

# The role of sharks in coral reef ecosystems: movements and trophic ecology of top predators along the Great Barrier Reef

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## OVERVIEW OF THE PROBLEM

Predatory fishes that occupy high trophic levels in marine ecosystems have been declining worldwide as a result of intense overfishing (Myers and Worm 2003). Although the magnitude of some of these declines has been debated (Burgess et al. 2005), a better understanding of the ecological consequences of these and future declines will be critical for fisheries and ecosystem-based management.

Sharks are thought to play a significant ecological role as top predators in aquatic ecosystems, and their disappearance may be linked to the release of prey populations from predatory control, followed by other changes through indirect trophic cascades (Ferretti et al. 2010).

Recent declines have also been reported in reef-associated shark populations. Reef sharks are thought to exhibit limited movement and strong site fidelity to coral reefs and thus may benefit from protected areas. However, movements of reef sharks are poorly understood, and there is little data available on their degree of site attachment. Additionally, other shark species that are not considered reef-associated (or residents) have also been reported in or near reefs, suggesting that reef ecosystems may also provide essential habitats and resources to several non-reef predators.

## HYPOTHESIS AND RATIONAL

The Great Barrier Reef has one of the largest network systems of protected reefs and management zones, providing an ideal opportunity to examine the distribution, movements, habitat use, connectivity and trophic ecology of sharks.

**In order to understand the role of sharks in reef ecosystems we need to know:**

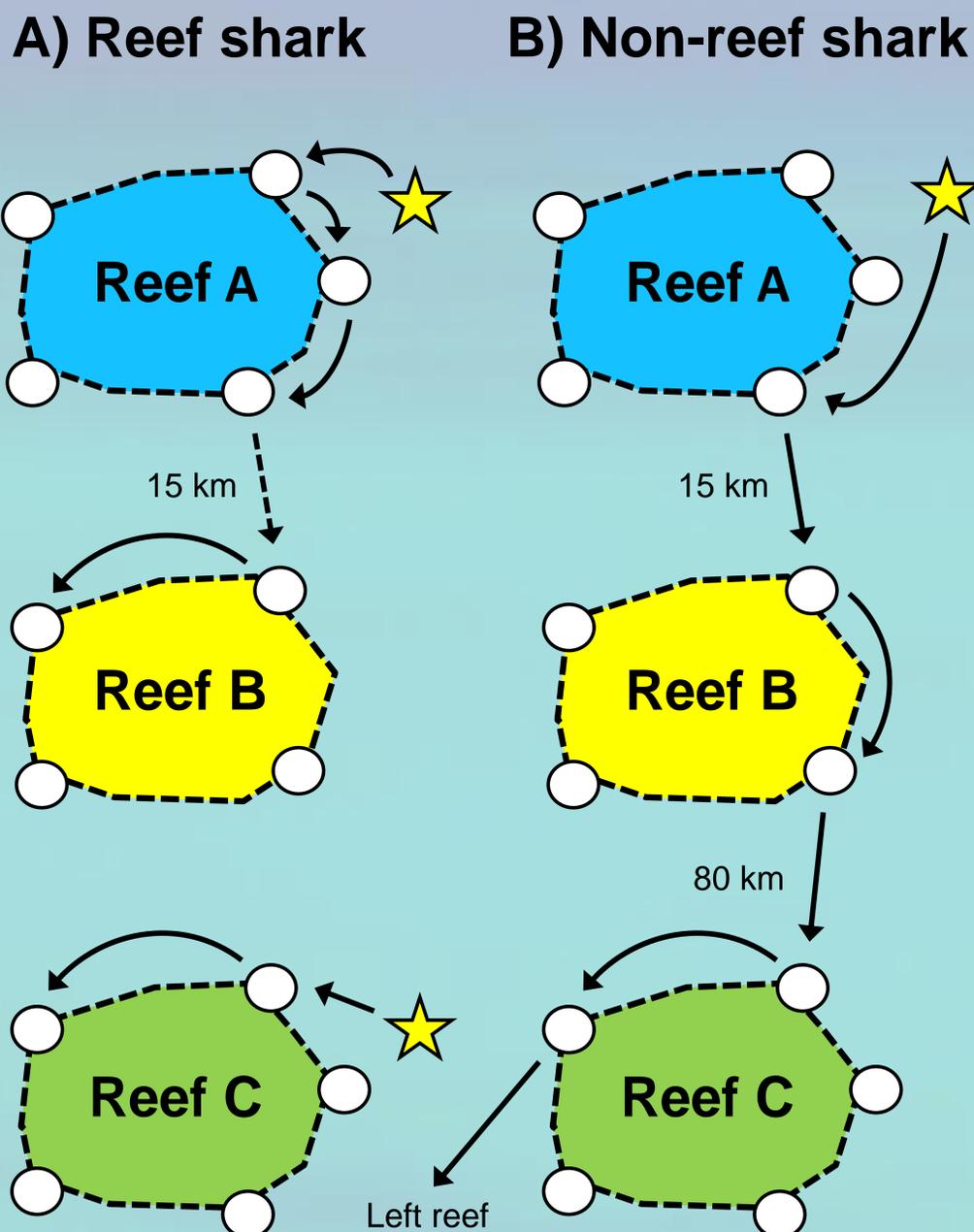
1. How long do they spend in or near reefs?
2. What type of habitats and depths are they using?
3. Do they move between reefs or to other adjacent areas?
4. Do they exhibit diel and seasonal movements?
5. Do these movements occur in predictable patterns?
6. Are they feeding in/near coral reefs? What is their trophic position?

### REEF ASSOCIATED SHARKS

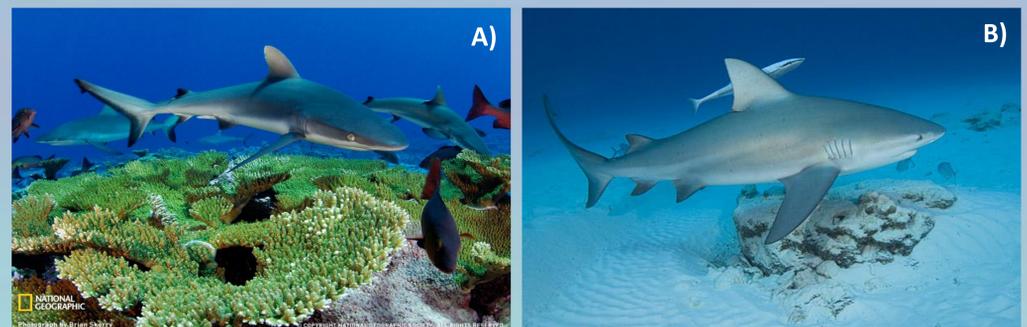
- ❖ Strong site attachment to coral reefs
- ❖ Limited movements between reefs
- ❖ Larger individuals may be more mobile
- ❖  $\delta^{13}\text{C}$  signatures from reef habitats
- ❖ Occupy high trophic levels ( $\delta^{15}\text{N}$ )

### NON-REEF SHARKS

- ❖ Weak site attachment to coral reefs
- ❖ Large-scale excursions between reefs
- ❖ Presumably, seasonal and diel patterns
- ❖ Higher variability in  $\delta^{13}\text{C}$  signatures
- ❖ Occupy high trophic levels ( $\delta^{15}\text{N}$ )



**Figure 1.** Diagram showing expected movements of reef and non-reef associated sharks. Reef sharks are expected to show a strong site attachment to a single reef and/or limited movements between reefs (dashed arrows), while non-reef sharks are presumed to make large-scale excursions across deep waters, thus remaining in reefs for shorter periods of time. Yellow stars represent tagged sharks and white filled circles represent the locations of VR2W acoustic receivers (monitoring stations).



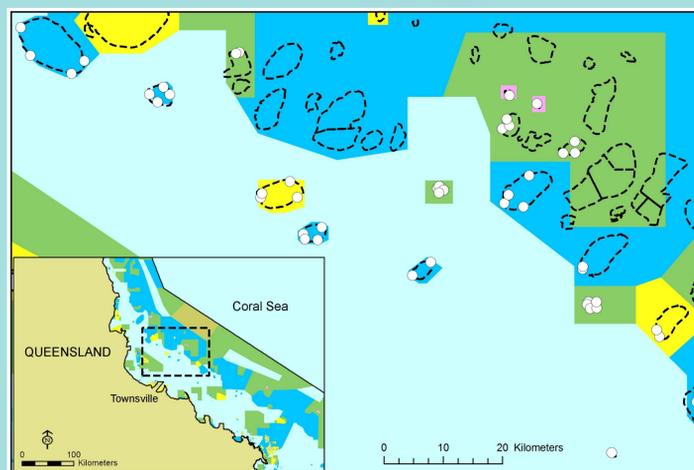
**Figure 2.** Example of a reef-associated shark (A – Gray reef shark, *Carcharhinus amblyrhynchos*) and non-reef shark (B – Bull shark, *Carcharhinus leucas*)

## METHODS

**Field surveys:** Long-line surveys will be conducted along the Townsville Reefs to examine seasonal abundance patterns and distribution of sharks.

**Movements and habitat use:** An array of 48 acoustic receivers (VR2W) will be used to monitor long-term (> 2 yr) site fidelity, movements, connectivity and habitat use of acoustically tagged sharks at the Townsville Reefs (approx. area = 3100 km<sup>2</sup>).

**Foraging ecology:** Stable isotopes ratios ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) from muscle, whole-blood and plasma of sharks and other reef-associated species will be used to determine trophic position, track dietary changes and examine movements between reefs



**Figure 3.** Map of the study area showing the location of acoustic receivers (white filled circles) in the Townsville Reefs. Colored polygons indicate reef (dotted-line polygons) zonation (dark blue = Habitat Protection, yellow = Conservation Park, green = Marine National Park, pink = Preservation Zone, light blue = General Use).

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