



Environmental drivers of presence and depth use by an exploited reef fish

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Background

- Coral reef ecosystems are highly complex and variable. Environmental changes can influence the dispersal and movement of teleosts. Movement patterns among individuals is highly variable¹, but little research has focused on environmental drivers of reef fish movement
- Tropical cyclones are known to alter the distribution of fish populations² and these extreme weather disturbances can have severe impacts on fisheries. For *Lethrinus miniatus*, an important fishery species worldwide, cyclones can increase catches by driving individuals into shallow areas with the intrusion of colder water²
- However, the effect of subtle environmental changes on presence and space use of reef fishes is less known. Elevated water temperatures have been linked to limited fish mobility³ and altered distributions⁴
- With changes in climate becoming an increasingly important issue, identifying key environmental drivers that affect the distribution of exploited species may allow managers to predict the effect of these changes

AIM: to investigate whether daily presence or weekly vertical activity space of *Lethrinus miniatus* are driven by environmental parameters



Fig. 1. VR2W acoustic receiver underwater, Fig. 2 & 3. transmitter insertion and sutures, Fig. 4. release of tagged *L. miniatus*



Fig. 5. Heron Island Reef depicting position of acoustic receivers (triangles)

Methods

- Twenty-five Vemco VR2W[®] acoustic receivers (Fig. 1) monitored the presence and movement patterns of 60 *L. miniatus* surgically fitted with V13P transmitters (Fig. 2 & 3) and released (Fig. 4) at Heron Island Reef, Australia (Fig. 5)
- Individuals detected for > 5 days were used in analysis of daily presence/absence (PA) and vertical activity space
- Hourly average positions of individuals were calculated in 2D space; vertical areas of core use (50% vertical kernel utilisation distributions, vKUDs) and extent (95% vKUDs) were calculated as distance around the reef edge by depth⁵
- *In situ* environmental parameters were monitored including water temperature (temp), atmospheric pressure, wind speed (wind), log₍₁₀₎ rainfall (rain) and moon phase (moon), and data was averaged per day (for PA) and per week (for vKUDs)
- Mixed effects models examined the influence of environmental parameters and fish size (fork length, FL) on presence (logistic regression approach) and vKUDs
- Models were ranked by the Akaike Information (AIC_c) approach and important parameters identified by model averaging

Results

- Environmental parameters (Fig. 6) and their influence on presence and vertical space use was examined for 26 individuals
- Individuals were detected from 2-52 weeks

Daily presence

- Three models provided best-fits to the presence data (Table 1)
- Model averaging identified presence was driven by water temperature
- *L. miniatus* were more likely to be present on the reef slope during days of lower temperatures (estimate = -1.187, $p < 0.001$, Fig. 7)

Vertical activity space

- Null models provided the best fit to 50% and 95% vKUD data with environmental parameters
- Results suggest vertical activity space (both core use area and extent) was not influenced by any environmental parameter examined nor by FL, but this result was likely to be influenced by the use of deeper habitat outside the acoustic array that was not monitored

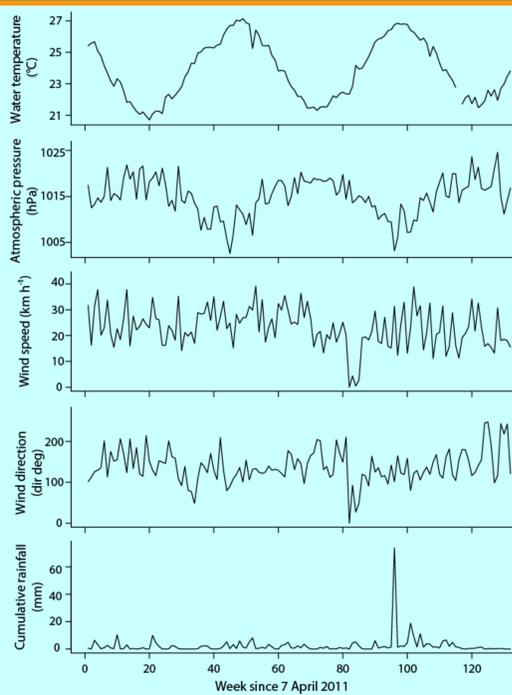


Fig. 6. Weekly environmental measurements for Heron Island Reef from April 2011 to 6 September 2013

Table 1. Best-fitting mixed effects models used to examine the effects of environmental parameters and FL on presence (PA)

	Model	df	AIC _c	ΔAIC _c	AIC _c weight
1	PA ~ temp	6	4791.88	0	0.32
2	PA ~ temp + rain	7	4793.81	1.93	0.12
3	PA ~ temp + wind	7	4793.86	1.99	0.12

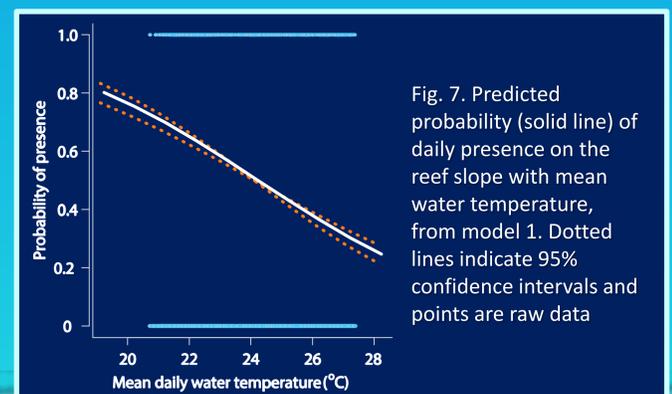


Fig. 7. Predicted probability (solid line) of daily presence on the reef slope with mean water temperature, from model 1. Dotted lines indicate 95% confidence intervals and points are raw data

Conclusions

- Water temperature was the key driver of *L. miniatus* presence. Individuals responded to elevated temperatures by moving away from the reef slope to deeper adjacent habitats, thus shifting their position in the water column to remain at a preferred temperature – which suggests a potential thermal tolerance threshold for this species
- Densities of *L. miniatus* on shallow coral reefs may be impacted by changes in climate, which in turn, may affect fisheries
- With elevation of ocean temperature, this mobile species will need to adapt to warmer waters or disperse into cooler habitats, by either shifting their distribution deeper or towards higher latitudes

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