

Implications for coral reef conservation of diver specialization

PHILIP DEARDEN*, MICHELLE BENNETT AND RICK ROLLINS

Marine Protected Areas Research Group, Department of Geography, University of Victoria, BC, Canada

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SUMMARY

One activity with potential to provide a direct incentive for reef conservation is scuba diving. In the absence of effective management, diving can also have negative impacts. This study shows how an understanding of diver specialization can be used to help manage diving and increase its effectiveness as an incentive-driven conservation activity. Surveys were used to assess motivations, satisfactions and dive history of divers in Phuket (Thailand) and categorize divers by degree of specialization. Highly specialized divers were more likely to be on a live-aboard trip than less specialized divers and placed greater importance on the characteristics of the dive itself rather than the trip. Less specialized divers put more emphasis on non-dive characteristics. Satisfaction levels differed significantly among specialization groups in terms of overall satisfaction with the dive experience, satisfactions compared with motivations and satisfactions with specific trip characteristics. Overall there was a decline in satisfaction levels with increasing specialization. These findings are compared to a wildlife tourism model that links impacts with client characteristics and suggests a displacement of specialists by generalists and changes in the limits of acceptable change (LAC) over time. The dive data supported this progression leading to increased industry competition and reduced opportunities to sustain a broad-based dive industry that will act as an incentive-driven mechanism for reef conservation. Specific actions related to reef access and zoning according to a diver opportunity spectrum (DOS), establishing LAC and monitoring programmes, enforcing safety and environmental regulations are suggested to promote a more sustainable approach to dive management. Social science insights can be used to aid reef management strategies and increase the potential for diving to contribute towards reef conservation.

Keywords: coral reefs, diving, marine protected areas, specialization, sustainability, Thailand

INTRODUCTION

Coral reefs are one of the most diverse, productive and ecologically valuable environments on Earth. South-east Asia is a region of special importance as the epicentre of marine biodiversity for many groups, including coral and reef-associated fish (Briggs 2005). Recent regional surveys have confirmed the extent of reef degradation in the area (Burke & Spalding 2002; UP-MSI *et al.* 2002; Wilkinson 2004). The causes of this destruction include overfishing, use of destructive fishing methods, pollution, increased ocean temperatures and tourism. Underlying many of these causes is the reality that the immediate returns from destructive activities often outweigh the long-term benefits of reef protection. Development of economic incentives for reef protection is critical for future reef conservation (Bellwood *et al.* 2004). One activity with potential to provide an incentive for reef conservation is scuba diving.

Divers are attracted to spend their money in areas with intact and rich marine environments (Pendleton 1994; Moscardo 1999; Rudd & Tupper 2002). Over the last 20 years, many tropical countries have developed significant recreational dive industries as divers have become aware of the beauty and comfort of diving in tropical environments (Musa 2002). If local people benefit financially from diving it is in their best interest to conserve rather than destroy reefs (Guzman *et al.* 2003). Provision of alternative sources of income was the single most effective influence on reef conservation in marine protected areas (MPAs) in one case study in the Philippines (Gjersten 2005). Diving is potentially an incentive-driven conservation activity and can be used both as a supplement to more traditional conservation approaches, such as the establishment of MPAs, as well as a free-market mechanism that can be used anywhere where conditions are suitable (Hawkins *et al.* 2005).

However, diving can also have negative impact on reefs (Hawkins *et al.* 1999; Tratalos & Austin 2001; Zakai & Chadwick-Furman 2002) and it is important to understand the nature and causes of impacts if management interventions are to be successful in their mitigation. Motivational aspects of diver behaviour may help managers reduce the incidence of diver damage (Rouphael & Inglis 2001; Dearden *et al.* 2006). Divers differ in their motivations, expectations and sources of satisfaction. In the recreational literature these intra activity differences have been linked to the concept of specialization (Bryan 1977; Inglis *et al.* 1999). There has been little research on diver specialization other than distinguishing amongst divers on the basis of camera use

* Correspondence: Dr Philip Dearden Tel: +1 250 721 7335 Fax: +1 250 721 6216 e-mail: pdearden@office.geog.uvic.ca

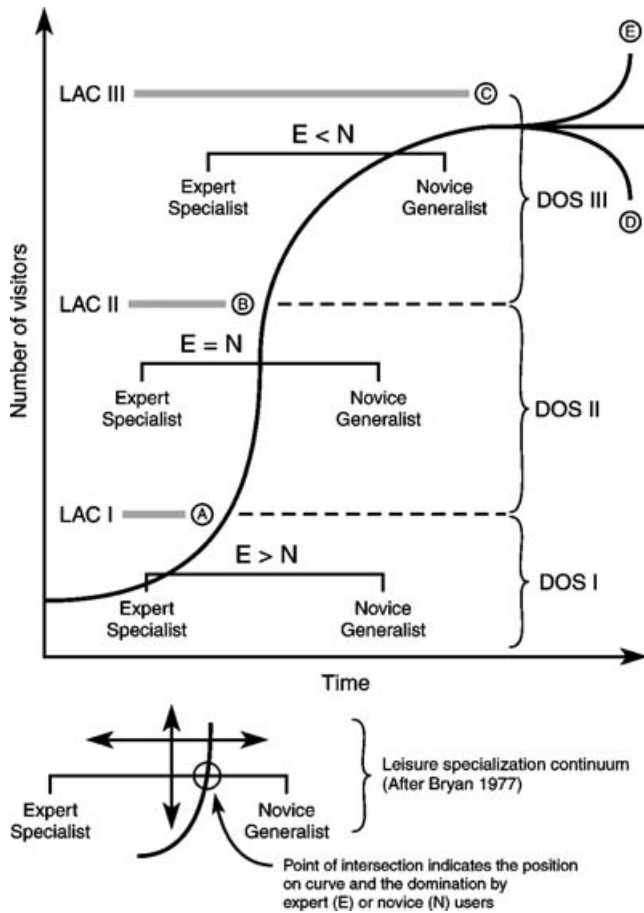


Figure 1 The relationship among user specialization, limits of acceptable change (LAC I–III) and stages in evolution of a wildlife tourism site (A to E) over time (after Duffus & Dearden 1990). DOS (I–III) is the diver opportunity spectrum used as a basis for matching dive site characteristics with specialization levels.

(Rouphael & Inglis 2001; Barker & Roberts 2004) and support for self-policing management actions (Todd *et al.* 2001). However specialization can provide important insights into the relationship between an activity and the environment it takes place in and, ultimately, the sustainability of the activity.

This relationship was outlined in a framework suggested by Duffus and Dearden (1990) and also used by other researchers (Warren & Taylor 1994; Higham 1998; Sorice *et al.* 2006) to understand the implications of the growth of wildlife tourism at a site over time. The framework (Fig. 1) shows the growth over time of visitation to a given location (Butler 1980), and its relationship to changes in specialization and limits of acceptable change (LAC). LAC is used to determine social and environmental indicators and standards in protected areas such as national parks, where both recreational and conservation goals must be fulfilled, and is a preferred alternative to carrying capacity approaches (McCool & Lime 2001). Developed and applied mainly in terrestrial environments (Stankey *et al.* 1985), LAC is now being applied more commonly to marine environments (Shafer & Inglis 2000). The Duffus and Dearden (1990) model suggests that

over time highly specialized participants in an activity (such as divers) will be displaced by less specialized participants. As this process takes place, different levels of LAC are reached and this has major implications for site conservation.

This paper reports on research undertaken to distinguish specialization levels among divers and link specialization to improving management effectiveness of diving on coral reefs. This is the first paper to construct a specialization index for divers, as opposed to simply using camera use, number of dives logged or self-reported measures of specialization, and examine the relationship between specialization and conservation of coral reef dive sites. Previous studies have concentrated on biophysical assessments to assess diver impacts and link impacts to numbers of divers (Dixon *et al.* 1993; Hawkins & Roberts 1997; Hawkins *et al.* 1999) and potential industry sustainability. These approaches concentrate on the numbers of divers and associated ecological LAC (Fig. 1). This paper addresses the question from a different dimension, specialization, and illustrates a different approach to assessing dive-site sustainability.

Phuket (Thailand) was selected as the study site because of the high quality and range of dive opportunities in the area and the value of the dive industry to the local and national economy. However, like similar expanding dive industries elsewhere (Musa 2002) sustainability is an ongoing concern (Bennett *et al.* 2003). In the early 1990s, it was possible to spend a week sailing among the islands and never encounter another tourist vessel (Piprell 1997). In the mid-1990s, a popular dive magazine rated some of the area's dive sites in the nearby Similan National Marine Park (Fig. 2) among the world's best (Strickland & Williams 2000). The dive industry expanded dramatically from two or three companies in the 1980s to more than 85 dive companies serving over 100 000 divers by the year 2000. Divers spend about three times more money per day than general tourists (Sritama 2004), and annual contributions to the local economy made by divers are estimated to be in excess of US\$ 150 million (Bennett *et al.* 2003).

METHODS

Survey methods

Fifteen of the 85 dive companies operating at the time (January–June 2000) were selected as being representative of the dive industry in Phuket based on factors such as the price, type and length of dive trip, the size and type of dive boat, the range of on-boat services, the dive locations visited, and any special dive-trip features. A major distinction is between one-day dive trips that focus on one or two dive sites and the multi-day 'live-aboard' trips that go further afield and visit a wide variety of dive sites. All companies approached agreed to participate and all divers on their boats that visited reef sites in the local waters surrounding Phuket, or dive sites in the Andaman Sea, including the Similan and Surin National Marine Parks were asked to complete surveys.



Figure 2 Main dive sites in the Phuket area.

Divers completed the pre-dive survey themselves while en route to the first dive site following an introduction to the survey by the dive master. The survey included questions to determine what attracted divers to Phuket for diving (motivations), the features that they valued in a scuba diving experience, their expectations for the trip and background information on their diving experience and the nature of their trip. Motives were derived from other studies (Davis & Tisdell 1995; Todd *et al.* 2002) and pilot studies conducted in Phuket. A post-dive survey was undertaken to assess satisfactions with the trip as the divers returned to Phuket. Both surveys consisted of a mixture of closed and open questions and were available in English, German and Japanese. Motivation and satisfaction assessment used a five point Likert scale to assess various dive features. The before and after surveys were matched for each respondent, and the results were compiled for analysis using SPSS. A total of 506 useable surveys were completed, however there is no reliable figure for response rate since inclement weather conditions towards the end of the season resulted in loss of some surveys and there was no way of telling how many surveys were distributed and how many got washed overboard.

Table 1 Classification of diver specialization indicators.

Diver specialization rating	Score assigned	
	0	1
Level of dive certification	Discover scuba and/or open water diver only (37.9%)	Advanced open water or higher (62.1%)
Time as certified diver	<3 years (19.9%)	≥3 years (80.1%)
Dives in past 2 years	≤5 (16.7%)	≥6 (83.3%)
Other dive locations visited	0 or 1 other countries (38.1%)	≥2 other countries (61.9%)
Dive gear owned	No dive gear, or only basic dive gear (snorkel, mask and fins) (25.9%)	More specialized gear (BCD, regulator, computer, UW camera or video) (74.1%)
Own coral or fish field guides	No coral field guide/book (76%) No fish field guide or book (61.6%)	Own a coral field guide/book (24%) Owns a fish field guide (38.4%)

Table 2 Distribution of diver specialization groups.

Diver specialization rating	Divers (%)	Number of divers
Low (0–3)	34.8	176
Medium (4–5)	34.6	175
High (6–7)	30.6	155
Total	100	506

Diver specialization index

A diver specialization index was designed based on responses to 12 questions on items that have been linked to the degree of specialization in other activities (see Bricker & Kerstetter 2000; Scott & Shafer 2001), as well as personal knowledge of diving. The questions fell into three categories:

- Past diving experience: the amount, variety and type of diving experience.
- Investment in diving: how much divers had invested in diving overall, both financially and in terms of time and effort.
- Centrality of diving to life: the role that diving plays in the lives of the divers overall.

Divers were grouped into subgroups based on their responses to the indicator questions using a binary scale (Table 1). If they satisfied the requirement for a particular indicator feature, they were given a score of one. If they did not, they were assigned a zero for that feature. A similar approach was used by Donnelly *et al.* (1986) in the creation of a specialization framework of boating-related activities. The individual scores were summed, and divers assigned to either the low, medium or highly specialized group (Table 2).

Table 3 Comparison of specialization with day and live aboard trips.

Level of dive specialization	Day trip		Live-aboard	
	%	n	%	n
Low	48.5	96	26	80
Medium	26.8	53	39.6	122
High	24.7	49	34.4	106
Total	100%	198	100%	308

Analysis of variance (ANOVA) tests were used to assess whether significant differences occurred among the diver specialization groups in terms of their pre-trip motivations for diving, and the importance attached to various features of the dive and dive trip. ANOVA was also used to test for significant differences among the dive specialization groups regarding overall satisfaction with their trip and satisfaction with the dive-trip features they had encountered while on the dive. Overall satisfaction was measured with three items: (1) a 10-point scale, with 1 being highly dissatisfied and 10 being highly satisfied; (2) a 5-point scale comparing the actual experience with expectations (much worse to much better); and (3) a 5-point scale comparing the actual experience with previous diving experiences (much worse to much better). Satisfaction with trip features were measured with a series of items where the response categories consisted of a 5-point scale, varying from very unsatisfied to very satisfied.

RESULTS

Diver specialization, trip type and dive trip features

Day and live-aboard trips varied in diver specialization ($\chi^2 = 26.984$, $df = 2$, $p = 0.000$; Table 3). Almost half of the day trip divers were in the low diver specialization category, compared to only slightly more than one-quarter of those surveyed on live-aboard trips. Considerably more divers were in the medium and high categories on live-aboard than on day dive trips.

Low, medium and highly specialized divers had different expectations for their dive trip, and placed different levels of importance on specific features. In many instances, a shift in motivational priorities was evident along the diver specialization continuum (Table 4).

Reasons for participating in diving

The flora and fauna expected at the dive site were significantly more important as the level of specialization increased, as was the opportunity for underwater photography and to see special underwater features (Table 4). Opportunities to expand knowledge, develop and challenge diving skills and experience social activities became less important with increased specialization. Less specialized divers were focused on the basic aspects of the sport, and placed importance on improving their knowledge and dive skills. Highly specialized

divers, however, were focused on more specific aspects of the sport, such as underwater photography (Table 4).

Reasons for diving in Phuket

Low specialization divers attributed significantly higher importance to the chance to dive in a unique setting. For more experienced divers, with more extensive diving experience around the world and more likely to have visited this area before, the setting was probably not unique. Nightlife and holiday experience motives for visiting Phuket diminished with higher specialization (Table 4).

Environment and setting features

Setting features that were more important with low specialization were good weather, warm water, good underwater visibility, easy dive conditions, good above water scenery and the opportunity to see turtles. On the other hand, good photo opportunities, the presence of whale sharks, other sharks and manta rays as important dive site attributes increased with specialization (Table 4). The features more important to highly specialized divers were aspects of the diving experience, whereas several factors identified as being more important to less specialized divers, were aspects of the dive trip experience, rather than the dive itself.

Service features

As the level of diver specialization increased, a good dive master, a good dive buddy, the information provided by the dive master and the additional activities on the boat became less important. Divers clearly became more focused on diving as specialization increased, and became less dependent on the guidance of dive staff and non-diving activities (Table 4). The commitment to the environment by the dive shop and crew was most important to less specialized divers and least important to the medium specialized divers (Table 4).

Diver specialization and satisfaction

There was an inverse relationship between the level of diver specialization and the three measures of overall satisfaction with the dive trip (Table 5). Less specialized divers rated their dive trip more highly than did medium and highly specialized divers. Less specialized divers also rated their dive trip higher than other divers in terms of satisfaction with the trip compared to their expectations, and compared to their other dive experiences. This pattern was evident also when comparing the responses of live-aboard and day trip subsamples. However, high specialists showed significantly higher satisfaction levels on live-aboard than day trips (Table 6).

Significant differences are evident among specialization groups in comparing how well the Phuket dive experience met the divers' motivations for participation (Table 7). For all items low specialization divers showed higher levels of satisfaction.

Table 4 Comparison of specialization levels and reasons for participating in diving and coming to Phuket (pre-dive survey). L–M = low to medium, M–H = medium to high, L–H = low to high. * = significant.

Dive trip features	Mean importance by specialization			F	df	p	Bonferroni comparisons		
	Low	Medium	High				L–M	M–H	L–H
<i>Motivation to dive</i>									
Marine flora and fauna	4.13	4.38	4.52	10.547	495	0.000	*		*
Underwater photography	2.36	2.69	2.99	8.248	489	0.000			*
Special underwater feature	2.62	3.02	2.97	5.032	485	0.007	*		*
Expand knowledge	4.05	3.80	3.76	4.254	494	0.015			*
Develop diving skills	4.18	3.62	3.30	28.671	496	0.000	*	*	*
Challenge diving skills	3.19	3.05	2.63	8.844	492	0.000		*	*
Social activity	3.10	2.96	2.76	3.777	490	0.024			*
<i>Motivation to dive in Phuket</i>									
Holiday	3.83	3.99	3.58	5.116	489	0.006	*	*	
Nightlife	1.77	1.93	1.64	3.104	492	0.046		*	
Enjoyed a previous visit	2.43	2.53	2.97	4.735	392	0.009			*
Unique environment	4.08	3.74	3.80	6.272	490	0.002	*		*
<i>Environmental features</i>									
Good weather	4.41	4.31	4.16	4.772	493	0.009			*
Warm water	4.31	4.08	4.13	4.028	493	0.018	*		
Good underwater visibility	4.61	4.46	4.43	3.854	495	0.022			*
Undamaged dive sites	4.73	4.60	4.69	3.263	495	0.027		*	
Easy dive conditions	3.73	3.30	2.91	27.598	494	0.000	*		*
Good above water scenery	3.73	3.48	3.46	4.178	494	0.016			*
Whale sharks	3.82	4.19	4.21	7.736	494	0.000	*		*
Other sharks	3.65	3.90	3.95	3.567	495	0.029			*
Manta rays	3.95	4.25	4.23	5.674	495	0.004	*		*
Turtles	4.05	3.84	3.76	4.418	494	0.013			*
Good photo opportunities	2.69	2.93	3.23	5.827	489	0.003			*
<i>Service features</i>									
Information by dive master	4.53	4.33	4.30	7.130	494	0.001	*		*
Good dive master	4.67	4.52	4.45	5.551	495	0.004			*
Good dive buddy	4.39	4.30	4.09	6.580	494	0.002		*	*
Environment commitment	4.52	4.24	4.45	6.186	495	0.002	*	*	
Additional activities	3.53	2.83	2.67	29.637	487	0.000	*		*

Table 5 Comparison of specialization levels by satisfaction measures. * = $p < 0.05$.

Satisfaction level	Mean satisfaction by specialization			F	df	p	Significant differences		
	Low	Medium	High				L–M	M–H	L–H
<i>Total sample</i>									
Overall satisfaction	8.36	7.81	7.70	6.587	394	0.002	*		*
Experience versus expectation	3.74	3.31	3.16	17.406	418	0.000	*		*
Experience versus other dives	3.61	3.40	3.12	9.670	406	0.000		*	*
<i>Live-aboard sub-sample</i>									
Overall satisfaction	8.81	8.23	8.13	15.895	223	0.003	*		*
Experience versus expectation	3.83	3.49	3.30	6.844	241	0.001	*		*
Experience versus other dives	3.80	3.59	3.21	8.269	232	0.000		*	*
<i>Day trip sub-sample</i>									
Overall satisfaction	8.03	7.02	7.02	6.599	170	0.002	*		*
Experience versus expectation	3.68	3.06	2.91	16.520	176	0.000	*		*
Experience versus other dives	3.51	3.02	2.96	6.596	173	0.002	*		*

Table 6 Comparison of satisfaction levels between live-aboard and day trips for high specialists.

Satisfaction level	Mean satisfaction by trip type		df	t	p
	Day	Overnight			
Overall satisfaction	7.02	8.13	113	3.562	0.001
Experience versus expectation	2.91	3.30	122	2.529	0.013
Experience versus other dives	2.96	3.21	123	1.786	0.002

Table 7 Comparison of specialization levels and satisfaction with dive trip features (post-trip survey). * = significant.

Dive trip features	Mean satisfaction by specialization			F	df	p	Bonferroni comparisons		
	Low	Medium	High				L-M	M-H	L-H
<i>Motivation to dive</i>									
Marine flora and fauna	4.39	4.10	3.98	7.415	419	0.001	*		*
Wilderness experience	4.15	3.84	3.77	6.782	416	0.001	*		*
Looking for adventure	3.71	3.42	3.35	8.211	415	0.000	*		*
Explore new environments	4.24	3.77	3.63	23.311	414	0.000	*		*
Expand knowledge	4.22	3.75	3.63	19.094	416	0.000	*		*
Develop diving skills	4.34	3.62	3.50	42.394	414	0.000	*		*
Challenge diving skills	3.91	3.43	3.33	17.999	412	0.000	*		*
To escape everyday life	4.22	4.09	3.93	3.643	420	0.801	*		*
Social activity	3.99	3.60	3.57	10.257	407	0.693	*		*
Exercise	3.70	3.55	3.40	4.165	415	0.012	*		*
<i>Environmental features</i>									
Good underwater visibility	3.82	3.49	3.56	4.401	420	0.013	*		*
Variety of marine life	4.23	4.10	3.77	8.421	419	0.000		*	*
Unpolluted dive sites	3.95	3.86	3.67	3.018	420	0.050			*
Undamaged dive sites	3.89	3.74	3.34	9.951	416	0.000		*	*
Easy dive conditions	3.97	3.86	3.69	3.770	419	0.024		*	*
Learn about marine environment	3.83	3.58	3.48	4.492	415	0.012			*
<i>Service features</i>									
Food on boat	4.40	4.28	4.52	3.477	421	0.032		*	
Information by dive master	4.72	4.49	4.60	4.767	421	0.009	*		
Good dive master	4.75	4.52	4.66	5.532	421	0.004		*	
General service quality	4.56	4.33	4.45	4.643	419	0.010	*		
Additional activities	3.85	3.50	3.61	5.150	390	0.006	*		

Satisfaction with trip features also varied among specialization groups (Table 7). Satisfaction with underwater visibility, variety and amount of marine life, clear unpolluted dive sites, undamaged dive sites, easy dive conditions, and opportunities to learn more about the marine environment decreased as specialization increased. More experienced divers found these features to be less satisfying than did divers with limited dive experience. With the exception of food provision, all service features were also rated more highly by less specialized divers (Table 7).

DISCUSSION

These findings have implications for the potential of diving to be an effective incentive-based conservation mechanism in Phuket. In the absence of management interventions, wildlife tourism attractions evolve over time to the overall detriment of the wildlife observed and the visitor experience (Duffus &

Dearden 1990; Higham 1998; Shafer & Inglis 2001) and the question is whether there is evidence of this progression for diving in Phuket. One indicator of this change is the higher dissatisfaction levels with the Phuket dive experience amongst more specialized participants.

The lower satisfaction of the specialists over time may result for several reasons (Duffus & Dearden 1990) and there is evidence for these in Phuket diving. One reason is that with increasing visitation there is likely to be greater environmental impact and a possible reduction in the range and quality of organisms to be seen. However research on the relationship between experience and likelihood of causing damage for diving is mixed. For example, no relationship was found between experience and the number of times that divers made contact with reefs (Rouphael & Inglis 2001). In contrast, divers with more training may have fewer impacts (Roberts & Harriott 1994), experienced divers may touch the reef less often (Townsend 2003)

and most damage may be associated with trainee divers (Zakai & Chadwick-Furman 2002). The specialist LAC for environmental impacts (Fig. 1, point A) may be exceeded with increased numbers of generalists. Specialized divers have a significantly higher motivational rating for fauna and flora than less specialized divers and are disproportionately affected by these impacts. These findings support the literature on other recreational activities that suggests that more specialized participants have more specific resource requirements (for example Bryan 1977; Williams *et al.* 1990; Graefe & Moore 1992). In contrast, many of the motivational factors rated most highly by the less specialized divers, such as development of diving skills, adventure, easy diving and above water scenery are service related and not affected by these changes.

Over time, site facilities and interpretation may be increasingly oriented towards the generalist rather than the specialist market (Duffus & Dearden 1990). A positive feedback loop is created between the type of visitor and the facilities provided. As facilities become increasingly oriented towards satisfying the novice/generalist market, they serve to make the site less attractive to specialists. Examples would be the level of interpretation provided or the facilities to undertake more advanced diving, such as provision of Nitrox facilities. The fact that low-specialist divers showed a significantly higher satisfaction for service aspects of the dive experience when compared with high-specialist divers provides support for this trend in Phuket.

Over time these factors may lead the market to become increasingly dominated by generalists at the expense of specialists. The model suggests that ultimately the impacts may become so severe that overall visitation starts to fall (Fig. 1, point D) as the LAC of not only the specialists, but also the generalists are exceeded and the industry goes into decline. The decline in the number of dive companies operating out of Phuket over the last six years provides circumstantial support for this hypothesis (Main & Dearden 2006). However, the decline could also result from factors unrelated to diving and may also not reflect the total numbers of divers.

In the initial phase of development, the companies are often run by specialists, people with an understanding of, and dedication to, the activity (Duffus & Dearden 1990). As the activity grows an increasing number of companies become involved for purely financial reasons, often leading to excess capacity. Fierce competition leads to cost cutting which may erode the high safety and service standards set by the original companies and lead to unwise practices, as in the development of ecotourism in Phuket (Kontogeorgopoulos 2004). This also appears to be the case in the dive industry.

Symptomatic of this competition was the sinking of the *Rhapsody* in April 2005. While at anchor at a dive site during the night, the vessel sank quickly in deep water far from land and had little functioning safety equipment. There had been no prior briefing on abandon ship procedures, the emergency locator did not work, there were no working flares

and the divers spent eight hours in the water before they were rescued.

The *Rhapsody* was the latest in a number of accidents. Installing and maintaining safety equipment is expensive. Dive companies are so intent on under-cutting each other's prices that they search for savings in all possible areas, including safety and provision of educational services. Economizing on safety is bad for the health of the customers; economizing on education is bad for the health of the reef (Medio *et al.* 1997).

Industry competition leading to adverse impacts also affects the environment. Low-budget operators lease low-cost boats in order to survive. Invariably such boats have no treatment systems for human waste or grey water. Oil leaking from old engines is discharged into the bilge and pumped overboard. The cumulative impacts of many boats using these practices on an ongoing basis is likely to degrade reefs (Harriott *et al.* 1997).

Industry response to excess capacity and increased competition can be two-fold. On the one hand the industry can concentrate on providing an increasingly low margin opportunity, catering to as many undiscerning generalists as possible. This is the default strategy and that largely followed in Thailand. The Asia-Pacific manager for PADI (Professional Association of Dive Instructors) was quoted as stating that, 'Diving fees in Thailand are still very much cheaper than in other countries. So divers prefer to come here' (Sritama 2004). Another company boasted that it had outlets in eight major shopping malls and was selling the open water diving certificate for Bt 5500 (US\$ 130), less than half of the minimum rate for certification generally available in the USA. This option seeks to maximize returns through maximizing numbers. The Duffus and Dearden model (1990) suggests that ultimately the social and environmental standards of even the least demanding divers will be exceeded and the industry will go into decline (Fig. 1, point D). The fact that the most discerning divers had the lowest levels of satisfaction suggests that this was happening in Phuket.

The other industry response to the market situation is to understand, and cater to, the specialist market. However within the context of diving, and most other wildlife tourism activities, new market development (Fig. 1, point E) is not increased numbers but rather the per unit value of each tourist. Destinations should be seeking to maximize this value rather than total numbers of tourists.

Concentration on the specialist market was the course taken by one of the main pioneer diving companies in Phuket which dropped day trips from its schedule in order to concentrate on live-aboard trips in the top price bracket for Phuket-based operators. Company advertising advised potential customers that trips were not for beginner divers. The boat had an extensive library and photographic support systems and a cruise director who was a well-known marine photographer. The company also kept extensive species records from dives and routinely assisted researchers through logistical and other forms of support (Theberge & Dearden 2006). A new boat

had the capability to take divers throughout South-east Asia when the monsoons made Phuket-based trips untenable. This extended the season during which a return could be made on investment, and reduced the dependence on the increasing limitations of the Phuket diving environment.

These two industry responses have differing needs and consequences for Phuket and the surrounding reefs and are often in conflict with each other. The first strategy, catering to ever-increasing numbers of novice divers, has benefited from the success of the tourism industry in Thailand in general and Phuket in particular, at least prior to the tsunami of December 2004 (Main & Dearden 2006). Within this mass tourism there are many individuals who may wish to try something different on their vacation, be it an ecotourism experience, or to try diving. Ecotourism in Phuket has benefited from this mass market (Kontogeorgopoulos 2004) and the same is also true for diving.

The limitations of this strategy over time have been described, but there is also an important spatial dimension. Over the last few years dive companies have been able to access some of the well known dive sites offshore, and particularly on the Similan Islands (Fig. 2), that were previously only available for live-aboard trips, through two means. The first is the availability of faster vessels based in Phuket that can access the Islands and return in one day (about a 200-km round trip). The second is the explosion of dive outlets, often branch plants of Phuket-based dive companies, in locations closer to the Similans than Phuket, particularly in Khao Lak (Fig. 2). Novice divers are now able to dive at the Similans on day trips without investing the time and money that was previously required to join live-aboard trips. This development has raised several management challenges. At Mu Koh Similan National Marine Park visitation has grown enormously and the growth has led to diver crowding and environmental impacts of diving (Dearden *et al.* 2003; Fein 2004).

Novice divers are clearly motivated and satisfied by aspects of diving that can be met virtually anywhere, while specialist divers have specific requirements particularly regarding viewing marine life and opportunities for photography. The last two characteristics are likely to suffer as the Similans are visited by increasing numbers of novices. The conflict in requirements between specialists and novice divers results in a lowering of the satisfaction levels of the specialists who will seek diving opportunities elsewhere more in keeping with their motivations. This will result in a reduction in the range of diving opportunities offered in Thailand. The higher spending more specialized live-aboard divers will spend their money elsewhere.

Management needs to ensure that a complete range of opportunity settings for diving remains around Phuket. This can be thought of as each LAC level representing a different setting on the Recreation Opportunity Spectrum (ROS) model (Fig. 1; Clark & Stankey 1979). As Shafer & Inglis (2000, p. 82) pointed out for the Great Barrier Reef: 'the challenge for managers [...] is to find ways to ensure that the range of current opportunities is protected and that measures

are taken to monitor the quality of experiences provided for each type of opportunity'. A dive opportunity spectrum (DOS) can be envisaged to represent these opportunities. DOS I (Fig. 1) would be dive sites zoned to protect the best diving experiences available in the area, characterized by the most attractive reefs and the lowest density of divers. Management interventions would be strict to monitor and maintain these conditions. The offshore MPAs, such as the Similans would fit into this category. DOS II sites would be less pristine with higher diver densities and less restrictive management. Many of the inshore MPAs would fit into this category. DOS III would be sites with minimal management intervention. These sites would be the most accessible and frequently used for training.

RECOMMENDATIONS AND CONCLUSIONS

This study has shown that divers are not homogenous in terms of their motivations, satisfactions and characteristics. Specialized divers tend to have more specific resource requirements. Their satisfactions with diving in Phuket are significantly lower than those of less-specialized divers. Although they are more likely to be on a repeat visit than less specialized divers, they are less likely to return in future. Over time more generalist divers will likely dominate. A positive feedback loop is created as dive companies increasingly cater to generalist divers and fail to satisfy more specialized divers. Over time this leads to lower economic returns and higher environmental impacts per diver.

This paper argues that it is in the best interest of the dive industry in most heavily-visited tropical dive destinations to maintain a diverse range of diving opportunities (Fig. 1, DOS I–III) through explicit management to maintain the specialist market. This will be advantageous for several reasons. First, the specialized market is a higher yielding market (Bennett 2002); specialized divers stay for longer and spend more, and it makes good economic sense to target this market. Second, it is this market that sets the reputation and standards for diving. There are few novice divers that will write magazine articles, make films or tell other members of their dive club about their experience. If a destination loses its more specialized markets, its reputation as a dive centre will be in jeopardy. Third, more specialized divers generally have less impact on the environment than novice divers, and the reefs will be maintained in better condition.

For many tropical sites, it should be possible to cater to a range of divers if appropriate management interventions are applied. First, access to dive sites should be controlled such that certain sites are maintained with the lower impacts and higher levels of marine wildlife demanded by more specialist divers. The Similan Islands (Phuket) are the greatest attraction for divers and if the Similans are to maintain their reputation as a world-class dive site then there is an urgent need to limit impacts. The most appropriate way of doing this initially in the Similan Islands is to forbid access for day trip boats because these are dominated by novice divers whose needs can be met

elsewhere and who tend to do most damage to the reef; this will help protect the reef from that damage. It is poor resource allocation to allow the users with the lowest requirements to consume the resource with the highest quality. Zakai and Chadwick-Furman (2002) report exceptionally high rates of damage to coral at dive sites used mainly for training, and suggest that training be confined to resilient sites with sandy substrates rather than reefs (i.e. Fig. 1, DOS III).

Second, concern with setting numbers of divers that a given site can sustain (Harriott *et al.* 1997; Hawkins *et al.* 1999; Schleyer & Tomalin 2000) should be transcended to a form of management that recognizes the provision of different settings (DOS) and LAC for those settings. Third, management interventions should be implemented to ensure that standards are not violated. There are many innovative ways of doing this, including spatial and temporal zoning of reefs and pricing mechanisms to encourage compliance (Davis & Tisdell 1996; Tratalos & Austin 2001). Requiring boats wishing to access the more pristine reefs to pay more or even bid for the limited number of licences available to dive a particular reef, would serve to limit numbers and impacts, given appropriate pricing, and also generate income that can be used to support monitoring programmes. Fourth, safety standards need to be enforced to meet international requirements. If dive boat owners are not willing to voluntarily bring their boats up to standard then the government should refuse to let non-complying boats leave port. Enforcement of these regulations would also help to reduce the pressure on special sites. Lastly, the same kinds of regulations and management interventions as suggested above should be used to reduce waste discharge from the dive boats, which are likely to adversely impact the coral reef.

Diving has tremendous potential to aid reef conservation by providing a direct monetary incentive to protect species and their habitat, but in the absence of effective management interventions, diving can be destructive to reefs (Dixon *et al.* 1993). The research reported here suggests that monitoring the specialization levels and satisfaction levels amongst divers can serve as an early warning system for management interventions and also help address the lack of equipment and detailed knowledge required for biological monitoring (Marion & Rogers 1994). Understanding the social science dimensions of the dive experience will ultimately lead to a more successful and sustainable dive industry and a more effective exponent of incentive-driven conservation at work.

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