Journal of Applied Ecology

BRITISH ECOLOGICAL SOCIETY

*Journal of Applied Ecology* 2017, **54**, 188–197 doi: 10.1111/1365-2664.12710

# Spatiotemporal modelling of crown-of-thorns starfish outbreaks on the Great Barrier Reef to inform control strategies

**Jarno Vanhatalo[1]*, Geoffrey R. Hosack[2] and Hugh Sweatman[3]**

[1]*Department of Mathematics and Statistics and Department of Biosciences, University of Helsinki, P.O. Box 65, 00014 Helsinki, Finland;* [2]*CSIRO Marine Laboratories, Castray Esplanade, Hobart, Tas. 7001, Australia; and* [3]*Australian Institute of Marine Science, PMB 3, Townsville MC, Qld 4810, Australia*

## Summary

1. Cyclical outbreaks of pests can impact the functioning of entire ecosystems. An eminent example is outbreaks of crown-of-thorns starfish (COTS; *Acanthaster planci*) that cause substantial coral mortality on the Great Barrier Reef (GBR).
2. We analyse COTS abundance and outbreaks with a Bayesian spatiotemporal model applied to a long-term survey of the GBR (1985–2014). We assess the relative increase in COTS abundance beyond that explained by a reef's location and explanatory covariates, and thereby incorporate local reef characteristics into the identification of outbreaks, while allowing for both randomness and predictable patterns in the development of outbreaks.
3. The model results confirm that waves of COTS outbreaks originate near Lizard Island (14·67°S) and progress in a northwesterly or southeasterly direction, with the southward wave progressing about 60 km year$^{-1}$.
4. The model reveals several previously unidentified hotspots with high average COTS abundance. The abundance of COTS may also have decreased on reefs protected from fishing after an expansion of protected areas within the GBR Marine Park in 2004, which suggests that closing reefs to fishing may help control COTS.
5. *Synthesis and applications*. In this study, we use 30 years of data from the Great Barrier Reef to show that the timing and geographic location of crown-of-thorns starfish (COTS) outbreaks can be modelled by incorporating covariates, spatial and spatiotemporal dependence within a single coherent framework. The model can be used to identify areas of high average COTS abundance, to assess the impact of fishery management actions such as no-take areas and to identify areas where waves of outbreaks may originate. The identification of outbreaks from noisy long-term spatially extensive data may help managers choose appropriate control strategies. This modelling approach is applicable to other ecosystems where outbreaks of damaging pests occur.