# Distribution, Size, and Temporal Trends in Macromedusae in the California Current

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## Introduction

Large jellyfish feed on zooplankton and early life stages of fish; they are potentially important competitors and predators of fish (Fig. 1). Previous studies in the California Current (CC) have demonstrated substantial interannual variability in abundance and distribution patterns of macromedusae. Documenting these changes in the CC is required for fishery and ecosystem management, however, we lack information on large-scale distribution and size patterns related to variability in climate and prey resources. Our goal is to understand the role of jellyfish in measurements of the changes in jellyfish abundance on the ecosystem.

## Methods

We analyzed size and distribution patterns of macromedusae from two large-scale surveys conducted in the California Current. The first is from early summer (June and July) and late summer (September) surface trawl collections for salmon described by Suchman et al. (2012) but expanded to include a similar survey off southern Oregon and northern California (Harding et al. 2011). Collections were made in the upper 20 m during the day along predetermined transects from Northern Washington to Central California (Fig. 2). The second survey used a modified Cobb midwater trawl fished at 30 m during nightime in the waters off central California during the spring (May-June) to sample the abundance and distribution of juvenile rockfish and other young-of-the-year fishes and forage species (Sakuma et al. 2016). The initial survey area was along the Central California coast; however, the survey was expanded to cover most California waters starting in 2004 and North to the Columbia River starting in 2011 by the NW Center (Fig.2).

Although not the target of these surveys, collecting data on large jellyfish have been an integral part of the surveys. Data on the species composition, abundance, and bell diameter size of the four most frequently encountered large scyphozoans (*Chrysaora fuscescens*, *Aurelia labiata*, *Chrysaora colorata*, and *Phacellophora camtschatica*) and one large hydrozoan (*Aequorea* spp.) were collected during these surveys.

Fig. 1

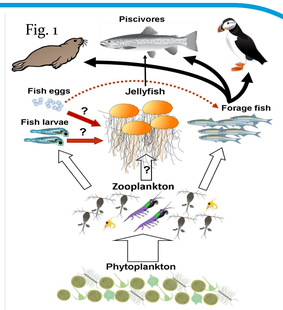
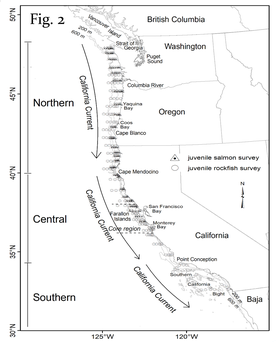
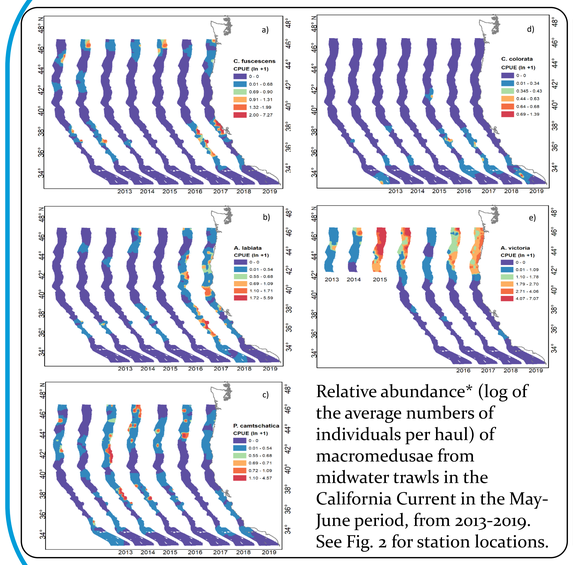



Fig. 2

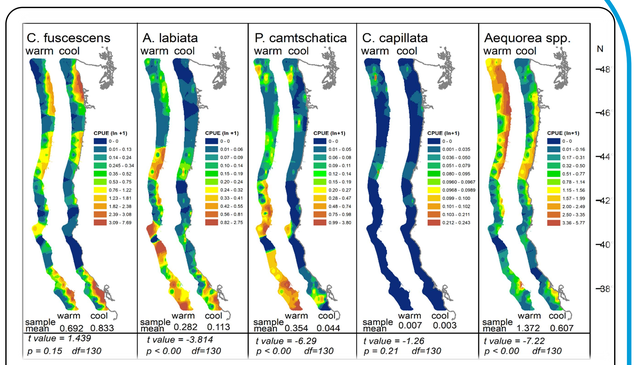



## Spatial Distributions



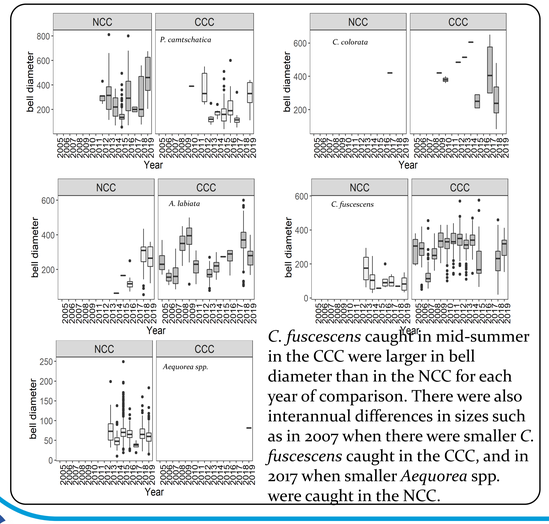

Relative abundance* (log of the average numbers of individuals per haul) of macromedusae from midwater trawls in the California Current in the May-June period, from 2013-2019. See Fig. 2 for station locations.

*Classifications are based on the quantile distribution of positive catches (0; 0.01-19%; 20-39%; 40-59%; 60-79%; 80-100%)

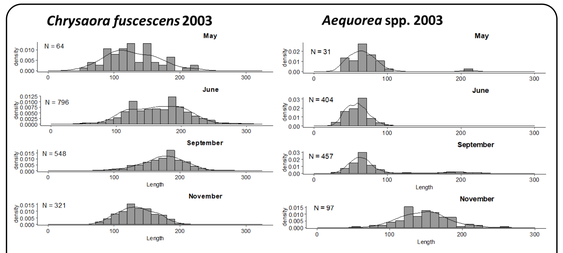



Dominant macromedusae distribution maps for cool (2011-2013) and warm years (2010, 2014-2016) in the California Current from daytime surface trawls for juvenile salmon (see Figure 2 for station locations). A total of 131 stations were included that had at least one sampling during both environmental regimes. Shown at bottom is the mean catch of a given species in the different conditions along with the results of a paired *t*-test comparing the catches from the two regimes.

## Size Distributions




*C. fuscescens* caught in mid-summer in the CCC were larger in bell diameter than in the NCC for each year of comparison. There were also interannual differences in sizes such as in 2007 when there were smaller *C. fuscescens* caught in the CCC, and in 2017 when smaller *Aequorea* spp. were caught in the NCC.

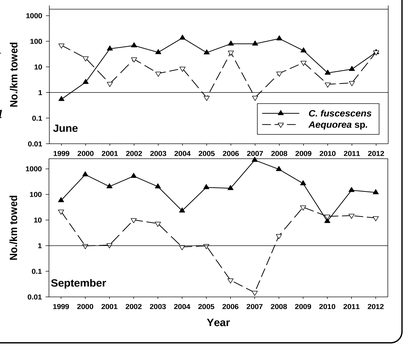



Seasonal changes in *C. fuscescens* bell diameter in 2003 showed growth between May and June, and potentially bell diameter shrinkage by November in the NCC. For *Aequorea* spp., there was little observed growth between May, June, and September, with a doubling of size between September and November. This may reflect that we were sampling the more offshore oceanic *A. coerulescens* versus the more coastal *Aequorea victoria*. Few larger *Aequorea* spp. were caught in May and September as well, but not June. Lastly, as a measure of growth in the NCC, we related the change of the average bell diameters of *C. fuscescens* or *Aequorea* spp. between May and June which was significantly related to ocean conditions as measured by winter PDO. The more negative the PDO (colder), the more both jellyfish grew between May and June (not shown).

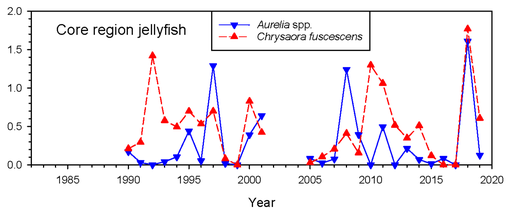
## Temporal Distributions

### Northern CC

Densities of the two dominant larger medusa species in the northern California Current, *C. fuscescens* and *Aequorea* spp. From surface trawl surveys in the northern California Current. For June and September, *C. fuscescens* dominated the catch and was generally 1 - 2 orders of magnitude higher than that of *Aequorea*.




### Central CC




The mean log-transformed catch of *C. fuscescens* and *A. labiata* for the SWFSC core survey area between 1990 and 2019 (excluding the years 2002 – 2004). During some periods, the abundance of these two species appear to be inversely related, while in some years, especially 2018 when both species reached peak abundance, they coincide in abundance patterns.

## Future research needs for jellyfish

- Few surveys directly sample jellyfish in the CC, but those that do could benefit from opportunities to conduct enhanced studies (directed surveys in jellyfish hotspots, incorporation of alternative sampling methods to better evaluate distribution and abundance patterns).
- As relatively few surveys collect data from late fall through early spring, enhanced sampling outside of these surveys would also be beneficial.

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## References

Harding, J. A., Ammann, A. J. & MacFarlane, R. B. 2011 . Regional and seasonal patterns of epipelagic fish assemblages from the central California Current. *Fishery Bulletin* **109**, 261-281.
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