Spatio-temporal Variability of Chorusing Fish

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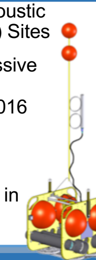
Introduction

Chorusing in fish is present in many waters of the world. Here we present a fish chorus of unknown origin, recorded at twenty passive acoustic monitoring stations throughout the Southern California Bight (500-1300 m depths). Two dominant signal types were observed with frequency bands between 150-275 Hz (Low Frequency) and 300-1000 Hz (High Frequency). These signals had similar diel patterns, consistently appearing throughout the night with crepuscular sound pressure level peaks, and with the strongest peak around sunset.

As distinct individual signals have not been identified within the choruses, we explore two sound source hypotheses: 1) the sound-producing fish are near the recorders in large numbers, masking each other by producing low intensity sounds, potentially from within the mesopelagic community; 2) the fish choruses originate from a distant area, for example from coastal fish populations, and propagate to offshore and deep recorder sites. We explored the spatio-temporal variability of the signals across the Bight.

Methods

- **Twenty** High Frequency Acoustic Recording Package (HARP) Sites
- **31 cumulative years** of passive acoustic recordings between 2005-2016
- Signal processing in Triton (and Matlab routines)
- Active acoustics processing in Echoview



Results

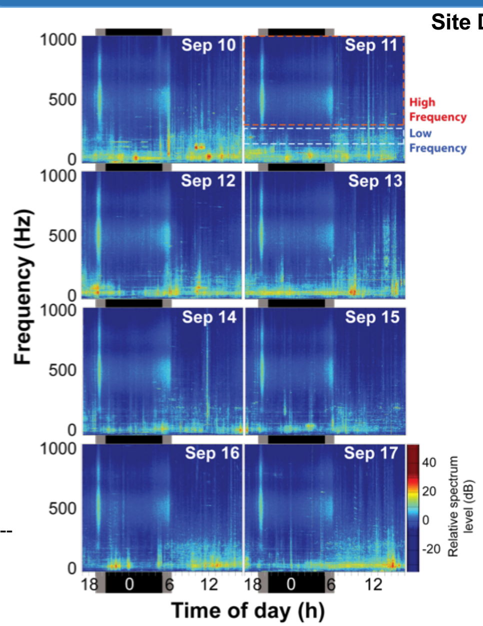


Figure 1. Daily Spectral Averages from the Del Mar (DM) Site (September 2016), with representative **low and high frequency bands** present.

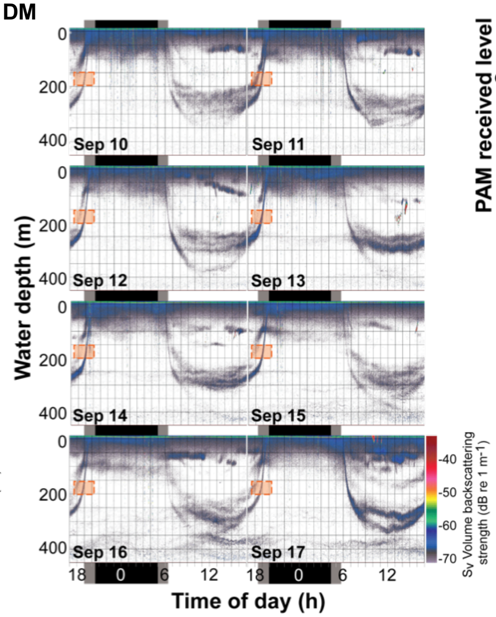


Figure 2. Upward-oriented 70-kHz echosounder at 500 m depth, site DM. Daily backscatter strength between 150-200 m depth at sunset (orange box) to provide estimates of mesopelagic migrators (see Figure 3).

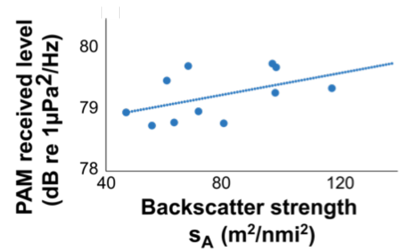


Figure 3. Positive relationship between backscatter strength and passive acoustic monitoring (PAM) received level.

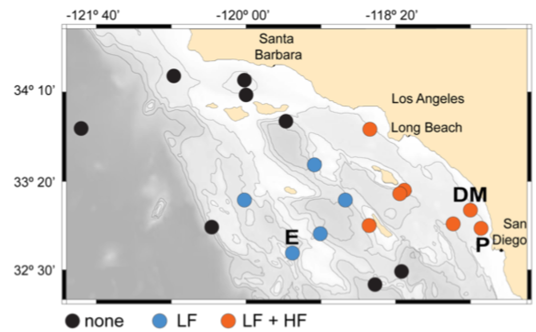
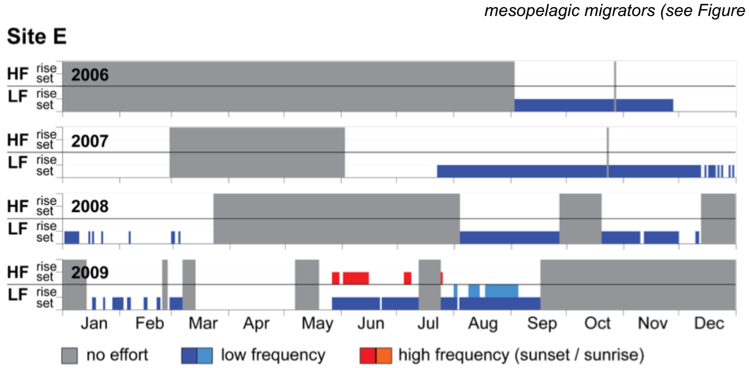


Figure 4. Sites in the Southern California Bight. Low and high frequency band present (orange), only low frequency band present (blue), and no signal (black).



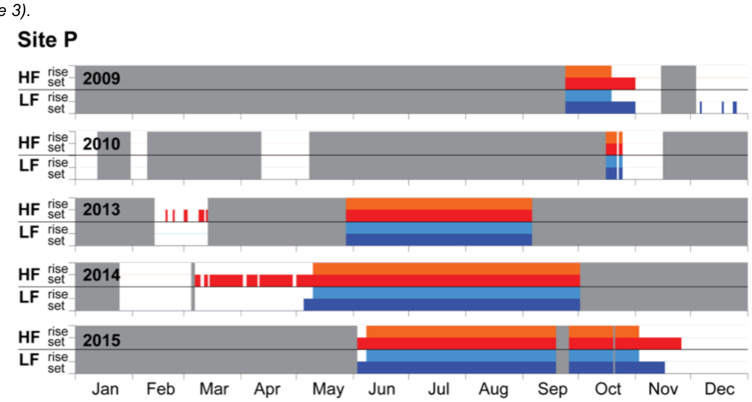


Figure 3. Low (blue) and high-frequency (red) signal presence for representative offshore (Site E) and inshore (Site P) sites.

Conclusions

- Positive relationship of received levels and backscatter strength; **connectivity** between source of sound and **mesopelagic migrators** (Figures 1-3)
- Spatial variability (Figure 4)
  - Inshore – Strong signal in all frequency bands
  - Offshore – Weak signal primarily in low frequency
  - Distribution implies **coastal community source**
- Temporal variability (Figure 5)
  - Inshore – Signal present March-November
  - Offshore – Signal present June-March
  - longer than most known fish choruses
- Inter-annual fluctuations in signal onset and end are likely caused by environmental variability. (Figure 5)

Future Directions

- Quantify signal amplitude over time and space.
- Model spatio-temporal presence.
- Model climate-related variability. Use climate indices and long-term, regional physical oceanographic data sets to examine variability in relation to the signals spatio-temporal occurrence.
- Use active acoustic data to examine links between backscatter strength and signal intensity and relation between coastal communities with vertical migrators

Acknowledgements

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