Environmental Conservation (2016) **43** (2): 181–198 © Foundation for Environmental Conservation 2016 doi:10.1017/S0376892916000023

Integrated land-sea management: recommendations for planning, implementation and management

KIM E. REUTER[1,2], DANIEL JUHN[2] AND HEDLEY S. GRANTHAM[2*]

[1] *Temple University, Department of Biology, 1900 N. 12th St., Philadelphia, PA, 19122, USA and* [2] *Conservation International, Betty and Gordon Moore Center for Science and Oceans, 2011 Crystal Dr., Arlington, VA, 22202, USA*

Date submitted: 28 May 2015; Date accepted: 3 December 2015; First published online 15 February 2016

SUMMARY

Marine, freshwater and terrestrial ecosystems face increasing anthropogenic threats that are exacerbated by the ecological connectivity between realms; integrated land-sea management (ILSM) is a framework that can help address this connectivity. However, gaps in our knowledge regarding ILSM remain. This study reviewed 108 relevant studies to understand how ILSM is being utilized. Summarized are: (1) characteristics of integrated land-sea programs; (2) recommendations made from the literature for program planning, implementation and management; (3) how applied programs have been planned, implemented and managed; and (4) recommendations for undertaking ILSM. It was found that applied programs did not often adhere to the strategies recommended by theoretical papers. Applied programs were less likely than theoretical papers to specifically name the land-sea connection, over 50% did not apply a framework or governance approach, many did not include key stakeholders, and over 80% listed at least one conflict or hurdle that decreased program success. This study highlighted the difficulties of undertaking ILSM given the high number of stakeholders, government agencies and experts involved. Based on the findings, recommendations for future ILSM programs are provided.

Keywords: conservation, freshwater, integrated land-sea management, land-sea boundary, marine, protected area, terrestrial

INTRODUCTION

Humans impact 100% of ocean areas (41% of oceans are strongly impacted; Halpern *et al.* 2008) and 83% of land surfaces (Sanderson *et al.* 2002) through livelihood activities. The need for integrated management across landscapes and seascapes is evidenced given that: (1) 40% of people globally live within 100 km of the coast (Millennium Ecosystem Assessment 2005); (2) most the world's megacities are in coastal areas (Klein *et al.* 2002); and (3) land-based anthropogenic use and pressures on coastal and marine ecosystems involve multiple sectors (e.g. agriculture, urban development, forestry). These anthropogenic impacts can be direct, indirect and sometimes occur in unexpected ways, due to the connectivity of ecosystems across terrestrial, freshwater and marine realms (GESAMP 2001; Ruttenberg & Granek 2011; Wilkinson & Brodie 2011; Chen & Hong 2012).

The challenges faced by integrated land-sea management initiatives (ILSM) cross social, economic and ecological boundaries (GESAMP 2001; Holt *et al.* 2011) and are multi-objective in nature. Many management institutions focus either on terrestrial, freshwater or marine realms, but do not typically cross the land-sea boundary (Lebel 2012). However, the conservation and sustainable use of coastal and marine areas often requires these realms to be managed in a coordinated and integrated manner (Ruttenberg & Granek 2011; Álvarez-Romero *et al.* 2015) while accounting for the needs of various people within each realm (Mora & Sale 2011). When terrestrial, freshwater and marine management programs are implemented independently there can be an increased risk of failure (Silvestri & Kershaw 2010).

The concept of ILSM has been discussed extensively (Crist *et al.* 2009; Ruttenberg & Granek 2011; Álvarez-Romero *et al.* 2015) as an effective strategy for conservation (Corson *et al.* 2014). The simultaneous conservation of land and sea can increase the success of conservation programs (Klein *et al.* 2012). In one study, protecting 2% of land area was 500 times more beneficial to the protection of coral reefs when the placement of a forest reserve considered nearby costal marine ecosystems (Klein *et al.* 2012). The importance of addressing the land-sea interface in conservation is also evidenced by some coral reefs being impacted more by the associated impacts of deforestation than by climate change, at least in the near future (Maina *et al.* 2013).

Despite the calls for action from the scientific community, it is unclear how or whether ILSM is consistently being integrated into conservation and sustainable development agendas. Few programs have successfully created management plans that connect terrestrial, freshwater and marine realms (Kirkman & Kirkman 2002; Beger *et al.* 2010), and programs that do consider land-sea connections are mostly local and only recently initiated (Lebel 2012). Success rates are further reduced by the lack of overlap between management and scientific realms, marine and terrestrial systems, and different government agencies and stakeholder

*Correspondence: Dr Hedley S. Grantham hedleygrantham@gmail.com

Supplementary material can be found online at http://dx.doi.org/10.1017/S0376892916000023

groups (Christie 2011; Holt *et al.* 2011; Ruttenberg & Granek 2011). In response to these limitations, several frameworks (e.g. Integrated River Basin Management, Integrated Island Management; Christie 2011; Jupiter *et al.* 2014 *a*) and a large number of management tools have been suggested (World Bank 2006). These planning and governance approaches often have overlapping goals (World Bank 2006), and frequently emphasize integration across different sectors and entities (e.g. across government agencies or ecosystems; Christie 2011). As such, the similarity between different approaches can be confusing to stakeholders (Christie *et al.* 2007), but highlight the socio-political challenges faced by integrative and regionally specific initiatives (Kenchington 2010). Despite these frameworks for action, ILSM is not easy; there are distinct differences between terrestrial, freshwater and marine conservation (Hockey & Branch 1994), and merging these efforts may not be intuitive. Also, some coastal programs are still planned without consideration of all three realms (Frid *et al.* 2008) or by considering the trade-offs of protecting one or another (Hughes *et al.* 2011).

Gaps in knowledge regarding ILSM approaches remain (Lebel 2012). While there have been reviews of integrated land-sea conservation (e.g. Álvarez-Romero *et al.* 2011, Álvarez-Romero *et al.* 2015), we are not aware of any systematic reviews of ILSM approaches. We conducted a review of the literature to increase understanding of ILSM programming, the objectives being to: (1) examine characteristics of ILSM programs profiled in the literature (program descriptions; factors prompting the use of ILSM; frameworks/strategies used); (2) assess recommendations made by theoretical/review papers regarding the planning, implementation and management of land-sea programs; (3) summarize how land-sea programming has actually been planned, implemented and managed in the field; and (4) provide recommendations on how to implement different stages of the ILSM process.

METHODS

This literature review was based on a systematic search of peer-reviewed literature, although several non-peer reviewed reports (grey literature) known to the authors were included to reflect ideas/programs being implemented, particularly by larger non-profit and multilateral funding agencies (e.g. GESAMP 2001; GEF 2004; Crist *et al.* 2009; Silvestri & Kershaw 2010; Govan 2011; Wilkinson & Brodie 2011). A systematic review of the grey literature was not undertaken due to the difficulties of systematically searching this source, much of which is not indexed online or found without help from subject experts. Although most of the information included in the review stems from the peer-reviewed literature, the grey literature provided helpful insight into aspects of ILSM not discussed elsewhere.

English-language peer-reviewed literature was searched using systematic review procedures in October 2014. To focus the search on relevant literature, and to decrease the scope of the review to a manageable size, thematically relevant journals were first identified due to their categorization as 'Biodiversity and Conservation' or 'Marine & Freshwater Biology' journals in the 2013 Thomson Reuters Journal Citation Report (143 journals). An additional six conservation-themed journals were added to this list, following the methods as in Fuller *et al.* (2014). To identify the relevance of candidate journals, journal scope statements and recently published articles were used to identify whether publication focus included any of these topic areas: (1) conservation or management; (2) marine areas; and (3) coastal regions. Journals were selected for inclusion in the literature search if: (1) they had an impact factor of greater than 1.00 (when impact factors were available); (2) they had a focus on conservation or management; and (3) marine or coastal regions were considered acceptable topics for publication. In total, 58 of the 143 journals met these requirements. Candidate journals were searched (ISI Web of Science) using the following search terms: 'marine OR coastal OR ocean* OR sea* AND coral reef* OR fish* OR protected area* OR mangrove* OR wetland* OR marsh* OR saltmarsh* AND land use OR sediment* OR ero* OR deforest* OR degrad* OR farm* OR agricultur*'. When candidate journals were not archived on ISI Web of Science, all past issues were surveyed for relevant literature.

Search results (n = 4371 ISI Web of Science results and n ≈ 300 papers from non-indexed journals) were screened using a three-step process, involving exclusion first by title, then by abstract examination and finally by reading the paper.

Search results were considered candidates for inclusion in the review if they: (1) took place in the context of land-sea connectivity in which the impacts of terrestrial, marine and freshwater realms are considered; and (2) tested or implemented conservation/management interventions. Papers could discuss any stage of the planning/implementation and management process. Papers were not included if: (1) they examined levels of chemicals/metals/sediments in coastal marine waters without considering program management or implementation; or (2) activities were undertaken that did not explicitly examine land-sea connections and conservation/management initiatives. We acknowledge that the inclusion of papers, and the information collected from papers, depended on how studies were framed by authors and on the use of keywords/phrases by authors in their manuscripts. The selection of papers and the subsequent interpretation of the data may have introduced bias into the review process, although the wide scope of the literature search (>4700 papers) ensured a thorough review of a substantial portion of the literature.

Articles selected for inclusion in the review were then categorized by the: (1) type of paper (hypothetical/theoretical/review papers, hereafter referred to as 'theoretical', and 'case studies'); (2) stage of intervention process ('planning and implementation' or 'management', with 'planning and implementation' defined as programs in the planning or first stages of implementation and 'management' defined as programs in any stage following the initial implementation of the project); (3) characteristics of relevant ILSM projects discussed within the papers, if applicable (e.g. location, year in which conservation program was implemented, geographic scope). 'Planning' and 'implementation' were grouped together as there was significant overlap in the literature between these two stages, with most papers discussing both stages simultaneously.

For objective one, the following information was extracted from both theoretical papers and case studies: (1) terminology used to describe land-sea connections; (2) reasons cited for undertaking ILSM; (3) frameworks used in ILSM; and (4) strategies for undertaking ILSM. For objective two, theoretical papers were used to compile key recommendations for the planning, implementation and management of ILSM programs. For objective three, case studies were reviewed to understand the real-world applications of the theoretical literature. For objective four, best practices guidelines from theoretical papers and lessons learned from case studies were summarized into recommendations for undertaking ILSM programs. Findings of the studies are discussed in detail under sub-headings organized first by objective and then either under planning/implementation or management.

Some quantitative data were extracted from case studies to illustrate the characteristics of ILSM programs included in this review. Qualitative data and the presence/absence of certain characteristics were also used to illustrate trends across the literature. In some cases, a categorical Pearson's Chi square test was used to confirm the magnitude of difference between different ILSM case studies.

RESULTS AND DISCUSSION

A total of 108 instances (17 from the grey literature) of ILSM described in 94 papers were found for this review, including 24 theoretical papers and 84 case studies (Fig. S1 and Table S1). The 84 case studies took place in 37 countries, on every continent except Antarctica, with 65% of the case studies recorded in countries with a Human Development Index of greater than 50 (Fig. S1 and Table S1). Of the 84 case studies, 24 focused on planning/implementation, 50 focused on management, and nine focused on both planning/implementation and management (Table S1). Papers were published between 1991 and 2014, with 88% (n = 95) published in or after the year 2000. Case studies focused on planning/implementation initiatives founded in the 1980s and later. Case studies discussing program management highlighted initiatives founded in every decade since the 1950s (Fig. S2).

Characteristics of ILSM programs

Terminology used to describe land-sea connections

All papers considered aspects of land and marine planning, however, not all papers mentioned land-sea connectivity. All theoretical papers (100%, n = 24) specifically mentioned the land-sea connection. By contrast, case studies were less likely to mention land-sea connections (29%, n = 84) despite fitting the inclusion criteria for this literature review (Pearson's Chi square test; Chi square = 38.581, $p < 0.0001$). A wide variety of terms were used to describe land-sea connections: (1) land-sea boundary/bridge/connection/planning; (2) linked habitats/land and ocean; (3) integration of various aspects of coastal ecosystems (e.g. integration of land, coastal and marine management; integration of coral reef, sea grass and mangrove management), approaches (e.g. land-sea approach), management policies (e.g. ocean and coastal policies), and planning (e.g. land and marine planning); (4) cross-system threats; (5) oceanic-terrestrial interface; (6) trans-boundary; and (7) transitional zone. Some papers used descriptive phrases linked to specific conservation initiatives, indicating the types of land-sea connection considered: 'Mountains to the Sea' (Whyte *et al.* 2008); 'Paddock to Reef' (Brodie *et al.* 2012); 'Reef to Ridge' (Govan 2011); 'Coastal Zone and Small Islands endeavour' (Cleary *et al.* 2006); and 'Vanua' (Adams 1994). The terminology used when describing ILSM can be used interchangeably (e.g. 'catchment' and 'watershed'; Wilkinson & Brodie 2011) or broadly (e.g. 'integration'; Tallis *et al.* 2008).

Terminology is important (Piraino *et al.* 2002). When terms are not used in a fixed manner or not adequately defined, they can lose their ability to convey meaning (Hess & Fischer 2001; Piraino *et al.* 2002). Within the context of ILSM, the use of many synonyms could dilute the public's understanding of ILSM and its scope (Piraino *et al.* 2002). However, the use of different terms to describe ILSM could also provide organizations with the flexibility to accurately describe their specific program activities. Additionally, the lack of uniform terminology in ILSM decreases the ease with which information about ILSM can move among and between researchers and practitioners; less than 30% of case studies clearly identified themselves as undertaking land-sea conservation. Finally, without consistent terminology, the goals and functions of ILSM may be unclear and lead to difficulties among practitioners to develop and manage a well-designed program; these concerns have been noted in landscape corridor planning, which shares many of the attributes of ILSM (corridors can cross over numerous habitats and administrative boundaries, and involve integrated management; Hess & Fischer 2001).

Reasons to undertake ILSM programming

Biodiversity protection was the most commonly cited reason why ILSM programs should be/were instituted, in both theoretical papers and case studies (Fig. 1). The percentage of case studies (82%) and theoretical papers (84%) that mentioned biodiversity protection as a reason for instituting ILSM programming did not differ (Pearson's Chi square test; Chi square = 0.021, $p = 0.8843$). Food security, human wellbeing, water security/quality and resource protection were also mentioned. These results reflect the emphasis on protecting biodiversity in the past (Rojas 1992), and the recent shift towards integrated conservation and development

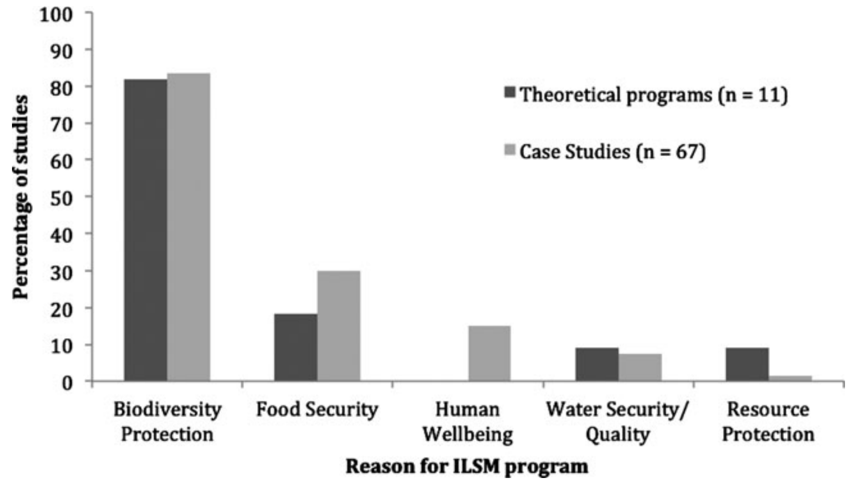

Figure 1 Reasons cited for the creation of integrated land-sea management programs (theoretical papers and case studies). Reasons were not mutually exclusive and papers could cite more than one reason. ILSM = Integrated land-sea management.

programs that consider human wellbeing (Egoh *et al.* 2007). These results may also reflect a bias in our review, given that many of the journals included in this study focused on biodiversity and conservation topics.

Most case studies (73%, n = 84) reported the simultaneous anthropogenic use of terrestrial and marine realms. The complexity of ILSM is emphasized by the fact that many threats cross the land-sea boundary; some are regional and global in scope, while others can be rather proximate (Fig. 2). The same types of terrestrial anthropogenic threats were cited at both the planning/implementation and management stages (Fig. 2). However, papers discussing program management were less likely to cite concerns with natural resource use (e.g. deforestation and hunting) and more likely to cite concerns related to tourism than papers discussing program planning/implementation (Fig. 2). Likewise, when discussing marine anthropogenic use, management papers were more likely to cite land-based threats (e.g. sediment/contaminants/pollution), tourism (e.g. diving/tourism) and global (e.g. climate change) impacts than those related to natural resource use (e.g. fishing, fish farming and dredging; Fig. 2). It therefore appears that during the planning/implementation phase of ILSM, programs focus on mitigating threats related to natural resource use and proximate environmental degradation. By contrast, during the management phase, programs focus on long-term programming (e.g. eco-tourism) and on mitigating ongoing impacts from less proximate environmental degradation. This mismatch between planning/implementation and management may reflect the transition that ILSM programs can undergo from program implementation to maintenance. Conversely, the mismatch may also reflect disconnects between the two phases, where programs that are initially planned/implemented are not those that will ultimately be most successful, useful or able to sustain themselves in the long-term. This highlights the need for ILSM programs to plan for a shift in program objectives over time and to consciously plan/implement programs that are likely to succeed during the management phase.

Frameworks used to approach management of the land-sea boundary

Theoretical (62.50%) and case studies (45.24%) did not differ in the percentage of studies mentioning a specific framework or governance approach when discussing ILSM (Pearson's Chi square test; Chi square = 2.226, $p = 0.1357$). Case studies and theoretical papers listed multiple frameworks, with several synonyms, as guiding their programming; in many cases, these frameworks were described in similar terms with broadly overlapping objectives (Table 1). For example, the integration of marine resource and environment management was considered synonymous to Integrated Coastal Management by Kenchington (2010), and Integrated Island Management in Jupiter *et al.* (2014 *a*) described an island-wide version of Integrated Coastal Management. However, the frameworks did show some differences in their approach, with some targeting specific aspects of the land-sea connection (e.g. Integrated Framework for Nutrient Management; Chen & Hong 2012) or emphasizing human wellbeing (e.g. Integrated Conservation and Development Program; Saunders 2011). Governance approaches were also mentioned, including: adaptive management; community based programming; co-management; indigenous peoples and local community conservation territories and areas; locally managed marine areas; neoliberal conservation; and participatory forest management (Table 1).

Several theoretical papers (37.5%) and many case studies (54.76%) did not explicitly list a framework or governance approach when discussing ILSM. This may be because popular frameworks and governance approaches are sometimes too inflexible or confusing to use in practice; in the Philippines, a switch to Ecosystem-Based Management (EBM) from Integrated Coastal Management at the national level caused confusion about the difference between the two approaches and concern for how EBM would fit in the cultural and political context (Christie 2011). This hypothesis is supported by the many synonyms used to describe similar and overlapping frameworks; it is logical that some programs would re-name a framework or governance strategy in order

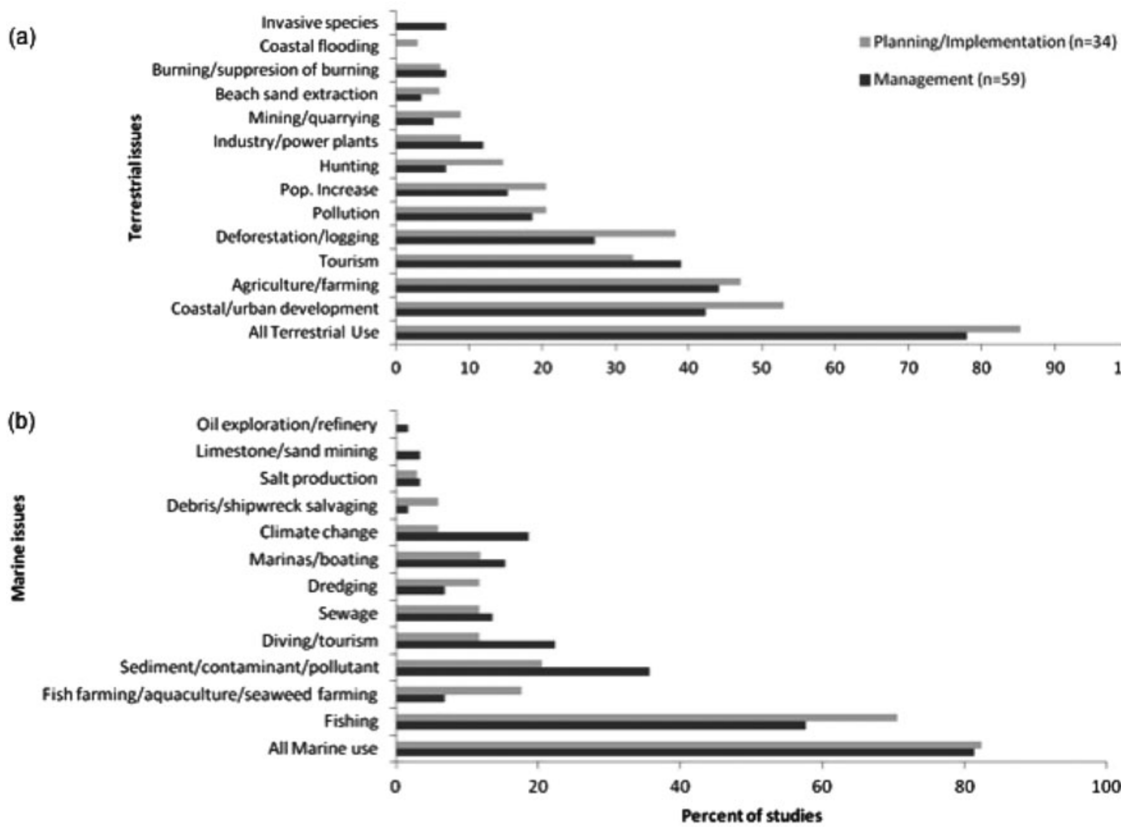

Figure 2 Types of (*a*) terrestrial and (*b*) marine issues in case studies at the planning/implementation and management stages. Issues were not mutually exclusive and papers could cite more than one issue.

to better reflect their goals and objectives. Alternatively, the fact that case studies did not usually list a specific framework or governance strategy may simply point to the disconnect between scientists and practitioners, a problem noted in other fields of conservation (Field *et al.* 2007). Finally, it is possible that case studies utilize the strategies suggested by theoretical papers but use different terminology or have developed their own approaches based on local context. Of course it is also possible that the decision to use certain terminology is driven by funding opportunities and/or by trends in conservation. However, no case studies or theoretical literature explicitly mentioned this.

Strategies for undertaking ILSM

Most case studies (94%, n = 84) proposed/implemented at least one type of terrestrial and one type of marine management strategy simultaneously. Protected areas, broadly defined as any area with some kind of year-round protection, including multi-use reserves, were the most common type of management strategy in both terrestrial and marine realms (Fig. 3). In addition, terrestrial management strategies were more diverse than in the marine realm (21 terrestrial vs. seven different marine programs/strategies mentioned). Terrestrial management strategies mentioned by >20% of case studies included: protected areas, community outreach programs, government legislation, use of eco-tourism, and the development of waste processing and disposal systems (Fig. 3). Strategies for marine management mentioned by >20% of case studies included: protected areas, fisheries/aquaculture programs, conservation of fishing grounds (e.g. periodic closure), changing fishing practices (e.g. banning specific types of fishing equipment) and implementation of biotic/abiotic monitoring programs. Case studies focusing on management tended to cite a lower diversity of terrestrial management initiatives and were more likely to list protected areas as a method of management than case studies focusing on creation/implementation (Fig. 3).

The popularity of protected areas as a method of management reflects past emphasis on habitat protection (Gaines *et al.* 2010). In addition, the fact that case studies utilized a wider diversity of management strategies in terrestrial areas, as compared to marine areas, also echoes trends seen in the literature. For example, the use of marine protected areas complemented by conservation efforts on both terrestrial and marine areas – to address threats from pollution and human population needs – have been recommended as a strategy for marine conservation (Allison *et al.* 1998). These protected areas can serve multiple functions including the protection of biodiversity or to increase the long-term

Table 1 Planning frameworks and governance strategies as utilized by case studies. Definitions are based on those provided in the text of the case study reports.

Framework or governance approach	*Definition*
Frameworks for planning (citation for definition; alternative phrasing used in texts)	
Ecosystem Approach (Holt *et al.* 2011)	Policy framework. Management of natural resources/ecosystems while maintaining human benefits and minimizing human impacts on ecosystems. May not translate to integrated management of ecosystems.
Ecosystem-Based Management (Christie 2011; Landscape Ecosystem Approach)	Management approach that considers ecosystems and human populations with goal of maintaining ecosystems to provide services to humans. Often focuses on ecologically relevant scales.
Integrated Costal Management (Christie 2011; Coastal Zone Management; Coastal Area Management; Integrated Coastal Zone Management; Integrated Coastal Area Management)	Decision-making framework concerning conservation and sustainable use of coastal resources. Designed to allow for cross-stakeholder/jurisdiction/institutional planning and collaboration.
Integrated Conservation and Development Program (Saunders 2011)	Enrolment of local communities in conservation policy/practice during protected area management, using development solutions to increase the success of conservation objectives.
Integrated Framework for Nutrient Management (Chen & Hong 2012)	The expansion of integrated coastal management to explicitly consider nutrient flow among and between coastal ecosystems. Advocates adaptive and interdisciplinary approach.
Integrated Island Management (Jupiter *et al.* 2014 *a*)	Island-wide ecosystem management including sustainable and adaptive management of natural resources by engaging local communities and considering biodiversity/ecosystem needs.
Integrated Land-Sea Planning (Crist *et al.* 2009)	Integrated land-sea planning that aims to mitigate costs of increased human activity, address human resource needs and maintain ecosystem integrity.
Integrated Resource Management Approach (Forest 1998; Integrated Management of Natural Resources; Integrated Marine Resource and Environment Management)	Protected area and resource management including environmental outreach and community participation.
Integrated River Basin Management (Wilkinson & Brodie 2011)	Coordination of conservation, management and development of terrestrial and aquatic realms of a river basin to realize socioeconomic benefits in a sustainable manner.
Systematic Conservation Planning (Álvarez-Romero *et al.* 2013)	Conservation programming with emphasis on minimizing cost and maximizing benefits from capacity building, stakeholder cooperation and awareness raising.
Governance strategies (citation for definition; alternative phrasing used in texts)	
Adaptive Management (Weeks & Jupiter 2013)	Flexible management of protected areas or natural resources that accommodate changing socioeconomic and environmental situations by incorporating new information into planning.
Community-Based [CB] Program (Clarke & Jupiter 2010 *a*; CB Approach; CB Conservation; CB Monitoring Program; CB Natural Resource Management)	Community-level governance systems in the management of natural resources and ecosystems.
Co-Management (Timko & Satterfield 2008)	Sharing of protected area management, including responsibilities and authorities, between different levels of government and stakeholders.
Indigenous Peoples and Local Community Conservation Territories and Areas (Basurto 2013)	Mechanism for incorporating local participation in biodiversity governance.
Locally Managed Marine Areas (Weeks & Jupiter 2013)	Locally managed marine area used as a social or cultural tool aimed at maintaining livelihoods, food security, conservation of biodiversity and planning for climate change.
Neoliberal Conservation (Brondo & Bown 2011)	Political strategy that incorporates privatization of public services, government deregulation and economic markets to facilitate use and management of natural resources.
Participatory Forest Management (Traynor & Hill 2008)	Local communities and government cooperate to protect and manage forested areas.

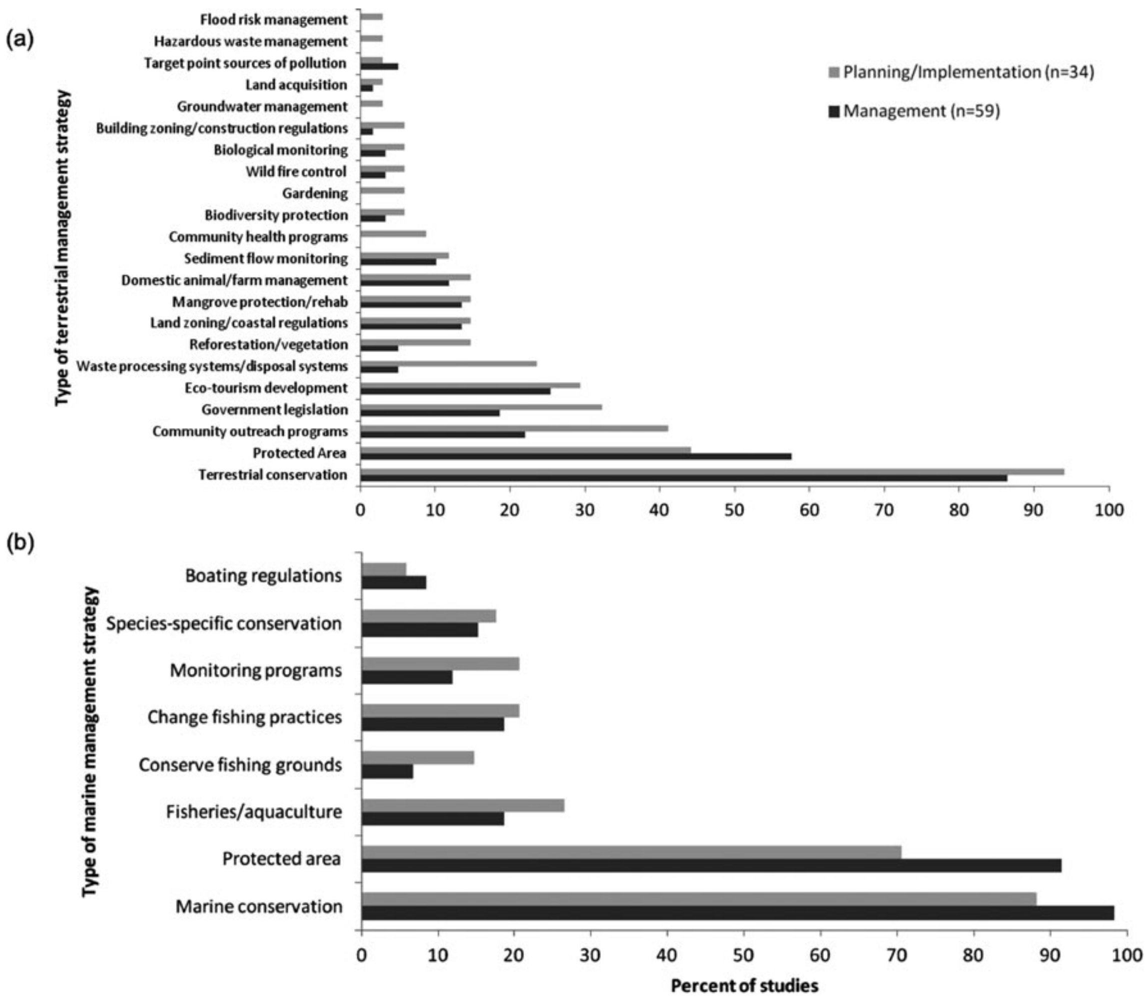

Figure 3 Types of management strategies used in case studies in (*a*) terrestrial and (*b*) marine realms. Strategies were not mutually exclusive and papers could cite more than one strategy.

sustainability of resources actively used by the community (Jupiter *et al.* 2014 *b*).

Key recommendations regarding the planning, implementation and management of ILSM programs

Recommendations by theoretical papers for the planning and implementation stage

Theoretical papers recommended that the following items be instituted or considered during the planning/implementation phase of a new ILSM program: (1) data collection, organization and analysis, including habitat/scientific/ecological data and socioeconomic information with the goal of providing guidance on how to distribute funds and management actions across programs (Halpern *et al.* 2009; Beger *et al.* 2010; Klein *et al.* 2010; Wilkinson & Brodie 2011); (2) articulated goals for the project agreed on by stakeholders (Wilkinson & Brodie 2011; Jupiter *et al.* 2014 *a*); (3) long-term planning for financial and human capacity needs (Jupiter *et al.* 2014 *a*); (4) communication with, and inclusion of, stakeholders in a transparent manner (Wilkinson & Brodie 2011; Lebel 2012); (5) conflict mitigation between stakeholders (Wilkinson & Brodie 2011); and (6) investment by the government, private sector and non-profits (Wilkinson & Brodie 2011).

The recommended order for considering these different aspects of the planning process differed between studies. The order in which these are considered may change based on regional conditions, existing stakeholder support, quality of background knowledge on the local ecosystems, biodiversity, anthropogenic impacts and socioeconomic landscape. However, a general framework for approaching and undertaking the planning process – and how it feeds the implementation process – is visualized in Fig. 4. There is a non-linear relationship between different aspects of the planning and implementation process (Fig, 4). While, in an ideal scenario, programs progress through the different stages of planning, implementation and management in an orderly and premeditated manner (e.g. re-evaluating project goals on a regular basis; Wells *et al.* 2010), in some cases, a crisis precipitates program development (Lebel 2012), including

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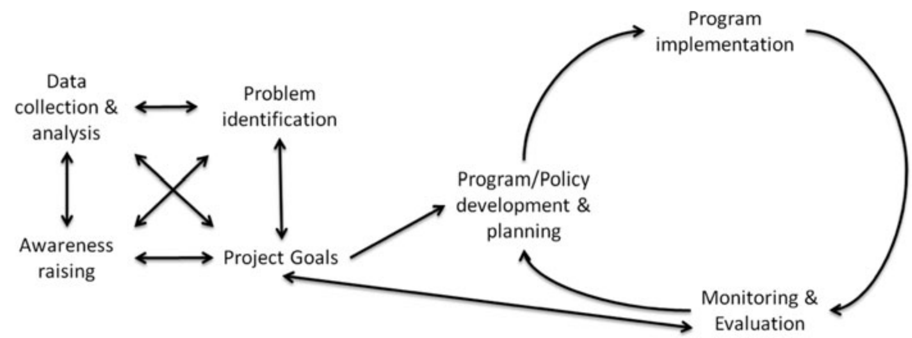

Figure 4 Flowchart of planning, implementation and management process in integrated land-sea management, summarizing the approaches recommended in the theoretical literature. Planning occurs on the left of the figure while adaptive management occurs on the right; different programs enter the flowchart in different places.

data collection, awareness raising, problem identification, monitoring and evaluation, or adaptive management.

Data collection and analysis were recommended for the planning phase of ISLM by every theoretical paper. While most papers focused on a subset of data types and collection techniques (Table 2), one study emphasized that the information available to planners may often be sufficient to justify action and that implementation should not be delayed significantly in order to collect additional information (GESAMP 2001). Nevertheless – in an ideal scenario – vast amounts of accurate and disparate sources of information are considered simultaneously when planning an ILSM initiative (Table 2). This information can be taken from a range of sources, including literature reviews, expert knowledge (Lagabrielle *et al.* 2009), satellite imagery (Klein *et al.* 2010), existing datasets and data-collection initiatives (Nobre 2011).

The theoretical papers did not comprehensively identify all of the data sources that could be useful in planning and implementation. For example, there was a lack of explicit emphasis on data to support project goals not directly related to conservation, such as resource and land access needs. The emphasis on collecting, almost exclusively, ecological data is a noted problem in the environmental policy realm and has led to inadequate policies; interdisciplinary research has been offered as a solution to this problem (Christie 2011). In addition, well-known strategies for collecting information with the help of local communities – including participatory geographical information systems (Brown & Raymond 2007) or surveying for Traditional Ecological Knowledge (Berkes *et al.* 2000) – were mentioned in almost no theoretical papers (but see Jupiter *et al.* 2014 *a*). They were, however, utilized by several of the case studies (e.g. Gerhardinger *et al.* 2009; Ens 2012). This may indicate a bias in past land-sea theoretical literature towards topics that are most relevant to ILSM (e.g. examining cross-realm nutrient flow; Chen & Hong 2012), while topics that are more general to conservation (such as the use of Traditional Ecological Knowledge, discussed in countless papers and reports; Clarke & Jupiter 2010 *b*; Govan *et al.* 2011) are left relatively unexamined in the context of ILSM. It is therefore important for programs to continue leveraging successful strategies from both the terrestrial and marine literature and modifying them to the ILSM context; the fact that case studies utilized these tools and strategies is evidence that this is already occurring in applied management programs.

Several papers provided strategies aimed at simplifying, streamlining, or managing the data analysis process (Table 3). For example, spatial mapping and modelling tools have been developed in order to function as decision-support tools (Crist *et al.* 2009; Halpern *et al.* 2009; Beger *et al.* 2010; Lebel 2012). Also, the use of experts or multi-disciplinary teams from governments, donors and NGOs can bring together the realm-specific expertise of multiple stakeholders (Adams 1994; Crist *et al.* 2009; Lagabrielle *et al.* 2009; Beger *et al.* 2010; Nobre 2011; Wilkinson & Brodie 2011; Lebel 2012). Multidisciplinary teams bring together conflicting points of view, but increase project success by identifying potential conflicts and focusing on priority issues that are easiest to manage (Wilkinson & Brodie 2011). These groups help ensure a thorough understanding of scientific methods, a process that may help decrease conflicts (Nobre 2011). When there is no decision-making group, and when no other mechanisms are in place to link research outputs to the planning process, research may not be incorporated into the program (Lebel 2012).

The use of data analysis or decision-making tools depends on program goals and available data. In many cases, goal setting should precede data analysis; tools and data sources should be identified only after project goals are articulated and should be selected to provide the highest benefit to the project, regardless of their inherent benefits (GESAMP 2001). When data analysis is initiated prior to goal setting, it can lead to inefficient resource use (e.g. collection of unnecessary data; use of metrics that do not measure project progress). Tools should only address the issues relevant to the program (Nobre 2011), should use the best data available and should not increase confusion or decrease communication between stakeholders (Silvestri & Kershaw 2010). Conversely, available tools are sometimes not utilized even when they are beneficial to the project (Lebel 2012). Data availability can constrain the use of the most appropriate tools, and may present a significant logistical bottleneck to program development.

No theoretical papers mentioned scenario planning or trade-off analysis although it could be argued that these analyses are implicit in the strategies aimed at simplifying, streamlining or managing the data analysis process (Table 3). In the time since we conducted our literature search, at least

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Table 2 Types of data to be collected or considered when planning an integrated land-sea management program, as recommended by the theoretical papers.

Type of data	*Sources*
Legal and land ownership framework	
Legal status or area, jurisdiction and responsible agencies	Lagabrielle *et al.* 2009; Wilkinson & Brodie 2011
Examination of traditional ownership and management	Wilkinson & Brodie 2011
Land-use data with zoning and local land-use guidelines	Crist *et al.* 2009
Existing developments	Crist *et al.* 2009
Existing conservation initiatives	Crist *et al.* 2009
Data to quantify program goals	
Extent of area to be managed	Klein *et al.* 2010; Wilkinson & Brodie 2011
Consideration of the type of ecological connectivity being planned for	Beger *et al.* 2010; Makino *et al.* 2013
Land and marine characteristics	
Physical features	Crist *et al.* 2009
Topography	Crist *et al.* 2009; Lagabrielle *et al.* 2009
Bathymetry	Crist *et al.* 2009
Water temperature	Crist *et al.* 2009
Water current direction and speed	Crist *et al.* 2009
Areas of remnant ecosystems	Lagabrielle *et al.* 2009; Klein *et al.* 2010
Land cover data/location of important ecosystem types	Makino *et al.* 2013
Soil type	Crist *et al.* 2009
Rainfall data	Crist *et al.* 2009
Spatial distribution of biodiversity/species abundances	Lagabrielle *et al.* 2009; Samhouri & Levin 2012
Anthropogenic pressures and issues	
Sources of sediments, nutrients and chemicals	Wilkinson & Brodie 2011
Future land use plans and development densities	Crist *et al.* 2009
Roads	Crist *et al.* 2009
Sewage and water infrastructure	Crist *et al.* 2009
Population projections	Tognelli *et al.* 2005; Crist *et al.* 2009; Lagabrielle *et al.* 2009
Locations of vulnerable human populations	Crist *et al.* 2009
Threats and relative impacts of those threats	Klein *et al.* 2010; Samhouri & Levin 2012
Conservation and development opportunities and constraints	
Development constraints (e.g. steep slopes)	Crist *et al.* 2009
Special places that affect human population growth (e.g. historic)	Crist *et al.* 2009
Viability requirements for conservation program (e.g. minimum size of project)	Crist *et al.* 2009
Social values and perceptions	Kirkman & Kirkman 2002
Economic and political realities	Kirkman & Kirkman 2002; Silvestri & Kershaw 2010
Financial/economic data/human use	
Cost-benefit analyses of management solutions	Lagabrielle *et al.* 2009; Klein *et al.* 2010; Nobre 2011; Wilkinson & Brodie 2011
Annual management and opportunity costs of management solutions	Klein *et al.* 2010
Valuation of ecosystem functions and services	Kirkman & Kirkman 2002; Silvestri & Kershaw 2010

one paper has been published on ILSM and scenario planning (Álvarez-Romero *et al.* 2015). Scenario planning is key to ILSM as it can facilitate cross-realm planning when data is missing, help stakeholders envision multiple different futures and increase stakeholder participation (Álvarez-Romero *et al.* 2015).

Recommendations by theoretical papers for the management of ILSM programs

Many papers discussed ILSM broadly, mentioning tools that could be used in both the planning/implementation and management phases (Table 4). However, some aspects of program design were discussed only in reference to the management phase. First, scalability (upscaling programs; Govan 2011) was considered important for program success. Second, long-term planning – separate from adaptive management – was mentioned by several studies. Third, the development of long-term finance strategies are key and can include self-financing or the inclusion of programs into national budgets (Govan 2011). Finally, the production of a strategic management plan that is easy to understand and implement was considered important to long-term success (Kirkman & Kirkman 2002).

Adaptive management (visualized in Fig. 4) was mentioned numerous times in the theoretical literature (Table 4). Adaptive management can help programs adjust to changing

https://doi.org/10.1017/S0376892916000023 Published online by Cambridge University Press

Table 3 Types of resources available for synthesizing and analysing data for integrated land-sea management programs, as recommended by theoretical papers. *These tools are rather broad due to the wording used by authors in the original papers. When authors suggested specific applications or tools, they are listed in this table. However, it was not uncommon for authors to refer – broadly – to a set of tools that could be useful.

Tool/resource	*Sources*
Spatial analysis	
Various mapping tools (e.g. geographic information systems)*	Crist *et al.* 2009; Halpern *et al.* 2009; Beger *et al.* 2010; Klein *et al.* 2010; Silvestri & Kershaw 2010; Nobre 2011; Wilkinson & Brodie 2011; Makino *et al.* 2013
Modelling tools	
Sediment plume models	Crist *et al.* 2009; Lebel 2012
Spatial modelling*	Lagabrielle *et al.* 2009
Hydrological models	Silvestri & Kershaw 2010
Cost-effectiveness analyses (e.g. costs of implementing alternative conservation programs)	Klein *et al.* 2010
Ecological modelling and food webs	Silvestri & Kershaw 2010; Nobre 2011
Integrated ecological-economic modelling	Nobre 2011
Optimization and spatial prioritization tools/conservation planning tools	Crist *et al.* 2009; Lagabrielle *et al.* 2009; Nobre 2011
CommunityViz (visualize/analyse planning decisions)	Crist *et al.* 2009
NatureServe Vista (examines alternate planning scenarios)	Crist *et al.* 2009
N-SPECT (non-point source pollution and erosion tool)	Crist *et al.* 2009
MARXAN (spatial planning tool)	Tallis *et al.* 2008; Crist *et al.* 2009; Makino *et al.* 2013
Habitat Priority Planner	Crist *et al.* 2009
Marine spatial planning*	Nobre 2011
Ecosystem valuation	
InVEST model	Silvestri & Kershaw 2010
ARIES (Artificial Intelligence for Ecosystem Services)	Silvestri & Kershaw 2010
Co$ting Nature	Silvestri & Kershaw 2010
Multidisciplinary teams and suggested experts	
Planning experts (land use planners; infrastructure planner; engineers; watershed managers; marine planner and managers)	Crist *et al.* 2009
Experts on ecological, social, and cultural conservation (zoologists; botanists; ecologists; biologists; sociologists; social scientists; historians; physical oceanographers)	Kirkman & Kirkman 2002; Crist *et al.* 2009; Lagabrielle *et al.* 2009
Water quality experts (hydrologists; chemists)	Kirkman & Kirkman 2002; Crist *et al.* 2009
Geographic Information Systems analysts	Crist *et al.* 2009
Data managers	Crist *et al.* 2009
Stakeholders (scientific community; local community; government; industry)	Kirkman & Kirkman 2002; Crist *et al.* 2009; Lagabrielle *et al.* 2009; Wilkinson & Brodie 2011; Nobre 2011; Lebel 2012
Communication tools	
Integrated environment assessments	Nobre 2011

anthropogenic threats, varying stakeholder needs and incorporate new information, and may become more important in governance (Lebel 2012) as the climate changes (GEF 2004). However, adaptive management can be challenging in the ILSM context, where the different realms and ecosystems might have markedly different objectives or be experiencing different levels of anthropogenic use. However – and despite these difficulties – adaptive management is key to the success of ILSM projects, especially at larger geographic scales (GEF 2004).

The literature suggests that a successfully managed ILSM program should include the following components: (1) ongoing education and outreach to raise problem awareness (GESAMP 2001; Kirkman & Kirkman 2002; Govan 2011); (2) ongoing monitoring to identify stressors causing ecosystem change (Kirkman & Kirkman 2002; Silvestri & Kershaw 2010; Govan 2011); (3) the use of environmental planning and management frameworks to address ecosystem connectivity (Fig. 4; GESAMP 2001; Silvestri & Kershaw 2010); (4) capacity building, focusing on the adoption and transfer of technologies (GESAMP 2001); (5) environmental impact assessments (GESAMP 2001); and (6) decisions made based on cost-benefit analyses (GESAMP 2001). These components do not have to be expensive to maintain. For example, ongoing monitoring can use communities as cost-effective monitors (Govan 2011).

Based on these components, the literature suggests that successful ILSM program outcomes can be summarized as: (1)

Table 4 Mechanisms used to manage integrated land-sea management programs, as recommended by theoretical papers.

Governance tools	*Sources*
Legal and policy tools	
Institutions/legal mechanisms to foster stakeholder-government linkages	GESAMP 2001; GEF 2004; Govan 2011
Implementation of existing agreements, standards and legislation	GESAMP 2001
Poverty alleviation	GESAMP 2001
Creation of new regulations and legislation	GESAMP 2001
Policy instruments that foster voluntary industry action and/or public and private investments	GESAMP 2001
Environmental management agencies	GESAMP 2001
Increased ability to file civil suits regarding environmental protection	GESAMP 2001
Zoning laws	Lebel 2012
Laws holding government agencies and non-government entities accountable for governance of project	Lebel 2012
Conservation/development tools and frameworks	
Protected areas (biodiversity and habitat protection)	World Bank 2006
Sustainable use marine-resource management tools (for extractive use; e.g. permit sportfishing, artisanal fisheries)	World Bank 2006
Multiuse management tools (balancing conservation and socioeconomic landscape; e.g. land zoning, multiuse reserve)	World Bank 2006
Cultural/ecological/social protection tools (for indigenous and traditional, local communities; reserves preserved for their cultural heritage)	World Bank 2006
Collaborations and commitments	
Multi-sector collaboration (regional and international agreements; across the scientific community)	GESAMP 2001; Kirkman & Kirkman 2002; GEF 2004; Govan 2011
Commitment from government and public	GESAMP 2001
Communication	
Clear communication between different aspects of program	Kirkman & Kirkman 2002; Lagabrielle *et al.* 2009; Lebel 2012
Planned communication structure between stakeholders	Kirkman & Kirkman 2002
Program specific manager (intermediary between different information sources/stakeholders)	Kirkman & Kirkman 2002
Management committee (adaptively manage program; reduce conflict)	Lagabrielle *et al.* 2009; Lebel 2012

locally and culturally appropriate (GESAMP 2001; Kirkman & Kirkman 2002; Govan 2011; Wilkinson & Brodie 2011); (2) appropriate for the type of ecosystem being planned for (Beger *et al.* 2010); (3) suitable to national institutional structure and capacity (GESAMP 2001; Kirkman & Kirkman 2002; Govan 2011; Wilkinson & Brodie 2011); (4) having national government commitment (Kirkman & Kirkman 2002) with a coordinated response across different institutions (Silvestri & Kershaw 2010); (5) managers chosen for technical ability (Kirkman & Kirkman 2002); (6) managed/advised by multidisciplinary teams (Kirkman & Kirkman 2002); (7) quality assurance protocols that allow for problems to be addressed when they arise (Kirkman & Kirkman 2002); (8) supported by scientific evidence, including a justification for the geographic placement of an initiative (Beger *et al.* 2010; Halpern *et al.* 2009; Govan 2011; Wilkinson & Brodie 2011); (9) considered to have a high likelihood of success, compared to alternative initiatives (GESAMP 2001; Govan 2011); (10) cost effective (Govan 2011); and (11) potentially applicable elsewhere (Govan 2011).

Key findings from case studies on the planning, implementation and management of ILSM programs

Local communities were not often utilized for their knowledge of local ecosystems or surveyed for their opinions, attitudes and needs. Case studies reported the inclusion of local knowledge and social science information less than 40% of the time in both the planning/implementation and management phases. By contrast, the use of scientific knowledge was cited 65% of the time in the planning/implementation phase and 46% of the time in the management of initiatives.

With the exception of government agencies, stakeholder involvement was low. This is surprising given the well-known benefits associated with stakeholder collaboration in conservation (Knight *et al.* 2006). Governments at the local, regional or national scale were involved in 79% of case studies examining program planning/implementation, and 80% of case studies discussing program management. By contrast, the involvement of all other stakeholders was mentioned by less than 50% of the planning/implementation and management case studies (Fig. 5), with management case studies always

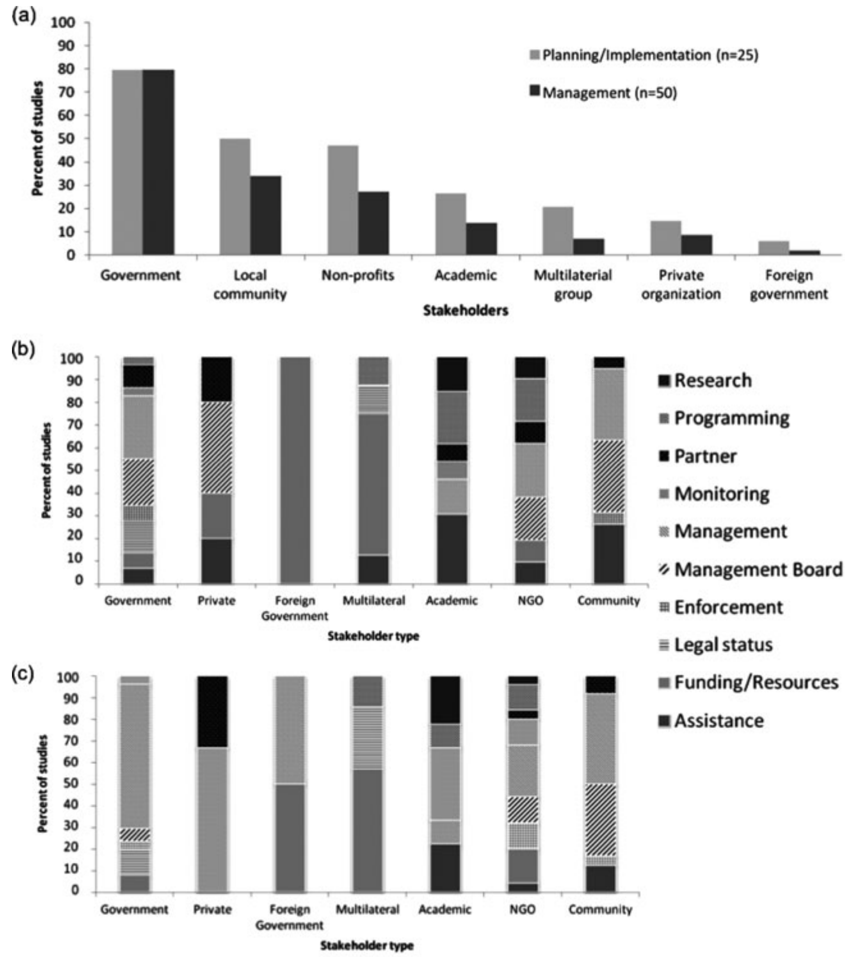

Figure 5 Participation of different stakeholders in case studies (*a*) and types of participation of different stakeholders in case studies during (*b*) planning and implementation (n = 34) and (*c*) management stages of land-sea conservation (n = 59). Case studies were excluded when no stakeholder engagement was noted.

citing the involvement of stakeholders at a lower rate than planning/implementation stage case studies (Fig. 5).

Efforts to involve stakeholders in program planning/implementation or management were not always successful. For example, almost 11% of case studies, which purportedly involved communities in the planning/implementation and/or management phases, reported that the lack of sufficient community involvement still presented a hurdle to program success. However, case studies were significantly less likely to list a lack of community involvement as a barrier to program success when the communities were involved as stakeholders in the program (Pearson's Chi square test, Chi square = 5.855, $p = 0.0155$). Therefore, involvement of the community does seem to decrease the hurdles faced by conservation programs and when efforts at involving local communities fail, the degree of participation that communities are entitled to should be addressed. This is especially true in cases where ILSM programs cannot advance except through community-led engagement of local communities; several successful case studies are highlighted in Wilkinson & Brodie (2011).

The degree of stakeholder participation and involvement varied (Fig. 5). Involvement could include anything from program management to participation in a management board. Different types of involvement were not mutually exclusive; for example, governments could provide both legal frameworks and funding. In some cases, involvement of a stakeholder was described in vague terms (e.g. using the word 'partner') or by indicating that the stakeholder assisted the program but without information about the scale, scope and longevity of that assistance. The level of stakeholder involvement could change over time (Fig. 5). For example, some communities were not involved in the planning/implementation phase but became active participants in program management (e.g. Timko & Satterfield 2008; Basurto 2013).

Few planning/implementation (21%, n = 34) and management (20%, n = 50) case studies mentioned the provision of benefits to communities. Benefits provided to local communities included: (1) alternative income-generating activities; (2) payments for land purchases; (3) park fees disbursed for social development programs; (4) compensatory payments in areas with human-wildlife conflict; (5) natural resource extraction, with profits and job availability benefiting local communities; (6) eco-tourism; (7) payments for ecosystem services; (8) microcredit programs; and (9) short-term jobs.

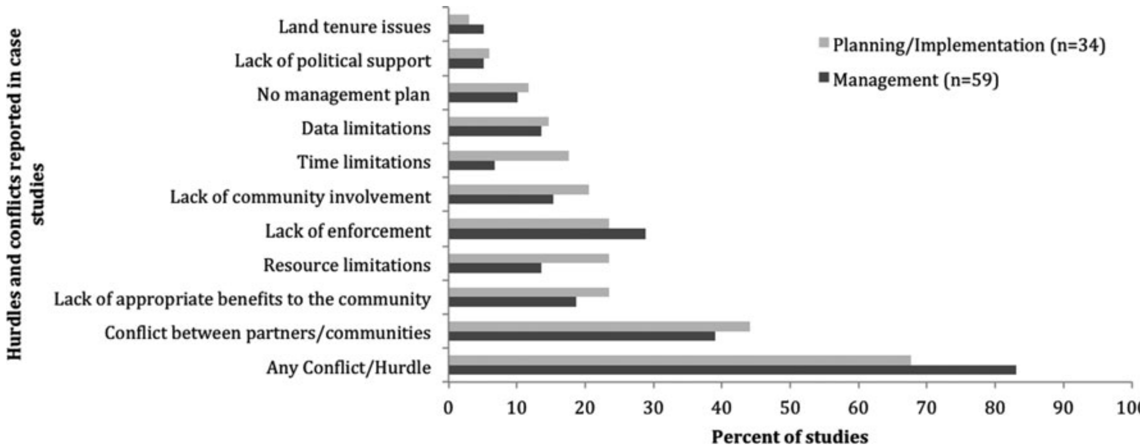

Figure 6 Hurdles and conflicts cited as barriers to conservation success in case studies. Hurdles/conflicts were not mutually exclusive and papers could cite more than one hurdle/conflict.

Most case studies faced conflicts and hurdles to their programs. Management case studies were more likely (83%) to name at least one conflict/hurdle than planning/implementation case studies (68%; Pearson's Chi square test, Chi square $= 4.265$, $p = 0.0389$; Fig. 6). Conflict between partners/stakeholders/communities was the most cited source of conflict (Fig. 6), and included: (1) lack of support from local communities; (2) weak communication between stakeholders and authorities; (3) incongruence between upland and marine management; (4) lack of consensus between the park management and the community; (5) confusion or lack of clarity about the rules of natural resource use; (6) tension between different eco-tourism operators and park management; (7) too many stakeholders and a lack of a communication/collaboration between them; and (8) conflict between legal frameworks at different levels. Conflict arising from inadequate/conflicting legal frameworks is perhaps the most difficult to overcome and suggests that the enabling conditions for ILSM may sometimes not be in place. The examination of whether conflicts, and subsequent program failures, are due to deficiencies in execution by practitioners or whether they are due to systemic barriers warrants further study in the ILSM context.

Key recommendations on the implementation of ILSM programs

Program focus and management

Where human activities simultaneously impact multiple realms in the same region, conservation strategies should consider integrated management of terrestrial, freshwater and marine areas (Klein *et al.* 2010). Different realms may not require equal levels of conservation effort; one study found that marine conservation, in most places, had a higher return on investment than terrestrial conservation (Klein *et al.* 2010). Depending on program priorities, some realms may be targeted more than others. For example, the velocity of climate change – which was mentioned by case studies almost exclusively in the context of ocean warming and acidification – and the shift in seasonal temperatures are predicted to occur at some latitudes at a greater rate in the marine realm than on land (Burrows *et al.* 2011). Of course, ILSM might not always be feasible due to resource limitations (Govan 2011).

Although biodiversity conservation is a common reason for the implementation of programs (Fig. 1), the need to explicitly account for human wellbeing is demonstrated by the fact that the second-most cited hurdle in ILSM case studies was the lack of provision of appropriate benefits to communities (Fig. 6). The explicit use of a framework and/or governance strategy may be useful in guiding the ILSM process; different frameworks can be modified to project needs, given their overlapping aims (Table 1).

Most project sites will face several different anthropogenic threats. Sewage is one of the highest priorities in many regions, though agricultural runoff and negative impacts from industry (GESAMP 2001) as well as coastal/urban development and deforestation can also be high priorities (Fig. 2). Programs should be willing to adapt to external threats (e.g. climate change; Silvestri & Kershaw 2010) in the face of population growth, changes in resource availability (Mora & Sale 2011), and changes in tourism levels, political instability and legal challenges. Some of the threats mentioned in case studies are not typically considered in management plans of protected areas (Mora & Sale 2011); therefore, these should be addressed either by increasing the scope of management plans or utilizing different tools (e.g. legal mechanisms).

Varied anthropogenic challenges can be addressed by combining different strategies and approaches (Mora & Sale 2011) at the multinational (Kohonen 2003; Nobre 2011; Hering *et al.* 2013), national (Nobre 2011) or sub-national level. Working with multiple levels of government may allow for protection against non-local threats such as climate change (Silvestri & Kershaw 2010) or regional sedimentation (Butler *et al.* 2011). Regulatory gaps should be addressed using legal frameworks, with adaptive management used to accommodate changes in the type and magnitude of anthropogenic threats (Lebel 2012). The implementation of programs presents a major impediment in ILSM (e.g. the implementation crisis; Knight *et al.* 2006; Wells *et al.* 2010; Lebel 2012) and programs should proactively plan for these difficulties.

Geographic, spatial and temporal considerations

Depending on the location, ILSM programs may not always be necessary. Some areas of the globe are experiencing higher anthropogenic pressures than others. Europe and Asia have been identified as areas with high land-based impacts on coastal regions (Halpern *et al.* 2008); 40% of the world's coastline experiences few impacts from terrestrial anthropogenic activities (Halpern *et al.* 2009).

Challenges facing ILSM programs may differ between developed and developing countries. For example, developing countries may lack financial resources and the institutional capacity required for effective implementation (Lebel 2012). Local communities in these countries may also be strongly affected by new conservation programs, necessitating increased stakeholder engagement and equitable information dissemination programs (Silvestri & Kershaw 2010). Many of the issues are described in a case study focusing on the Solomon Islands (Lane 2006). By contrast, developed countries may have more stakeholders (e.g. government agencies) with overlapping management responsibilities; in these situations, management groups that mitigate conflict between stakeholders are recommended (Lagabrielle *et al.* 2009; Lebel 2012).

ILSM can be implemented at different scales (Klein *et al.* 2010) and the size of the program will depend on its goals. The stressors of marine systems may not always be in close proximity to the marine area of interest (Wilkinson & Brodie 2011). However, when an ILSM program is considered necessary, land-based and marine-based conservation initiatives should be relatively close to one another geographically because the benefits obtained by the marine system from the ILSM approach may decrease with distance (Beger *et al.* 2010). Nevertheless, there are cases in which ILSM should consider implementation over a larger area. For example, when the upstream and inland processes affecting coastal ecosystems occur over large areas or across complex networks of tributaries, it can be important to protect upstream habitats/ecosystems (e.g. for anadramous/catadromous fishes). In cases where ILSM takes place over large areas, or when land-based and marine-based programs cannot be located in proximity to one another, different interventions may increase the success of the conservation initiative (Klein *et al.* 2010). One key consideration is that larger projects may include more stakeholders, complicating the communication and collaboration process (Ruttenberg & Granek 2011); the difficulties of managing large numbers of stakeholders were cited several times in case studies (Ruttenberg & Granek 2011). Conversely, if a program is too small, it might not be able to tackle underlying issues or to reach some of its goals (e.g. protecting biodiversity or ensuring ecosystem connectivity; Mora & Sale 2011).

Finally, the temporal aspect of ILSM must be considered. Short-term projects are needed in cases where action is urgently needed or where program success is likely (GESAMP 2001). Long-term programs, however, reflect the reality that the successful implementation of ILSM programs takes time (GESAMP 2001). Time limitations were noted by several case studies, as the time lag following interventions can frustrate donors and local communities who: (1) may expect to experience socioeconomic benefits very quickly; and (2) expect interventions to noticeably improve ecosystems within a short period of time. The planning process, including building trust and consensus, can also take a long time.

Organization and planning of ILSM

Projects should either be organized as one all-encompassing campaign (e.g. a protected area covering both land and marine areas of interest) or, if multiple related projects are taking place across the same region, should be organized under one management plan at a programmatic level. The type of approach taken depends on geography, scale, time and access to resources. For example, programs taking place in developing areas (where there are, perhaps, fewer stakeholders) or at small scales may wish to consider one all-encompassing campaign. On the other hand, projects organized over a long time period, over large areas and/or in developed countries (where there are many stakeholders, existing programs and/or resources) may benefit from utilizing a management plan. These approaches are not mutually exclusive and a nested approach could be used (see principle 10 in Jupiter *et al.* 2014 *a*). If a management plan is used, it should clearly articulate the land-based and marine-based objectives; program goals should be identified with stated data-collection and monitoring mechanisms that can provide information directly related to the program objectives (Nobre 2011). In addition, the use of a management committee is suggested when several stakeholders are involved (Lagabrielle *et al.* 2009). Management committees should be composed of elected officials and stakeholder representatives, and should: (1) develop a management plan; (2) consider both ecological and socioeconomic objectives/needs; (3) provide a mechanism for linking research/date outputs into the planning process; (4) integrate management across realms; and (5) adapt management practices based on monitoring outcomes (Lagabrielle *et al.* 2009; Lebel 2012). Management committees should also ensure that strategic plans are utilized and that regulations and other legal mechanisms are not ignored (Lebel 2012).

Stakeholder engagement

The lack of authentic stakeholder engagement is a problem for many programs (Lebel 2012). Despite frameworks that explicitly aim to involve local communities (Table 1) and recommendations that stakeholders can be valuable information resources (Table 3), local communities were involved in less than 50% of the case studies. This presents a major conflict (Fig. 6) to ILSM and in cases where ILSM programs are appropriate, programs will likely not be successful unless they include stakeholders in the planning, implementation and management process (Lebel 2012). Programs often fail due to conflicts between stakeholders and not due to technical issues (Silvestri & Kershaw 2010).

Effective communication with stakeholders can be improved as a part of the adaptive management cycle (Fig. 4), though simply increasing the number of involved stakeholders without providing a framework for conflict resolution (e.g. management committee) may negatively impact conservation programming (Silvestri & Kershaw 2010; Lebel 2012). The case studies suggest that simply involving a community in programming does not guarantee that the involvement will have the intended outcomes (e.g. community adherence to program rules). This is especially true if some stakeholders hold more power than others (Lebel 2012). Economically important stakeholders are usually considered in the planning process (e.g. fishing communities); however, less well-organized stakeholders should also be engaged (Lebel 2012). Examples where stakeholder engagement may have been biased are discussed in Fortwangler (2007) and Larsen *et al.* (2011). Political and social theories can be used to increase understanding of why some stakeholders might engage differently than other (e.g. social identity theory; Mason *et al.* 2015). Understanding the role that stakeholders play in the management process may help clarify stakeholder relations (Silvestri & Kershaw 2010) as can the use of both direct and indirect stakeholder communication methods (Vella *et al.* 2009).

CONCLUSION

Instances of ILSM were used to increase understanding about how ILSM programming is adapting to cross-realm outcomes. While there have been steps taken in the theoretical literature to address ILSM (Wilkinson & Brodie 2011; Jupiter *et al.* 2014 *a*; Álvarez-Romero *et al.* 2015), these strategies and recommendations are not necessarily being adhered to by applied programs. Case studies were less likely than theoretical papers to name the land-sea connection and >50% did not explicitly list a framework or governance approach. Our study also highlights the differences between undertaking land-based and sea-based management individually, and the unique challenges faced by organizations that integrate multiple ecosystems into one comprehensive program. Finally, our study points to the increased need for long-term planning, in addition to adaptive management in conservation, and especially in ILSM.

In this study, we synthesized recommendations from the literature regarding ILSM, discussed how these recommendations have been implemented by applied programs and highlighted opportunities for improvement. Given the importance of ILSM (Ruttenberg & Granek 2011) in the context of a future where a large portion of the globe's population will live in coastal areas (Klein *et al.* 2002; Millennium Ecosystem Assessment 2005), we believe that this review is an important step in clarifying how ILSM programming can be implemented successfully.

ACKNOWLEDGEMENTS

HG and DG thank the Betty and Gordon Moore Foundation. This material is based upon work supported by the National Science Foundation (NSF) Graduate Research Fellowship under Grant DGE-1144462 to KER. All opinions, findings, conclusions and recommendations expressed are those of the authors and do not necessarily reflect the views of the NSF.

Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S0376892916000023

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