

Costs and Effectiveness of Education and Enforcement, Cairns Section of the Great Barrier Reef Marine Park

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ABSTRACT / Education, not enforcement, is the preferred management tool to gain acceptance for management prescriptions in marine protected areas. The cost and effectiveness of education and enforcement programs is difficult to estimate. In the management of the Cairns Section of the Great Barrier Reef Marine Park from 1985 to 1991, the cost and effectiveness of the two programs were evaluated using an awareness survey and an analysis of annual reports.

Both programs were effective in meeting program objectives. Education costs per person were approximately a tenth the cost of enforcement; however, the total cost for education programs was twice that of enforcement programs. Education and enforcement programs interact together with other management activities, and neither program can totally replace the other. Some users will willingly comply with management measures, other users will comply in response to education, but there will be another group who will only respond to enforcement activities. There will also be users who persistently disregard park rules and regulations and will continue to present a problem to managers. For these individuals, education in association with enforcement actions are necessary.

Public acceptance and support of marine protected areas is just as essential as user compliance with rules and regulations for effective management. The most common approach to gain user compliance is through enforcement programs that include surveillance activities. Users readily see enforcement programs as necessary for the protection of specific areas and personal safety, and therefore these programs are supported by management. Management also supports surveillance and enforcement activities because they have a high profile within the community, and their impacts are immediate and easily measured.

One alternative is to develop public awareness through education (Wood 1989; Lemay and Hale 1989). In the area of visitor management, the education approach is favored by managers of protected areas (Olson and others 1984; Alcock 1991). It has the potential to increase visitor experiences, reduce social conflicts and resource impacts, gain support for management practices, and reduce management costs (Roggenbuck and Ham 1987). Education can also promote public participation in management (Lemay and Hale 1989). The benefits of education programs are often only realized

long after the program is implemented. Resource managers are therefore reluctant to assign adequate funding for education programs since it is difficult to measure the benefits of such programs.

The effectiveness of education programs is evaluated in a number of ways, including manager assessment and systematic appraisal (Roggenbuck and Ham 1987). Manager assessment is subjective, while systematic appraisal provides an empirical value. One approach to systematic evaluation of education programs is through periodic surveys that examine changes in responses to a variety of cognitive, behavioral, and attitudinal variables over time. This approach was used to evaluate the public education program in the management of the Cairns Section of the Great Barrier Reef Marine Park (Alder 1994). Using this approach, the cost and effectiveness of education and enforcement were studied.

Background

The Great Barrier Reef Marine Park (GBRMP), situated off the northeast coast of Australia, is the world's largest system of coral reefs (Figure 1). The GBRMP was established in 1975 under the Great Barrier Reef Marine Park Act. The park is one of the largest in the world, encompasses 348,000 square kilometers and supports nearly 3000 coral reefs, 700 islands and cays, over 1500 species of fish, more than 4000 species of mollusks, and 240 species of birds. The park also contains several

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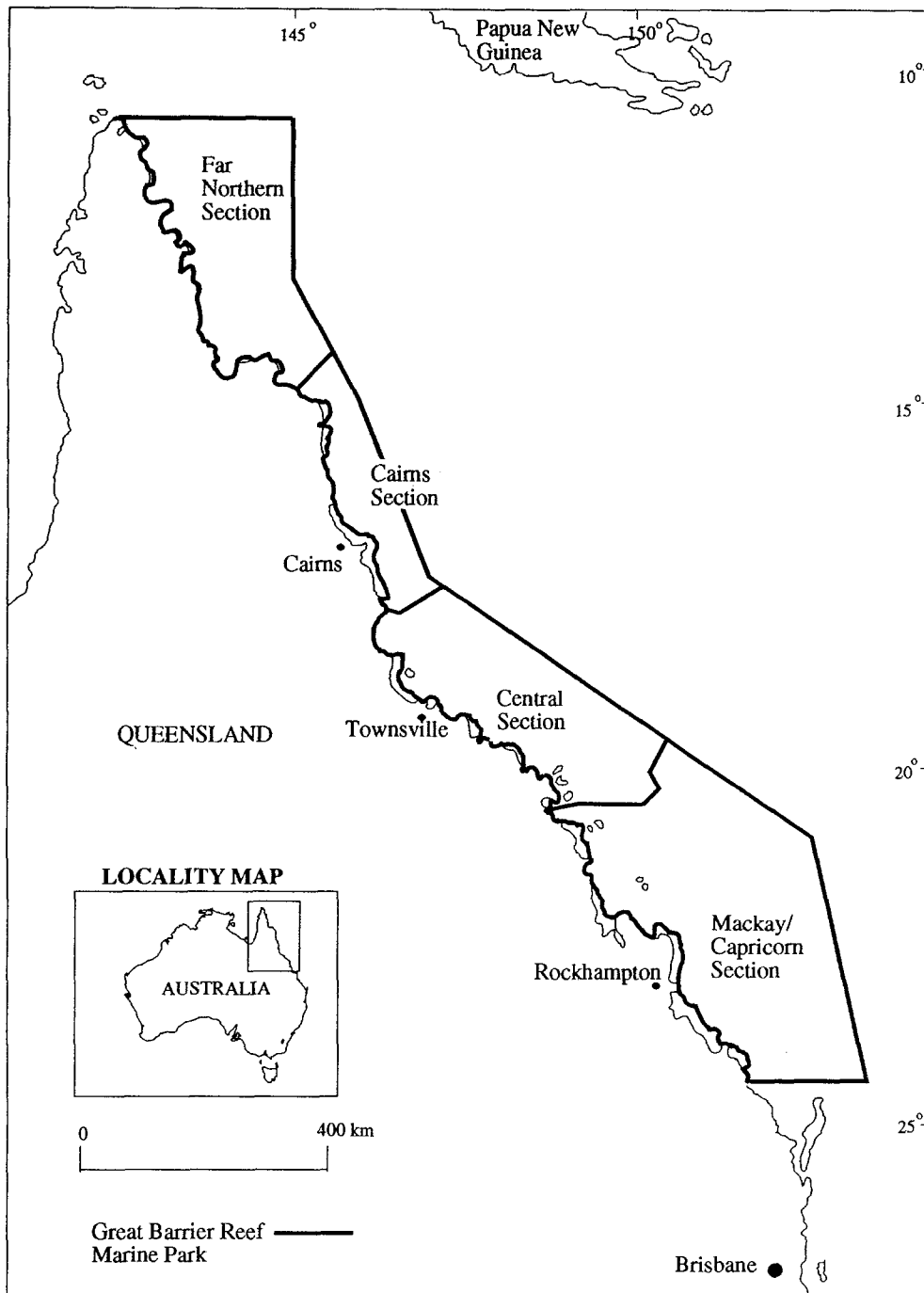


Figure 1. Great Barrier Reef Marine Park.

species of threatened animals—turtles (six species), whales, dugong, and birds. The GBRMP falls within IUCN category VI classification (Managed Resource Protected Area) and is inscribed on the World Heritage Listing. It is a multiple-use park where a range of activities are allowed (with or without permission). Activities can range from commercial prawn trawling, which dis-

turbs the seabed, to nonmanipulative research in areas where public access is prohibited.

The park is divided into five sections, and as specified in the GBRMP Act, a zoning plan forms the basis for managing each section along with the act and associated regulations. The zoning plan for the Cairns Section came into effect in 1983, but it was not until 1985 that

staff were appointed and on-the-water management commenced. Overall management of the park is the responsibility of the Great Barrier Reef Marine Park Authority (GBRMPA). Day-to-day management is the responsibility of Environment and Heritage (DEH), formerly Queensland National Parks and Wildlife Service (QNPWS). For the purposes of this study, the combined efforts of the two organizations is simply termed management.

The Cairns Section is 35,000 square kilometers and located in the northern half of the park adjacent to Cairns, a major regional centre for tourism, fishing, and cane farming (Figure 1). The major activities in this section of the park are tourism, commercial fishing including trawling, and recreational boating and fishing. Clearly a range of tools—education, enforcement, planning, research, and monitoring—are required to meet the multiple-use management objectives of such a vast area and highly diverse group of stakeholders. When management commenced, education and enforcement were recognized as important tools in meeting several management objectives, especially increasing the awareness of the park's existence and values, improving zoning compliance, and gaining community support for management activities.

Problem Statement

When management of the Cairns Section commenced in 1985, managers were well aware of the range of tools, including education and enforcement, at their disposal to manage this area of the GBRMP. Two of the many questions the managers needed to address in this early stage of management included education and enforcement. The first was how to best allocate resources to meet management objectives among the various tools used, especially education and enforcement programs, which can consume substantial resources. The second was what methods can be used to measure the effectiveness of these two programs.

Managers could not find any empirical studies to measure the effectiveness of the proposed education and enforcement programs in changing awareness, attitudes, and behaviors in the community.

In response to these questions and a lack of standard methodology, managers, in consultation with social science specialists, decided that:

- A baseline survey of Cairns residents would be undertaken to determine the levels of awareness of the park, and attitudes towards various aspects of management of the area;

- follow-up surveys would be undertaken to measure changes in awareness and attitudes; and
- the number of nature of breeches of the zoning plan, the Act and regulations (infringements) would be monitored.

Objectives

The objectives of this study were:

- to assess the costs of education and enforcement in meeting specific management objectives related to awareness, attitudes, behavior, support for management, and participation in planning;
- to evaluate the effectiveness of education programs in raising community awareness of the park, changing attitudes, increasing support for management and participation in management; and
- to investigate the interaction of education and enforcement on influencing behavior changes relating to compliance with park rules.

Previous Studies

Evaluation is seldom carried out formally in conservation education programs in the United States or elsewhere. Similarly, studies in marine protected areas to investigate the costs and effectiveness of various tools, such as education and enforcement, are very limited. The cost of recreational fisheries enforcement has been studied in Australia, and it was found that for 2% of the cost of enforcement, an effective education program can be implemented (Bergin 1993). Others note that education costs less money and effort than enforcement (Alcock 1991).

Few studies could be found that focused on the effectiveness of enforcement programs or strategies. Christensen (1987) and Christensen and Davis (1984) examined enforcement and its influence on vandalism and depreciative behavior, but did not measure its effectiveness. Recent studies on the effectiveness of educational programs, however, can be found. The study of Olson and other (1984) of the effectiveness of a visitor education strategies noted that empirical studies were lacking in the assesment of effectiveness of interpretation on knowledge and attitudes levels. Their approach to testing the effectiveness of the visitor education strategy was based on a survey of visitors to a nature preserve. Other studies have also taken a survey-based approach to measuring effectiveness. Educational strategies for reversing population declines in seabirds in Quebec,

Table 1. Summary of education programs and responses (%) where a program or medium was noted by informed respondents^a

Public education program or medium (1985–1991)	Duration	Audience	% responses (N = 85)
Display at boat show	yearly	Cairns	6
Display at coast guard office	1987–1988	Cairns	4
Display—local show	yearly	Cairns	0
Displays—other	opportunistic	Cairns	8
Sighted “user activity guides”	ongoing	Reef-wide	16
DEH office information	ongoing	Cairns	5
School (postsecondary) talks	opportunistic	Cairns	6
Talks to local organisations	opportunistic	Cairns	5
Newspaper articles—general	opportunistic	Cairns	5
Television documentary	opportunistic	Cairns	2
Television advertising	daily Jan–Mar 1991	Reef-wide	16
Radio—general	opportunistic	Cairns	0
Radio advertising	daily since July 1991	Reef-wide	0
<i>Reflections</i> newsletter	quarterly	Reef-wide	0
Posters	ongoing	Reef-wide	0
Tide tables	1988	Cairns	0
Boat ramp sign	ongoing since 1988	Cairns	1
Tourist operator course	yearly since 1987	Cairns	0
Local knowledge/word-of-mouth	ongoing	Reef-wide	21

^aAlder (1994).

Canada, were also assessed using a survey of stakeholders (Blanchard and Monroe 1990). Studies that focused on the GBRMP are limited to a survey of changes in community awareness after a public participation program for the Mackay/Capricorn Section and a park-wide media awareness survey.

Methods

Education Programs

From 1985 to 1991 the QNPWS and the GBRMPA conducted a variety of education and public contact programs (Table 1). Programs targeted the community as well as specific users within the section and parkwide. The common theme of all programs was to inform the audience of the park's existence, values, issues, and management. Programs designed for a specific type of user would include additional messages that focused on changing attitudes and behavior. For example, television advertisements were used to try to motivate recreational fishers to reduce their daily catches. The number of people who were directly contacted by a DEH staff member (direct contacts) were recorded. Managers expected that these programs would contribute to improving support for management and changing community attitudes.

Enforcement Programs

Between 1985 and 1991, the enforcement program consisted of air surveillance and vessel patrols. Air surveillance was designed on an annual basis to survey particular areas of the section at certain frequencies based on a stratified random sampling scheme. Vessel patrols were also designed to cover specific areas at a certain frequency, but weather and staffing constraints limited the statistical basis for the patrols. In either program, breeches of the act, regulations, or section zoning plan were recorded, and these records were used to examine changes over the six years of the study. The numbers of infringements were correlated with the resources spent on an annual basis using Spearman's correlation coefficient.

Public Participation

A two-phase public participation program was used to provide a forum for the community to have a say on the formulation of the original Cairns Section Zoning plan (in 1982) and a second zoning plan (in 1989). In both planning projects, extensive publicity campaigns were used to encourage residents to write down and forward their concerns about management and their desires for the future management of the section. These written comments, commonly termed submissions, were

recorded and analyzed and were used to examine changes in public participation over the study period.

MPA Surveys

In August and September 1985, a survey of 348 Cairns residents (0.6% of the population) was conducted to gather information on their awareness of and attitudes towards management of the marine park. This coincided with the start of management of the section. A simple random design was used to administer a face-to-face questionnaire to Cairns residents. Cairns residents were defined as people registered on the electoral roll and living within the City of Cairns or the Shire of Mulgrave, which is commonly termed Cairns.

The 1985 questionnaire was divided into three parts. The first examined the profile of residents; levels of use, spatial distribution, activities, age, and sex. The second section investigated respondents awareness of the marine park, their ability to identify the park, their knowledge of zoning, their perceptions of who managed the park, and the most effective method for informing residents. The last section examined the attitudes of respondents to various aspects of park management: general attitudes and attitudes towards encouraging or restricting various activities.

Similar to the 1985 survey, a face-to-face survey of 454 Cairns residents (0.6% of the population) was conducted in October and November 1991. The questionnaire was also administered by trained personnel to randomly selected Cairns residents. When the 1985 survey was analyzed, improvements in the survey were noted. In addition, the nature of tourism and recreation changed over the six years of management of the section. Therefore some questions used in the 1985 survey were modified or deleted and new questions were added.

The first three sections of the 1991 survey were similar to those used in 1985, but with minor changes. In light of six years of management, the 1985 questions that sought community opinion of the need to manage the park was modified to obtain more appropriate information on two specific aspects of management. One question examined the importance of management, and the other investigated community perceptions of management effectiveness. A fourth section was added that examined respondents' perceptions and concerns towards environmental, social, and economic aspects of the park. For both surveys the term "management" was defined as some form of control on park user activities.

A total awareness score (TAS) was developed for both surveys. This provided an overall assessment of respondent's awareness of the marine park. The score was

calculated from seven questions in both surveys concerning park management concepts, which are described in Alder (1994). Each correctly answered questions increased the respondent's TAS by one, a wrong answer was valued at zero. Therefore, the highest score was seven and the lowest zero.

Changes in percentages between 1985 and 1991 variables were tested by computing the normal deviate (z). The Shapiro-Wilk test of normality was used to test the distribution of variable and Spearman's rho for correlations.

Costs

Estimates of staff time and money spent on public education, and enforcement for the same financial years covered in the marine park awareness survey were taken from management annual reports. Costs were adjusted for inflation since 1985 so that changes in costs since 1985 could be accurately measured. Staff time is the percentage of time spent on public education, or on enforcement, of the total available staff time.

The money spent for education is the corresponding percentage of salaries and associated costs plus all project requisite costs. Money spent on enforcement is the percentage of salaries and associated costs plus 50% of vessel running costs, and in addition, air surveillance costs as detailed in annual reports. Total vessel running costs were prorated since vessels are also used for other functions, such as resource assessment and monitoring. For example, if staff spent 20% of their time on enforcement, salary costs were AUD\$100,000, vessel running costs were AUD\$100,000, and air surveillance costs were AUD\$100,000, then the total enforcement costs for the financial year were:

$$0.2 * 100,000 + 0.5 * 100,000 + 100,000 \\ = \text{AUD}\$170,000.$$

The total annual cost of GBRMPA education programs including salaries were taken from annual reports (Table 2). The GBRMPA contributes approximately AUD \$400,000 annually to Coastwatch, a federal air surveillance program. The distribution of resources for these two programs to the management of the Cairns Section is not detailed in annual reports. It was assumed, based on the proportion of Coastwatch flights in the section, that a third of these annual costs contributed to the management of the Cairns Section. The determination of costs are based on assumptions that have not been tested. Consequently they provide indications of differences between program costs.

Table 2. Time and funds^a spent on education and enforcement programs (1985–1986 to 1990–1991)

Financial year	Education program				Surveillance and enforcement program			
	Staff time (%) ^b	Money spent (AUD\$)	Direct contacts	Cost (US \$) per contact	Staff time ^b (%)	Money spent (AUD\$)	Infringements detected	Cost (AUD\$) per infringement
1985–1986	10	333,302	994	335	19	346,550	113	3066
1986–1987	17	391,327	842	468	11	330,177	108	3057
1987–1988	13	476,631	847	563	15	364,543	87	4190
1988–1989	12	497,102	692	718	13	347,000	51	6804
1989–1990	12	564,690	3145	179	11	307,508	61	5042
1990–1991	15	603,335	1023	591	15	391,189	57	6863

^aTotal DEH and GBRMPA expenditure adjusted to 1985 prices based on CPI index data from the Australian Bureau of Statistics (ABS 1994)

^bDay-to-day management staff time only.

^cIncludes GBRMPA's proportional contribution to Coastwatch.

Benefits

The benefits of the two programs were examined by measuring changes in:

- detected infringement (especially those associated with zoning compliance);
- community awareness of the park and management;
- community attitudes towards specific aspects of management;
- support for management practices; and
- public participation in the formulation and review of zoning plans.

Results

Education Programs

The number of people contacted personally by a DEH staff member (direct contact) varied throughout the study depending on the programs undertaken in a particular financial year. In 1989–1990 there was a significant increase in the number of direct contacts made due to a number of public meetings and training programs held that year.

The 1991 survey asked informed respondents to specify how they obtained their knowledge of the park to determine which education programs were more effective than others. Local knowledge or word of mouth were the most frequently mentioned sources, followed by television campaigns and user activity guides (Table 1). Other sources were indicated, but less frequently.

Enforcement

Total infringements declined steadily until 1988–1989 and then remained constant (Table 2). This pattern was also evident for infringements related to zoning

compliance (Table 3). The number of infringements related to zoning compliance declined from 74 in the 1985–1986 financial year to 18 in 1988–1989 and remained at this level. Other types of infringements, however, were variable over the same time. The total number of infringements detected and zoning plan infringements were not significantly correlated ($P > 0.05$) to the amount of staff time or funds spent annually on enforcement.

Public Participation

During the formulation of the first zoning plan for the Cairns Section of the GBR in 1982, 199 submissions were received. Zoning was the most noted issue (36% of the submissions), followed by recreational fishing (25%). In the second zoning process in 1989, 278 submissions were received. This represents an increase of 30%, while the population change over the same period was less (26%). Zoning was again the most noted issue, but it was only mentioned in 17% of all submissions. Other issues such as recreational fishing (14%), day-to-day management (12%), and diving (12%) were marginally less significant ($P > 0.05$) than zoning.

MPA Surveys

Public use of the reef did not change significantly ($P > 0.05$) over the study. Sixty percent and 61% of respondents went to the reef at least once per year in 1985 and 1991, respectively. Awareness of the park's existence and total awareness, however, increased significantly ($P < 0.05$) between 1985 and 1991 (Table 4). Awareness of zoning concepts also increased, while knowledge of zoning details declined; however, neither change was significant.

The most effective medium for conveying information to the community changed between 1985 and 1991.

Table 3. Number and type of infringement detected (1985–1986 to 1990–1991)

Financial year	Entry of wrong zone	Collecting in wrong zone	Tourism	Discharging	Miscellaneous
1985–1986	74	9	2	15	13
1986–1987	52	12	5	8	27
1897–1988	39	10	3	12	23
1988–1989	18	5	10	7	11
1989–1990	24	1	2	27	6
1990–1991	23	2	1	21	10

Table 4. Responses (%) in awareness, attitudes and support for management for 1985 and 1991 surveys

Variable	1985		1991		z	P
	%	N	%	N		
Awareness						
Identified the park on a map (informed respondent)	10.0	348	45.0	454	10.9	<0.01
Knew zoning concept (for informed respondents)	64.7	34	70.4	201	0.5	>0.05
Zoning details	45.5	22	18.6	24	1.8	<0.08
Total awareness score (>3) ^a	26.4	348	31.5	454	1.3	>0.05
Attitudes ^b						
Restricting						
Commercial fishing	89.3	347	82.5	451	0.5	>0.05
Recreational fishing	52.7	347	57.5	452	0.6	>0.05
Spearfishing	80.1	347	72.3	451	0.7	>0.05
Resort developments	80.1	346	89.4	451	1.0	>0.05
Shell collecting	84.1	347	79.0	451	1.7	>0.05
Encouraging						
Fishing competitions	57.3	347	54.1	451	0.3	>0.05
Island camping	54.6	346	60.6	454	0.5	>0.05
Floating hotels	37.7	347	12.0.6	451	2.67	<0.05
Support for management						
GBRMP should be managed ^b	96.0	347				
Managing the reef ^c			91.3	451		
Effectiveness of management ^d			30.4	424		

^aSee Alder (1994).

^bAgreed to agreed strongly.

^cImportant to very important.

^dEffective to very effective.

In 1985, most respondents (41%) who had some knowledge of the park were informed through non public media such as club meetings, newsletters, or word of mouth. In the 1991 survey, most informed respondents (69%) indicated television as the medium for gaining park information. In 1985, respondents indicated a single medium, in 1991 respondents were allowed to give multiple answers. Consequently, statistical comparisons between the two surveys are not possible.

The survey indicated that support for restricting specific issues remained high between 1985 and 1991 (Table 4). Agreement with restricting recreational fishing

and resort development increased but not significantly ($P < 0.05$). Respondent's agreement with encouraging floating hotels declined significantly ($z = 2.67$ $P < 0.05$) from 38.7% in 1985 to 12.0% in 1991. Agreement with encouraging fishing competitions and island camping and restricting shell collecting changed over the six years; however, these changes were not statistically significant.

In 1985, 96% of respondents "agreed" to "agreed strongly" that the park should be managed. In 1991, most respondents (91%) considered management to be "important" to "very important," but most respondents

(46%) were undecided on management effectiveness. Only 30% of respondents thought management was "effective" to "very effective." Although these variables are not statistically comparable, it is clear that the community maintained a high level of support for the overall management of the park.

Costs

Annual staff time spent on education and surveillance and enforcement activities ranged from 10% to 19% of total staff time between 1985 and 1991 (Table 2). Over the same time, total funds spent (adjusted for inflation) on educational programs increased annually from AUD\$333,302 to AUD\$603,335. Funds for surveillance and enforcement, however, varied annually and averaged AUD\$347,828 over the six years. The number of direct contacts made through education programs varied considerably each year and consequently the cost per direct contact also varies substantially (AUD\$179 in 1989–1990 to AUD\$718 in 1988–1989). Similarly, costs per infringement detected fluctuated between AUD\$3,057 and AUD\$6,863 over the six years of the study.

Discussion

Education and enforcement programs are expensive. During this study, the two programs used 23%–30% of the staff time and 30%–45% of DEH funding. In this study, total education costs continually increased and exceeded enforcement costs after the first year of management. Enforcement costs, however, remained relatively stable. It is difficult to find a common measure for these two costs. The cost of a direct contact through education or enforcement activities (detected infringement) is a possible measure, but it assumes that in either case management messages are conveyed to the community utilizing various media. If this measure is used, then the cost of education is substantially lower than enforcement. Over the six years of the study, the average cost of an educational contact was one tenth of the cost of detecting an infringement and varied between one third and one twentieth of the cost of detecting an infringement.

The cost per infringement may be misleading since it ignores the cost of providing a "threat of prosecution." The study did not focus on users' motivations for compliance with park rules and regulations. Other aspects of this study, however, suggest that the threat of prosecution was not a major cost. Early in the management of the park, executive officers and managers made a conscious decision to focus on education programs to achieve user compliance. Education programs avoided the "big brother is watching you approach" and did not

introduce the threat of prosecution to motivate users to comply with the rules and regulations. Consequently, the threat of prosecution was assumed to be a minor cost in this study.

This leads to the question "What are the benefits to management from spending these resources?" The potential benefits of education to management of the park include improved awareness of the park and its management, changes in attitudes and behaviors towards specific aspects of management, support for management, and increased participation in management. Enforcement, in addition to detecting changes in behavior, can also influence user behaviors through the threat of prosecution but does little to improve awareness and change attitudes.

In managing the park, the impacts of education and enforcement are not mutually exclusive. Some people naturally want to comply with the rules and will seek the necessary information, and others may not seek information but when information is provided on the justification for the rules and they agree with the rationale, they will comply. It is difficult in any study of education and enforcement to discriminate between their impacts or to control this interaction. The study attempted to do this by detailing how knowledgeable respondents were informed about the park.

Education programs between 1985 and 1991 contributed to meeting a number of management objectives: increasing awareness, altering attitudes, influencing user behavior especially regarding zoning compliance, and maintaining support for management.

Community awareness about the park and its management increased over the study. This increase in awareness can be attributed in part to education programs. In 1985, prior to the commencement of management, knowledgeable respondents (41%) indicated that informal sources such as club newsletters, word of mouth, and local knowledge were their main sources of information. After six years of education programs, this source of information changed to television. Survey respondents (58%) indicated that television was their prime source of park information, followed by newspapers and radio. Over the six-year study a number of television advertisements and promotion spots were broadcast to all communities adjacent to the park. These advertisements were frequently cited by informed respondents as a source of their knowledge of the park. The results between the two surveys are not statistically comparable; nevertheless, television was proved to be one of the best media to deliver messages to the Cairns community.

Attitudes were also influenced by education programs delivered to the Cairns community over the study

period. Prior to the start of management in 1985, respondents supported restrictions on commercial fishing, spearfishing, and shell collecting. In 1991, the survey found similar levels of support for restricting these activities. Although not statistically significant, there was an increase from 53% to 58% of respondents supporting restrictions on recreational fishing. Continued support for restricting extractive activities is possibly due to education programs and media campaigns from a range of conservation agencies. The most notable programs and campaigns in this survey, however, were park management initiatives. Park managers were primarily responsible for conveying messages to reduce fish catches and to encourage the wise use of all reef resources over the period of the study.

The survey also noted support for restricting resort development including floating hotels. Several contentious marine developments adjacent to the park and a rapid increase in tourism received extensive publicity during the study. It is possible that this exposure may have raised local residents' awareness of the potential impacts of such developments and influenced their attitudes towards restricting resort development. In addition, education programs did not focus on controlling resort development in the Cairns area.

The cost of achieving these changes in awareness and attitudes was AUD\$2.9 million over six years. The costs presented in this study were only for direct contacts, yet education programs that use mass media indirectly reach a greater audience, as the surveys have indicated. The AUD\$2.9 million spent on education programs has likely had a major impact on changing awareness and attitudes in the Cairns community and has therefore been effective in helping to meet management objectives. The question managers must resolve is whether or not they are willing to maintain this level of funding to continue influencing awareness, attitudes, and support for management; if not, will the impact of previous programs diminish?

Infringements appeared to decline over the first three years of management and then remain constant. This suggests that the initial efforts of education and enforcement were effective, but diminished later. There are three possibilities for this diminished impact: messages no longer had an impact, messages did not reach a particular group of users, or the remaining users of the park blatantly disregarded park rules and regulations. For the latter groups, education alone may not be effective.

The nature and frequency of infringements detected also changed over the study (Table 3). The number of infringements related to zoning compliance declined from 74 in the first year of management to 18 in the third

year, and remained at this level. Discharging breeches, however, remained variable over the six years. Approximately 85% of these discharges are from commercial vessels (foreign and domestic) with staff who are only exposed to general education programs or have no exposure at all if they are on a foreign vessel. These users are not exposed to user-specific education programs such as those targeted on recreational fishers.

The decline in zoning-related infringement could be due to the threat of prosecution, which includes surveillance activities, or less resources spent on surveillance or education programs. The threat of prosecution was not considered the single factor in zoning compliance for this study, and education also played a role. Informed respondents' answers to questions regarding sources of information often indicated education programs, which focused on providing residents with basic information about the park and zoning, not surveillance and enforcement. There were no significant correlations between the resources (staff and funds) and the total number of infringements or zoning infringements detected, which suggests that the level of resources spent on enforcement is not a major factor. It is likely that education is the most significant factor in zoning compliance among users.

Discriminating how much of the change in overall compliance and in zoning compliance is due to enforcement and education programs is a complex task, and outside the scope of this study. Nevertheless, both programs do influence user behavior towards compliance. The cost of reducing infringements from 113 in the first year of management to approximately 56 after six years using both education and enforcement was AUD\$2.9 million. Has reducing the number of infringements by 50% been worth the money? This question is outside the scope of this study, but is clearly the responsibility of managers of these programs.

Support for managing the park was maintained over the study. Prior to the commencement of management in 1985, 95% of respondents supported management of the Great Barrier Reef. After six years of management, 91% of the respondents considered management to be important to very important. Although the two results are not statistically comparable, they do indicate that community support for managing the park was maintained over the study.

Respondents' perceptions of management effectiveness, however, were mixed, with most respondents (46%) undecided. This result reflects the efforts of the education programs over the six years, which were focused on awareness of the park's existence and the basis for management. Education programs did not deal with evaluating park management among the community.

Management did very little to publicise criteria on which to judge effective management actions. Therefore, the public lacked mechanisms to judge management effectiveness. Managers have also not provided the community with criteria to measure the effectiveness of management.

If education programs were effective over the study, then public participation should have increased. The number of submissions received during the public participation programs of the zoning process did increase from 199 in 1982 to 278 in 1989, an increase of 39%. Although the population of Cairns increased by approximately 26% over the same time, the number of submissions did increase. More importantly, the issues that were mentioned in the submissions changed. In 1982, zoning was the most noted issue followed by recreational fishing. Zoning was also the most noted issue in 1989, but other issues such as day-to-day management, recreational fishing and diving were more important than in 1982 (Alder 1993). This change in noted issues also reflects the impacts of the major campaigns of education programs between 1985 and 1989, which focused on improving community understanding of zoning and management, and encouraging reduced recreational fish catches.

Conclusions

Funds spent on education and enforcement contributed to achieving management objectives in this study. Education programs can impact on a multitude of management objectives related to community awareness, attitudes, behaviors, and perceptions; while enforcement focuses on changing user behavior related to compliance of park rules and personal safety. Consequently, education programs have a wider impact on the community and are cheaper than enforcement.

Education and enforcement together with other social and economic factors influence user behavior towards compliance with park rules. This interaction of factors adds to the difficulty in determining each program's impact and costs on changing user behavior and requires further investigation.

Zoning infringements are still committed by some users who blatantly ignore zoning provisions, especially if they do not agree with the rationale for management actions. The question then remains, "Can managers accept this level of zoning infringements, and if not, how can the two programs change such behavior?"

The education program may need to consider a specific campaign to alter discharging practices among the commercial fleet. It is difficult to prosecute such offenders due to evidence requirements and the transient activ-

ities of many commercial ships. Education programs that focus on the impacts of discharging and ways to avoid it may be more effective.

In summary, the analysis of education and enforcement programs from 1985 to 1991 has identified areas for future planning which include:

- investigating the interaction of education and enforcement programs, as well as other social and economic factors, on changing user behavior towards compliance of park rules;
- reviewing current education and surveillance approaches to continuing infringements and those infringements due to blatant disregard for management regimes;
- discussions amongst the community on developing criteria to monitor management effectiveness in education programs and management activities;
- shifting the focus of education programs from awareness to understanding management and changing attitudes, so that combined with other management activities such as enforcement, user behavior is influenced; and
- developing education programs to improve public participation by all user groups and non users in the management planning of marine resources and areas.

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