

SHORT TERM Mobility Program 2015

Report of Norman Yan's research with Dr. Marina Manca, and other scientists at the CNR, Istituto per lo Studio degli Ecosistemi

Title of the Research Program: Past and contemporary threats on lakes: re-visiting long-term zooplankton data on Italian and North American lakes to improve understanding of patterns and regulators of change and to predict their effects.

Specific Objectives of the Research Program: 1) detecting patterns of change in plankton biomass, abundance and community structure observed with changes in trophic and climate; 2) comparing response patterns in lakes from different geographic areas which share similar anthropogenic and climate impact; 3) defining permanent vs. temporary response patterns and mechanisms (direct, indirect) for delayed response and resilience, and 4) predicting effects and suggesting management strategies for buffering consequences of impacts.

Research completed during Yan's visit: During Yan's visit to ISE in Verbania significant progress was made on each of the objectives. Re: objective 1, Yan worked with Dr. Manca and her staff to describe long-term patterns in plankton abundance and composition in Lake Orta and in Lake Maggiore. Re: objective 2, we compared the changes in the plankton of Lake Orta with changes in the plankton of lakes in Sudbury, Canada, both of which are responding to similar long term changes in anthropogenic drivers, especially recovery from acidity and metal pollution. Re: objective 3, we developed new methods based on novel calculations from species presence matrices to identify the mechanisms controlling recovery of zooplankton in these lakes, specifically distinguishing whether recovery was attributable to processes external to the lakes, i.e. colonist introduction rates, vs. processes internal to the lakes, i.e. colonist survival and subsequent population growth. This work is sufficiently novel that it is leading to two co-authored manuscripts, listed below. Re: objective 4, we initiated a new collaborative project between Yan, ISE personnel and a new professor at Cambridge University, Dr. Andrew Tanentzap, to employ structural equation modelling to identify the actual, from among the possible determinants of long-term changes in the planktonic fauna of Lago Maggiore. Re: objective 4, we are not yet at the point of recommending management strategies, but the knowledge emanating from these ongoing and new collaborations will have management implications as one of their products.

In addition to this planned work, Yan's visit to the ISE in Verbania had several other unplanned benefits. 1) During his visit, Yan fostered a new collaboration between Dr. John Gunn, Canada's foremost freshwater fisheries, restoration ecologist, and staff in Verbania that are planning the fish re-introduction experiment for Lago D'Orta. Gunn is excited to compare recovery of fisheries in Canadian vs. Italian lakes. 2) His conversations with chemical limnologists at ISE unearthed a previously undescribed but very important pattern of long-term recovery of the hypolimnetic oxygen regimes in Lago D'Orta, and this has led to the planning of a new manuscript. 3) He worked with mollusc biologists at ISE to identify researchers in N.

America that could help solve their problem with aging long-lived molluscs recovering in Lake Orta. Finally, 4) his many conversations with Marina Manca have stimulated interest in long-term collaborations on both climate change and the biology of *Bythotrephes*, and in novel analyses of species accumulation data to unearth mechanisms of changes in planktonic communities.

Products of the Mobility Grant visit:

During his mobility-grant visit, Yan delivered a lecture at the Institute entitled "Advice for young limnologists in an increasingly complicated, multi-stressor world".

This mobility grant-funded research collaboration has already produced one manuscript and several others are either in advanced stages of writing or planning, as follows:

1. Yan, N.D., J. Bailey, J.C. McGeer, M. Manca, W.B. Keller, M.P. Celis-Salgado and J.M. Gunn. 2015. Arrive, survive and thrive: essential stages in the re-colonization and recovery of zooplankton in urban lakes in Sudbury, Canada. *J. Limnol.* (in press).
2. Piscia, R., N.D. Yan and M. Manca. Mechanisms underlying recovery of zooplankton in Lake Orta after liming. *J. Limnol.* (in final preparation).
3. Rogora, M., P. Volta, R. Mosello and N.D. Yan. Restoration of oxygenated hypolimnetic habitat in Lake Orta, Italy, following reduction in ammonium pollution (in planning stage).

Verbania, July 31st, 2015

Marina Manca