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FOREWORD

Many countries are struggling with the task of meeting ecological and economic goals associated with the establishment and management of protected areas. Sometimes the attempt to meet both goals leads to conflict. For land based parks the problems are well-known: establishment of protected areas often results in depriving nearby residents of important economic benefits from use of the flora and fauna contained in the newly protected area.

Marine parks, especially those found in the Caribbean, offer opportunities for both resource conservation and generation of economic benefits. The establishment of marine parks helps protect fragile coral reefs and their associated fish and plant populations. Marine-based tourism, including both SCUBA divers and yachting, are also important economic activities that do not have to be in conflict with conservation and protection of the marine ecosystem.

This Dissemination Note explores these issues in the case of the Bonaire Marine Park in the Netherlands Antilles. It examines the impact of tourism and recreational use on the marine ecosystem, and the economic importance of tourism and recreation to the island economy. The study is a multi-disciplinary effort as the authors include both economists (Dixon and Scura) and an ecologist (van't Hof). The paper presents an analytical approach to understanding the dynamics of diver impact on the Park's reefs, and describes management alternatives that can allow increased diver use of the Park's coral reefs without exceeding a damage-inducing "stress threshold" level.

Since divers both causes stress on the marine ecosystem, and generates the revenues that pay for improved marine conservation and management, at certain levels of use the ecological and economic benefits can be considered as a type of "joint product" of recreational diver use. Beyond the "stress threshold" level, however, increased use leads to direct tradeoffs between marine conservation and generation of economic returns, e.g., increasing levels of direct use result in increased income (at least in the short run), but may damage the reefs and the fish population, thereby hurting the very thing that attracted visitors in the first place.

The authors estimate that the critical stress threshold level is between 4000-6000 dives per site per year, an intensity of use that is already being exceeded in certain areas. They then suggest measures that can help increase the effective carrying capacity of the Park (e.g. allowing more divers into the water while minimizing negative impacts) and increasing the generation of income, both to help pay for park management, and to keep a larger share of economic benefits within the Bonairean economy. It should be possible, therefore, to meet both ecological and economic goals.

Like other papers in this series, this Dissemination Note has not been subject to either substantial internal review or editing. Therefore the findings, interpretations, and conclusions expressed are entirely those of the authors and should not be attributed to the World Bank, members of its Board of Executive Directors, or the countries they represent.



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ECOLOGY AND MICROECONOMICS AS "JOINT PRODUCTS": THE BONAIRE MARINE PARK IN THE CARIBBEAN

by

John A. Dixon, Louise Fallon Scura, Tom van't Hof¹

1. The growing worldwide concern with the protection of biodiversity and unique natural places frequently comes into direct conflict with those who wish to exploit the same resources for personal gain or national benefit. This is true both on the land and in the seas. Marine ecosystems are less well understood in general than terrestrial systems, and their study presents interesting analytical issues -- both on the economic and on the biological side.

2. In a number of locations, especially in the Caribbean and more recently in East Asia, the development of marine protected areas and SCUBA diving and other water-sport tourism have gone hand-in-hand. These activities -- conservation and tourism -- are potentially a "joint product" of the protected area system.² The act of protection produces both ecological benefits and direct economic benefits to the local economy. In turn, the generation of economic benefits helps create the political support (and the financial resources) necessary for better management of the protected area.

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2 This use of the term "joint product" is somewhat different than the traditional examples found in the literature (e.g. crop production yields grain and fodder; a thermal powerplant produces electricity and air pollution). The idea is similar, however: the act of marine resource protection yields ecological benefits because the use of the park for dive tourism produces economic benefits that make protection possible. For certain levels of use the two products re-enforce each other: more direct use allows better management and improved ecological health compared to the limited-use, but unmanaged case.

- 3. This note explores the extent to which this joint production is a reasonable and feasible development option. It also explores the situation where the intensity of recreational use begins to result in degradation of the marine resource, thereby leading to a potential downward spiral of both decreasing ecosystem health and falling revenues. Indeed, it has become increasingly obvious that, rather than selecting the extremes of strict preservation or unmanaged development, balanced use of these resources for both economic and ecological functions is central to their sustainable management.³ A recent study on the Bonaire Marine Park in which information on reef stress is used to develop indicators of potential carrying capacity, is presented to illustrate the issue.

Marine Parks in the Caribbean

4. The potential tradeoffs between protection of rich ecological resources and the use of the same resources for economic gain is very evident in the Caribbean. For a number of small countries in the Caribbean "sun and sea" tourism is the mainstay of their economy, and tourism contributes between 15 to 30 percent of GDP (see Blommenstein 1985, 1993). Although a large share of tourism expenditures leaks out to other countries, a substantial share stays within the region in the form of salaries, purchase of local food, handicraft, and services, and returns to local capital investment. In 1990 Caribbean tourism earned \$8.9 billion and employed over 350,000 people (Holder 1991). Divers and other special-interest tourists may account for one-fifth or more of the total.

5. Many states in the Caribbean have established parks or protected areas to protect marine biodiversity and associated economic returns. A recent inventory noted some 135 legally established marine and coastal protected areas in the Greater Caribbean Basin (OAS/NPS 1988). The thirty-three countries and territories in the inventory had from as little as 6 hectares (Montserrat) to as much as 1 million hectares protected (United States, Venezuela, Cuba).

6. Only limited attention has been paid to the economic analysis of the benefits and costs of marine parks. Selected past studies that explicitly consider this dimension include the Virgin Islands National Park studies (Posner et al. 1981; Rogers, McLain and Zullo 1988); van't Hof's 1985 survey of the local economic benefits of marine parks; an analysis of the Saba Marine Park (Caribbean Conservation Association 1989, van't Hof 1989); and a study of the proposed Tobago Cays National Park (Heyman et al. 1988).

7. The interesting economic questions of marine parks focus on two important, and linked, aspects of their management: are the benefits of protection (with the production of the "joint products" of resource conservation and economic revenue) greater than the costs (and how can these costs be covered?) and, second, are there physical limits beyond which the production of both outputs -- conservation and

³ For more information on the economic analysis of protected areas see Dixon and Sherman, 1990.

.. economic returns -- is no longer feasible? These questions are explored in a study of the Bonaire Marine Park in the Caribbean. The Bonaire Marine Park study is unique since it explicitly considers the link between the production of ecological and economic benefits, and identifies the limits to joint production. Details are available in Scura and van't Hof, 1993, and Dixon, Scura and van't Hof, 1993.

THE BONAIRE MARINE PARK

The Physical and Socio-Economic Setting of Bonaire

8. Bonaire, a crescent shaped island with an area of 288 square km is located in the Caribbean Sea approximately 100 km north of the coast of Venezuela (Map 1). Curacao, Bonaire and the Leeward Islands of Saba, St Eustatius and Saint Martin (located approximately 170 km east of Puerto Rico), constitute the Netherlands Antilles. The neighboring island of Aruba joins the Netherlands Antilles and Holland to form the Kingdom of the Netherlands. The resident population of Bonaire was estimated at 10,800 in 1990.

9. The topography of the island is generally flat, dipping below sea level on the southern tip, with higher elevations only in the northern part of the island. A small uninhabited island, Klein Bonaire, is located just off the leeward coast of Bonaire. The entire coasts of both Bonaire and Klein Bonaire are lined by narrow fringing coral reefs containing lush coral growth and abundant fish and invertebrate populations. The waters of the Caribbean Sea surrounding Bonaire -- from the shoreline to a depth of 60 meters -- are officially protected as the Bonaire Marine Park, BMP.

10. Bonaire's Gross Domestic Product (GDP) in 1985 (the last year for which statistics are available) was estimated at approximately US\$ 44 million (CBS 1989, 1990). Bonaire has no mineral or fossil fuel deposits to speak of. Neither is there a domestic source of most inputs needed to support a manufacturing sector. In addition, Bonaire's small population means there is a very limited domestic market and import substitution is not particularly feasible.

11. Primarily as a result of the island's modest resource endowment, the economy of Bonaire is strikingly undiversified. Some of the larger economic activities include an oil trans-shipment facility, a salt works, and a smattering of agriculture, animal husbandry, and fisheries. However, the economic mainstay for Bonaire is tourism, particularly that related to SCUBA diving; almost 17,000 SCUBA divers visited Bonaire in 1991. Supporting activities include hotels, a modest number of restaurants and shops, and a few casinos and nightclubs, ground tour operators, rental cars

agencies and transport services. Based on tourism statistics, the annual rate of growth of diver visitation to Bonaire is approximately 9 to 10 percent per year.⁴

12. Both the environment and the economy of Bonaire are somewhat fragile. Because of its small size, unmanaged growth could quickly damage the natural environment, at the same time lessening Bonaire's appeal for tourism, the mainstay of the economy.

History of Bonaire Marine Park

13. In the early 1980s the Bonaire Marine Park (BMP) was established with aid from the Dutch Government and other sources under a three year US \$319,000 pilot project to meet recreational and scientific needs (van't Hof and Kristensen 1981). A total of 38 permanent moorings were placed in the Marine Park during the project to provide easy access to the most important dive sites while eliminating anchor damage to reefs. A snorkel trail was laid out later and shore markers, indicating the location of dive sites accessible from shore, were also placed. A field research station, park headquarters and visitors' center was set up and information brochures prepared (van't Hof 1983).

14. Considerable scientific work began at this time. The reefs along the leeward coast of Bonaire and the entire coast of Klein Bonaire were surveyed to select "scientific reserves", to identify new mooring sites and to prepare dive site descriptions for the guidebook. Permanent photoquadrats (underwater photographs taken of specific areas of the reef to permit comparisons over time of its health and quality) were established for comparison of heavily dived areas with similar reef types in the scientific reserves (van't Hof 1982). Photoquadrats were also used to monitor recovery of storm damage and anchor damage to the reef.

15. In 1981 a proposal to introduce a visitor fee system for BMP based on a levy of 1 Antillean guilder (equivalent to about US \$ 0.56) per airfill was discussed with the dive operators and submitted to the Island Government. At the time the Government did not act on the proposal and, although the dive operators initially did not decline the proposed fee, they gradually started lobbying against it. Due to the failure to introduce a visitor fee system for BMP, serious difficulties in managing the Park occurred when grant monies had been depleted by the end of 1984. Eventually, with no staff or funding, the Park became a "paper park"; management and control of access were left to the dive operators.

⁴ These estimates of annual diver visitation should be interpreted with caution. The source of the information is immigration entry and departure cards combined with reports from the dive operators to the Bonaire Government Tourist Bureau. The survey of major hotels conducted as part of the BMP study indicated that an average of approximately 63 percent of their estimated 31,240 guests were divers, yielding 19,680 divers in 1991, an estimate which is significantly higher than that based on the tourism statistics. In addition, a sample survey of 100 departing visitors conducted as part of this study indicated that approximately 80 percent of those interviewed are divers. The reason for the differences between the surveys and the tourism statistics are not known. While not conclusive, the survey results indicate that the estimates of diver visitation based on tourism statistics seem to be conservative. Nevertheless, throughout this report, the visitation rate of 17,000 divers in 1991 will be used.

16. Early in 1990, after serious concerns about the lack of formal management of the BMP, an increase in diver activity, and the consequences of coastal development in general, the Island Government of Bonaire commissioned an evaluation of the situation which resulted in the following major recommendations:

- Introduce a visitor fee system;
- Introduce a licensing system for commercial watersports operators; and
- Create a new institutional structure for BMP, including representation from the tourism industry (van't Hof, 1990).

17. On the basis of these recommendations the Dutch Government approved funding and technical assistance for the revitalization of BMP for a period of 3 years: US \$125,000 for operational costs and capital expenditure plus \$28,000 in technical assistance were allocated for the first year, and \$250,000 was reserved for subsequent years.⁵ Allocation of funding in the second and third year of the project would be subject to approval of annual budgets. One condition to the grant was the requirement that a visitor fee be introduced, which would eliminate the need for further financial assistance beyond 1993.

18. The process began in April, 1991, with the appointment of a new park manager and a consultant to provide training and technical assistance. At the beginning of the 1992 the Park had a staff of 3 full time and 1 part time employees, 2 vehicles and 1 boat, and most park functions were being fulfilled adequately.

19. The Park was re-established and revenues were being generated by the introduction of an annual admission fee of \$10 per diver to help pay expenses. In 1992 the fees (called "admission tickets") raised over \$170,000, enough to cover salaries, operating costs and capital depreciation.⁶ Revenues are also produced by sales of souvenirs and books, and from donations.

THE ECOLOGICAL BENEFITS AND COSTS OF BMP

20. There is no doubt that the existence of the BMP, and the all-important support of dive operators, has been essential in preventing more severe degradation of the marine ecosystem. Nevertheless, there is an environmental cost associated with the multiple uses of BMP. Diver use was the common element and accounted for both increased stress on the reef, and increased revenue generation. The question,

5 The Island Government signed a management agreement with STINAPA, a local park management NGO, and the BMP Management Committee was created with representatives from the Government, STINAPA, the Council of Underwater Resort Operators, and the Bonaire Hotel and Tourism Association. The Committee is functioning well.

6 Personal communication with Kalli De Meyer, manager, BMP. It should be noted that the \$10 per diver fee is not all profit. The plastic admission tags cost 1 Antillean guilder each (about \$.56) and there is a 1% Bank charge for cash deposits. In addition, evasion of payment and other costs may lead to a loss of up to 5% of total potential income.

• therefore, is to what extent marine park protection can produce the desired "joint products" of resource conservation and economic revenue generation (e.g. ecological and economic benefits). And at what level of use is joint production no longer feasible? These questions are now considered in the case of Bonaire Marine Park.

21. In an attempt to evaluate the success of the BMP in providing protection to the marine ecosystem, van't Hof applied both qualitative and quantitative tests to evaluate the "health" of the marine ecosystem (Scura and van't Hof 1993): First, a visitor's survey was conducted to obtain divers' perceptions of the present condition of the Park and their rating of selected parameters in comparison to other Caribbean areas or to the condition of BMP in the past. These question helped to assess the environmental carrying capacity of the Bonaire Marine Park from a diver's perspective. A total of 79 SCUBA divers were interviewed. For the analysis the sample was divided between divers who had logged 100 dives or less on Bonaire (n=38) and those who had logged more than 100 dives on Bonaire (n=41).

22. Second, a photoanalysis was carried out to analyze coral cover and species diversity. Since little long-term reef monitoring has been conducted in the Bonaire Marine Park, possible changes over time in live coral cover or reef community structure to individual sites as a result of diving pressure were not recorded. Nevertheless such changes were definitely thought to have taken place in certain areas and comparative analysis was used to identify trends.

23. A number of sites were included in the study ranging from those heavily dived to sites rarely visited. At each site a series of photographs (color slides) was taken in the drop-off zone at a depth of 9 to 10m. Starting at the dive boat mooring (where available) individual photographs were spaced 3 fin kicks apart. Within the indicated depth range photographs were completely random. The total distance over which 36 frames were spaced was estimated at 100 to 110m. (Details can be found in Scura and van't Hof 1993).

Assessment of Ecological Sustainability

24. **Results of the Diver Survey.** The majority of the divers interviewed rated the present condition of the reefs as high. About half of all divers rated the reefs a 2 on a scale of 1 to 5 (with 1 being the best and 5 the worst), thereby indicating that the reefs are not pristine, but certainly in very good condition. More than 50% of the more experienced divers, however, noted that underwater visibility has deteriorated over the last 5 years.

25. Divers were also asked to compare the condition of the reefs and the fish life with other Caribbean dive destination they had visited. Almost all divers rate the condition of the reefs in Bonaire better than or equal to any other destination they have visited, with the exception of Little Cayman and Cayman Brac.

26. One question related specifically to social carrying capacity: did divers find the dive sites on Bonaire overcrowded? Of the 44 respondents (divers employed in the diving industry and other resident divers who do not normally go out on the boat

dives were excluded), 73% said "no". However, it should be noted that several of the "yes" respondents were diving from shore or were diving with one of the smaller operations exactly because of overcrowding, indicating that there is a potential problem.

27. **Results of the Photoanalysis.** Increased diver use was having an impact on the coral reef, however. The comparison of coral, both over time and between sites, indicated that cover has decreased significantly at the heavily dived sites (see Figure 1). The higher diversity indices at the heavily dived sites in comparison with the control sites confirm the intermediate disturbance principle: the finding (e.g. Dollar 1982) that a higher species diversity is maintained at intermediate levels of physical stress or disturbance as ecological "niches" are opened up that new species occupy. As stress increases, however, species diversity declines. The highest overall diversity in this study is found at sites which are exposed to moderate wave action and swell.

28. Although the photoanalysis demonstrates a significant impact of recreational diving on the reef communities, it was obvious from subjective observation that the impact was limited to a rather small area adjacent to the moorings. Divers seldom cover a distance of more than 300 m in one direction during a dive, while in fact most divers do not venture very far from the mooring at all. Photo analysis indicated that the linear extent of diver impact is more than 100 m but less than 260 m.

Relation Between Diver Density and Impact

29. Perhaps the most difficult question to address is: "What is acceptable in terms of diver-induced damage and what isn't?". Based on the interviews with divers, and based on the data on coral cover and species diversity from the photoanalysis it appears that visitation at certain sites had already exceeded the local carrying capacity. (The average visiting diver makes 10 or 11 dives during the course of his or her stay on Bonaire.)

30. The results of the photoquadratic analysis suggest that there may be a critical level of visitation above which the impact becomes significant. This relationship is illustrated in Figure 2 where the apparent threshold stress level is between 4000 to 6000 dives per year per site. For example, there is anecdotal evidence that Carl's Hill and Jerry's Jam, two of the monitored sites, began to show signs of "wear" around the mid-1980s. At that point the estimated visitation of these sites had just exceeded 5,000 dives per year.

31. The total "divable" coastline of Bonaire and Klein Bonaire is about 52 km (reserves not included). If moorings are spaced 600 m apart in order to maintain a small buffer zone in between sites, the Park could have a maximum theoretical number of 86 dive sites. With maximum allowed visitation set at 4,500 dives per year (just below the "critical level"), the theoretical carrying capacity would be 387,000 dives annually. In reality this figure would be much lower, because the distribution of dives is uneven due to differences in distance and accessibility of sites.

FIGURE 1 RELATIONSHIP BETWEEN CORAL COVER, SPECIES DIVERSITY, AND STRESS

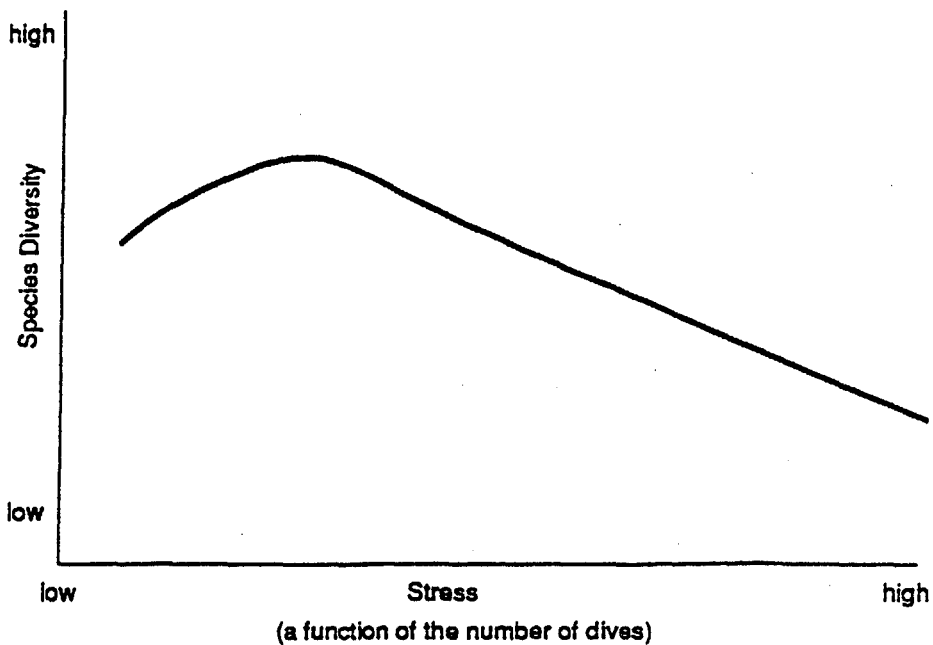
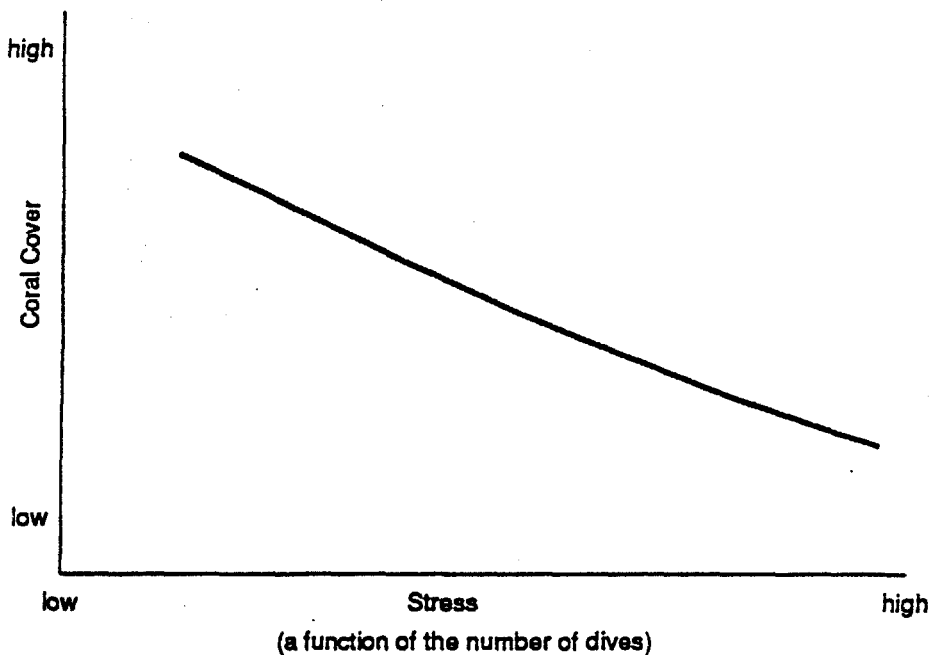
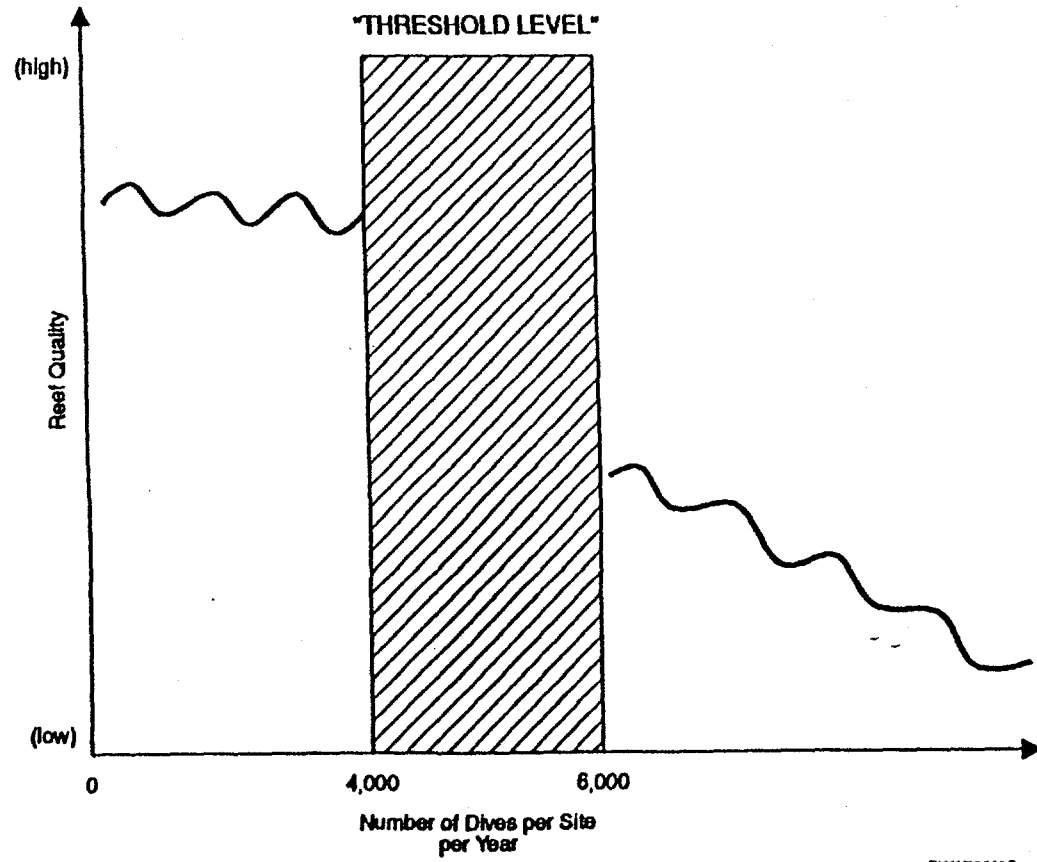


FIGURE 2 DIVING INTENSITY AND THRESHOLD STRESS LEVEL



The model also does not take into account the fact that shore divers are not limited to the moored dive sites and can access the buffer zone in between dive sites. It seems therefore more realistic to set the carrying capacity at half the maximum theoretical capacity, that is 190,000 to 200,000 dives per year. Annual use was already more than 180,000 dives in 1991 and, with an annual increase of visiting divers of 10%, the estimated "carrying capacity" of the Bonaire Marine Park will be reached in the next few years. If this capacity is exceeded, fairly rapid loss of reef biodiversity may result.

QUANTIFICATION OF FINANCIAL BENEFITS AND COST OF BMP

32. The working hypothesis in Scura and van't Hof (1993) is that Bonaire is attractive because its unique resources are protected. Aided by its protected status, a significant privately operated sector is successfully marketing Bonaire as a tourist destination. However, if protection of the marine ecosystem is not maintained, much of Bonaire's attraction would be lost, and along with it the associated revenues currently accruing to the private and public sectors.

33. It was not possible to estimate the true "economic" benefits of the BMP since resource constraints prohibited the carrying out of either a travel cost, or a survey-based contingent valuation study (CVM) analysis of park users, and estimating any other economic benefits from protection, including both ecosystem services and biodiversity benefits. In the analysis, therefore, Scura focussed on the generation of gross financial revenues due to the existence of world-class diving in Bonaire. Since there are few other attractions on the island, a decrease in the level of protection and degradation of the marine resource would result in loss of both ecological and economic benefits: any loss of reef and water quality and reduction in the fish population would result in divers shifting their demand to other islands competing for the same market. The loss of this market would be very difficult to replace with other visitors.

Financial Revenues Associated with BMP

34. The main categories of benefits included in the financial analysis are gross revenues to the private sector and BMP user fees. The primary uses of the waters contained in the Park are: 1) dive-based tourism; 2) small-scale and recreational fisheries; 3) yachting and other water sports; 4) cruise tourism; and 5) ocean transport. Of these, only revenues from dive-based tourism are considered, as the other uses of BMP waters are less dependent on the protection afforded by the Park. Land-based supporting activities to dive-tourism include hotels, restaurants, souvenir sales, and car rental. Table 1 lists the main revenues and costs, including divers' fees, associated with Bonaire Marine Park. In 1992, diver and other direct use fees, the one source of "direct" revenues from use of BMP, totalled about \$190,000. This amount is tiny in comparison to other park-related gross revenues.

35. **Private Sector Revenues.** Total gross revenue generated through dive-based tourism was estimated at US\$ 23.2 million in 1991. Data on revenues were obtained

. through interviews with hotels and dive operators. These data were cross checked and estimates of revenues from other economic activities were made using tourism statistics and the findings of a motivational and expenditure survey of departing visitors conducted as part of the study. Of the total revenues generated, US\$ 10.4 million is attributable to hotels (including hotel restaurant sales)⁷, US\$ 4.8 million to dive operations (including retail sales in dive shops)⁸, an estimated US\$ 4.7 million attributable to other expenditures including non-hotel restaurants, souvenirs and car rentals⁹, and US\$ 3.3 million for air transport of diving tourists on the local airline.¹⁰

36. **Employment** should not strictly be considered a benefit. In an economic sense employment is a cost of generating total gross revenue. Nevertheless, employment, particularly of locals, is probably the most long lasting "benefit" to the local economy of the activities in BMP, especially given the fact that alternative employment opportunities are very limited. The data on employment in park-related activities were obtained through interviews with hotels and dive operations, as well as from records provided by the Island Government Department of Labor. Employment in activities directly related to the BMP, including Park staff, dive operators, hotels, restaurants, and the large and small retail trade, represents as much as 22 percent of total island employment.¹¹ Assuming 24 percent of all labor is foreign, employment in activities associated with the BMP is estimated to be as much as 755 local workers and up to 238 foreign workers. In addition, because of the dominance of tourism in the economy, employment in support activities such as construction, banking, trade and even government are indirectly related to the activities in the Park.

37. The financial returns from Park-based recreation contribute to tax revenues for the Island Government and generate employment. One has to be careful to avoid double counting of benefits since tax revenues are already included in the estimates of gross financial revenues. The Island Government of Bonaire collects several direct and indirect taxes; it is estimated that for 1991 total government revenue from indirect taxes (e.g. income, land, and business profit taxes) was approximately US\$ 8.4 million. Even if the portion of this revenue attributable to dive-based tourism

7 Five of the major hotels surveyed reported total revenues of US\$ 10.5 million. Multiplying revenues reported by each hotel by the percentage guests who are divers in each hotel yields an estimated total revenue attributable to dive tourism in these five hotels of US\$ 6.55 million. These five hotels represent approximately 63 percent of the total room nights. Therefore, it is estimated that total revenue generated for all hotels by dive tourism is US\$ 10.4 million per year.

8 This estimate is compiled from the gross revenues reported by dive operators as part of the survey of dive operators conducted as part of this study.

9 The results of the visitor motivational and expenditure survey conducted as part of the study indicate that expenditures over and above packages amounted to an average of \$275.00 per person per 6 day stay. Multiplying this average outside expenditure by the 17,000 of divers visiting Bonaire in 1991 yields an estimated expenditure of US\$ 4.7 million.

10 Average fare quoted is approximately US\$300. Since, according to official tourism statistics ALM, the local airline, accounts for 65 percent of all air traffic in and out of Bonaire, and there were an estimated 17,000 divers visiting Bonaire in 1991, estimated revenues are US\$ 3.3 million.

11 Assuming a total work force of 4,501 workers.

could be easily calculated, these revenues represent transfer payments rather than additional benefits generated by use of the park.

38. Taxes levied by the Island Government directly on tourists include room tax, casino tax and departure tax. Room tax is calculated at US\$ 2.25 per room night. Casino tax and departure tax are calculated on a per visitor basis at US\$ 1.12 and US\$ 9.83, respectively. The total government revenue generated in 1991 through these taxes levied directly on visiting divers is estimated at US\$ 340,000. Revenues from these taxes may be considered as additional revenue generated for the Island Government through use of the BMP.

Retention of Economic Benefits in Bonaire

39. There are, however, several factors which in combination tend to limit the amount of revenues which remain in the local economy. First of all, sales in the tourism sector are dominated by offshore sales of packages commonly referred to as voucher sales. The tourist pays the agent in the United States or Europe for the complete package, including the goods and services to be provided in Bonaire, and in return receives a voucher to be presented to the hotel and/or dive operation representative upon arrival in Bonaire. Tourists who purchase packages typically make few additional expenditures during their stay. The motivational and expenditure survey conducted as part of the BMP study indicated that outside expenditures were as low as US\$275 per person per average 6-day stay.

40. The sales agent sends the revenue from voucher sales, less a commission of between 10 and 20 percent, to the United States or European marketing office of the hotel and/or dive operator. Before remitting funds to Bonaire, the marketing office offsets operating expenses and costs of procurement of goods to be imported to Bonaire. The balance, which can be a small portion, is sent to Bonaire to cover local expenses including salaries and procurement of local goods and services. There is also a lack of locally produced agricultural products and other consumer goods in Bonaire and most food and manufactured goods to support the dive tourism industry must be imported. The total value of all imports to Bonaire is estimated to have been US\$ 34.4 million in 1989 (the latest year for which data are available) (CBS 1990). Of this, US\$ 5.5 million was for food, and US\$ 13.9 million was for manufactured goods. As a consequence of this only a small portion of gross revenues generated by dive tourism effectively remains in Bonaire. This surplus, however, is a clearer measure of the true economic benefits to Bonaire of the BMP.

Costs of Protection.

41. The costs of the establishment and protection of BMP include direct costs, indirect costs and opportunity costs.

42. **Direct Costs.** Based on data provided by the BMP management, the costs associated with the establishment, subsequent rehabilitation and initial operation of the

BMP were estimated to be approximately US\$ 518,000; annual recurring costs are approximately US\$ 150,000.

43. **Indirect Costs.** Anecdotal information suggests that divers destroy fish traps set by local fishermen because it is felt that the traps frequently become detached from their moorings but nonetheless continue to "ghost fish", that is, trap fish that will never be collected by the fishermen or divers. However, it was not possible to quantify the extent to which this takes place or the costs which accrue to fishermen as a result of this activity.

44. There is some evidence of congestion within the BMP. Currently there are 29 dive boats in operation, serving approximately 17,000 divers per year in 1991, diving a total of approximately 187,000 single tank dives per year.¹² Given the limited number of mooring allowed in the BMP and the fact that all dive operations run dives on approximately the same schedule, divers surveyed complained that the dive boats often have trouble finding an open mooring. No evidence was available of any other major indirect costs.

45. **Opportunity Costs.** The opportunity costs of a park or protected area are the benefits that are lost as a result of the establishment and operation of the park. These include the value of foregone output from prohibited uses of resources in the protected area or, the foregone value of conversion of the site to an alternative use. The only opportunity costs considered by this study are those which accrue to Bonairians. Because development opportunities are somewhat limited, the opportunity costs of protection are likewise limited. In addition, since BMP is managed as a multiple use area where few uses are strictly prohibited, opportunity costs are minimized.

46. However, other limitations may impose costs. For example, there are quite significant costs associated with limiting the island's ability to rely on the use of septic tanks, as was done in the past, for waste disposal, and imposing the need for a sewage collection and treatment system. In addition, there may be opportunity costs associated with possible limitations on the type and scale of future development on the island which would be compatible with maintaining the integrity of the BMP. Nevertheless, such growth creates social and economic costs, including such things as the cost of provision of public infrastructure such as roads, streets, and water distribution systems. Therefore, the opportunity cost should be based on the net rather than gross benefits foregone.

Who Benefits and Who Pays

47. Although some economic benefits of protection afforded by BMP accrue to Bonairians, a large portion of these benefits accrue to resident aliens and foreigners. At least 50 percent of the hotels and dive operations are completely foreign owned.

¹² This assumes a rate of 11 single tank dives per diver. This rate was obtained from the survey of dive operators made as part of the study.

In addition, currently 24 percent of the work force are foreign workers, and this percentage is increasing rapidly.

48. Due to a combination of factors including the predominance of offshore voucher sales in the tourism industry, liberal laws regarding repatriation of funds, free exchange between the US dollar and the Antillean guilder, and lack of locally produced agricultural products and other consumer goods, the revenues generated by the diving-based tourism sector tend to pass through the local economy with only a small portion effectively remaining in Bonaire. In addition, many immigrant workers have families in other countries and repatriate a large portion of their earnings.

49. This situation, in which such a small portion of the benefits of the current development trickle down to the local population, creates incentives to continually increase the number of visitors. Indeed, the current approach to development of Bonaire is a high volume, low margin approach. It is "low margin" in the sense that the benefits which accrue to the economy of Bonaire from current development are relatively small, and it is "high volume" in the sense that more development is deemed needed to increase the absolute magnitude of the benefits to the local economy.

50. In order to cover the direct costs of operation of the BMP an estimated US\$ 150,000 is needed annually. Since the Island Government is currently running a fiscal deficit, it is desirable that the BMP be self-financing, generating the needed funds through user fees. (The US\$ 10 user fee generated revenues of over US\$ 170,000 in 1992, its first year, enough to cover operating costs and contingencies.)

51. Given the controversy surrounding the institution of a user fee system, as part of the motivational and expenditure survey of departing visitors, a series of questions were asked in late 1991 to get an inference of visitor's general perception of and willingness to pay user fees for the BMP. The survey technique used is known as contingent valuation because the values elicited are contingent on the hypothetical situation described in the survey.

52. Although only 68 percent of the visitors surveyed knew of the existence of the BMP before coming to Bonaire¹³, and only 26 percent knew of the plans for institution of a user fee system, an overwhelming 92 percent agreed that the user fee system is reasonable and would be willing to pay the proposed rate of \$10/diver /year. Hypothetical changes in the fee also were discussed and willingness to pay

13 It should be noted, however, that the stated motivation of the visitors for choosing Bonaire as their destination was its reputation for excellent diving conditions. Important aspects of this are the reef conditions and the abundance of fish and invertebrate life -- a product of the protection afforded by BMP.

higher user fees were solicited.¹⁴ These responses were then averaged and extrapolated to the total diver population to obtain an estimate of the willingness-to-pay (WTP) for park management that would maintain dive quality.

53. Approximately 80 percent of those surveyed said that they would be willing to pay at least \$20/diver/year, 48 percent would be willing to pay at least \$30/diver/year, and 16 percent would be willing to pay \$50/diver/year, yielding an average value for WTP of \$27.40 (excluding the 8% who were not willing to pay a fee). Interestingly, this amount is fairly close to a similar estimate of A\$44 calculated by Sloan (1987) for divers at Australia's Heron Island, another prime diving location. One could only capture this average value if one were a perfectly discriminating price setter and charged each visiting diver their entire WTP for park use. Of course, one cannot do this so an admission fee is set that captures part of the WTP.

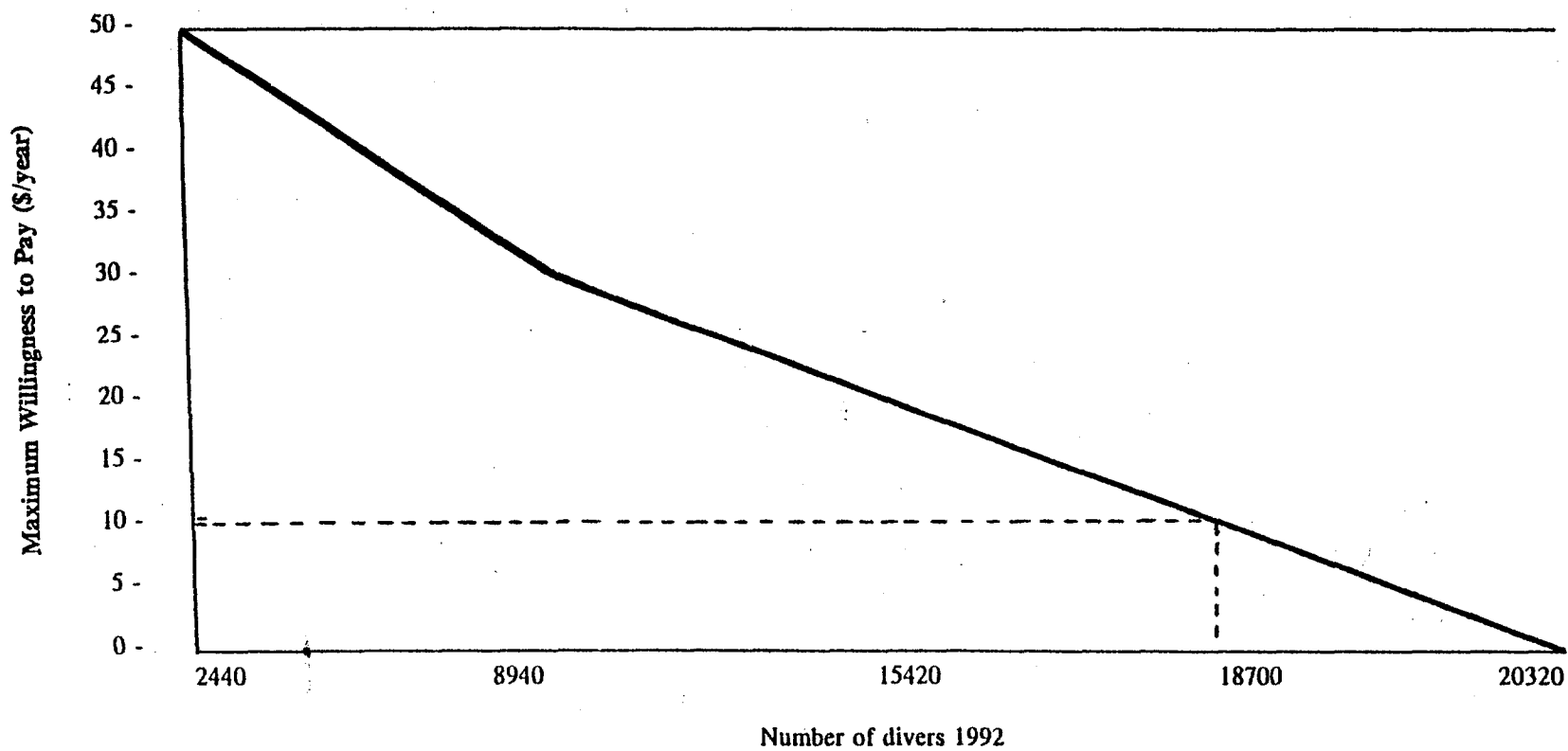
54. Clearly the average willingness-to-pay exceeded the relatively modest US\$10 fee instituted in 1992 (although this amount would cut off some use as you moved up the demand curve). The difference between what people would be willing to pay for a good or service and what they actually pay is known as consumers' surplus (CS). This value is not observed in market transactions and, in the case of BMP, is not captured by dive operators or hotels. However, it is a very important economic value, as it represents that portion of the value of the diving experience that is above what is paid for it in the market (including transport and ground costs). At the current rate of dive visitation (an estimated 18,700 divers in 1992) admission fees and estimated CS total \$512,000 per year, of which \$325,000 is CS. Figure 3 presents the information from the WTP survey, and indicates the area of remaining CS. With a doubling of the number of divers, the admission fees and CS would total almost \$960,000 per year.¹⁵

14 The following questions were asked; details can be found in Scura and van't Hof, 1993.

- 1) Were you aware before coming here that Bonaire waters are protected as a marine park?
- 2) Are you aware that starting in January 1992 there will be a US\$ 10.00 per year per person admission fee to be able to dive within the waters of the BMP?
- 3) The admission fee is specifically earmarked for the operation of the BMP. That is, revenues generated through the admission fees can only be used to defray the costs of park operation. Do you feel the US\$ 10.00 per year fee is reasonable?
- 4) Would you be willing to pay such a fee?
- 5) At what level would you find the admission fee to be unreasonable?
US\$ 20? US\$ 30? US\$ 50? US\$ 100?

15 It is very probable that actual consumer's surplus is considerably larger than the average value of \$27.40 per diver given the total cost of a typical dive vacation (anywhere from US\$ 800 to US\$ 1500 for a week). The average value of \$27.40 represents that portion of CS that can be extracted via a user fee. In addition, the amount was estimated based on a simple CVM analysis and was influenced by the frequently observed resistance to large entrance or user fees. To more completely and accurately estimate diver CS, a travel cost (or a more comprehensive CVM analysis) could be used.

FIGURE 3 WILLINGNESS TO PAY FOR PARK MANAGEMENT - BONAIRE MARINE PARK



CONCLUSIONS

55. Bonaire and its marine park are representative of the issues facing many marine protected areas in the Caribbean. Bonaire is, to some extent, an extreme case since SCUBA diving is basically the only reason visitors come. This characteristic is shared however, to a greater or lesser extent by other dive destinations including the Caymans, Mexico, the Turks and Caicos, and the Bay Islands in Honduras, among others. Bonaire illustrates the difficult trade-offs that exist in combining economic and ecological goals. Its marine ecology is rich, protected, but threatened. Even relatively benign forms of use such as diving and yatching in a well-managed protected area have had adverse impacts on the marine ecosystem.

56. **The study has two major findings:**

- First, marine park development and park use can be an important source of revenues, both to the local economy and to the park authorities, thereby helping to provide protection and associated ecological benefits. This is especially true when the initial level of use and income generation are low. Improved park management costs money; increased visitation helps create both the demand for improved management and the resources to pay for it. As such, both ecological and economic benefits can be considered as "joint products" of marine protected areas.
- Second, there are ecological limits that lead to trade-offs between protection and increasing use and income generation. Although the two can be considered as "joint products" up to a point, there is a point beyond which additional use of marine protected areas will lead to degradation of the marine resource; increased use (and revenue generation) then result in decreased ecosystem health.

57. The main causes of reef degradation are known: use of anchors (largely prevented by the installation of mooring points); human pressure from excessive diver use; improper disposal of wastes and oil products at sea; and run-off of nutrients and other materials from the land (sewage, agricultural chemicals, storm drainage). The BMP study reported on here has focussed on the major direct cause of reef degradation: SCUBA diving.¹⁶

58. The ecological studies carried out on the marine ecosystem found measurable degradation around the dive-boat moorings. The data suggest that there may be a critical level of diver use of about 4,500 dives per year at individual sites, after which reef degradation becomes apparent. (In this case information on actual diver use was

¹⁶ The problem of nutrient run-off, especially from septic tanks, was not considered in detail but was identified as a potential major problem. In the Florida Keys, especially around Key Largo, sewage seepage has resulted in a pollution problem that resulted in significant negative impacts on the protected reefs off-shore.

compared to observed degradation [a physical indicator] to develop an estimate of the threshold stress level.)

59. The economic analysis illustrates the dependence of Bonaire on dive tourism. Its small size, modest resource endowment, dry climate and relatively remote location combine to limit the potential for other forms of economic development. There is scope for both increasing diver-based revenues (e.g. attract more visiting divers) and increasing retention of diver-related income in Bonaire; the latter will require changes in the type and style of tourism development.

Assessing the tradeoffs.

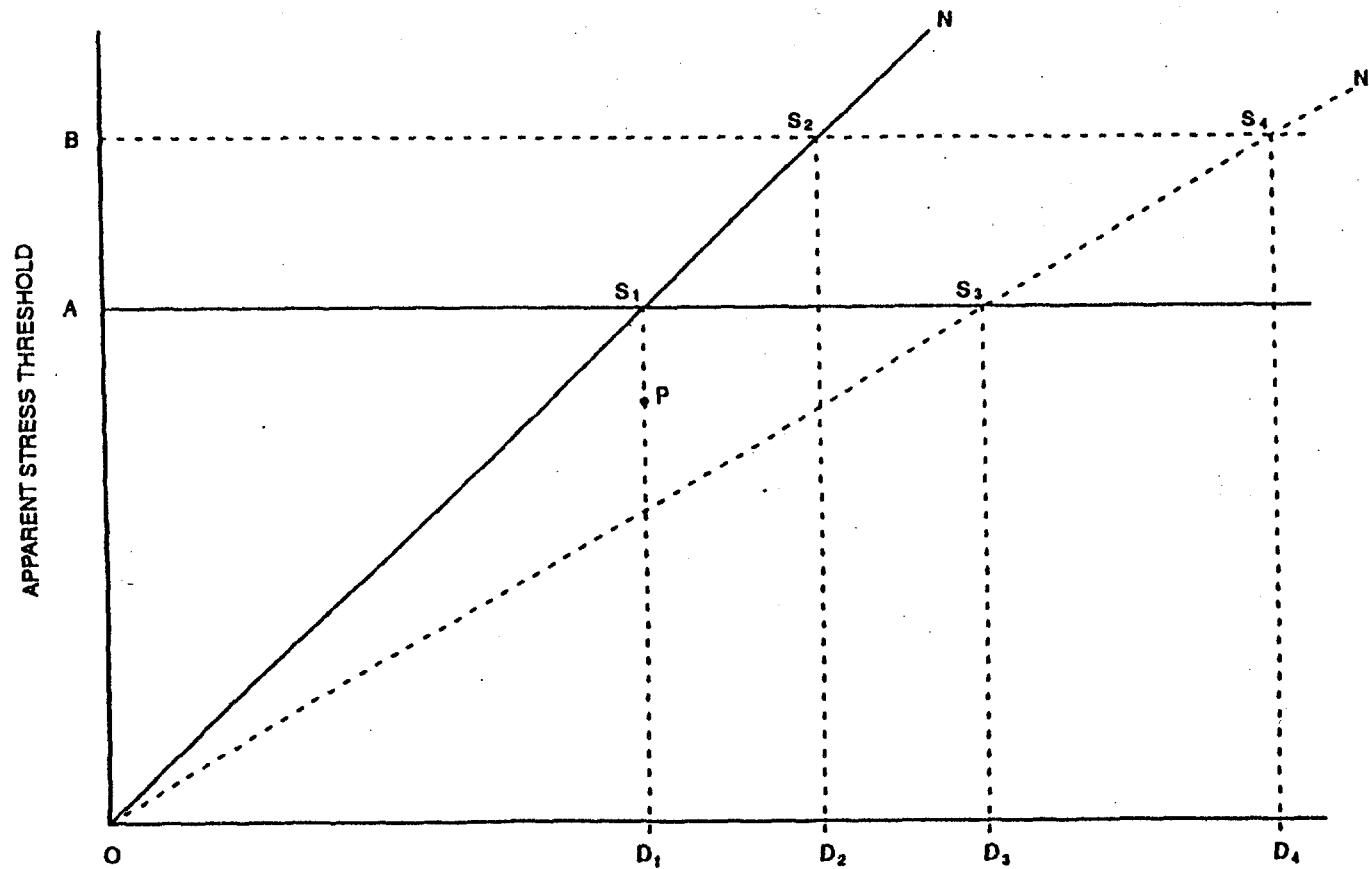
60. Are continued expansion of dive tourism (with its associated economic benefits) and ecosystem protection compatible? Can the protection provided by the BMP continue to produce these valuable joint products? The data presented from Bonaire indicate that it may rapidly be approaching a point whereby increased dive tourism results in measurable degradation of the marine environment. The physical stress constraint, however, may be changeable. Figure 4 presents a simple schematic relating an apparent stress threshold on the marine ecosystem on the vertical axis to the intensity of diver use on the horizontal axis. Level A represents the level of stress (either from divers or on-shore activities) at which reef degradation becomes noticeable. Below this level there is no or minimal impact. Above this level there is a loss of coral cover, reduction in species diversity, decreased visibility and other impacts.

61. It may be possible to raise the apparent stress threshold to level B by improved management -- rotating dive sites, spacing out divers, regulation of underwater photography (e.g. ban tripods, promote better buoyancy control), controlling land-based pollution, and monitoring and supervision of park users. (These management measures do not increase the tolerance of the marine ecosystem to stress, rather they help to distribute the burden more evenly across the ecosystem. Such measures require both money and legal authority.)

62. The horizontal axis maps the most important direct determinant of reef stress--diver activity. Line ON represents the impact of diver use of the park, measured in the number of single tank dives per year.¹⁷ At point S1 diver use is such that ecosystem degradation begins to be noticeable. If there is improved park management, this "stress point" is shifted to point S2. However, not all divers are equal and the level of stress per dive varies with the skill of the diver. In general, an experienced diver has better buoyancy control and "reef etiquette" and imposes less

17 Both ON and ON' are shown as linear in Figure 4. Note that these lines are not damage functions per se, but are notional representations that increasing diver use places increasing stress on the marine ecosystem. Below the "apparent stress threshold level" (A or B), however, there is no measurable impact of increasing use on the marine ecosystem.

FIGURE 4 PARK MANAGEMENT, DIVER EDUCATION AND THRESHOLD STRESS LEVEL



TOTAL NUMBER OF DIVES PER YEAR

$D_1 \cong 200,000$

$D_4 \cong 400,000$

EK/WS3200A

, stress on the reef ecosystem than the novice diver.¹⁸ Consequently, diver education can shift out line ON to ON' by reducing the average stress per dive, thereby expanding permissible use of the park's waters, and leading to increased economic benefits.

63. The result of these two factors--improved park management and diver education--is to increase the effective carrying capacity of any given site and the park as a whole. Improved diver education can shift the carrying capacity to point S3, while improved park management and diver education can shift the point to S4. Since more divers mean more revenue, the increase in dives from D1 to D4 represents an estimate of the potential economic gain to the economy of Bonaire from these management measures (in essence, this would expand the "joint product" space where increased use and improved management are achieved simultaneously). Based on study results, the increased spending associated with a doubling of the number of dives (and divers) could mean increasing gross revenues in Bonaire by \$20 million or more per year.

64. At present Bonaire Marine Park, with some 200,000 dives per year, already receives many experienced divers who have good "reef etiquette," and actual diver impact thereby falls on a line between ON and ON'. The management of the park, both by the BMP authorities and the dive operators themselves, has also helped to raise the effective damage threshold level and there is only limited, localized reef degradation. The current situation is represented by point P. Nevertheless, Bonaire is approaching the limit where the two uses--protection and dive tourism--are still compatible. It may be possible to expand from the estimated present level of 200,000 dives per year to as much as 300,000 to 400,000 dives or even more. Whether this in fact happens is directly dependent on both improved management and improved diver education.

65. It is somewhat ironic that the BMP has faced such severe financial restrictions in the past. As the BMP study has shown, dive tourism and the existence of BMP are intimately linked and form the cornerstone of the local economy. Without world class diving Bonaire would receive many fewer visitors. And yet, the very modest sums needed for annual recurrent costs have, up until this year, proved difficult to raise.

Lessons for Marine Park Management

66. Several lessons can be drawn from the case of the BMP for other marine parks in the Caribbean:

18 However, as pointed out in a personal communication from Kalli de Meyer, Manager of the BMP, it is far from given that an experienced diver has better buoyancy control and reef etiquette than a novice. For example, experienced divers with cameras may do much more actual damage and over a wider area than a novice diver without a camera. Experienced divers from cold-water environments also typically dive overweighted and are ill-informed about the necessity of staying clear of the bottom. In short, there may be major benefits to improved education for both novice and experienced divers.

- **Marine parks can be effective means of protecting marine biodiversity while still allowing direct, but non-consumptive, use of the marine ecosystem that result in the generation of important economic benefits for the local economy, and the resources needed for improved park management.**
- **Localized overuse is commonly observed before large scale degradation begins, and can serve as a useful "early warning indicator."**
- **Park management costs are small in comparison with the total level of gross economic benefits associated with and directly dependent on the park.**
- **Park user fees, levied either directly on users or on firms that organize use, can be implemented and cover costs but are often resisted. It may be desirable to use some form of "marginal cost" pricing that factors in congestion and potential damage at more popular sites. In this way the cost per dive would reflect how close any given site is to the threshold level, and the dive charge for the more popular sites being set higher than for those sites under less user pressure.**
- **It is important to plan development and grant incentives such that a larger share of the economic benefits of tourism are retained in the local economy. In this way it will be possible to increase revenue generation and revenue capture without constantly increasing the number of divers.**
- **The larger issue of shore-based development, especially the disposal of sewage and other wastewater and its potential negative impact on the surrounding waters, has not been addressed. The additional costs of proper sewage treatment and wastewater disposal will be a major future cost item, but a necessary expenditure to maintain both water and reef quality in the BMP. Ideally, these costs should be passed on to the polluters as part of room surcharges or other tax measures.**
- **And finally, even though there is a certain level of park use with good management and enlightened divers where ecological and economic benefits can be considered as "joint products" of protection, there is also a maximum level of use that is sustainable. Beyond this point one moves into the world of tradeoffs between ecological and economic benefits. Excessive use will lead to reef degradation and ultimately, to a decrease in diver numbers. This maximum sustainable use level may be lower than what is desired by local governments or business interests, but must be respected if the investment in marine natural capital is to be economically profitable and if marine parks are going to continue to meet both ecological and economic goals.**

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