

RSG-11055-1
Progress Report
May 2013

Project title: Linking conservation and livelihoods in Lakshadweep's tuna fishery: Community-based monitoring of baitfish populations along a gradient of fishing pressure.

Principal Investigator: Mahima Jaini

Summary

Coral reefs around the world are under the threat of climate change, ocean acidification and overfishing. In the coral atolls of Lakshadweep, the oceanic tuna fishery has helped divert fishing pressure off the reef. The Lakshadweep live-bait pole and line tuna fishery utilizes small planktivorous fish from island lagoons and reefs to harvest oceanic skipjack tuna; Targeting the lower trophic levels in the reef ecosystem and top predators in the open ocean system, thus avoiding the sensitive slow growing, late maturing top predators on the reef. This project aims to assess the status of baitfish populations, understand the dynamics of the live-bait tuna fishery and initiate community-based catch monitoring programs. Our study is the first to conduct an in-water assessment of baitfish resources. We focused our efforts on four islands with increasing levels of fishing pressure; Kadmat, Kavaratti, Agatti and Minicoy. Tuna fishermen preferentially use clupeids (*Spratelloides delicatulus* and *S. gracilis*) as live-bait, but also turn to small planktivorous caesionids, apogonids, serranids, pomacentrids and atherinids. On the reef we sampled baitfish using 60 minute random swims and in the lagoons we conducted 50 m timed transects and point counts. Our results show that high densities of baitfish were found in Kavaratti. A weak association between fishing pressure and lagoon baitfish (clupeids and atherinids) was observed for the study islands. Minicoy and Agatti islands that are known to harvest lagoon apogons and pomacentrids, respectively, showed the lowest densities for their target species. Decline in *Spratelloides* populations may be linked to their harvest at time of spawning.

We chose to study baitfish populations due to concerns that were raised by the community over 2 years ago. From our experience there seems to be an inverse relationship between tuna catch and baitfish availability. The 2012-2013 season was especially poor for tuna harvest. Conversations with fishermen, government officials and locals highlighted concerns over declines in tuna catches, whereas baitfish populations were of minimal concern. Currently islanders have been landing undersized tuna, a trend that may be linked to the rapid use of FADs in these regions. We are interested in initiating catch-monitoring programs for both baitfish and tuna with hopes of building a conservation culture among resource users and managers in order to facilitate a paradigm shift from one of exploitation to that of sustainable utilisation. Our time in the islands has informed us about how we may proceed with this. We hope to be back there by end August to do some pre-fishing season surveys and initiate the catch monitoring program. In addition to this we also plan on conducting some educational seminars to clarify and build on the concerns that locals generated during our interactions with them.

Introduction

The Lakshadweep islands constitute an archipelago of coral atolls that lie 200-400km off the south west coast of India. With dense human populations, limited land area and ecologically sensitive coral reefs, sustainable development in these islands is of utmost concern. Coconut cultivation and tuna fishing constitute the two main sources of livelihood for the Lakshadweep islanders. Skipjack tuna (*Katsuwonus pelamis*) is harvested with traditional pole and line technology that utilizes small lagoon and reef planktivorous fish as live-bait. The tuna fishery reduces the pressure on sensitive coral reef fish groups. Recent declines in tuna and live-bait catch is a cause for social and ecological concern.

This study constitutes the first in-water assessment of the live-bait resources in the Lakshadweep islands. The tuna fishery opportunistically utilizes a wide array of small planktivorous fish that are found in island lagoons and reefs. Fishers preferentially target clupeids – *Spratelloides delicatulus* and *S. gracilis* but also use small planktivorous fusiliers (caesionids), anthias (serranids), cardinal fish (apogonids) and damselfish (pomacentrids). Our efforts were focused on three islands; Kadmat, Kavaratti and Agatti, with varying levels of fishing pressure. We were also able to include an assessment of the southernmost Lakshadweep Island – Minicoy. Further research in Minicoy may prove to be very informative as this island has a distinct culture, with traditional management practices and distinct resource use history.

The various components of this study have been undertaken with a view to developing a community-based monitoring project for baitfish species commonly utilised in tuna fishery. As the first part of the study for collecting base-line information, we designed an in-water sampling protocol to assess the live-bait populations. These were designed and undertaken both within the lagoon and on the reef across four islands with varying levels of fishing pressure. Our discussions with fishers and other key informants regarding baitfish and tuna catch, and the possibility of establishing long-term community-based resource monitoring programs revealed a set of recent developments linked to decline in tuna catch. Conversations with fishermen, government officials and community members revealed concerns about tuna availability as a result of which the baitfish problem is increasingly seen as less relevant. To tide over the crisis in tuna availability, exploitation of fishery resources from the coral reefs is being contemplated. Reef fishery, which was hitherto buffered by a focus on tuna resources, is increasingly seen as a viable alternative. In the light of these developments, we are reworking the project objectives to develop a revised monitoring framework that will capture these aspects of the changing fishery.

Methods

In our original proposal we had planned on conducting socio-ecological surveys of 3 Lakshadweep islands; Kadmat, Kavaratti, Agatti; initiating a catch monitoring program and documenting the dynamics of the live-bait tuna fishery in terms of its efficiency and management regimes. Over 5 months of fieldwork we have been able to conduct a thorough ecological assessment of baitfish resources. We have also conducted social surveys to document the state of the live-bait tuna fishery. In addition to our main 3 islands, we were able to extend our surveys to Minicoy as well. Involvement with fisherfolk has provided insight as to how one would proceed with a community-based catch-monitoring program. Over the next few months we hope to plan out the baitfish tuna catch monitoring protocol. Once the monsoon is over we plan to be back in

the islands mid-august to early September to initiate the community-based catch monitoring, continue our socio-ecological surveys and study of baitfish tuna fishery dynamics.

Ecological surveys

Tuna fishermen use a variety of different species as live-bait. Certain groups are found on the reef at average depths of 8-10 m where as others commonly occur in the lagoon either free swimming or associated with coral boulders. In order to document the various groups in their various habitats we devised 3 different sampling methods.

On the reef we conducted 60 minute timed random swims, at depths ranging between 6-12 m, using SCUBA and documented all planktivorous caesionids, clupeids, atherinids, pomacentrids, apogonids and serranids along with size, species and number. In each island we sampled 10 sites (5 on the Eastern side and 5 on the Western side). In Minicoy, we sampled 5 sites in total (3 on the East and 2 on the West).

Lagoons were divided into a 500 m x 500 m grid, with each grid cell representing a sample site. Lagoon sites were randomly selected from the grid to constitute at least 10% of the lagoon area (Table 1). For each site, 14-15 50 m transects were swum to observe the lagoon small free-swimming silver baitfish (clupeids and atherinids). Stationary pomacentrids and apogons that associate with coral boulder were point counted and standardized for comparison using the average surface area of the coral boulder (Table 1).

Table 1. Lagoon sampling details by island. Total lagoon area statistics were obtained from the Lakshadweep Department of Science and Technology

Island	Total Lagoon Area (km ²)	Total # of 500 x 500 m ² Sites (% Area sampled)	Total # of coral boulder point counts
Kadmat	37.5	15 (10%)	71
Kavaratti	4.96	4 (20%)	37
Agatti	17.5	11 (16%)	73
Minicoy	30.6	8 (7%)	53

Social surveys

Interviews were conducted to assess current & historical tuna and baitfish landings, decipher fisher perspectives regarding factors responsible for ongoing catch changes, and gauge interest in community-based monitoring of baitfish and tuna resources. Due to difficulties with finding translators in the field, one was only able to conduct the bare minimum for formal interviews; 2 in Kadmat, 3 in Kavaratti, 4 in Agatti and 1 in Minicoy; thus limiting interisland comparisons. General interviews were also conducted in all islands with locals and government officials.

Results & Discussion

Ecological Assessment

Landings records from 2006 show Minicoy leading in Tuna production accounting for 24% of the entire archipelago catch, Agatti is a close second at 23%, Kavaratti ranked 5th with 9% and Kadmat had the lowest landings at less than 2% coming in last at 11th place (Directorate of Planning & Statistics, Lakshadweep, 2007). Using this landings data as a proxy for fishing

pressure we arranged our islands along a gradient of increasing fishing pressure - Kadmat, Kavaratti, Agatti and Minicoy, to assess the impact of fishing on baitfish and tuna populations.

Reef baitfish

Highest densities of clupeids were observed in Kavaratti & Agatti islands indicating that factors other than fishing pressure may be impacting these populations (Figure 1). It is also important to note that Kavaratti, despite having fairly decent levels of fishing pressure (5th in 2006 Tuna landings), has some of the highest baitfish densities on its reefs (Figure 1 through 4). Kavaratti is observed to be distinct from the other islands in terms of coral health as well, different oceanographic regimes (upwelling, currents etc) have been hypothesized as reasons behind its uniqueness. Further research is required to understand the dynamics of the reef system in Kavaratti. The results of the reef survey have high standard error (SE), due to high spatial and temporal variability inherent in such populations, thus making inter-island comparisons challenging.

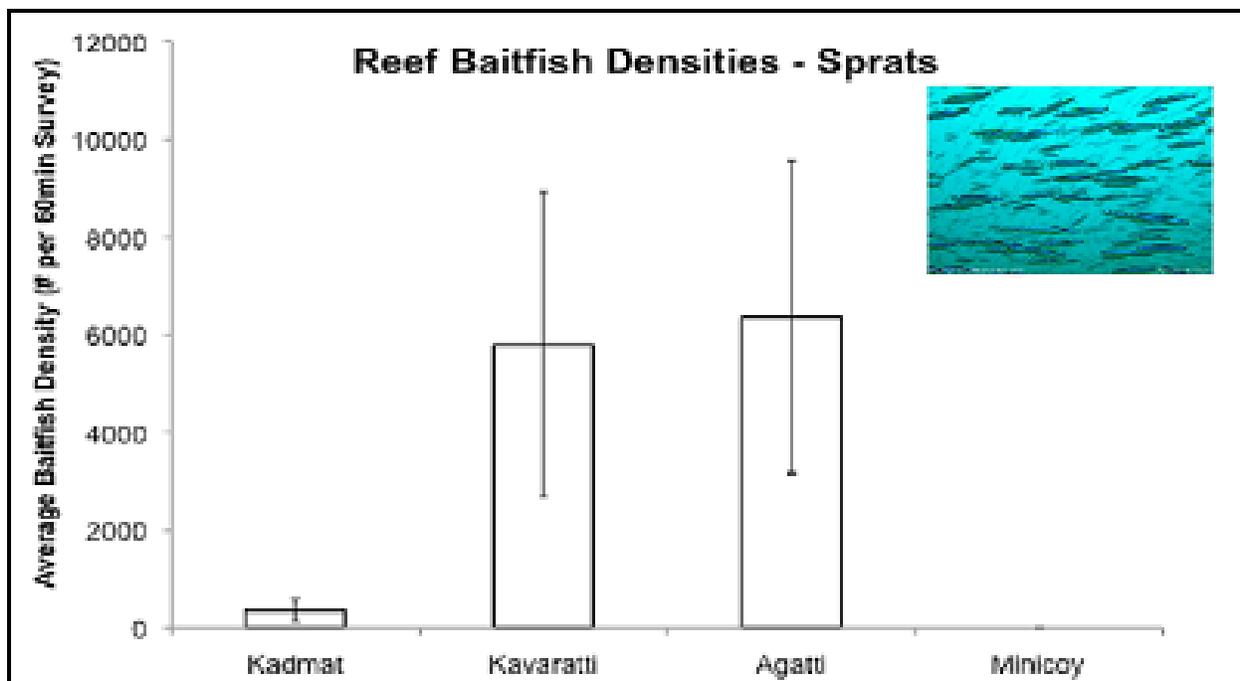


Figure 1. Average # of clupeids (*Spratelloides gracilis* and *S. delicatulus*) observed per 60 minute dive survey for reefs of four Lakshadweep islands in the 2012-2013 season. Islands are arranged in increasing order of their 2006 tuna landings. Error bars indicate \pm SE.

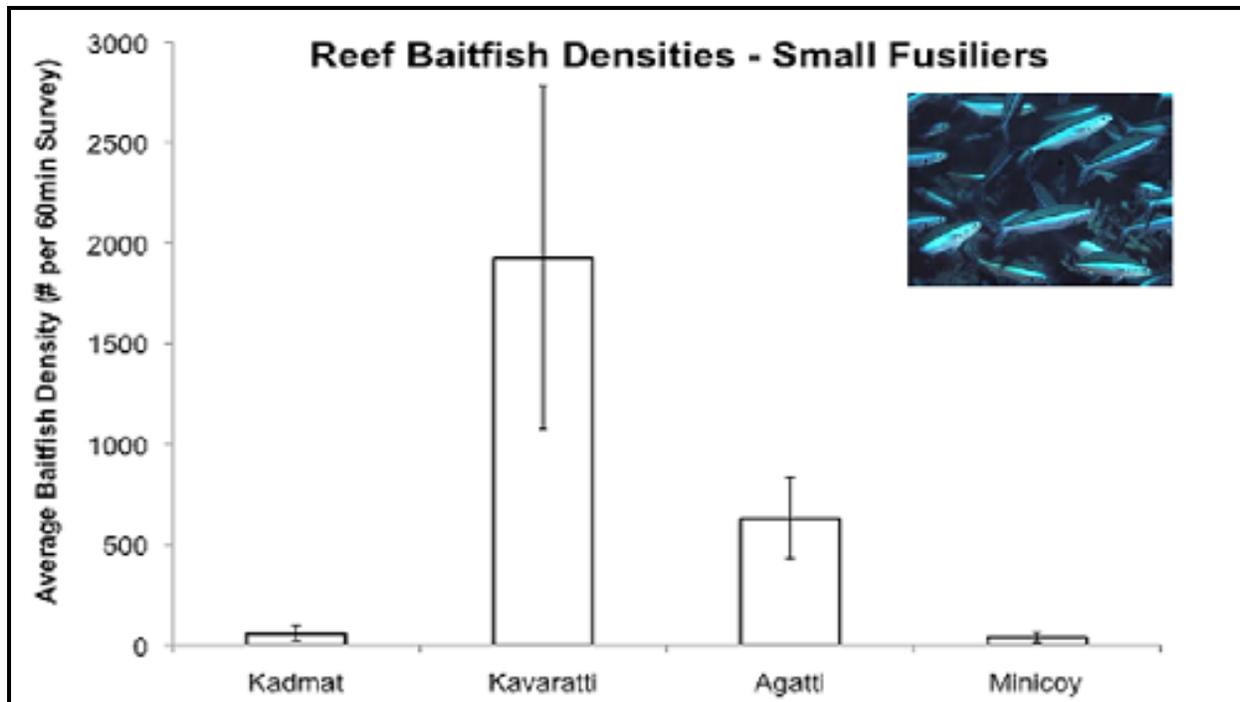


Figure 2. Average # of small fusiliers (<15cm total length) observed per 60 minute dive survey for reefs of four Lakshadweep islands in the 2012-2013 season. Islands are arranged in increasing order of their 2006 tuna landings. Error bars indicate \pm SE.

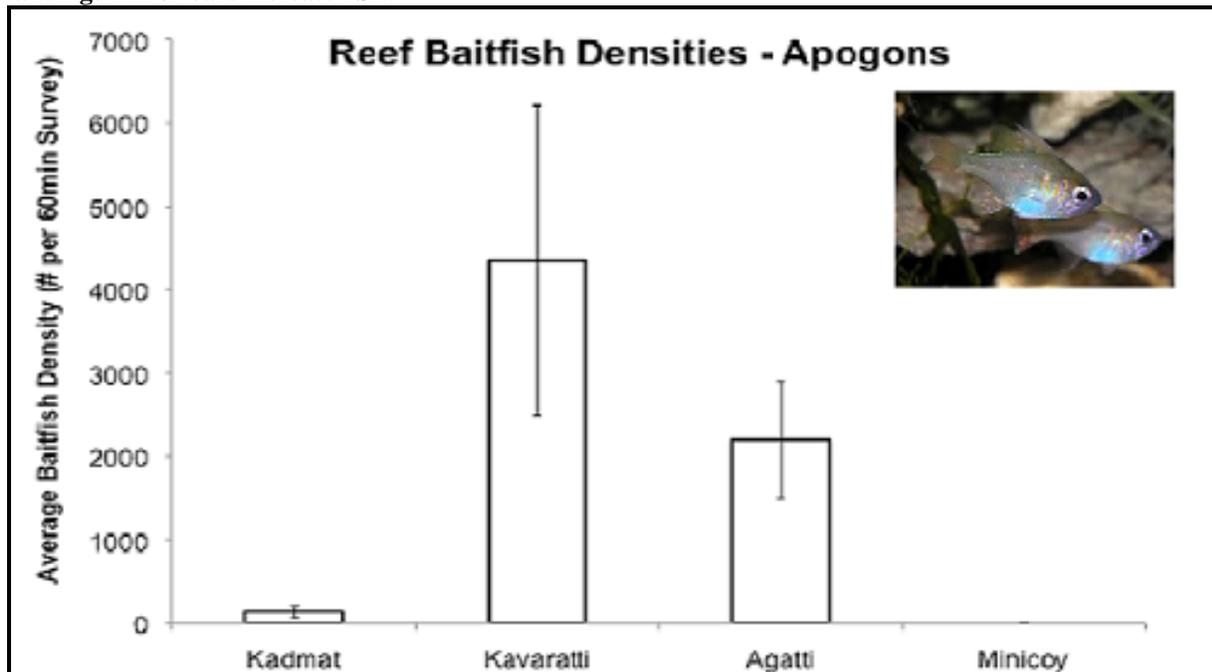


Figure 3. Average # of apogons observed per 60 minute dive survey for reefs of four Lakshadweep islands in the 2012-2013 season. Islands are arranged in increasing order of their 2006 tuna landings. Error bars indicate \pm SE.

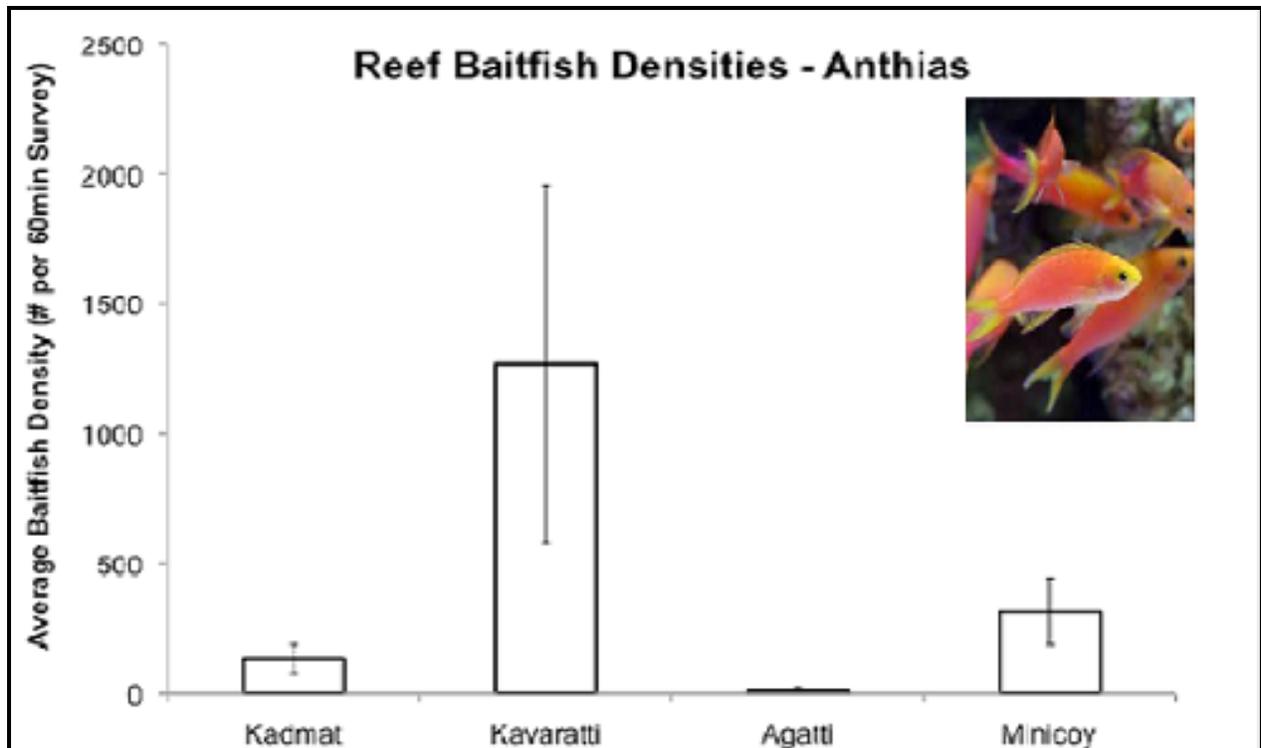


Figure 4. Average # of anthias observed per 60 minute dive survey for reefs of four Lakshadweep islands in the 2012-2013 season. Islands are arranged in increasing order of their 2006 tuna landings. Error bars indicate \pm SE.

Lagoon baitfish

Due to the difficulty in distinguishing between clupeids (*Spratelloides delicatulus* and *S. gracilis*) and silversides (Atherinids), we decided to group them for the lagoon surveys. Populations of silvery baitfish (clupeids and atherinids) decline as one moves up a gradient of fishing pressure (Figure 5). But high SE deems this observation inconclusive. Highest densities of apogons were observed in Agatti and highest pomacentrid densities were observed in Minicoy (Figure 6 & 7). In Minicoy, apogons are extensively used as tuna live-baits and this maybe the reason for observed trends (Figure 6) but should be approached with caution given the small sample size that was achieved in Minicoy (Table 1). On the other hand, Agatti fishermen are known to prefer pomacentrids to apogons as live-bait and the locals have also started harvesting blue green chromis (pomacentrid) for ornamental purposes, the impact of which can be observed from our survey (Figure 7).

Although trends are not robust, the impact of tuna fishing on local baitfish populations is decipherable. In addition to fishing, other environmental factors such as moon phases, tides, winds, currents etc. may play a critical role in the distribution and abundance of these species, thus requiring further more detailed study to tease apart the mechanisms.

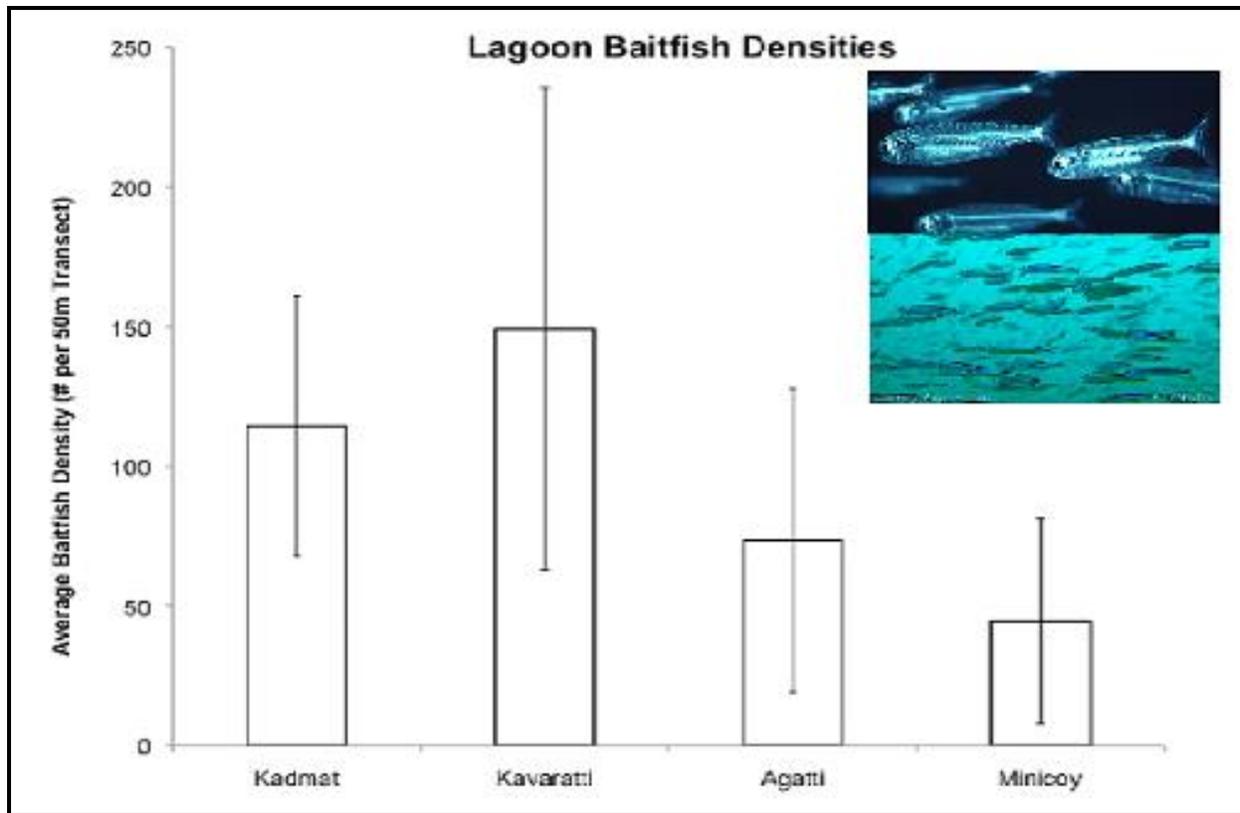


Figure 5. Average # of baitfish (clupeids and atherinids) observed per 50m transect for each island lagoon for the 2012-2013 season. Islands are arranged in increasing order of their 2006 tuna landings. Error bars indicate \pm SE.

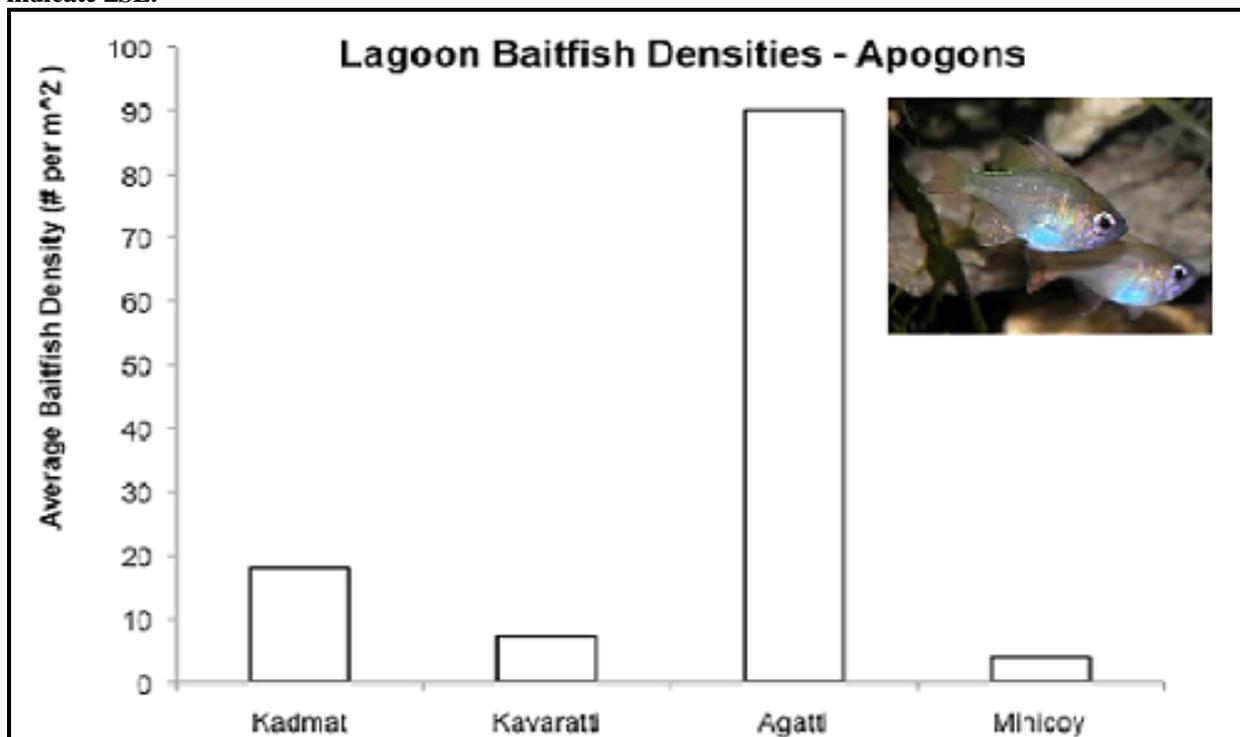


Figure 6. Average # of apogons per m² of coral boulder observed in each island lagoon for the 2012-2013 season. Islands are arranged in increasing order of their 2006 tuna landings.

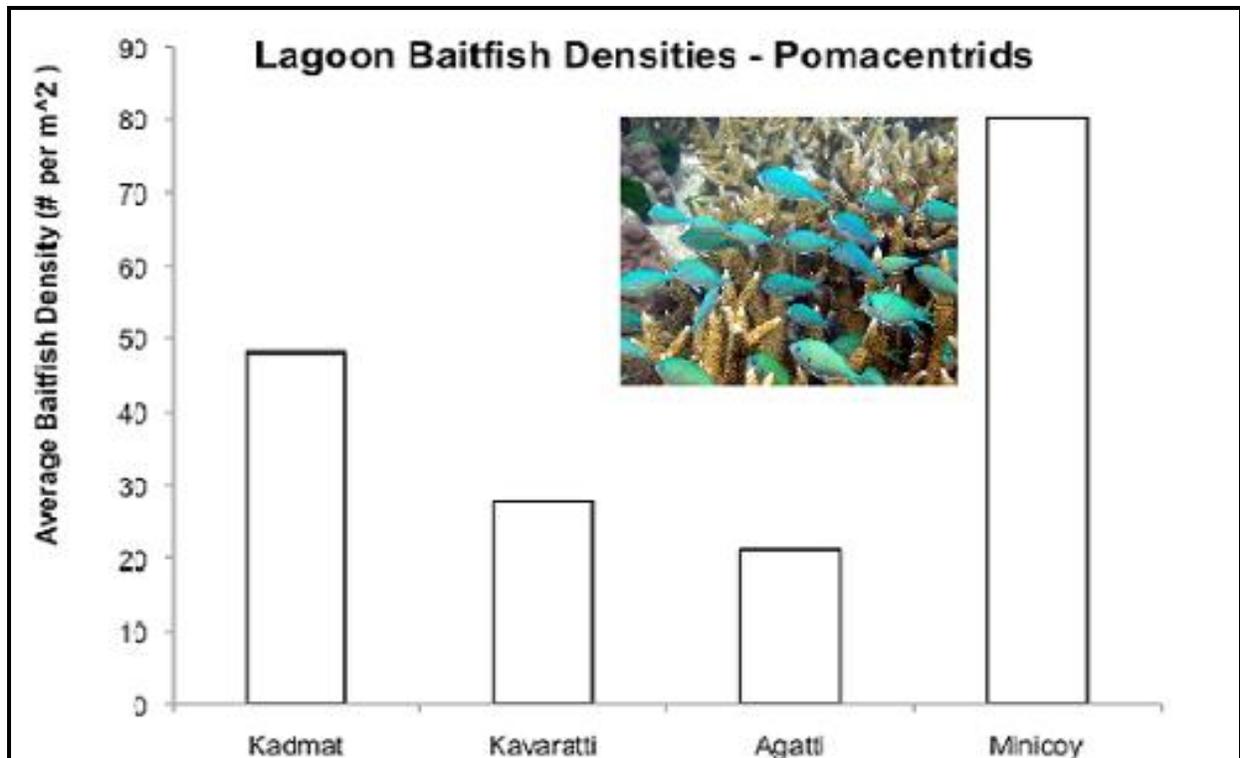


Figure 7. Average # of pomacentrids per m² of coral boulder observed in each island lagoon for the 2012-2013 season. Islands are arranged in increasing order of their 2006 tuna landings.

Social Assessment

Due to the small sample size (n=10), it is too early to gauge inter-island differences in perspectives but the interviews and general discussions help in assessing the current state of the fishery plus formulating our next steps.

Live-bait tuna fishery perspectives

Our interviews and conversations with fishermen and locals revealed minimal concerns over baitfish populations. Most agreed to seasonal and interannual fluctuations in bait populations but there were no claims of long-term declines. Where cited, seasonal declines were attributed to fishing pressure. One fisherman raised concern over the harvest of *S. delicatulus* at time of spawning, which is interesting, as regulating spawning time harvest may prove to be a good conservation measure. Most indicated currents and winds as critical drivers. Two fishermen raised concern over increasing turtle densities that are damaging seagrass beds – a habitat they felt was critical to the development of juvenile baitfish. 6 out of 7 respondents voiced interest in baitfish catch monitoring.

On the other hand, declines in tuna catch volume and catch size were unequivocal. Many observed post-tsunami (2004) declines in tuna fishery and attribute the declines to changes in currents or movement of fish to the Bay of Bengal, among other regions. Some were against outside boats fishing in their waters. 5 out of 6 respondents were interested in community-based tuna monitoring. Most respondents were interested in the results of tuna tagging studies that have been conducted in the islands over the past few decades by other agencies.

Further work comparing historical and current perspectives of Lakshadweep tuna fishery is required. A study of the history of pole and line fishing in Lakshadweep may be informative and requires an analysis of the historical culture of Minicoy, its relationship with the Maldives and rest of the Lakshadweep archipelago.

Changes and Challenges

Over the last decade the fisheries department has been establishing Fish Aggregating Devices (FADs) around the islands to increase tuna production. These FADs eliminate the need for fishing boats to search for tuna schools, thereby reducing search time and saving fuel. Unfortunately, these FADs attract a variety of fish and a variety of fish sizes. Thus fishing boats targeting tuna at FADs in comparison to free-swimming oceanic tuna shoals end up harvesting a wide variety of fish, a lot of which are undersized. Fishermen are in favour of FADs as they guarantee them fish without much search time, albeit smaller and highly mixed landings. Local fishermen's unions and local governments (panchayats) have been raising money to establish more FADs near the islands. The current skipjack tuna catch in Lakshadweep is dominated by individuals measuring 20-30cm in total length, a size much smaller than the size at first maturity. If current trends are left unchecked, the islands run serious risks of growth overfishing.

Sustainable development of the tuna live-bait pole and line fishery may involve a set of input and output controls regulating effort and catch size. Sustainable harvest of live baits requires reducing the harvest of spawning populations of *S. delicatulus*, having rotational harvests of various baitfish species and target regions.

Declines in the tuna stock, raises significant threats to the sensitive reefs, if the fishing pressure shifts to reef fish species such as groupers and snappers. Currently infrastructure to export reef fish fresh is required before commercial reef fishing can take off on a full scale. Certain facilities like ice plants are already in place on most islands. Transport facilities between mainland and the islands are also being improved with more frequent shipping schedules and talks of airport expansions underway. There is a need to better plan and manage any upcoming reef fishing in the islands.

Next Steps

Our main islands of study for next season are Kavaratti, Agatti and Minicoy. We hope to be back out on the islands by end August, before the beginning of the tuna season, to establish community-based catch monitoring, continue our survey work and hold informational seminars. Although we will maintain our baitfish work majority of our focus will shift to the tuna fishery.

Outlined below are our plans for the next season.

- Baitfish surveys – continue
- Social surveys – continue
 - Gauge interest in tuna and baitfish conservation measures
 - Understand the history of Pole and line fishing in Lakshadweep
 - Determine the propensity to switch to reef fishing
- Community-based catch monitoring
 - Voluntary & maintained in one note book per boat

Table 2. Catch-monitoring template for boat record books.

NAME			ISLAND		
DATE			BOAT NAME		
TIME (Start & End)			AMOUNT OF FUEL USED		
FISHING REGION			WEATHER CONDITIONS		
Baitfish					
Tuna					
BAITFISH					
SPECIES	EFFORT		CATCH		
	Search	Capture	Size	Quantity	Amount leftover
TUNA					
SPECIES	EFFORT		CATCH		
	Search	Capture	Size	# / Weight	Egg bearing (Y/N)
COMMENTS					

- Informational Series
 - Tuna: Biology and Ecology
 - Baitfish: Biology and Ecology
 - Climate change and ENSO
 - Local oceanography
 - Reef resources

Conclusion

Our work over the past few months has highlighted the need to better study the tuna fishery and its interactions with reef fishing. Our original objective of understanding and monitoring baitfish species has been expanded to include tuna as well. The next steps of the project will be critical for the establishment of a long-term community-based catch monitoring program, that we hope will enable fishing communities to evaluate the status of their own resources. Thereby empowering them with the ability to make decisions and regulate their resources.