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I. Report Title, Author, Organization, Grant Number, Date

Report title: “Economic valuation of the coral reefs of Hawaii”

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II. Abstract

Hawaii’s coral reef ecosystems provide many goods and services to coastal populations. A variety of anthropogenic practices threatens reef health and therefore jeopardizes the benefits flowing from these services and goods. These threats range from nutrients, pollution, sedimentation and overfishing to invasive algae and tourist-overuse. The study shows both the total economic value of coral reefs in Hawaii and presents outcomes for a threat-analysis in three sites (Hanauma Bay, Kihei and Kona coast) where detailed research has been carried out regarding ecologically sound mass tourism, loss of property value due to algae nuisance related to nutrient problems and aquarium fisheries respectively. The study concludes that Hawaii’s coral reefs generate $360 million a year for Hawaii’s economy, based on reef-related tourism and fisheries activities, while the overall value of the state’s 410,000 acres of potential reef area is estimated at $10 billion.

III. Executive Summary

Coral reefs are essential for the livelihood of many Hawaiians, both through tourism and fisheries. Furthermore, reefs dissipate wave energy and thereby protect coastal infrastructure, tourist beaches and communities. Because of their unique biodiversity, they are of great interest to scientists, students, pharmaceutical companies, and others. In addition, coral reefs play an important spiritual and cultural role. These and many other functions give coral reefs a crucial socio-economic value in Hawaii. Various anthropogenic activities in Hawaii negatively impact coral reefs and therefore jeopardize the benefits provided by their services and goods. Threats include overfishing, excess nutrients, invasive algae, sedimentation, and tourism pressure. These threats result from lack of awareness, market failures, un(der)valuation of resources and insufficient enforcement of protective legislation.

The objective of the study is threefold: *(i) to assess the economic value of selected case study areas (see below) and of Hawaii as a whole, (ii) to determine the economic costs of reef degradation; (iii) to compare the costs and benefits of various management options which aim to reverse these trends.*

The following case study sites were analyzed: (i) Hanauma Bay (Oahu), addressing tourist overuse; (ii) Kihei and Kaanapali (Maui), addressing excessive nutrients and algae blooms; and (iii) Kona coast (Hawaii), addressing overfishing;

An integrated model developed under this project formed the basis of the analysis. This model, referred to as SCREEN (Simple Coral Reef Ecological Economic Model), links ecology and economy in a dynamic manner. The model uses a 25-year period (2000-2025); this leaves enough time for the main ecological outcomes to come into effect, while being short enough to allow for predictions about future developments.

Data for the scenarios were obtained through dive shop surveys, surveys on real estate and the hotel/condo business, a tourism and resident survey and an aquarium fisheries survey. In addition, data were obtained from various literature, government statistics and through benefit transfer. This latter technique uses data from comparable sites elsewhere to form a proxy for an area for which no data are available.

Hanauma Bay is the remnant of the inside of a large volcano, whose crater partly collapsed into the sea. The Bay is located southeast of Waikiki on Oahu and is one of the most heavily used marine reserves in the world. The Hanauma Bay Marine Life Conservation District (MLCD), established in 1976. Reef monitoring by CRAMP showed an average coral cover of 25.8 percent at 3-meter depth. Macro-algae coverage was very low, at around 2 percent, while percentages of crustose coralline algae and turf algae were high. Fish were abundant, with densities of 417 fish per 125 m^2 at 3 m and 630 fish per 125 m^2 at 10 m. In the late 1980s, Hanauma Bay was almost being 'visited to death' with 13,000 visitors a day at peak times. These crowds stirred up sediment, touched and trampled the coral and algae, dropped trash, fed the fish and left a slick of suntan lotion on the bay's surface. To decrease these impacts, the number of visitors was reduced by limiting the entry of cars to the parking lot. A $3 admission fee is charged to non-Hawaii residents over the age of 13, as well as a $1 parking charge per car. These fees, together with shop concessions, give Hanauma Bay a solid financial base.

In August 2002, a new visitor education center opened up with an obligatory video to be watched by all new visitors to the Bay. The investment costs of the new center were $13.5 million and operating expenses of the center are estimated at around $ 2 million annually. Is this a worthwhile investment? Our study showed that the overall net-benefits over time of the education program, in comparison to the absence of such a program, are roughly $100 million (net present value at 4% discount rate). The costs of the program over time are estimated to be $29 million, making the program completely economically justified. Our survey also showed that visitors are willing to pay more for their Hanauma Bay experience than the current $3 admission. Visitors spent an average of $38 per visit to the bay, of which the entry fee was only $3. About 85 percent of the respondents went snorkeling or diving. When queried about the value of their experience, only 13 percent felt they had spent too much; on average the respondents were willing to pay $5 more than they actually spent.

Kihei's algae: Algae blooms have been a recurring problem on reef flats off the southern and western coasts of Maui for almost ten years. This has caused significant disturbance to the beach front, both in terms of its u nattractive appearance and unpleasant odor. Potential contributing factors include wastewater discharge, leaching of injection wells, storm water and agricultural runoff, and golf course runoff. This leads to nutrient enrichment of the shallow reef area, which can cause phytoplankton blooms. These blooms limit the amount of sunlight reaching stony corals, thereby affecting their health. The major algal blooms occur in the North Kihei area, which has an algae cover of over 50 percent. Algae cover in South Kihei, which has not had such problems, was estimated at around 5 percent. The North Kihei algae problem is both a costly nuisance and a direct biological threat to local coral resources

Currently, the largest economic cost is the drop in occupancy rates, room rates and property values in North Kihei. According to our survey, these declines can be largely attributed to the algal blooms. One- bedroom units in the 'algae zone' were, over the three year study period, are only ~43% as valuable as one bedroom units in the 'non-algae zone'. Occupancy rates and room rates were equally different between the two zones.

This case study estimated the net-benefits of solving the algal bloom problem in Kihei. Not surprisingly, the annual benefits further decline from $25 million to $9 million if the coral reef gradually disappears and algae blooms continue to occur. However, in a situation where nutrients are successfully reduced,, the annual benefits will eventually increase by almost $30 million. The majority of this increase can be attributed to the growth in property values. It is not clear how the algae blooms can be eliminated. However, the associated economic benefits of their elimination are such that major spending is justified.

Aquarium fisheries along the Kona coast: The aquarium fish industry, though relatively small, is one of the largest inshore fisheries in the State of Hawaii. Its gross sales amount to $3.2 million, with industry profits of $1.2 million. These values have been reasonably stable over the last decade, since spectacular growth in the 1980s. The largest share of the aquarium fish collection, 58% of the State total, takes place along the West Hawaiian coast (Kona coast). In 2002, the estimated gross value and profits for the 22 collectors and 8 wholesalers were US$ 1.8 million and US$ 0.7 million respectively (Table E-3).

In 2000, 35% of the Kona coast became designated Fish Replenishment Areas (FRAs), in which aquarium fish collection is not allowed. This designation was largely due to public

concern that aquarium fish populations were declining. Since then, tensions have subsided and the public accepts present catch effort. The FRAs have limited potential catch areas, but preliminary findings suggest that unprotected areas are now more heavily fished than before. In terms of economic value, the aquarium fishery along the Kona coast remains small in comparison with other economic activities and in terms of its contribution to local welfare. The inhabitants of the Kona coast have a strong attachment to marine life; it is calculated that this is worth around $1.2 million in local snorkel/dive trips, as well as in terms of the non-use value they attribute to coral reefs. In addition, around $7.1 million of tourist expenditure can be attributed to the reefs along Kona coast. In total, the reef-associated benefits along the Kona coast are around $ 17.7 million.

Total Economic Value of reefs for the Main Hawaiian Islands: The outlined case studies, together with general data on fisheries, recreation, property value, and biodiversity, allow us to come up with a 'lower bound' estimate for the Total Economic Value of reefs for the Main Hawaiian Islands. It is assumed that benefits remain constant over time. The time period considered is 50 years and results are presented at a discount rate of 3 percent.

Table 1 shows the composition of the main economic benefits of the coral reefs in Hawaii, as well as the benefits for each of the case study sites. The average annual benefits accruing from the Hawaiian coral reefs amount to $385 million. This leads to a net present value of more than $10 billion (at a discount rate of 3%). This figure represents the asset value of the coral reefs of the Main Hawaiian Islands. The largest contribution (85%) to the yearly benefits of $385 million is the annual value added by recreation and tourism ($325 million). Second in line is the amenity/property value, with benefits of $40 million per annum. The impact of reefs on the total property value in Hawaii is modest, but as total property values are so high in Hawaii, a high coral reef related value is still generated. The third most important benefit is biodiversity. This is partly expressed in terms of reef-related research expenditures ($10 million per year) and partly in terms of non-use value ($7 million per year).

Table 1 Annual benefits and the net present value of the Hawaiian coral reefs and the different study sites

Benefits		Hanauma Bay, Oahu	Kihei Coast, Maui	Kona Coast, Hawaii	Hawaii – overall
Recreation/Tourism	*Million$/year*	36.23	8.02	8.06	325.00
Amenity/Property	*Million$/year*	0.00	18.26	4.57	40.05
Biodiversity	*Million$/year*	1.11	1.71	4.35	17.00
Fisheries	*Million$/year*	0.01	0.10	0.70	2.50
Education spill-over	*Million$/year*	0.22	-	-	-
Total annual benefits	*Million$/year*	37.57	28.09	17.68	384.55
Net Present Value @ 3%	*Million$*	1,053	522	389	10,279

Table 1 also shows the various benefits for the three case studies, as well as the figures for the State of Hawaii. For Hawaii overall, the asset value of its coral reefs are estimated to be worth $10.3 billion. This is the determined as the sum of all future quantified benefits streams over a 50-year period and a 3% discount rate. Regarding the individual sites, the differences are quite surprising. First of all, reefs at Hanauma Bay have a higher asset value (over $ 1 billion) than the whole Kona coast (less than $ 400 million). Also, benefits related to reef-associated amenity/property value dominate in Kihei, while tourism/recreation constitutes over 95% of benefits in Hanauma Bay.

The annual benefits and total economic values can also be expressed on a 'per area' basis. Table 2 shows these values for each of the three case study sites. This enables a comparison between the three case studies in economic value per acre. Not surprisingly, Hanauma Bay is the most valuable site in terms of coral reefs with a net present value of US$10 million per acre, while Kona coast is estimated to have an asset value of US$ 79,000 per acre.

IV. Purpose

The three main challenges of the project were in: (i) formulating a simple yet credible ecological-economic dynamic model; (ii) obtaining a large random sample of reef users in Hawaii; (iii) obtaining all the local data needed to come up with the values for the three sites and for Hawaii as a whole.

The objective of the study is threefold: *(i) to assess the economic value of selected case study areas and of Hawaii as a whole, (ii) to determine the economic costs of reef degradation; (iii) to compare the costs and benefits of various management options which aim to reverse these trends.*

V. Approach

For a detailed description of the work performed, see the executive summary.

A consortium has been formed of a multidisciplinary group with wide experience in the economic valuation of natural resources. The group is lead by Herman Cesar, principal at Cesar Environmental Economics Consultants (CEEC) and Researcher at the Vrije Universiteit in Amsterdam, the Netherlands. The tasks have been divided as follows: (1) Kihei case study by Sam Pintz (local consultant); (2) Kona coast case study by Jan Dierking (UH student); (3) Hanauma Bay case study by Pieter van Beukering (CEEC); (7) The dynamic simulation model will be developed by Pieter van Beukering (CEEC). (8) Report writing and dissemination by Herman Cesar and Pieter van Beukering (both CEEC).

VI. Findings

See executive summary.

Additional work will be carried out under HCRI year 5, focusing on the economics of MPA. This study will be co-funded by DAR and DBEDT.

VII. Evaluation

The project goals were all met (see executive summary). Initially, in the inception report, the plan was to describe 7 case studies. This appeared to be too ambitious and labor intensive. Therefore, it was decided to select 3 case studies to carry out the analysis. For the rest, no modifications were made.

A press release based on the initial findings got broad attention in the local media, both TV, radio, and newspapers. The main report will be distributed widely and will be available on the web. A glossy executive summary will be made available and will be presented at a press conference in early 2003 in Hawaii as well as at the US Coral Reef Task Force Meeting in February 2003 in Washington DC. A summary article will be published in the Pacific Science journal. Furthermore, other scientific publications will follow.

VIII. Signature of Principal Investigator

Herman Cesar