International workshop on advancing methods to overcome challenges associated with life history and stock assessments of data-poor deep-water snappers and groupers

Stephen J. Newman[a,b,*], Corey B. Wakefield[a,b], Ashley J. Williams[c,d], Joseph M. O'Malley[e], Brett M. Taylor[f], Simon J. Nicol[c,g], Ryan S. Nichols[e], S. Alex Hesp[a], Norm G. Hall[a], Nicholas Hill[h], Joyce J.L. Ong[i,j], Allen H. Andrews[e], Claire M. Wellington[a,b], Euan S. Harvey[b], Peter Mous[k], Zack S. Oyafuso[l], Cassandra Pardee[m], Michael Bunce[b], Joseph D. DiBattista[b], Bradley R. Moore[n]

[a] Western Australian Fisheries and Marine Research Laboratories, Department of Fisheries, Government of Western Australia, P.O. Box 20, North Beach, WA 6920, Australia
[b] Department of Environment and Agriculture, Curtin University, GPO Box U1987, Perth, WA 6845, Australia
[c] Australian Bureau of Agricultural and Resource Economics and Sciences, Department of Agriculture and Water Resources, 18 Marcus Clarke St, Canberra City, ACT 2600, Australia.
[d] Centre for Sustainable Tropical Fisheries and Aquaculture, College of Marine and Environmental Sciences, James Cook University, Townsville, QLD, Australia
[e] NOAA Fisheries, Pacific Islands Fisheries Science Center, 1845 Wasp Boulevard, Building 176, Honolulu, Hawaii 96818, USA
[f] Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa, Honolulu, Hawaii 96822, USA
[g] Institute for Applied Ecology, University of Canberra, Bruce, ACT 2617, Australia.
[h] Oceanic Fisheries Programme, The Pacific Community, BP D5, 98848 Noumea CEDEX, New Caledonia
[i] Centre for Marine Futures, School of Animal Biology, The University of Western Australia Oceans Institute (M096), 35 Stirling Highway, Crawley, WA 6009, Australia
[j] Australian Institute of Marine Science, UWA Oceans Institute (M096), 35 Stirling Highway, Crawley, WA 6009, Australia
[k] The Nature Conservancy Indonesia Fisheries Conservation Program, Jl Pura Segara, Benoa harbour, Bali, Indonesia
[l] Hawaii Institute of Marine Biology, School of Ocean and Earth Science and Technology, University of Hawaii, Kaneohe, HI 96744, USA
[m] Western Pacific Regional Fishery Management Council, 1164 Bishop Street, 1400, Honolulu, HI 96813, USA
[n] Coastal Fisheries Programme, The Pacific Community, BP D5, 98848 Noumea CEDEX, New Caledonia

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ABSTRACT

Most fisheries for deep-water snappers, groupers and other demersal fishes in many countries and territories throughout the Indo-Pacific are data-poor and/or resource-poor. Current and emerging methods for obtaining important information on life history, ecological assessments, and stock assessments for these deep-water species were discussed at an international workshop in Perth, Western Australia in July 2016. The key issues raised included: (i) the ongoing need to adopt nascent methods for otolith sectioning and interpretation; (ii) the need for standardised international ageing protocols to be documented; (iii) the benefits of investigating otolith chronologies both for age validation and the influence of climate variability on fish populations; (iv) a need to investigate the ecological niches and requirements for deep-water fishes; (v) improved understanding of genetic stock structure/connectivity, diet and gene flow across a range of spatial scales; (vi) the need for an improved understanding of the performance and uncertainty associated with length- and age-based catch curves and spawning potential ratio stock assessments; and (vii) the issues and challenges in developing harvest strategies for deep-water data, and/or resource poor resources. Many new or refined strategic directions for further investigation were identified to resolve uncertainty in monitoring and assessment approaches to contribute toward more rigorous fisheries management arrangements.

* Corresponding author at: Western Australian Fisheries and Marine Research Laboratories, Department of Fisheries, Government of Western Australia, P.O. Box 20, North Beach 6920, Western Australia, Australia.
E-mail address: Stephen.Newman@fish.wa.gov.au (S.J. Newman).

1. Introduction

Snappers (Lutjanidae) and groupers (Epinephelidae) are the main species captured in deep-water tropical demersal fisheries throughout the Indo-Pacific region [35]. These deep-water tropical demersal fisheries provide significant cultural and economic value, and support commercial, recreational, customary, subsistence and artisanal fisheries. These fisheries supply local, domestic and export markets at varying scales and are a valuable source of protein for indigenous communities. The magnitude and value of catches varies among countries and territories. For example, in Australia commercial catches of deep-water snappers and groupers exceed 1500 t annually compared to Hawaii (~220 t), Tonga (~230 t) and Vanuatu (~110 t), mainly as a consequence of the available area of continental or insular shelf and/or slope habitats. There are no reliable data on catches of deep-water snappers in Indonesia, but FAO reports that Indonesia landed 137,000 t of snappers in 2014 (all Lutjanidae combined), which makes Indonesia the world's largest producer of wild-caught snapper. Deep-water snappers form an important part of this combined lutjanid catch.

Data-poor deep-water fisheries in the Indo-Pacific are typically characterised by; limited or absent: mixed species catch and effort data, management capacity, governance arrangements, funding, and resources [33]. This has led to a dearth of robust quantitative assessments of the status of deep-water fisheries stocks across the region. Recently, Newman et al. [35] completed an extensive review of the life history characteristics of deep-water tropical demersal fishes and reported that the results of many studies that investigated longevity, growth and size/age at maturity are unreliable and/or biased due to low samples sizes, representativeness of the data, and/or the use of methods that have not been validated or verified. As such, there is a clear need for the reassessment and revision of species-specific life-history information. In addition, Newman et al. [35] advise on the use of consistent methods and protocols across studies in addition to information sharing to facilitate the development of robust data-poor assessments for these species.

In July 2016, an international workshop was held in Perth, Western Australia to update standardised ageing protocols, compare quantitative stock assessment methods and procedures, harvest strategies and emerging methods and techniques that have application in the monitoring, assessment and management of deep-water tropical snappers and groupers. The workshop brought together fisheries scientists, ecologists and resource managers involved in monitoring, assessment and the provision of management advice for deep-water demersal fisheries across the Indo-Pacific region.

The aim of this workshop was to improve our understanding of the processes required for revising important life history parameters, establish representative and adequate monitoring programs, provision of qualified assessment advice and, in particular, the application of data-limited methods for determining stock status to better inform fisheries managers. Each of these themes involved the sharing of learned experiences, knowledge and quantitative methods to promote best scientific practice across key fisheries throughout the Indo-Pacific region. The workshop discussions and conclusions are synthesised herein.

2. Regional updates of significance

The status of the Hawai'i Deep 7 bottomfish complex has been assessed using Bayesian surplus production models fitted to logbook standardized catch-*per*-unit-effort (CPUE) data [12,14]. Similarly, the United States Pacific Territories (American Samoa, Guam, and Commonwealth of the Northern Mariana Islands) bottomfish complexes of 17 species were assessed by fitting such models to creel census nominal CPUE data [13,59]. A Center for Independent Experts (CIE) review of the 2014 Hawai'i Deep 7 Bottomfish Complex stock assessment concluded that the assessment had serious flaws that compromised its utility for management primarily due to strong reservations regarding the quality of the input catch data and the CPUE index of abundance. Further, the 2014 CIE review supported the intent of NMFS to move toward single species assessments, especially for the endemic *Hyporthodus quernus*. A Tier 3 Western Pacific Stock Assessment Review (WPSAR) of the 2016 US Territorial Bottomfish Complex stock assessment found that the results and conclusions of the assessment were reliable and sound, including the estimated population benchmarks and management parameters. However, it recommended splitting future assessments into shallow and deep-water species complexes. Both reviews also recommended that each assessment explore length-based data and life history-based approaches for the assessment process if sufficient data are available. These assessment updates were timely and contributed to directions and discussions at the workshop.

Indonesia is the largest producer of tropical snappers and groupers in the world. No detailed assessments have been completed to date, however monitoring has been undertaken in the eastern waters since 2014 (TNC & [48,49]). Few overarching governance arrangements are in place and there is a need to develop rapid assessment approaches. Encouragingly, recent advancements in resource-poor techniques may present potential options to inform management for this fishery (Hill et al., unpublished data). Information to date indicates that formal catch statistics do not reflect the reality at sea. There is a need for periodic assessments that contribute data on fishing practices and fishing grounds, as well as data on species, size, and age composition of the commercial catch.

There has been recent progress with the development and implementation of management plans for deep-water snapper fisheries in the Pacific Island countries of Tonga and Vanuatu. Tonga implemented a revised management plan in 2014 that introduced an annual total allowable catch of 200 t for all deep-water snapper and grouper species combined, and a maximum overall vessel length of 23 m. This management plan is under revision for the next 3 year period (2017–2019), and will look to incorporate information from recent stock assessments [27] and potentially a bio-economic analysis. In 2016, Vanuatu implemented their first management plan for deep-water snappers and groupers. The plan outlines compulsory licenses and an overall cap on the number of licenses, a closure of coastal waters to large vessels, the identification of three key indicator species (*Etelis* sp., *Paracaesio kusakarii* and *Epinephelus morrhua*) for monitoring the fishery, and interim harvest limit reference points including a catch limit that triggers a reduction in licenses.

3. Ageing protocols

Discussions regarding the development of standardised ageing protocols at this workshop progressed from those reported by Newman et al. [33], and adopted nascent otolith sectioning and interpretation methods as outlined by Wakefield et al. [52], that achieved ageing results with an acceptable level of bias and precision for deep-water snappers among multiple readers. Importantly, this international co-operative approach to the development and ratification of ageing protocols for deep-water tropical fishes (in particular snappers and groupers) is providing an enhanced understanding of their life history and estimates of mortality. These data are subsequently being used as the base level information required for assessment purposes in Western Australia. The methods underpinning otolith preparation (i.e. optimal section thickness, quality control in sectioning orientation, calibration of equipment, and post section treatments (e.g. polishing, acid dipping)) is species-specific and has recently been refined to maximise growth zone clarity (see [52]).

As noted by Newman et al. [33], sampling strategies for otolith collections need to consider plans that are focused on either deriving estimates of age-based life history parameters (e.g. growth parameters, age at maturity, by sampling across the length and age range, stratified