Shortbelly vignette

The 2014-2016 Pacific Marine Heatwave induced a bevy of ecological surprises with unexpected impacts to fisheries. One of these unanticipated events involved shortbelly rockfish *Sebastes jordani*. Different rockfishes exhibit a wide range of life history characteristics ranging from long-lived apex predators (200+ years) to short-lived (< 10 years) diminutive species (Love et al. 2002). Shortbelly fall distinctly into the latter category: they are small (< 30 cm), fast-growing (50% of females were reproductively active at age 2), short-lived (of approximately 8500 individuals, 95% were less than 12 years old, and 99% less than 17 years old), suffer high rates of natural mortality, form large schools and are semi-pelagic (Pearson et al. 1991, Love et al. 2002, Field et al. 2007). The lifestyle of shortbelly in many ways resembles that of coastal pelagic fishes such as sardine (*Sardinops sagax*) and northern anchovy (*Engraulis mordax*). Indeed, Love et al. (2002) characterized shortbelly as “the least ‘rockfish’… of the rockfish”.

There is currently neither a directed fishery nor a reasonable assertion that one may develop in the near future. However, in the late 1970s and early 1980s it was believed that a commercial fishery for shortbelly would develop, and the Pacific Fisheries Management Council (PFMC) established an acceptable biological catch limit of 13,900 tons in 2001 (Field et al. 2007). Although a directed fishery did not emerge, shortbelly are often taken as by-catch in hake (*Merluccius productus*) or rockfish fisheries. Historically, bycatch did not come close to approaching the ABC limit (Field et al. 2007). This changed radically in 2018.

Within the first two weeks of the opening of the 2018 fishing season, the commercial hake fishery encountered several shortbelly by-catch “lightning strikes” off Oregon and came very close to exceeding the allowable catch limit. The high catch of shortbelly was a serious situation because it could have resulted in the shut down of the hake fishery at the very beginning of the season, which would have incurred negative social and economic costs to the fishers. The bycatch was also surprising because although shortbelly range from approximately Punta Baja, Baja California Norte to La Peruse Bank, Canada, the population center is off Monterrey, California and historical by catch north of California had been very low. With the high by catch, it became important to understand why shortbelly turned up in such high numbers off Oregon and whether the take could appreciably impact the overall shortbelly population.

Evaluating catch of young of the year shortbelly from NOAA’s Rockfish Recruitment and Ecosystem Assessment Survey (RREAS) helped guide PFMC decisions regarding shortbelly by catch in the hake fishery. RREAS conducts systematic midwater (30 m) trawls off the coast of California to provide recruitment data for rockfish stock assessments (Sakuma et al. 2016). Beginning in 2013, the abundance of several species of young of the year rockfish increased for most species, but jumped more than an order of magnitude for shortbelly (figure 1; (Schroeder et al. 2018)). Shortbelly recruitment dropped a bit in 2014 (but was still higher than any year prior to 2013), but was then extraordinarily high again in 2015 and 2016. Counterintuitively, rockfish recruitment was highly correlated with cool, fresh water; despite the overall warm conditions, the volume cool water was relatively high during the MHW (Schroeder et al. 2018). As a result of the massive recruitment events, it is likely that adult populations were the highest in recorded history by 2018. The persistent warm water through at least 2019, probably resulting in the expansion of the range of shortbelly and the interaction with the northern hake fishery.

The high shortbelly bycatch forced the PFMC to make relatively rapid changes to the shortbelly ACL. Prior to altering regulations, the PFMC considers statements from advisory bodies (e.g., groundfish management team, groundfish advisory panel) and the public (e.g., nongovernment organizations (NGO)). While all parties agreed that the ACL needed to be raised, there was some debate over the de magnitude of the change. Specifically, there was tension between ensuring that sufficient shortbelly were available as forage for marine predators versus needlessly constraining the hake fishery. Upon reviewing the best available science (primarily the RREAS recruitment data), the PFMC decided to adopt the higher ACL.

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