Synthesis of Long-term Monitoring Information on Striped Bass (*Morone saxatilis*) in the Central Valley to Describe Range-wide Distribution and Identify Monitoring Gaps

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Background

Understanding the spatial ecology of fishes is key to investigating the influence of human activities on fish populations, describing interactions between species, and determining the most effective management strategies. However, syntheses of basic abundance and distribution data are lacking for most fish species in the Delta and surrounding watersheds, in particular non-native species. Of all the non-native fishes in the Delta, the striped bass (Morone saxatilis) has received the most monitoring and research attention because it is the focus of a robust and well-established sport fishery.

Population Status. Striped bass populations grew quickly when they were introduced to the Bay-Delta in the late 1800s; however, the young-of-the-year (Age-0) and adult populations declined between the 1970s and 1990s, and during this period striped bass stocking supplemented the wild population (Kohlhorst 1999). Abundance indices for Age-0 striped bass have been declining since the 1960s. In contrast, the adult population has fluctuated, and adult and Age-0 populations are no longer trending together (Baxter et al. 2008). The decline in Age-0 striped bass in trawl surveys may, in part, be accounted for by a distribution shift toward shoal areas and away from channels sampled by the trawls, but the effects of other factors such as age structure, contaminants, entrainment, and habitat quality cannot be discounted (Sommer et al. 2011).

Distribution. Striped bass predominately spawn in the Sacramento River in May and June (Turner 1976), and Age-0 striped bass are associated with the low salinity zone (Sommer et al. 2011). Age-1 striped bass occupy nearshore areas in the Delta (e.g., flooded island habitats, Nobriga and Feyrer 2007). Adult striped bass are generally considered anadromous, but in their native habitat on the East Coast they show distinct behaviors, ranging from "resident" to "migratory" (Wingate and Secor 2007). While telemetry efforts have shown that adult striped bass frequently move throughout the Delta (Vogel 2011), evidence from otolith microchemistry indicates that Central Valley populations of striped bass have both resident and anadromous individuals (Walsh 2011).

Purpose

While numerous monitoring programs gather data on striped bass, these data are only occasionally summarized and examined across programs and the whole population range. Furthermore, it has been ten years since the Pelagic Organism Decline report synthesized information on striped bass in the Bay-Delta (Baxter et al. 2008). The aim of this study is to use striped bass abundance and distribution data from long-term monitoring programs (e.g., trawls, fish salvage, weir passages) in the tributaries, Delta, and Bay to provide a broader perspective on their spatial ecology.

Objectives

- Examine changes in striped bass site occupancy through time and space, to pilot an approach that could be applied to any species.
- Describe the spatial and temporal gaps in data collection throughout the Central Valley

Box 1. List of monitoring program data used for this poster and assessment.

- Fall Midwater Trawl: operated by CDFW monthly from September to December since 1967
- 20-mm Townet: operated by CDFW every-other-week from March to July/August since 1995
- Summer Townet: operated by CDFW every-other-week from June to August since 1959
- Bay Study: midwater and otter trawls operated by CDFW monthly, year-round since 1980
- Beach Seine: operated by USFWS, biweekly from January to June since 1977
- Enhanced Delta Smelt Monitoring (EDSM): Kodiak trawls operated by USFWS since December to August since 2016
- Creel Surveys: conducted by CDFW year-round; data from 1976-2009
- Weirs: fish counts were obtained from weirs on the Stanislaus River (since 2003), Tuolumne River (since 2009) and Yuba River (since 2004).

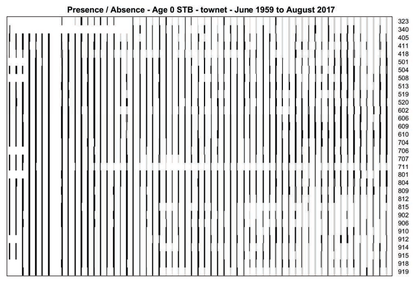

Figure 2. Example heatmap showing Age-0 striped bass detection / non-detection data from townet dataset (data from 1959 to 2017).

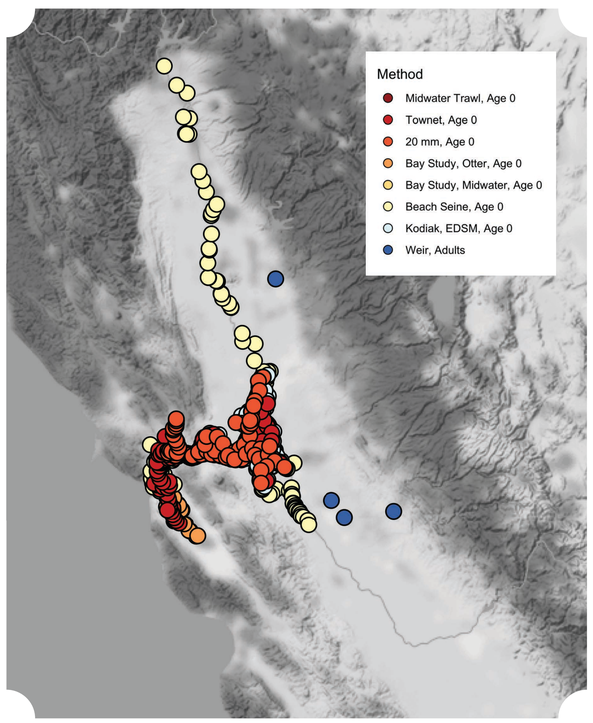

Figure 1. Overall distribution of monitoring sites (from 8 different monitoring programs described in Box 1) across the Central Valley. Color codes for each monitoring program are described in the legend. Note: creel data not included in map.

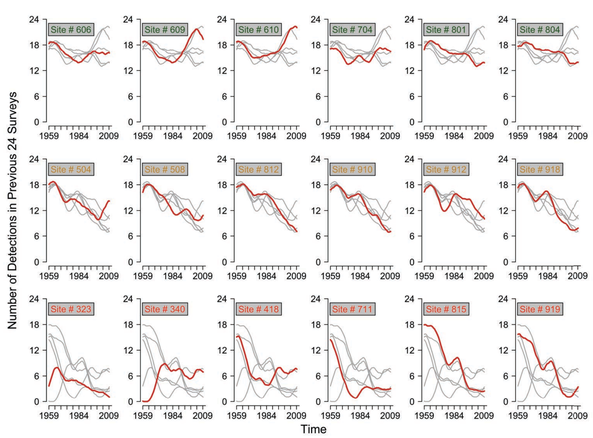

Figure 3. Long-term trajectories of naive site occupancy estimates of Age-0 striped bass from data from Figure 2. Data is grouped into three categories according to overall site occupancy (top row - high; middle row - average; and bottom row - low). The top row indicates sites with relatively stable trajectories; middle row shows trajectories that have declined moderately; and, bottom row have declined the most, relatively.

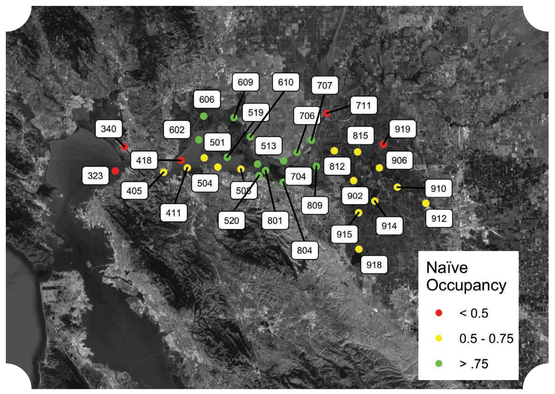

Figure 4. Townet stations where Age-0 striped bass occur, color coded by their trajectories as described in Figure 3. Note correspondence in locations with sites with estimates generally clustering together.

Methods

Data from numerous long-term monitoring programs throughout the Central Valley were gathered and summarized into presence/absence of striped bass (by age class) by month and year. Age-0 striped bass were the focus of this assessment with data compiled from eight different monitoring survey types (Figure 1; Box 1: Data Sources). Detection / non-detection (0 = no detection; 1 = detection) was summarized for each program (Figure 2). Then, the proportion of detection / non-detection at each unique monitoring site was estimated without accounting for imperfect detection (i.e., naive occupancy). These data were plotted over time to visualize changes in naive occupancy across the Central Valley.

As an additional component, we characterized the trajectory of naive occupancy for the longest running monitoring program, California Department of Fish and Wildlife's summer townet survey (began in 1959). This measure was calculated using a rolling mean function, which calculated the number of times each site was occupied over the previous 24 months. Sites were categorized as 'low' (<0.5), 'medium' (0.5< x <0.75), and 'high' (>0.75) levels of overall occupancy (i.e., total number of times detected / total number of surveys). These points were plotted to visualize locations or regions where no, little, or large amounts of change in detection has occurred for 60 years of data.

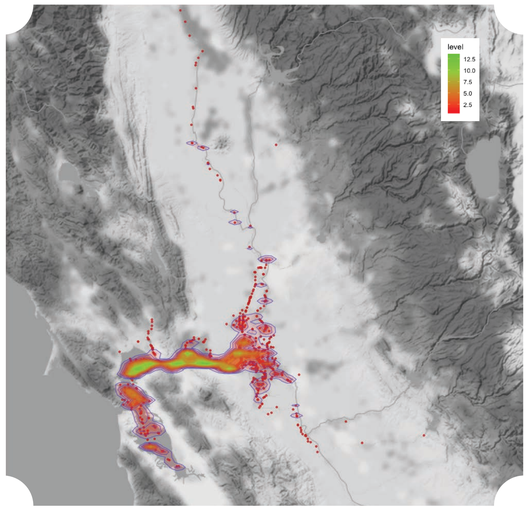

Figure 5. Monitoring effort (total number of months sampled over study period) heatmap for the entire data set used. With inclusion of effort, most heavily monitored regions include San Pablo and Suisun bays.

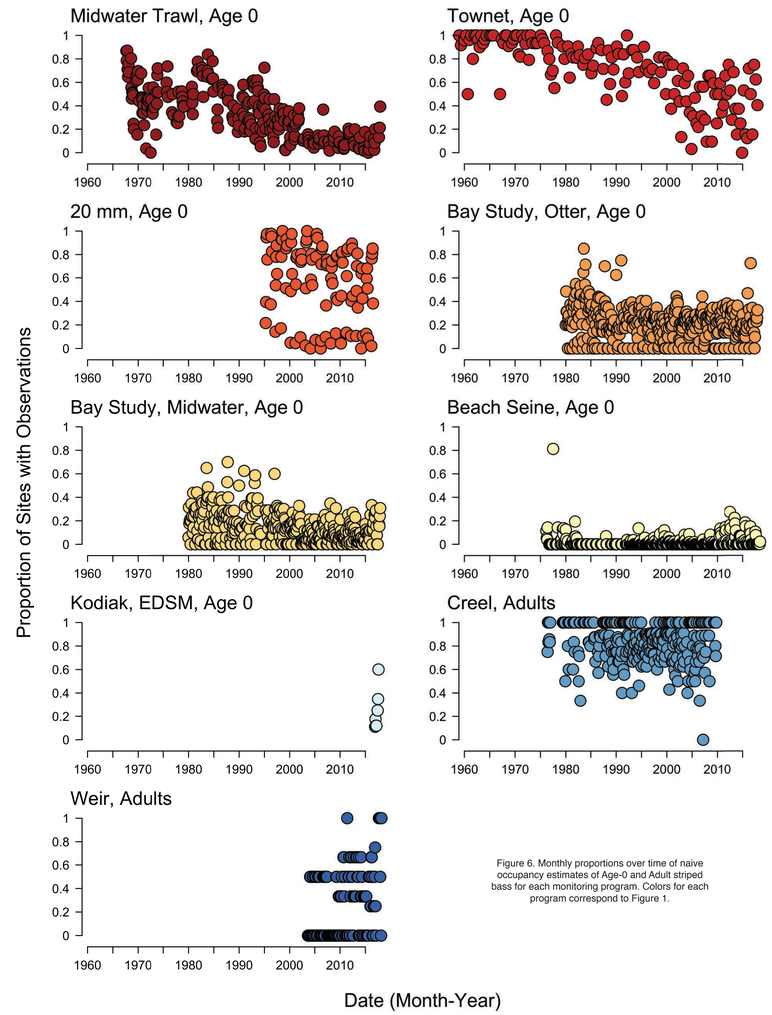

Figure 6. Monthly proportions over time of naive occupancy estimates of Age-0 and Adult striped bass for each monitoring program. Colors for each program correspond to Figure 1.

Outcomes

Changes in Occupancy through Time and Space

- Naive occupancy estimates (without accounting for detection) of Age-0 striped bass appeared to have declined or remained stable throughout the study period of each monitoring program.
- In general, trends in and magnitude of estimates appear to be relatively congruent despite differences in gears, locations, and durations of programs. Additionally, these estimates track with relative abundance indices from each respective monitoring program.
- Visualizations of naive occupancy estimates of Age-0 striped bass from townet data (CDFW) indicate spatial variation in declines with sites in the North Delta Arc showing relative stability. Declines were more pronounced with increased distance from the North Delta Arc.
- No apparent trends were observed using adult data, but inference may be limited due to relatively low numbers of sites relative to more widespread surveys.
- Adults striped bass have been utilizing riverine habitats more frequently than previously based on weir passages in the San Joaquin tributaries.

Spatial Gaps in Monitoring:

- Brown and Michniuk (2007) found that between the 1980s and 2000s there were significantly greater increases in non-native fishes (including striped bass) in the southern Delta, in comparison with the Northern or Western Delta regions; however, the density map of survey effort indicates relatively little effort in the South Delta.
- The CDFW striped bass population study (mark-recapture) provides population estimates of adult striped bass, but few programs provide subadult and adult bass distribution and occupancy information.

Next Steps:

- Continue incorporating more datasets (e.g., rotary screw trap data, additional seine data, etc.)
- Refine methods to account for imperfect detection
- Develop method(s) to integrate data across programs using similar approach
- Test with other species and/or fish communities
- Could be part of a larger synthesis to update and expand the POD conceptual model of striped bass in the Central Valley.
- Similar syntheses could be conducted regularly for any species of management concern, and made available through online fisheries databases and visualization tools such as Bay Delta Live.

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