Impacts of Marine Reserves in the Galápagos Islands: Some Considerations

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Abstract. The recent establishment of the Galápagos Marine Reserve (GMR) presents a unique opportunity to analyze the economic implications of using zonification as a tool to manage conflicting claims to a fragile and limited resource. Recognizing that the long-term success of the GMR depends on the cooperation of all of the stakeholders involved, a remarkable feature of the new legislation is that further policy development depends upon analysis of the socio-economic and environmental impacts that the new management regime has on both the users and the ecosystems of the GMR. We consider some of the economic impacts to the residents of Galápagos, and in particular to the fisheries sector, resulting from the use of "no take" zones as a management tool. We develop a simple two-sector fixed labor model to illustrate how the establishment of "no take" zones, which impact the fishing sector, will also affect the tourism sector through both the labor market and biotic mechanisms. Although we find that the establishment of marine refugia passes a rough cost-benefit analysis, we discuss the importance of considering the intertemporal nature of the impacts resulting from the closure of fishing grounds in the GMR when analyzing the economic impacts to the various sectors.

Keywords: Marine Reserves, Fisheries, Ecotourism

1. INTRODUCTION

All over the world, policy makers are working to balance the needs of growing populations with the desire to preserve the natural environment upon which these growing populations depend. The trade-offs between extractive and protective resource uses are often acutely felt in marine ecosystem management, where the interests and goals of various user groups frequently come directly into conflict. Regional management plans have been one approach used by policy makers to balance the demands of various interest groups. Typically, these strategies incorporate some sort of zonification regime, wherein an open access resource is divided into regions set aside for specific uses. In some cases, a particular region may be set aside as a reserve or a "no take" zone dedicated to tourism activities and conservation exclusively. It is believed that the increased revenues generated by tourist activities will offset the losses incurred by reducing the available exploitable resource base for the extractive users, while at the same time creating economic incentives to preserve or protect the environment. When applied to marine ecosystems, a second objective of "no take" zones is to build up the biomass as a form of insurance against overexploitation and to enhance adjacent fisheries via spillovers.

While the establishment of marine reserves is widely applauded by scientific and conservationist interests, the fisheries sector often perceives zonification regimes as simply further limitation on its opportunity to practice the fishing livelihood. Often, the establishment of "no take" zones is highly contentious, and enforcement problematic, particularly in developing countries where regulatory institutions might be weak. The long-term success of marine reserves obviously depends on the cooperation of all actors involved (McManus 1996), and hence it is important to include representatives of various interest groups in the decision-making process, and to assess and balance the needs of, and economic impacts on the various user groups. The recent establishment of the Galápagos Marine Reserve (GMR) in Ecuador represents a multilateral effort to manage conflicting claims on a common marine resource base.

The Galápagos Islands represent a unique situation for analyzing the impacts to various user groups, and in particular to fishermen and the tourism industry, of the establishment of a marine reserve to manage access to valuable marine resources for several reasons. First, in 1998, in response to the increasing pressures and damages wrought upon the fragile habitat of the Galápagos by human activity, the Ecuadorian government enacted the "Special Law for the Conservation and Sustainable Development of the Province of Galápagos." The provisions of the Special Law are widespread, and focus on several principles including: limiting migration to the province, the development of policies which encourage local residents and institutions to capture more of the rent generated from the lucrative tourism industry, and the establishment of the GMR. Second, in addition to fixing the total labor supply through migration control, entry into the fishing sector, as well as the total number of

fishing vessels has been limited, as has total tourist carrying capacity on tourist cruise ships. Employment priority, especially into the lucrative tourism sector, is to be granted to local Galápagos residents. Third, the Galápagos Islands lie 1,000 kilometers off the coast of mainland Ecuador, so the economy displays some of the characteristics associated with an archetypical "island" economy: highly integrated economic sectors, and some locally-determined prices, including wages.

Several interesting and policy relevant questions arise as a result of the management policies introduced by the Special Law, and in particular, by the development of the zonification regime. In general, what will be the economic and environmental impacts of the establishment of the Galápagos Marine Reserve? Given that the total labor supply has been fixed and that entry into the fishing sector is limited, how will fishing effort, and by extension the labor force in Galápagos, reallocate in response to the changing opportunities resulting from management policies to control access to the GMR, such as placement of the zones? The main cost-benefit question that emerges from the marine reserve component of the Special Law is: how will net benefits to all Galápagos residents change with the creation of marine refugia? We ignore secondary impacts associated with service industries for the time being, and instead focus on the effects to the fishing and tourism sectors. We will evaluate some of the potential impacts using a stylized two-sector labor market, and abstracting away from detailed characterization of the production process.

In the next section, we develop a simplified two-sector model with a fixed labor supply in order to illustrate some of the potential economic implications of regulating access to the marine resources by the various users of the GMR. In Section 3, we discuss some preliminary empirical results based on data collected from surveys and interviews in an attempt to quantify the potential scale of the impacts. Section 4 discusses our findings and the direction of future work.

2. THE THEORETICAL MODEL

Both the fishing and tourism sectors use labor and marine habitat as inputs in production. There is a finite amount of nearshore marine area and biomass available for users of the Galápagos Marine Reserve, and the two sectors have competing demands for these marine resources. The tourism sector uses the GMR in a non-extractive way, offering visitors exposure to the marine environment. The other sector dependent upon the marine environment is the fishing sector, which relies on extraction of marine biomass. To some extent, the demands by the two sectors are exclusive. Although both sectors benefit from higher marine biomass and access to larger areas of the GMR, the tourism sector spatially excludes fishermen (diving sites have long been considered off-limits to fishing activities), and the extractive nature of fishing decreases the marine biomass, impacting the quality of the tours offered by the tourism sector.

The tourism sector is assumed to behave competitively, choosing the optimal level of labor by maximizing profits to equate VMP_L with the wage. Although tourism operators pay access fees to the National Park Service for permission to operate inside the Galápagos National Park, these costs are indexed the quality of the tour amenities provided and the capacity of the tour vessels. The tourism sector makes no specific payments for visits to actual sites, and thus benefits accruing to the tour operators specifically from use of the GMR can be considered rents that the tourism sector captures.[1]

In contrast to the tourism sector, the fishing sector is characterized by an open-access situation, where all rents are dissipated. Fishermen note that the catch rates (and their incomes) are declining, even though their effort is increasing, and according to biologists, several fisheries may be on the verge of collapse.[2] Prior to the passage of the Special Law, there was significant inflow into the fishing sector of people who were drawn by the prospect of fishing opportunities in Galápagos. In an open-access scenario, labor will flow into an activity until all rents are dissipated in the sector (Gordon 1954). This will occur where the wage equals the value average product of labor. The unemployment rate in Galápagos is significantly lower than in the rest of Ecuador, and it is reasonable to assume full employment in the province.[3] With a binding labor constraint, the wage becomes endogenous. Assuming two sectors in the economy, labor will be allocated between tourism and fishing so as to equate the value marginal product of labor in the tourism sector with the value average product of labor in the fishing sector, which in turn will equal the endogenous island wage paid to labor in both sectors. This is illustrated in Figure 1:

[1] For simplicity, we assume initially that tour operators are based in continental Ecuador, and that rents from tourism accrue to non-local tourism operators. Thus, all returns to the labor sector come from wage earnings.
[2] Ospina, 1998, 1999.
[3] INEC 1999 Census data.

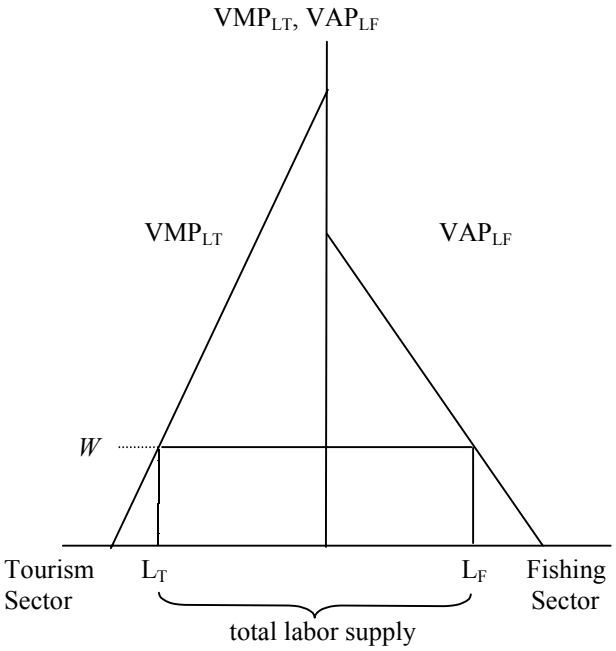

Figure 1

2.1 The Short Run

The initial impacts of the establishment of "no take" zones are graphically depicted in Figure 2 below. Labor is initially allocated across the tourism and fishing sectors in a manner equalizing net wages at w^0. First, there will be some "impact effect" on the fishing sector associated with the immediate reduction in fishable area associated with the closures. This is shown with a downward shift in the value of average fishing product curves to VAP_L', signifying the "first round" effect of being excluded from areas previously fished. With the removal of area previously fished and no other adjustments, fishermen's wages would fall (to w') relative to wages in the tourist sector. If this condition persisted, fishermen would exit and attempt to find new employment in the other sector, driving down wages, all other things equal.

We would expect, however, that soon (on the order of a few months) after the initial closures, fishermen would reallocate fishing effort over the remaining open areas, finding new un- or under-exploited patches, etc. This is depicted by the short run partial recovery in production associated with more intensive exploitation of remaining open areas, a shift upward to VAP_L^1. The degree of this mitigation depends upon fishermen behavior and on regulatory changes in response. If regulators allow fishermen to reallocate effort spatially with no reaction to the higher effort (e.g. by shortening the season in response to higher fishing mortality), then there will be some mitigation of the impact effect, although not enough to fully compensate for the loss in fishable area. In the short and intermediate runs, whether labor exit occurs in response to the losses in fishing income opportunities depends upon labor options in other sectors (which may be enhanced by the policy change), transition costs of entering new occupations, the perceived permanence of the productivity change.

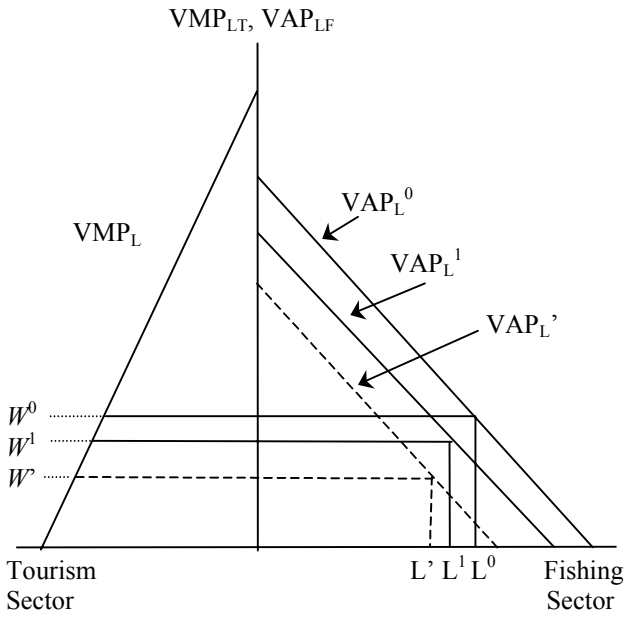

Figure 2

2.2 The Long Run

Over a longer period, the creation of reserves will most likely have some effect on the marine habitat. This should affect both the fishing and tourist sectors in positive ways. In the fishing sector, closed areas will exhibit higher biomass, changes in biodiversity, and potentially, increases in productivity of juveniles and larvae. These increases in productivity may spill over into the remaining open areas, adding to the exploitable biomass. The degree to which these changes take place, and the time that they take to emerge, are issues over which there is considerable uncertainty and disagreement. Most ecologists view the dispersal process as a key determinant of larval and juvenile transport, but little is known either generally or specifically about dispersal and larval transport in real ecosystems. Most hypotheses entertain the likelihood that currents, upwelling, winds, and other oceanographic factors are key, but the manner in which these operate and the times scales over which they operate are uncertain.

In principle, creation of reserves ought to have some positive impact on tourism, shifting the sector productivity curves upward. The mechanism by which

this could happen depends upon the nature of the tourist market and the manner in which individual tourists perceive that reserves increase the value of their Galápagos experience. There are two paths by which tourist sector values might be enhanced. First, tourists and many non-tourists may experience some **existence value** just by knowing that the Galápagos marine ecosystem exists in a well-protected and reasonably pristine state. These existence values presumably also exist for the Galápagos terrestrial system and they are likely to be independent of whether the tourists in question actually view underwater ecosystems. Existence values have been well documented in other cases and a considerable amount of effort has been expended to measure their size and to identify attributes which contribute to the scale of these values. An important issue in the Galápagos case is whether existence values are associated with protection and preservation per se, or whether they are associated with hard measured characteristics of "naturalness" as the system recovers.

This is important, because if existence values are primarily associated with protection, there will be an impact effect in the tourist sector immediately after reserves are created, as there is (in the opposite direction) in the fisheries sector. On the other hand, if existence values are associated with objectives measures of recovery, they would not begin accruing until the system actually begins to respond to the set-aside policies. Second, some tourists may also experience an increase in **use value** associated with marine ecosystems that are more "natural." These kinds of use values should be tied to actual underwater experiences, of course, so that they are likely to be associated with trips involving diving and snorkeling and underwater activities. They also would presumably be associated with objective changes in the marine ecosystem composition, and hence would begin to accrue over time as the reserves began to impact species composition and population sizes.

For the Galápagos economy as a whole, the long run implications of marine reserve creation depend upon the relative shifts in the value of ecosystem services of marine habitat associated with the two sectors. In Figure 3 below, we depict one long run scenario, in which the fishing sector has not fully recovered the lost productivity from habitat loss while the tourist sector has gained moderately from improved tourist willingness to pay. As depicted in this (pessimistic) scenario, the fishing sector losses have been relatively significant and sustained, causing a long run labor shift to the tourist sector. The labor shift has depressed wages overall because the increase in tourist sector activity has been insufficient to absorb fishermen exiting the fishery. In this scenario, fishing and tour industry laborers would not be better off with the policy. Whether the Galápagos economy as a whole would be worse off depends upon how much of the resource rents are captured by Galápagos residents who, for example, own tour facilities. The increased rents might be sufficient to offset labor payment reductions, but that would leave a situation in which overall welfare increased while the distribution of income between recipients turned unfavorably from labor.

In any case, this is but one of many different long run scenarios. The best of scenarios would be those in which both the fishing and tourist sectors gained productivity from the reserves policy, thereby raising labor wages overall and generating rents to some residents. It is conceivable, in principle, for marine reserves to either benefit or harm the Galápagos economy in the aggregate, and also redistribute income among different groups. Compliance with management policies, which in turn influence the long-term health and viability of the ecosystems of the GMR, will be affected by the degree to which the fishing sector is impacted, both in the short and long run. That is why analysis of the sort discussed here and monitoring are important.

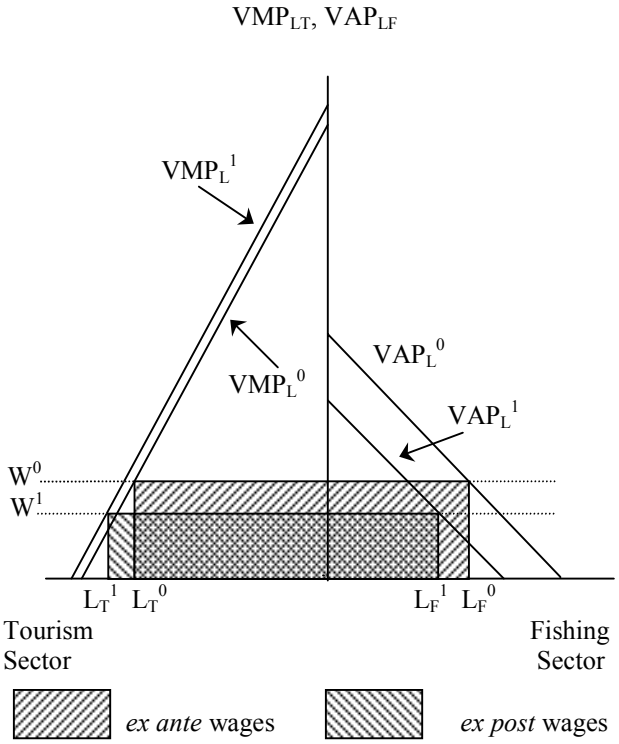

Figure 3

2.3 Intertemporal Considerations

It is critically important to reinforce the fact that the changes in productivity to be experienced in both the fishing and tourist sectors are likely to have different

intertemporal patterns. We would expect, for example, that the fishing sector would experience a short term impact effect associated with closures, a short- and intermediate-term mitigation as fishermen reallocated, and then a longer term recovery effect as the benefits of closures began to spill over into remaining open areas. In the tourist sector, it is reasonable to assume that both existence and use values would change with a pattern reflecting the recovery towards the "natural" unexploited and protected state. Figure 4 below shows the patterns expected in both sectors. The solid tourist benefit curve depicts a scenario where the benefits of an enhanced marine environment to tourism are closely linked to the actual condition of the marine habitat, as would be the case when use values are high relative to existence values. The dashed curve represents a case where the existence, or non-use values are relatively high.

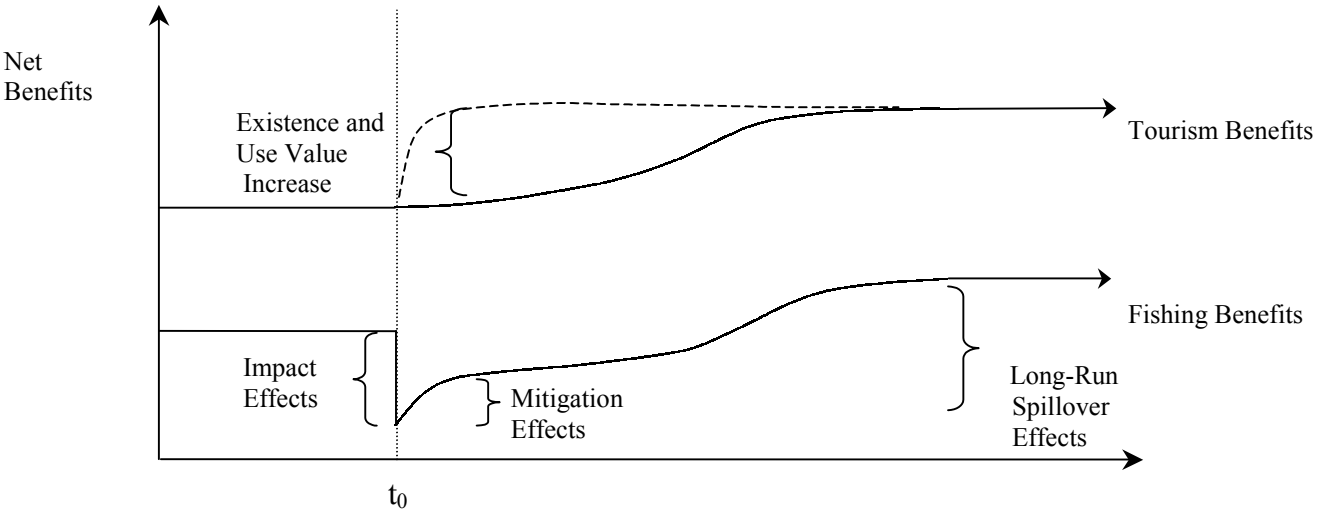

Figure 4

The key point here is that the short term impact effect on the fishing sector is the most important cost, and it will be balanced by the benefits that accrue either gradually as the marine ecosystem begins to recover or instantly depending upon the nature of tourist perceptions. Whether the investment "pays" in a strictly economic sense depends upon the relative size of benefits and costs in both sectors, the discount rate, and the recovery rate. It is conceivable under some conditions (high discount rate and low recovery rate) that the present value of costs may exceed benefits. On the other hand, if the benefits to the tourist sector captured by Galápagos residents outweigh the costs to the fishing sector by large margins, the policy would be more likely to pass the cost-benefit test.

3. AN EMPIRICAL EVALUATION

In late April 2000, the multilateral management authority of the GMR agreed upon the extent and placement of nearshore "no take" zones. In the establishment of the experimental zones, the management plan stipulates which factors should be considered and these include the predicted socio-economic costs and benefits in the short and long-term, as well as the priority areas identified for extractive and non-extractive use, and the important areas for biodiversity. According to the Management Plan, these zones are provisional. The biological, ecological, and socio-economic impacts of the zonification regime are to be analyzed at the end of two years, and adjusted if necessary. The current plans call for total closures of about 23% of the near-shore fishing grounds. Eight per cent of the closed area will be designated as no-take/non-use zones designed to be strict control areas. Another 10% will be no-take zones, but with use allowed that does not involve exploitation. Five per cent will be temporarily closed rotational zones, leaving 77% to be managed under conventional management restrictions. The closed areas cover all kinds of marine ecosystems and are spread spatially throughout the archipelago. Given these anticipated closures, and given the conceptual framework outlined above, we undertook a rough cost-benefit examination of the proposed reserve system on the Galápagos economy.

3.1 Impacts to the Fishing Sector

Ideally, quantification of the very short-run impacts of fishing ground closures would incorporate catch rates by species or fishery in each closed zone, and the percentage of total fishing activity affected by the closures. It is

reasonable to assume that these impacts would vary by zone and by fishery. Fishermen would mitigate the impacts of the closures by reallocating fishing effort to the remaining open fishing grounds. The simplest approach used by some fishery analysts is to assume that the fishermen redistribute uniformly. It is more likely, however, that fishermen would tend to focus their effort in the areas with the highest expected returns. Incorporating this assumption into the assessment entails the elaboration of a behavioral model of site selection, such as a Random Utility Model where the probability of a fisherman fishing in a given site is a function of expected net returns as well as fisher- and site-specific attributes. Finally, the long-term impacts also depend on how the marine biomass reacts to changes in the distribution of fishing effort. To capture these effects, a spatially-explicit model of the marine habitat which incorporates the biological inter-patch dynamics, such as biotic response to changes in the distribution of fishing effort, migration, and larval dispersal would be an appropriate modeling technique.

In this section, we focus on the potential **initial** impacts of the zonification regime. To do so, we assume a 10 – 20% reduction in fishing days as a reasonable estimation of the impact effect on the fishing sector. Our understanding of the negotiation process is that fishermen have generally been reluctant to give up highly productive areas but willing to give up areas that were either overfished, or otherwise historically lightly fished. It is thus likely that the 23% of the marine habitat planned to be set aside probably will not "cost" 23% of recent yield. We consider this first-cut approximation to reflect the worst-case scenario, as we are not considering the mitigation effects of fishing effort reallocation here.

Between November 1998 and January 1999, and again in May 1999, 50 fishing households were surveyed in order to solicit detailed information concerning fishing activities such as effort, costs, income, and fishing methods and technologies. Fishermen were asked about their fishing behavior for the year prior to the survey. In particular, they were asked about which fisheries they participated in, and approximately how frequently they fished, or how many fishing trips in the season they went on. Average duration of trips and catch rates were recorded. All respondents were asked to describe how compensation and cost sharing arrangements were organized. Boat owners were asked to detail provision and fishing gear expenditures for typical trips for each type of fishery they participated in, as well as investment, operating, and annual maintenance costs of their boats. Boat owners also described the division of the catch or salaries paid to crews in the different fisheries, and information about other income generated through the rental or non-fishing use of the boats was also solicited. Crewmembers were asked to describe any costs they incurred to participate in a given fishery, such as food or diving equipment. All fishermen were asked about additional household income. Finally, the survey asked fishermen for their observations about the size and abundance of fish relative to prior years.

Our calculations show that fishing households earn approximately 68.6% of their total income from fishing in Galápagos. There are approximately 500 fishing households, each with an estimated total annual income equivalent to 6,245 U.S. dollars. Each fishing day nets fishermen approximately US$ 15 – 50, depending on the fishery. With a total of 600 fishermen participating in the sector, and an average number of fishing days of 185 per year, total fishing income is US$ 4,375 per household. If we assume a scenario in which households lose between 10 – 20% of their potential fishing days, this translates into a fishing household income loss of US$ 438 – 875 per year, and a total sectoral loss of between US$ 262,500 – 525,000 per year from closures.

3.2 Impacts to the Tourism Sector

The mechanisms for assessing the benefits of setting aside marine refugia within the GMR are less direct. The Galápagos Islands are a renowned ecotourism destination. Visitors typically travel on cruise ships to various terrestrial sites to observe the flora and fauna that are unique to the different islands in the archipelago. As a supplement, most tours also include snorkeling activities at various anchoring sites. In recent years, diving tours focusing on the marine habitat have become increasingly popular. The National Park Service determines visitor sites and total visitor capacity, and fishing has been prohibited in diving and anchoring sites for a number of years. However, it is believed that the density and variety of certain species have been impacted negatively by fishing activities, and that the establishment of "no take" zones will eventually lead to increases in marine biomass in the diving sites. This in turn may be associated with increases in the value of and/or demand for trips to Galápagos. For the residents of Galápagos, increases in the demand for trips may translate into an increase in the demand for labor in the tourism industry as occupancy rates increase on the cruise ships. A second possible affect may be through increased wages as the VMP_L adjusts to reflect price increases. These shifts are dependent on how (potential) changes in conditions of the marine ecosystem affect the world market for trips to Galápagos.

We designed and implemented a contingent valuation survey in order to get some idea of possible magnitudes that tourists might place on added value associated with marine reserves. We asked a series of socioeconomic background questions as well as some questions on

expenditures. We then asked some willingness to pay questions for the whole Galápagos experience. This was designed to ground the answers to the subsequent questions, which asked about how overall willingness to pay would change with a marine reserve system in place.

Between November 1998 and January 1999, and again in August and September 1999, exit surveys of tourists were undertaken. In the first sample, 517 surveys were completed, and in the second sample, an additional 367 visitors were surveyed. The first survey concentrated on total trip experiences and expenditure patterns, while the focus of the second survey shifted more toward eliciting travel costs measures and non-market valuations of the environmental qualities of the Galápagos. Because of significant differences between the incomes and expenditure patterns of foreign and Ecuadorian visitors, we divided visitors into two groups.

According to the exit surveys, foreign tourists spend an average of US$ 3676.67 for vacations that include a visit to Galápagos, of which 15.1%, or US$ 553.68 goes directly to the Galápagos. For 49% of those in our survey, visiting the Galápagos was the primary reason for their trip to Ecuador. Visitors to the Galápagos who are Ecuadorian residents spend an average of US$ 932.32 on their vacations. Ecuadorian visitors spend US$ 339.26, or 36.7% of their total expenditures directly to Galápagos accounts. Considering that there were 50,351 foreign visitors and 14,440 Ecuadorian visitors to Galápagos in 1998, the tourism industry generates approximately US$ 33 million for the Galápagos economy. It is important to note that these figures do not take into account multiplier effects, nor leakages, but are merely gross revenue amounts based on our exit surveys. Our findings are that the mean foreign tourist willingness to pay for the creation and maintenance of marine reserves is approximately US$ 53 per person/trip, and the mean willingness to pay of Ecuadorian resident visitors is US$ 6.36. Given the number and composition of visitors to Galápagos, this implies that the aggregate annual benefits, expressed as a willingness to pay, are on the order of US$ 2,745,000.

We did not find evidence of any incremental willingness to pay associated with on-site use, as represented by scuba and snorkeling activity. We interpret this finding as supporting the notion that respondents are expressing a pure existence value, or a willingness to pay for the creation and protection of underwater sanctuaries, even when they may not take the opportunity to actually dive or otherwise view the underwater habitat. If that view is reasonable, it also sheds light on the perceived time path of benefits illustrated in Figure 4. The benefit stream for the tourist sector would more closely follow the dashed path. If our interpretation of the survey results is correct, respondents would actually be willing to pay for the protection of the closed areas, independent of their actual attributes.

Our results are preliminary, of course, and they raise as many questions as they answer. We may be finding little evidence of use value because of a small sample size, or because of a non-representative sample, or for any number of other reasons. If there is some kind of enhanced willingness to pay for tourist trips that focus on underwater experiences that are improved by zonification, it would be worth exploring the diving, snorkeling and scuba market more thoroughly. Some tourist representatives (and fishermen) interviewed discussed confidence that the dive market was the next source of tourism "value added" and that it might be a particularly important source of employment for the unlicensed splinter fleet of small day-boat tour operators. It is possible, if the demand exists, that a new market might develop in response to more pristine underwater habitat created by no-take zones. This is a topic for future investigation.

4. SUMMARY

It is very important to note that although at a first glance, it appears as though the establishment of "no take" zones within the GMR easily passes a cost-benefit analysis, there are several important caveats. First, although the willingness to pay results indicate a potential value for the protection of the marine ecosystems, it does not necessarily follow that these benefits will accrue to the residents of Galápagos. In fact, many of the local residents who are employed in the tourism sector as considered in this analysis are employees on cruise ships, rather than owners. As such, their returns are in the form of wages instead of rents. It is conceivable that the increased willingness to pay might translate into benefits for local residents through a number of mechanisms. For example, although the total number of cruise ships and their itineraries are fixed, an increase in the protection of the marine habitat may lead to higher occupancy rates, and thus an increase in the demand for labor in the tourism sector. Furthermore, an increase in demand for tours in Galápagos may drive the price of tours up, which in turn may lead to increased wages. Changes in the structure of the tourism sector, such as an increase in the number of tours devoted to diving activities may also benefit residents of Galápagos, as fishermen and other long-term residents exploit the comparative advantage of their familiarity with the marine environment. However, most of these adjustments will take place sometime in the future, and must be discounted appropriately.

A second important consideration is that the costs of the closure of certain fishing grounds will, in contrast, be borne directly by the fishing sector in the short run. If

fishermen do not adjust their spatial pattern of effort and if fishermen do not reduce overall participation, the first-cut approximation presented above would be a reasonable measure of the worst-case scenario. But fishermen will adjust, of course, and hence we need to determine the kinds of adjustment likely to take place as a second step. The establishment of marine refugia could lead to positive spillover effects, as mobile fish populations move into areas open to fishing, leading to increasing catch rates in the remaining open areas. *A priori*, the scale and scope of potential benefits are difficult to determine, and must be discounted appropriately. In addition, because the Galápagos economy is so isolated, the displaced fishermen will enter into the labor market of the other sectors of the economy, in particular into the tourism sector. This has the potential to drive down wages paid to labor in general.

In sum, the results of our findings are somewhat inconclusive. While a basic cost-benefit analysis indicates that the establishment of marine refugia in the GMR has the potential to benefit residents of Galápagos, we find that it is critical to consider the institutional and environmental settings when analyzing the implications of management policies. In particular, it is critical not only to consider the biological linkages inherent in the system, but also the linkages created through a fixed labor supply. Because of the fixed labor supply, it is important to understand the full social costs and benefits of alternative policy regimes in the Galapagos, including zonification. These social and environmental costs and benefits are not only important from a welfare point of view. They also create social incentives and disincentives for complying with new regulations, and these obviously can influence the effectiveness of any regulations. The new regulations governing the use of the GMR will affect different sectors of the economy at different times and in different ways. Special care must be taken to elaborate policies that enable the benefits accruing to the tourism sector to be channeled to those bearing the costs in the fishing sector.

Many proponents of reserves have pointed out that there are benefits other than average harvest benefits associated with reserves. One oft-cited benefit is the so-called "insurance" benefit that hedges against natural shocks and management mistakes. In a fishery in which exploitation is uniformly and homogeneously spread over space and at a relatively high exploitation rate, perturbations and mistakes endanger the whole population. In contrast, if certain areas are protected from all harvesting, they serve as potential reservoirs of reproductive capacity if other areas are endangered. Another benefit of closed areas may be associated with research. Most management that depends upon modeling the exploited population must be parameterized to capture critical life history parameters and processes. One of the parameters that age- and size-structured models are most sensitive to is natural mortality. Measuring natural mortality and distinguishing it from fishing mortality in an exploited population is difficult. Having various fished and unfished areas to sample and survey in increases the chance of accurate depiction of important life history processes; in turn, we can expect modeling to be more useful to making sensible management decisions.

The physical and economic circumstances of the Galápagos create an extraordinary opportunity to analyze in detail the implications of the new policies enacted in the archipelago, both to the sectors directly affected by the new zonification regime as well as to the rest of the economy of the islands. Because the archipelago is situated 1,000 kilometers from the rest of Ecuador and policies to regulate migration to the province have been enacted, the economy of Galápagos is different than that of the rest of the country, and because of high transactions costs between the islands and the mainland, many of the prices of the province are locally determined. In addition, the economy is highly dependent on the state of the marine environment, both directly (the tourism and fishing sectors) and indirectly (the service and commerce sectors).

The continued viability of the unique habitat that defines the Galápagos depends in part upon the successful implementation of a management scheme that is recognized as legitimate by the users of the Galápagos Marine Reserve. Enforceability of the rules and regulations governing use of the GMR will in turn depend upon compliance by the actors whose behavior is to be regulated and modified by the management policies. One of the objectives of the Special Law was to modify policy-making institutions so as to incorporate members of the various long-term stakeholders into decision-making bodies, with the assumption that these user groups would have a common interest in the sustainable management of the resource base upon which they all depend. Additionally, as participants in the decision-making process, these groups might have more incentive to comply with the management policies instituted. A potential complication arises when the interests of different sectors are in direct conflict. The decision-makers will be better able to balance the conflicting claims upon the resources if they have more data available to them. In turn, users of the GMR will be more willing to accept the decisions made if they themselves are informed, and they feel that the decision-makers base their decisions on carefully collected data. Thus, the development of an analytical tool capable of assessing the economic impacts of various policy institutions using actual economic and biological data will directly augment the policy-making process for sustainable management of the resources of the Galapagos Marine Reserve.

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