2001; Argo Science Team 2001; Bishop *et al.* 2002; Perry and Rudnick 2003), autonomous underwater vehicles (Griffiths 2003; Perry and Rudnick 2003), and gliders (e.g. Davis *et al.* 2003; Perry and Rudnick 2003). Many of these platforms include near-real-time data telemetry systems. Looking towards the future, miniaturized, low-power biological, optical, chemical, and acoustic 'chip-based' sensors will be developed and will be suitable for interfacing to these and other novel platforms (e.g. Dickey and Bidigare 2005). Already, there is great promise as indicated by microelectromechanical systems (MEMS; Tokar and Dickey 2000) and nanotechnologies (e.g. Bishop *et al.* 2001), which are being developed at a rapid pace for a host of applications. While there will always be a need for ship platforms for certain observations, oceanographers will need to be especially vigilant in following these developments and will need to form partnerships to facilitate the widespread availability and application in field programmes of these new sensors and telemetry methods.

While GLOBEC developed much new technology that is reviewed in the chapter it is interesting to reflect that many of the key advances in understanding came from conventional approaches to sampling and experimentation. 'Working with the animals' through traditional net sampling and shipboard and laboratory experimentation has been a fundamental foundation of the programme. The advances based on these approaches are well represented in the studies reviewed.

Particularly, promising future directions involve the application of molecular and biochemical techniques to complex species assemblages and their interactions within marine ecosystems (e.g. DeLong *et al.* 1999). A specific example is provided in Box 6.1 demonstrating the potential of the application of techniques from the rapidly advancing field of molecular biology.

The shipboard, laboratory and *in situ* process studies have provided fundamental insight and data needed to formulate and parameterize essential processes controlling abundance of zooplankton and ichthyoplankton species targeted in GLOBEC programmes. Coupled physical-biological modelling is still at an early stage. Nevertheless it shows the potential to extract from the complexity of the ecosystem and population dynamics processes, simplifying formulations and approaches. These will allow evaluation of effects of environmental forcing on species abundance and distribution and on processes determining ichthyoplankton survival, with implications for use as a tool in ecosystem approaches to management. The challenge for the future is to build on this foundation of methodological approaches and integrative tools. A key issue is to establish appropriate observing systems and gather knowledge of population dynamics and ecosystem production processes that will provide us with useful predictions of change in the coastal and open ocean ecosystems.

The utilization of satellites and aircraft for biological applications has been well developed for phytoplankton and primary productivity. Recent advances in hyperspectral optical sensing of the ocean for both *in situ* and satellite platforms bode well for identifying at least groups if not species of phytoplankton (e.g. Dickey 2004; Dickey *et al.* 2006). However, major development is needed in order to capitalize on these platforms, which can in principal provide large-scale upper-ocean sensing, for studies of higher trophic level organisms and their distributions. Satellite-based data telemetry (i.e. for near-real-time data transmission) and positioning information will continue to advance both in quality and quantity. Tracking of organisms from aircraft and satellites can be especially powerful as has been demonstrated (see Section 6.3.4.). Sound transmission in the sea remains one of our most important *in situ* sensing methods for zooplankton and higher trophic level organisms (Foote *et al.* 2000; Chu and Wiebe 2003; Wiebe and Benfield 2003). In analogy to hyperspectral optics, broadband, multi-frequency acoustics has perhaps one of the greatest potentials and can in principle allow studies of trophic interactions, especially if deployed in conjunction with video and holographic methodologies.

There is growing consensus that observationalists and modellers need to coordinate their efforts and the studies reviewed in this chapter illustrate good progress in this regard (e.g. Robinson and Lermusiaux 2002). For example, development of sampling strategies, adaptive sampling, and more traditional inter-comparisons of data and model