Phytoplanktons are microscopic sized plants living in the water. Most of them are unicellular organisms representing diverse groups that vary in size, shape and pigment content. Too much phytoplankton growth in the water bodies is usually an indication of eutrophication. Thus, they are excellent ecological indicators to monitor the water quality of an area. Analysis of the seasonal distribution pattern is one method of evaluating phytoplankton monitoring data. Phytoplankton species succession is linked to changes in the stratification of water-column surface layers. Morphological and physiological adaptations of phytoplankton cells enable certain taxa groups of species to compete significantly during various steps of the continuous transition between vertical mixing and stratification of the surface layer.

Lake Biwa is the largest lake in Japan, which is about one sixth of the total area of Shiga prefecture with a surface area of 670 km$^2$ with a maximum depth of 103.6 m. The lake provides freshwater for drinking, industry, agriculture, and other many purposes to approximately 14 million people living in Shiga, Kyoto, Osaka and Hyogo prefectures in the Kansai region. It can be divided into two parts; the northern basin with surface area of 618 km$^2$, a volume of 27.3 billion m$^3$ and a mean depth of 44 m, and the southern basin with a surface area of 57 km$^2$, a volume of 0.2 billion m$^3$ and a mean of depth of 3m. In summer, the northern basin is thermally stratified which usually is from May to November, thus resulting in lesser vertical mixing of the lake water (monolithic lake). Land-uses surrounding the lake include urban areas, paddy fields, crop fields, and forests (mountainous areas). There are more than 450 rivers and streams flowing into the lake, whereas there is only one natural outlet, the Seta River, and there are two artificial canals supplying lake water to Kyoto.

The quality of Lake Biwa's water was profoundly influenced by economic development since the 1960's through rapid eutrophication. The legal control of waste water discharge from industries implemented by the National Government in 1970 slowed down the rate of eutrophication to a certain extent, but the steady increase of population, ever-rising standard of living, increased fertilizer application, etc. in the catchment area combined to result in a slow but steady march of
The Shiga Prefectural Government enacted in 1980 the Ordinance for the Prevention of Eutrophication of Lake Biwa, which, for the first time in Japan, prohibited the use of phosphate-containing synthetic detergents. The phosphorus content of lake water was thereby reduced considerably, but the effect of reduced phosphorus loading on biological processes in the lake is not yet apparent.

Although anthropogenically induced eutrophication has been recognized since the early 1960s, intensive plankton monitoring was not started until 1965 in Lake Biwa. A report from Shiga prefecture in 2000 indicated new records of 39 species of Chrysophytes and 9 species of the Bacillariophyceae family. Phytoplankton community in Lake Biwa has been changed somewhat since the 1970’s due to rapid urban development around the lake. A ‘red tide’ by sudden propagation of Uroglena americana occurred in 1977 and it has been observed annually ever since. Further, populations of Pediastrum biwae (Pediastrum simplex) and Stephanodiscus suzukii had shown decrease from the middle of 1980s, while Anabaena spp. and Microcystis spp. showed increasing trends. Another report in 2001 showed the Aulocoisera nipponica and Stephanodiscus suzukii to be regarded as endangered species.

The taxonomic composition of phytoplankton assemblages is highly variable among ecosystems and often difficult to predict. Many taxonomy-based descriptors of phytoplankton, such as species lists, percent contribution of each species to total phytoplankton biomass, and the number of species in each major taxonomic group, are often reported for long-term inter-site comparisons, but variation changes of planktonic populations are not easy to understand quantitatively. Hence, we have introduced four new dominancy indicators to evaluate the phytoplankton behavior. The main purpose is to study the phytoplankton variations in Lake Biwa during the past 30 years (1979 - 2008), using these indicators for Taxa and species. Each indicator is used to understand the variation pattern of the phytoplankton species for sampling sites, seasonal changes, and overall decade trends. Then, these data were statistically analyzed by multi-ways layout ANOVA (Analysis of Variance) to make quantitative discussions on several related factors, such as site, season, year, and random effects. The results clearly indicated that influent patents of these effects have a variety of differences depending on phytoplankton species, but that there are some similarities among several species. Cluster Analysis was successfully introduced to categorize a variety of patterns into a few groups.

Thus far into our research, the 30 years phytoplankton community variations study in Lake Biwa can be summarized as below:

I. A total of 298 phytoplankton species have been detected, belonging to 9 major taxa groups
II. The most dominant taxon in terms of Occurrences was the brown flagellum algae taxon with 98.5%, the highest abundance and with the largest Biovolume was the green algae group and the blue-green taxon was with the highest number of cells (25.9 x 10³ cells/mL)
III. In terms of species composition, the most frequently detected species (Cryptomonas spp. and Rhodomonas spp.) were both from the brown flagellum taxon followed by Staurastrum dorsidentiferum var. ornatum from the green algae group.

IV. The sampling site effects determined that the Southern basin had higher density with larger cell counts of the phytoplankton community comparatively with the Northern basin.

V. Decade analysis confirmed that the Southern basin is undeniably more abundant than the Northern basin, which was likely due to huge depth difference between both sites with lacking of mixing in the water column and low light penetration would have some direct relationship with phytoplankton community growth.

Overall, our data suggest that environmental factors at both the northern and southern basin of Lake Biwa influences the seasonal and growth patterns of the phytoplankton community which vary annually. Our future analysis would be to relate temporal changes of the phytoplankton diversity to temporal changes in environmental conditions, resulting in the development of a better understanding of the nature of interactions between the phytoplankton community and its environment in Lake Biwa.