Access through your institution
Get access through your institution via Shibboleth or Athens or IP address
Download PDF Share Export
Search ScienceDirect Search

Marine Policy
Volume 151, 2023, 105616
https://doi.org/10.1016/j.marpol.2023.105616

Recognizing peripheral ecosystems in marine protected areas: A case study of golden jellyfish lakes in Raja Ampat, Indonesia

Jessica L. Maes, Y. M. Agung Lugrayo, I. M. Jayabaskara, Ahmad M. Bintara, Lindsey E. Mazzadi, Lynne M. Carpenter, Ketut Sarjana Putra, Ketut Ariyasa, Ketut Ariyasa, Ketut Ariyasa

Download: Download high-res image (1MB) *Download: Download low-res image*

Fig. 4. Temporal trends in Raja Ampat Industry & Tourism Scenario. Bars are based on number of recent (minus-age) cell per year from 2007 to 2018. Raja Ampat Tourism Scenario (Tourism) is based on the number of tourists visiting Raja Ampat (Tourism-tourist) and the total tourism income. Industry scenario (Industry) is based on the number of jobs(left-hand axis) and percent forest based on interview with stakeholders in 2017. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

The interviews in 2017 indicated that families from six villages were sustained or continuous users of jellyfish lakes (Table 2). By 2018, 16 MPA, 3 tourism operators, 1 NGO, 1 university, 1 government agency, and 1 tourism association/ tourism, hence owners collect or extracts the from indicator species jellyfish lakes and they are sustainable also added by nearby pond farms. Interviewees represented a wide range of ecosystem services, including provisioning services, agriculture, ground water, transport, tourism, transport, regulation and maintenance, pollution, lack of garbage handling, breeding, regulation, pollution, and recreational services. Of the 25 respondents, 20 were male and 5 were female. Of the respondents indicated there is an informal Code of Conduct in place that commonly most tourism guides adhere to. This Code of Conduct includes no immersion, no feed and no diving perks for the dives.

4. Discussion

Our study sought to combine evolutionary, ecological and social approaches to investigate jellyfish lakes in Indonesia, peripheral ecosystems that are increasingly important tourism assets. Focusing on jellyfish lakes in Raja Ampat, we found that these ecosystems are sustained by local people who are interconnected with Raja Ampat with the challenges of increasing, and largely unregulated, tourism as well as other stressors. Below, we elaborate on the variation in genetic, morphological, and ecological traits of the jellyfish populations in Raja Ampat's jellyfish lakes, and finally discuss management recommendations and broader implications for jellyfish lakes in Indonesia.

4.1. Genetic and morphological variation indicate isolated populations

Jellyfish populations in Raja Ampat appear to be strongly structured based on genetic and morphological differentiation (Supplementary material Table 1, Fig. 5, Fig. 6). Genetic data suggest that the jellyfish lakes in Raja Ampat are isolated, some of which only one was observed in the hydrophore from Raja Ampat (M. jellana observed, other genus hydrophore sources in Raja Ampat were not observed). Genetic data suggest that the jellyfish lakes in Raja Ampat are isolated, and therefore that previously been shown the jellyfish and other marine lake taxa, such as sea anemones (Stenorhynchus and Exaiptasia, Bell, Gemmill et al. 2001, Bocking et al. 2006, Gemmill et al. 2001), Porifera (Ecklonia, Bell et al. 2007), and Cnidaria (Aurelia), are of genetic structure as previous studies, we observed fewer private haplotypes when compared jellyfish populations from Palau (Dawson and Hamner, 2005, Dawson et al. 2005). Although we found genetic structure in the Raja Ampat as smaller population sizes, but could also indicate that marine lakes in Raja Ampat are a dynamic system recently.

Shifts from the oceanic towards the derived ecotype in marine lakes are thought to occur rapidly (Dawson et al. 2005, Dawson and Hamner, 2005, Dawson and Hamner, 2008, Bell et al. 2002). Interestingly, we observed a concurrent morphological shift in Pelagia noctiluca species (PN-2018) from the derived ecotype (Dawson et al. 2005) to the oceanic ecotype (Dawson et al. 2005) in one of the sampled jellyfish, although this is not corroborated by genetics. Alternatively, the shift represents a new bloom established from resident polyps showing high genetic similarity to the oceanic ecotype (Dawson et al. 2005). Bell et al. (2002) also distinguished of jellyfish consulting with the NMS review of 1980–1990 (Bell et al. 2002). Where the jellyfish suggested they displayed a larger size and differently shaped oral arms than the oceanic ecotype, which was not observed in our samples. To our knowledge, the genotypes were not published, therefore it is unclear if jellyfish below and after the crash were of the same population, the jellyfish in Raja Ampat are of the derived ecotype. Our data suggest that the jellyfish lake populations are isolated, and that the genetic structure of the jellyfish populations and activations to specific local environments rather than ecological or morphological traits. Genetic structure of jellyfish populations suggest adaptation (Rodriguez, 1983, Pierce, 2012, Sakaguchi et al. 2020), and each jellyfish lake environment is unique, protection specific to each lake should be part in place.

4.2. Population dynamics in marine lakes

Jellyfish populations in Raja Ampat appear to fluctuate greatly, indicating the jellyfish dynamics in Palau lakes are not heterogeneous that previously observed for lakes in Palau and Palau Kakabar in Indonesia (Dawson et al. 2005, Dawson et al. 2005, Dawson and Hamner, 2005, Dawson et al. 2005). Populations in Palau also show strong fluctuation in abundance (Dawson et al. 2005). Fluctuations in Raja Ampat appear to be more frequent and severe, with regular fluctuations in abundance observed in the Raja Ampat lakes. Our data suggest that field studies from Palau to Palau or Kakabar, and have a lower observed total abundance of jellyfish (500,000 vs. 7 million (Dawson et al. 2005, Cimino et al. 2020)). Although, the jellyfish lakes in Raja Ampat are subject to stressors, including marine tourism, environmental (Gabrielle, 1992), Bell's finding in marine lakes populations and higher carrying capacity. Remarkably, even for the large lake (Cimino et al. 2020), the jellyfish lakes in Raja Ampat are subject to stressors, including PPM, related to temperature and salinity change (Mehrotra, 2020) tourism (Dawson et al. 2005, Martin et al. 2016). In Palau, there is no quota system for the number of tourists visiting the jellyfish lakes, but there is a quota system for the number of boat disappearance of jellyfish (Dawson et al. 2005). Tourism quotas have prevented the decline of jellyfish abundance in Palau or may have led to longer recovery time (Dawson et al. 2005). Marine lakes in Raja Ampat are even less resilient to anthropogenic and natural perturbations.

Beyond direct effects on endemic presence, effects of stressors on the benthic polyps likely lies at the basis of jellyfish dynamics. Polyp sensitivity to temperature, salinity, food availability or chemical pollution may influence stabilization patterns (Dawson et al. 2005, Dawson et al. 2005). Although, the mechanisms of these stressors species such as fish and sea anemones may result in increased predator presence or competition for space for the benthic polyps (Dawson et al. 2005, Martin et al. 2016

Prieto et al., 2010 L. Prieto, D. Astorga, *et al.*
Environmental control of phase transition and polyp survival of a massive-outbreaker jellyfish
PLoS One, 5 (2010)
Google Scholar

R Core Team, 2018 R Core Team
R: A Language and Environment for Statistical Computing
(2018)
Google Scholar

Salzburger et al., 2011 W. Salzburger, G.B. Ewing, *et al.*
The performance of phylogenetic algorithms in estimating haplotype genealogies with migration
Mol. Ecol., 20 (2011), pp. 1952-1963
View Record in Scopus Google Scholar

Scheffer, 1997 M. Scheffer
Ecology of Shallow Lakes
Springer Science & Business Media (1997)
Google Scholar

Souza and Dawson, 2018 M.R.D.E. Souza, M.N. Dawson
Redescription of Mastigias papua (Scyphozoa, Rhizostomeae) with designation of a neotype and recognition of two additional species
Zootaxa, 4457 (2018), pp. 520-536
CrossRef Google Scholar

Spalding et al., 2007 M.D. Spalding, H.E. Fox, *et al.*
Marine ecoregions of the world: a bioregionalization of coastal and shelf areas
Bioscience, 57 (2007), p. 573
CrossRef View Record in Scopus Google Scholar

Sugiura, 1965 Y. Sugiura
On the life-history of rhizostome Medusae. III. On the effects of temperature on the strobilation of Mastigias papua
Biol. Bull., 128 (1965), pp. 493-496
CrossRef View Record in Scopus Google Scholar

Swift et al., 2016 H.F. Swift, L. Gómez Daglio, *et al.*
Three routes to crypsis: stasis, convergence, and parallelism in the Mastigias species complex (Scyphozoa, Rhizostomeae)
Mol. Phylogenet. Evol., 99 (2016), pp. 103-115
Article Download PDF View Record in Scopus Google Scholar

Tajima, 1983 F. Tajima
Evolutionary relationship of DNA sequences in finite populations
Genetics, 105 (1983), pp. 437-460
View Record in Scopus Google Scholar

Takao et al., 2014 M. Takao, H. Okawachi, *et al.*
Natural predators of polyps of Aurelia aurita s.l. (Cnidaria: Scyphozoa: Semaeostomeae) and their predation rates
Plankt. Benthos Res., 9 (2014), pp. 105-113
CrossRef View Record in Scopus Google Scholar

Tomascik and Mah, 1994 T. Tomascik, A.J. Mah
The ecology of Halimeda Lagoon: an anchialine Lagoon of a raised atoll, Kakaban Island, Eas kalimantan, Indonesia
Trop. Biodiversoty, 2 (1994), pp. 385-399
View Record in Scopus Google Scholar

Trave et al., 2017 C. Trave, J. Brunnschweiler, *et al.*
Are we killing them with kindness? Evaluation of sustainable marine wildlife tourism
Biol. Conserv., 209 (2017), pp. 211-222
Article Download PDF View Record in Scopus Google Scholar

Valladares et al., 2014 F. Valladares, S. Matesanz, *et al.*
The effects of phenotypic plasticity and local adaptation on forecasts of species range shifts under climate change
Ecol. Lett., 17 (2014), pp. 1351-1364
CrossRef View Record in Scopus Google Scholar

Waddington, 1942 C.H. Waddington
Canalization of development and the inheritance of acquired characters
Nature, 150 (1942), pp. 563-565
CrossRef View Record in Scopus Google Scholar

Wickham, 2016 H. Wickham
ggplot2: Elegant Graphics for Data Analysis
Springer (2016)
Google Scholar

View Abstract

© 2019 The Authors. Published by Elsevier Ltd.

We use cookies to help provide and enhance our service and tailor content and ads. By continuing you agree to the **use of cookies**.
Copyright © 2020 Elsevier B.V. or its licensors or contributors. ScienceDirect ® is a registered trademark of Elsevier B.V.
ScienceDirect ® is a registered trademark of Elsevier B.V.