**Methods**

* Hydrophones were deployed at 5 sites around Kiritimati in the summer of 2017 and the summer of 2018.
* Hydrophones were set to a duty cycle of 5 minutes of recording for every 15 minutes deployed.
  + Recordings occurred every 15 minutes of the hour (9:00, 9:15, 9:30, etc.)
* While these hydrophones were deployed, at least 3 fish surveys were conducted at each site
  + Fish surveys consisted of belt transect surveys…etc…etc
* At the end of the field season hydrophones were recovered and brought back to the University of Victoria for analysis.

**Analysis Methods**

* Before analysis, several steps were taken to control for any anthropogenic influences to the reef soundscape
* All sites were scanned with a boat detector and any samples involving boat noise were removed
* All dates in which the site was visited by divers were removed

To analyze diurnal patterns in acoustic variability:

* ACI and SPL were calculated for all samples at all sites to determine diurnal patterns
  + ACI and SPL were calculated in 3 different frequency bands:
    - 50 – 22000 Hz – **Broadband**
    - 100 – 1000 Hz – **Low Frequency**
    - 1 – 22 kHz – **High Frequency**
* Four time periods were determined that were representative of the diurnal pattern
  + 3:00 AM – the highest period of SPL
  + 9:00 AM – the “decreasing” period of SPL
  + 3:00 PM – the low period of SPL
  + 9:00 PM – the “growth” period of SPL
* \*\***This pattern was observed in the opposite for ACI**
* ~~Every other day was sampled at these four times~~.
* Every day that no divers visited any of the sites were sampled.
  + ~~Days in which the boat was present at the site were discarded to avoid any interaction effects between the boat/divers and fish calls~~
  + These days were sampled to eliminate the need to include tide, waves and weather as random effects in the model
* At each of the four sampling times one 5 minute sample was analyzed:
  + Snaps were quantified using a detector set to a frequency and time threshold
  + Individual fish sounds were quantified (falling between 100 and 1000 Hz)
  + Knock trains were quantified (each train was quantified as 1)
  + Long calls were quantified and identified (each identifiable call was quantified as 1)
    - Identifications only show presence absence as “long call” groups all long calls
    - However, counts are done in 10 s intervals so you can map the number of times it was present within a 5 minute sample

To analyze temporal changes associated with species assemblages at each site:

* Samples were taken \_\_\_\_\_\_\_\_ around fish surveys conducted at the sites
* Samples were analyzed as described above
* Correlations between fish communities and acoustic measures were found using a multivariate analysis

**DRAFT 1**

To assess the effect of temporal and spatial changes on coral reef bioacoustics soundscapes, this research project included 5 sites around Kiritimati, Kiribati which varied in coral cover, fish abundance, and proximity to human habitation. Reefs were chosen based on a gradient of human impact (**JULIA GRADIENT PAPER**) to represent the breadth of the gradient while keeping deployment and retrieval availability in mind. All recordings and fish surveys ranged between 10 – 12 m.

**Visual Surveys**

Fish communities were characterized through SCUBA visual surveys during the periods of acoustic sampling. Visual fish surveys were conducted along 3 consecutive 25 m belt transects, each separated by 10 m along the 10 - 12m isobath. Two divers identified all fish to the species level. Fish > 20 cm were enumerated while deploying the transect within an area of 4 m on either side of the transect. At the end of their 25 m transect they returned to the start, enumerating all fish < 20 cm within an area on either side of the transect. Fish surveys were conducted multiple times at each site at different times of day to determine any effects that changing communities of fish might have on the reef soundscape.

Benthic cover was identified using 1m x 1m quadrats, photographed at a perpendicular angle. X quadrats were photographed at each site along a 100 m transect. These photographs were analyzed using CoralNet TM to identify a representative sample of the benthos underneath each of the quadrats. Surveys for fish and benthic cover were carried out along the same heading and the acoustic recorder was placed within a few meters of the surveys.

Fish data were grouped by trophic level (Herbivores, Carnivores, Detritivores) (**YAEGER REF**) and summarized as fish density (**UNITS?**) at each reef. Benthic data was classified by coral type (**???**).

**Acoustic Recordings**

Acoustic measurements were made using autonomous long-term SoundTrap hydrophones deployed at each of the 5 sites around Kiritimati in 2017 and 2018. Each SoundTrap recorder consists of a calibrated omnidirectional cylindrical hydrophone (sensitivity re V/μPa, range 20 Hz - 150 kHz), pre-amplifier and digital recorder (high gain, 16-bit, 288 kHz sampling rate), as well as an ancillary temperature sensor (±0.5°C) with duty cycles set to 5 min/15 min. All hydrophones were fastened to iron rods used for long term sampling at sites around Kiritimati, roughly 1 meter from the seafloor by SCUBA operators. In 2017, deployments lasted from July 11 to July 25 while 2018 deployments lasted from June 18 to June 27.

**Acoustic Analysis**

Post-processing was carried out in Matlab (**VERSION?**) using customized scripts written specifically for these data. Data was sampled to include only days in which divers were not visiting any of the acoustic sites. Sound pressure level (SPL) was then calculated for each 5 minute recording by using a (**WHAT KIND**) filter in 3 frequency bands: Broadband (50 – 22000 Hz), Low Frequency (100 – 1000 Hz), and High Frequency (1000 – 22000 Hz).

Acoustic Complexity Index (ACI) was calculated for each 5 minute file (ACI; Pieretti et al. 2011) using a temporal step of **WHAT** and FFT size of **WHAT**. ACI was calculated in the same three bands as SPL: Broadband, Low Frequency, and High Frequency.

To sample for diurnal changes seen in the soundscape, audio files were subsampled to include only 4 times of day, 0300, 0900, 1500, and 2100 hours.

These files were then visually analyzed using Raven Pro 1.5 (**HOW DO I REF THIS**) to enumerate and identify fish calls to determine their effect on ACI and SPL within the low frequency band (100 – 1000 Hz). Snaps produced by snapping shrimp were counted using a detector set to a dB and time threshold determined using Raven Pro 1.5.