Biological Studies with the Charles Darwin Research Station: Fish Maturation Rates for Fisheries Management, Native Plant Restoration, Plankton Ecology for Future MPAs, and Megafauna Community Assessment

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Fertility and Maturation of Scorpionfish

Pontinus clemensi, the Mottled Scorpionfish, has become a popular target for local fishermen of the Galápagos Islands, however, the increase in fishing and the lack of information about this fish has led to an investigation to try and conserve the species. César Reyes, a student at Escuela Superior Politécnica del Litoral in Ecuador, studied the breeding patterns by analyzing the gonadal cells of *P. clemensi.* Ultimately, the research will be used by the Galápagos National Park to create a management plan for *P. clemensi*. The study spanned from November 2014 through August 2015.

1. *P. clemensi* samples were obtained from local fishermen in Puerto Ayora, Santa Cruz and on fishing excursions to multiple islands and islets surrounding Santa Cruz, Galapagos (Figure 1).
2. Dissections focused on removing the stomach, liver, guts, otoliths, and gonads. Measurements were used to calculate parameters of growth for each fish.
3. Histology of the gonadal tissue was conducted.
4. Microscope slides of the gonadal tissue were made from cutting of the paraffin blocks using a microtome (Figure 2).
5. Gonadal cells were classified by their maturity stage (Figure 3).

At the conclusion of the study the research would suggest that *P. clemensi* do not have only one spawning event per year, (like other fish) but rather they spawn year round with one main spawning event in September.

Figure 1. Cesar Reyes on board a local fishing vessel reeling in *P. clemensi* samples.

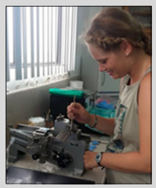

Figure 2 (right). Morgan Freeburg using the microtome to make microscope slides.

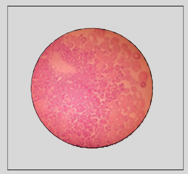

Figure 3. *P. clemensi* gonadal cells under the microscope, the final product.

Plankton Community Comparison

Plankton play an important role in marine habitats. In Galápagos, the plankton species have been identified, but the list of species present is not yet complete, nor has there been a detailed comparison of plankton communities between seamount (a hotspot for diversity in otherwise open ocean) and pelagic habitats. Casey Aumann worked with Ana Moya and Maria Mar, students at Universidad Internacional del Ecuador, to examine the plankton communities between these two habitat types. Seamount habitats were expected to have greater abundance, richness, and biomass of both phytoplankton and zooplankton due to upwelling currents.

1. Plankton samples were collected from one pelagic site and four seamount sites, a CTD (or sonde, an instrument used to collect conductivity, temperature, and depth measurements) was used to find maximum fluorescence to determine at what depth to deploy plankton nets.

2. Zooplankton and Phytoplankton were separated using mesh nets.

3. Zooplankton were identified, counted in a Bogorov chamber to estimate total counts (Figure 4 and 5).

4. Phytoplankon microscope slides were created via sedimentation chambers, identified, measured, and counted (Figure 6).

5. Zoo- and phytoplankton were dried and weighed separately to estimate biomass.

The information collected from this study will hopefully lead to more extensive studies comparing the habitat types to investigate the potential for more protection of seamounts from marine traffic.

Figure 4: Zooplankton study equipment including Bogorov chamber for count estimates, microscope for identification and measurement needles for extraction and manipulation of individuals, and small vials for storage of species.

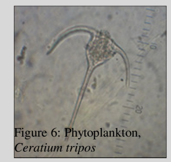

Figure 6: Phytoplankton, *Ceratium tripos*

Figure 5: Zooplankton, *Corecaeus affinis*

Stereo-video Assessments

Two projects worked on by students, Morgan Freeburg and Casey Aumann utilized stereo-video techniques. One study sought to identify the differences in community assemblage and megafauna between mangrove habitats in protected and unprotected environments. The other study looked at the shark population dynamics and distributions throughout the Galapagos Islands. Students were involved in video collection during the study on sharks and video analysis during the study on mangrove habitats.

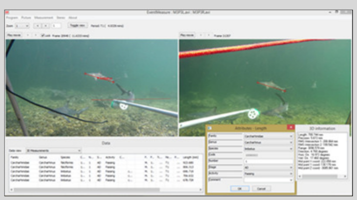

Figure 7: Screenshot taken of the video analysis process. Max N of megafauna, *Carcharhinus limbatus*, and measurements, age, sex, and behavior for each individual of the Max N frame being recorded.

Mangrove Habitat Comparison

All species that entered the video frame were identified.
Max N (maximum number of individuals for each species) were recorded for each video.

Additional information such as approximate age/life stage, sex, behavior, and body measurements were recorded for megafauna (Figure 7).

Shark Populations and Distribution

To determine the species present in the Galapagos Islands, their distributions, and relative abundance and population dynamics, stereo-video data were collected at many sites throughout the Galapagos Islands and in pelagic and non-pelagic environments. Students assisted with the preparation and deployment of the stereo-video apparatus to collect the videos (Figure 8).

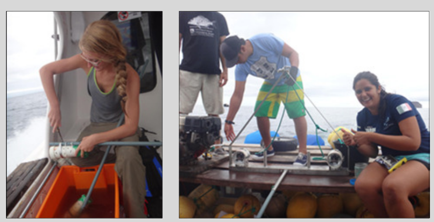

Figure 8: Student, Casey Aumann, preparing bait canisters used to attract sharks to the stereo-video apparatus (A) and the stereo-video apparatus being prepared for deployment (B).

Native Plant Restoration

Introduced species are the biggest threat to terrestrial biodiversity of the Galapagos Islands. Patricia Jaramillo, the leader of a project called Galapagos Verde 2050, aims to restore large swaths of inhabited as well as uninhabited islands with the help of endemic plants. The project hopes to control and/or eradicate invasive species in areas of high economic importance, as well as contribute to economic growth through year-round sustainable agriculture. In order to achieve the goals set out for the project, various day to day tasks had to be completed including:

1. Seeds were collected from numerous endemic species such as *Scalesia affinis spp. Affinis*, *Opuntia echios var. echios*, and *Parkinsonia aculeata*
2. Seed coatings were removed and the seeds were dried
3. The various seeds were germinated and the seedlings were reared until they were large enough to be planted on the islands they came from
4. Data were gathered every month for heights as well as the state (healthy, unhealthy, dead) and the latitude/longitude of each plant (Figure 10)

A new technology has been implemented in order to speed up the recovery process of endemic plant species. This technology, known as Groasis Technology (GT) or a waterboxx acts as a reservoir that collects rainwater and continuously supplies that water directly to the plants' roots. Since the plants receive a constant supply of water, they tend to grow at a much faster and much healthier rate than their counterparts that do not have the aid of a waterboxx.

Figure 9: Informational board about Galapagos Verde 2050, assembled on Floreana Island for educational purposes.

Figure 10: Student, Jesse Hagen and worker, Fabian Masaquiza gathering data (height, condition, location) of a *Scalesia affinis spp. Affinis* individual.

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