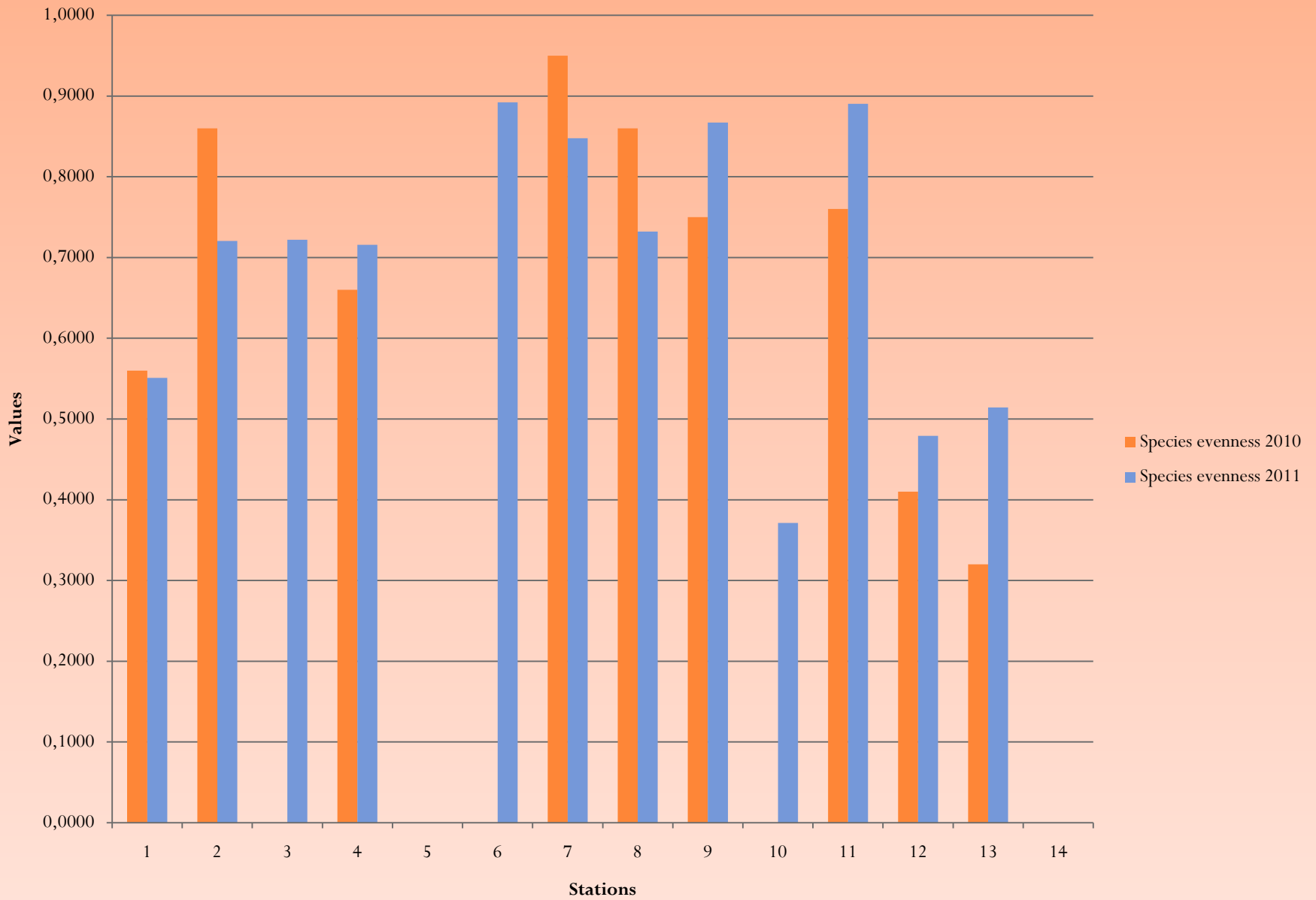
| Indices | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|------------------|-------|---------|---------|--------|---------|--------|--------|---------|---------|--------|--------|---------|---------|---------|--------|
| Simpson index | 2010 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 2011 | 0,4758 | 0,2830 | 0,6772 | 0,2714 | 1,0000 | 0,3170 | 0,1855 | 0,2453 | 0,4174 | 0,8669 | 0,2630 | 0,4021 | 0,4859 | 1,0000 |
| Shannon index | 2010 | 0,3400 | 0,7200 | 0,0000 | 0,7100 | 0,0000 | 0,0000 | 0,4500 | 0,5200 | 0,4500 | 0,0000 | 0,5900 | 0,2500 | 0,2500 | 0,0000 |
| | 2011 | 0,8866 | 1,7280 | 0,5004 | 1,8359 | 0,0000 | 1,2367 | 1,9519 | 1,6861 | 0,9526 | 0,2573 | 1,4328 | 1,2291 | 0,9217 | 0,0000 |
| Species evenness | 2010 | 0,5600 | 0,8600 | 0,0000 | 0,6600 | 0,0000 | 0,0000 | 0,9500 | 0,8600 | 0,7500 | 0,0000 | 0,7600 | 0,4100 | 0,3200 | 0,0000 |
| | 2011 | 0,5509 | 0,7206 | 0,7219 | 0,7157 | 0,0000 | 0,8921 | 0,8477 | 0,7323 | 0,8671 | 0,3712 | 0,8902 | 0,4792 | 0,5144 | 0,0000 |
| Margalef | 2010 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 2011 | 0,6045 | 1,4608 | 0,4215 | 1,7128 | 0,2212 | 0,7117 | 1,5378 | 1,3517 | 0,4665 | 0,3463 | 0,8659 | 1,5250 | 0,6861 | 0,2212 |
| BMWP | 2010 | 12,0000 | 28,0000 | 0,0000 | 50,0000 | 0,0000 | 0,0000 | 4,0000 | 12,0000 | 5,0000 | 0,0000 | 26,0000 | 15,0000 | 15,0000 | 0,0000 |
| | class | IV | IV | V | III | V | V | V | IV | V | V | IV | IV | IV | V |
| BMWP | 2011 | 24,0000 | 36,0000 | 0,0000 | 30,0000 | 0,0000 | 0,0000 | 32,0000 | 26,0000 | 0,0000 | 0,0000 | 19,0000 | 54,0000 | 27,0000 | 0,0000 |
| | class | IV | IV | V | IV | V | V | IV | IV | V | V | IV | III | IV | V |
| EPT % | 2010 | 0,0000 | 6,2500 | 0,0000 | 12,0879 | 0,0000 | 0,0000 | 0,0000 | 10,0000 | 0,0000 | 0,0000 | 25,0000 | 0,0000 | 1,6666 | 0,0000 |
| | 2011 | 0,0000 | 3,7037 | 0,0000 | 6,9767 | 0,0000 | 0,0000 | 13,7931 | 2,8169 | 0,0000 | 0,0000 | 28,5714 | 2,7397 | 2,5641 | 0,0000 |
| EPT Chironomidae | 2010 | 0,0000 | 0,1700 | 0,0000 | 0,2200 | 0,0000 | 0,0000 | 0,0000 | 0,2500 | 0,0000 | 0,0000 | 0,5000 | 0,0000 | 0,0200 | 0,0000 |
| | 2011 | 0,0000 | 0,0040 | 0,0000 | 0,0072 | 0,0000 | 0,0000 | 0,0600 | 0,0045 | 0,0000 | 0,0000 | 0,2484 | 0,0010 | 0,0013 | 0,0000 |

Indices and BMWP scores of macroinvertebrates taxa of Lake Durowskie (1 m²)

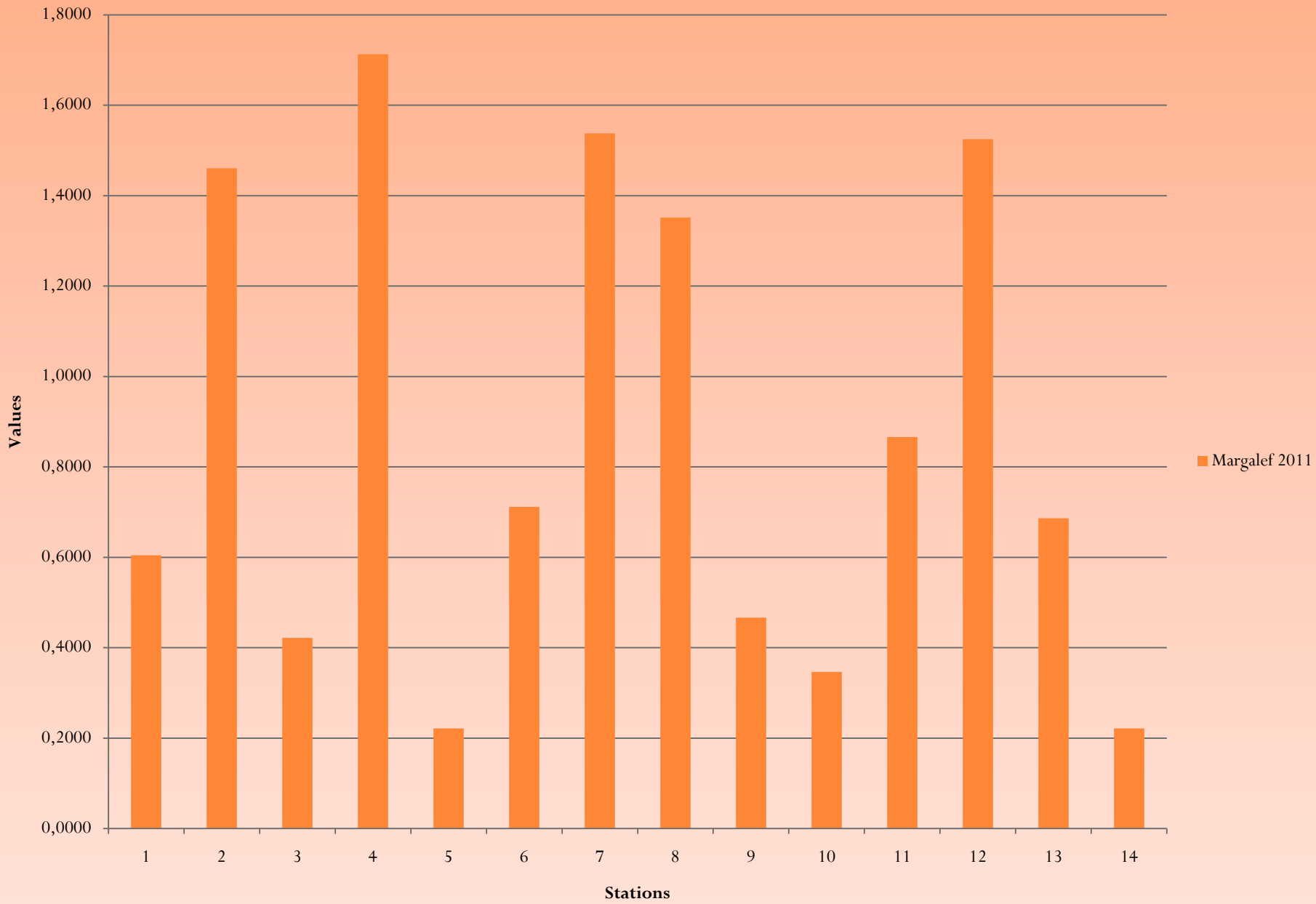
Shannon index 2010/2011



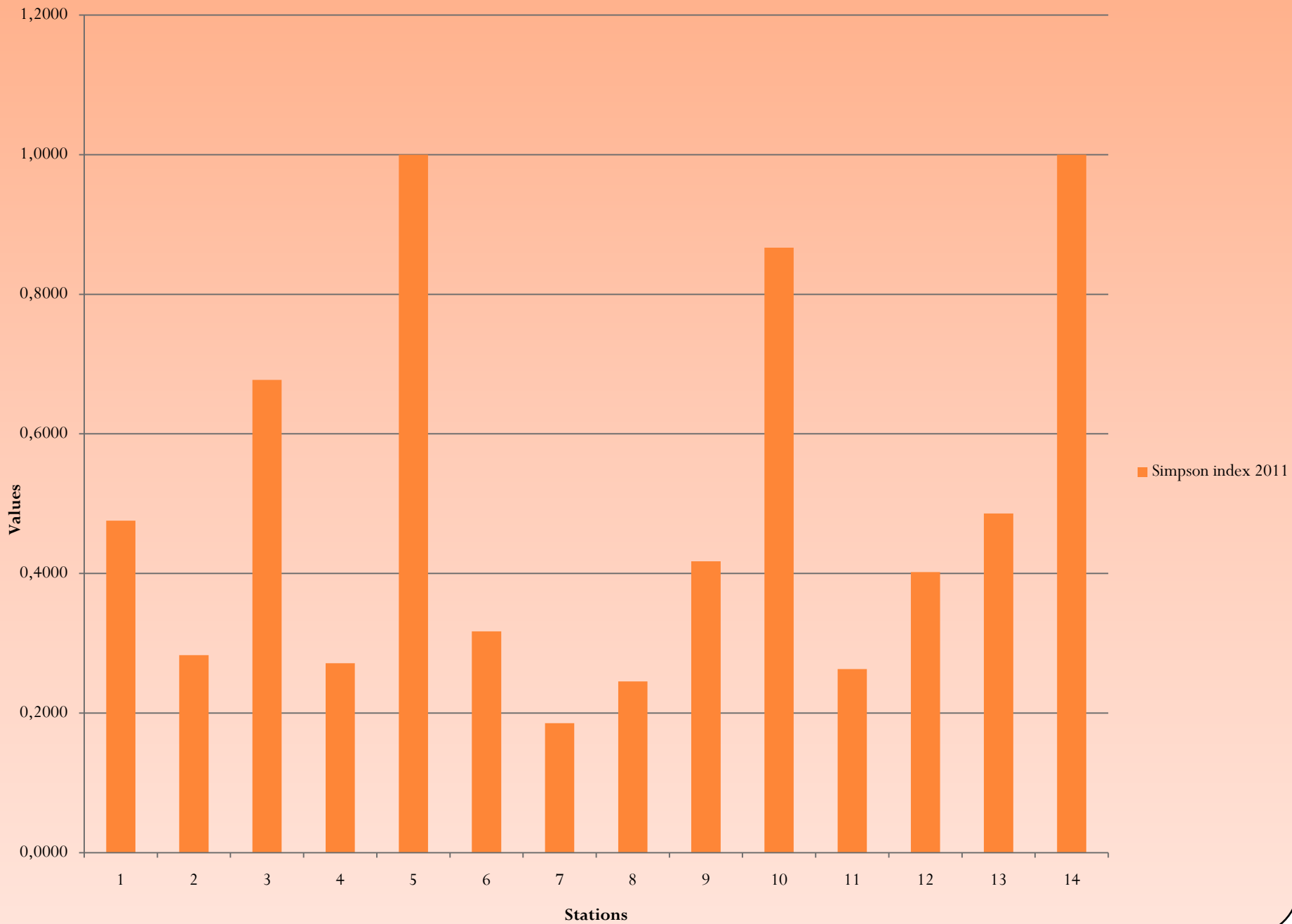
Species evenness



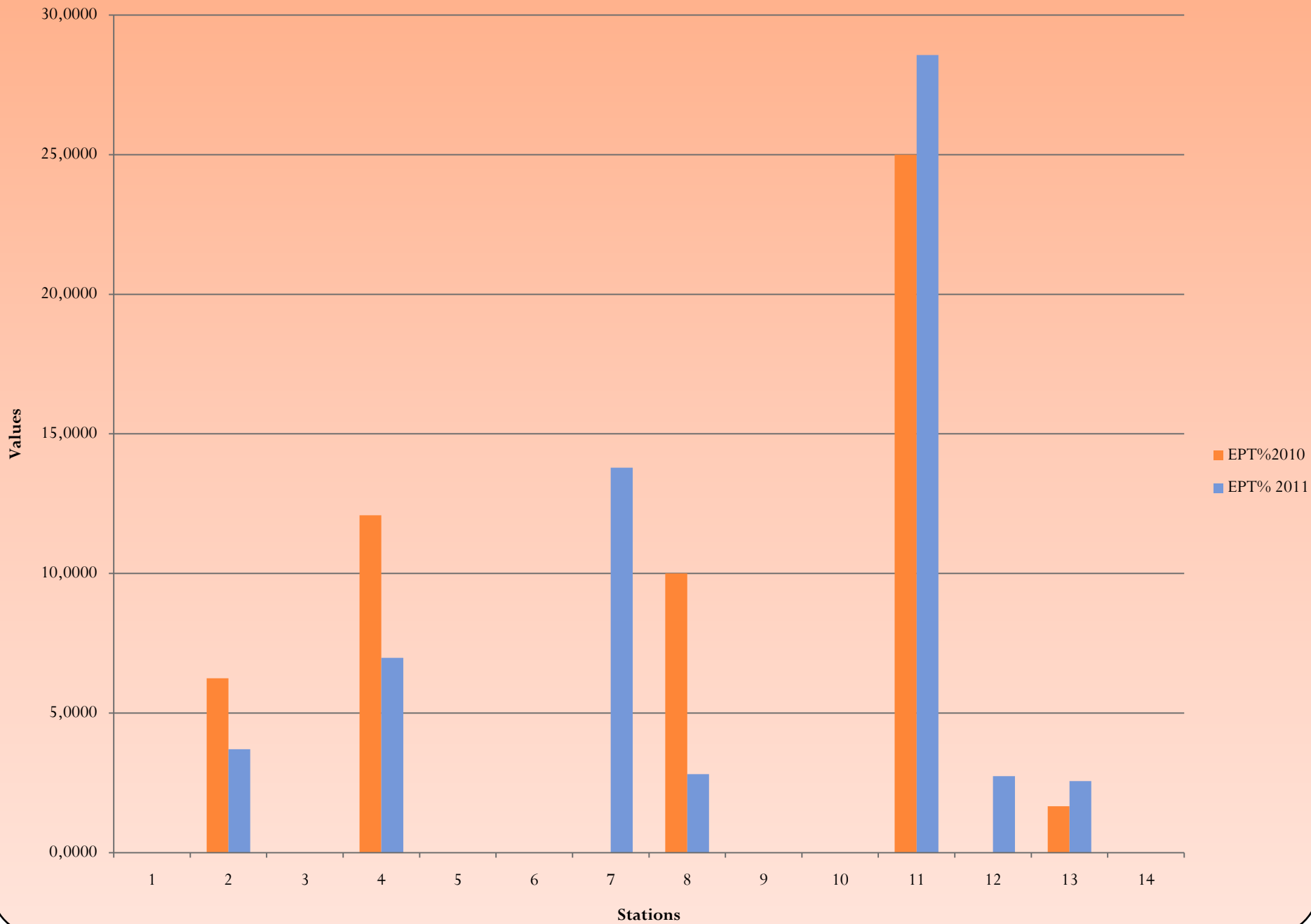
Margalef



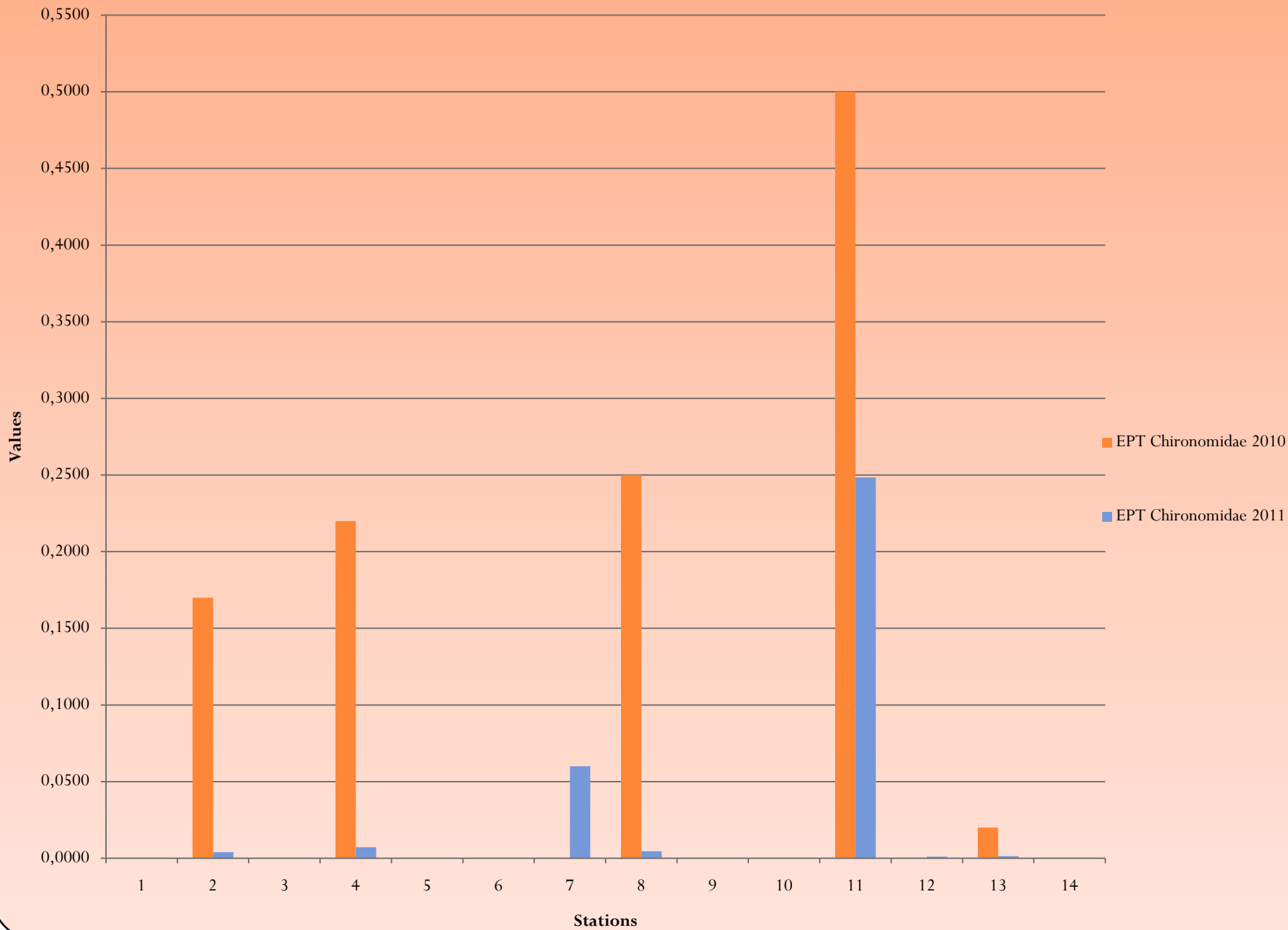
Simpson index 2011



EPT %



EPT Chironomidae



Conclusions

- The biodiversity has increased from 19 taxa in 2010 to 26 taxa in 2011. All the indexes of biodiversity indicate that the measures of restoration are effective.
- In the littoral stations the diversity is bigger than in pelagic and aerators stations.
- In the 3 stations of Littoral urban area was found the highest number of species (18 species) followed by the 5 station of Littoral near forest area (16 species). Although in Littoral urban area the number of species is higher, many of them are adapted to more polluted ecosystems (Hirudinea) so we can say that Littoral near forest area has the most important biodiversity

- The Pelagic zone (12 species) has a higher biodiversity than the Aerators zone (2 species) due to the differences in water depth.
- In station 4 (Littoral near urban area) the water quality decreased from class III to class IV due to antropic input of organic substances. We also observed that in stations 7 and 12 the water quality improved from class V to class IV, respective from class IV to class III.
- Hirudinea taxa consists in the highest number of species (5) followed by Bivalvia and Gastropoda with 4 species.
- The highest density is revealed in Station 13 by the species *Potamopyrgus antipodarum* with 3910 individuals/m².

From the results and judging from the measures of restoration and land use change from 2010 to 2011 in the Lake Durowskie it is observed that the water quality has improved in the sectors near the aerator and the littoral zones are most rich in species diversity.

Thank you!