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Developing a commercial-vessel-based stock assessment survey methodology for monitoring the U.S. west coast widow rockfish (*Sebastes entomelas*) stock

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ABSTRACT

The widow rockfish (*Sebastes entomelas*) inhabits the continental shelf and upper slope of the west coast of North America. The U.S. west coast widow rockfish stock has declined since the mid-1980s, leading to implementation of increasingly stringent management restrictions upon the commercial fishery. The low numbers, patchy distribution, and preference for rocky habitats of the widow rockfish make this stock difficult to monitor using standard bottom trawl survey techniques and commercial landings data; currently, there is no reliable index of abundance. An *ad hoc* government-industry working group began meeting in 2004 to devise a new stock assessment survey strategy. The proposed strategy utilized local fishermen's knowledge of widow rockfish distribution and behavior, chartered commercial fishing vessels, and a combination of fisheries acoustics and underwater video sampling techniques. Results are presented from fieldwork conducted at three study sites off the central coast of Oregon, USA, in March 2005. Acoustic backscatter at 38 kHz between 50 m from the surface to 15 m off the bottom was attributed primarily to widow rockfish. This classification was based on historical widow rockfish distribution at these sites, fish school appearance on acoustic echograms, and deployments of an underwater camera sled. Repeated acoustic sampling along predetermined transects spaced at 0.3 nmi (0.56 km) at two of the study sites documented the temporal and spatial variability of widow rockfish schools over the course of a single day and week-to-week. The CVs of average vertically integrated acoustic backscatter measured in repeated sampling passes at these two sites were 0.31 and 0.36, which are not unreasonable values for a fisheries survey time series. Fine-scale acoustic sampling at a total of three study sites showed that the spatial scale (horizontal dimensions) of the groups of widow rockfish schools observed ranged from 0.2 to 0.8 nmi (0.37–1.48 km). This study demonstrates that sampling of a coastwide suite of study sites selected using local fishermen's knowledge with a standard 38 kHz scientific echosounder, supported by underwater video and limited midwater trawling, may be a promising way of monitoring U.S. west coast widow rockfish abundance. These techniques may also be relevant to monitoring other difficult-to-assess semi-dermersal species inhabiting rocky, untrawlable areas.

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1. Introduction

The widow rockfish (*Sebastes entomelas*) is one of more than 60 species of *Sebastes* that inhabit the continental shelf and upper slope of the west coast of North America. Widow rockfish range from Baja California to the western Gulf of Alaska, most commonly occurring from northern California to British Columbia near areas of hard bottom and rocky relief. They lead a more pelagic existence as adults than many other members of the genus *Sebastes*, often occurring in small midwater schools well above the bottom (Wilkins, 1986). Adults typically grow to lengths of 30–40 cm and can live for up to 60 years. Commercial exploitation of widow rockfish remained at low levels until the late 1970s, when they became a preferred target (along with other west coast rockfish) of midwater and bottom trawlers (cf. review by Love et al., 2002).

The U.S. west coast widow rockfish stock declined steadily from the mid-1980s to the 1990s, leading to increasingly stringent restrictions on fishing (He et al., 2005). These restrictions have not only had an impact upon the directed fishery that targets widow rockfish, but also upon the high-volume fishery for Pacific hake (*Merluccius productus*), in which widow rockfish have been a small but significant source of by-catch over the years. Widow rockfish stock assessments have used NOAA Fisheries bottom trawl monitoring survey data, catch-per-unit-effort (CPUE) data from the

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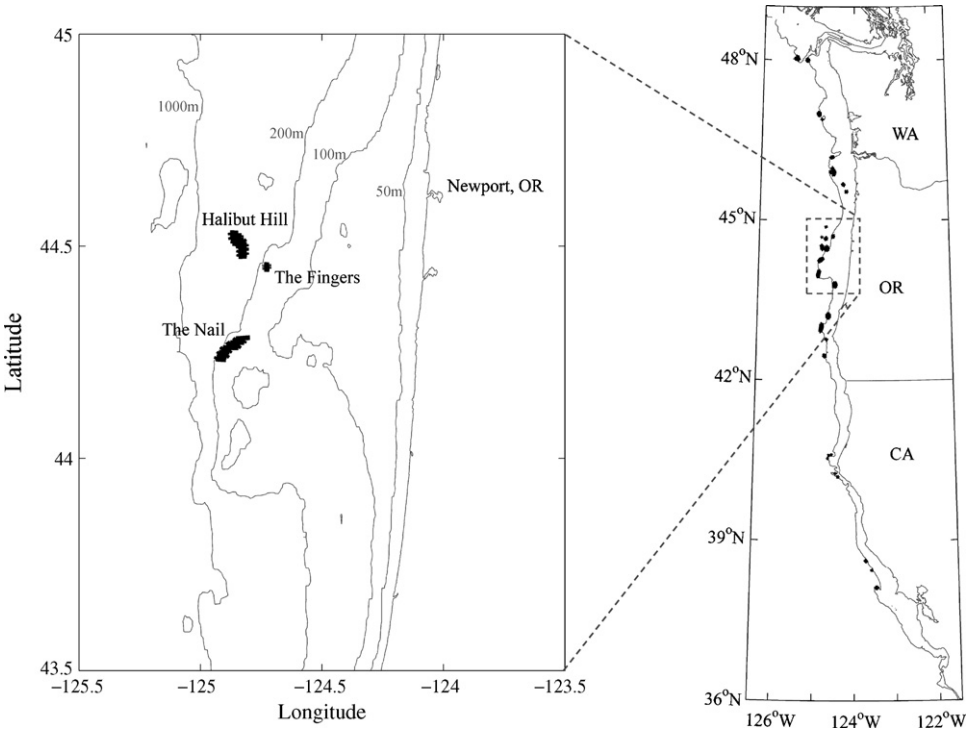

Fig. 1. Black polygons in the left panel indicate the locations of widow rockfish survey sites off Newport, Oregon surveyed during March 2005; black polygons in the right panel indicate the entire suite of potential study sites along the U.S. west coast identified by the *ad hoc* widow study group. The coastline and 1000, 200, 100, and 50 m isobaths are shown in grey in the left panel (only the 200 m isobath is shown in the right panel).

directed fishery, and more recently, the by-catch rate in the Pacific hake fishery as indices of adult widow rockfish abundance (He et al., 2005). However, the decline in widow rockfish abundance has steadily eroded the utility of all of these data sources. Widow rockfish, always an uncommon catch in bottom trawl surveys because of their relatively pelagic existence and preference for rocky habitat, became even more rare in these surveys as the stock reached lower levels (He et al., 2005). In addition, commercial catches fell as the widow rockfish fishery was increasingly restricted, and the appearance of widow rockfish as by-catch in the Pacific hake fishery plummeted as well, as hake fishermen actively avoided areas prone to widow rockfish by-catch in an effort to prevent an early closure of the hake fishery (due to the widow rockfish catch limit being reached). As a result, there has been no reliable index of widow rockfish abundance since ca. 1999 (He et al., 2003, 2005).

In response, a government-industry *ad hoc* working group was convened in 2004 to explore the development of a new methodology for indexing widow rockfish abundance. In a series of meetings, NOAA Fisheries scientists and fishermen participants reviewed a range of alternative techniques and survey strategies for widow rockfish that included the local fishermen's knowledge of variations in this species' distributions, concentrations, and associated behaviors (for other examples of such inclusion of local knowledge, cf. Bergmann et al., 2004; Silvano and Begossi, 2005; Harms et al., 2008). As a first step in developing a new survey, the working group agreed upon a series of study sites along the U.S. west coast that were identified by the fishermen as historic fishing grounds and areas of concentration for widow rockfish. These sites formed an initial geographic basis for sampling (Fig. 1). Studies by Wilkins (1986) and more recently by Stanley et al. (2000) had indicated that widow rockfish might be reliably assessed with fishery acoustics. The group agreed on the deployment of scientific fishery echosounders from a number of commercial fishing vessels (cf. review by ICES, 2007) at the identified study sites as a practicable strategy for conducting annual coastwide surveys.

Pilot survey work was conducted off central Oregon, USA, in March 2005 (Fig. 1) as proof of concept for the proposed techniques and to guide further development of the project. The goal of the pilot work was to acoustically survey several study sites, documenting widow rockfish distributions and movements using fishery acoustics deployed from a commercial fishing vessel. Owing to the depleted status of this species and restrictions on capture by trawling, the use of a towed camera was explored as an alternative means of determining the species composition of the fish schools detected acoustically. Based on initial results of the pilot work, recommendations for developing an effective survey strategy are provided, which may help address the specific assessment need for a new index of U.S. west coast widow rockfish abundance. The approach and results described here are also relevant to the more general challenge of monitoring other patchily distributed, depleted fish stocks that are found in untrawlable or otherwise inaccessible areas.

2. Materials and methods

The fieldwork was conducted in two periods, the first from 15 to 18 March ("Leg 1"), and the second from 21 to 23 March ("Leg 2"), 2005. In addition to 2–3 scientists and the crew of the chartered commercial trawler, two other fishermen from the *ad hoc* widow rockfish group participated in the survey operations.

2.1. Acoustic gear

A Simrad (Simrad, Kongsberg AS, Horten, Norway) EK60[1] with a 38 kHz hull-mounted transducer (model ES38-12), was operated from the 65 ft (20 m) commercial trawler F/V *Excalibur* during both Legs 1 and 2. A standard sphere calibration (Foote et al., 1987) was

[1] References to trade names or specific products does not constitute endorsement.