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RECONCEPTUALIZING TOURISM

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Abstract: This article argues that in order to facilitate a more effective transition to sustainability, tourism researchers need to keep abreast of transformations occurring in related fields, especially ecosystem ecology, ecological economics, global change science, and complexity theory. New knowledge from these spheres relating to complex adaptive systems, a necessary retreat from reductionism, extensive integration of human and natural systems, new interpretations of sustainability, and the emergence of sustainability science is of great relevance to contemporary tourism study. The article provides an introduction to the potentially extensive application of this knowledge to tourism and concludes by suggesting a reconceptualization of the field of study to accommodate it. **Keywords:** complex adaptive systems, sustainability transition, adaptive management. © 2003 Elsevier Ltd. All rights reserved.

Résumé: Une nouvelle conceptualisation du tourisme. L'article soutient que, afin de faciliter une transition plus efficace à la durabilité, les chercheurs doivent se tenir au courant des transformations qui ont lieu dans des domaines apparentés, surtout l'écologie des écosystèmes, l'économie, la science des changements mondiaux et la théorie de la complexité. Les nouvelles connaissances de ces domaines liées aux systèmes complexes d'adaptation, une retraite nécessaire du réductionnisme, l'intégration de grande envergure des systèmes naturels et humains, de nouvelles interprétations de la durabilité et la naissance d'une science de la durabilité sont particulièrement importantes à l'étude contemporaine du tourisme. L'article sert d'introduction à l'application, qui pourrait être étendue, de ces connaissances au tourisme, et il conclut en suggérant une nouvelle conceptualisation du domaine d'études afin de s'adapter à ces connaissances. **Mots-clés:** systèmes complexes d'adaptation, transition de durabilité, gestion d'adaptation. © 2003 Elsevier Ltd. All rights reserved.

INTRODUCTION

Many authoritative researchers believe that the Earth and human-nature relationships are entering a period of intense and accelerating change. Humans now consume the Earth's natural resources at a rate and scale quite out of proportion to the biosphere's regenerative capacity (GECP 2001; IGBP 2001; Wackernagel et al 2002; Wilson

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2002). Some believe that if continued, this could lead toward new dynamic states far less hospitable than those experienced at present, described by Gallopin (2002) as the "breakdown scenario".

This is different from past environmental crises in both global extent and scale. It is manifested in such events as climate change, believed to lead to extensive cascades of change in multiple locations and of unpredictable severity, excessive exploitation of resources resulting in the degrading of ecosystems, and likely governmental and community resistance to widespread remedial action (Ayensu et al 1999; Gewin 2002; WRI 2000). For the first time in history, human beings have become a world force for disruption, co-opting for their own uses many of the biosphere's needed ecosystem resources and services.

In a world subject to such enormous ecological and human contingencies, sustainable development, referred to here as sustainability, has evolved over three decades from an environmental issue to a sociopolitical movement for beneficial social and economic change. Despite the numerous counter forces—influential skeptics, contesters, and political leaders readily paying it lip service while promoting indiscriminate economic growth—sustainability is being advanced by some of the world's most respected scientific thinkers as a rewarding way forward (Kates et al 2001; NRC 1999). Its basic principles, to which this paper subscribes, are to improve and sustain human wellbeing indefinitely without impairing the life support systems on which it depends.

Tourism first applied these principles during the 70s with interdisciplinary research teams working in British Columbia (Holling and Chambers 1973) and the Austrian Alps (Bramwell and Lane 1993; Moser and Petersen 1981). Over the past decade, and particularly the last five years, a significant number of scholarly contributions on sustainable tourism development have been made (Bramwell, Henry, Jackson, van der Straaten 1996; Butler 1999; Hunter 1995, 1997; Mowforth and Munt 1998; Stabler and Goodall 1996; Swarbrooke 1999; Wall 1997; Weaver and Lawton 1999). These works have provided many useful insights particularly in the areas of participation, stakeholder collaboration, and resource management techniques that have helped to advance and operationalize the concept. However, it is argued here that future progress will be severely hampered if more attention is not paid to progress in what is being called "sustainability science" (described later).

Scientific contributions in this area took the lead from those with largely political leanings in the mid-90s (Folke et al 2002; Kates 2002; Kates et al 2001), assisted by networks investigating global change (GECP 2001; IGBP 2001; NRC 1999). An important aspect of the new approaches is that sustainability must be conceived as a transition, journey or path, rather than an end point or an achievable goal. Another widely accepted finding of international scholarly research groups, cited above, is that addressing the earth's environmental crises depends on better understanding of the links between human and natural systems and knowledge of nonlinear methods fundamental to complex systems. This is because the Earth and its components have been found to operate as an interactive whole; a *complex adaptive system,*

one with interdependent and integrated parts displaying unpredictable behavior, constantly evolving, and in general not amenable to analysis by orthodox, linear, deterministic science. Sustainability science is being developed as a new means of coping with global change and the way in which complex systems function. It examines the dynamic interactions and behaviors of natural and social complex systems and is a synthesis of biological, social, geophysical, and technology systems research (NRC 1999; Sustainability Science Forum 2002).

Acknowledgement of and commitment to these principles is now needed within tourism. At present, because of prevailing structural deficiencies, only a minority of researchers are working in this area. Consequently, tourism is managed with markedly incomplete knowledge, especially of the manner in which the whole (completely integrated) system operates, and of the science behind it. Sustainability depends not just on those key elements often referred to as the "tourism industry" but on the whole "comprehensive tourism system" (discussed later). This knowledge will require a substantial shift toward more adaptive, interdisciplinary and whole system management and research which, while not easy to accomplish, are likely to bring considerable and long-term rewards.

This paper reflects the topics outlined above: the state of the ecosphere, nonlinear study paradigms, complex adaptive systems, integration, revised views of ecology and sustainability, and their implications for the future study of tourism. It looks at the conventional study of tourism, attempts to see it systemically and emphasizes the incompleteness of present approaches. The existence of complex adaptive tourism systems (CATS) and their affinity with the behavior of other ecosystems is then stressed, before discussing how to manage CATS in the context of uncertainty, and demonstrating the urgent need for a reconceptualization of tourism studies in line with progress made in the new science. Because of the conceptual and exploratory nature of this paper, it must be stressed that suggestions made are largely based on research in other fields, and most are yet to be tested in tourism.

RECONCEPTUALIZING TOURISM SYSTEMS

It is frequently acknowledged that tourism study is lacking in substantial theory of its own (Dann, Nash and Pearce 1988; Hall 2000; Hall and Butler 1995) and has failed to capitalize on progress made in other disciplines. Consequently, as a field of study it appears isolated and research and teaching appear to have grave shortcomings attributable to its multidisciplinary history, organization, and relations with other fields that should inform the study. While conventional linear methods may provide valuable results within a short time span, in discussions of sustainability they are found wanting, particularly in the case of unexpected processes and events. There has been little debate on the costs and benefits of the current direction, but such a restricted approach to research, governed by disciplinary priorities and researchers' reductionist backgrounds, is an impairment to inte-

gration, unity, and sustainability. This situation appears to lie uneasily with researchers (Leiper 2000; Tribe 1997, 2000) and the plethora of debate about the future, although not the direct subject of this study, illustrates some of the limitations of current approaches. The central problem is that tourism researchers schooled in a tradition of linear, specialized, predictable, deterministic, cause-and-effect science, are working in an area of study that is largely nonlinear, integrative, generally unpredictable, qualitative, and characterized by causes giving rise to multiple outcomes, quite out of proportion to initial input.

New knowledge of complex systems and integration provides enormous scope for further research, building on the work of global change and sustainability science that so far few tourism researchers have begun to explore (Faulkner and Russell 1997; McKercher 1999). There is understandable reticence to abandon simple linear frameworks in exchange for uncertainty, especially without the benefit of results from comparative fieldwork. However, as is shown later in this paper, evidence relevant to tourism conducted in other fields is compelling, as is news of tourism systems undergoing multiple cascades of change as a result of SARS, terrorism, war and economic crises. Attempts to maintain stability in such a volatile environment may work temporarily, but without deep knowledge of the tourism ecosystem, efforts to adapt and take advantage of new situations are likely to be short-lived.

Parallels from Complexity Theory

In order to understand complex systems it is essential to review progress in fields such as ecosystem ecology, ecological economics, and complexity theory. In the 70s, fieldwork by a group of pioneering ecologists led to new understanding that systems are more than frameworks, rather they are integrated, interacting entities displaying unpredictable behavior (Holling 1973, 1978, 1995). Ecologists were not alone in their findings. The shortcomings of reductionist science have been further demonstrated in thermodynamics, quantum mechanics, ecological economics, complexity economics, complexity science, and importantly, for present purposes, in global change science and revised ecosystem ecology. Based on research findings in these fields it can now be said with a degree of confidence that all natural and social systems are interdependent, nonlinear, complex adaptive systems (Gunderson, Holling and Light 1995; IGBP 2001; Levin 1998; NRC 1999; Prigogine 1997; Waldrop 1992). They are complex because, in contrast to the simple systems of particle physics that are interchangeable (Gell-Mann 1994), each has its own identity, emerging from the interaction of important connections, variables and processes. They are adaptive because, together with their component parts, they have the capacity to evolve, learn, and work toward adjusting to their surroundings.

A key point to note from advances in these fields is that complex systems are not built frameworks but actually exist in reality, all with their own unique character. They consist of components driven by

flows of energy, materials and information that either co-operate or compete, resulting in multiple system changes of an unpredictable nature known as "self-organization" (Kauffman 1995; Odum, Odum and Brown 1998). Three distinct situations within these processes may be usefully identified. Positive feedback occurs as a result of continuing and increasing cyclic flows of energy, characterized by tourism destination growth-oriented development. Negative feedback describes the slowed connections and diminished cyclic flow that may result from sluggish economic conditions in a market area or an imposed cap or construction moratorium. Structural entropy describes decay setting in as a result of inadequate or declining energy or investment, associated with aging or abandoned sites.

Systems Applied to Tourism

The study of complexity appeared in business and organizational research (Kelly and Allison 1999; Wood 2000) and contemporaneously several pioneers, noted later in this paper, began to interpret tourism to some degree: as a complex, uncertain, unpredictable system. Unfortunately, progress in tourism has lagged behind as researchers have only shown passing interest in whole systems approaches, despite the advantages such methods afford for coping with the multidisciplinary environment in which tourism operates. Researchers frequently refer to systems in casual reference, sometimes as a framework for focused understanding, and very occasionally as a real entity. Getz surveyed literature in 1986 and found that of 150 models identified, only four attempted to take a whole systems approach. Hall (2000) devotes an entire book chapter to systems and planning but finds the situation little better. He notes several contributors (Leiper 1989; Mill and Morrison 1985, 1992; Pearce 1989) who model the elemental character of a perceived tourism system as highly abstract functional regions representing a market, a destination, and a corridor between. Simmons and Leiper (1993, 1998) and Leiper (2003) provide perhaps the most thorough account, recommending a systems approach as a means for researchers to grapple with broad issues relating to the interdisciplinary nature of the subject. Using three geographic areas, they suggest that "Around each element and around whole tourism systems are many kinds of environmental features: social, cultural, economic, physical, legal, political, technical. Interactions between tourism systems and their environments are pervasive..." (1998:90). However, this work and that of Leiper (2003:36–41) still indicates a clear focus on tourism's "industrial core" and little beyond, despite the wide connections noted. Similar difficulties are found in the work of Smith (1980) and Murphy (1985).

It is argued here that researchers need to venture outside the "core system", to explore the other connections and interactions that extend as far as tourism significantly affects the ways of life, the economic wellbeing of the system, and the people involved, either directly or indirectly. This comprehensive tourism system encompasses multiple

system levels from the core, to the global or Earth system, all interrelated, open and hierarchical.

Figure 1 shows a diagrammatic representation of the *tourism panarchy*—the hierarchical nesting of one system level within another, where founding components structure the system from the bottom up (Gunderson and Holling 2002). The core is shown as the inner section of the tourism system, itself part of the regional ecosystem, and any number of larger systems (shown by the dotted lines) up to the global or Earth system. Whereas the core generally consists of an assemblage of structures, goods, services, and resources directly contributing to the sector, the comprehensive tourism system includes significant social, economic, geological, and ecological components, along with processes and functions that complement its totality and are essential to its sustainability. In the panarchy, the lower levels are semi-autonomous, facilitating some connection and transfer to the level above which is slower moving and largely unaffected by many lower level disturbances. However, small changes in one level may occasionally have unpredictable, sometimes profound effects on other parts of the same system level, triggering a cascade of repercussions which may be significantly greater than the initial disturbance. Somewhat similar occurrences in meteorology, technically called sensitive dependence on initial conditions have been popularized as the butterfly effect (Gleik 1987). The implications of these findings are discussed in later sections of this paper.

Tourism researchers have called for closer integration in the past, and some have already identified the need to study a more comprehensive system (Farrell 1982; Farrell and Runyan 1991; Hall and Lew 1998a; Inskeep 1991; Wall 1993). Farrell and Runyan observe:

> In particular, tourism, in all its complexity, must be seen to interface with the complexities of environment and culture, to view the whole

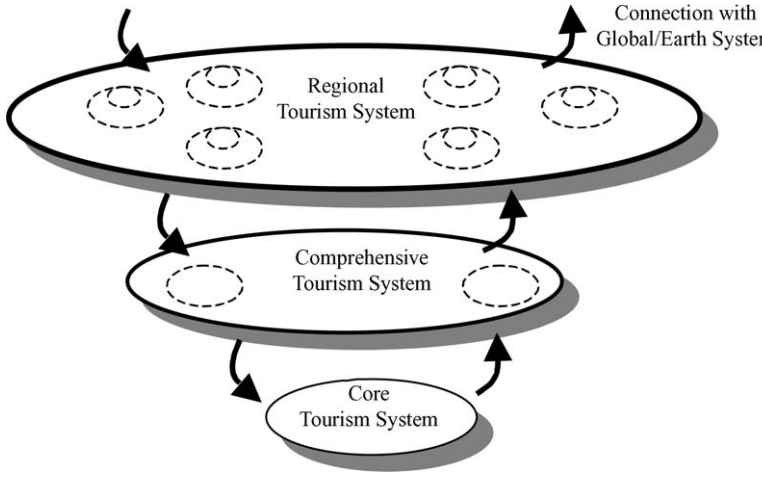


Figure 1. The Tourism Panarchy

> picture of integrated activity rather than only half a picture—tourism operating in a virtual vacuum—with which people have lived for decades (1991:37).

Here the authors urge that a basic understanding of the tourism panarchy and the dynamics of nonlinear complex systems appears essential to effect a sustainability transition. Studying the tourism system gives far greater significance to vital ecosystem goods and services, structures and functions, local society, its perceptions and aspirations, and a host of other components that affect its behavior. In the same way, understanding the destination in terms of the panarchy of systems adds further substance and meaning, and the possibility of discovering how destination character emerges, how it may be kept or even enhanced.

Revised Ecosystem Ecology

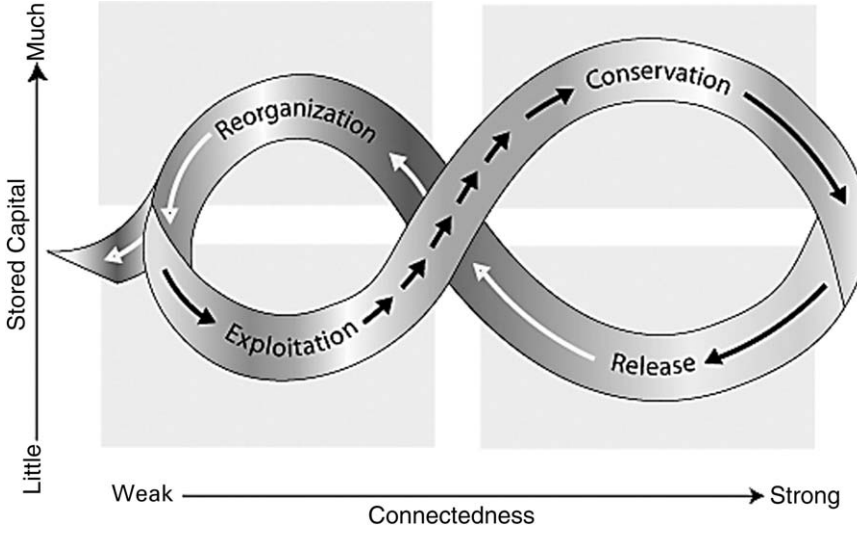
Ecosystems, ranging in area from tiny puddles to the global ecosystem, are associations of living things and their physical, chemical, and biological surroundings. They provide essential life support through goods and services such as food, water, nutrients, minerals and resources, sequestrating carbon dioxide, cycling materials and energy, filtering water, and providing habitats for plants and animals, including humans. As tourism is a constituent of the local ecosystem, a sustainable future for both requires serious attention be given to ecosystem structure and dynamics (Christensen et al 1996; ESA 1995; Gunderson, Holling and Light 1995; Christensen et al 1996; ESA 1995; Gunderson, Holling and Light 1995: Holling, Schindler, Walker and Roughgarden 1995).

Although a great deal is known about individual selected parts of the tourism system, there is little knowledge of their multiple interactions and roles in self-organization. Apart from an understanding that systems have geographic dimension, researchers demonstrate scant appreciation of different temporal and spatial scales, and the multiple consequences of actions or emergent properties that complex systems are known to have (Jervis 1997). As a result, they frequently imply that the physical environment is a separate entity, aggregate intricate ecosystem functions, and refer vaguely to "the environment" or "natural attractions" with constant reference to impacts, implying chronic human-nature conflict. This tends to highlight obvious visual effects rather than the causes, processes, and indicators of incipient ecosystem stress in which tourism plays a prominent part (WGBU 1996). This is not helped by researchers' general lack of knowledge of natural sciences. This reflects a long tradition of educational slanting, with national and community leaders over-emphasizing social sciences and business studies, together with in-built antagonism some disciplines and practitioners have toward these fields (Milton 1996; Redclift 1987; Searle 1995; Wilson 1998).

More complete research requires understanding multiple human-ecosystem interactions and the fact that humans and most ecosystems have coevolved and adapted one with the other (Norgaard 1994). It also requires that tourism researchers have a clear understanding of

revised or new ecology (Botkin 1990; Clark and Munn 1986; Pickett, Parker and Fiedler 1992), and question the validity of entrenched concepts such as climax, equilibrium, and optimality for understanding how natural ecosystems function. Instead of seeking a single equilibrium in complex systems, stability is now believed to be offset by periods of disturbance and disorder associated with the cyclic life of ecosystems. This means that within emergent situations an ecosystem may be in a steady state, multiple stable states, unstable, chaotic, or in several states simultaneously (Gunderson and Pritchard 2002). Based on their degree of maturity, systems are also now thought to cycle through different dynamic states, in a non-constant, episodic manner with extended varying periods of stability followed by periods of turbulence. This process is illustrated by the adaptive cycle first published by Holling (1986) and since then considerably refined (Gunderson, Holling and Light 1995; Gunderson and Holling 2002).

The four-box heuristic shown in Figure 2 is a continuous loop resembling a reclining figure eight. The front-loop, possibly best known in terms of the increasing maturity of a tourism area (Butler 1980), portrays a markedly slowing (short, close arrows), stable movement toward "conservation", characterized by the incremental accumulation of capital, energy, materials, and investment. However, without system management, this part of the loop has also been found to lead to over connection (Tainter 1996), rigid internal controls, low levels of "resilience", general fragility, and vulnerability to "surprise" (Kates and Clark 1996). Resilience is the degree of disturbance a system can withstand while still maintaining the same variables determining its behavior (Holling 1996). Surprise is an unexpected event that may cause



Source: After Holling and Gunderson (2002)

Figure 2. The Adaptive Cycle

collapse (creative destruction), the release of accumulated capital and the beginning of the fast moving back-loop from "release" to "reorganization".

When a surprise occurs, the stability state flips into chaos or intense oscillation, a process that may take place over a few minutes (an earthquake), weeks (SARS cascade effect), months (Asian economic crisis of the late 90s), and years or centuries (the decline of ancient societies, the Soviet Union collapse, the present decline of a number of African states such as Zimbabwe). On the less predictable, fast moving (long arrows), back-loop there is a movement in and out of orderly states but with growing order, increased resilience, and new variables jockeying to control the system. During this acceleration, opportunities abound for human creativity and "movers and shakers" may seize the moment and create new forms of entrepreneurial activity (Russell and Faulkner 1999; Weaver and Oppermann 2000).

By the reorganization phase the outline of the new system or possibly destination character is taking shape. It will not result in the restoration of the previous system, but it will be in a new form with unpredictable component parts and connections. The trajectory shown leading away from the cycle in Figure 2 suggests how part of the system's potential could leak away and where a flip into a less productive system is most likely. Each system has distinct variations and some will inevitably deviate from this pattern, about which there is much more to be learned.

Notwithstanding the gaps in knowledge, there are clearly significant implications for these findings in tourism. It is suggested here that CATS function in a similar manner to other types of complex ecosystems. That is, they have component parts such as people, airports, hotels, restaurants, water, rivers, forests and hospitals. When these are driven by sources of energy in the form of natural resources, human energy and initiative, tourist spending and associated investment, they interact, form networks and create systems with emergent self organizing properties quite different from those of their components. If one component of the CATS is disturbed, the disturbance will travel well beyond its place of origin, almost always with unexpected, multiple, results (Gleik 1987; Jervis 1997). There is much to be learned about the behavior of CATS. Butler (1980) and others working on destination evolution have focused mainly on parts of the front-loop. The potential for applying findings to CATS from the entire cycle and the development of an adaptive tourism cycle would seem particularly rewarding.

Hovinen, when applying Butler's model (1980), and in the context of his later observations (2000), notes the work of Russell and Faulkner (1998, 1999), and observes that complexity theory helps to explain changes in Lancaster County. He says "Chaos/complexity theory does provide a useful alternative and perhaps in part a complementary perspective to Butler's Life Cycle Model" (Hovinen 2002:226). New knowledge derived from ecosystem dynamics, for example, suggests that it may be quite possible for a CATS to have "multiple stable states". This could be the case if long-term stress, poor or rigid management, or some disturbance such as a tropical cyclone caused a system to slide

from one fairly stable state (such as incipient stagnation) into another of lower utility (such as decline). But each separate stable state may indicate a change from the original and each would have its own life cycle. This would appear compatible with Holling's loop and the panarchy with systems within systems.

The dynamics and behavior of social systems can also be profitably studied using the adaptive cycle. Social systems, allow humans to live like no other species, move between systems, extend their reach worldwide and develop cultures, through which they interact with other groups. Some groups become so tightly connected they insulate themselves from other systems (Westley et al 2002). This may explain an apparent barrier in the developed world, preventing wide understanding of the significance of natural systems, poverty or suffering elsewhere. This situation also requires further investigation but appears potentially a substantial counter force to sustainability and of considerable significance to tourism in a number of ways including possibly, an unrecognized barrier between hosts and guests and researchers and the biophysical environment.

Increasing acceptance of sustainable development as an appropriate way forward for human activities gives additional impetus to the need to expand current tourism thinking from its narrow focus on the core system to the more inclusive CTS. It also provides opportunities to integrate new knowledge about sustainability and complex systems into tourism studies to complement the existing foundation.

Sustainability and Managing Complex Adaptive Tourism

Today, despite increased interest in sustainable development, much work is based on literature such as the Brundtland Report (WCED 1987); the United Nations Conference on the Environment and Development; *Agenda 21* (UN 1993); and more recently from publications relating to the World Summit on Sustainable Development (UN 2002). Although relevant, this represents a singular viewpoint and can be augmented by important scientific explanations of sustainability and complex systems, referred to in this present work.

A small number of researchers has begun to explore these new avenues of research (Abel 2000; Faulkner and Russell 1997; Hein 1997; Jennings 2001; Laws, Faulkner and Moscardo 1998; McKercher 1999; Reed 1999; Russell and Faulkner 1999; Walker, Greiner, McDonald and Lyne 1999; Wight 2002). Faulkner and Russell as well as Hein (1997) point out the inability of normal, reductionist science to accommodate what are inherently unstable tourism systems. McKercher criticizes mainstream research in its interpretation of systems as "expectable, stable, orderly, and conducive to linear change" and instead views them as "complex and uncontrollable, characterized by nonlinear, non-deterministic chaotic behavior" (1999:426). Casagrandi and Rinaldi (2002), from the viewpoint of systems analysis, relate nonlinear dynamics to destination lifecycles and sustainability. Others provide valuable evidence of the existence of CATS (McKercher 2003; Murphy 1985; Richter 1999; Wall 1997). This work complements foundations

based on pre-complexity general systems theory, established by the early and contemporary pioneering research of Leiper and his associates (Harris and Leiper 1995; Leiper 1989, 2000, 2003; Simmons and Leiper 1993, 1998).

Nevertheless, few present-day researchers have matched these concepts with recent findings in ecology or examined the implications for contemporary tourism management. As a result, the orthodox ecology doctrine continues to prevail, and those principles of stability, equilibrium, predictability, and the reductionist idea that management actions can be accurately controlled and predicted, continue to pervade contemporary tools such as carrying capacity, environmental impact assessment, and tourism planning (Lindberg, McCool and Stankey 1996; Stankey 1999; Williams and Gill 1994). Current ecological knowledge suggests that such management is more likely to result in diminished resilience and collapse as demonstrated by the adaptive cycle (Figure 2). Gunderson and Holling explain:

> Ecosystems are moving targets, with multiple futures that are uncertain and unpredictable. Therefore, management has to be flexible, adaptive, and experimental at scales compatible with the scales of critical ecosystem functions (2002:27).

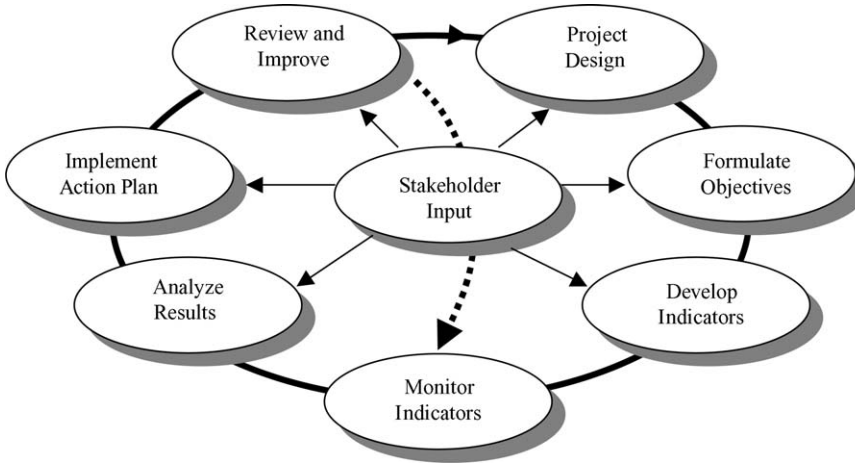
This is not to say the concept of limiting the numbers visiting certain areas is not a useful one (Butler 1991, 1996, 1999; Inskeep 1991), but changes are needed as a result of new knowledge of the way CATS function. For example, carrying capacity limits could be used in a more experimental sense, under continuous revision to factor in new scientific knowledge, locality, seasonality, tourist behavior, and local preferences, to become *adaptive carrying capacity*. Similarly tourism planning is not rejected per se, but there is a need to move towards greater integration of systems techniques where the process of planning is a continual one, incorporating constant review and revisions. Techniques such as Limits of Acceptable Change (Clark and Stankey 1979), Recreation and Tourism Opportunity Spectrum (Butler and Walbrook 1991) and Growth Management (Schiffman 1989) make initial steps in a useful direction by adopting more integrated and participatory approaches, but they still demonstrate fairly rigid top-down management structures.

Over recent years many new tools and concepts have been devised for the study of ecology, sustainability science, and global change science, some of which seem appropriate for tourism. These include adaptive ecosystem cycle theory, scenario planning, simulation models, integrated assessment models, integrated landscape planning, regional information systems, and, recently, resilience analysis and management (Folke et al 2002; Resilience Alliance 2000; Walker et al 2002). Relevant information is found in an ever-growing body of literature that may be harnessed through many of the sources cited throughout this paper. Of these "adaptive management" stands out as an effective way of managing the comprehensive tourism system.

AM is the process of building resilience and coping with uncertainty through a continual process of experimenting, monitoring, and social

learning (Clark 2002; Holling 1978; Walters 1986). Rather than trying to obtain and then maintain an idealized equilibrium state, adaptive management progressively accumulates knowledge through "social learning", preparing managers and stakeholders to experiment, probe, adapt to and benefit from small and large-scale change (Berkes and Folke 1998). In this context, social learning involves the sharing of knowledge among stakeholders and within the community transferal of knowledge from one group of stakeholders to another, building of a systemic history, and use of this expertise to understand and maintain human and social resources (Parsons and Clark 1995).

AM principles have successfully been applied to a wide range of ecosystems in North America including the Clayoquot Sound, British Columbia (Nyberg 1999) and Columbia River Basin (Lee 1993) and have received a high level of interdisciplinary endorsement. It is also being used to manage social systems and has begun to be recognized by tourism researchers (Manning 1998; Reed 1999, Rollins, Trotter and Taylor 1998; Twining-Ward 2002). Rollins, Trotter and Taylor (1998) report on the use of adaptive management to assess the effectiveness of three alternative strategies for dealing with recreation conflicts in British Columbia. They explain that using adaptive management helped researchers design programs to generate feedback and then adjust policies accordingly. Similar principles and methods were adapted for use in Samoa by Twining-Ward (2002, 2003) to develop a set of sustainable tourism indicators. As Figure 3 shows, the approach was circular, involving the design of objectives and indicators, monitoring, analysis of results and review as a continual cycle. At each stage stakeholders had major input. In this way the development of indicators became a learning process, whereby ownership emerged, capacity was built, and the project's resilience was enhanced.



Adapted from: Twining-Ward and Butler (2002)

Figure 3. Samoa Sustainable Tourism Indicator Project

(Although it is not the purpose of this article to examine the implementation of adaptive management and associated methods in any great detail, the examples reviewed serve to highlight some of the likely characteristics of tools useful for managing CATS.)

Researching CATS

In order to learn more about how to effect the transition to sustainability, there is a need to expand tourism's horizons considerably. Interdisciplinary approaches are already supported to some degree by a wide range of studies including geography, ecological economics, zoology, and biology, as well as in sustainable development literature. In a presidential address to the Association of American Geographers, Gober suggests that the future of geography lies in bridging the gaps among the major branches of knowledge in the disciplines: "Disciplinary boundaries must be crossed, different languages spoken, new methods learned, and world views changed" (2000:4). In a similar vein, biologist Wilson shows that most real world problems lie at the intersection of biology, social science, environmental policy, and ethics, and suggests that only through "pursuit of consilience [integration]" (1998:13) can a balanced perspective be acquired. Norgaard, an ecological economist, goes further, opting for a transformation from disciplinary to interdisciplinary or even transdisciplinary thinking (in Wilk 2000). Constanza, Segura and Mártinez-Alier (1996:3–4) suggest such an approach can help move beyond the boundaries of academic disciplines towards a "pluralistic win-win approach" incorporating many different disciplines simultaneously.

It is argued that in order to begin to understand and study CATS, both theoretical and practical boundaries need to be crossed, which will involve increased interdisciplinary and transdisciplinary studies (Knight, Mitchell and Wall 1997). Valuable though it may be for certain functions, relying solely on business knowledge, economics, and some social sciences is inadequate in a universe where managers must proactively protect and contribute to the ecosystems their operations depend on. The wider, more versatile, research-oriented transciplinary approach allows for better understanding of the integration of natural and social systems (Constanza, Segura and Mártinez-Alier 1996; Küffer 2002; Wilson 1998).

There is, for example, much more to learn from ecosystem ecology and ecological economics and other social science work cited. This would help researchers understand a tourism system is a special ecosystem in its own right, and welcome the incorporation of new work emerging from studies linking social and natural systems (Holling and Sanderson 1996; Marten 2001). It would also assist them to appreciate the importance of spatial and especially temporal scales, and how their mismatch, or the long time lags between action and outcomes, has often been the cause for development failure.

In order to further advance understanding of the behavior and management of CATS, greater attention needs to be given to place-based studies. These allow researchers to become adjusted to interwoven

place and time-scales, and become alert to the scale or scales that govern problems under investigation. Although place-based approaches have been applied by tourism researchers (Hall and Lew 1998b; Laws, Faulkner and Moscardo 1998; Stankey 1999), missing to date is a wider understanding that conclusions drawn from a small destination cannot yet be readily transferred to the much larger region (up-scaling), nor can they be reversed (through down-scaling). This is because nonlinear techniques are still to be devised; and at every level, properties, behaviors and processes, and controlling variables, tend to differ.

Therefore, there is much exploration and research to be undertaken concerning CATS, especially if self-imposed limitations are removed and the implications of interactions and processes within systems are investigated. This could perhaps lead to the introduction of new courses and teaching specialties combining aspects of nonlinear tourism; ecosystem ecology and tourism; resource science; systems analysis; resilience analysis and management; ecological economics of tourism; adaptive planning and management; participation, collaboration and co-management; tourism destination restoration; nonlinear tools and methods; modeling and simulation; geographical information systems; futurism and scenario construction; transdisciplinarity; and regional information systems and complexity theory applied to business. University professors, well versed in natural and social sciences and with interdisciplinary outlooks, will need to be recruited to support new programs, and students previously trained in biological, earth, or computer sciences might be encouraged to move on to tourism after graduation.

CONCLUSION

The degraded state of the earth's resources and ecosystems and existence of severe social inequities appears widely accepted. Community, government, and scientific attempts to remedy the situation hinge on the attainment of a sustainability transition. The scientific study of sustainability is informed by new knowledge and understanding complex systems is seen as crucial to the transition. Both social and natural systems are considered complex and real entities, tightly integrated, and functioning together as nonlinear, evolving socioecological systems. To move tourism towards such a transition, researchers, consultants, managers, and stakeholders need to understand complex systems through integrative and nonlinear approaches; otherwise progress will be hampered and results distorted, incomplete and devoid of full meaning. Transdisciplinarity is desirable and interdisciplinarity is essential, with building desperately needed bridges as the goal.

In the light of recent advances in science, the concept of sustainability has been reassessed. The old myth of how living systems function based on linear reductionism, harmony, and equilibrium is being displaced by non-linear science capable of working with the realities of dynamic change and uncertainty. These ideas—together with social learning, the abandoning of rigid prescription and definition, attention to place-based studies and non-linear tools—are

endorsed by some major scientific organizations including the US National Research Council, the Ecological Society of America, and leading international groups, as well as outstanding international scholars. Understanding of sustainability has shifted from the notion of a stable achievable goal, to the concept of transition based on multiple spatial and temporal scales in a dynamic landscape of evolving human values.

Movement toward a transition is practicable and one in which researchers might be guardedly optimistic. There are, however, powerful counter-forces in the form of firmly held social and cultural values, government economic policy, the insulating properties of social systems, persistent use of partial solutions, and problems of human adversity to grasping concepts of scale and uncertainty. Administrators and managers need to be alert to these forces and aware of the processes that are likely to drive the comprehensive tourism system at different times and levels, and work actively to have its status and capacity continually monitored. To be concerned with only those structures, goods and services perceived as directly contributing to sector activity appears insufficient. It is believed such change requires, among other things, a reconceptualizing of the structure of tourism study. Contemporary approaches that have provided valuable knowledge remain, but may be valuably adapted and complemented through far greater integration, transdisciplinarity, and the use of nonlinear tools and concepts. This paper makes some suggestions for changes that make approaches more adequate and complete to meet present challenges, but it is no more than a beginning.

The evidence for change is stressed throughout this work. If sustainability is not the objective, there is no need for change, but if the transition is desired and more complete and effective tourism is to be practiced, then investigation of appropriate applications from other fields to tourism should proceed with haste. A

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REFERENCES

Abel, T.
2000 The Complex Systems Dynamics of a Development Frontier: The Case of Eco-Tourism on the Island of Bonaire, Netherlands Antilles. PhD dissertation in anthropology, University of Florida. <http://www.clas.ufl.edu/users/abeltd/research.htm>

Ayensu, E., D. Van Claasen, M. Collins, A. Dearing, L. Fresco, M. Gadgil, H. Gitay, G. Glaser, C. Juma, J. Krebs, R. Lenten, J. Lubchenco, J. McNeely, H. Mooney, P. Pinstrup-Andersen, M. Ramos, P. Raven, W. Reid, C. Samper, J. Sarukhan, P. Schei, J. Galizia Tundisi, T. Watson, X. Guanhua, and A. Zakri
1999 1999 International Ecosystem Assessment. Science 286(5440):685–686.

Berkes, F., and C. Folke, eds.
1998 Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience Cambridge: Cambridge University Press.

Botkin, D.
1990 Discordant Harmonies: A New Ecology for the Twenty-First-Century. Oxford: Oxford University Press.
Bramwell, B., and B. Lane
1993 Sustainable Tourism: An Evolving Approach. Journal of Sustainable Tourism 1(1):1–5.
Bramwell, B., I. Henry, G. Jackson, and J. van der Straaten
1996 A Framework for Understanding Sustainable Tourism Management. *In* Sustainable Tourism Management: Principles and Practice, B. Bramwell, I. Henry, G. Jackson, A. Prat, G. Richards and J. van der Straaten, eds., pp. 23–72. Tilberg: Tilberg University Press.
Butler, R.
1980 The Concept of a Tourist Area Cycle of Evolution: Implications for Management of Resources. Canadian Geographer 24(1):5–12.
1991 Tourism, Environment and Sustainable Development. Environmental Conservation 18(3):201–209.
1996 The Concept of Carrying Capacity for Tourism Destinations: Dead or Merely Buried? Progress in Tourism and Hospitality Research 2(2/3):283–293.
1999 Sustainable Tourism: A State of the Art Review. Tourism Geographies 1(1):7–25.
2000 The Resort Cycle Two Decades On. *In* Tourism in the 21st Century, B. Faulkner, G. Moscardo and E. Laws, eds., pp. 284–299. London: Continuum.
Butler, R., and L. Walbrook
1991 A New Planning Tool: The Tourism Opportunity Spectrum. The Journal of Tourism Studies 2(1):2–14.
Casagrandi, R., and S. Rinaldi
2002 A Theoretical Approach to Tourism Sustainability. Conservation Ecology 6(1):13<http://www.consecol.org/vol6/iss1/art13>.
Christensen, N., A. Bartuska, J. Brown, S. Carpenter, C. D'Antonio, R. Francis, J. Franklin, J. MacMahon, R. Noss, D. Parsons, C. Peterson, M. Turner, and R. Woodmansee
1996 The Report of the Ecological Society of America Committee on the Scientific Basis of Ecosystem Management. Ecological Applications 6:665–691.
Clark, W.
2002 Adaptive Management. Heal Thyself. Environment 44(2)unpaged editorial.
Clark, R., and G. Stankey
1979 The Recreation Opportunity Spectrum: A Framework for Planning, Management and Research. US Department of Agriculture and Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report, PNW-98. Washington DC: US Department of Agriculture and Forest Service.
Clark, W., and R. Munn, eds.
1986 Sustainable Development of the Biosphere Cambridge: Cambridge University Press.
Constanza, R., O. Segura, and J. Mártinez-Alier, eds.
1996 Getting Down to Earth: Practical Applications of Ecological Economics Washington DC: International Society for Ecological Economics.
Dann, G., D. Nash, and P. Pearce
1988 Methodology in Tourism Research. Annals of Tourism Research 15:1–28.
ESA
1995 The Report of the Ecological Society of America Committee on the Scientific Basis of Ecosystem Management. <http://esa.sdsc.edu/ecmtext.htm>.
Faulkner, B., and R. Russell
1997 Chaos and Complexity in Tourism: In Search of a New Perspective. Pacific Tourism Review 1:93–102.
Farrell, B.
1982 Hawaii, the Legend that Sells. Honolulu. Honolulu: University Press of Hawai'i.

Farrell, B., and D. Runyan
1991 Ecology and Tourism. Annals of Tourism Research 18:26–40.
Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C. Holling, B. Walker, J. Bengtsson, F. Berkes, J. Colding, K. Danell, M. Falkenmark, L. Gordon, R. Kasperson, N. Kautsky, A. Kinzig, S. Levin, L-G. Mäker, F. Moberg, L. Ohlsson, P. Olsson, E. Ostrom, W. Reid, J. Rockström, H. Savenije, and U. Svedin
2002 Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Background paper for WSSD, Johannesburg, Resilience Alliance for the Swedish Environmental Advisory Council and the International Council for Science. ICSU Series for Sustainable Development No 3. <http://www.resalliance.org/reports/resilience_and_sustainable_development.pdf.>
Gallopin, G.
2002 Planning for Resilience: Scenarios, Surprises and Branch Points. *In* Panarchy: Understanding Transformations in Human and Natural Systems, L. Gunderson and C. Holling, eds., pp. 361–394. Washington DC: Island Press.
GECP
2001 Earth Science System: An Integrated Approach. Environment 43(8):21–27.
Gell-Mann, M.
1994 The Quark and the Jaguar: Adventures in the Simple and the Complex. New York: W. H. Freeman.
Getz, D.
1986 Models in Tourism Planning: Towards Integration of Theory and Practice. Tourism Management 7:21–32.
Gewin, V.
2002 Ecosystem Health: The State of the Planet. Nature 417:112–113.
Gleik, J.
1987 Chaos: Making a New Science. New York: Penguin Books.
Gober, P.
2000 Presidential Address: In Search of Synthesis. Annals of the Association of American Geographers 90(1):1–11.
Gunderson, L., and C. Holling, eds.
2002 Panarchy: Understanding Transformations in Human and Natural Systems. Washington DC: Island Press.
Gunderson, L., C. Holling, and S. Light, eds.
1995 Barriers and Bridges to the Renewal of Ecosystems and Institutions New York: Columbia University Press.
Gunderson, L., and L. Pritchard, eds.
2002 Resilience and the Behavior of Large-Scale Systems. Washington DC: Island Press.
Hall, C.
2000 Tourism Planning. Harlow: Prentice Hall.
Hall, C., and R. Butler
1995 In Search of Common Ground: Reflections on Sustainability: Complexity and Process in the Tourism System: A Discussion. Journal of Sustainable Tourism 3(2):99–105.
Hall, C., and A. Lew
1998a Sustainable Tourism: A Geographical Perspective. New York: Addison Wesley Longman.
1998b The Geography of Sustainable Tourism Development: An Introduction. *In* Sustainable Tourism: A Geographical Perspective, C. Hall and A. Lew, eds., pp. 1–12. New York: Addison Wesley Longman.
Harris, R., and N. Leiper
1995 Sustainable Tourism: An Australian Perspective. Oxford: Butterworth-Heinemann.
Hein, W.
1997 Tourism and Sustainable Development: Empirical Analysis and Concepts of Sustainability. A Systems Approach. *In* Tourism and Sustainable Development, Number 41, W. Hein, ed., pp. 359–399. Hamburg: Schriften Des Deutchen Ubersee Instituts.

Holling, C.
1973 Resilience and Stability in Ecological Systems. Annual Review of Ecology and Systematics 4:1–23.
1986 The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change. *In* Sustainable Development of the Biosphere, W. Clark and R. Munn, eds., pp. 292–317. Cambridge: Cambridge University Press.
1995 What Barriers? What Bridges? *In* Barriers and Bridges to the Renewal of Ecosystems and Institutions, L. Gunderson, C. Holling and S. Light, eds., pp. 1–34. New York: Columbia University Press.
1996 Engineering Resilience versus Ecological Resilience. *In* Engineering Within Ecological Constraints, P. Schultze, ed., pp. 31–43. Washington DC: National Academy of Engineering Press.
Holling, C. ed.
1978 Adaptive Environmental Assessment and Management. New York: Wiley.
Holling, C., and A. Chambers
1973 Resource Science: The Nurture of an Infant. BioScience 23(1):13–20.
Holling, C., and L. Gunderson
2002 Resilience and Adaptive Cycles. *In* Panarchy: Understanding Transformations in Human and Natural Systems, L. Gunderson and C. Holling, eds., pp. 25–62. Washington DC: Island Press.
Holling, C., and S. Sanderson
1996 Dynamics of (Dis)harmony in Ecological and Social Systems. *In* Rights of Nature: Ecological, Economic, Cultural and Political Principles of Institutions for the Environment, S. Hanna, C. Folke, K. Mäler and Å. Jansson, eds., pp. 57–86. Washington DC: Island Press.
Holling, C., D. Schindler, B. Walker, and J. Roughgarden
1995 Biodiversity in the Functioning of Ecosystems and Ecological Synthesis. *In* Biodiversity Loss: Economic and Ecological Issues, C. Perring, K. Mäler, C. Folke, C. Holling and B. Jansson, eds., pp. 44–83. Cambridge: Cambridge University Press.
Hovinen, G.
2002 Revisiting the Destination Lifecycle Model. Annals of Tourism Research 29:209–230.
Hunter, C.
1995 On the Need to Re-Conceptualise Sustainable Tourism Development. Journal of Sustainable Tourism 3(3):155–165.
1997 Sustainable Tourism as an Adaptive Paradigm. Annals of Tourism Research 24:850–867.
IGBP
2001 Global Change and the Earth System: A Planet Under Pressure. IGBP Science No. 4. <http://www.igbp.kva.se//uploads/ESO_IGBP4.pdf>
Inskeep, E.
1991 Tourism Planning: An Integrated and Sustainable Development Approach. New York: Van Nostrand Reinhold.
Jennings, G.
2001 Tourism Research. Milton: Wiley.
Jervis, R.
1997 System Effects: Complexity in Political and Social Life. Princeton: Princeton University Press.
Kates, R.
2002 One Road to Johannesburg. Environment 44(4), editorial unpaged.
Kates, R., and W. Clark
1996 Environmental Surprise: Expecting the Unexpected. Environment 38(2):6–11, 28–34.
Kates, R., W. Clark, R. Corell, J. Hall, C. Jaeger, I. Lowe, J. McCarthy, H. Schellnhuber, B. Bolin, N. Dickson, S. Faucheux, G. Gallopin, A. Grübler, B. Huntley, J. Jäger, N. Jodha, R. Kasperson, A. Mabogunje, P. Matson, H. Mooney, B. Moore III, T. O'Riordan, and U. Svedin
2001 Sustainability Science. Science 292(5517):641–642.

Kauffman, S.
1995 At Home in the Universe: the Search for Laws of Self-Organization and Complexity. New York, Oxford: Oxford University Press.
Kelly, S., and M. Allison
1999 The Complexity Advantage: How the Science of Complexity Can Help Your Business Achieve Peak Performance. New York: McGraw Hill.
Küffer, C.
2002 Transdisciplinarity. Swiss Academic Society for Environmental Research and Ecology. <http://www.transdisciplinarity.ch/bibliography/index.html>
Knight, D., B. Mitchell, and G. Wall
1997 Bali: Sustainable Development, Tourism and Coastal Management. Ambio 26(2):90–96.
Laws, E., B. Faulkner, and G. Moscardo
1998 Embracing and Managing Change in Tourism. *In* Embracing and Managing Change in Tourism: International Case Studies, E. Laws, B. Faulkner and G. Moscardo, eds., pp. 1–10. New York: Routledge.
Lee, K.
1993 Compass and Gyroscope: Integrating Science and Politics for the Environment. Washington DC: Island Press.
Leiper, N.
1989 Tourism and Tourism Systems. Occasional Paper No.1, Department of Management Systems, Massey University, Palmerston North.
2000 An Emerging Discipline. Annals of Tourism Research 27:805–809.
2003 Tourism Management. Sydney: Pearson.
Levin, S.
1998 Ecosystems and the Biosphere as Complex Adaptive Systems. Ecosystems 1:431–436.
Lindberg, K., S. McCool, and G. Stankey
1996 Rethinking Carrying Capacity. Annals of Tourism Research 23:461–465.
Manning, E.
1998 Governance for Tourism: Coping with Tourism in Impacted Destinations. Toronto: Centre for a Sustainable Future, Foundation for International Training.
Marten, G.
2001 Human Ecology: Basic Concepts For Sustainable Development. London: Earthscan Publications.
McKercher, B.
1999 A Chaos Approach to Tourism. Tourism Management 20:425–434.
2003 6,999,986 HK residents NOT diagnosed with SARS today! Public e-mail posting from <hmbob@inet.polyu.edu.hk> to <trinet-l@hawaii.edu> (April 28).
Mill, R., and A. Morrison
1985,1992 The Tourist System: an Introductory Text. Englewood Cliffs: Prentice Hall.
Milton, K.
1996 Environmentalism and Cultural Theory: Exploring the Role of Anthropology in Environmental Discourse. London: Routledge.
Moser, W., and J. Petersen
1981 Limits to Obergurgl's Growth: Alpine Experience in Environmental Management. Ambio 10(2):68–72.
Mowforth, A., and I. Munt
1998 Tourism and Sustainability: New Tourism in the Third World. London: Routledge.
Murphy, P.
1985 Tourism: A Community Approach. New York: Routledge.
NRC
1999 Our Common Journey: A Transition Toward Sustainability. Washington DC: National Academy Press.
Norgaard, R.
1994 Development Betrayed: the End of Progress and a Coevolutionary Revisioning of the Future. New York: Routledge.

Nyberg, B.
1999 An Introductory Guide to Adaptive Management: For Project Leaders and Participants. Victoria: British Columbia Forest Service.
Odum, H., E. Odum, and M. Brown
1998 Environment and Society in Florida. Boca Raton: Lewis Publishers.
Parsons, E., and W. Clark
1995 Sustainable Development as Social Learning: Theoretical Perspectives and Practical Challenges for the Design of Research Programs. *In* Barriers and Bridges to the Renewal of Ecosystems and Institutions, L. Gunderson, C. Holling and S. Light, eds., pp. 428–460. New York: Columbia University Press.
Pearce, D.
1989 Tourism Development. (2nd ed.) Harlow: Longman Scientific and Technical.
Pickett, S., V. Parker, and P. Fiedler
1992 The New Paradigm in Ecology: Implications for Conservation Biology above the Species Level. *In* Conservation Biology: The Theory and Practice of Nature Conservation, Preservation and Management, P. Fiedler and S. Jain, eds., pp. 65–88. New York: Chapman Hall.
Prigogine, I.
1997 The End of Certainty: Time, Chaos and the New Laws of Nature. New York: The Free Press.
Redclift, M.
1987 Sustainable Development: Exploring the Contradictions. London and New York: Methuen.
Reed, M.
1999 Collaborative Tourism Planning as Adaptive Experiments in Emergent Tourism Settings. Journal of Sustainable Tourism 7:331–355.
Resilience Alliance
2000 <http://www.resalliance.org>
Richter, L.
1999 After Political Turmoil: The Lessons of Rebuilding Tourism in Three Asian Countries. Journal of Travel Research 38(1):41–45.
Rollins, R., W. Trotter, and B. Taylor
1998 Adaptive Management of Recreation Sites in the Wildland-Urban Interface. Journal of Applied Recreation Research 23:107–125.
Russell, R., and B. Faulkner
1998 Reliving the Destination Lifecycle in Coolangatta: An Historical Perspective on the Rise, Decline and Rejuvenation of an Australian Seaside Resort. *In* Embracing and Managing Change in Tourism: International Case Studies, E. Laws, B. Faulkner and G. Moscardo, eds., pp. 95–115. London: Routledge.
1999 Movers and Shakers: Chaos Makers in Tourism Development. Tourism Management 20:411–423.
Schiffman, I.
1989 Alternative Techniques for Managing Growth. Institute of Governmental Studies, Berkeley: University of California.
Searle, J.
1995 The Construction of Social Reality. New York: Free Press.
Simmons, D., and N. Leiper
1993 Tourism a Social Science Perspective. *In* Leisure, Recreation and Tourism, H. Perkins and J. Cushman, eds., pp. 204–220. Auckland: Addison Wesley Longman.
1998 Tourism Systems in New Zealand and Australia. *In* Time Out? Leisure, Recreation and Tourism in New Zealand and Australia, H. Perkins and J. Cushman, eds., pp. 86–108. Auckland: Addison Wesley Longman.
Smith, V.
1980 Anthropology and Tourism: A Science-Industry Evaluation. Annals of Tourism Research 7:13–33.
Stabler, M., and B. Goodall
1996 Environmental Auditing in Planning for Sustainable Island Tourism. *In* Sustainable Tourism in Islands and Small States: Issues and Policies, L. Briguglio, B. Archer, J. Jafari and G. Wall, eds., pp. 170–196. London: Pinter.

Stankey, G.
1999 The Recreation Opportunity Spectrum and the Limits of Acceptable Change Planning Systems: A Review of Experiences and Lessons. *In* Ecosystem Management: Adaptive Strategies for Natural Resource Organizations in the Twenty-First Century, J. Alay, W. Burch, B. Conover and D. Field, eds., pp. 173–188. Philadelphia: Taylor and Francis.
Sustainability Science Forum
2002 <http://sustsci.harvard.edu/>
Swarbrooke, J.
1999 Sustainable Tourism Management. Oxon: CABI.
Tainter, J.
1996 Complexity Problem Solving and Sustainable Societies. *In* Getting Down to Earth: Practical Applications of Ecological Economics, R. Constanza, O. Segura and J. Mártinez-Alier, eds., pp. 61–76. Washington DC: International Society for Ecological Economics and Island Press.
Tribe, J.
1997 The Indiscipline of Tourism. Annals of Tourism Research 24:638–657.
2000 Indisciplined and Unsubstantiated. Annals of Tourism Research 27:809–813.
Twining-Ward, L.
2002 Indicator Handbook: Guide to the Development and Use of Samoa's Sustainable Tourism Indicators. Apia: SPREP and NZODA.
2003 Monitoring Sustainable Tourism Development: A Comprehensive, Stakeholder-driven, Adaptive Approach. PhD Dissertation in Tourism Management, University of Surrey.
Twining-Ward, L., and R. Butler
2002 Implementing Sustainable Tourism Development on a Small Island: Development and the Use of Sustainable Tourism Development Indicators in Samoa. Journal of Sustainable Tourism 10(5):363–387.
UN
1993 Earth Summit Agenda 21: The United Nations Programme of Action from Rio. New York: UN Department of Public Information.
2002 Report on the World Summit on Sustainable Development, Johannesburg, South Africa. New York: UN Department of Public Information.
Wackernagel, M., B. Schulz, D. Deumling, A. Callejas Linares, M. Jenkins, V. Kapos, C. Monfreda, J. Loh, N. Myers, R. Norgaard, and J. Randers
2002 Tracking the Ecological Overshoot of the Human Economy. <www.pnas.org/cgi/doi/10.1073/pnas.142033699> (June 27).
Waldrop, M.
1992 Complexity: The Emerging Science at the Edge of Order and Chaos. New York, London: Simon and Schuster.
Walker, B., J. Carpenter, N. Anderies, G. Abel, M. Cumming, L. Janssen, J. Lebel, G. Norberg, G. Peterson, and R. Pritchard
2002 Resilience Management in Social-ecological Systems: A Working Hypothesis for a Participatory Approach. Conservation Ecology 6(1):14.
Walker, P., R. Greiner, D. McDonald, and V. Lyne
1999 The Tourism Futures Simulator: A Systems Thinking Approach. Environmental Modeling and Software 14:59–67.
Wall, G.
1993 International Collaboration in the Search for Sustainable Tourism in Bali, Indonesia. Journal of Sustainable Tourism 1(1):38–47.
1997 Is Ecotourism Sustainable? Environmental Management 21:483–491.
Walters, C.
1986 Adaptive Management of Renewable Resources. London: Macmillan.
WCED
1987 Our Common Future. Oxford: World Commission on the Environment and Development. Oxford University Press.
Weaver, D., and L. Lawton
1999 Sustainable Tourism: A Critical Analysis. Queensland: CRC Griffith University.

Weaver, D., and M. Oppermann
2000 Tourism Management. Brisbane: Wiley.
Westley, F., S. Carpenter, W. Brock, C. Holling, and L. Gunderson
2002 Why Systems of People and Nature are Not Just Social and Ecological Systems. *In* Panarchy: Understanding Transformations in Human and Natural Systems, L. Gunderson and C. Holling, eds., pp. 103–120. Washington DC: Island Press.
WGBU
1996 World in Transition: The Research Challenge. Annual Report. Berlin: Springer. <http://www.wbgu.de/wbgu_jg1996_engl.pdf>
Wight, P.
2002 Tourism Strategies for Sustainability and Profit: Is Balance Possible? Ambassador Lane Lecture on Sustainable Tourism, School of Travel Industry Management, University of Hawaii. <http://www.tim.hawaii.edu/step/step_lane.htm> (April 9).
Wilk, R.
2000 Being Transdisciplinary: An Informal Interpretation of a Conversation with Ecological Economist, Richard Norgaard. <http://dizzy.library.arizon.edu/ej/jpe/transdisciplinarity.htm>
Williams, A., and A. Gill
1994 Tourism Carrying Capacities Management Issues. *In* Global Tourism: The Next Decade, W. Theobald, ed., pp. 174–187. Oxford: Butterworth-Heinemann.
Wilson, E.
1998 Consilience: The Unity of Knowledge. New York: Alfred A. Knoff.
2002 The Future of Life. New York: Alfred A. Knopf.
Wood, R.
2000 Managing Complexity. London: Economist Books.
WRI
2000 World Resources 2000–2001. People and Ecosystems: The Fraying Web of Life. <http://www.wri.org/wr2000/ecosystems.html>

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