Comparison of sampling efficacy of bongo and manta plankton nets in Southern California

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Abstract

Ichthyoplankton sampling is used worldwide to track spawning dynamics of myriad fishes. Since the late 1970s the California Cooperative Oceanic Fisheries Investigation (CalCOFI) program has consistently utilized both oblique bongo and neustonic manta net tows to quantify abundances of larval fishes. Although many publications have analyzed bongo data to track fish assemblages, mantas have received much less attention, and the utility of this net to sample species relative to bongos is currently unclear. Here we evaluate the capacity of bongo versus manta nets to quantify abundances of fish larvae in southern California from 1978-2015. 1) We examine what species are most abundant in the manta versus bongo samples. 2) We assess whether there are any significant correlations between larval fish abundances in bongo nets compared to manta nets. 3) We evaluate impacts of day versus night sampling for manta versus bongo nets. Although many larval fish species were abundant in both types of nets, some species were much more abundant in mantas than bongos (e.g., California Grunion, Pacific Saury) and vice versa (e.g. rockfishes, sanddabs, and mesopelagic species). In addition, whereas abundances were highly correlated between nets for some species, there are no correlations for others. Finally, there was no systematic bias for day versus night sampling for either net. We conclude that although manta data are rarely used to track species abundances, mantas are better suited for quantifying abundance of several common species in southern California whose larvae are neustonic.

Introduction

Ichthyoplankton studies are used worldwide to quantify spatial and temporal patterns of fish spawning (Govoni 2005). Analyses of ichthyoplankton data have provided much insight in the marine biology realm such as that fishing induces greater fluctuation in fish population sizes (Hsieh et al. 2006), how fish assemblages respond to marine heatwaves (Nielsen et al. 2020; Thompson et al. 2021), and their importance to formal assessments of fish stocks (Field et al. 2009; Hunter et al. 1993). Despite the studies using ichthyoplankton data to discern the status of fishes, less effort has been devoted to understanding the capacity of various nets to capture various species. There are multiple ichthyoplankton long-standing monitoring programs off the west coast of North America (Nielsen et al. 2020; Gallo et al. 2022). Of these, the CalCOFI program is the oldest continuous ichthyoplankton monitoring program in the United State. CalCOFI ichthyoplankton data has been analyzed in hundreds of studies (McClatchie 2014), but these have almost exclusively focused on oblique tows, and have a relatively poor understanding of the efficacy of manta (surface) samples to characterize the ecosystem. In this study, we compare fish abundances among the bongo and manta net collections.

Methods

Field & Lab Work

- Bongo and manta net tows were collected from the core 66-station CalCOFI pattern (Figure 1). Bongo nets have been used since 1977 (Thompson et al. 2017) and manta nets began in 1977.
- We analyze data from stations that sampled both bongo and manta tows from 1978-2015
- All fish larvae were identified to lowest possible taxa

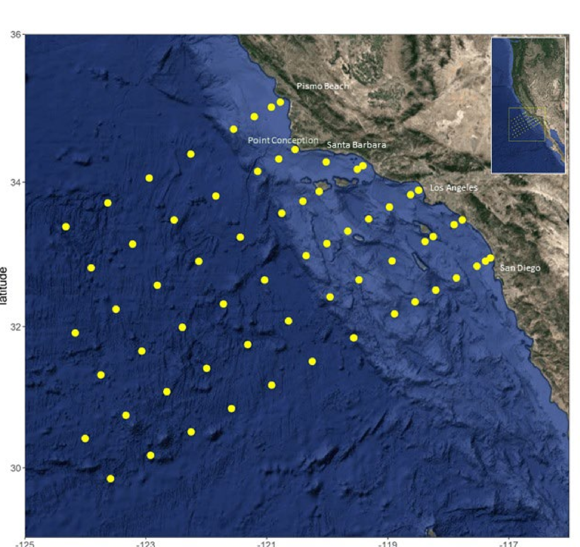

Figure 1: Map of CalCOFI's gridded core 66-station pattern

- Samples surface waters (Brown and Cheng 1981)
- 505 µm-nylon mesh and 333 µm-nylon mesh cod end
- Towed at surface for 15 min
- Flowmeter attached to center of net mouth
- Preserved in 5% buffered formalin at sea

- Samples water column down to 210 m (depth permitting)
- 505 µm-nylon mesh and 333 µm-nylon mesh cod end
- Towed obliquely
- Flowmeter attached to center of starboard net mouth
- Preserved in 5% buffered formalin at sea

Data Analysis

- We removed all 0-0 observations between station and cruise comparisons
- To compare catches between stations: summed species abundance from each net, found top 10 species in each net, 16 species compared
- To compare catches between cruises: calculated means of abundance by each cruise
- Day/night differences: summed larvae from each net in each season caught during day and night then divided by number of samples

Results

Species	Common Name	Adult Habitat	Bongo Rank	Manta Rank
Citharichthys sordidus	Pacific Sanddab	benthic - groundfish	8	
Citharichthys stigmaeus	Speckled Sanddab	benthic - groundfish	8	
Cololabis saira	Saury	pelagic	61	4
Engraulis mordax	Northern Anchovy	coastal pelagic	1	1
Hexagrammos decagrammus	Kelp Greenling	benthic		10
Hypsoblennius jenkinsi	Mussel Blenny	benthic		5
Leuroglossus stilbius	California Smoothtongue	mesopelagic	6	
Lipolagus ochotensis	Deep Sea Smelt	mesopelagic	9	70
Merluccius productus	Pacific Hake	pelagic - groundfish	2	7
Sardinops sagax	Pacific Sardine	coastal pelagic	4	2
Scomber japonicus	Pacific Mackerel	coastal pelagic	23	6
Scorpaenichthys marmoratus	Cabezon	benthic	70	9
Sebastes	rockfishes	benthic - groundfish	5	3
Sebastes jordani	Shortbelly Rockfish	benthic - groundfish	10	16
Stenobrachius leucopsarus	Northern Lampfish	mesopelagic	7	
Vinciguerria lucetia	Panama Lightfish	mesopelagic	3	15

Table 1: Table comparing the top 10 species caught in both manta and bongo nets, showing fish habitat, and ranking/species for both manta and bongo nets. Some species are in the top 10 for both nets, and some species are caught more in one net than the other

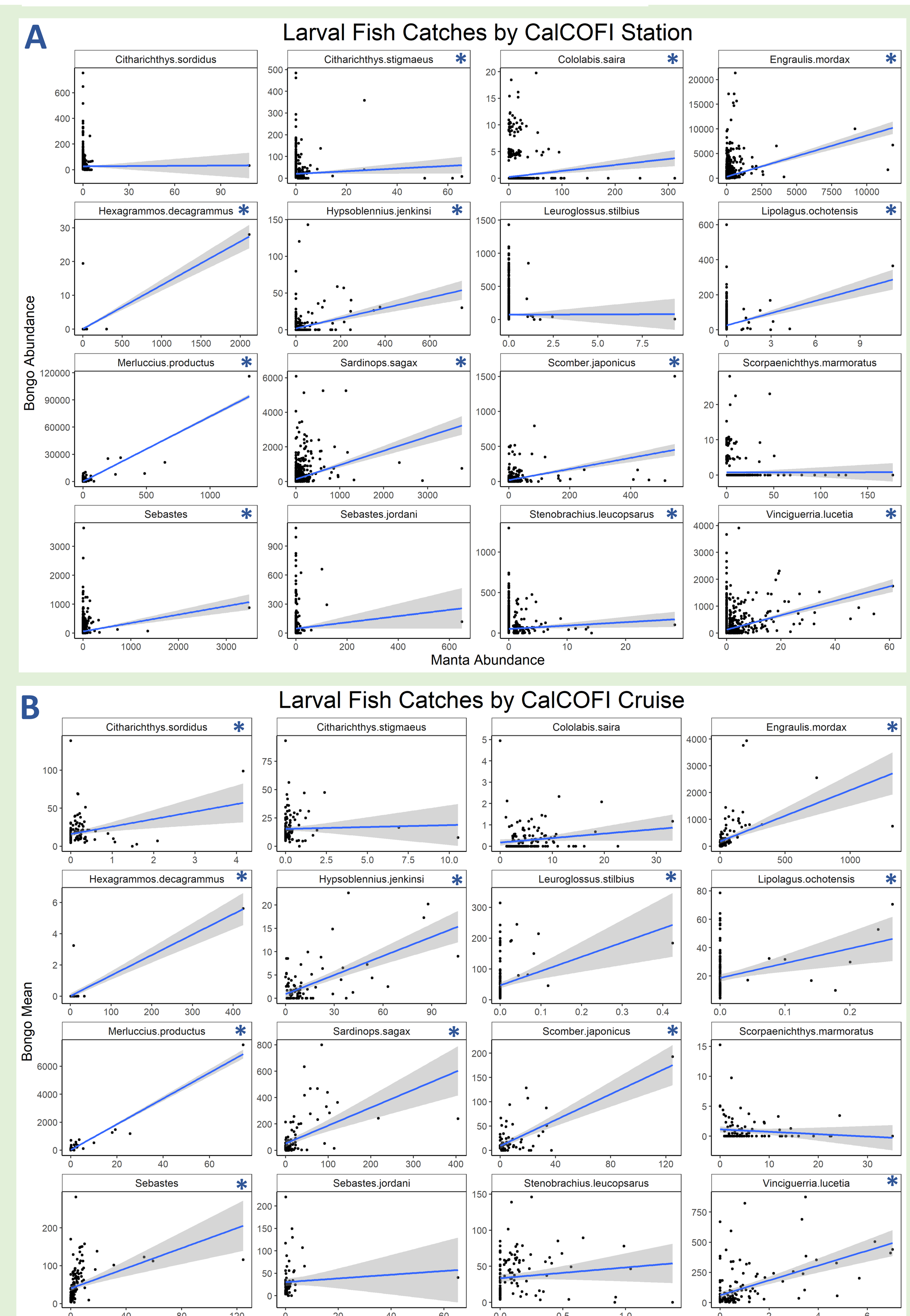

Figure 2: A; plot comparing larval fish abundances between bongo nets and manta nets, * indicate that the difference is significant ($p \leq .05$) B; plot comparing larval fish means between bongo nets and manta nets, * indicate that the difference is significant ($p \leq .05$)

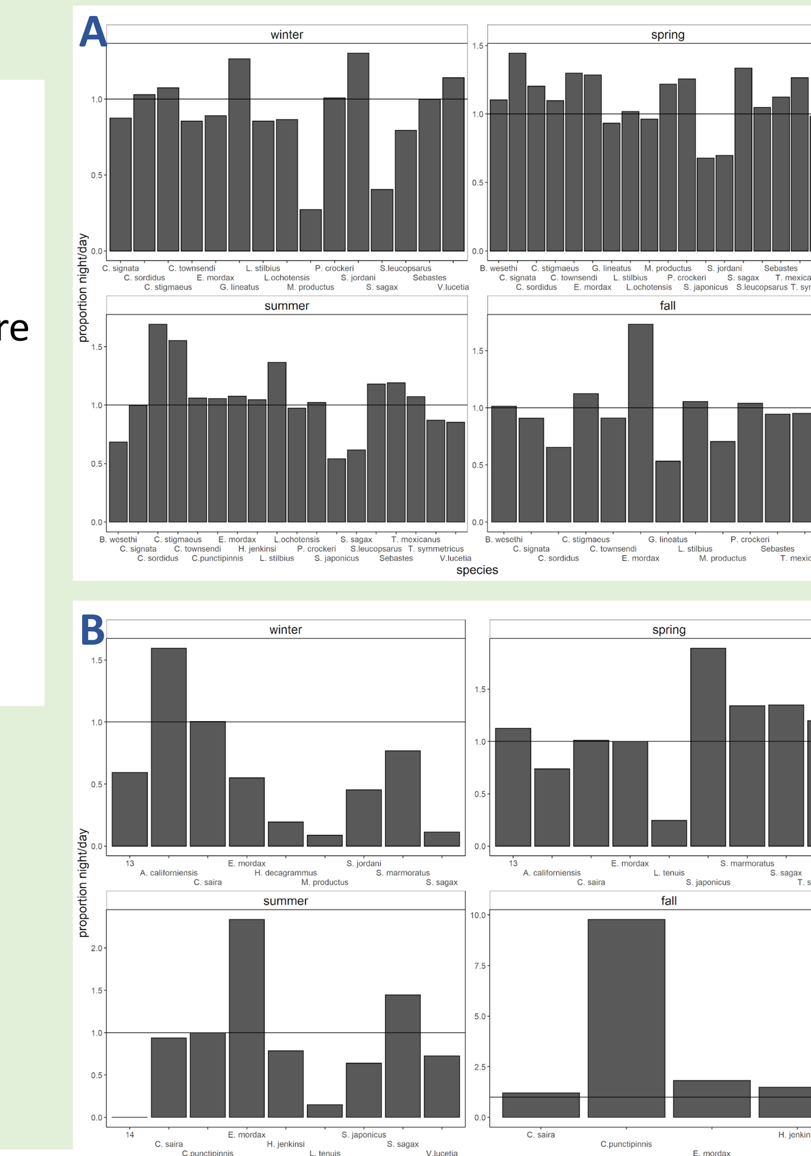

Figure 3: Day/night differences by season per species. A; plot comparing bongo caught larvae day/night differences. A day/night ratio >1 indicates more larvae were caught at night B; plot comparing day/night differences in manta caught larvae. A day/night ratio >1 indicates more larvae were caught at night

Discussion

- Some larval fish species are caught in high numbers in both manta and bongo nets – *Engraulis mordax*, *Merluccius productus*, *Sardinops sagax*, and *Sebastes*
- Some species are predominately found in the manta net *Hexagrammos decagrammus* (Kelp Greenling) and *Hypsoblennius jenkinsi* (Mussel Blenny)
- Some species are predominately found in the bongo net *Citharichthys sordidus*, *Citharichthys stigmaeus*, *Leuroglossus stilbius*, and *Stenobrachius leucopsarus*
- Most species have significantly difference abundances in bongo and manta samples
- For species with similar rank in both manta and bongo samples, bongo net catches generally are larger
- For most species there is not a significant difference been day and night catches – In contrast to other studies (Zaitsev 1970; Tully and O'Ceidigh 1989; Hempel and Weikert 1972)
- For the few species with higher catches at night, the difference occurs only during one season, which tends to be one when larger larvae are most likely to be present

Future Work

- Expand the list of species analyzed
- Compare all three ichthyoplankton nets used on CalCOFI surveys; bongo, manta, and pairovet (vertical tow)
- Look at egg catches in addition to larval catches
- Measure larvae to evaluate the observation that day-night differences in catches tend to be more likely to occur when larger larvae are more likely to be present.

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