Lake and Reservoir Management

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doi: 10.2175/106143008X328798

A review of the literature published in 2007 on topics relating to lake and reservoir management is presented. This review, which covers more than 300 papers from more than 40 journals, focuses on topics directly related to the management of lakes and reservoirs. The journals with the most papers are Hydrobiologia, Journal of Great Lakes Research, Limnology and Oceanography, Water Research, and Water Resources Research. The review is divided into the following sections: Climate, Ecology, Eutrophication, Limnology, Mercury, Methods and Analytical Techniques, Modeling, Monitoring, Nutrients, Organic Matter, Planning and Management, Restoration and Treatment, Sediment, and Water Quality.

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Climate

Conductivity and major ion chemistry in a suite of Nebraska (USA) lakes and reservoirs were studied by Bennett et al. (2007) to evaluate the relative magnitudes of climatic and non-climatic influences on ionic concentration and composition. Sub-saline and saline lakes showed more seasonal variation in conductivity than freshwater lakes, and lakes in arid regions were more sensitive to precipitation change than lakes receiving greater precipitation. Seasonal and annual discharge of matter into large, shallow Lake Vortsjarv (Estonia) was determined to be influenced by climate and changes in agricultural practices (Noges et al., 2007a). Significant positive correlations between precipitation and annual loadings of ammonium, phosphates, chemical oxygen demand (COD), and manganese were found by the authors.

Jackson et al. (2007) assessed the implications of winter climate on lake biotic structure and function by comparing the chemistry and biology of shallow Canadian and Danish lakes that have similar morphology. They predicted that shallow Canadian prairie lakes will experience increased survivorship of planktivores and stronger control of zooplankton if climate change leads to warmer winters and a shorter duration of ice cover.

Livingstone and Padisak (2007) measured daily mean lake surface-water temperatures (LSWT) in Swiss Alpine Lakes and found that the response of LSWT in very dissimilar lakes in two different geographical regions demonstrates that large-scale climatic forcing on synoptic timescales is much more important for lakes than previously thought. To reveal the response of catchment environment to climate changes and human activities during the past four centuries, Liu et al. (2007a) studied element content, grain size, and pollen and performed 210Pb dating analysis on sediment cores from Taibai Lake (China).

Combining long-term measurements and projections from a Regional Climate Model, the potential impact of climate change on surface temperature and residence times of lakes in the English Lake District was assessed (George et al., 2007b). The most serious limnological effects were projected for summer months and included increased stability and decreased flushing rate for lakes with short residence times. Applying the ecosystem model PCLake, Mooij et al. (2007) analyzed the impact of climate change on shallow lakes and concluded that it will likely lead to decreased overall loading of critical nutrients. However, external nutrient loading was predicted to increase, which would probably cause a shift from clear to turbid states.

Ecology

Planktonic microbial community structure and the classical food web in large eutrophic Lake Taihu (China) were investigated by Wu et al. (2007b). They identified site-specific nutrient enrichment and sediment resuspension as causes of the observed intra-habitat differences in food web structure. Fukushima et al. (2007) examined the effects of habitat fragmentation on freshwater fish species caused by dams in Hokkaido, Japan. Nalepa et al. (2007) surveyed benthic macroinvertebrate communities in the main basin of Lake Huron in 2000 and 2003 and in Georgian Bay and North Channel in 2002, and they compared these results to best estimates for the 1960's and early 1970's. The total density of the four major benthic taxa (*Diporeia spp., Oligochaeta, Sphaeriidae, and Chironomidae*) in the main basin has declined dramatically in recent decades. To test the importance of allochthonous carbon to consumers, (HCO3)-C-13 was added to a large clear-water lake for 56 days (Pace et al. 2007). Particulate and dissolved organic carbon, phytoplankton, bacteria, zooplankton, and the invertebrate predator Chaoborus spp. all increased to a maximum during the addition and declined once the addition ceased. Qualls et al. (2007) analyzed data from a pre and post Zebra mussel (Dreissena polymorpha) invasion in Green Bay, Lake Michigan (USA) to determine the impacts on water clarity, nutrients, and the relationship between chlorophyll and phosphorus. The impact of zebra mussels on water quality and chlorophyll-phosphorus dynamics was found to differ depending on initial trophic status and zebra mussel densities.

Using field enclosure experiments, Derry and Arnott (2007) showed that local conditions are suitable for most zooplankton species in acid-recovering lakes with pH $\geq$ 6.0 but that other factors such as dispersal limitation and biotic interactions may be impeding community recovery. The results of qualitative and quantitative analyses of

zooplankton, as well as saprobiological analysis of the plankton community, in the Potpec Reservoir (Serbia) were presented by Cadjo et al. (2007). Rinke et al. (2007) investigated the effect of wind-induced internal waves on vertical distribution of zooplankton in Bautzen Reservoir (Germany) and concluded that classical limnological field sampling can lead to severely biased estimates of zooplankton abundance due to the interfering effects of hydrophysical processes like internal waves. The role of pelagic cladoceran communities were studied in two Estonian lakes, moderately eutrophic Lake Peipsi and strongly eutrophic Lake Vortsjarv, and the community reflected the difference in lake trophic states (Haberman et al. 2007). To determine if there is a relationship between crustacean biomass and trophic indicators, Wang et al. (2007f) conducted a comparative limnological study of three lake groups. They reported no consistent relationship between crustacean biomass and trophic indicators, suggesting little control of phytoplankton by macrozooplankton in the shallow subtropical lakes.

In a field study of phytoplankton dynamics, wind events were found to modify size structure and exported biomass during a time scale of a few days (Pannard et al., 2007). Seasonal development of planktonic diatoms in Lake Tovel was studied to investigate the role of weather conditions and lake hydrology in regulating *Cyclotella* and *Fragilaria* species groups (Tolotti et al., 2007). Because the lake has scarce internal nutrient reserves and its hydrology is strongly affected by precipitation, diatom phenology is indirectly regulated by weather conditions. Stenuite et al. (2007) focused on phytoplankton production in Lake Tanganyika and provided new estimates of daily and annual primary production and growth rates, which are lower than previously published values.

The effect of different spring warming scenarios on the succession of cyanobacteria, diatoms. and green algae were investigated by De Senerpont Domis et al. (2007), who showed that algal functional groups respond differently to climate warming under phosphorus-limited conditions. Dissolved iron concentrations were found to be an important factor in determining the structure of the bloom-forming cyanobacteria community in Lake Kasumigaura (Nagai et al., 2007). The first documented observation of the potentially toxic cyanobacterium *Cylindrospermopsis* in Lake Erie and Sandusky Bay was recorded by Conroy et al. (2007) in 2005. They propose that *Cylindrospermopsis* will increase in importance in the lake, as previous research on climate change predicts higher water temperatures and lower water levels in the Great Lakes region. The development of cyanobacterial blooms in Lower Karori Reservoir (New Zealand) was shown to be a result of low nitrogen concentrations that favor nitrogen-fixing cyanobacteria and their ability to adjust buoyancy (Smith and Lester, 2007).

Eutrophication

Bayley et al. (2007) examined the roles of total phosphorus and submersed vegetation in defining clear or turbid states in biotic structure in 24 naturally eutrophic shallow lakes with variable vegetation in Alberta, Canada. The authors reported that these systems are strongly abiotically regulated and lack mechanisms to maintain

stabilization. To identify the effects of nitrogen on the eutrophication of a phosphorus-rich lake in Lough Neagh, Northern Ireland during 1933–1995, Bunting et al. (2007) compared fossil records of nitrogen inputs, aquatic production, algal abundance, and gross community composition with climatic variability, atmospheric and urban nutrient loading, whole-catchment nutrient budgets, and limnological monitoring data. They concluded that degradation of water quality resulted from excessive loading of diffuse nitrogen from agricultural lands. Integrated monitoring of internal and external nutrient fluxes was employed by Matzinger et al. (2007b) to detect a progressing eutrophication in Lake Ohrid in southeastern Europe. To prevent further decreases in minimum dissolved oxygen concentrations, the authors stated that phosphorus loading must decrease by at least 50%. Phytoplankton biovolume and species composition were analyzed for forward and reverse regime shifts in a shallow urban lake (Dokulil et al., 2007). Because of changes in hydrology, the pelagic zone switched from a clear-water, macrophyte dominated state to a stable turbid state with an abundant cyanobacteria population.

Heinsalu et al. (2007) used a paleolimnological approach to assess the recent eutrophication history in shallow eutrophic Lake Peipsi in Europe. They reported that the lake exosystem was still unstable. Changes in trophic dynamics in Lake Maggiore from 1943–2002 were described by Manca et al. (2007) using subfossil cladoceran records, long-term contemporary data, and historical information. The researchers concluded that a combined paleo-neolimnological approach can be a powerful tool for elucidating past changes in trophic dynamics and interactions with climate-induced changes. To assess trophic status of Hungarian lakes as suggested by the Water Framework Directive, Stenger-Kovacs et al. (2007) developed an index using littoral diatoms as indicators of trophic status. Trophic indicator and sensibility values were defined for the Trophic Diatom Index for Lakes, which is needed to assess the ecological status of shallow lakes under the Directive.

Limnology

Crawford and Collier (2007) examined key limnological properties (primarily temperature, salinity, and dissolved oxygen), in Crater Lake, Oregon (USA) and discussed variability in the hypolimnion on time scales of days to a decade. They show that surface cooling and wind-driven mixing during the early stages of reverse stratification may determine the net ventilation possible during a particular year. The limnological features of Lake Puma Yum Co (China) were described by Murakami et al. (2007), from data collected during a second expedition in September 2004. Physical and chemical properties of 17 Afro-alpine lakes and 11 pools in the Rwenzori Mountains (Uganda-DR Congo) were described by Eggermont et al. (2007), to establish baseline conditions to evaluate future environmental and biological changes in these unique tropical ecosystems, and to provide a foundation for paleo-environmental studies. They reported that because the lakes' abiotic environment is strongly related to temperature and catchment hydrology, these Afro-alpine ecosystems may be sensitive to climate change and glacial melting.

The extent of stratification and vertical mixing in the western basin of Lake Erie was investigated by Loewen et al. (2007), who revealed that vertical transport of oxygen and heat is controlled by the complex interaction of several physical mechanisms. Aeschbach-Hertig et al. (2007) studied the development of the vertical mixing dynamics of the deep, meromictic northern basin of Lake Lugano. Budget calculations using tracer concentrations revealed an annual renewal of the deep water below 100 m depth and enabled calculation of long-term mean profiles of the effective vertical turbulent diffusivity K-z. von Rohden et al. (2007) investigated vertical transport in a small eutrophic lake in the Upper Rhine Graben (Germany). They reported that governing mixing processes were influenced by strong density stratification, and they quantitatively estimated profiles of the effective vertical transport coefficient K-z. To explain its ecological richness, the physical character of Priest Pot's water column was elucidated by Folkard et al. (2007). The authors reported that where the water column was stratified, turbulence was strongly damped by both buoyancy and viscosity and that K-z was an order of magnitude smaller.

Using moored thermistor records and meteorological data, Churchill and Kerfoot (2007) examined how changes in lake stratification are related to surface winds and heat flux in Portage Lake. They indicated that when the water column restratifies, the lake becomes more susceptible to convectively-driven overturn during cold air outbreaks. Torremorell et al. (2007) studied the dynamics of Laguna Chascomus (Argentina) and hypothesized that wind contributes to the permanent mixing of the lake, as well as to lessen sedimentation losses of photoautotrophs.

The water balance of Lake Qinghai (China) was investigated by Li et al. (2007a) to identify causes for the decline in lake level. The trend of cold/warm and dry climate in recent decades may be the main reasons for the decline in lake level. Redmond (2007) investigated the hydrologic budget of Crater Lake, Oregon (USA) by taking advantage of its relatively simple geometry, climatic circumstances, and the concurrent availability of years of traditional data. They concluded that the water budget is controlled more by variability of precipitation than evaporation. Wolfe et al. (2007) used stable isotopes and water chemistry to characterize the water balance and hydro-limnological relationships of 57 shallow basins in the Peace-Athabasca Delta, Alberta, Canada. They suggest that changes in hydrology are likely to be coupled with marked alterations in water chemistry due to the strong relationship between water balances and limnological conditions.

Vidal et al. (2007) examined the causal mechanisms and seasonal evolution of the internal wave field in a deep, warm, monomictic reservoir. During the time period analyzed, wind forcing was periodic and the lake thermal structure was characterized by the presence of a shallow surface layer overlying a thick metalimnion, typical of small to medium sized reservoirs with deep outtakes.

Anselmetti et al. (2007) investigated the effects of high-alpine hydropower damming on lacustrine sedimentation and transport of solid particles in the

glaciated Grimsel area and Lake Brienz (Switzerland), providing quantitative denudation rates and sediment yield on a source-sink basis. The study indicated that the fine fraction budgets are only slightly affected by damming but that the reservoirs cause a shift in seasonal runoff timing resulting in increasing and decreasing particle transport in winter and summer, respectively.

Gale et al. (2007) analyzed the circulation and exchange between two intermittently closing and opening lakes and lagoons and the ocean, and suggest that intermittent estuarine systems may be quite complex and variable within the same regional area and, consequently, throughout the world.

Boss et al. (2007) measured spectral inherent optical properties (IOPs) at Crater Lake, Oregon (USA), and observed variations in the spatial distribution of IOPs, which reflect biogeochemical processes in the lake. Underwater spectral measurements of solar radiation (300-800 nm) were collected in Crater Lake by Hargreaves et al. (2007). They suggest that penetration of ultraviolet (UV) radiation has significant ecological impact, including effects on measured chlorophyll-a. The UV transparency of surface waters of an oligotrophic lake in Pennsylvania (USA) were studied by Williamson et al. (2007), who observed clear-water phase events for potentially damaging UV wavelengths.

Using data from multiple surveys during two rainy seasons, McCullough et al. (2007) described vertical distributions of suspended solids in the Linthipe River delta region of Lake Malawi. The authors concluded that the upper metalimnion is the prevailing pathway carrying watershed runoff horizontally throughout the lake. Using microscopy to analyze clastic suspended sediment, Hodder and Gilbert (2007) provided evidence of in-situ flocculation in glacier-fed Lillooet Lake. They reported that flocculation is a plausible explanation for accelerated sedimentation of the clay-sized sediments known to dominate the varves in other glacier-fed lakes. Larson et al. (2007c) studied water clarity in Crater Lake (USA) using Secchi disk and transmissometers to measure turbidity, and they observed that both of these measurements provided additional evidence about the exceptional clarity of the lake.

Staehr and Sand-Jensen (2007) studied temporal dynamics and regulation of oxygen metabolism in the upper mixed layer of a Danish lake. They report that daily monitoring can provide the optimal background for evaluating temporal changes and regulation of algal biomass and organic pools in nutrient-rich shallow lakes. Aerobic methane oxidation rates in Petit Saut Reservoir (French Guiana) were measured by Guerin and Abril (2007). Total pelagic oxidation was shown to reduce atmospheric emissions by more than 85% for the whole lake-river system, and this process was responsible for more than 25% of total CO_2 emissions from the whole reservoir-river system.

Diez et al. (2007) studied ferrous iron in the Halls Brook Holding Area, Massachusetts (USA), and reported nearly complete oxidation of ferrous iron as it mixed upward across the lake's pycnocline. Oxidation in the pycnocline was primarily due to catalysis by microorganisms.

Walker et al. (2007) sampled three dimictic lakes and one meromictic lake around the Trout Lake, Wisconsin (USA), watershed to determine the variation of chlorofluorocarbon (CFC) within the lakes. They reported that CFC profiles and degradation were likely the result of in-lake processes such as degradation in the water column and sediments as well as gas exchange rates and the duration of turnover.

Using Principal Component Analysis and PHRQPITZ reaction path modeling, Radke and Howard (2007) conducted a hydrogeochemical study of lakes in western Victoria, Australia. The study revealed a small group of lakes with chemical characteristics so diverse that it compares to that recorded for lakes from the entire region of western Victoria and south-eastern South Australia. Also, the study confirmed that the chemical diversity of the lakes is largely due to the groundwater system.

Serra et al. (2007) investigated the effect of convection caused by surface cooling and mixing attributable to wind shear stress on transport of phytoplankton cells in the water column of Sau Reservoir. Internal waves, together with wind-driven current generated at the surface, seemed to be responsible for horizontal transport of phytoplankton across the reservoir. The importance of vertical mixing in modulating the impact of ultraviolet radiation (UVR) on phytoplankton photosynthesis was assessed by Villafane et al. (2007) in a tropical, shallow lake in southern China. They observed that rapid vertical mixing not only counteracted the impact of UVR but also stimulated photosynthetic efficiency. The driving forces shaping phytoplankton assemblages in two subtropical plateau lakes with contrasting trophic status, the oligotrophic deep Lake Fuxian and the eutrophic shallow Lake Xingyun were studied by Zhang et al. (2007b). Their results suggest that the major driving forces in Lakes Fuxian and Xingyun were physical variables and nutrients, respectively, and, hence, phytoplankton communities in both lakes are regulated primarily by bottom-up controls. The vertical and horizontal distribution of phytoplankton during the stratification period in Sau Reservoir (Spain) was investigated by Marce et al. (2007). They reported that in canyon-shaped reservoirs, internal seiches, turbulence, and advective water movements act concurrently with biological features of algae to produce a heterogeneous phytoplankton distribution.

Mercury

To characterize heavy-metal transfer through a food web and to assess risk to humans, Hogan et al. (2007) collected Micropterus dolomieui samples in Lake Erie and analyzed for total lead (Pb), total mercury (Hg), and methyl mercury (MeHg). They reported that total Pb was bio-diminished and MeHg was bio-magnified through the food web to smallmouth bass, which could increase the risk of Hg contamination to humans. Knightes and Ambrose Jr (2007) explored the feasibility of applying a regional mercury cycling model to develop fish advisories using existing data from 91 Vermont and New Hampshire (USA) lakes. The authors concluded that process-based models cannot be used for a-priori predictions at the regional scale at this time because of the current lack of parameterization of mercury transport and transformation processes.

Atmospheric data collected above Devil's Lake and Mt. Horeb (USA) indicated that elemental and particulate mercury concentrations were affected by regional and local sources, while reactive gaseous mercury was mainly impacted by local sources (Manolopoulos et al. 2007). The study suggests that traditional modeling approaches that utilize source emissions and large-scale grids may not be sufficient to predict mercury deposition at sensitive locations due to the importance of small-scale sources and processes.

Outridge et al. (2007) studied the effects of climate warming during the 20th Century on the limnology of High Arctic lakes. They reported substantial increases in autochthonous primary productivity, which affected organic carbon and mercury core profiles due to mercury scavenging by algae and/or suspended detrital algal matter.

The history of mercury inputs to 55 Minnesota (USA) lakes was reconstructed from sediment core data to determine if erosion of agricultural soils and urbanization contributes a significant loading to lakes and whether lakes near mercury-emitting facilities receive appreciable atmospheric deposition (Engstrom et al., 2007). The authors reported that modern mercury accumulation rates are substantially higher in metropolitan and agricultural areas than in the forested regions and that modern loading from atmospheric deposition is also greater in metropolitan regions. Sediment samples were collected from Mary Lake, St. George Lake, and Philips Lake (Canada) to evaluate atmospheric mercury loading (He et al., 2007). Concentrations and distributions of MeHg in overlying and sediment-surface water in Mary Lake and St. George Lake suggested that both in-situ production and sediment release of MeHg contributed to high concentrations in deep anoxic water. Published background and modern mercury accumulation rates derived from globally distributed lake sediments and peat bogs were compared by Biester et al. (2007). They discuss reasons for the differences in absolute values and the relative increase during the industrial age.

Methods and Analytical Techniques

Xu et al. (2007) evaluated total nitrogen and total phosphorus in Chaohu Lake by the fuzzy method and calculated the lake's eutrophication driving exponent. Using principal component analysis, Diaz et al. (2007) analyzed chemical compositions and nutrient concentrations of 39 little-studied Patagonia (Argentina) lakes, and they demonstrated that the extreme oligotrophy characterizing many water bodies of the Patagonian region is due to nitrogen, rather than phosphorus, deficiency. Hanson et al. (2007) sampled 168 lakes in the Northern Highland Lake District of Wisconsin (USA) for a broad suite of limnological variables. The researchers found that regional summaries of lake characteristics for the District are influenced by the inclusion of small lakes in the sample. Using several multivariate techniques, Qian et al. (2007) evaluated water quality in the Indian River Lagoon, Florida (USA). They reported that the median water quality indices were significantly greater in the wet season, which implied a more natural nutrient water status during the dry season.

Using the point cumulative semivariogram technique and data from 40 surface water stations in Keban Dam Lake, Kulahci and Sen (2007) performed a spatial analysis of 90Sr artificial radionuclide in relation to global fallout and the Chernobyl nuclear accident. They provided a measure of cumulative similarity of the regional 90Sr around any measurement site and hence showed that regional similarity maps could be developed at any desired distance around each station.

Ginn et al. (2007b) used diatom-based paleo-limnological techniques to reconstruct acidification trends in 51 low-alkalinity Nova Scotia lakes with varying dissolved organic carbon concentrations and sulphate deposition. They reported that the generally low pre-industrial pH values suggest that many of these lakes were somewhat naturally acidic, but acidified further as a result of atmospheric deposition. The same researchers (Ginn et al., 2007a) again used diatom-based paleo-limnological methods to study 14 lakes from two regions of Nova Scotia, representing regions of high and low sulphate deposition. Ginn and coworkers concluded that the lakes that have been most impacted by acidic deposition had the lowest pre-industrial pH and relatively high sulphate deposition.

Oros et al. (2007) analyzed samples of water, aerosol, surface slick, and sediment by gas chromatography-mass spectrometry to evaluate hydrocarbon inputs to Crater Lake from anthropogenic and natural sources. They showed that hydrocarbons originate from both natural (terrestrial plant waxes and algae) and anthropogenic (petroleum use) sources and are entering the lake through hydraulic inflows and atmospheric transport. Surface sediment biofilm samples from 82 Pyrenean lakes were analyzed for marker pigment composition by Buchaca and Catalan (2007) using high performance liquid chromatography. Their results suggest historical changes in the relative importance of planktonic versus benthic primary production that may be related to climatic or environmental changes. To obtain porewater from precisely located positions on the deep-sea floor, Dattagupta et al. (2007) developed a peeper that can be deployed using remotely operated or manned submersibles. The authors provided details on peeper cell size, spacing, and integrity.

LaBounty and Burns (2007) determined long-term changes in the hypolimnetic volumetric oxygen demand (HVOD) of Boulder Basin, Lake Mead (USA) and observed that HVOD was highest when reservoir water was nutrient-rich and flow rates were low. This suggests that use of HVOD should be considered for monitoring trophic state changes in Boulder Basin.

Integration of remote sensing technologies into the water quality monitoring programs of Lake Garda were tested by Giardino et al. (2007) using the spatial and spectral resolutions of Hyperion and physics-based approaches. The transferability of the method to other sensors and the ability to assess water quality independent of in-situ data suggest that water quality management of subalpine lakes could be supported by remote sensing.

Using a beam transmissometer to estimate Secchi depth, Larson et al. (2007b) addressed potential sources of error in estimating the water clarity of mountain lakes.

Their prediction model reliably estimated Secchi depths and can be used where conditions for standardized Secchi disk deployments are limited.

The diversity and abundance of sulfate-reducing bacteria (SRB) in Lake Suigetsu, Japan were studied by Kondo and Butani (2007) using polymerase chain reaction to assess the distribution of SRB in the water column and sediments. The results indicate that habitat-specific SRB communities may contribute to the biogeochemical cycling of carbon and sulfur. Multiple microbial source-tracking methods were used by Edge and Hill (2007) to determine the source of elevated *Escherichia* (*E.*) *coli* levels at Bayfront Park Beach on Lake Ontario. The results indicated the importance of bird droppings and foreshore sand as primary and secondary sources of *E. coli* contamination.

Brand et al. (2007) introduced a novel sensor for measurement of extremely low flow velocities. The authors presented high-resolution in situ measurements at the bottom of a pre-alpine lake with shear velocities as low as 0.13 +/- 0.02 cm s(-1), resolving the transition zone between the viscous and logarithmic boundary layer.

Fukuhara et al. (2007) used a stable nitrogen isotope analysis to clarify the relative importance of denitrification and nitrate uptake by plants in a reed belt of Lake Kamisagata (Japan). They reported that a technique using the natural variation of 15N abundance may provide useful information on the nitrate dynamics in wetlands in a non-destructive manner.

Using a new instrument for in-situ ultraviolet spectrophotometry, Pawlowicz et al. (2007) obtained measurements of physical, biological, and chemical parameters in Nitinat Lake, British Columbia. Observations from continuous profiling of nitrate and bisulfide were also presented. A miniaturized photometrical method for the rapid analysis of phosphate, ammonium, ferrous iron, and sulfate in sediment pore water was presented by Laskov et al. (2007). The method can handle large sample sets (> 1000) and requires a sample volume of only 250 mu L. To identify indicative bands and develop suitable estimation models for chlorophyll and suspended solids concentrations in Taihu Lake (China), Ma et al. (2007) measured reflectance spectra in-situ and compared the results to laboratory analyses of collected water samples.

Combining simultaneous measurements of metabolism using dissolved oxygen sensors with a spatial model, Van de Bogert et al. (2007) studied the underlying heterogeneity in lake ecosystem metabolic parameters such as gross primary production (GPP) and respiration (R). They showed that estimates of GPP and R for the lake perimeter were typically greater than measurements for the middle of the lake, with their model estimating that benthic-littoral processes were roughly equal to 40% of epilimnetic GPP and R. Karlsson et al. (2007a) carried out short-term experiments in nine unproductive lakes in northern Sweden in order to investigate organic carbon sources supporting lake water respiration. They reported that the Keeling plot method is a powerful technique to characterize and quantify organic carbon sources contributing to respiration.

Modeling

The Perfect Stochastic Dynamic Nash Game model was developed by Ganji et al. (2007) to describe the associated conflicts among different consumers due to limited water. The proposed model has the ability to generate reservoir operating policies, considering the needs of water users and reservoir operators.

Nguyen et al. (2007) proposed a new approach for testing integrated water system models and applied the approach to the RaMCo model. Their work revealed an insufficient number of land-use types available in the model, which makes the model inadequate to describe the consequences of changes in socio-economic factors and policy options on erosion from a catchment and sediment yields of a storage lake.

Based on a Bayesian network (Bn), Ticehurst et al. (2007) developed an integrated model framework to assess the sustainability of eight coastal lake-catchment systems in New South Wales (Australia). They described the potential advantages of using Bn's, the methods used to develop their framework, and the applicability of Bn techniques to support management in similar situations.

Li et al. (2007c) proposed a projects pursuit regression forecasting model of comprehensive indexes for eutrophication trends in Taihu Lake (China). The authors showed that the water quality of Taihu lake will gradually degrade during the next 5–30 years unless pollution loading is reduced.

Wang et al. (2007a) developed two hybrid models based on the principle of maximum entropy and engineering fuzzy set theory and applied them to 12 lakes and reservoirs in China to determine the trophic level. The results showed that the proposed models are effective tools for generating realistic and flexible optimal solutions for complicated water quality evaluations.

The catchment nutrient model SWAT was applied by Yu et al. (2007) to Lake Taihu, China. The model was used to examine eutrophic long-term changes and the impacts of natural eutrophication and anthropogenic changes in catchment discharge and land use. SWAT was also applied by Barlund et al. (2007) to analyze the effectiveness of proposed measures to reduce agricultural and sparse settlement nutrient loading in Lake Pyhajarvi. The authors indicated that SWAT can be calibrated for flow and sediment yield using catchment-scale parameters; however, for nutrients, parameters describing more detailed catchment processes are needed.

To evaluate the long-term effects of climate change on water quality and aquatic ecosystems in Shimajigawa Reservoir (Japan), Komatsu et al. (2007) applied a watershed runoff model and reservoir water quality model with meteorological input calculated by a GCM A2 scenario. Global warming was shown to increase eutrophy in the reservoir by promoting algal growth and changing the aquatic ecosystem.

Rueda et al. (2007a) examined, by means of scaling analysis tools and three-dimensional numerical simulations, the time and spatial scales of transport and mixing processes during the cooling phase of the ice-free period in La Caldera (Spain). They demonstrated that transport and mixing in small high-mountain lakes are shaped by the severe changes due to heat fluxes through the

air-water interface exhibited at diurnal time scales, strong winds of episodic nature (storms), and the limited horizontal and vertical length scale of the basin. Leon et al. (2007) evaluated the performance of the three-dimensional hydrodynamic model ELCOM on Great Slave Lake. Simulations showed dominant circulation patterns that can create relatively large spatial and temporal gradients in temperature and that knowledge of model sensitivity will be crucial when meteorology effects are taken into account. A method, based on the Princeton Ocean Model, for assimilating current observations into a two-dimensional circulation model of Lake Michigan was presented by Zhang et al. (2007c). They showed that the method successfully melds observations into the model, and the influence of data assimilation propagates in space and time.

To investigate the flow conditions within Lake Vostok, Thoma et al. (2007) tested different parameter settings with a three-dimensional numerical model. Simulations predicted a baroclinic circulation within the lake that splits into three flows and that a basal mass loss of ice indicates either a constant growth of the lake or its periodic discharge into a subglacial drainage system.

Jayaraman et al. (2007) described the development of a two-dimensional depth-averaged hydrodynamic model for Chilika Lagoon, India and the simulation of currents and salinity corresponding to (i) the Southwest and Northeast monsoon seasons and (ii) pre- and post-mouth-opening conditions. They showed that salinity levels are much lower during the southwest monsoon and report that the model will be important for on-going work in seasonal study of the ecology of Chilika Lagoon.

Using a simple dynamic model to represent water level, Sanderson and Baginska (2007) compared model output with measurements of tidal oscillations and tidal pumping within a lake. Comparisons of freshwater inflow with other estimates of catchment runoff were favorable. To model temporal changes in water levels of Lake Van, Turkey, Altunkaynak (2007) used artificial neural networks and concluded that neural networks can successfully model the complex relationship between rainfall and consecutive water levels.

Bravo et al. (2007) applied bubble plume models to study de-stratification and aeration of reservoirs and accounted for efficiency in simulating the two-phase flow. They discuss a strategy to overcome under-dispersion and include air-water mass transfer effects through user-defined functions. Using data collected from a full-scale diffuser installed in Spring Hollow Reservoir, Virginia (USA), Singleton et al. (2007) validated an existing improved linear bubble plume model. Their results suggest that plume dynamics and oxygen transfer can successfully be predicted for linear bubble plumes using the discrete-bubble approach.

Applying a fully coupled, integrated surface water/groundwater model, Smerdon et al. (2007) studied hydrologic controls on lake-groundwater interaction in the Boreal Plains of Alberta, Canada. Spatially and temporally variable evapotranspiration was found to govern the water table configuration and lake-groundwater seepage patterns.

Hurdowar-Castro et al. (2007) used a three-dimensional transport model to perform a comparative analysis of several potential drinking water intakes located along the northwest shore of Lake Ontario, specifically assessing each intake considering long- and short-term transport of pollutants released from the Pickering Nuclear Generating Station and potential and actual pollutant releases from land sources. The results indicated that four intake locations outperformed others by maintaining bottom pollutant levels within governmental standards and warning times that exceeded 20 hours.

To evaluate reservoir performance, plan modifications, and design new water storage, Jaber and Shukla (2007) used the one-dimensional Saint Venant equations for hydrodynamic modeling of flood detention reservoirs. They reported that the new time step criteria could easily be integrated into existing models for an adaptive time stepping scheme.

Choi et al. (2007) investigated the potential impacts of an enlarged reservoir due to dam reconstruction using the laterally-averaged, two-dimensional hydrodynamic and water quality model CE-QUAL-W2. It was determined that dam reconstruction would increase hypolimnetic volume, steepen temperature gradients between the epilimnion and hypolimnion, and strengthen and prolong thermal stratification during summer.

To model sedimentation in the main pool of a deep hydropower reservoir, Elci et al. (2007) applied a three-dimensional numerical model of hydrodynamics and sedimentation for different wind, inflow, and outflow conditions. The authors revealed likely zones of sediment deposition in a thermally stratified reservoir and presented a methodology for integration of shoreline erosion into sedimentation studies that can be used in other reservoirs.

A two-dimensional sediment transport model capable of simulating sediment resuspension of mixed (cohesive plus noncohesive) sediment was developed by Cheegwan et al. (2007), who applied it to quantitatively simulate the March 1998 resuspension events in southern Lake Michigan. They reported that the main physical mechanisms determining the sedimentation pattern are (1) two counter-rotating circulation gyres producing offshore transport during northerly wind and (2) the settling velocity of sediment floes which controls the deposition location. De Villiers and Basson (2007) described two-dimensional modeling of hydrodynamics and fine cohesive sediment transport for Welbedacht Reservoir using Mike21C software from DHI Water and Environment. The applicability of the model to determine long-term equilibrium sedimentation as well as future flood levels was discussed. Evans (2007) evaluated the impact of sediment release in the context of channel evolution models and compared short-term and long-term released sediment volumes from a downstream sediment trap reservoir. They showed that stages lasted from minutes to 3-5 years and highlighted the importance of long-term downstream migration of coarse-grained sediment stored in the reservoir. A turbidity model for Schoharie Reservoir, New York (USA) was developed and tested by Gelda and Effler (2007b). The model accurately simulated the timing and magnitude of peaks, vertical and longitudinal distribution

patterns, diminishment following runoff events, and the dependence of impact on magnitude of a runoff event.

Lewis et al. (2007a) described the development, calibration, and application of a model for phosphorus exchange at the sediment-water interface of a eutrophic urban system, Onondaga Lake, New York (USA). They report that the findings have important implications with respect to natural recovery of eutrophic systems and will assist water quality managers in developing appropriate public expectations for the timing of lake restoration.

Zeng et al. (2007) presented the comparison of a radial basis function neural network and an adaptive neuro-fuzzy inference system, which modeled the sorption kinetics of pentachlorophenol (PCP) to sediments from 8 lakes in southern China. The individual changes of the three different inputs (concentration of PCP in the aqueous phase, reversible fraction, and irreversible fraction) affected the modeling results similarly, suggesting that sorption kinetics of PCP to these sediments were affected by all three factors.

A three-dimensional water quality model (CCHE3D_WQ) to simulate temporal and spatial variations with respect to phytoplankton, nutrients, and dissolved oxygen was developed by Chao et al. (2007). The model was verified using analytical solutions, calibrated, and validated using water quality data from a shallow oxbow lake. Nutrients were generally in good agreement with field observations, and sensitivity studies were conducted to demonstrate the impacts on chlorophyll concentration due to varying nutrients and suspended sediment loads.

Perekal'skiy and Kremenetskaya (2007) developed a two-dimensional X-Z model of current velocity, temperature, and dissolved oxygen for a reservoir of complicated form. They reported that the model reproduced the development of stratification and formation of an anoxic zone in the hypolimnion.

Schmid et al. (2007) studied the methane (CH_4) budget of Lake Baikal, using a one- dimensional model to estimate the large-scale vertical CH_4 fluxes within the South Basin, determine exchange with the atmosphere, and constrain CH_4 inputs from seeps and mud volcanoes to the deep water. The net flux between the atmosphere and the main water body was determined to be negligible, with occasional local sources in the Central and South Basins.

The Lake Michigan model MICH1 was resurrected by Pauer et al. (2007) to predict total phosphorus and phytoplankton concentrations, and the results fit the lake-wide average total phosphorus data well. However, the model was less successful in simulating chlorophyll-a measurements, especially in the hypolimnion. Strengths and limitations of this model can guide future development of eutrophication models for Lake Michigan and the other Great Lakes.

A coupled one-dimensional physical-biological model of Crater Lake, Oregon (USA) was presented by Fennel et al. (2007). The model simulated the seasonal evolution of two functional phytoplankton groups, total chlorophyll, and zooplankton in good quantitative agreement with observations from a 10-year monitoring study. Peeters et al. (2007) applied a one-dimensional mechanistic phytoplankton model combined with a one-

dimensional hydrodynamic model to simulate phytoplankton growth during winter and spring in deep monomictic Upper Lake Constance. The interannual variation in the timing of phytoplankton growth was adequately simulated by the model. Using the phytoplankton community model PROTECH, Jones and Elliott (2007) modeled the algal response to changing annual mean retention time in a small lake. They reported that the change in thermal structure influenced the magnitude and composition of the phytoplankton population, particularly those in the CS-functional group, such as Aphanizomenon. Kang-Ren et al. (2007) presented the Lake Okeechobee Environment Model (LOEM), a three-dimensional hydrodynamic, sediment, water quality, and submerged aquatic vegetation model of Lake Okeechobee, Florida (USA). The model results are consistent with observed data indicating that algal growth in the lake is primarily nitrogen limited in the summer and nitrogen and light co-limited in the winter.

Chan et al. (2007) applied non-supervised artificial neural networks and hybrid evolutionary algorithms to model 12 years of limnological time-series data of the shallow hypertrophic Lake Suwa in Japan. They presented an improved understanding of relationships between changing microcystin concentrations, Microcystis species abundances, and annual rainfall intensity to to forecast microcystin concentrations based on limnological and meteorological data.

Naithani et al. (2007) studied the ecosystem response of Lake Tanganyika using a nutrient-phytoplankton-zooplankton-detritus, phosphorus-based ecosystem model coupled to a nonlinear, reduced-gravity, circulation model. The simulated annual net production and chlorophyll-a agreed quite well with observed production available in the literature.

A simple model to separate the effects of washout from in-situ zooplankton population dynamics in Ford Lake, Michigan (USA) was developed by Lehman et al. (2007), who reported that grazer control of phytoplankton and water transparency was responsive to inter-annual variations in river discharge and water retention time.

Using a modified version of the Comprehensive Aquatic Simulation Model, Amemiya et al. (2007) simulated three types of folded bifurcations due to nutrient loading. They suggested that temporal behaviors of lakes after biomanipulation can be explained by pulse-dynamics in complex ecosystems and that not only the amplitude (manipulated abundance of organisms) but also the phase (timing) is important for biomanipulation.

Monitoring

Examining the factors that have influenced surface temperatures of Lake Windermere (United Kingdom) and Lough Feeagh (Ireland) since 1960, George et al. (2007a) concluded that lakes that are topographically different "filter" the imposed climate signal in subtly different ways. The dynamics of Snake River inflows into Brownlee Reservoir were analyzed to explain the onset and maintenance of an oxygen-depleted region in the surface layer, and it was confirmed that the water in this region is hydrodynamically and biologically isolated (Botelho and Imberger, 2007).

Finlay et al. (2007) examined the newer Laser Optical Plankton Counter using samples from 18 lakes in Quebec, Canada and indicated that the instrument may be well suited for analyses of zooplankton abundance and biomass in productive freshwater lakes. Measuring cyanobacterium *Microcystis aeruginosa* in four Sicilian reservoirs, Naselli-Flores et al. (2007) recommended that monitoring of Mediterranean drinking water supplies be intensified during winter, a season usually considered to be less prone to the formation of cyanobacterial blooms.

Evaluating a 10-year limnological study of Crater Lake, Oregon (USA), Larson et al. (2007a) reported no long-term variations in water quality that could be attributed to anthropogenic activity. Also, a permanent monitoring program was established to ensure a reliable future data base. Holocene sedimentary samples from Lake Sarbsko were analyzed to reconstruct the aquatic system response to environmental change (Bechtel et al., 2007). Sedimentary organic matter content and composition were a function of the degree of isolation from sea water. Also, organic geochemical data of coastal lake sediments were determined to be sensitive indicators for tracing Holocene environmental changes. Using data collected from small polymictic Lake Mekkojarvi (Finland), Kankaala et al. (2007) showed showed that the greatest methane-oxidizing bacteria activity and effluxes of methane occur during autumnal mixing in stratified boreal lakes.

Nutrients

Hakanson et al. (2007) presented a study to bridge the gap between freshwater and marine eutrophication works. They concluded that there was no simple relationship between the total nitrogen (TN)/total phosphorus (TP) ratio and empirical chlorophyll concentrations or between concentrations of cyanobacteria and different bioavailable forms of the nutrients such as dissolved inorganic nitrogen and phosphorus, phosphate, and nitrate.

The effect of the Hugh Keenleyside Dam on hydraulics and primary productivity in the Arrow Lakes Reservoir (British Columbia, Canada) was investigated by Matzinger et al. (2007a). Productivity loss was comparable to the reduction caused by nutrient retention behind dams constructed upstream of the reservoir, and this loss may be responsible for the dramatic decline of kokanee (Oncorhynchus nerka) observed in the reservoir.

Rueda et al. (2007b) examined the consequences (in terms of uncertainty) that our lack of knowledge of river-reservoir mixing in one-dimensional transport models has on estimates of river nutrient loads into the euphotic zones of reservoirs. They demonstrated that transport and mixing in small high-mountain lakes are shaped by severe changes due to heat fluxes through the air-water interface at diurnal time scales, strong winds of episodic nature (storms), and the limited horizontal and vertical length scale of the basin.

Scheffer and Van Nes (2007) discussed how spatial heterogeneity and fluctuation of environmental conditions may affect the stability of lakes, and the authors demonstrated that the critical nutrient level for lakes to become turbid is higher for smaller lakes and is affected by climatic change. The degraded water quality of Lake Taihu

(China) was studied by Qin et al. (2007), who concluded that water quality will improve if nutrient loading into the lake is managed.

The variation between lakes with respect to concentrations of particulate nutrient pools was studied by Bryhn et al. (2007) for 126 Norwegian lakes covering a wide range of lake-specific properties. Particulate phosphorus (P) always constituted almost 60% of TP concentrations, whereas particulate nitrogen (N) and organic carbon (C) concentrations were sensitive to several lake characteristics, particularly TP.

Luo et al. (2007) collected precipitation and made measurements of TP, TN, and other components at five cities around Lake Taihu to characterize wet deposition of P and N to the lake. Total P and N concentrations and deposition rates exhibited strong spatial variation in the whole catchment and had significant effects on eutrophication in the lake, suggesting that air deposition be considered when reducing external nutrient loading.

Unckless and Makarewicz (2007) determined the impact of Canada Goose (Branta canadensis) feces on water chemistry. Because fecal material settles quickly to the sediment, no significant changes in water column phosphorus and nitrogen compounds, chlorophyll-a, or phycocyanin were observed.

To describe the nitrogen cycle in Lake Superior (USA), Kumar et al. (2007) present data to resolve spatial and temporal variation along with vertical profiles of ammonium concentration. The higher potential for ammonium uptake compared to external inputs suggested rapid turnover of ammonium in the lake. Townsend-Small et al. (2007) sampled Lake Taihu, China, to measure concentration and delta stable isotope nitrogen-15 (N-15) of nitrate. Delta N-15 values show that urbanized areas of the lake have more sewage-derived N than those areas dominated by agriculture, aquaculture, or industry, implying implications for human health. The spatial-temporal distribution of nitrogen in Lake Taihu from open water to lakeshore was examined by Wang et al. (2007c), who reported that the reed belt affected nitrogen transformation and was a sink for internal-lake nitrogen. The relative nitrate-nitrogen loss rates in 100 north-mid-European lakes from late spring to summer was determined by Weyhenmeyer et al. (2007) using an exponential function., The authors explained decreasing nitrate-nitrogen concentrations by a reduction in external nitrogen loading, including atmospheric deposition, and by changes in climate. The observed prolongation of nitrate depleted conditions might contribute to the increasing occurrence of nitrogen-fixing cyanobacteria in a variety of lake ecosystems.

To develop a quality classification scheme for TP concentration in support of the recent Water Framework Directive, Cardoso et al. (2007) assembled a large dataset of 567 European lakes. Reference TP concentrations were derived from the dataset using two empirical approaches. Havens et al. (2007) presented results from 30-year research on Lake Okeechobee, Florida (USA) to illustrate key features of P dynamics, and they concluded that complex models that explicitly consider hydrodynamics, sediment resuspension and transport, and biological

processes are needed to accurately predict how TP will respond to different management options.

A phosphorus budget for Gouet Reservoir (France) was established by Jigorel et al. (2007) by measuring inflow and outflow of P and sedimentation processes. The input of P to the reservoir was found to depend on the hydrological cycle (floods during winter and spring) while the storage of the P by sedimentation is according to biological cycles (algal blooms). A detailed budget of the fluxes of bio-available phosphorus for ultra-oligotrophic Lake Brienz (Switzerland) and its catchment was determined by Muller et al. (2007). They reported that maximum eutrophication of the lake in the late 1970s and subsequent re-oligotrophication can be attributed to urban wastewater loads.

To understand the effect of hydrodynamics on P concentrations, Zhu et al. (2007) observed wind, wave, and several water quality indices in Meiliang Bay, a shallow and eutrophic bay located in northern Lake Taihu (China). They concluded that a new method for confirming the critical stress for intensive sediment resuspension and nutrient release still needs to be developed.

The relationship between major nutrients (C, H, N, and P) and trace metals (Cu, Fe, and Mn) were investigated by Pedrosa et al. (2007) using seston samples from ten lake/lagoon systems in southern Brazil. The relative content of organic matter in seston and seston concentrations in lake water tended to correlate positively and negatively, respectively, with trace metal concentrations.

Chanudet and Filella (2007) studied the fate of colloidal particles in Lake Brienz (Switzerland) and its two main tributaries and reported that the concentration of natural organic matter is so low that it is not having any significant effect on the fate of inorganic colloids.

Eckert and Conrad (2007) studied the differential impact of microbial sulfate reduction and methanogenesis on the mineralization of particulate organic carbon (POC) in warm monomictic Lake Kinneret, Israel. Overall, sulfate reduction accounted for more than 60% of the POC settling flux, a finding that differs from similar studies of temperate lakes where methanogenesis was shown to be the primary mode of terminal carbon mineralization.

To understand the factors that regulate dissolved organic carbon (DOC) in lakes, Sobek et al. (2007) assembled a large database (7,514 lakes from 6 continents) of DOC concentrations and other parameters that characterize lake conditions, catchment, soil, and the climate. Their results suggest a hierarchical regulation of DOC, where climatic and topographic characteristics set the possible range of DOC concentrations of a certain region, and catchment and lake properties then regulate the DOC concentration in each individual lake. Pagano and Titus (2007) tested the hypothesis that growth response to dissolved inorganic carbon (DIC) enrichment would be greatest for species that use bicarbonate and free carbon dioxide (CO_2) from the water column, intermediate for species restricted to free CO_2, and least for species able to use free CO_2 from both sediment porewater and the water column. Results that indicate that DIC availability may

influence community structure in acidic and circumneutral lakes.

McLellan et al. (2007) assessed *Escherichia coli* distribution and persistence in nearshore Lake Michigan, and they reported that *E. coli* survival characteristics and population dynamics are most likely influenced by multiple factors in complex systems such as the watershed/estuarine/lake environments of the Great Lakes.

Experiments were conducted by Groeger (2007) to determine the nutrients primarily responsible for limiting phytoplankton productivity in ultra-oligotrophic Crater Lake (USA). A trace metal or its availability was the primary factor limiting epilimnetic phytoplankton productivity.

North et al. (2007) conducted three nutrient enrichment experiments involving the addition and removal of iron (Fe) alone, as well as in combination with P and/or N, in the offshore and nearshore waters of the eastern basin of Lake Erie. They found that phytoplankton communities experienced co-limitation by P, N, and Fe during summer stratification.

Nowlin et al. (2007) examined patterns of epilimnetic planktonic P pool sizes and turnover rates in eight lakes in British Columbia, Canada over a 2-year period. The pico- and nanoplankton size fraction (0.2-20 mu m) played a central role in planktonic P cycling in the study lakes.

The temporal trends of conductivity, ions, nutrient concentrations, and phytoplankton biomass expressed as chlorophyll a in three Kenyan Rift Valley saline-alkaline lakes were investigated by Oduor and Schagerl (2007). It was shown that nitrate-N, conductivity, phosphorus, and light supply were the key variables influencing algal biomass in these lakes.

Solim and Wanganeo (2007) determined the nitrogen dependence of algal biomass development for the first time for Dal Lake (a shallow Himalayan lake), where chlorophyll a was observed to increase progressively with increasing nitrogen share in the N:P ratio.

Using paleolimnology, historical records, and nutrient modeling, Michelutti et al. (2007) assessed the limnological response of Annak Lake (Belcher Islands, Arctic Canada) to a quarter century of persistent and increasing sewage inputs. They reported on the incredible resilience displayed by the *Fragilaria sensu lato* assemblage to 20 years of nutrient enrichment, reflecting the overriding influence of extended snow and ice cover on diatom assemblages in Arctic regions.

Subsurface water from Dashahe Reservoir of Guangdong Province, China was analyzed for algae growth velocity by Wang and Cui (2007), who showed that TN, TP, water temperature, and light intensity have notable influences on the growth velocity.

Malve et al. (2007) aimed to estimate confounded effects of nutrients and grazing zooplankton (*Crustacea*) on phytoplankton groups, specifically nitrogen-fixing *Cyanobacteria*, in shallow mesotrophic Lake Pyhajarvi (Finland). Within the observational range, TP marginally affected *Cyanobacteria* compared to the temperature-dependent zooplankton grazing effect.

Hambright et al. (2007) compared grazing and nutrient mineralization by naturally co-existing crustacean

and micro-zooplankton assemblages from mesoeutrophic Lake Kinneret in a series of microcosm experiments. The authors suggest that micro-zooplankton grazing and nutrient mineralization are driving forces affecting bacteria and phytoplankton dynamics, playing important roles in carbon and nutrient transfer to upper trophic levels even in lakes containing abundant crustaceans.

To assess how bacterioplankton growth on DOC affects the growth of calanoid copepod (*Eudiaptomus graciloides*) and cladoceran (*Daphnia longispina*) zooplankton, Karlsson et al. (2007b) added DOC in various amounts to 6 enclosures in an oligotrophic subarctic lake. The transfer of DOC through the food web was found to be more efficient via cladocerans than via calanoid copepods, and the effect became more pronounced as bacterial energy mobilization increased.

Organic Matter

To help utilities better understand and manage their source waters, Rosario-Ortiz et al. (2007) characterized dissolved organic matter (DOM) under varying ambient conditions from the four main tributaries to Lake Mead (USA). Toth et al. (2007) measured the biological availability of dissolved organic carbon (DOC) in the mouth of the River Zala and in Lake Balaton (Hungary), and they observed that much of the refractory DOM resides in the non-humic pool in standing waters. For a range of lakes of varying conductivity in the low Arctic of Greenland, the DOC concentration was found to be strongly related to [log(10)] conductivity and total nitrogen (Anderson and Stedmon, 2007). To determine the relative influence of physiographical and hydrological effects on seston transport and food resources, Spoljar et al. (2007) analyzed the spatial and temporal variation in seston transport on three reaches of the karstic cascading system of the Plitvice Lakes (Croatia).

Planning and Management

Wells et al. (2007) evaluated the erosion, transport, and deposition of sediments over a 37-year period using the channel evolution model CONCEPTS for three simulation scenarios: Dams In (DI), Dams Out (DO), and Design (D). They found that (1) removal of the low-head dams will cause significant erosion of sediments stored behind the dams and increased sediment loads passing downstream and (2) sediment loads for the proposed channel design are similar to existing conditions and offer reduced fine-sediment loadings. The benefits of multilevel intake configurations in managing withdrawal temperature and turbidity from Schoharie Reservoir, New York (USA) was evaluated by Gelda and Effler (2007a). The effects of upstream hydropower operation and oligotrophication on light attenuation and reflectance in Lake Brienz (Switzerland) was studied by Jaun et al. (2007), who reported that light attenuation before dam construction upstream was double the current value during summer and nearly half in winter.

Due to concerns about dam removal and contaminated sediment in Ballville Reservoir, Ohio (USA), Evans and Gottgens (2007) analyzed sediment cores for 18 metals and 138 organic contaminants. The authors concluded that removal of the dam would require dredging

or release downstream of 0.35 million m(3) of sediment to re-establish the Sandusky River channel, sediment contamination in the reservoir involves concentrations less than or equal to those in existing Lake Erie sediment, and the effects would be diluted by mixing with downstream or nearshore Lake Erie sediments. The seasonal partitioning of phosphorus across the sediment-water interface in Loch Leven, Scotland was described by Spears et al. (2007a), who discussed the implications for a future lake management strategy. They reported that regulating the water level to increase flushing during sediment release periods and decrease flushing during uptake periods can significantly enhance the recovery of shallow lakes and reservoirs following historic nutrient loading.

Using a back-propagation neural network to relate key factors that influence water quality indicators, Kuo et al. (2007) offered an alternative approach to quantifying the cause-and-effect relationship in reservoir eutrophication with a data-driven method. For a reservoir in central Taiwan, they showed that the neural network can predict these indicators with reasonable accuracy and be a valuable tool for reservoir management.

Oldenburg et al. (2007) studied whitefish and herring in Lake Erie and reported that current ecological conditions will not inhibit recovery of the coregonine species. However, the authors recommended that management procedures, including commercial fisheries, may be needed to assist in recovery. To assess attainment of a Great Lakes Strategy 2002 objective, Bhavsar et al. (2007) examined long- and short-term levels of polychlorinated biphenyls in lake trout (Salvelinus namaycush) and walleye (Sander vitreus) from the Canadian waters of the Great Lakes using the bootstrap resampling method. They reported on the progress toward the long-term goal of all Great Lakes fish being safe to eat without restriction.

Izaguirre and Taylor (2007) studied episodes involving either geosmin or 2-methylisoborneol (MIB) in Diamond Valley Lake, California (USA), and they showed that a new reservoir in a mild climate can be colonised by benthic cyanobacteria that produce MIB and geosmin within a relatively short time.

Gruberts et al. (2007) explored various limnological characteristics of 24 floodplain lakes and reservoirs along the Middle Daugava to reveal possible impacts of the long-term mean annual flooding frequency on phytoplankton, zooplankton, macrozoobenthos and macrophyta communities. The authors reported a significant negative impact on zooplankton species diversity but a positive impact on Oligochaeta density, whereas other biotic parameters were affected by local factors such as lake morphology, internal nutrient loading, throphic interactions, and local sources of dissolved organic matter.

To determine whether severe nitrogen gas (N2) depletion in lakes has implications for N2 fixation and for model structures describing the nitrogen cycle, Bryhn and Blenckner (2007) reviewed the general processes of the N2 cycle in lakes and empirically analyzed N2 concentrations in Lake Erken, Sweden. They showed that the N2 concentration in surface waters vastly exceeds the half-saturation constant for uptake by phytoplankton and

consequently concluded that N2 fixation is unlikey to be limited by the concentration.

To assess riparian influences on lake functioning and develop simple tools for lake monitoring, Costantini et al. (2007) examined the association between remotely-sensed riparian factors, water chemistry, and the breakdown rate of reed litter in Lake Vico, Italy. The riparian index was determined to be is a promising cost-saving tool for monitoring lake function using remotely-sensed data.

Dean et al. (2007) studied the flow diversion from Bear River to Bear Lake to evaluate the isotopic structure precipitation. Isotopic evidence from the sediments showed that aragonite that accumulated in the bottom sediment and that constitutes the bulk of post-diversion sediments is reworked and redistributed from shallow sites to deep sites.

Studying Lakes Bonney and Frome in South Australia, Haynes et al. (2007) reported on the freshening of these brackish to saline systems as well as nutrient load changes and eutrophication as a result of anthropogenic changes to the environment.

Moss (2007a) evaluated the European Water Framework Directive and reported that it has implications for every aspect of how catchments are used by human societies and could potentially mean a step change in how waters and catchments are managed. However, they cautioned that a rigid adherence to this approach may undermine the spirit of the Directive and fail to bring about fundamental reform.

To control phosphorus inputs as a major priority of a lake management program, Schussler et al. (2007) developed watershed phosphorus balances for 11 recreational lakes in Minnesota. They reported that the watershed balance tool can help managers develop novel strategies for managing phosphorus, keeping in mind that inputs and exports should balance so that phosphorus does not accumulate.

Seidou et al. (2007) used a model to compute a time series of ice thickness on the Gouin Reservoir and Outardes 4 Reservoir (Quebec, Canada) to evaluate the immobilization of water, which has significant negative impacts on reservoir operation. They showed that the ratio of frozen water left on the banks to water in active storage varies from 2–8% at the Gouin Reservoir and from 0.41–1.15% at the Outardes 4 Reservoir, depending on water usage policy and reservoir geometry. Lewis et al. (2007b) studied limnological, sedimentological, and hydrological parameters related to impacts of a large ice-dammed lake draining catastrophically into Lake Tuborg. The authors found evidence of rapid settling of suspended sediment, the saltwater layer being slightly freshened and cooled, and no erosion occurring toward the distal end of the lake.

Restoration and Treatment

Jeppesen et al. (2007) studied improving the ecological quality of shallow lakes by reducing external nutrient loading as well as several physico-chemical and biological restoration methods to accelerate recovery. Because many warm lakes suffer from eutrophication, new insights are needed into trophic interactions and potential

restoration methods, especially since eutrophication is expected to increase in the future. Moss (2007b) evaluated lake restoration from a trivial and profound form and concluded that both are required if lake restoration is to be effective. Istvanovics et al. (2007) presented an overview about recovery of shallow Lake Balaton from eutrophication by assessing quantitative and qualitative changes in phytoplankton, zooplankton, and chironomids as a function of load reduction. They concluded that simple targets (desired phytoplankton biomass and permissible load) are the best choices during initial stages of eutrophication management, but more complex schemes including ecological criteria are needed to trace recovery when ecosystem re-organization occurs.

Because shrinkage has led to deterioration of flood storage in Dongting Lake (China), a proposed restoration strategy was evaluated by Jiahu et al. (2007) using a coupled one-dimensional and two-dimensional hydrodynamic model. Appropriate strategies of lake restoration were recommended according to different flood responses.

To quantify the effectiveness of a destratification system on weakening stratification and increasing dissolved oxygen in Lake Elsinore, California (USA), Lawson and Anderson (2007) conducted a 3-year study and presented results that quantify the influence of axial flow pump operation on water column properties under shallow water conditions. Also, the effectiveness of the destratification system at two strongly different lake levels was compared. Inch (2007) reported on a reservoir mixing system developed by AMG Ltd, called the Aquaerator technology, to provide water for recreational users and manage water resources and water quality in the UK. The authors provided results on air jets that are designed to increase the swirl in the bubble plume.

The potential impact of dredging on dissolved reactive P flux out of the sediments and the equilibrium P concentration of post-dredge sediments in Lake Okeechobee, Florida (USA) was determined by Reddy et al. (2007), who suggested that dredging can reduce internal P loading. However, further evaluation is needed to determine whether controlled laboratory experiments can be used to predict fluxes in the lake under natural conditions, and the long-term sustainability of improving water quality by dredging. Phytoplankton density and composition, together with P concentrations and size-fractionated alkaline phosphatase activity,, in dredged and undredged zones in Lake Taihu (China) were investigated by Cao et al. (2007). They reported that dredging might regulate algal density and composition in the water column by reducing P bioavailability.

Pinault and Berthier (2007) proposed a methodological approach to characterize the resilience of aquatic ecosystems with respect to the evolution of environmental parameters as well as their aptitude to adapt to forcings in Lake Annecy, France. The simulation raised relevant questions about whether a connection exists between physicochemical parameters and global warming, which should not induce harmful consequences on water quality and biodiversity in deep water.

The effects of oligotrophication due to efficient sewage treatment and by altered water turbidity due to

upstream hydropower operations were evaluated by Finger et al. (2007) using a combined approach of modeling and data interpretation for a case study on Lake Brienz (Switzerland). It was shown that enhanced nutrient supply increases the nutritious value of algae and stimulates zooplankton growth, phytoplankton growth is limited by stronger top-down control, and the entire nutrient cycle is seasonally delayed. Denkenberger et al. (2007) selected a reference lake, Otisco Lake, New York, (USA), to evaluate rehabilitation initiatives to mitigate severe cultural eutrophication of Onondaga Lake, New York. Continued robotic monitoring at Otisco Lake as a reference site and Onondaga Lake through the rehabilitation program will support ongoing comparisons to assess progress and will help engage stakeholders in the process.

Kim et al. (2007b) evaluated the effects of limiting nutrients and the N:P ratios on the growth of phytoplankton (mainly cyanobacteria) in a shallow hypertrophic reservoir. Overall, the response of cyanobacterial growth was a direct function of added P in the Nutrient Enrichment Bioassays (NEBs) and was greater with increased N concentrations.

Total P inputs to Lake Simcoe, which have led to hypolimnetic dissolved oxygen depletion and loss of cold water fish habitat, were studied by Winter et al. (2007). They report that efforts to reduce TP loads to the lake need to continue. Noges et al. (2007b) studied P content in Lake Peipsi and showed a positive relationship between P content in sediments and the relative depth of the lake. The authors concluded that the most important measure to improve water quality in the lake would be reduction of P loading. Two methods of P management in lakes, applying aluminum sulfate (alum) in-lake and tributary (inflow) treatment, were evaluated by Pilgrim et al. (2007) using a modeling approach. A case study was developed to illustrate the approach for typical eutrophic lakes. Zaccara et al. (2007) studied implementation of a series of external and internal remedial actions in Lake Varese (Italy) to improve water quality. They reported that anoxic conditions are still the prevailing force driving the lake P budget, maintaining the lake in eutrophic status.

A comprehensive study to estimate hypolimnetic oxygen demand in eutrophic San Vicente Reservoir, California (USA) was undertaken by Beutel et al. (2007). Chamber experiments confirmed that turbulence and oxygen concentration at the sediment-water interface dramatically affect sediment oxygen demand. Dixit et al. (2007) ascertained the effectiveness of lake artificial aeration by an Ozonizer unit installed at Lower Lake, Bhopal and presented results of water quality deterioration as well as performance of the dual aeration system. Results of studies monitoring the response of sediments in Lake Jelonek to aerator operation were presented by Wisniewski (2007), who concluded that it is necessary to optimize aerator efficiency to inactivate phosphorus in the sediments.

Matsumoto et al. (2007) proposed a method for chemical-free removal of metal from lake sediment, and its subsequent pH adjustment, based on electrochemical migration and precipitation. They reported that the electrochemical metal removal method was effective not

only for lake sediment, but also for municipal sludge cake, human sewage, and contaminated scallop organs.

Leoni et al. (2007) investigated the effects of lime treatment with $Ca(OH)_2$ on a hypereutrophic hardwater lake (Lake Alserio, Italy), focusing on its impact on plankton communities. It was shown that liming with $Ca(OH)_2$ is a suitable treatment for accelerating recovery of the lake and that multiple treatments will be necessary to improve the trophic level over a longer period.

Four pilot whole-lake herbicide treatments for extensive Eurasian watermilfoil (*Myriophyllum spicatum L.*) infestations were conducted by Wagner et al. (2007) in Wisconsin using fluridone. The authors concluded that future applications should consider, among other criteria, the dominant natives in the plant community, their sensitivity to fluridone, and potential impacts associated with decreased water clarity.

The effect of macrophyte-covered littoral zones on water quality were studied by Wang et al. (2007d) in Taihu Lake, China. Restoration of the littoral zone by intercepting algae was an important method for protecting drinking water supplies in the lake, where increased water shortages are an emerging problem.

Hiratsuka et al. (2007) compiled long-term changes in Secchi disk transparency in Lake Nakaumi, Japan, including periods before and after the loss of eelgrass (Zostera marina L.) beds. Long-term monitoring data of transparency suggested that restoration of submerged aquatic vegetation may be indispensable for remediation of the lake environment in this shallow eutrophic lagoon.

Ditches grown with nature reed (*Phragmites communis Trin*) and wild rice (*Zizania latifolia Turcz*) were selected by Jiang et al. (2007) to study the removal capacity of agricultural non-point source pollutants in Lake Taihu, China. Reeds and wild rice were found to have high uptake ability for N and P, but are not likely to be harvested, and subsequently remove nutrients from the lake, because of the low economic value.

Bicudo et al. (2007) evaluated the effects of mechanical removal of *Eichhornia crassipes* on the limnological characteristics and algal biomass of a polymictic shallow tropical reservoir. Their findings have important implications for the restoration of shallow stratifying eutrophic lakes. Moreover, feedback mechanisms in tropical and subtropical shallow lakes seem to be stronger than in temperate ones, as stratification events are more likely to occur during the year, intensifying system resilience to restorative strategies.

The impact of bioturbation by Campsurus notatus (Ephemeroptera: Polymitarcytidae) on potential gas fluxes in the sediment of Lake Batata was studied by Leal et al. (2007). who reported that the new substratum of the lake decreased methane concentrations in sediment and water column. C. notatus nymphs had a significant effect on gas flux (methane and CO_2) and oxygen consumption, consequently influencing the carbon cycle in this lake.

Benthic bivalve, *Anadara trapezia*, were collected by Burt et al. (2007) from a 'clean' reference site and transplanted along a suspected trace metal contamination gradient in Lake Macquarie, New South Wales (Australia).. Zinc, Cd, and Pb concentrations in

sediments decreased together, with the highest concentrations in the Cockle Bay area, suggesting that this is the main source of contamination.

Pires et al. (2007) studied grazing on the green alga *Scenedesmus obliquus* and the cyanobacterium *Planktothrix agardhii* (a microcystin-producing and a microcystin-free strain, respectively) by three different filter-feeders to compare the efficiency with which these grazers remove Planktothrix from the water. The authors suggested that water managers, who may be interested in using filter-feeders as a biomanipulation tool, focus on the improvement of settlement conditions for native bivalves, such as Anodonta, instead of exotic species like Dreissena.

Rowe (2007) studied changes in water clarity (secchi disc transparency) in relation to the presence/absence of introduced, exotic fish, including rudd (*Scardinius erythrophthalmus*), tench (*Tinca tinca*), perch (*Perca fluviatilis*), brown bullhead catfish (*Ameiurus nebulosus*), goldfish (*Carassius auratus*), and koi carp (*Cyprinus carpio*) for 49 small, North Island, New Zealand lakes. There was a negative association between water clarity and the presence of exotic fish independent of lake depth. Moreover, a 'before-and-after' comparison and examination of case-studies indicated that introductions of exotic fish reduce water clarity. Scharf (2007) studied six deep, soft-water reservoirs, ranging from oligotrophic to eutrophic, in which fishery management has been guided by the use of biomanipulation to improve water quality. The results support the importance of indirect (non-lethal) effects as the driving forces for the successful biomanipulations, particularly in slightly eutrophic reservoirs. A simple model was applied by Skov and Nilsson (2007) to assess the efficacy of pike stocking as a lake restoration tool in shallow, eutrophicated lakes to reduce cyprinid densities. The findings of their study question the efficacy of pike stocking as an appropriate and reliable tool for shallow lakes and indicate that efforts should be made to optimize the timing of stocking in relation to young-of-the-year cyprinid production and to increase the stocking body size of the pike.

Data from more than 70 restoration projects conducted mainly in shallow, eutrophic lakes in Denmark and the Netherlands were evaluated by Sondergaard et al. (2007), who focused on the removal of zooplanktivorous and benthivorous fish. In more than half of the biomanipulation projects, Secchi depth increased and chlorophyll a decreased to less than 50% within the first few years. The strongest effects were obtained 4-6 years after the start of fish removal, and lake water quality deteriorates unless fish removal is repeated..

Restoration efforts for lake trout, Salvelinus namaycush, in deep water of Lake Michigan were studied by Janssen et al. (2007). They proposed that plans for restoration of lake trout into deepwater habitats in the lake must proceed in concert with research leading to a better understanding of extant deepwater strains in Lake Superior.

O'Neill et al. (2007) tested the general hypothesis that the abundance and diversity of epifauna would be reduced by salting in Lake Macquarie (New South Wales, Australia). The authors reported that abundances of most organisms varied significantly among times and locations

with no evidence of the consistent effect of salting on diversity or abundance of epifauna.

Sediment

Koschorreck et al. (2007) investigated the effects of a periphyton layer on the biogeochemistry of the sediment-water interface. They reported that the diurnal redox shift and the maintenance of neutral conditions in the periphyton layer lead to an effective precipitation of iron and phosphorus, due to high microbial activity maintaining neutral pH conditions and contributing to natural alkalinity production.

Sampling techniques. Using magnetic susceptibility and petrography, de Fontaine et al. (2007) detected tephra-fall deposits from Cook Inlet volcanoes in sediment cores from Tustumena and Paradox Lakes, Alaska(USA). The peak period of tephra fall (7000-9000 cal yr BP; 2.6 tephra/100 yr) in Paradox Lake is consistent with the increase in volcanism between 7000 and 9000 years ago recorded in the Greenland ice cores. To apply a purpose-built Bayesian mixing model, Douglas et al. (2007) undertook a detailed lake sediment and catchment soil sampling program in Lake Wivenhoe, Queensland (Australia) to estimate the proportion of sediment from major catchment sources. They reported that the Esk Formation is the major sediment source, comprising about 10% of the catchment area but contributing 50% of the sediment and 33% of the total phosphorus loading to the lake. Li et al. (2007b) examined extensive chemical data for Lake Biwa sediments with statistical factor analysis to find correlation patterns among element concentrations and sample groups.

Metals. Lattanzi et al. (2007) determined if residual As is present in elevated concentrations in the surface sediments (top 0-15 cm) of lakes treated with sodium arsenite and whether As is being significantly remobilized. The study showed that As was remobilized from sediments of both the treated and untreated lakes where reducing conditions existed.

Franco et al. (2007) investigated the geochemical behavior of iron oxides and oxyhydroxides in the sediments of an urban water reservoir in Great Sao Paulo, Brazil. They found remarkable indications of interference on meta-stable phases evolution to its final products.

To evaluate the spatial distribution and temporal trends of contamination, Gewurtz et al. (2007) surveyed the sediments of Lake St. Clair for a range of compound classes including metals (such as total mercury and lead), polychlorinated biphenyls, polychlorinated dibenzo-pdioxins and dibenzofurans, organochlorine pesticides, polycyclic aromatic hydrocarbons, and short- and medium-chain chlorinated paraffins. The authors reported that management actions to reduce contaminant loadings to Lake St. Clair have been generally successful.

To determine sources and spatial variability of nutrients such as N and P and heavy metals such as Cu, Zn, Pb, Cr, and Cd in surface water and sediments, Huang et al. (2007) extensively sampled surface water and sediment within an industrial peri-urban interface with a riverine system in Wuxi, Taihu Lake area, China.. They showed that urbanization, not agriculture, is the main contributor of

N and P in the peri-urban interface and that concentrations of N, P, Cu, Zn, Pb, and Cr in the river sediment decreased with distance from the source area. The sediment chemistry of three other lakes in China, Lakes Dianchi, Qilu, and Qionghai, were analyzed for Pb and Cu to determine the effect of natural and recent anthropogenic activities (Liu et al., 2007b). Concentration variations of heavy metals in the sediments were an important indicator of industrial pollution and suggested acceleration of lake eutrophication due to increased levels of total phosphorus from anthropogenic sources.

Fractionation of metal ions in sediments of Lake Nainital were analyzed by Jain et al. (2007) to determine the their eco-toxic potential. They reported that comparison of sediments with average shae values indicated anthropogenic enrichment with Ni, Pb, Cd, and Zn.

Nutrients. To study the influence of different primary producers and sediment types on benthic fluxes of dissolved inorganic nitrogen (DIN), Qu et al. (2007) installed a batch incubation system in Lake Illawarra, New South Wales, Australia. On an annual basis, unvegetated sediments displayed net DIN effluxes, while seagrass beds showed a net DIN uptake, and the highest DIN uptakes coincided with the largest standing crop of seagrass and/or macroalgae and the highest levels of benthic production.

Nitrogen transformations and their response to salinization in bottom sediment of Haringvliet Lake, Netherlands, were studied by Laverman et al. (2007), who showed that salinity affects the relative importance of denitrification compared to alternative nitrate reduction pathways, limiting removal of bioavailable nitrogen by denitrification. Wang et al. (2007b) analyzed nitrogen transformations in anaerobic sediments and leachate in Lake Taihu (China) for ammonium, nitrate, and nitrite. Among the four electron donors studied, higher nitrogen removal efficiencies were observed with acetate and starch.

Stadmark and Leonardson (2007) investigated the impact of nitrate ($NO3^-$) concentration and temperature on the production of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) from a constructed pond in south Sweden. They reported that under environmental conditions generally occurring in South Swedish ponds, i.e. low temperature and high $NO3^-$ concentration during spring and high temperature and low $NO3^-$ concentration during summer, $NO3^-$ concentration is of minor importance.

To understand the eutrophication history lake and P cycling and to evaluate needs for management and restoration of Lake Hormajarvi, Finland, Valpola et al. (2007) analyzed short sediment cores. They demonstrated that lake management or restoration decisions should not be based on water quality and algal bloom observations alone. You et al. (2007) studied the effects of resuspension on sediment P release in cylindrical microcosms, and indicated that there was a positive correlation between flux of suspended substance across the sediment-water interface and wind speed, followed by a steady state. Using in situ benthic chambers, Burger et al. (2007) determined seasonal sediment release rates of soluble reactive phosphorus and ammonium in Lake Rotorua. They indicated that internal nutrient sources derived from benthic fluxes are more important than external nutrient sources to the lake.

To compare internal and external P loads and to evaluate the spatial variability in measured sediment P flux under aerobic and anaerobic conditions, Sen et al. (2007) collected sediment cores representing the lacustrine, transitional, and riverine zones in Beaver Reservoir, Arkansas (USA). The annual internal P load from bottom sediments was less than 10% of the external load, leading the authors to conclude that it would not currently be cost effective to manage this P source.

Spears et al. (2007b) recorded sediment and water column P fraction Loch Leven, Scotland, which is recovering from nutrient pollution. The study highlighted the biological mediation of internal loading, and in particular, the role of sediment algae in decreasing, and sediment bacteria in enhancing, sediment P release.

By reconstructing the development of sediment P-sorption characteristics through the Late Glacial and Holocene periods in Plesne Lake, Czech Republic, Kopacek et al. (2007) showed that sediment ability to bind P can naturally develop during lake history because of changes in the $Al(OH)_3$ concentration and the $Al(OH)_3$ to $Fe(OH)_3$ ratio in sediment. The ability of the sediment to immobilize P increased further during the anthropogenic acidification era because of elevated terrestrial export of ionic aluminum (Al), suggesting that this P-immobilizing mechanism can occur in lakes with high Al inputs.

Zhou et al. (2007) investigated kinetics of alkaline phosphatase in sediments of a shallow Chinese freshwater lake (Lake Donghu), and they observed that the enzyme is immobilized in sediments, which became more stable with accelerated eutrophication. The benthic nepheloid layer in Lake Biwa, Japan was studied by Kim et al. (2007a), who found that potential activity of particle-bound alkaline phosphatase was remarkably high in the nepheloid layer of a large mesotrophic lake during thermal stratification.

The effect of ice cover on sediment resuspension and internal TP loading in the northern temperate Kirkkojarvi basin in Finland was investigated by Niemisto and Horppila (2007). They concluded the annual internal TP loading caused by resuspension will increase by 28% in the basin if the double-carbon dioxide climate scenario occurs.

Paulson and Cox (2007) examined reservoir sediments from Lake Roosevelt (Washington, USA) that were contaminated with smelter waste discharged into the Columbia River (British Columbia, Canada) using three measures of elemental release reflecting varying degrees of physical mixing and time scales. All three measures of Cd release suggested potential toxicity for one site farther down the reservoir, and releases of Zn and As were not potentially toxic. Metal contents of surface sediments were analyzed temporally and spatially in Lake Chaohu, China by Zhang et al. (2007a) They suggested that significant anthropogenic impact on metal levels and the correlation between trace metals concentrations indicated the co-contamination of anthropogenically derived metals in surface sediment. Canavan et al. (2007) measured concentrations of Fe, Mn, Cd, Co, Ni, Pb, and Zn in pore water and sediment of a coastal fresh water lake (Haringvliet Lake, Netherlands), Reactions affecting trace metal mobility near the sediment-water interface, especially

sulfide oxidation and sorption to newly formed oxides, strongly influenced the modeled estimates of diffusive effluxes. Concentrations of toxic metals in water, sediment, and consumed fishery products from Phayao Lake in northern Thailand were measured by Tupwongse et al. (2007). The concentrations of metals in these products were lower than the recommended average daily dietary intake, but the authors recommended routine monitoring of Mn and As in the lake water as a precaution.

To study the geochemical features and pollution history of heavy metals in Lake Taihu (China), Shen et al. (2007) analyzed sediment cores for total content and chemical fractionation of Cu, Fe, Mn, Ni, Pb, and Zn. The increased Cu, Mn, Ni, Pb, and Zn content and percentage of extractable fractions in the upper sediment layers correlated with anthropogenic input of heavy metals due to rapid industrial development.

A quantitative model to evaluate the transport and fate of Zn, Pb, and Cu in Lake Coeur d'Alene sediments was developed by Sevinc Sengor et al. (2007) to investigate local-scale processes, with particular emphasis on metal transport through reductive dissolution of Fe hydroxides. The model provided insights on important biogeochemical processes affecting metals cycling in the lake and similar metal-impacted lacustrine environments.

Xue et al. (2007) analyzed total organic carbon, TN, pigments, and particle size in sediment cores from eastern, northeastern and southwestern Lake Taihu (China) to understand past trophic status and pollution levels. They reported that sediment particle size has became coarser since the 1920s, the lake has been contaminated by heavy metals such as Cu and Zn since the 1970s, and eutrophication has increased dramatically since the 1980s.

To analyze the migration behavior of radionuclides, particularly 137Cs, Putyrskaya and Klemt (2007) developed a model consisting of sedimentation-diffusion equations. They concluded that the results of an optimization process can provide the sedimentation rate and 137Cs distribution coefficients, which determine the uptake of activity into the sediment and retarded diffusion within the sediment.

Aberg et al. (2007) measured the pelagic and benthic net DIC productions in situ in Lake Diktar-Erik in subarctic Sweden and inferred that nearly 100% of accumulated DIC in the hypolimnion had an allochthonous carbon source.

To evaluate the spatial distribution of sulfate-reducing bacteria (SRB) activity in Devils Lake, North Dakota (USA), Manous et al. (2007) analyzed sediment cores. They suggested that SRB activities in the sediments change with submergence times; thus, applying a uniform sulfate reduction rate to the entire lake is only a crude approximation. Conrad et al. (2007) studied the methanogenic archaeal community, methane production, and carbon isotopic fractionation in the sediments of oligotrophic Lake Stechlin. They reported that a remarkable microbial community is able to produce methane in the oxidized surface layer of oligotrophic lake sediments, where methane is not normally produced. Using Biolog EcoPlates to measure sediment-interface bacterial carbon substrate utilization rates, Christian and Lind (2007) conducted a multi-seasonal study in a monomictic

eutrophic reservoir. Seasonal changes in utilization rates corresponded to various changes in bacterial assemblage composition.

Izaguirre et al. (2007) reported on several microcystin-producing benthic filamentous cyanobacterial isolates from four drinking-water reservoirs in California (USA): Lake Mathews, Lake Skinner, Diamond Valley Lake, and Lake Perris. They reported that the significance of these organisms lies in the relative scarcity of known toxin producers among freshwater benthic cyanobacteria and also as a source of cell-bound microcystin in these reservoirs.

To study the influence of chironomids on the distribution of pore-water concentrations of phosphate, iron and ammonium, Lewandowski et al. (2007) conducted a laboratory experiment using mesocosms populated with different densities of Chironomus plumosus., New (redox) interfaces occurred with diffusive pore-water gradients perpendicular to the course of chironomid burrows, and the site of major phosphate, ammonium, and iron release shifted from the sediment surface to the burrow walls. Stief (2007) studied the combined effects of deposit-feeding, bioturbation, and bioirrigation by benthic macrofauna on the enzymatic hydrolysis of organic matter using microcosms. They concluded that deposit-feeding and bioturbation can quickly remove freshly deposited particulate organic matter from the sediment surface and transfer it to less oxygenated sites.

Soler et al. (2007) studied changes in the dynamics of sediment transport in Lake Banyoles, Spain and reported that lake sediment fluidization events are linked to atmospheric circulations patterns through monthly precipitation.

Wang et al. (2007e) evaluated the effects of a familiar submerged macrophyte in China, *Hydrilla verticillata*,, on phosphate retention and release at the sediment-water interface. Organic matter, cationic exchange capacity, Ca, Fe, and Al of the sediments with H. verticillata were higher than those of the control sediments, and the concentrations of TP, Olsen-P, and reactive dissolved phosphorus were lower.

A case study that combined geochemical and statistical methods to distinguish anthropogenic sources from the natural background in lake sediments was presented by Wu et al. (2007c). They suggested that the reed-covered littoral zone had strong nitrogen transformation potential and was a sink for internal-lake nitrogen, whereas the bare lakeshore showed little effect.

To reconstruct the historical development of three dimictic lakes in Mecklenburg-Vorpommern (Germany) during the Holocene, Selig et al. (2007) investigated sedimentological composition, major trace elements and nutrients as well as parameter for core chronology in sediment profiles of the last 4,000-14,000 years. They reported that (1) since the Middle Ages, a permanent settlement in the catchment area resulted in higher sedimentation rates; (2) variations in sediment composition were caused by different land management techniques and natural changes in the catchment area; (3) P accumulation increased in the upper sediment layers associated with human settlement activities in the catchment area; and (4) lead and zinc increase in the uppermost part of all three

lakes reflect atmospheric anthropogenic input during the last 150-200 years.

Water Quality

A comprehensive study of the seasonal pattern of major ions in Lake Pandoh was conducted to understand the geochemical processes controlling water quality (Anshumali and Ramanathan, 2007). The authors found that carbonate weathering is the main control on water chemistry, in contrast to other Himalayan lakes. The seasonal variation of nutrients in the water column and sediments of Vistonis Lagoon (Greece) was presented by Markou et al. (2007). They found that anoxia in the bottom water and resuspension of sediments are the main factors affecting internal nutrient loading. Naumenko (2007) observed a seasonal trend in transparency for Lake Ladoga and reported that the character of a spatial trend distribution is dependent on the month.

In a study of Poyang Lake (China), Wu et al. (2007a) concluded that dredging caused an increase in water turbidity and that simultaneously monitoring the water turbidity and vessels enhanced the remote assessment of dredging impact. Wu et al. (2007d) studied two estrogenic pollutants [4-nonylphenol (NP) and 4-tert-octylphenol (OP)], suspended particulate, and sediments in urban eutrophic lakes and presented a reasonable correlation of NP and OP among water, suspended particles, and sediment. They also reported an increasing trend in concentration close to sewage inlets, which was found to be a major factor affecting spatial distribution of alkylphenols in the lakes.

To study the long-term dynamic ecosystem pattern of Lake Pskov and to identify the start of its degradation, Kangur et al. (2007) used limnological monitoring data and palaeorecords to show that the water quality has deteriorated and caused adverse changes in the whole ecosystem. Nakashima et al. (2007) clarified the distribution and variation of bioelements in dam lakes of the Shikoku region of Japan and indicated that precipitation directly and indirectly affected lake water quality.

Measuring water quality parameters of a China Lake, Shuhaimi-Othman et al. (2007) calculated the Malaysian Department of Environment Water Quality Index (DOE-WQI) and classified the lake according to the Interim National Water Quality Standard, Malaysia (INWQS). Analyzing water quality monitoring and climate data for three lakes in Western Victoria, Australia, Tibby and Tiller (2007) reported that the strongest climate-water quality relationship exists between air and water temperature and that effective precipitation also appears to exert a strong influence on water quality in these lakes.

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