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ARTICLE

Regional Planning and Resilient Futures: Destination Modelling and Tourism Development—The Case of the Ningaloo Coastal Region in Western Australia

TOD JONES, JOHN GLASSON, DAVID WOOD &
ELIZABETH A. FULTON

Abstract

The Ningaloo Destination Model (NDM) is an approach that engages key stakeholders in a more participative learning process, with the implications of potential future changes clearly set out for all to see. The case study for this approach is a region in Western Australia that is home to a globally significant fringing coral reef. This paper focuses on how the process and use of the NDM project builds regional resilience to cope with disturbances to socioecological systems in the context of regional planning. The various stages of the development and use of the NDM are discussed. The paper concludes that the NDM needs more than good data and reliable modelling to contribute to regional planning; it also needs to encourage the characteristics that build regional resilience through the modelling process and model use.

Introduction

In many countries worldwide, from the member states of the European Union to the individual states in Australia, the value of a regional scale in the planning hierarchy is being increasingly recognized (Commission of the European Communities, 1997; Brenner, 2004; Glasson & Marshall, 2007). Very broadly, the aim of such planning is ‘to better manage, or at least influence, the development of a region in the interests of society’ (Glasson *et al.*, 1997, p. 31)—but why at this intermediate level of the region? Wannop (1995, p. 1) identifies a ‘strong regional planning imperative’, because regional issues endure. Issues can range from rapid growth in congested metropolitan regions to rural decline,

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resource booms, and/or tourism development in remote regions—the latter being the focus of this paper. The regional level, defined here as a geographical area larger than a local government area, often linked by a shared (or similar) ecosystem or economic activity, may be a particularly appropriate level for the territorial integration of natural and socioeconomic systems (Yorque *et al.*, 2002; Jenkins *et al.*, 2003; Roberts, 2006).

In addition, major projects, now a familiar element of modern life, increasingly affect regions and are often the building blocks of regional strategies. The infrastructure requirements of such developments can have wide-ranging impacts on a region and not all may be beneficial. Societal trends and the associated major projects can pose major challenges for regional planning, and particularly in the case of tourism developments in pristine and fragile, remote environments. As an intermediate level of planning, regional planning is sometimes seen as an unwelcome intruder between local and national levels (and the state level in Australia—which is the country focus of this paper). Often lacking the power base and legitimacy of an underpinning level of government, regional planning can be subject to the influence of dominant stakeholders—such as major landowners, tourism operators and mineral resource developers. Examples of successful regional planning suggest that key ingredients for an effective process can be grouped into four categories. These are: a *continuity* of both that process and responsible agency; *coordination* of a disparate array of stakeholders (including various levels of government agencies, private sector, and voluntary sector amongst others—avoiding silo mentalities); improved *control*, through for example financial resources, but also possibly through democratic legitimacy, is also important; and the final ingredient, *commitment*, through a process that fully engages key stakeholders who become committed to the plan and the planning process (Glasson *et al.*, 1997).

This paper explores aspects of these ingredients, with a particular focus on how increasing regional resilience strengthens the capacities of a region to successfully participate in and commit to regional planning. The next section provides a brief introduction to regional planning, resilience and managing complexity. The core of the paper introduces modelling methods for integrating regional planning and regional resilience, followed by a discussion of the Ningaloo Destination Model (NDM). Drawing on the definition of social resilience discussed in the next section, regional resilience is defined as the capacity of a region to cope with disturbance and change. The remote and natural resource rich Ningaloo region in the larger Gascoyne Region of Western Australia, home to one of the world's most significant fringing coral reefs, provides the test bed for the approach, drawing on a major research project funded under the Ningaloo Collaboration Cluster initiative. There are sections on the background to the Ningaloo area and its contested environment, and on the development and use of modelling for improved stakeholder participation, to build regional resilience to cope with future disturbances. A concluding section seeks to assess the costs and benefits of such an approach.

Regional Planning, Resilience and Managing Regional Complexity

This paper is set in the context of contemporary approaches to regional planning, and the importance of managing regional complexity to deliver regional resilience.

Contemporary regional planning is influenced by shifting attitudes to politics and legitimacy, which raise crucial issues of consultation, participation and the interactions with a wide array of stakeholders (Glasson & Marshall, 2007).¹ Coordination of stakeholders is a major challenge, both vertically, especially to adjacent levels of government, and horizontally, for example between regional planning bodies and devolved levels of Central Government, key pressure groups (e.g. from industry and environment) and sectoral agencies (McKenzie, 2003). The management of this coordination has been theorized in various ways, including strategic choice (Friend *et al.*, 1974)—which argued that planners should be ‘reticulists’ with a role of reducing uncertainty in the process, by bringing together all the relevant actors with influence and resources. Alternatively, Rhodes (1997) stresses that regional planners should be networkers, working with networks to cover a wide range of interests. The work of Healey (1997) and others around the themes of collaboration and communication is of particular significance to our arguments. This work focuses on the careful construction of arenas for dialogue, leading to the making of concerted storylines for areas, to form the basis of durable shared strategies. Yet all such approaches have limitations in practice; for example, the achievement of consensus through a fair and open process must often confront deep-seated vested interests (e.g. between householders wanting to build on sites on the edges of settlements, and environmentalists wishing to preserve open space or bushland). This also assumes a regional planning process with the provision for participation, and participants with the means and ability to participate.

Our approach to managing social and environmental complexity draws on a history of ecological writings. Beginning in the 1970s, most notably with the book *Adaptive Environmental Assessment and Management* (Holling, 1978), ecological researchers began to critique management systems that reduced the natural variation in ecological systems, causing such systems to become less resilient to external change (Holling & Meffe, 1996). As the environment has been recognized as an essential resource, so social–ecological system (SES) principles and concepts have been applied to areas beyond managing ecological systems;² in particular, the ecological and socioeconomic elements of sustainable development (Adger, 2000; Folke *et al.*, 2002; Perrings, 2006), governance (Lebel *et al.*, 2006), and public policy more broadly (Holling, 2004; Holling & Meffe, 1996). Ecological research links changes in SESs to their *resilience*—defined as the magnitude of disturbance that can be absorbed before the system alters its structure by changing the variables and processes that determine its behaviour (Holling & Gunderson, 2002).³ Resilience focuses policy decisions on managing the capacity of SESs to cope with, adapt to and shape change (Folke *et al.*, 2002). Socioeconomic resilience is ‘the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change’ (Adger, 2000, p. 347).

Institutions, broadly interpreted here to include both public and private organizations, affect a region’s ability to avoid unwanted outcomes, protect important resources and contribute to regional resilience in several ways. First, institutions are important caches of knowledge that contribute to the regional resilience. The extent to which institutions understand the dynamics of a system (Perrings, 2006), and are involved in monitoring and planning, will have important

implications for a region's capacity to cope with disturbance and change. Second, strong relationships between institutions increases resilience by providing the trust, social networks and leadership necessary for responding to disturbances cooperatively and effectively (Lebel *et al.*, 2006; Walker & Salt, 2006). Third, institutions (either separately or as a network) can experiment with creative and improved methods to manage ecosystems (Holling, 2004). There is also agreement in SES literature that regions are the most appropriate scale for improving ecological and social resilience. Yorque *et al.* (2002) define regions as the scale at which ecosystems and people are tightly connected. The issue is how to equip and work with the relevant groups to make informed decisions about regional socioeconomic and environmental resilience within a regional planning framework.

Modelling to Integrate Regional Planning and Resilience

In this paper, modelling refers to system dynamics modelling (a version of numerical modelling). This is a computer-based methodology to support decision-making by simulating the dynamics of complex systems through quantifying the effects of a system's interconnections and time delays (van den Belt, 2004; Schianetz *et al.*, 2007). The main value of this modelling is not its capacity to predict the future (Holling, 1978), because the delivery of a fully-fledged model without local involvement, no matter how accurate, ignores how model use needs to be linked to institutional learning, to build relationships between groups, and be trusted if it is going to facilitate experimentation. In short, modelling needs to contribute to the resilience of the organization or group for whom it has been constructed.

While concepts from SES research have been applied at a number of different scales, regional planning focused on tourism development requires careful consideration because of the diversity of the groups affected by tourism, the changing organizational requirements of a destination over time, the high rate of transition of a large proportion of workers in a location, and the wide range of disparate areas on which it impacts (Farrell & Twining-Ward, 2005; Schianetz *et al.*, 2007). Similar modelling techniques have been used elsewhere to assist planning for tourism destinations with varied success (see Schianetz *et al.*, 2007). The most successful modelling work in achieving sustained change in planning processes has focused on participation and consensus building (Moser & Moser, 1986; Walker *et al.*, 1999).

A framework that analyses the challenges of using modelling in tourism destination management is Schianetz *et al.*'s (2007) Learning Tourism Destination (LTD) concept. Through a review of the previous uses of similar models, Schianetz *et al.* indicate that modelling has the potential to be a valuable tool as long it is incorporated into a framework that addresses learning at the individual, group and inter-organizational (regional) level. They identify four ways that modelling can contribute to destination management. First, it can underlie an information system that is essential for a field like tourism where broad number of groups and individuals are affected. A model provides a way for different groups to test and refine their understandings of the tourism system, and a focus for information gathering and

dissemination; it focuses stakeholder attention on thresholds and cumulative impacts (van den Belt, 2004) that can be overlooked in other planning processes. Second, building a model can contribute to cooperation and collaboration between disparate groups. Modelling provides a method through which people with different involvement in tourism can express their view of how tourism functions and then test that view in a setting with other groups. Third, modelling can contribute to continuous learning if the model is used as a focus for ongoing planning and evaluation; it has the potential to integrate a wide variety of research through a process that addresses the concerns and priorities of a wide variety of stakeholders (Jones & Wood, 2008). Fourth, modelling contributes to regional resilience through providing a tool that assists in the articulation of assumptions and the perceived levels and types of uncertainties (Schreiber *et al.*, 2004).

While providing a valuable framework to assess the effectiveness and define the purpose of modelling in support of tourism planning, Schianetz *et al.* (2007) do not discuss any processes for how modelling can be initiated and implemented in a way that enhances resilience or assists with creating the learning framework that is central to the LTD concept. However, in another article Schianetz *et al.* (2009) discuss the application of the LTD framework and the use of modelling through examining the early stages of the project that is the basis of this case study. In this article, we extend this earlier study to include initial engagement with stakeholders, the process of development and application of the NDM to analyse how the use of modelling could advance regional planning through building regional resilience. The two broad stages of development (Table 1) address the process of *model development* (Stage 1) and the *application and ongoing use of the model* (Stage 2). The stages are discussed separately following a brief outline of the regional context of the NDM project.

Case Study from the NDM: Regional Context

The Ningaloo Reef is the largest fringing coral reef in Australia, stretching over 300 km along the northwest coast between Carnarvon and Exmouth (Figure 1). Carnarvon, the southern-most tip of the Ningaloo Coast region, is 900 km from Western Australia's capital city of Perth. The exceptional conservation values of the

TABLE 1. Stages of the NDM project

Stage	Description
1	Model development
1.1	Stakeholder assessment
1.2	Stakeholder modelling workshops
1.3	Formal and informal meetings and communications with stakeholders
1.4	Data collection and dissemination
1.5	Model development
2	Model use
2.1	Learning about the tourism system through model use
2.2	Model use and integration with regional planning

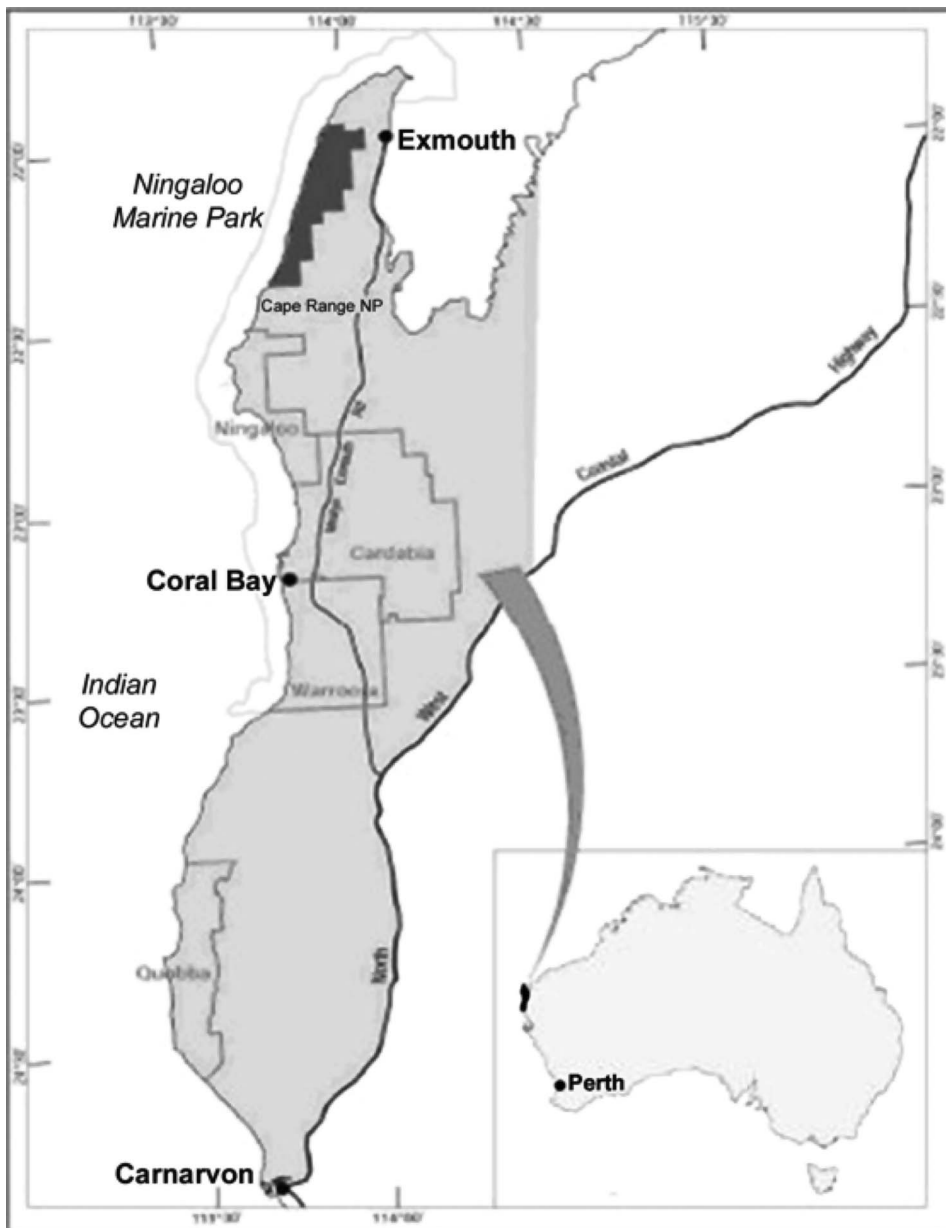


FIGURE 1. The Ningaloo coastal region of Western Australia. *Source:* Department of Conservation and Land Management (2005b).

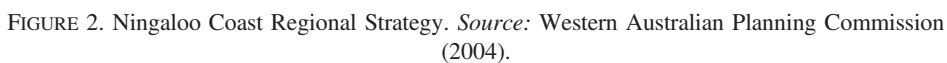
region include marine and terrestrial flora and fauna, karst formations and subterranean fauna, and remoteness values. This coastal region is sparsely populated and its approximately 8,000 residents live mainly in the towns of Carnarvon (71%), Exmouth (26%) and Coral Bay (2%). The region's economy is based on tourism,

fishing, mining, horticulture and livestock, while nature-based and wilderness tourism is the main source of income in Exmouth and Coral Bay, and is marketed nationally and internationally as a premier tourism destination (Western Australian Tourism Commission, 2003). The primary attraction of the region is the Ningaloo Marine Park, which Western Australia's Department of Environment and Conservation (DEC) labelled the state's 'premier marine conservation icon' (Department of Conservation and Land Management [CALM], 2005b). The number of tourists visiting the Ningaloo Coast in 2008 was 176, 000, which was lower than previous years due, most probably, to the advent of the global financial crisis. The highest recorded number of visitors was 208, 000 in 2004. Although reliable statistics are not available for the early 1990s, it is thought that visitor numbers have increased markedly since then (Wood & Dowling, 2002).

Planning in the region has been an issue of state and national interest, particularly since the mid-1990s with the advent of a proposal for a large marina development at Maud's Landing in the middle of the reef, just north of Coral Bay (Pforr *et al.*, 2007). The proposal evoked widespread protest in Western Australia through the 'Save Ningaloo' campaign that was part of the political milieu where the Liberal party lost power in Western Australia in 2001. The new Labour Government rejected the marina proposal in 2003 and began preparation of the 'Ningaloo Coast Regional Strategy Carnarvon to Exmouth' (the Regional Strategy). This strategy was overseen by the Ningaloo Sustainable Development Committee that was supported by the Ningaloo Sustainable Development Office (NSDO), a regionally based office of the Western Australian Department of Planning and Infrastructure.⁴ The Regional Strategy provides a comprehensive framework for tourism development in the region, limiting the construction of high-impact developments, such as marinas and canals, to the towns of Carnarvon and Exmouth (see Figure 2). While this plan covers the coastal strip, the region is subject to a variety of planning processes that are largely uncoordinated. The DEC has separate management plans for Ningaloo Marine Park (CALM, 2005b) and Cape Range National Park (CALM, 2005a), and the Shire of Exmouth is undertaking a Structure Plan and Local Tourism Planning Strategy to assist coordination of a new marina development and future town growth. The independence of the planning processes raises the concern of the cumulative impacts of plans.

Additionally, recent changes to the regional planning framework for Western Australia may have implications for the Ningaloo region. In 2009, following the recommendations of this report, the Western Australian Planning Commission resolved to establish regional planning committees for each region that will not be supported by regional offices. The NSDO closed in June 2009 at the time the Western Australian Planning Commission resolved to establish the Gascoyne Regional Planning Committee.

Research efforts have been intensified in the past decade to protect the unique character and marine and terrestrial ecosystems of the Ningaloo Coast. The Ningaloo Collaboration Cluster group of projects aims to integrate the knowledge of reef use, biodiversity and socioeconomics into a framework to assess management strategies for the Ningaloo region.⁵ The Ningaloo Destination modelling project is one of six projects within the Ningaloo Collaboration Cluster



and has the objective of developing a simulation model based on system dynamics modelling that incorporates both the socioeconomic and environmental implications of tourism on the Ningaloo coast.

The largest risk to the region's ecology is recreational fishing catch, which on recent modelling work is likely to be double the commercial catch (Beth Fulton, pers. comm.). Recreational fishing is an important resident and tourist activity and changes to its regulation are highly political. Another ecological threat to tourism is coral damage in the most popular snorkelling sites, which is unlikely to significantly impact biodiversity values when measured across the entire coast. Recent oil and gas initiatives north of the region also have raised both development opportunities for the region and concerns about the possible social and environmental impacts of increased industry and pressures from increased levels of recreational activities.

The project and region provide an ideal case study for testing the application of a modelling process as a method to increase regional resilience, as the main stakeholder groups⁶ expressed interest in engaging in collective learning processes. However there are some barriers to strengthening networks between stakeholders. A DEC decision to extend the sanctuary zones at Ningaloo Marine Park in 2004 was not received well by local residents. Such issues have inhibited the development of local and state-wide social networks between institutions that support regional resilience.

Case Study from the NDM: Developing Scenarios and Modelling for Improved Stakeholder Participation

Stakeholder Assessment: Getting to Know the Destination

The first step in the NDM project was to identify and establish contacts with stakeholder groups and consider their interests, issues and reasons for becoming involved in the project. Through a stakeholder assessment, possible conflicts were noted that could impact on the capacity of the project to facilitate strong local networks and collaborative learning. While the largest barrier was between the protected area managers (DEC) and groups impacted by changes to fishing regulations, other important issues were identified. These were the regulation of the tourism industry (causing conflicts between the regulator DEC and tourism operators) and clashes between planners and DEC on the one side and pastoralists on the other over tenure and coastal planning. World Heritage became a major issue over the course of the project as the local Chamber of Commerce, the Shire of Exmouth and community members were concerned that World Heritage would prevent them from accessing resources (such as gravel for roads) and alter local leisure pursuits.

Resource-sector developments were also raised consistently across the project as both an opportunity for industrial development (by the Regional Development Commission, Chambers of Commerce and the Shires) and a threat through either oil spills, increased recreational fishing, and increased land and ocean traffic (local conservation groups, protected area managers, community members). From a community and Shire perspective, a major issue in the region was residential

housing. Coral Bay has unsanitary and unsafe living conditions for staff as they wait for staff housing to be developed, and locals are being priced out of Exmouth. Despite these conditions, environmental impact has consistently been identified in community consultations as the greatest community concern. Indigenous participants identified participation in tourism development, and environmental protection, as key issues. Many of these conflicts and issues manifest themselves throughout the process as issues that the model was requested to address.

Stakeholder Modelling Workshops: Creating an Environment for Collective Learning and Collaboration

The stakeholder assessment fed into a series of four initial workshops held in each of the town centres (Exmouth, Carnarvon and Coral Bay) in June and September 2007. Groups were identified through the stakeholder assessment and invited to attend by telephone and a follow-up email invitation or letter. We also distributed invitations through the visitor centres, and made general invitations through a radio interview and a newspaper article. Three of the workshops (one in each town centre) were aimed at introducing the modelling process, identifying the potential questions that the model should answer (expressed as scenarios for the future of tourism), discussing data availability and eliciting further involvement. Seventy-one people attended the workshops, with attendees from a broad range of backgrounds.⁷ Through a series of large and small group workshop activities (described in more detail in Schianetz *et al.*, 2009), participants refined a list of opportunities and concerns about tourism development into scenarios. This was the beginning of linking groups through the modelling process, building shared understandings. The four resulting scenarios (Table 2) were then used to focus the model building process.

The fourth workshop was a 2-day meeting to identify an agreed model structure for representing tourism development in Ningaloo and the process that could influence how it might evolve over the next 20–30 years. This smaller workshop involved key local stakeholders from the tourism industry, the shires, government agencies and researchers. The aim was to address nine areas thought to capture the key elements of the tourism system (Table 3). Participants collaboratively designed sub-models that identified the economic, social and environmental drivers and impacts, as well as critical feedback loops and thresholds. The conceptual modelling workshop provided an opportunity for discussion regarding the key elements and structure of tourism through which diverging views of the tourism system could be resolved through debate and a broader view of the tourism system. This was the beginning of the process of asking a wide variety of people to explain their understanding of the tourism system and to begin to assess and integrate these worldviews.

Formal and Informal Meetings and Communications with Stakeholders: Keeping People Involved

Three rounds of workshops were held in all three towns, and in Perth, where the scenarios were further refined and early prototypes of the model were

Destination Modelling and Tourism Development

TABLE 2. The four collated scenarios and the rating of relevance for workshop participants

Scenario	Relevance ^a
<i>Scenario 1: a large increase in visitor numbers versus a controlled increase.</i> Addresses the impacts of growth in visitor numbers and, if you can control growth in particular market segments (e.g. in a particular accommodation type) and for particular activities, what will be the costs and benefits to the environment, community and economy?	4.3
<i>Scenario 2: changes to governance.</i> Addresses questions about governance raised in particular in Exmouth and Coral Bay. If there are changes in governance over accommodation and activities, what will be the impacts on tourism? Will they be substantial or minor? Particular concerns were over tourism license tenure and land release (zoning).	4.5
<i>Scenario 3: varied rates and uncertainties of growth.</i> Addresses a second aspect of growth. What if there are unexpected interruptions in tourism numbers? What are the best strategies for a fast recovery following an unexpected event or variations in visitor numbers to the region? The scenario also addresses the issue of capacity constraints by testing a variety of land release policies.	4.3
<i>Scenario 4: green technologies and development strategies.</i> Addresses how adoption of green technologies could affect the capacities of the town sites to expand in the short, medium and long term, given current constraints on water, electricity and waste water, and the spatial allocation of tourists. It also addresses the costs and savings over different time periods.	4.4

^aParticipants were asked to rate the relevance to the region of the scenarios for all communities in the region, on a scale from 1 (not relevant) to 5 (very relevant).

demonstrated, commented on and results discussed. While the process of describing scenarios and recording worldviews is an important step in assisting people affected by tourism to understand both how impacts occur and the viewpoints of others, there still remains questions of power regarding the different levels of participation in the process. In addition to the workshops, researchers also conducted a number of individual interviews. These interviews sought to ensure that the process remained locally grounded; for example, individual meetings with a key Indigenous organization assisted in including an Indigenous perspective on tourism and its potential impacts.

An important element of the individual meetings was the use of conceptual diagrams to capture different understandings of different elements of the tourism system. For instance, a meeting with DEC staff and researchers developed a set of diagrams that represented the relationships between coastal camping impacts and regulations. Further meetings and research led to refinement of the diagram that neatly and elegantly captures the key elements of coastal camping and regulation (Figure 3). Ongoing dialogue also clarified that changes in regulation (including who regulates, access and infrastructure), not environmental degradation, determined the kind of campers that visited a site. The clarification of important dynamics with key stakeholders assisted institutional knowledge, a key component of regional resilience, as well as assisting the model's accuracy.⁸

TABLE 3. The nine submodels addressed in the conceptual modelling workshop

Submodel	Summary content
Visitor numbers and mix	Links the visitor cycle (numbers, mix and seasonality) to other cycles in the region (weather, cyclones, marine, European visitation, holidays)
Residents and industry	Addresses growth in regional industries and housing availability as determinants of population numbers and the activities undertaken by the resident population
Visitor activities	Links visitor activities and experiences to tourism infrastructure, environmental quality and the characteristics of the tourism industry
Accommodation sector	Addresses accommodation supply and demand in the context of land availability, investment returns, demand from other sectors and staffing
Visitor spending	Uses visitor spending and economic data to calculate employment, income, value added and gross regional product
Environmental loads	Addresses water availability in the context of climate change and water consumption, waste water generation, treatment and the implications for the region's ecology, electricity demand and supply, and the potential impacts of sustainable technologies for reducing water and electricity use
Environmental impacts	Links the activities of visitors and residents to a range of environmental impacts, including marine and terrestrial impacts such as coral damage, fish stocks and vegetation loss, and the monitoring of these impacts
Transport linkages/options	Addresses transport to the region and within the region, including transport constraints and shocks that could disrupt travel, and links to national trends
Social impacts of tourism	Identifies the positive impacts (extra facilities, regional pride) and negative impacts (crowding, incidents, dislocation) to residents' quality of life

Data Collection and Dissemination: Learning through Data Collection

Data collection was an important activity for building institutional knowledge and for populating the NDM. Due to the absence of key data to address the scenarios, the research team designed and implemented three surveys; 1, 574 visitor responses were collected to provide the detailed, geographically specific information on psychographic, visitation and activity patterns to inform the NDM.⁹ These data supplemented Tourism Research Australia data that were available from 1999. Additionally, a perception of tourism impacts survey was distributed to residents in Carnarvon, Coral Bay and Exmouth providing a sample of 292 responses.¹⁰ The third survey was designed to estimate the water, electricity, waste water and waste produced by the tourist accommodation sector. Additional data on water and electricity use were provided by service providers (Water Corporation and Horizon Power), and information on visitation was provided by the two visitor centres in the region and DEC. The contribution of these data to institutional knowledge is best represented through the way it was immediately used in planning processes in the region that were underway simultaneously with the NDM project, such as the preparation of DEC landscape plans, local tourism planning strategies, and town planning schemes.

Model Development: Integrating World Views and Data

Two key methodologies were the development of conceptual diagrams and the process of transforming the diagrams into a model through quantifying the relationships between variables. In an interdisciplinary project, communication between researchers and research integration can be challenging. Conceptual models of different aspects of the tourism system, such as the coastal camping diagram in Figure 3, provided a language for ensuring that the important aspects of the tourism system were being captured (Jones & Wood, 2008). The information elicited in the individual meetings was presented as part of conceptual models in the forums where they could be addressed by larger groups. A central element of this process is identifying the feedback loops and thresholds of impacts that determine the dynamics of the system.¹¹

The second method is putting data behind the conceptual diagrams using Vensim modelling software. This involved firstly refinement of the conceptual diagrams in Vensim to identify key feedback loops in order that the model captured the important system dynamics while remaining as simple as possible. Inputs also required the assessment of currently available plans for the region in order to address the uncertainties around future development. Model development included model testing through sensitivity analysis and against historical data and discussing results with members of the tourism industry and agency managers.

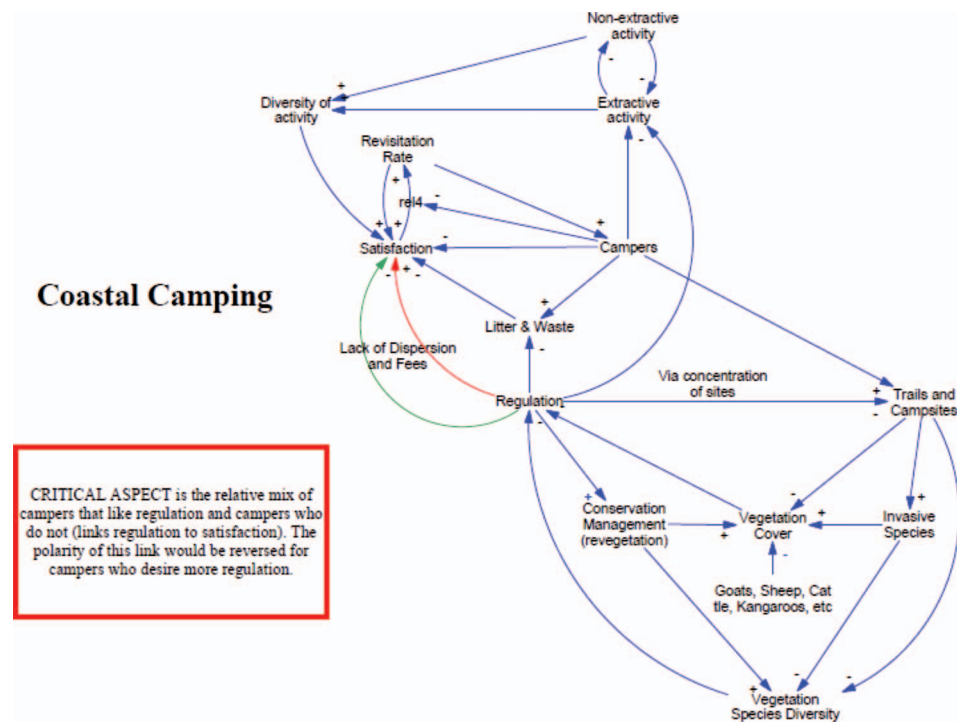


FIGURE 3. Conceptual diagram of the key variables and relationships for coastal camping impacts.

The regional discussions of results, through 15 regional forums, were an essential element of building knowledge and understanding of the SES, particularly the consequences of current plans and decisions, and overlaps in areas of institutional responsibility (discussed in the next section). By integrating regional resilience throughout the model-building process, the use of the model could build on the increased knowledge and social networks of groups in the region, rather than expecting these elements to come together in the final stages of the project.

Case Study from the NDM: Using Scenarios and Modelling for Improved Stakeholder Participation

Learning about the Tourism System through Model Use: Demonstrating Thresholds and Feedbacks and Enhancing Group Learning

The second stage of the NDM project was to contribute to regional resilience through, firstly, responses to engagement with the model and, secondly, to the challenges of organizing ongoing use of the NDM. An important lesson learnt through the project was that models for planning need to have a large degree of flexibility as planning priorities are constantly changing. The NDM needed to be capable of adaptation to address a variety of different processes in order to be responsive to the requests for information and experimentation of a wide group of collaborators. In the course of building the NDM, the range of submodels was refined and some were combined. Figure 4 provides a summary of the different submodels and key variables within the model and their relationship to each other.

An example that we used regularly and is of great relevance to the region is an assessment of the implementation of the Ningaloo Coast Regional Strategy (the Regional Strategy). The scale used here is the whole region and takes into account plans for growth in the towns of Carnarvon, Coral Bay and Exmouth. The area that

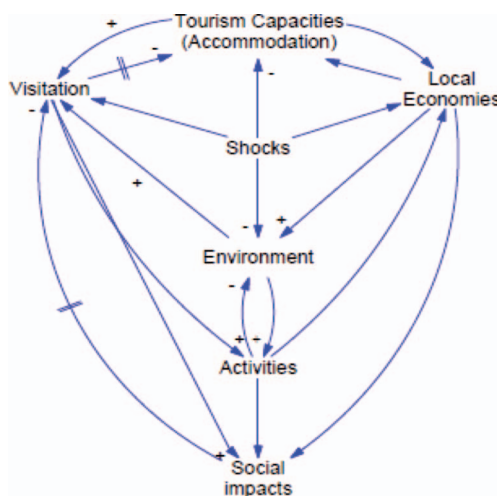


FIGURE 4. NDM conceptual diagram.

will experience the greatest change is the pastoral stations that extend across approximately 190 kilometres of the coastline (see Figure 5 on the planned changing accommodation mix for the pastoral stations between 2007 and 2037). In order to run the model, the growth in tourism numbers throughout the area was assumed to be 2% per annum, with the exception of the pastoral stations, where growth was set at 4% per annum. While this is historically large, it is necessary to stimulate demand for the new accommodation to a reasonable level as demand for hotels and caravan parks are starting from a very low baseline. The model adjusts these growth rates for seasonality. The Regional Strategy reduces the capacity of the existing campgrounds as the new accommodation is to be located on these sites.

The results are summarized in Figure 6. Visitors to the region increased by 66%, with 300,000 people visiting the region for the first time in 2031. While the region previously had approximately 9,000 visitors staying at the same time during the school holidays, this increased to 13,000 in 2037. Tourism was still seasonal,

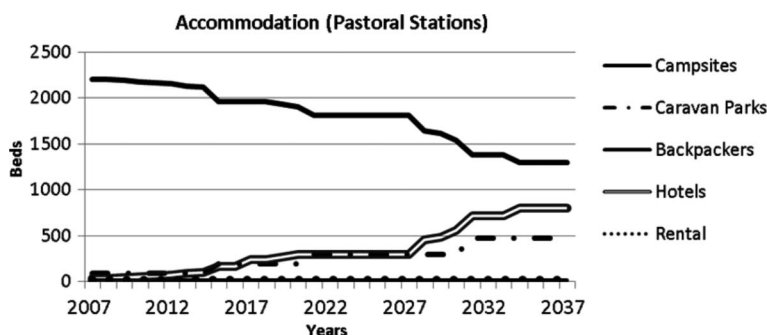


FIGURE 5. Change in tourist accommodation in the pastoral stations allowed within the Ningaloo Regional Coastal Strategy.

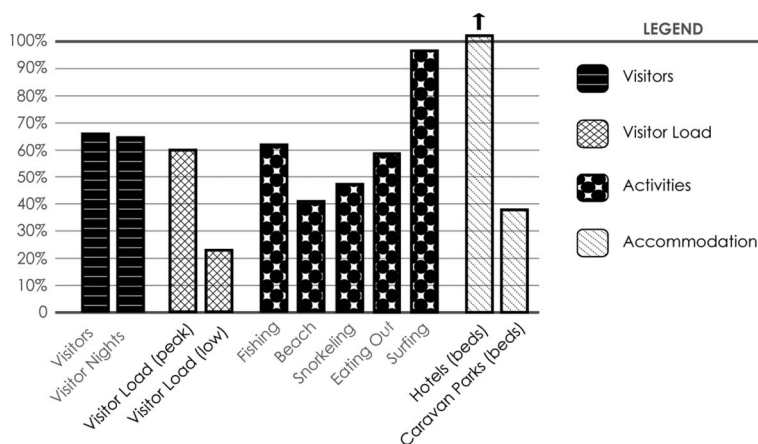


FIGURE 6. Tourism impacts for the Ningaloo Coast from a baseline of 2007.

creating problems for tourism businesses. Visitor activities had grown markedly as well. Fishing had increased by 60% despite the reduction in campsites. Snorkelling increased by 48%, but this is concentrated in particular areas—it amounted to a doubling of snorkelling in Cape Range National Park. The economic impacts of implementation of the Regional Strategy blended with growth in Carnarvon and Exmouth (Figure 7). Overall, expenditure increased from \$95 million to \$155 million, and tourism’s contribution to Gross Regional Product increased from \$32 million to \$52 million.

The social impacts of growth in the Ningaloo Coast Regional Strategy are summarized in Figure 8. Employment was the greatest benefit, with jobs increasing to 1, 400 people. However, the greater amount of people coming to the region also created more opportunities to showcase the region, increasing community pride. Negative social impacts were also felt by the region. Decreases to fish stocks and impacts on corals were negative social impacts, and delinquent behaviour also increased due to greater numbers of holiday accommodation next to resident accommodation and higher levels of transient workers. Cultural diversity, measured as the percentage of tourists from outside Australia, increased by a small margin (5%).

Tourism growth increased resource use. The growth in residents and visitors increased water use by 20% to over 150, 000 gl (Figure 9). While not reaching the limits of water draw on the underground water supplies, water restrictions would be more common and have more impact on the agricultural sector. Electricity increased by over 70%. The nodal developments were forced to supply their own power through generators and alternative energy sources, supply their own water and ensure that they did not allow waste water to enter the ocean due to their proximity to the Ningaloo Reef. They use over 20, 000 kWh and 71 gl of water.

There were negative ecological impacts from fully implementing the Ningaloo Coast Regional Strategy (Figure 10). Whale sharks decreased by 5% due to increased strikes from boats; this decrease resulted in a doubling of the possibility

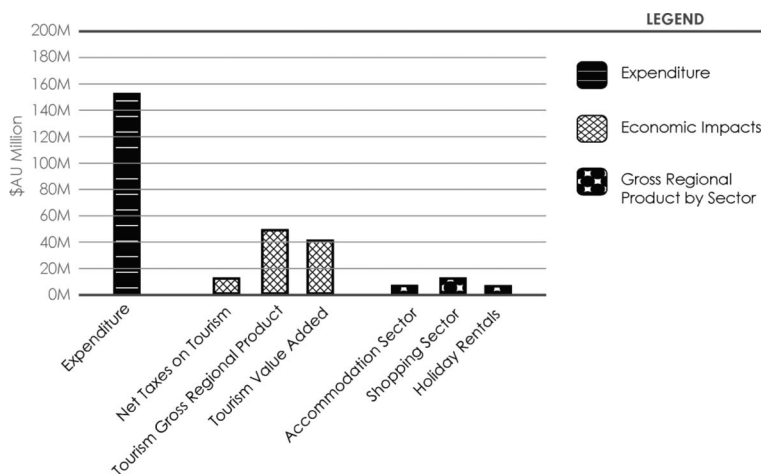


FIGURE 7. Percentage change for economic impacts for the Ningaloo Coast from a baseline of 2007.

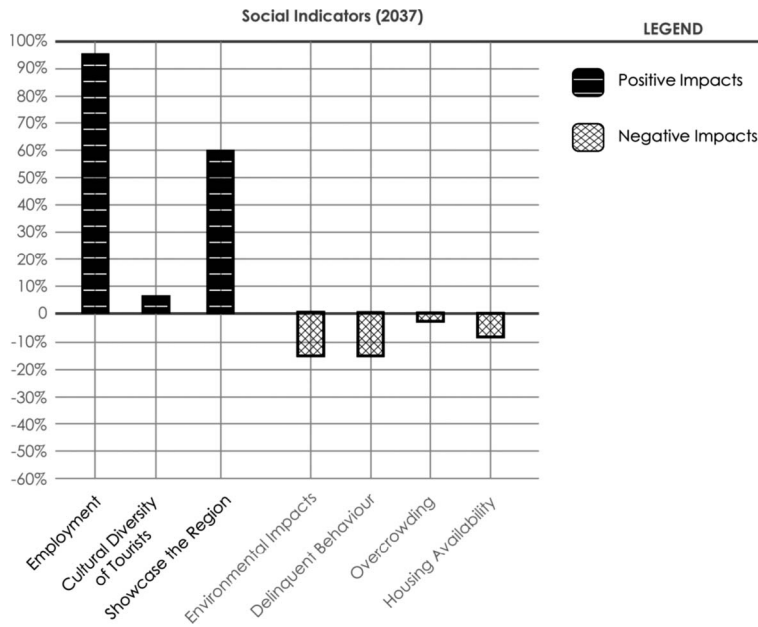


FIGURE 8. Percentage change of social impacts for the Ningaloo Coast from a baseline of 2007.

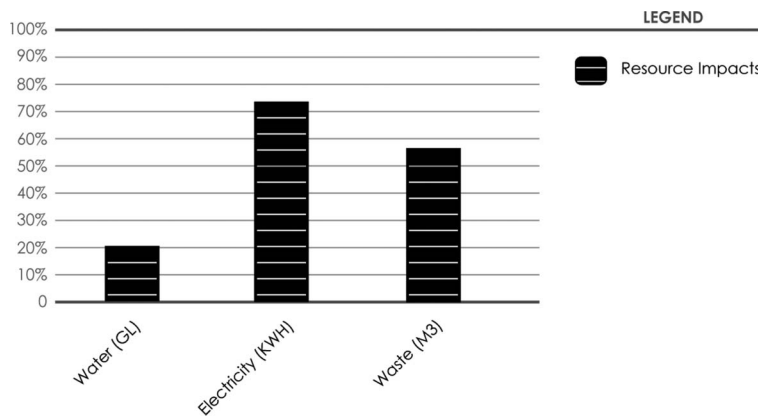


FIGURE 9. Graph of percentage change of demand for resources for the Ningaloo Coast from a baseline of 2007.

of not seeing a shark while on a tour, causing greater costs to the industry that has a policy of a free repeat tour if a whale shark is not sighted. Corals decreased by 4%, but this is concentrated in the areas where the majority of people snorkel. The easily accessible corals in the most popular coral viewing spots in Coral Bay and Turquoise Bay were severely degraded. Fish stocks were reduced by 14% and catch rates by 15%. Spangled Emperor, the key target species in the northern part of the region, was reduced by 20% by recreational fishing. These kinds of

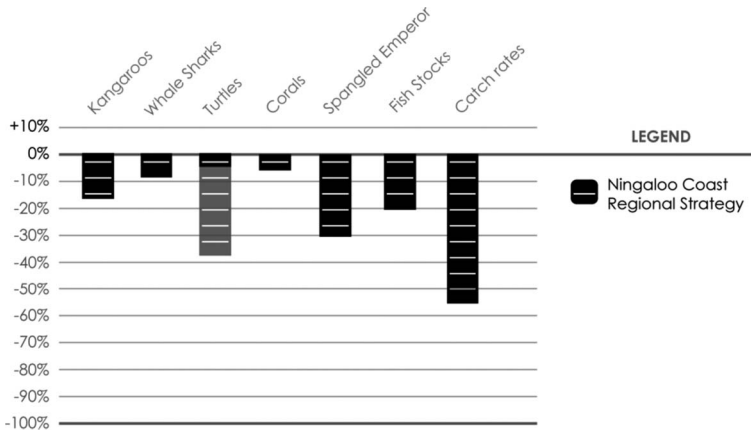


FIGURE 10. Percentage change of ecological impacts for the Ningaloo Coast from a baseline of 2007. *Note:* Grey shading, the decline in turtles if fox-baiting is not continuously applied; black shading, for turtles assumes continuous fox-baiting.

reductions impacted an important part of the ecosystem and a popular resident activity. It should be remembered that this result assumed that current regulations stay in place for recreational fishing and boating.

We presented the model results to both institution-specific and multi-stakeholder forums in the region and in Perth. Institutions had the opportunity to request specific issues, while a group of locals from different organizations and sectors chose the scenarios for the multi-stakeholder forums. The requests reflect different issues amongst different communities. Carnarvon Shire and business owners asked for a comparison of two different development strategies, and an exploration of the implications of a large surfing competition on the pastoral stations. Coral Bay residents explored the differences between a large resort near Coral Bay versus expanding Coral Bay and the implications of further delays in building workers' accommodation. An Exmouth group of local stakeholders chose to explore likely pressures on Exmouth, the effects of new resident accommodation, a boat ramp upgrade and the differences between caravan park and hotel accommodation. Exmouth Shire explored the impacts of upgrading a boat ramp, housing issues and how recycling would reduce pressure at the local dump. We also regularly explored a large resort development as an alternative to the Coastal Strategy, which received responses in all forums that the ecological impacts outweighed the economic benefits. These requests are evidence of experimentation, where the models are used to explore likely and alternative outcomes and upcoming plans.

The model potentially is having its greatest impact in the areas of collaboration and learning. Linking development and infrastructure decisions to economic, social and ecological outcomes has demonstrated the importance of communication between local government and different agencies. Communication through a broadly representative local reference group convened to advise researchers about how to communicate with the region led to requests for joint forums where groups

originally recommended separate meetings. The ecological impacts have concerned participants, and have increased attention on the likelihood and thresholds of fish stock decline. Another scenario we ran in the region changed recreational fishing regulations to 'wilderness fishing' standards, which specifies that fishers can only catch what they are going to eat that evening. Under this scenario, fish stocks increased so that the rate at which fishers catch fish increased from the current levels by over 20%, and the available fish increased in size. This has encouraged a community response to seek change to fishing regulations. We have put locals in touch with a CSIRO researcher who is working with the Western Australian Department of Fisheries to test different recreational fishing regulations. These realizations and links indicate how modelling can build social networks within and across scales (local, state and national in the case of research networks).

Model Use and Integration with Regional Planning: Getting Buy-in and Ongoing Learning

The major failing of modelling projects is that often they are not used by the prospective recipients. We have attempted to address this issue through ongoing discussions about the project's legacy with stakeholders, particularly institutions involved in land management and planning, throughout the project.¹² We presented two alternatives to stakeholders in the forums. The first was the current plans for the project's legacy, with training and desktop models available for local and state institutions, access to the researchers for consultation, and opportunities to pay for longer, more involved projects if required. The second alternative presented what could happen with a broad base of support and investment from other institutions. This included a Perth-based modeller to support the project, a region-based support person who could promote the models, an annual forum for model use, and the use of the models to construct a community vision for Ningaloo. Support was demonstrated by a number of stakeholders through letters of support to politicians and the CSIRO to resource model uptake. CSIRO has invested in a model uptake project that will extend for another year past the finalization of the models. After hearing presentations, groups requested joint forums with other groups, and the latter phase of presentations incorporated training in adaptive management into extended stakeholder engagement with the NDM. The position of a regional research coordinator has also received funding from three research projects and the Regional Development Commission, and will work with the committee of a new research centre that is planned for Exmouth.

Despite the closure of the NSDO, the NDM now has a broad base of support in a number of different institutions and there is a strong desire in the region and amongst a variety of different groups, agencies and the tourism industry for the model to be adopted into a broad range of planning processes. While the issues raised by these groups have been specific to their own planning processes and operations to date, there is strong support to use the model for upcoming planning processes, specifically the review of the Regional Strategy that is due to take place in the next 12 months. The enhanced relationships between stakeholders and

knowledge of a common methodology for planning and assessment set the stage for more effective regional planning at the level of the region, but also through the planning and operations of individual stakeholders.

Conclusion and Summary Assessment of the NDM Approach

This paper has focused on how increasing regional resilience strengthens the capacities of a region to successfully participate in and commit to regional planning. The process of using modelling described here should be understood as a tool for a communicative approach and a contribution to regional planning knowledge. Through its use of principles and practices from SES research and organizational learning, modelling can assist regional planning to focus on building a region's capacity to manage SESs and therefore better cope with change and unexpected outcomes and events. In the Ningaloo case, the use of the model approach has highlighted in particular the resource and ecological implications of some of the scenarios considered, leading to both a valuing of much in the Regional Strategy, but also the need for a reconsideration of some of the elements, their phasing and the need for adaptation. The local response to these results has included a group requesting tougher fishing regulations, experimentation with a number of factors including the level of residential housing and recycling, and criticisms of the alternative strategy of a large resort.

The challenge for this work, and for other studies that might benefit from such an approach, is how to build inter-institutional decision-making processes that are capable of understanding and working with variability and uncertain outcomes. Systems dynamics modelling is seen as having many attributes that can contribute to these goals, in the stages of both model development and model use. In the first stage, the development in a collaborative way of tourism scenarios, model and submodels helped to assess and integrate different stakeholder understandings of tourism systems. The work identified critical feedback loops and thresholds for ecological and resource impacts. It employed effective methods to keep people involved and strengthened regional information networks, using conceptual diagrams, the identification of causal links, and the provision of a common language for capturing important aspects of tourism in this sensitive location and for testing understandings of the tourism system. The second, application, stage of the NDM illustrated the way that model use can enhance experimentation and relations between institutions, and build knowledge about how SES work through exploring different scenarios. The example of the Coastal Strategy shows how the model can draw attention to cumulative impacts and thresholds that can often be overlooked in the regional planning process. Additionally, this process has developed a wide range of indicators for stakeholders to assess the impacts of plans, strategies and events, and provides a basis for stakeholder groups to collaboratively draw and test their own thresholds, discuss mitigation measures if required, and potentially negotiate trade-offs.

Returning to some of the key ingredients for successful regional planning noted at the beginning of this paper, modelling can be seen to have positive outcomes for regional planning when it focuses on building regional resilience. In particular, the NDM process has helped to build coordination and commitment: coordination

through a focus on strengthening social networks and group learning about the SES impacted by regional planning; and commitment through an acknowledgement of areas of shared concern and mutual dependence for positive outcomes, and the early signs of increasing coordination. Modelling has the capacity to assist collaborative regional planning and integrate it with learning about the key SESs that underpin the values and resources of a region. The need for broad involvement and commitment is a fundamental challenge, as exemplified by the demise of the NSDO. Regional planning supported by modelling for regional resilience could underpin the next generation of regional planning initiatives.

Notes

1. 'Stakeholders' is defined in this article as the groups and individuals whose activities and/or interests are impacted by a planning process.
2. The field of research into SESs encompasses adaptive management, which uses many of the concepts present in this article.
3. In this article we focus on the resilience of SES related to tourism and use the literature from this field (for instance, the work of the Resilience Alliance (www.resalliance.org) and in *Ecology and Society*). Elements of this theory are present in economic geography (Martin & Sunley, 2007), but this has focused more on the application of such principles to social systems than on modelling and managing complexity in SESs.
4. It should be noted that one of the authors, David Wood, was Chair of the committee that oversaw the NSDO.
5. An initiative of the Commonwealth Science and Industry Research Organisation (CSIRO), the Cluster brings together multi-disciplinary researchers from six Australian universities, the Sustainable Tourism Cooperative Research Centre and the CSIRO Wealth of Oceans Flagship. The CSIRO is the Australian Federal Government's peak research body.
6. This includes government, tourism agencies and operators, research institutions, environmental groups, residents and tourists.
7. The groups can be divided into government authorities (7 agencies), tourism associations (3), tourism operators, accommodation providers, research institutions/projects (7), and other groups including local government councillors, tourists, residents, and Indigenous groups (6). For more information on the stakeholder groups, see Schianetz *et al.* (2009).
8. Other methods of communication were a regular newsletter that provided the latest data from the project and a technical report summarizing survey data collected for the project.
9. For a summary, see Jones *et al.* (2009).
10. This survey identified employment and cultural diversity as the perceived most positive impacts, and environmental damage, delinquent behaviour, crowding and housing dislocation as the perceived most negative impacts.
11. The technique employed in the NDM project for integrating research from different disciplines is described in more detail in Jones and Wood (2008).
12. The primary institution in the early and middle stages of the project was the NSDO as the institution with the primary responsibility for regional planning. The closure of the NSDO underlines the need for a broad base of support and involvement with planning research projects, as well as indicating the difficulties political cycles pose for long-term planning.

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