This paper was accepted for publication in the journal Environmental Conservation, with further corrections made to e-proofs. The full reference for the published paper and supplementary material is:

Jupiter SD, Wenger A, Klein CJ, Albert S, Mangubhai S, Nelson J, Teneva L, Tulloch VJ, White AT, Watson JEM (2017) Opportunities and constraints for implementing integrated land-sea management on islands. Environmental Conservation 44:254-266. doi:10.1017/S0376892917000091

Opportunities and constraints for implementing integrated land-sea management on islands

STACY D. JUPITER[1,], AMELIA WENGER[2,3], CARISSA J. KLEIN[3], SIMON ALBERT[4], SANGEETA MANGUBHAI[5], JOANNA NELSON[6,7], LIDA TENEVA[8], VIVITSKAIA J. TULLOCH[9], ALAN T. WHITE[10], JAMES E. M. WATSON[3,11]*

[1]Wildlife Conservation Society, Melanesia Program, 11 Ma'afu St, Suva, FIJI
[2] Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Queensland 4811, AUSTRALIA
[3]Centre for Biodiversity and Conservation Science, School of Geography Planning and Environmental Management, University of Queensland, St. Lucia, Queensland 4072 AUSTRALIA
[4]School of Civil Engineering, University of Queensland, St. Lucia, Queensland, 4072 AUSTRALIA
[5]Wildlife Conservation Society, Fiji Country Program, 11 Ma'afu St, Suva, FIJI
[6]The Nature Conservancy, Arlington, VA 22203, USA
[7]The Natural Capital Project, Stanford University, Stanford CA 94305, USA
[8]Conservation International, 7192 Kalaniana'ole Hwy, Honolulu HI 96825, USA
[9]Australian Research Council Centre of Excellence for Environmental Decisions, School of Biological Sciences, University of Queensland, St Lucia, Queensland 4072, AUSTRALIA
[10]The Nature Conservancy, 923 Nuuanu Ave, Honolulu, HI 96817, USA
[11]Wildlife Conservation Society, Global Conservation Program, 2300 Southern Boulevard, Bronx, NY 10460, USA

*corresponding author
Stacy D. Jupiter
Wildlife Conservation Society
11 Ma'afu Street
Suva, Fiji
(e) sjupiter@wcs.org
(p) +679 331 5174
(f) +679 331 0178

Word count: 7528 (inclusive of Summary, Keywords, Main body text, Acknowledgements, References, and Figure & Table captions)

SUMMARY

Despite a growing body of literature on integrated land-sea management (ILSM), very little critical assessment has been done to evaluate ILSM in practice on island systems. Here we develop indicators for assessing ten integrated island management principles and evaluate the performance of planning and implementation in four island ILSM projects from the tropical Pacific across different governance structures. We find that where customary governance is still strongly respected and enabled through national legislation, ILSM in practice can be very effective at restricting access and use according to fluctuations in resource availability. However, decision-making under customary governance systems may be vulnerable to mismanagement. Government-led ILSM processes have the potential to design management actions that address the spatial scale of ecosystem processes and threats within the context of national policy and legislation, but may not fully capture broad stakeholder interests and implementation may be poorly coordinated across highly dispersed island archipelagos. Private sector partnerships offer unique opportunities for resourcing island ILSM, though are almost always likely to be geared towards private sector interests that may change in the future and no longer align with community and/or national objectives. We identify consistent challenges that arise during island ILSM planning and implementation and offer recommendations for improvement.

Keywords: integrated coastal management, integrated island management, community-based management, management implementation, tropical Pacific

INTRODUCTION

Isolation of island systems from continental landmasses has promoted unique biological and cultural attributes, particularly on small, remote islands (MacArthur & Wilson 1967). There is also especially tight connectivity between land and sea on high islands given the generally smaller size of watersheds compared with those on continents (Ruddle *et al.* 1992; Jenkins *et al.* 2010). However, because these ecosystem connections operate across small geographies, the health and well-being of island peoples are highly vulnerable to large-scale disturbance (e.g., from tropical cyclones, flooding) that disrupts ecosystem processes and functions operating across multiple realms (Griffith & Ashe 1993; Aston 1999; Jenkins & Jupiter 2015). For instance, in-stream water quality and biodiversity can be degraded following periods of high rainfall and flooding: in high island watersheds with high rates of deforestation on erosion prone soils, researchers have documented reduced abundance and diversity of freshwater resources and increased in-stream bacteria and incidence of waterborne bacterial disease (Jenkins & Jupiter 2011; Ragosta *et al.* 2011; Jenkins *et al.* 2016). Given the small size of many islands and often complex tenure or private property arrangements, affected island people may have limited opportunities to replace loss and damage to natural resources on which they depend for ecosystem service provisioning, thus heightening the need for pro-active, integrated management across linked land and sea realms.

A number of environmental management approaches have been applied to safeguard island ecosystem functionality and maintain or increase the adaptive capacity of island social-ecological systems to respond to environmental change, which include: community-based adaptive management (CBAM); customary management (CM); ecosystem-based management (EBM); integrated coastal management (ICM); and integrated island

97 management (IIM; Table 1; Jupiter *et al.* 2014a). Integrated land-sea management (ILSM),
98 which specifically targets cross-system threats and processes (Table 1), can be applied on
99 islands within the context of any of the above environmental management approaches to
100 maintain or restore sensitive biodiversity, ecosystem services and human well-being.
101 Important cross-system processes to maintain on islands include nutrient subsidies, which can
102 influence the productivity and diversity of linked ecosystems (e.g., Polis & Hurd 1996;
103 Anderson & Polis 1999), and species' movements across their life history stages (Polis *et al*.
104 1997; Hazlitt *et al.* 2010; Jenkins *et al.* 2010). Cross-system threats requiring management
105 stem both from land-based activities that affect marine realms (Stoms *et al.* 2005) and
106 maritime activities that affect other realms (Gresh *et al.* 2000).
107
108 Yet despite a growing number of projects on islands funded under ILSM initiatives with
109 differing environmental management approaches and governance structures, very few in
110 practice are able to effectively manage these cross-system threats and processes to achieve
111 biodiversity protection and livelihood outcomes (Álvarez-Romero *et al.* 2011; Adams *et al.*
112 2014; Jupiter *et al.* 2014a). Recent reviews (e.g., Álvarez-Romero *et al.* 2011; Álvarez-
113 Romero *et al.* 2015; Reuter *et al.* 2016) highlight several hurdles to achieving effective ILSM
114 outcomes in both continental and island systems. Barriers to effective ILSM planning and
115 implementation include: (1) lack of mechanisms to coordinate institutions with different
116 mandates and area jurisdictions across levels of government and between public and private
117 sector (Cicin-Sain & Belfiore 2005; Lane 2008); (2) conflict arising due to poor involvement
118 of the full range of stakeholders with interests across the land and sea divide (Reuter *et al.*
119 2016); (3) inability to address potentially conflicting objectives and mandates across agencies
120 (e.g., conservation through sustainable use versus economic gain from commercial
121 extraction; Álvarez-Romero *et al.* 2011); (4) lack of adequate data on ecosystem responses to

management measures to appropriately prioritize actions, particularly with regards to muti-objective project goals (Álvarez-Romero *et al.* 2015); (5) uncertainty about the effects of management actions across connected realms (Adams *et al.* 2014); and (6) labor, time and complexity of analyses required to develop and/or adapt models and decision-support systems that deal with the above issues (Álvarez-Romero *et al.* 2011). ILSM project implementation may be further hampered by the inability of responsible agencies and institutions to simultaneously schedule management actions in linked terrestrial and marine realms to comprehensively address threats at appropriate spatial and temporal scales (Álvarez-Romero *et al.* 2011).

Despite a large body of potential socioeconomic, governance and environmental indicators (e.g., Ehler 2003; Pollnac & Pomeroy 2005), little monitoring and evaluation has been done to assess ILSM planning and implementation (Christie 2005), although there are a few island examples showcased as successes (Jupiter *et al.* 2014a). Here we provide novel indicators for island ILSM, based on ten IIM principles (Jupiter *et al.* 2014a) built on Ostrom's (1990) framework for the sustainable governance of common-pool resources, that can be used to evaluate the potential effectiveness of island ILSM planning and implementation for managing cross-system processes and mitigating cross-system threats. We use our indicators to evaluate four island ILSM projects across community, government and private sector led approaches. We showcase how each project embodies some aspects of best practice for ILSM and highlight the challenges faced. We then provide some recommendations for how the challenges may be addressed to improve island ILSM outcomes.

METHODS

147 *Development of ILSM indicators*

148 An expert working group convened in April 2015 to propose a list of monitoring and
149 evaluation indicators within the context of ten principles designed to guide best practice for
150 integrated island management (IIM; Jupiter *et al.* 2014a). The principles are based on
151 common-pool resources theory (e.g., Ostrom 1990; Cox *et al.* 2010) and consultations with
152 regional practitioners (Jupiter *et al.* 2014a). The IIM principles, which can be grouped into
153 planning and implementation categories, provide a clear framework under which island ILSM
154 projects can be evaluated. Indicators were refined during a second workshop in January 2016,
155 yielding a list of 32 (Table 2, Table S1). Of these, 22 (68.8%) specifically relate to ILSM,
156 while the remaining indicators characterize aspects of best practice management relevant to
157 any IIM project (Table 2). The principles and indicators are not necessarily unique to island
158 settings, but given smaller geographies, there are faster and tighter feedbacks between social
159 and ecological systems across island terrestrial and marine realms, heightening the need for
160 integrated management. Community and government managers, particularly in remote island
161 settings, may additionally benefit from more efficient resource allocation through integration
162 and coordination of activities across sectors and realms to achieve mutual aims of
163 maintaining ecosystem services and securing human health and well-being (Lane 2006;
164 Jupiter *et al.* 2014a).

165

166 *Case selection and scoring*

167 We selected four island ILSM projects from locations in the tropical western Pacific where
168 there was adequate information from the literature or place-based expert knowledge to assess
169 the characteristics of ILSM planning and implementation against the indicators (Fig. 1).
170 Although we recognize the limitations about generalizing from our small sample size, we
171 found, similar to Jupiter *et al.* (2014a), that very few island ILSM projects exist with

adequate documentation on planning and implementation to enable critical evaluation. The selected projects cover a range of geographic scales, governance and management systems: (1) customary management of a single community of approximately 150 people, with little external input and resources (Zaira, Solomon Islands); (2) community-based management at the district level, covering 10 villages and approximately 1000 people, with financial and technical support from non-governmental organization (NGO) partners (Kubulau, Fiji); (3) provincial-level government decision-making and prioritization, operating within the context of indigenous tenure systems across entire island systems with approximately 450,000 residents (New Britain, Papua New Guinea); and (4) top-down management from a private sector company that owns 98% of an island with about 3,100 local residents (Lāna'i, Hawai'i; Table 3).

To evauate the projects, designated co-authors most familiar with each entered supporting information into an Excel database from the literature and their own experience about project planning and implementation as it related to the measurement of each indicator. To maintain some objectivity, only co-authors who were uninvolved in project planning and implementation scored each project on performance against each indicator using uniform scoring criteria (Table S2). Results were averaged across all scorers and performance of each ILSM project against the indicators is described. Evaluation of these four projects is meant to highlight factors which contribute to successful planning and implementation, while raising challenges that may ultimately impact ILSM outcomes and thus provide learning to improve practice at other sites. We hypothesize that projects which score high across most indicators will be most successful at delivering on management objectives, which largely focus on protecting biodiversity, maintaining ecosystem functions, and provision of ecosystem services for human health, cultural practice and well-being (Table 3). For projects where

periodic monitoring data have been collected, additional indicators could also be used to measure ILSM outcomes for biodiversity and livelihoods (e.g., changes in coral health and fish catch as a response to watershed management), though this is beyond the scope of this assessment because two of the projects (New Britain and Lānaʻi) are still in planning phases.

RESULTS

Zaira Village, Solomon Islands

Positive attributes: The Zaira project scored consistently high on indicators related to: adopting a long-term integrated approach to management; using clearly defined management boundaries at the appropriate scale; accounting for connectivity between ecological realms and social networks; ensuring management systems reflect local values; monitoring and punishing offenders; and resolving conflicts (indicators associated with principles 1-3, 5, 7-8; Table 4). Through a commitment to longstanding cultural values, the three tribal groups that form Zaira have successfully managed their linked land and sea resources for millennia under a customary management system, which allows certain resources to be restricted at certain times and considers connectivity and feedbacks between the cultural interaction of people with land and sea systems (Table 4 *indicators 3a-c*; Hviding 1996). The customary practices are generally regarded as fair and equitable within the local social contexts (Table 4 *indicators 5a-c*). Zaira community members are committed to achieving sustainable resource management because the customary practices are part of their identity; thus, ILSM benefits are as much about maintaining cultural practice as ensuring livelihoods and well-being derived from environmental services (Table 4 *indicator 5b*).

More recently in 2010, the Zaira tribes independently adapted their customary resource management mechanisms to more formalised planning and implementation under an ILSM plan, which integrates customary and scientific approaches, as per Aswani & Ruddle (2013). The plan: covers management rules for all linked ecosystems within the customary land and sea tenure boundaries of three cooperating tribes at the scale over which cross-system processes are occurring; has objectives focused on maintenance of culture and tenure, food security, iconic species and education; and is discussed during annual meetings, with a five year timeline for review (Table 3 and Table 4 *indicators 1a,b,f, 2a-c*). The evolution of Zaira's customary management system into more structured ILSM implementation has provided a platform of confidence for the local management committee to enforce their authority on outsiders interested in resource extraction: recently, one high profile case of a peaceful boarding of an international logging vessel illegally entering the management area was settled with significant financial compensation paid to Zaira community members (Table 4 *indicators 7a-b*; S. Albert, pers. comm.). Meanwhile, internal conflicts and punishments for local offenders are dealt with through customary mechanisms (Table 4 *indicators 8a-b*).

Constraints: The governance and decision-making systems in Zaira are clear (Table 4 *indicator 2d*), but do not allow for full participation of all segments of the population affected by management decisions (Table 4 *indicators 4a,c*), which may ultimately lead to system vulnerabilities should future conditions change. Though the community-centric approach in Zaira is viewed by outsiders as bottom-up governance, internally the governance is relatively top-down and is not nested within broader government management systems (Table 4 *indicator10c*). Lack of broad involvement is not currently an issue in Zaira, as resource users perceive that the chief represents their interests and values, but it may become a challenge in the future if respect for the customary governance system is eroded and top down imposition

of rules is perceived as less legitimate. Furthermore, there is no guarantee that the successor to the current chief will not be swayed by development interests (Table 4 *indicator 4d*). A further constraint is that although formal land and sea tenure rights are recognized by Solomon Islands legislation (Hviding & Baines 1994), the tenure and use rights boundaries are not legally demarcated (Table 4 *indicator 6b*), which can create conflict when outsiders interested in resource extraction or conservation are interested in distributing benefits to the resource owners (Hviding 1996). Moreover, the government has authority to award timber rights to a third party without landowner consent (Hviding & Bayliss Smith 2000), and has recently done so for forests of Zaira (S. Albert, pers. comm.), jeopardizing both land and linked sea ecosystems within the conservation area.

Kubulau District, Fiji

Positive attributes: The Kubulau project scored high on some but not all indicators related to: adopting a long-term integrated approach to management; ensuring management systems reflect local values; ensuring management authority and rules are recognized; resolving conflicts; implementing evidence-based adaptive management; and nesting ILSM within existing governance systems operating across land and sea sectors (indicators associated with principles 1, 5-6, 8-10; Table 4). As in Zaira, local communities in Kubulau traditionally regulated local land and sea resource use through customary management; however by the early 1990s they realized that customary measures alone were insufficient to prevent commercial overexploitation of marine resources by outside users (Clarke & Jupiter 2010b). The chiefs requested support from an international NGO specializing in natural resource management, who assisted the Kubulau leadership in 2009 to develop a district-level ILSM plan designed to regulate resource use and minimize downstream impacts of land activities

by facilitating dialogue across multiple stakeholders from the communities, government and private sector (Table 4 *indicator 4a*). The goals of the plan, which covers the entirety of the relatively intact Kubulau land and fisheries management area (Table 4 *indicator 1b*), reflect local values and are focused on ensuring ecosystem integrity for biodiversity conservation and to maintain important services (e.g., food and water provision) for livelihoods and well-being (Table 3; Table 4 *indicators 1f, 5a*).

The Kubulau ILSM plan outlines a governance structure, which includes a coordination body (the Kubulau Resource Management Committee) made up of representatives from coastal and inland villages that oversees management implementation (Table 4 *indicator 1c*). The Management Committee is nested within the traditional chiefly governance system, through which internal conflicts are resolved through customary mechanisms (Table 4 *indicators 8a,b, 10a,c*). The plan was reviewed and adapted in 2012, based on monitoring data, local knowledge and community aspirations that consider future uncertainty (Table 4 *indicators 9a,c*; Weeks & Jupiter 2013). There is a general perception from Kubulau community household survey data that management positively affects resource state (Table 4 *indicator 5c*), with a majority of respondents specifying some level of involvement in and a high degree of satisfaction with the management process (Table 4 *indicator 5b*; Egli *et al.* 2010).

Constraints: The mismatch between the scale of threats and management implementation is an issue in Kubulau, where local actors are not capable of managing all threats to their ecosystems (Table 4 *indicator 2b*). In 1998, local communities attributed mass fish kills and coral die-offs downstream of the Yanawai River mouth to runoff from tailings released from an upstream gold mine (Jupiter *et al.* 2010). As the tailings ponds are located outside the boundaries of Kubulau District near the headwaters of the Yanawai, the community has no

297 influence in mining operations there, particularly as mining leases in Fiji may be granted over
298 native land under the Mining Act without landowner consent (Clarke & Jupiter 2010b). A
299 second major constraint is that community ILSM plans are not legally recognized by the
300 government (Clarke & Jupiter 2010b), which particularly affects local ability to enforce no-
301 take freshwater and marine protected areas (Table 4 *indicator 7b*). The Fiji Fisheries Act
302 permits all fishers to fish for subsistence anywhere in Fiji's fresh and coastal waters with
303 certain permitted gear types, compromising the effectiveness of ILSM as a large number of
304 Fiji's fishes move between freshwater and marine realms during their life cycles (Jenkins *et*
305 *al.* 2010). Presently, the only legal mechanism available for completely prohibiting all
306 subsistence and commercial fishing is for the Minister for Fisheries and Forests to gazette an
307 MPA as a restricted area, but Kubulau communities, like others in Fiji, have been reluctant to
308 use this instrument as it would require ceding management control to the government (Clarke
309 & Jupiter 2010b).
310
311 *New Britain, Papua New Guinea (PNG)*
312
313 Positive attributes: The New Britain project scored high on some but not all indicators related
314 to: adopting a long-term integrated approach to management; ensuring broad sectoral
315 participation in management planning across land and sea; ensuring management systems
316 reflect local values; and adapting existing management (indicators associated with principles
317 1, 4-5, 9; Table 4). Through its commitments to the United Nations Convention on Biological
318 Diversity's Programme of Work on Protected Areas and the Coral Triangle Initiative on
319 Coral Reefs, Fisheries and Food Security, the PNG national government, with support of
320 NGO and research partners, has developed national priorities for terrestrial and marine
321 conservation. In recognition that these two prioritization processes were undertaken

separately without considering the connectivity between land and sea, PNG's national Conservation and Environmental Protection Authority, in partnership with the United Nations Development Programme (UNDP), funded an assessment of land-based threats to downstream coastal ecosystems from upstream land-use and land cover change, using methods developed by Tulloch *et al.* (2016) that consider uncertainty in future development scenarios (Table 4 *indicator 9c*). The outputs from this connectivity assessment are being integrated into ILSM planning decentralized to New Britain Island (covering 2 provinces), which include prioritization of locations for protected areas specifically to manage for cross-system threats from land-based activities that increase sedimentation and negatively impact biodiversity. There are aspirations that at least some of these priority areas will become legally protected under new protected area legislation in development in PNG, though the protected area type and agencies responsible for their management are not yet clear.

An international NGO and an Australian research organisation are facilitating the development of an ILSM plan for East New Britain as part of the Bismarck Sea Adaptive Governance project, which complements an ILSM plan already completed for West New Britain with UNDP support (V.Tulloch, pers. comm.). Contents of the two plans will be incorporated into five year sustainable development plans for provincial governments (Table 4 *indicator 1a*) with the aim to enable community and government stakeholders to make informed and inclusive decisions to support sustainable resource management and economic development within an ILSM framework. All coastal ecosystems will be covered in the finalized plans (Table 4 *indicator 1b*) and a broad range of stakeholders have been included in consultations, including the National Fisheries Authority, Mineral Resources Authority, provincial government staff, oil palm and deep-sea mining companies and representatives from local communities (Table 4 *indicator 4b*). Local values surrounding how connected

terrestrial, freshwater and marine resources are used are being captured through participatory planning workshops with provincial, district and local level government stakeholders to collate ecosystem goods and services' values and define management rules (Table 1 *indicator 5a*).

Constraints: Actual implementation of the individual ILSM plans and integrated sustainable development plan for New Britain is likely to be challenged by resourcing, buy-in and enforcement issues. Current ILSM plan development is based on a two year funded project: while there is hope that additional funding will become available for another five to ten years, the PNG national government has no immediate plans to mainstream the plans' implementation into government budgets and there is presently little buy-in from provincial governments (Table 4 *indicator 4d, 10a-c*). Furthermore, because of customary tenure systems in PNG, implementation ultimately depends on land and reef owner participation in management. Yet the majority of indigenous land- and reef-owners have not been consulted on plan design (Table 4 *indicator 4a*) and may have contrary objectives. They may choose to log rather than restore lands (Table 4 *indicator 5b*), thus potentially preventing implementation across scales necessary for threat mitigation (Table 4 *indicator 3a,b*). Offenses for existing mangement are generally not punished (Table 4 *indicator 7b*) and corruption is rife.

Lānaʻi, Hawaiʻi, USA

Positive attributes: The Lānaʻi project scored high on indicators related to: adopting a long-term integrated approach to management; using clearly defined management boundaries at the appropriate scale; accounting for connectivity between ecological realms and social networks (Mills *et al.* 2014; Guerrero & Wilson 2016); ensuring management authority and rules are recognized; and establishing the framework to implement evidence-based adaptive management (indicators associated with principles 1-3, 6, 9; Table 4). Lānaʻi, the sixth largest (364 km^2) of the main Hawaiian Islands, suffers from extensive soil erosion due to proliferation of invasive feral ungulates (e.g., deer and sheep), with significant capacity to devegetate large parts of the island. Over 3,000 people live on the island, though the majority of the land is privately owned by a single for-profit company, Pūlama Lānaʻi, who run resorts on the island. The company is developing an ILSM plan covering the 98% of the island that it owns, while the remaining 2% is owned by local people, the State of Hawaiʻi and The Nature Conservancy. Jurisdictionally, the management plan is likely to be easily implemented because: the local community and state recognizes the management authority of the private land owner (Table 4 *indicators 6a-c*); land and sea ownership is clearly demarcated and recognized (Table 4, *indicators 2a*-c); and the management and monitoring of the company land is well-coordinated (Table 4 *indicator 10a*).

The goals of the plan are to reduce threats to downstream systems, restore connectivity across landscapes and across the land-sea interface, and maintain and restore ecosystem services (Table 3). Proposed activities for watershed restoration, terrestrial and marine invasive species management, and marine debris management will minimize sedimentation and maximize the potential for recovery of the nearshore reefs (Table 4 *indicators 3a,b*). The ILSM plan will account for cumulative impacts to the coastal zone (Table 4 *indicator 1e*), using outputs from quantitative models estimating soil erosion and dispersal to adjacent reefs,

394 which will be coupled with evaluation of human fishing effort and other marine uses (e.g.,
395 recreation) to assess reef impact and recovery potential. Scenarios will be developed based on
396 various strategies for managing feral ungulates to prioritize areas for management and
397 restoration. Plans are under development to install an integrated land-sea monitoring system
398 once the watersheds for restoration have been determined in order to monitor and evaluate
399 management effectiveness (Table 1 *indicators 9a-c*).
400
401 Constraints: Although a broad range of partners have been involved in discussions about
402 management plan development, including the Hawai‘i Division of Aquatic Resources, the
403 Hawai‘i Department of Fish and Wildlife and the U.S. Fish and Wildlife Service, local
404 residents of Lāna‘i have not been consulted (Table 4, *indicators 4a-c*). Local residents have
405 some contradictory values to the company and its management partners, with respect to their
406 preference to maintain populations of feral ungulate for hunting. They are thus not convinced
407 that the management benefits will outweigh the costs to them in terms of lost hunting
408 opportunities and view the company with some distrust (Table 4, *indicators 5a-c*). The
409 landowner is clear that the company will take local community concerns into account and
410 will provide future opportunities for local engagement. However, there is little scope for local
411 residents to question the company's management authority should their future interests
412 diverge (Table 4 *indicator 4d*).
413
414 **DISCUSSION**
415
416 Based on the constraints identified in the four island ILSM projects evaluated, we identify
417 opportunities to improve the effectiveness of project planning and evaluation through
418 increasing local participation in decision-making and mainstreaming ILSM into government,

private sector or public-private partnerships systems for durable and sustainable implementation. We additionally draw on the ILSM literature to identify best-practice examples from other regions that can serve as models for island ILSM projects, while recognizing that outcomes will additionally be influenced by number of resources users and uses and governance capacity.

Improving local participation in decision-making

The common-pool and community-based resource management literature is rich in theory and examples of how local participation promotes more effective and accountable resource management policies and outcomes because local resource users have higher stakes in maintaining the sustainability of resources and have good local knowledge about local processes and feedbacks (e.g., Ostrom 1990; Brechin *et al.* 2002; Cox *et al.* 2010). Furthermore, various evaluations of island projects have emphasized the importance of community-driven decisions for regulating resource use (World Bank 1999; Pollnac & Pomeroy 2005). For many Pacific Island systems, these local decision-making processes concerning access to and use of land and sea resources are embedded in customary governance structures operating across linked ridge-to-reef units (Ruddle *et al.* 1992; Hviding 1996). In places like Zaira and Kubulau where customary governance is still strongly respected and largely supported by national legislation, participatory, community-based management systems can be extraordinarily effective at restricting access and use according to fluctuations in resource availability, particularly as systems of customary management blend with more contemporary concepts of ILSM (Johannes 2002; Aswani & Ruddle 2013). Thus, these customary systems should be supported and strengthened.

443 The ability to participate in management rule development during island ILSM planning will
444 likely have strong impact on the long-term sustainability of implementation. Giving all
445 stakeholders opportunity to voice opinions will improve buy-in (Kearney *et al*. 2007), though
446 if these opinions are not valued it can create dissatisfaction in the planning and
447 implementation process (e.g., Risvoll *et al.* 2014). In New Britain and Lāna‘i, where outside
448 actors are spearheading ILSM initiatives, the success of plan implementation will therefore
449 hinge on engaging local landowners to ensure that they recognize both the process and the
450 rules as legitimate.
451
452 Level of participation can potentially be increased by ensuring that local governance is nested
453 within broader supporting agencies and structures (Ostrom 1990) and by working with
454 influential actors to engage people across their social networks, noting that participation will
455 likely be more effective where there is cultural predilection towards social cooperation
456 (Gurney *et al.* 2016). Expectations of all stakeholders must be clearly articulated from the
457 outset or could ultimately result in project failure if and when local actors do not feel their
458 objectives are being met and/or benefits are not distributed equitably (Christie 2005).
459 Adequate time and effort must be given for participatory consultations to define management
460 objectives, systems and rules, which may require donor education to ensure that project
461 budgets and timelines allow for enough facilitated discussion to build consensus. As an
462 example, the participatory processes supporting the rezoning of the Great Barrier Reef
463 Marine Park, which is often upheld as a model of ILSM, took six years and included over
464 1000 meetings and consideration of 31,000 written submissions to the management authority
465 (Hughes *et al.* 2007).
466
467 *Mainstreaming ILSM for long-term implementation*

Governments have capacity to create the legal enabling framework for ILSM and harmonize laws across multiple sectors (e.g., forests, fisheries, environment, health; Lane 2008) and multiple scales, from local rules to internationally agreed multi-lateral frameworks (e.g., CBD). While this does not happen frequently, it may improve policy implementation when local rules are recognized at higher levels (Christie 2005). Government-led processes, such as from the New Britain project, also have the potential to design management that addresses the spatial scale of ecosystem processes and threats within the context of national policy and legislation. Decentralization and nesting of these broader government policies and plans should improve implementation when local actors have more ownership over decisions (Ostrom 1990). A prime example of this comes from island systems in the Philippines, where the Local Government Code of 1991 devolves most responsibility for coastal resource management, including management of cross-system processes and threats, to local government units (LGUs) to manage from their inland boundary to 15 km offshore (White *et al.* 2005).

Funding for many ILSM projects in developing countries has historically been donor-driven, resulting in cessation of implementation following project termination (Christie 2005; Pollnac & Pomeroy 2005). Thus, mainstreaming ILSM into government budgets and agency mandates should enable long-term support, particularly for monitoring and enforcement that local communities may be ill-equipped on their own to carry out (Christie & White 1997; Christie 2005). This is exemplified in the Philippines where a Coastal and Marine Management Office was created within the Department of Environment and Natural Resources, and coastal management issues, including ILSM, were resourced with funding from national budget allocations (Christie 2005; White *et al.* 2005). To achieve this, policy makers controlling national accounts will need to be convinced that effective ILSM can

493 achieve desirable high-level policy outcomes for food security, livelihoods, sustainable
494 development and biodiversity conservation (Jupiter *et al.* 2014a). Secondly, in order for
495 locally-driven projects to be able to access mainstreamed government resources, local
496 management objectives need to be directly linked to broader policies and plans. For example,
497 gazettal of the Zaira Resource Management Area under the Solomon Islands Protected Area
498 Act 2010 would make it eligible in principle to receive support through legally mandated
499 government financing mechanisms, though in practice Solomon Islands has yet to declare a
500 single national protected area under the Act or mobilize funds for their management.
501
502 Across highly dispersed island archipelagos, central government will not always have
503 resources to lead ILSM planning and implementation in more remote areas, thus
504 decentralization and coordination are essential (Lane 2008). Decentralization will only be
505 effective, however, where local rights to organize and make rules regarding access and use of
506 resources are recognized by higher authorities (Ostrom 1990). Where these rights do not
507 presently exist, granting them to cooperatives of resource users issued exclusive access for
508 harvesting can be effective for incentivizing local actors to self-police and manage for long-
509 term sustainability (e.g., Afflerbach *et al.* 2014). In areas like Kubulau (Fiji) where
510 indigenous people's inherited resource use and access rights have been partially eroded as a
511 consequence of colonial systems, devolving marine tenure rights from the State to traditional
512 fishing owners is highly contentious (Vukikomoala *et al.* 2012). Thus, in the absence of the
513 ability to give local people more direct control over ILSM implementation, projects should
514 focus on improving resources for enforcement of existing rules and building relationships
515 between local wardens and magistrates to enhance opportunities for successful prosecutions.
516 Improved sub-national and national policies can encourage these relationships and improve
517 cooperation among stakeholders that may not normally collaborate (White *et al.* 2006).

Where there are consistent roadblocks to accessing government funds for ILSM, opportunities can be investigated through private sector engagement, as in Lānaʻi. In some cases, large-scale private landowners are motivated by the direct economic incentives of improving ecosystem service provision. For example, following presentations of modelled scenarios for land-use planning incorporating ecosystem service values, Kamehameha Schools, a large landowner on the north shore of Oahʻu (Hawaiʻi) is working to implement a land-use plan prioritizing small-scale agriculture and forestry while also mitigating negative impacts of runoff (Goldstein *et al.* 2012). Other landowners may be swayed to action through corporate social responsibility policies (MacDonald 2010). Small-scale private landholders can be incentivized towards better watershed management practices through payment for ecosystem services initiatives that collectively may act to reduce pollution affecting downstream biodiversity (e.g., Brodie *et al.* 2012). In Kubulau, management costs for implementing the district ILSM plan are offset by tourist user fees for entering the community-managed Namena Marine Reserve (Clarke & Jupiter 2010b), though such schemes are unlikely to be practical or effective in very remote areas (Jupiter *et al.* 2014b). Other opportunities may exist to harness developers' fees paid into trust funds that could be leveraged towards strategic ILSM implementation, though risks of funds being absorbed into consolidated revenue or mismanaged are high, particularly in developing countries (Maron *et al.* 2016).

In summary, we have identified variability in how island ILSM projects are planned and implemented across geographic scales and with different actors driving the process. All projects would benefit from more inclusive participation of all stakeholder groups affected by management decisions across the land-sea divide. Local scale projects could gain from being

nested within government policy frameworks in terms of long-term resourcing and external support. In general, outcomes will only be achieved where adequate government legal and institutional policies encourage, rather than disincentivize, ILSM. Application of our framework for island ILSM project evaluation periodically throughout the lifetime of projects should ultimately lead to better achievement of project goals for biodiversity conservation, sustainable livelihoods and human well-being, though the practicality of its use will ultimately depend on ensuring that ILSM projects are well-documented and the information is readily obtainable.

ACKNOWLEDGEMENTS

Funding for workshops to develop this paper was provided by the Science for Nature and People Partnership (SNAPP) to the Ridges to Reef Fisheries Working Group. SNAPP is a collaboration of The Nature Conservancy, the Wildlife Conservation Society and the National Center for Ecological Analysis and Synthesis (NCEAS). Assessment of the Zaira and Kubulau case studies was additionally supported by NSF grants EF-1427453 and 1325874, respectively.

REFERENCES

Adams, V.M., Álvarez-Romero, J.G., Cawardine, J., Cattarino, L., Hermoso, V., Kennard, M.J., Linke, S., Pressey, R.L. & Stoeckl, N. (2014) Planning across freshwater and terrestrial realms: cobenefits and tradeoffs between conservation actions. *Conservation Letters* **7**: 425-440.

567 Afflerbach, J.C., Lester, S.E., Dougherty, D.T. & Poon, S.E. (2014) A global survey of
568 "TURF-reserves", Territorial Use Rights for Fisheries coupled with marine reserves.
569 *Global Ecology and Conservation* **2**: 97-106.
570 Álvarez-Romero, J.G., Pressey, R.L., Ban, N.C., Vance-Borland, K., Willer, C., Klein, C.J. &
571 Gaines, S.D. (2011) Integrated land-sea conservation planning: the missing links.
572 *Annual Review of Ecology, Evolution and Systematics* **42**: 381-409.
573 Álvarez-Romero, J.G., Adams, V.M., Pressey, R.L., Douglas, M., Dale, A., Auge, A., Ball,
574 D., Childs, J., Digby, M., Dobbs, R., Gobius, N., Hinchley, D., Lancaster, I.,
575 Maughan, M. & Perdrisat, I. (2015) Integrated cross-realm planning: a decision-
576 makers' perspective. *Biological Conservation* **191**: 799-808.
577 Anderson, W.B. & Polis, G.A. (1999) Nutrient fluxes from water to land: seabirds affect
578 plant nutrient status on Gulf of California islands. *Oecologia* **118**: 324-332.
579 Aston, J. (1999) Experiences of coastal management in the Pacific Islands. *Ocean & Coastal*
580 *Management* **42**: 483-501.
581 Aswani, S. & Ruddle, K. (2013) Design of realistic hybrid marine resource management
582 programs in Oceania. Pacific Science **67**: 461-476.
583 Brechin, S.R., Wilshusen, P.R., Fortwangler, C.L. & West, P.W. (2002) `Beyond the square
584 wheel: Toward a more comprehensive understanding of biodiversity conservation as
585 social and political process. *Society and Natural Resources* **15**: 41-64.
586 Brodie, J.E., Kroon, F.J., Schaffelke, B., Wolanski, E.C., Lewis, S.E., Devlin, M.J., Bohnet,
587 I.C., Bainbridge, Z.T., Waterhouse, J. & Davis, A.M. (2012) Terrestrial pollutant
588 runoff to the Great Barrier Reef: An update of issues, priorities and management
589 responses. *Marine Pollution Bulletin* **65**: 81-100.
590 Christie, P. (2005) Is integrated coastal management sustainable? *Ocean & Coastal*
591 *Management* **48**: 208-232.

592 Christie, P. & White, A.T. (1997) Trends in the development of coastal area management in
593 tropical countries: from central to community orientation. *Coastal Management* **25**:
594 155-181.
595 Cicin-Sain, B. & Knecht, R.W. (1998*) Integrated coastal and ocean management: concepts*
596 *and practices.* Washington, DC, USA: Island Press.
597 Cicin-Sain, B. & Belfiore, S. (2005) Linking marine protected areas to integrated coastal and
598 ocean management: a review of theory and practice. *Ocean & Coastal Management*
599 **48**: 847-868.
600 Clarke, P. & Jupiter, S.D. (2010a) *Principles and practice of ecosystem based management:*
601 *A guide for conservation practitioners in the tropical Western Pacific*. Bronx, USA:
602 Wildlife Conservation Society.
603 Clarke, P. & Jupiter, S.D. (2010b) Law, custom and community-based natural resource
604 management in Kubulau District (Fiji). *Environmental Conservation* **37**: 98-106.
605 Cox, M., Arnold, G. & Villamayor Tomas, S. (2010) A review of design principles for
606 community-based natural resource management. *Ecology and Society* **15**: 38 [www
607 document]. URL http://www.ecologyandsociety.org/vol15/iss34/art38/
608 Egli, D.P., Tui, T., Jupiter, S.D. & Caginitoba, A. (2010) *Perception surveys of coastal*
609 *resource use and changes following establishment of a marine protected area network*
610 *in Kubulau, Fiji. Technical Report no. 07/10*. Suva, Fiji: Wildlife Conservation
611 Society.
612 Ehler, C.N. (2003) Indicators to measure governance performance in integrated coastal
613 management. *Ocean & Coastal Management* **46**: 335-345.
614 Goldstein, J.H., Caldarone, G., Duarte, T.K., Ennaanay, D., Hannahs, N., Mendoza, G.,
615 Polasky, S., Wolny, S. & Daily, G.C. (2012) Integrating ecosystem-service tradeoffs

into land-use decisions. *Proceedings of the National Academy of Sciences USA* **109**: 7565-7570.

Gresh, T., Lichatowich, J. & Schoonmaker, P. (2000) An estimation of historic and current levels of salmon production in the Northwest Pacific ecosystem: evidence of a nutrient deficit in the freshwater systems of the Pacific northwest. *Fisheries* **25**: 15-21.

Griffith, M.D. & Ashe, J. (1993) Sustainable development of coastal and marine areas in small island developing states: A basis for integrated coastal management. *Ocean & Coastal Management* **21**: 269-284.

Guerrero, A. M. & Wilson, K. A. (2016) Using a social-ecological framework to inform the implementation of conservation plans. *Conservation Biology* [www document]. URL doi:10.1111/cobi.12832

Gurney, G.G., Cinner, J.E., Sartin, J., Pressey, R.L., Ban, N.C., Marshall, N.A. & Prabuning, D. (2016) Participation in devolved commons management: Multiscale socioeconomic factors related to individuals' participation in community-based management of marine protected areas in Indonesia. *Environmental Science & Policy* **61**: 212-220.

Hazlitt, S.L., Martin, T.G., Sampson, L. & Arcese, P. (2010) The effects of including marine ecological values in terrestrial reserve planning for a forest-nesting seabird. *Biological Conservation* **143**: 1299-1303.

Hughes, T.P., Gunderson, L.H., Folke, C., Baird, A.H., Bellwood, D.R., Berkes, F., Crona, B., Helfgott, A., Leslie, H., Norberg, J., Nystrom, M., Olsson, P., Ö sterblom, H., Scheffer, M., Schuttenberg, H., Steneck, R.S., Tengö, M., Troell, M., Walker, B., Wilson, J. & Worm, B. (2007) Adaptive management of the Great Barrier Reef and the Grand Canyon World Heritage Areas. *Ambio* **36**: 586-592.

641 Hviding, E, (1996) *Guardians of Marovo Lagoon: practice, place, and politics in maritime*
642 *Melanesia*. Honolulu, USA: University of Hawaii Press.
643 Hviding, E. & Baines, G.B.K. (1994) Community-based fisheries management, tradition and
644 the challenges of development in Marovo, Solomon Islands. *Development and*
645 *Change* **25**: 13-39.
646 Hviding, E. & Bayliss Smith, T. (2000) *Islands of rainforest: agroforestry, logging and eco-*
647 *tourism in Solomon Islands*. London, UK: Ashgate.
648 Jenkins, A.P. & Jupiter, S.D. (2011) Spatial and seasonal patterns in freshwater ichthyofaunal
649 communities of a tropical high island in Fiji. *Environmental Biology of Fishes* **91**:
650 261-274.
651 Jenkins, A.P & Jupiter, S.D. (2015) Natural disasters, health and wetlands: A Pacific small
652 island developing state perspective. In: *Wetlands and Human Health*, eds. C.M.
653 Finlayson, P. Horwitz & P. Weinstein, pp. 169-192. Dordrecht: Springer.
654 Jenkins, A.P., Jupiter, S.D., Qauqau, I. & Atherton, J. (2010) The importance of ecosystem-
655 based management for conserving migratory pathways on tropical high islands: A
656 case study from Fiji. *Aquatic Conservation: Marine and Freshwater Ecosystems* **20**:
657 224-238.
658 Jenkins, A.P., Jupiter, S., Mueller, U., Jenney, A., Vosaki, G., Rosa, V., Naucukidi, A.,
659 Mulholland, K., Strugnell, R., Kama, M. & Horwitz, P. (2016) Health at the sub-
660 catchment scale: typhoid and its environmental determinants in Central Division, Fiji.
661 *EcoHealth* [www document]. URL doi:10.1007/s10393-10016-11152-10396
662 Johannes, R.E. (2002) The renaissance of community-based marine resource management in
663 Oceania. *Annual Review of Ecology and Systematics* **33**: 317-340.
664 Jupiter, S.D., Tui, T., Shah, S., Cakacaka, A., Moy, W., Naisilisili, W., Dulunaqio, S.,
665 Patrick, A., Qauqau, I., Yakub, N. & Caginitoba, A. (2010*) Integrating EBM science*

to assess marine protected area effectiveness: clues from coral proxies of land disturbance, ecological assessments and socioeconomic surveys. Technical report no. 02/10. Suva, Fiji: Wildlife Conservation Society.

Jupiter, S.D., Jenkins, A.P., Lee Long, W.J., Maxwell, S.L., Carruthers, T.J.B., Hodge, K.B., Govan, H., Tamelander, J. & Watson, J.E.M. (2014a) Principles for integrated island management in the tropical Pacific. *Pacific Conservation Biology* **20**: 193-205.

Jupiter, S.D., Cohen, P.J., Weeks, R., Tawake, A. & Govan, H. (2014b) Locally-managed marine areas: multiple objectives and diverse strategies. *Pacific Conservation Biology* **20**: 165-179.

Kearney, J., Berkes, F., Charles, A., Pinkerton, E. & Wiber, M. (2007) The role of participatory governance of community-based management in integrated coastal and ocean management in Canada. *Coastal Management* **35**: 79-104.

Lane, M.B. (2008) Strategic coastal governance issues in Fiji: The challenges of integration. *Marine Policy* **32**: 856-866.

MacArthur, R.H. & Wilson, E.O. (1967) *The Theory of Island Biogeography*. Princeton, New Jersey, USA: Princeton University Press.

MacDonald, K.I. (2010) The devil is in the (bio)diversity: private sector "engagement" and the restructuring of biodiversity conservation. *Antipode* **42**: 513-550.

Maron, M., Ives, C.D., Kujala, H., Bull, J.W., Maseyk, F.J.F., Bekessy, S., Gordon, A., Watson, J.E.M., Lentini, P.E., Gibbons, P., Possingham, H.P., Hobbs, R.J., Keith, D.A., Wintle, B.A. & Evans, M.C. (2016) Taming a wicked problem: resolving controversies in biodiversity offsetting. *Bioscience* [www document]. URL doi:10.1093/biosci/biw1038

Mills, M., Álvarez-Romero, J. G., Vance-Borland, K., Cohen, P., Pressey, R. L., Guerrero, A. M. & Ernstson, H. (2014) Linking regional planning and local action: Towards using

social network analysis in systematic conservation planning. *Biological Conservation* **169**: 6-13.

Olsen, S.B., Tobey, J. & Hale, L.Z. (1998) A learning-based approach to coastal management. *Ambio* 27:611-619.

Ostrom, E. (1990) *Governing the commons: The evoluton of institutions for collective action*. New York, USA: Cambridge University Press.

Polis, G.A. & Hurd, S.D. (1996) Linking marine and terrestrial food webs: allochthonous input from the ocean supports high secondary productivity on small islands and coastal land communities. *The American Naturalist* **147**: 396-423.

Polis, G.A., Anderson, W.B. & Holt, R.D. (1997) Toward an integration of landscape and food web ecology: the dynamics of spatially subsidized food webs. *Annual Review of Ecology and Systematics* **28**: 289-316.

Pollnac, R.B. & Pomeroy, R.S. (2005) Factors influencing the sustainability of integrated coastal management projects in the Philippines and Indonesia. *Ocean & Coastal Management* **48**: 233-251.

Ragosta, G., Evensen, C., Atwill, E.R., Walker, M., Ticktin, T., Asquith, A. & Tate, K.W. (2011) Risk factors for elevated enterococcus concentrations in a rural tropical island watershed. *Journal of Environmental Management* **92**: 1910-1915.

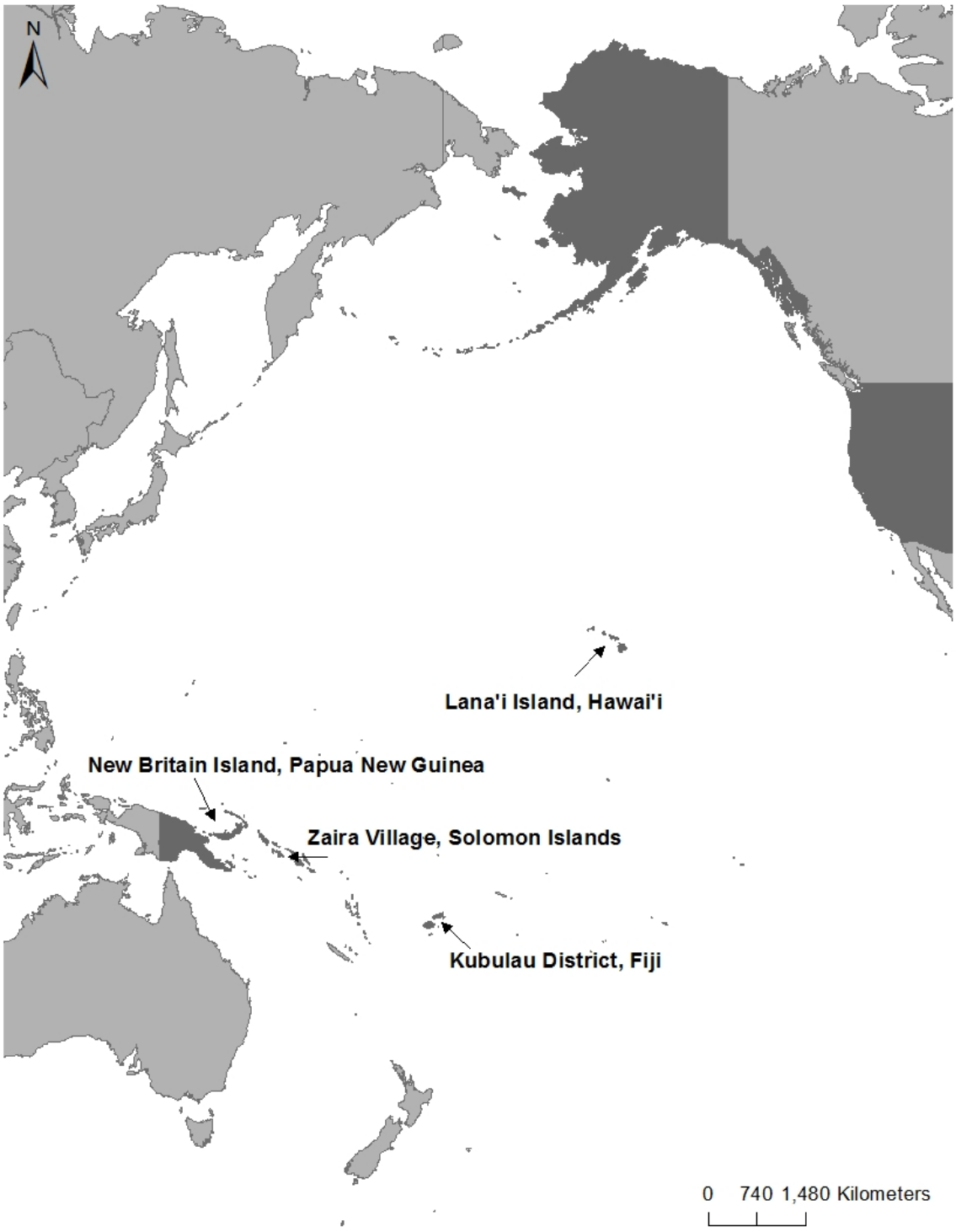
Reuter, K.E., Juhn, D. & Grantham, H.S. (2016) Integrated land-sea management: recommendations for planning, implementation and management. Environmental Conservation **43**: 181-198.

Risvoll, C., Fedreheim, G.E., Sandberg, A. & BurnSilver, S. (2014) Does pastoralists' participation in the management of national parks in Northern Norway contribute to adaptive governance? *Ecology and Society* **19**: 71 [www document]. URL http://dx.doi.org/10.5751/ES-06658-190271

716 Ruddle, K., Hviding, E. & Johannes, R.E. (1992) Marine resource management in the context
717 of customary tenure. *Marine Resource Economics* **7**: 249-273.
718 Tulloch, V.J.D., Brown, C.J., Possingham, H.P., Jupiter, S.D., Maina, J. & Klein, C. (2016)
719 Improving conservation outcomes for coral reefs affected by future oil palm
720 development in Papua New Guinea. *Biological Conservation* **203**: 43-54.
721 Vukikomoala, K., Jupiter, S., Erasito, E. & Chand, K. (2012) *An analysis of international*
722 *law, national legislation, judgements, and institutions as they interrelate with*
723 *territories and areas conserved by indigenous peoples and local communities. Report*
724 *No. 19 Fiji.* Bangalore and Delhi, India: Natural Justice and Kalpavriksh.
725 Weeks, R. & Jupiter, S.D. (2013) Adaptive comanagement of a marine protected area
726 network in Fiji. *Conservation Biology* **27**: 1234-1244.
727 White, A.T., Christie, P., D'Agnes, H., Lowry, K. & Milne, N. (2005) Designing ICM
728 projects for sustainability: Lessons from the Philippines and Indonesia. *Ocean &*
729 *Coastal Management* **48**: 271-296.
730 White, A., Deguit, E., Jatulan, W. & Eisma-Osorio, L. (2006) Integrated coastal management
731 in Philippine local governance: evolution and benefits. *Coastal Management* **34**: 287-
732 302.
733 World Bank (1999*) Voices from the village: a comparative study of coastal resource*
734 *management in the Pacific Islands. Pacific Islands Discussion Paper Series No. 9*.
735 Washington, DC, USA: World Bank.
736

Figure caption

Figure 1. Location of four island ILSM projects in the tropical Pacific.



741 Table 1. Definitions of environmental management approaches applied to safeguard linked land and sea resources, with special reference to
742 implementation in island systems, adapted from Jupiter *et al.* (2014a).
743

Approach	Definition and relevance to islands	Supporting reference
Community-based adaptive management (CBAM)	Integration of design, management and monitoring in order to learn and to improve responses to management efforts, carried out by, or with a major role played by, local communities. In island systems, communities often have the ability to influence management over linked terrestrial and marine ecosystems at the scale in which ecosystem processes and threats are occurring.	Govan *et al.* (2008)
Customary management (CM)	Management of natural resources and systems as part of customary practice and institutions. For example, many Pacific Island peoples retain customary tenure over land and sea ecosystems and resources and can self-define rules for their access and use.	Ruddle *et al.* (1992)
Ecosystem-based management (EBM)	Management of cumulative impact of human activities to maintain ecosystems in a healthy, productive and resilient condition for delivery of ecosystem services and protection of biodiversity. Application of ILSM on island systems is a specific form of EBM that targets maintenance of ecosystem services and biodiversity that rely on connections between land and sea.	Clarke & Jupiter (2010a)
Integrated coastal (zone) management (ICM or ICZM)	A conscious management process that acknowledges the interrelationships among the multiple objectives for use of coastal areas and the environments affected by those uses. Islands are bound by coastlines and thus ICM should form an integral part of any natural resource management scheme.	Cicin-Sain & Knecht (1998)
Integrated island management (IIM)	Sustainable and adaptive management of island natural resources through coordinated networks of institutions and communities that bridge habitats and stakeholders, at the scale of socio-ecological processes and threats, with the common goals and maintaining ecosystem services and securing human well-being.	Jupiter *et al.* (2014a)

Integrated land-sea management (ILSM)	Management that specifically targets cross-system threats and processes between linked terrestrial, freshwater and marine ecosystems to maintain or restore biodiversity, ecosystem services and human well-being. Because of the geographic proximity between water catchments and coastal marine areas in island systems, cross-realm processes and ecosystem functions are more easily disrupted by large-scale disturbance and thus require heightened consideration for integrated management.	Álvarez-Romero *et al.* (2011)

744
745
746

747 Table 2. Indicators designed to evaluate island ILSM projects, associated with ten integrated island management (IIM) principles from Jupiter *et*
748 *al.* (2014a). (P) – principle related to planning; (I) – principle related to implementation. * - denotes indicator specific to ILSM projects.
749

Principle	**Indicator**
1. Adopt a long-term, integrated approach to ecosystem management (P)	a. Explicit time frame of implementation stated (including overall timescale and review frequency)
	b. Proportion of linked ecosystems incorporated in plan*
	c. Presence of coordination body or mechanism to integrate sectors (e.g., public versus private; land versus sea mandates)*
	d. Accounting for cumulative impact of multiple threats to the coastal zone*
	e. Accounting for lag time for impacts to be realized and benefits from management to accrue across realms*
	f. Objectives integrate ecological, social, economic and cultural issues and feedbacks that account for connectivity between land and sea realms*
2. Use clearly defined boundaries for ecological and governance systems (P)	a. Degree to which spatial boundaries of the management zone matches boundaries of watersheds and linked coastal areas*
	b. Management boundaries represent scale of ecological processes and threats for priority features relevant to ILSM*
	c. Resource users are aware of management boundaries
	d. Decision-makers and decision-making processes clearly identified
3. Maintain and restore connectivity between complex social and ecological systems (P)	a. Appropriate strategies proposed and management actions identified to minimize land-based threats to downstream systems relative to number of issues*
	b. Appropriate strategies proposed and management actions identified to restore connectivity processes relative to number of issues*
	c. Strength of social networks that connect people using land and sea resources*
4. Incorporate stakeholders through participatory governance with collective choice arrangements that consider gender and social equity outcomes (P)	a. Proportion of population who access and use land and sea resources in the management area able to participate in management planning and implementation*
	b. Proportion of different sectors and stakeholder groups across land and sea realms participating relative to presence in area*
	c. Opportunities for input from marginalized sectors of communities in affected areas
	d. Consistency of mandate through changes in political leadership
5. Ensure that management rules reflect/incorporate local values and conditions (P)	a. Management objectives reflect local concerns and issues related to cross-system threats and processes*
	b. Local perception that benefits of management outweigh costs
	c. Equity in distribution of management costs and benefits across land and sea resource users*
	a. Level (formal or informal) of recognition of management authority

6. Ensure recognition of rights to organize and develop management rules (I)	b. Clearly defined and demarcated ownership of both land and sea and use rights of land and sea resources*
7. Develop appropriate sanctions for users who violate rules (I)	a. Frequency and effectiveness of monitoring, control and surveillance integrated across land and sea realms*
	b. Proportion of offenses that are adequately punished across both land and sea*
8. Identify appropriate, efficient and cost-effective conflict resolution mechanisms (I)	a. Existence of forum or means to settle disputes
	b. Perception that conflict resolution is handled fairly and in culturally appropriate way
9. Implement adaptive management where regular monitoring, evaluation and review in the face of uncertainty lead to evidence-based decision-making (I)	a. Monitoring information relevant to the spatial scale of impacts of human activities on linked ecosystems and responses of linked ecosystems to management interventions is communicated to decision-makers*
	b. Decision-makers use relevant information to adapt management measures*
	c. Adaptions to rules consider present and future uncertainty regarding cross-realm threats and processes*
10. Nest management layers across sectors, social systems and habitats (P,I)	a. Management actions/monitoring is carried out by individuals across land and sea realms who report to coordinating body*
	b. Frequency and consistency of communication between lower to higher scales of nested systems (upward and downward communication)
	c. Consistency in goals and motivations between nested levels in achieving ILSM outcomes*

753 Table 3. Summary information on ILSM project management objectives, resident population within and/or affected by management area rules,
754 size of management area, nature of governance systems, and entities driving the ILSM process.
755

Case	Country	Management Objective(s)	Resident population size	Management Area	Governance	Entity Driving Management
Zaira Resource Management Area	Solomon Islands	(1) Maintain traditional resource management regime and local leadership that recognizes cultural values and protecting historical heritages; (2) Sustainable use of natural resources to meet the basic present and future livelihood and development needs of the dependent local community; (3) Protect iconic species; (4) Support cultural and environmental education of current and future generations	~150	Terrestrial: 25 km^2; Marine: 15 km^2	Tribal chief	Community
Kubulau District	Fiji	(1) Maintain or restore marine resources; (2) Maintain ecosystem connectivity and function; (3) Protected and provide good habitats for endemic forest species; (4) Ensure sustainable land management; (5) Protect water catchments; (6) Provide economic opportunities for the people of Kubulau (WCS 2012)	~1000	Terrestrial: 98.5 km^2; Marine: 260.1 km^2	Tribal chiefs	NGO
New Britain East and West Province	Papua New Guinea	(1) Build capacity at the local, provincial and national level to improve decision making around marine resource management in the Bismarck Seascape; (2) Develop a comprehensive spatial information dataset to support decision making, which is accessible to a range of stakeholders (through comprehensive maps and a supporting Ridges to Reefs (R2R) plan); (3) R2R planning and management capable of informing decisions across jurisdictions as well as being institutionalised within provincial government, district and tribal governance structures	~450,000	Terrestrial: 37,000 km^2; Marine: 11,170 km^2	Tribal chiefs	Provincial government
Lana'i, Hawai'i	USA	Reducing threats to downstream systems, restoring connectivity across landscapes and across the land-sea interface, and maintaining and restoring ecosystem services, particularly: (1) plant cover which helps aquifer recharge; (2) hunting opportunities for local community; and (3) productive, healthy coastal environments for recreational and provisioning purposes.	~3,100	Terrestrial: 364 km^2	Private landowner	Private sector / NGO

756

Table 4. Evaluation of island ILSM projects. Mean scores for Zaira (Z), Kubulau (K), New Britain (NB) and Lānaʻi (L) projects. Cells shaded white show mean scores ≥1.5, indicating strong project performance against indicator. Cells shaded grey show mean scores >0.5 and <1.5. Cells shaded black show mean scores ≤0.5, indicating poor performance against indicator.

Indicator	**Z**	**K**	**NB**	**L**
1a. Explicit time frame of implementation stated (including overall timescale and review frequency)	2	2	2	1.6
1b. Proportion of linked ecosystems incorporated in plan	2	2	1.5	1
1c. Presence of coordination body or mechanism to integrate sectors (e.g., public versus private; land versus sea mandates)	1.2	2	1.7	1.8
1d. Accounting for cumulative impact of multiple threats to the coastal zone	2	2	0.8	0.6
1e. Accounting for lag time for impacts to be realized and benefits from management to accrue across realms	0	1	0	0.8
1f. Objectives integrate ecological, social, economic and cultural issues and feedbacks that account for connectivity between land and sea realms	2	2	2	2
2a. Degree to which spatial boundaries of the management zone matches boundaries of watersheds and linked coastal areas	2	1	0	2
2b. Management boundaries represent scale of ecological processes and threats for priority features relevant to ILSM	1.8	1	1	2
2c. Resource users are aware of management boundaries	2	1.4	1	2
2d. Decision-makers and decision-making processes clearly identified	2	1.4	1	1
3a. Appropriate strategies proposed and management actions identified to minimize land-based threats to downstream systems relative to number of issues	2	1.8	1.3	1.2
3b. Appropriate strategies proposed and management actions identified to restore connectivity processes relative to number of issues	2	1	1.5	1.2
3c. Strength of social networks that connect people using land and sea resources	2	2	2	2
4a. Proportion of population who access and use land and sea resources in the management area able to participate in management planning and implementation	1	1.2	0.8	0.2
4b. Proportion of different sectors and stakeholder groups across land and sea realms participating relative to presence in area	1.8	0.8	1.8	0.5
4c. Opportunities for input from marginalized sectors of communities in affected areas	0.4	1.2	1.3	0.2
4d. Consistency of mandate through changes in political leadership	1.6	2	1.2	0.4
5a. Management objectives reflect local concerns and issues related to cross-system threats and processes	2	2	1.5	0.8
5b. Local perception that benefits of management outweigh costs	2	2	0.3	0
5c. Equity in distribution of management costs and benefits across land and sea resource users	2	2	0	0
6a. Level (formal or informal) of recognition of management authority	1.2	1.6	0.6	1.8
6b. Clearly defined and demarcated ownership of both land and sea and use rights of land and sea resources	0	2	0.3	2
7a. Frequency and effectiveness of monitoring, control and surveillance (MCS) integrated across land and sea realms	1.8	1	0.5	0.8
7b. Proportion of offenses that are adequately punished across both land and sea	1.2	0.6	0	0
8a. Existence of forum or means to settle disputes	2	2	0.7	2
8b. Perception that conflict resolution is handled fairly and in culturally appropriate way	1.8	1.8	0	0
9a. Monitoring information relevant to the spatial scale of impacts of human activities on linked ecosystems and responses of linked ecosystems to management interventions is communicated to decision-makers	0.2	1.2	1.3	1.8
9b. Decision-makers use relevant information to adapt management measures	0	0	0	2
9c. Adaptions to rules consider present and future uncertainty regarding cross-system threats and processes	0.8	2	2	2

10a. Management actions/monitoring is carried out by individuals across land and sea realms who report to coordinating body	0	2	0	1.8
10b. Frequency and consistency of communication between lower to higher scales of nested systems (upward and downward communication)	1	1	1	0.4
10c. Consistency in goals and motivations between nested levels in achieving ILSM outcomes	0	1.8	0	0

Table S1. Rationale for selection of indicators for each of the ten integrated island management principles (Jupiter *et al.* 2014), based on the coastal zone management and common-pool resources theory literature but focused on relevance for island systems. (P) – principle related to planning; (I) – principle related to implementation. * - denotes indicator specific to ILSM projects.

Principle	**Indicator**	**Rationale for indicator selection**
1. Adopt a long-term, integrated approach to ecosystem management (P)	a. Explicit time frame of implementation stated (including overall timescale and review frequency) b. Proportion of linked ecosystems incorporated in plan* c. Presence of coordination body or mechanism to integrate sectors (e.g., public versus private; land versus sea mandates)* d. Accounting for cumulative impact of multiple threats to the coastal zone* e. Accounting for lag time for impacts to be realized and benefits from management to accrue across realms* f. Objectives integrate ecological, social, economic and cultural issues and feedbacks that account for connectivity between land and sea realms*	Plans should set long-term objectives with short-term benchmarks (Tear *et al.* 2005) to allow for sufficient time to detect management responses above natural variability, while accounting time lags in responses of social-ecological systems to management actions (e.g., Meals *et al.* 2010). Management should integrate and coordinate decision-making for multiple objectives across land and sea sectors contributing to cumulative impacts, those affected by impacts and actors who have the mandate and capacity to reduce impact (Álvarez-Romero *et al.* 2011). ILSM will not be effective under highly fragmented legal and policy systems in the absence of coordination mechanisms (Christie 2005). Because small and/or developing island nations are often under-resourced, integrating and coordinating management implementation across ministries and sectors can lead to more efficient spending and achievement of overlapping objectives (Aston 1999; Lane 2008).
2. Use clearly defined boundaries for ecological and governance systems (P)	a. Degree to which spatial boundaries of the management zone matches boundaries of watersheds and linked coastal areas* b. Management boundaries represent scale of ecological processes and threats for priority features relevant to ILSM*	Management effectiveness relies on the ability of decision-makers to have clearly defined and recognized authority to make rules at appropriate scales that are communicated and understood by resource users (Ehler 2003).

	c. Resource users are aware of management boundaries d. Decision-makers and decision-making processes clearly identified	
3. Maintain and restore connectivity between complex social and ecological systems (P)	a. Appropriate strategies proposed and management actions identified to minimize land-based threats to downstream systems relative to number of issues* b. Appropriate strategies proposed and management actions identified to restore connectivity processes relative to number of issues* c. Strength of social networks that connect people using land and sea resources*	The well-being of island people is intimately tied to strong connections between natural systems to provide critical ecosystem services (e.g., water and food provisioning, natural hazard reduction, disease regulation) and social systems that exchange knowledge and resources (Ruddle *et al.* 1992).
4. Incorporate stakeholders through participatory governance with collective choice arrangements that consider gender and social equity outcomes (P)	a. Proportion of population who access and use land and sea resources in the management area able to participate in management planning and implementation* b. Proportion of different sectors and stakeholder groups across land and sea realms participating relative to presence in area* c. Opportunities for input from marginalized sectors of communities in affected areas	Broad stakeholder involvement in management increases ownership of and compliance with decisions (Kearney *et al.* 2007). Top down imposition of rules without local stakeholder input may be perceived as less legitimate (McCay & Jentoft 1996). Frequent changes in leadership and mandate of decision-making authority are likely to result in changes to management priorities, impacting achievement of long-term goals (Ehler 2003; Christie 2005).

	d. Consistency of mandate through changes in political leadership	
5. Ensure that management rules reflect/incorporate local values and conditions (P)	a. Management objectives reflect local concerns and issues related to cross-system threats and processes* b. Local perception that benefits of management outweigh costs c. Equity in distribution of management costs and benefits across land and sea resource users*	Management buy-in hinges on whether local actors feel that they receive benefits that match their objectives and how fairly benefits are distributed within the context of existing social structures (Christie 2005; Pollnac & Pomeroy 2005).
6. Ensure recognition of rights to organize and develop management rules (I)	a. Level (formal or informal) of recognition of management authority b. Clearly defined and demarcated ownership of both land and sea and use rights of land and sea resources*	Although community-based management is the foundation for many ILSM programs, rules and rights must be recognized and supported by external institutions to ensure sustainability of implementation (Ostrom 1990; Christie & White 1997).
7. Develop appropriate sanctions for users who violate rules (I)	a. Frequency and effectiveness of monitoring, control and surveillance integrated across land and sea realms* b. Proportion of offenses that are adequately punished across both land and sea*	The nature of sanctions must fit the scale of the offense, be perceived as legitimate by the offenders, and serve as a deterrent (Ostrom 1990).
8. Identify appropriate, efficient and cost-effective	a. Existence of forum or means to settle disputes	As the objective of most ILSM projects is to simultaneously achieve multiple objectives for resource use across the land-sea interface, coordination and mediation mechanisms are essential to balance multiple,

conflict resolution mechanisms (I)	b. Perception that conflict resolution is handled fairly and in culturally appropriate way	often conflicting stakeholder interests (Christie 2005). Conflict resolution mechanisms and processes need to be efficient, cost-effective and perceived as legitimate and fair within the local social contexts (Cox *et al.* 2010).
9. Implement adaptive management where regular monitoring, evaluation and review in the face of uncertainty lead to evidence-based decision-making (I)	a. Monitoring information relevant to the spatial scale of impacts of human activities on linked ecosystems and responses of linked ecosystems to management interventions is communicated to decision-makers* b. Decision-makers use relevant information to adapt management measures* c. Adaptions to rules consider present and future uncertainty regarding cross-realm threats and processes*	ILSM should be an iterative process of fine-tuning rules and regulations based on monitoring and review (Olsen *et al.* 1998), and should consider how the tight feedbacks in island systems respond to present and future changes.
10. Nest management layers across sectors, social systems and habitats (P,I)	a. Management actions/monitoring is carried out by individuals across land and sea realms who report to coordinating body* b. Frequency and consistency of communication between lower to higher scales of nested systems (upward and downward communication) c. Consistency in goals and motivations between nested levels in achieving ILSM outcomes*	Smaller groups with strong mutual trust may be able to better organize collectively to design and implement locally-appropriate rules (Ostrom 1990), but need to be coordinated to manage across the spatial scale of threats and resource use on island systems to achieve higher order objectives, particularly across highly dispersed island archipelagos.

References

Álvarez-Romero, J.G., Pressey, R.L., Ban, N.C., Vance-Borland, K., Willer, C., Klein, C.J. & Gaines, S.D. (2011) Integrated land-sea conservation planning: the missing links. *Annual Review of Ecology, Evolution and Systematics* **42**: 381-409.

Aston, J. (1999) Experiences of coastal management in the Pacific Islands. *Ocean & Coastal Management* **42**: 483-501.

Christie, P. (2005) Is integrated coastal management sustainable? *Ocean & Coastal Management* **48**: 208-232.

Christie, P. & White, A.T. (1997) Trends in the development of coastal area management in tropical countries: from central to community orientation. *Coastal Management* **25**: 155-181.

Cox, M., Arnold, G. & Villamayor Tomas, S. (2010) A review of design principles for community-based natural resource management. *Ecology and Society* **15**: 38 [www document]. URL http://www.ecologyandsociety.org/vol15/iss34/art38/

Ehler, C.N. (2003) Indicators to measure governance performance in integrated coastal management. *Ocean & Coastal Management* **46**: 335-345.

Jupiter, S.D., Jenkins, A.P., Lee Long, W.J., Maxwell, S.L., Carruthers, T.J.B., Hodge, K.B., Govan, H., Tamelander, J. & Watson, J.E.M. (2014) Principles for integrated island management in the tropical Pacific. *Pacific Conservation Biology* **20**: 193-205.

Kearney, J., Berkes, F., Charles, A., Pinkerton, E. & Wiber, M. (2007) The role of participatory governance of community-based management in integrated coastal and ocean management in Canada. *Coastal Management* **35**: 79-104.

Lane, M.B. (2008) Strategic coastal governance issues in Fiji: The challenges of integration. *Marine Policy* **32**: 856-866.

McCay, B. & Jentoft, S. (1996) From the bottom up: participatory issues in fisheries management. *Society and Natural Resources* **9**: 237-250.

Meals, D.W., Dressing, S.A. & Davenport, T.E. (2010) Lag time in water quality respons to best management practices: A review. *Journal of Environmental Quality* **39**: 85-96.

Olsen, S.B., Tobey, J. & Hale, L.Z. (1998) A learning-based approach to coastal management. *Ambio* 27:611-619.

Ostrom, E. (1990) *Governing the commons: The evoluton of institutions for collective action*. New York, USA: Cambridge University Press.

Pollnac, R.B. & Pomeroy, R.S. (2005) Factors influencing the sustainability of integrated coastal management projects in the Philippines and Indonesia. *Ocean & Coastal Management* **48**: 233-251.

Ruddle, K., Hviding, E. & Johannes, R.E. (1992) Marine resource management in the context of customary tenure. *Marine Resource Economics* **7**: 249-273.

Tear, T.H., Kareiva, P., Angermeier, P.L., Comer, P., Czech, B., Kautz, R., Landon, L., Mehlman, D., Murphy, K., Ruckelshaus, M., Scott, J.M. & Wilhere, G. (2005) How much is enough? The recurrent problem of setting measurable objectives in conservation. *Bioscience* **55**: 835-849.

Table S2. Criteria to evaluate island ILSM projects against indicators.

Indicator	**Scoring criteria**
1a. Explicit time frame of implementation stated (including overall timescale and review frequency)	Timeframe of plan implementation stated: 2 Timeframe of plan implementation not stated: 0
1b. Proportion of linked ecosystems incorporated in plan	All linked ecosystems explicitly included in plan: 2 Management actions for some but not all linked ecosystems: 1 Management actions only for one ecosystem and no consideration of linkages: 0
1c. Presence of coordination body or mechanism to integrate sectors (e.g., public versus private; land versus sea mandates)	Coordination body exists: 2 Coordination body does not exist: 0
1d. Accounting for cumulative impact of multiple threats to the coastal zone	Management measures exist for multiple threats: 2 Management measures exist for one threat: 0
1e. Accounting for lag time for impacts to be realized and benefits from management to accrue across realms	Lag times considered and planned for: 2 Lag times not considered and planned for: 0
1f. Objectives integrate ecological, social, economic and cultural issues and feedbacks that account for connectivity between land and sea realms	Yes: 2 No: 0
2a. Degree to which spatial boundaries of the management zone matches boundaries of watersheds and linked coastal areas	High degree of overlap: 2 Moderate degree of overlap: 1 Very mismatched boundaries: 0
2b. Management boundaries represent scale of ecological processes and threats for priority features relevant to ILSM	Boundaries cover full scale of ecological processes and threats: 2 Boundaries do not cover full scale of ecological processes and threats, but areas covered are likely to have most impact/relevance: 1 Boundaries do not cover full scale of ecological processes and threats, and do not cover areas likely to have most impact/relevance: 0
2c. Resource users are aware of management boundaries	All resource users aware: 2 Most resource users aware: 1 Most resource users not aware: 0
2d. Decision-makers and decision-making processes clearly identified	Everyone aware of who are decision-makers and decision-making process is transparent: 2 Everyone aware of who are decision-makers and decision-making process is a bit unclear: 1 It is not clear who makes decisions and how decisions are made: 0

3a. Appropriate strategies proposed and management actions identified to minimize land-based threats to downstream systems relative to number of issues	Proposed strategies and actions will be fully effective at minimizing downstream impact from existing threats: 2 Proposed strategies and actions will be somewhat effective at minimizing downstream impact from existing threats: 1 Proposed strategies and actions will be not be effective at minimizing downstream impact from existing threats: 0
3b. Appropriate strategies proposed and management actions identified to restore connectivity processes relative to number of issues	Proposed strategies and actions will be fully effective at restoring connectivity processes: 2 Proposed strategies and actions will be somewhat effective at restoring connectivity processes: 1 Proposed strategies and actions will be not be effective at restoring connectivity processes: 0
3c. Strength of social networks that connect people using land and sea resources	People who use land and sea realms are strongly connected through social networks via sharing of information and resources: 2 People who use land and sea realms are somewhat connected through social networks via sharing of information and resources: 1 People who use land and sea realms are poorly connected through social networks via sharing of information and resources: 0
4a. Proportion of population who access and use land and sea resources in the management area able to participate in management planning and implementation	All resource users have opportunity to directly (e.g., attend planning meetings) or indirectly (e.g., submit comments) contribute to management planning and implementation: 2 Only some resource users can directly contribute and there are no processes for others to indirectly contribute: 1 Decisions are made by people from outside the management area without input from resource users: 0
4b. Proportion of different sectors and stakeholder groups across land and sea realms participating relative to presence in area	All relevant sectors and stakeholders are involved in planning: 2 Most relevant sectors and stakeholders are involved in planning: 1 Key relevant sectors and stakeholders are missing: 0
4c. Opportunities for input from marginalized sectors of communities in affected areas	There are processes for gaining input from marginalized sectors and these are followed: 2 There are process for gaining input from marginalized sectors, but these are not followed through: 1 There are no processes for marginalized sectors to give input: 0
4d. Consistency of mandate through changes in political leadership	Mandate for ILSM remains/will remain through leadership change: 2 Mandate for ILSM changes/may change through leadership change: 0
5a. Management objectives reflect local concerns and issues related to cross-system threats and processes	Management objectives clearly incorporate local concerns and issues: 2 Management objectives incorporate some local concerns and issues, but also include objectives from outside actors: 1 Management objectives are fully imposed by outside actors: 0

5b. Local perception that benefits of management outweigh costs	The majority of people affected by management rules feel that they are benefitting: 2 Some people feel that they are benefiting: 1 A majority of people feel that the costs outweigh the benefits: 0
5c. Equity in distribution of management costs and benefits across land and sea resource users	Resource users perceive equitable distribution of costs and benefits across land and sea realms and users: 2 Resource users perceive inequitable distribution of costs and benefits across land and sea realms and users: 0
6a. Level (formal or informal) of recognition of management authority	Management authority is legally recognized and locally perceived as legitimate: 2 Management authority has no legal recognition but is locally perceived as legitimate: 1 Management authority is not legally recognized or locally perceived as legitimate: 0
6b. Clearly defined and demarcated ownership of both land and sea and use rights of land and sea resources	Ownership and resource use rights for the land and sea are legally defined: 2 Ownership and resource use rights are not legally defined and/or there is a contradiction between customary and national law: 0
7a. Frequency and effectiveness of monitoring, control and surveillance (MCS) integrated across land and sea realms	MCS is performed regularly across both land and sea realms: 2 MCS is performed irregularly or regularly in one but not multiple realms: 1 MCS is performed irregularly and only in one realm: 0
7b. Proportion of offenses that are adequately punished across both land and sea	Large proportion of offenses are punished across both realms: 2 Offenses inconsistently are punished across realms: 1 Most offenses go unpunished: 0
8a. Existence of forum or means to settle disputes	Forum for conflict resolution exists: 2 Forum for conflict resolution does not exist: 0
8b. Perception that conflict resolution is handled fairly and in culturally appropriate way	People within management area feel that conflict resolution is handled fairly and appropriately: 2 People within management area feel that conflict resolution is not handled fairly or appropriately: 0
9a. Monitoring information relevant to the spatial scale of impacts of human activities on linked ecosystems and responses of linked ecosystems to management interventions is communicated to decision-makers	Monitoring information relevant to the spatial scale of impacts, processes and responses is regularly collected and communicated: 2 Monitoring information is collected and only sometimes cpmmunicated: 1 Monitoring information is not collected or communicated: 0
9b. Decision-makers use relevant information to adapt management measures	Management measures are adapted based on monitoring information about land-sea impacts, processes and responses: 2 Management measures are not adapted when monitoring information indicate a need to change rules: 0
9c. Adaptions to rules consider present and future uncertainty regarding cross-system threats and processes	Present and future uncertainty regarding cross-realm threats and processes considered: 2 Present and future uncertainty regarding cross-realm threats and processes not considered: 0

10a. Management actions/monitoring is carried out by individuals across land and sea realms who report to coordinating body	Individual actors or groups implementing management are reporting to coordinating body: 2 Individual actors or groups implementing management do not report to coordinating body: 0
10b. Frequency and consistency of communication between lower to higher scales of nested systems (upward and downward communication)	There is regular communication between vertical governance scales: 2 There is patchy communication between vertical governance scales: 1 There is no communication between vertical governance scales: 0
10c. Consistency in goals and motivations between nested levels in achieving ILSM outcomes	Goals and motivations are consistent across nested levels: 2 Goals and motivations are not consistent across nested levels: 0