

What about recreational catch? Potential impact on stock assessment for Hawaii's bottomfish fisheries

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Received 21 June 2007; received in revised form 30 October 2007; accepted 7 November 2007

Abstract

The bottom-fish stocks of the Main Hawaiian Islands (MHI) are intensively fished, both commercially and recreationally. Recent assessments of the Bottomfish Management Unit Species (BMUS) complex suggested overfishing, and expressed concerns about missing non-commercial data. We used reported commercial time-series data and estimation ratios to indirectly estimate non-commercial catches for non-pelagic species (i.e., excluding tuna and billfishes) for 1950–2005. Using adjustment ratios, we also accounted for commercial under-reporting, which suggested that total commercial non-pelagic catches were 28–128% higher than reported commercial catches for any given year. Estimated non-commercial catches for 1950–2005 were 2.1 times higher than reported commercial catches. Reported catches underestimated likely total catches (reported and un-reported commercial plus non-commercial) of non-pelagic species and BMUS components for 1950–2005 by a factor of 3.9 and 2.9, respectively. We incorporated the reconstructed BMUS non-commercial catches into stock assessments of the officially reported commercial BMUS catches via a Schaefer production model. Total catch increased by 2.5–3.5 times with the addition of non-commercial BMUS catch estimates, which in turn increased model estimates of MSY and carrying capacity (k) by approximately four times compared to analyses with reported commercial data alone. As the CPUE data lacked information to resolve the confounding between large, unproductive and small, productive stocks, an informative prior was used for fishing mortality rate to attain MSY (F_{MSY}). To address uncertainty in key management parameters, independent estimates of exploitation rate, or fisheries independent estimates of abundance, and informative trends in recreational effort or catches are required. © 2007 Elsevier B.V. All rights reserved.

Keywords: Catch reconstruction; Bayesian analysis; Bottom-fish; Main Hawaiian Islands; Recreational fisheries; Stock assessment; Tropical fisheries

1. Introduction

Despite focus on the June 2006 declaration by the US Government assigning the Northwest Hawaiian Islands (NWHI) as the first national marine monument in the USA, and the concomitant slow phase-out of fishing (Anonymous, 2006a), a more pressing fisheries issue in the Hawaiian archipelago relates to the pressures being exerted on marine resources in the Main Hawaiian Islands (MHI). The MHI have a high human population density (U.S. Census Bureau, <http://www.census.gov>), major tourism industry, and easy access to fishing grounds. While the majority of commercial fisheries revenue (80–90%) comes from large pelagic species, Hawaii's non-pelagic resources have substantial cultural, subsistence and recreational value (Pooley, 1993; Lowe, 2004). A major component of the non-pelagic fisheries

is the deeper-water 'bottomfish' fishery, which concentrates on a dozen species, primarily eteline snappers (Lutjanidae), jacks (Carangidae) and the Hawaiian grouper (*Epinephelus quernus*, Serranidae) at depths of about 50–300 m (Polovina, 1987). Some of these species have been fished on a subsistence basis for hundreds of years, and commercially since the early 20th century (Anonymous, 2004). Presently, they support a large number of non-commercial and commercial fishers in the MHI, and a very small number of commercial fishers in the NWHI (Anonymous, 2004).

Past disagreements between US State and Federal jurisdictions over management of the MHI bottomfish resources have contributed to relatively unsuccessful management, with assessments suggesting overfishing, and high uncertainty about stock status (Martell et al., 2006). Assessments have traditionally used relative abundance estimates based on Catch Per Unit of Effort (CPUE) indices of 'high-liners', i.e., each year's subset of most productive fishers. Such CPUE indices are known to be hyperstable, and readily mask declines in stock status (Walters and

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Table 1

List of Hawaiian Bottomfish Management Unit Species (BMUS), their taxonomic affinity and FAO common names, modified from Martell et al. (2006)

Local name	Family	Species	FAO common name
Armorhead ^a	Pentacerotidae	<i>Pseudopentaceros wheeleri</i>	Armorhead
Black Ulua	Carangidae	<i>Caranx lugubris</i>	Black jack
Butaguchi	Carangidae	<i>Pseudocaranx dentex</i>	White trevally
*Ehu	Lutjanidae	<i>Etelis carbunculus</i>	Ruby snapper
*Gindai	Lutjanidae	<i>Pristipomoides zonatus</i>	Oblique-banded snapper
*Hapuupuu	Serranidae	<i>Epinephelus quernus</i>	Hawaiian grouper
Kahala	Carangidae	<i>Seriola dumerii</i>	Greater amberjack
*Kalekale	Lutjanidae	<i>Pristipomoides sieboldii</i>	Lavender jobfish
Kinmedai	Berycidae	<i>Beryx spendens</i>	Alfonsin
*Lehi	Lutjanidae	<i>Aphareus rutilans</i>	Rusty jobfish
*Onaga	Lutjanidae	<i>Etelis coruscans</i>	Flame snapper
*Opakapaka	Lutjanidae	<i>Pristipomoides filamentosus</i>	Crimson jobfish
Taape ^b	Lutjanidae	<i>Lutjanus kasmira</i>	Bluestripe snapper
Uku	Lutjanidae	<i>Aprion virescens</i>	Green jobfish
White Ulua	Carangidae	<i>Caranx ignobilis</i>	Giant trevally
Yellowtail Kalekale	Lutjanidae	<i>Pristipomoides auricilla</i>	Goldflag jobfish

Species comprising the 'deep-seven' species of current management interest are indicated with (*).

^a This seamount taxon is not caught by recreational fishers, and the commercial seamount fisheries are closed.

^b Exotic species introduced into the Hawaiian archipelago in 1958.

Martell, 2004). Also, standard assessments relied on a pooled multi-species complex (Bottomfish Management Unit Species or BMUS, Table 1) and analyses were based entirely on reported commercial catch data (Martell et al., 2006). Fundamental to the assessment problem is the realization that an unknown, but likely large percentage of data are missing, i.e., non-commercial catches. In response to the concerns about overfishing, the US federal fishery management agency (Western Pacific Regional Fishery Management Council), in collaboration with the state management agency (Hawaii Division of Aquatic Resources, HDAR) implemented a 4.5 month seasonal MHI closure for the main deep water species (called the 'deep-seven', Table 1) in 2007 and 2008 as an interim attempt to reduce fishing mortality rates, while the subsequent use of Total Allowable Catch limits (TAC) is explored.

The lack of basic catch data from some sectors (e.g., recreational sector) of a fishery is a global problem, yet until recently the scale of non-reporting and its implications have rarely been seriously considered (but see Zeller et al., 2006a; Zeller et al., 2006b; Zeller et al., 2007a). In essence, the issue of missing data, even in the form of the legal but un-accounted recreational sector in Hawaii, forms part of the global IUU (Illegal, Unregulated and Unreported) problem (Bray, 2000), which includes the issue of discarding (Zeller and Pauly, 2005).

1.1. Fisheries data

Holders of Hawaiian commercial fishing licenses are required to file monthly catch reports, including the reporting of unsold catch. However, it is known that not all 'commercial' catch is reported (see Zeller et al., 2007b). Illegal sales and under-reporting contribute to under-recording of commercial catches by the state catch reporting system maintained by the HDAR. Incomplete reporting may be influenced by the large fraction of 'part-time' commercial fishers being active in Hawaii, which are

known to sell only a fraction of their catch through the formal framework.

No licensing or reporting requirements currently exist for non-commercial marine fishing (Zeller et al., 2007b), despite the high proportion of residents and visitors who fish. Existing recreational bag limits for several key bottomfish target species can easily be circumvented through the purchase of the low-cost commercial fishing license (<US\$50) and the annual sale of at least one fish. Attempts have been made to estimate non-commercial catches, at least on a spatially and temporally limited scale (e.g., Hamm and Lum, 1992; Friedlander and Parrish, 1997; Everson and Friedlander, 2004). In the early 2000s, creel surveys through the Marine Recreational Fishery Statistics Survey (<http://www.hawaii.gov/dlnr/dar/surveys/>) were initiated to provide estimates of fishing effort and catches, but their design has not been optimized for assessing the bottomfish sector.

The objectives of the present study were to derive estimates of non-commercial catches for non-pelagic species (i.e., excluding tuna and billfishes) for Hawaii for 1950–2005, and to assess their potential impact on stock assessments. Given the absence of time-series data on non-commercial catches, we present an approach of 'qualitative data' application to derive approximate levels of likely catches. Specifically, we use existing reported commercial catches, available qualitative information, and local expert knowledge, to derive *adjustment ratios* for un-reported commercial catches, and *estimation ratios* for indirectly estimating non-commercial catches. While uncertainties around our estimates may be high, we remain conservative in our estimation approach. We then incorporate the reconstructed non-commercial catches of Bottomfish Management Unit Species (BMUS) into a BMUS stock assessment approach via a Schaefer production model of the reported commercial BMUS catch data to evaluate what likely impact non-commercial catches may have on formal stock assessment outcomes, and the

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