



INTRODUCTION

South Pacific Integrated Ecosystem Studies meeting: toward conservation and sustainable use of marine resources in the South Pacific

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INTRODUCTION

The South Pacific region represents the world's largest oceanic water mass and plays a significant role in the earth's climate systems. This region also contains the largest group of island nations, most of whom are dependent on marine resources for their livelihoods. Several of the largest coastal and oceanic fisheries also occur in this region (FAO, 2014). In addition, for the countries associated with the southern Pacific Ocean region, the sea provides significant social, cultural and economic benefits, with many countries being heavily reliant on both coastal and oceanic marine resources (Bell *et al.*, 2013). Increasing coastal populations and climate change are expected to augment human demands on already fully exploited or over-exploited marine resources, threatening both food security and sustainable livelihoods (Bell *et al.*, 2011). Therefore, it is imperative that the science that describes and predicts linked biophysical and human systems is understood and developed to meet these needs. Climate change will have many impacts on marine ecosystems, with implications for end users including individuals, local communities, industries and governments. Improved scientific support for policy and management decision-making in the face of these potential impacts is essential.

CLIMATE VARIABILITY AND CHANGE IMPACTS ON MARINE RESOURCES AND FISHERIES IN THE SOUTH PACIFIC SYMPOSIUM: TOWARD A SOUTH PACIFIC INTEGRATED ECOSYSTEM STUDIES (SPICES) PROGRAM

Between January 7–10, 2013, an International Symposium and Workshop on 'Climate variability and

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change impacts on marine resources and fisheries in the South Pacific (SP): Toward a South Pacific Integrated Ecosystem Studies (SPICES) Program' was held in Concepcion, Chile. Ninety-one scientists from Australia, Canada, Chile, England, Germany, Mexico, New Zealand, Peru, Uruguay and the U.S. met to describe and discuss the current knowledge around six core themes. There were 53 oral and 29 poster contributions at the symposium. A 1-day workshop was conducted as a forum to discuss the development of an international marine research cooperative network for the southern South Pacific region. The unanimous consensus of participants was to support this initiative and to engage in its development. This supplement to *Fisheries Oceanography* presents contributions organized around three central theme sessions: (i) Assessing species-specific responses to climate variability; (ii) Climate variability and change: impact on fisheries and coastal communities; and (iii) Managing fisheries and ecosystems under a variable and changing climate.

Assessing species-specific responses to climate variability and change

Understanding and predicting the effects of natural variability and climate change on specific populations requires identification of physical, chemical and biological factors impacting populations as well the linkages between abiotic indices and pelagic fish communities. This supplement presents two articles related to this major theme, both exploring the use of environmental variables to forecast landings. Naranjo *et al.* (2015) presented a set of models based on neuronal networks to forecast jack mackerel landings (*Trachurus murphyi*) in central southern Chile. For jack mackerel, anthropogenic effects (e.g. fishing effort) were more dominant than environmental effects in predicting variability in commercial landings. Similarly, Briceño *et al.* (2016) found that lobster catch rate was an important variable in predicting octopus predation of lobsters within lobster traps in southeastern Australia. While both anthropogenic and environmental variables (e.g. sea surface temperature) explain part of the variance in octopus predation rates, the contribution of each variable varied substantially across major regions of the fishery, demonstrating the need for fine-scale (regional) resolution.

Climate variability and change: impact on fisheries and coastal communities

The Pacific basin is home to the El Niño/Southern Oscillation, the largest source of interannual variability in the global climate system which translates to major environmental impacts in the ocean. In

addition, the Pacific Decadal Oscillation shapes climate variability at longer time scales. Climate change projections indicate a consistent warming of the South Pacific (England *et al.*, 2014), but with marked spatial heterogeneity (e.g. Falvey and Garreaud, 2009) from a minimum in the eastern South Pacific to a maximum in the western South Pacific. To understand the impact of climate variability and change on fisheries and coastal communities it is necessary to assess the vulnerability of the people and industries dependent on the marine environment. A local community's vulnerability depends on their exposure, sensitivity and adaptive capacity to cope with change, and is also impacted by large-scale processes such as economic globalization, technological change and social innovation. This supplement presents three articles that describe various aspects of the approaches being developed in Australia to enhance coastal communities' knowledge of marine climate change impacts and to assist in the development of adaptation options and plan over various time-scales. Jennings *et al.* (2016) demonstrated the use of the Analytic Hierarchy Process, using a stakeholder-developed weighted hierarchy of objectives including fisheries management and climate adaptation objectives, to underpin effective adaptation planning. Setting objectives for evaluating management adaptation actions requires a multi-criteria approach that captures biological, economic and social objectives, especially as different stakeholder groups can have different and conflicting aims. Although the sensitivities of species exposed to climate change will be sector specific (e.g. rock lobster fishery), climate change impacts are expected to affect different multiple users of the marine environment (e.g. commercial and recreational fisheries, aquaculture, tourism, conservation) with implications that affect the entire coastal community. Frusher *et al.* (2015) developed a socioecological vulnerability index that enables coastal communities to undertake a 'first pass' assessment of their vulnerability to marine climate change. The contributions by Jennings *et al.* (2016) and Frusher *et al.* (2015) are good examples of challenges posed in this section, where an increased knowledge of factors affecting vulnerability of coastal communities, the need for models and frameworks that deal with climate change and ways to engage community are required. While many studies have focused on the longer-term predictions of environmental variables, recent studies in Australia are also focusing on shorter-term predictions that have greater certainty. Hobday *et al.* (2016) provide examples of the benefits of shorter term (4 months) forecasts in marine farming and fishing operations in Australia.

Managing fisheries and ecosystems under a variable and changing climate

Each country's fishery management system is developed around a complex system of government and non-government drivers. For the main fisheries in the South Pacific region, total biologically allowable catches are set in the context of a harvest strategy, implemented through a combination of monitoring, assessment of the status of the stocks through a variety of assessment models and implementation of harvest control rules. The harvest strategy implementation will typically use a tiered approach, with the different tiers based on data availability and quality. Following the precautionary principle, targets and limits are defined in terms of biological reference points related to maximum sustainable yield or suitable proxies, although management in Australia has shifted to the use of maximum economic yield as a target reference. Emphasis during the session was on the need for the science supporting the management process to be peer reviewed. In various jurisdictions there is a range of co-management arrangements that incorporate various levels of stakeholders or address the needs of small communities or indigenous sectors. While many broader ecosystem issues are reflected in government policy on by-catch and impacts on threatened, endangered or protected species, there is a range of ecological risk assessment processes that have been developed to prioritize ecosystem issues. In this supplement various aspects of Fisheries Management in New Zealand are described. These fisheries have evolved from a traditional system focused on estimating the total allowable catch for individual species to what might be considered a first-level ecosystem approach. Cryer *et al.* (2016) documented these changes including the introduction of measures to deal with marine mammal and bird by-catch, biodiversity issues and the effects of fishing on benthic habitats.

CONCLUSIONS

Key issues arising from the Symposium included the following: a need for coordinated monitoring programs across the South Pacific region; enhancement of our understanding and modeling capabilities of climate variability and change in the South Pacific region, from the large-scale to the ecosystem scale, and their links to target species variability; identifying key ecosystem indicators for SP region; developing a broad range of ecosystem models/tools, incorporating climate change scenarios; developing expertise on socio-economic skills in marine science to improve

understanding of climate change on the human system; improving flexibility of management systems and adopting trans-disciplinary approaches; defining *a priori* management objectives; considering tiered approaches for assessing stock status; adopting spatial management and ecological risk assessment approaches; and ensuring peer review of the science supporting management. A unify message across all sessions of the Symposium was the need for trans-disciplinary research teams. Such teams need to work collaboratively to ensure sustainability of both the marine resources and their dependent communities under a changing climate. This includes data collection and analysis, model development of both the biological and human systems and increased stakeholder participations to marine resources. The Symposium concluded that better intra-regional cooperation and collaboration in research in the southern South Pacific region is needed and that the formation of a network of researchers would provide a continuing forum for meeting the needs and priorities identified during the Symposium which, in-turn, would work towards ensuring that future fishing communities and governments derive the benefits from sustainable use of their marine resources.

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