Original recordings of reef soundscapes and recordings of playbacks from coral reefs in St. John, U.S. Virgin Islands collected between 2013 to 2017

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Project
» Coral Chorus: The Role of Soundscapes in Coral Reef Larval Recruitment and Biodiversity (Coral Chorus)

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Abstract
Original recordings of reef soundscapes and recordings of playbacks used in Suca et al. (2020).

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Coverage

Spatial Extent: **N**:18.31 **E**:-64.704 **S**:18.301 **W**:-64.722
Temporal Extent: 2013 - 2017

Methods & Sampling

Experiment 1 Original Reef Recordings: Continuous recordings of Tektite and Ramhead reefs in August 2013 Pa
Experiment 1 Playback Experiment: Recordings Recordings of playbacks from experiment 1 in 2016 for each site in each night
Experiment 2 Original Reef Recordings: Continuous recordings of Tektite and Booby Rock reefs in summer 2017
Experiment 2 Playback Experiment Recordings: Recordings of playbacks from experiment 2 in 2017 for each site in each nightFull Methods can be found in Suca et al. (2020). The following descriptions are exercpts from the methods of this paper.

Units in these data are Pa.

Experiment 1 Original Reef Recordings: Natural reef soundscape treatments were randomly selected 24 h periods from a 4 d continuous recording of 2 nearby reefs, Tektite (18.310° N, 64.722° W) and Ram Head (18.301° N, 64.704° W) (see Fig. 1 in Suca et al., 2020). Initial recordings were made in August 2013 using a 120 kHz sampling rate and 50 kHz low-pass filter, and were down-sampled to 48 kHz for this experiment.

Experiment 1 Playback Experiment Recordings: The reef soundscape recordings were amplified using Adobe Audition (Adobe Systems) to ensure broadband SPLrms were similar to the original reef recordings. At the initiation of a given trial, the playback recordings were started at the time of day matching the start time of the experiment. This allowed the playback recordings to match the diel cycle, including the crepuscular fish chorus, of the local coral reefs. High and low sound level treatments were manipulated through the volume settings on the audio players such that the full-band SPLrms (0.1−20 kHz) of the high and low treatments were approximately 120 and 115 dB re 1 µPa, respectively. Because decibels are logarithmic, this 5 dB difference is equivalent to one treatment being about twice the amplitude of the other in terms of sound pressure. A silent file was played on loop as the silent control treatment to account for potential effects of the electromagnetic field generated by the playback equipment. Locations of treatments (high, low, and silent) were randomly selected each night to minimize confounding spatial effects on settlement.

Experiment 2 Original Reef Recordings: Soundscape playback treatments consisted of natural reef soundscapes, recorded continuously for 24 h from 1−4 nights prior to each trial. This allowed us to closely match season and lunar phase of fish settlement (unlike Expt 1), as reef soundscapes are known to vary (though weakly) at these temporal scales. Recordings were made using a SoundTrap ST300 with a 48 kHz sampling rate, at 2 reefs, both with high coral cover and fish abundance relative to other reefs in the region (Booby Rock, 18.302° N, 64.710° W; Tektite, 18.310° N, 64.722° W) maximizing the likelihood of elevated SPLrms in frequencies below 3000 Hz. While it is unlikely that most fish hear the high frequencies of snapping shrimp, it is worth noting that these reefs had similar SPLrms in the snapping shrimp acoustic band (which generally have greatest acoustic energy above 2000 Hz). Five continuous recordings of reef sounds were collected and used for playbacks.

Experiment 2 Playback Experiment Recordings: A hydrophone (SoundTrap ST300, Ocean Instruments) was attached to the bottom of each light trap and recorded at a sampling rate of 48 kHz for 63 s every 5 min to acquire sufficient recordings of playbacks while maximizing the efficiency of data processing. The playback experiment was conducted for 13 nights, with 10 nights occurring in July and 3 in August. Five continuous recordings of reef sounds were collected and used for playbacks. Three of these recordings were collected at Tektite reef and 2 at Booby Rock reef. Most recordings were used for less than 3 playbacks, except for 20−23 July when the same recording was used for 4 experiments due to time constraints precluding the collection and processing of an additional continuous recording. Overall, this randomization of multiple acoustic treatments sought to reduce pseudoreplication of sound stimuli and more closely replicate natural soundscapes from reefs with abundant fish sounds. The continuous recordings of reef soundscapes were amplified and initiated, and treatments (high, low, silent) were assigned in the same manner as Expt 1.

Instruments:
Experiment 1: DMON; Woods Hole Oceanographic Institution; flat frequency response from 100 Hz to 50 kHz and total design sensitivity of −167 dB re V/µPa

Experiment 2: SoundTrap ST300; Ocean Instruments; ST8 = -171.3 dB re V/µPa; ST10 = -171.9 dB re V/µPa; ST4 = -171.2 dB re V/µP

Data Processing Description

Experiment 1: Acoustic recordings of the playback treatments and original recordings of reef soundscapes were processed using Matlab 9.2 (MathWorks). Prior to calculating SPLrms, data were down-sampled to 48 kHz and filtered to a 100−3000 Hz band (lowband) using a 4th order Butterworth filter for analyses relating playback to fish catches, though power spectral density (PSD) was also computed for the 100− 20 000 Hz band. This frequency range omits low frequency electronic noise from the recording system, encompasses acoustic frequencies that reef fish are known to detect and is near the approximate cutoff frequency (~128 Hz) for this experiment based on water temperature, depth, and substrate. The SPLrms values were calculated from 1 min samples, each spaced 5 min apart, to generate a median SPLrms for each treatment level of each trial; median values were used because soundscape data are often not normally distributed. This also minimized the effects of noise from passing vessels, which generate high amplitude, but short duration, low frequency sounds that inflate mean SPLrms values. However, files containing boat noise from the vessel used to deploy and recover the experimental equipment were excluded from use in the analysis. For each treatment in each trial and the original recordings of reef soundscapes used for playbacks, PSDs (in dB re 1 µPa2 /Hz, with 1 Hz and 1 s bins, with 50% overlap of time bins) of each recording were calculated using Welch’s method to assess the power of the soundscape at various frequencies.

Experiment 2: Acoustic recordings of the playback treatments and original recordings of reef soundscapes were processed using Matlab 9.2 (MathWorks). SPLrms values for low-band (100−3000 Hz) frequencies for each treatment and PSDs were calculated in the same manner as Expt 1, including identical treatment of vessel noise.

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Related Publications

MathWorks (2017), MATLAB version R2017a (9.2) Documentation, The Mathworks, Inc. Retrieved November 13, 2020 from https://www.mathworks.com/help/releases/R2017a/index.html
Software

Suca, J., Lillis, A., Jones, I., Kaplan, M., Solow, A., Earl, A., ... Mooney, T. (2020). Variable and spatially explicit response of fish larvae to the playback of local, continuous reef soundscapes. Marine Ecology Progress Series, 653, 131–151. doi:10.3354/meps13480
Results

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	DMON, Woods Hole Oceanographic Institution
Generic Instrument Name	Acoustic Recorder
Generic Instrument Description	An acoustic recorder senses and records acoustic signals from the environment.

Dataset-specific Instrument Name	SoundTrap ST300
Generic Instrument Name	Hydrophone
Generic Instrument Description	A hydrophone is a microphone designed to be used underwater for recording or listening to underwater sound. Most hydrophones are based on a piezoelectric transducer that generates electricity when subjected to a pressure change.

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Project Information

Coral Chorus: The Role of Soundscapes in Coral Reef Larval Recruitment and Biodiversity (Coral Chorus)

NSF Award Abstract:
Coral reef ecosystems host some of the highest biodiversity of life per unit area on Earth and harbor about

one-quarter to one-third of all marine animals. Reef-associated animals are a major source of protein for millions of people, and reefs offer shoreline protection and provide a significant source of tourism revenue, especially in developing countries. Factors that influence supply and settlement of young (larval) fish, coral, and associated animals can have large impacts on reef ecosystem and population structure, and learning more about these can help improve understanding of how to maintain the benefits provided by coral reefs. This study will lead to a detailed, mechanistic understanding of how young larvae use natural sounds to orient toward, locate, and select preferred settlement habitat. The approach will combine detailed field measurements and experiments to isolate key soundscape variables that impact coral reef larvae.

For marine communities, such as those on coral reefs, factors influencing larval supply and settlement can have major impacts on community structure and population replenishment. There are now some indications that sound plays an important role in attracting larvae to suitable settlement habitat. There is little understanding of what soundscape habitat information is available to larvae and how differences and variability in sound can influence settlement. This project will include comprehensive experiments, environmental measurements, and modeling with the goal of understanding the role of sound in influencing larval recruitment and local biodiversity. The investigators will measure in situ settlement of larval fish and coral in relation to different soundscapes and habitat conditions in a marine protected area using traditional larval sampling methods, moored acoustic recorders, and a suite of environmental observations. Controlled and calibrated environmental playback experiments will isolate soundscape components and determine specific and fundamental acoustic cues larvae use to orient and settle. The spatial and temporal variability of soundscape cues and components across reef habitats will be established. Finally, the project will determine the relevant ranges of sound plumes that larvae may encounter through direct measurements of the sound fields of multiple reefs.

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Funding

Funding Source	Award
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