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Discounting, Amenity Values, and Marine Ecosystem Restoration

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Abstract *Colin Clark, during his wrap-up of the 2005 Biennial Forum of North American Fisheries Economists that took place at the University of British Columbia, Vancouver, Canada, challenged participants regarding discounting as a barrier to demonstrating the economic viability of ecosystem restoration. Through this contribution, we hope to initiate a conversation among marine resource economists on the role of discounting on ecosystem restoration and the long-term, sustainable management of marine resources. We relate the problem of discounting benefits of ecosystem restoration to that of valuing the amenities that restored ecosystems could produce, and suggest how empirical research might contribute to the debate over the proper discount rate to apply in valuing natural and ecosystem resources.*

Key words Discounting, ecosystem restoration, capital investment, ecosystem services, net benefit, utility.

JEL Classification Codes Q22, E2, E3, C1, C2.

Introduction

At the 2005 Biennial Forum of North American Fisheries Economists that took place at the University of British Columbia, Vancouver (B.C., Canada, May 25-27, 2005: www.feru.org), Colin Clark, during his wrap-up of the meeting, threw a challenge to participants. He asserted that economists needed to address the role of discounting as a barrier to demonstrating the economic viability of ecosystem restoration. Discounting is the means by which economists compute the present values of policy alternatives. It is standard to discount the net benefits that will accrue in the future and compare them to net benefits that can be achieved today (Koopmans 1960; Heal 1997) to help decide whether or not to implement a policy.

Discounting has attracted considerable attention from economists since Böhm-

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Bawerk (1889) and Fisher (1930) invented intertemporal preferences. There are many arguments for and against standard discounting in the literature (Baumol 1952; Sen 1961; Clark 1973; Arrow 1979; Burton 1993; Schelling 1995; Chichilnisky 1996; Goulder and Stavins 2002). This is because discount rates used in these time stream comparisons can have a big impact on the apparent best policy or project, with potentially vast consequences for society (Nordhaus 1997).

Another problem with demonstrating the economic feasibility of marine ecosystem restoration is that commodity production (*e.g.*, fish catch) represents only part of their value to people (Eggert 1998). Ecosystems also produce services—amenities—that directly contribute to well-being (Daily 1997; Costanza *et al*. 1997), but are rarely considered alongside commodity values in restoration studies. Through this contribution, we hope to initiate a debate among marine resource economists on the role of discounting and amenities on the value of ecosystem restoration and the long-term sustainable management of marine resources. We relate the problem of discounting benefits of ecosystem restoration to that of valuing the amenities that restored ecosystems could produce, and suggest how empirical research might contribute to the debate over the proper discount rate for restoration investments.

Point of Departure: The Problem with Discounting

We start in a provocative way by asserting that the issue of discounting and ecosystem restoration has typically been framed as a problem of present discounted value over time of commodity production from the ecosystem. In this formulation of the problem, the market value of gains in the distant future rarely justifies the up-front cost of foregone harvests. The figures that follow, taken from Sumaila (2004), support this statement.

Figure 1 plots the catches obtained from simulating the Icelandic marine ecosystem under two management options; namely, status quo and restoration. Figure 2 graphs the profile of discounted value from the two management options using a discount rate of 7%. The model predicted high initial total average catches under the status quo option. But this declines steadily from year to year until it approaches zero by the end of the 100-year simulation period. On the other hand, average catches start low in the restoration model and remain so for 25 years, after which the ecosystem has been restored and a higher level of average catch can be sustained. The restoration effort then starts to pay off with higher steady catch levels until year 100.

We see from figure 2 that when discounting is applied on the net benefits from the catches (production), average net benefits are high initially but decline rapidly, approaching zero by year 35 under the status quo regime. The picture differs slightly under the restoration scenario. With the restoration option, average net benefits start low and decline slowly until year 26 when they receive a sudden increase, signaling the end of the restoration effort and the resumption of higher sustainable average catch. It should be noted that in both the status quo and restoration scenarios, benefits that accrue in the distant future count for nothing even though their harvests are high under the restoration model. Since the status quo delivers benefits early in the time horizon, the area under the status quo option is higher than that under the restoration scenario, implying that the net present value from the status quo option is higher than that from the restoration option. Hence, it is not economically sensible to restore the ecosystem.

We argue that the reasons we face the barrier mentioned by Colin Clark and supported by the figures above are twofold. First, we are looking narrowly at only production value. Second, the production values are discounted heavily. We suggest that, in fact, these are related problems.

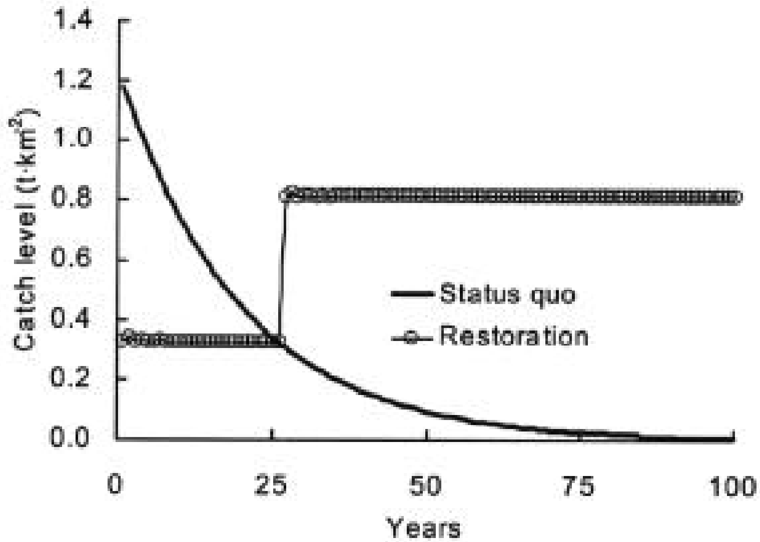

Figure 1. Profile of Catches under the Status Quo and Restoration Management Options

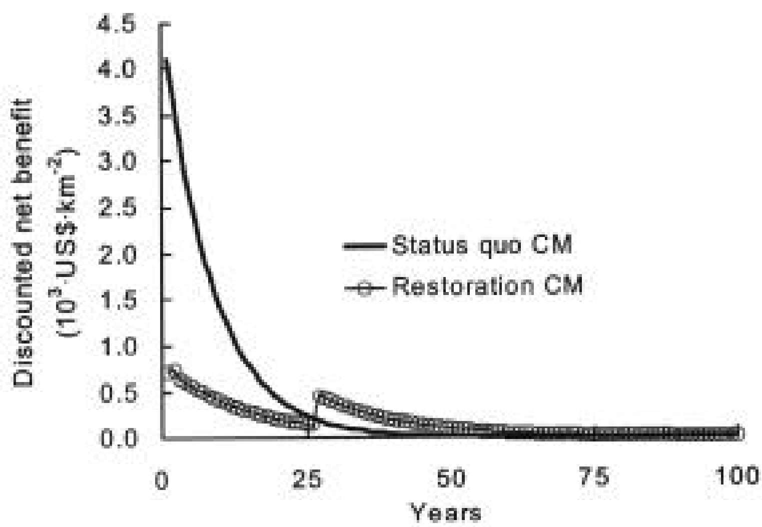

Figure 2. Net Discounted Benefits Obtained under the Status Quo and Restoration Management Options

Ecosystem Restoration and Amenity Values

While economists have discussed amenity values for many years, there is surprisingly little research that attempts to quantify their contribution to the benefits that might be produced by restored marine ecosystems. Evidence from the few empirical studies that do estimate amenity values of ecosystems suggests that such values are typically substantial, and often exceed commodity values. Amenity values include use and nonuse values.

One obvious contribution ecosystems make to amenity use values is in the marine recreational fisheries (Gillig, Ozuna, and Griffin 2000; Breffle and Morey 2000; Bockstael, McConnell, and Strand 1989). Tisdell (1983) noted that annual expenditures on recreational fishing in Australia exceed the gross value of commercial fisheries by several fold. Restoration of depleted fisheries would, in many cases, significantly improve recreational fishing opportunities, but this has received little study. On the other hand, a number of studies has directly related water quality to marine recreation values (Freeman 1995; Kaoru 1995). Nunes, van den Bergh, and Jeroen (2004) estimated that recreation, human health, and marine ecosystem restoration benefits associated with water quality improvements at a popular Dutch beach resort would be worth at least 225 million euro.

Ecotourism is an economic activity that thrives on ecosystem health. Yeo (2002) found in a contingent valuation survey that visitors to a Malaysian marine park were willing to pay an average of $US4.20, amounting to nearly $US400,000 in annual benefits. This evidence corroborates that of similar contingent valuation studies of tropical forest ecosystems. For example, van Beukering, Herman, and Janssen (2003) found that the ecotourism and biodiversity value of conservation of a Southeast Asian tropical rainforest park subject to illegal logging was worth $US5 per visitor, far exceeding commodity values of development. A survey by Naidoo and Adamowicz (2005) found that increasing biodiversity would raise the value of a central African tropical rainforest to ecotourists from $US0.60 per ha. to $US1.35 per ha.

Non-game species often comprise a key ingredient of marine ecotourism (Davis and Tisdel 1999), and protection of these species may contribute to local economic values in a variety of ways. In a contingent valuation survey, Solomon, Corey-Luse, and Halvorsen (2004) estimated that residents of a Florida county would pay an average of $US10.25 per year for manatee protection, adding $US192,000 annually for the county. However, protecting manatees would add another $US300,000 annually in ecological services by controlling plant growth in navigable waterways.

As the Solomon, Corey-Luse, and Halvorsen (2004) study suggests, ecosystem services potentially provided by restored marine ecosystems go beyond the amenity values of recreational and tourist users. Moberg and Folke (1999) review the literature on benefits of coral reefs, including coastal protection from storms. Holmlund and Hammer (1999) catalogued ecosystem services provided by fish, including fundamental services for regulating and linking ecosystems, and services based on human use values, such as food production, recreation, cultural amenities, and health. Costanza *et al*. (1997) in their world survey of ecosystem services, estimated that food production contributed only $US15 out of the $US252 per ha. annual value of ocean ecosystem services and only $US93 of the annual $US4,052 per ha. of coastal ecosystem services. While restoration of these ecosystems to full productivity would change only a portion of these values, Costanza's survey suggests that restoring cultural, recreational, and biological control services might greatly exceed increased food production values.

Amenity benefits of restored marine ecosystems also include nonuse values, when tangible and well-publicized across a large population, can add to a large number. In one well-known example, Carson *et al*. (2003) found in a contingent valuation survey a median willingness to pay of $30 per U.S. household to avoid another *Exxon Valdez* oil spill, adding $US3 billion of value to the nation.

Discounting and Amenity Values

A number of economists have suggested specific alternatives to a fixed periodic discount rate based on capital markets or aggregate income growth when evaluating environmental conservation or restoration projects. Among suggested theoretical approaches are hyperbolic discounting (Gowdy 1996), gamma discounting (Weitzman 2001), and intergenerational discounting (Sumaila and Walters 2005). What these approaches have in common is that they discount benefits accruing in the distant future at a lower periodic rate than benefits accruing in the near future. That is, they involve time-inconsistent preferences.

Time-inconsistent Preferences and Amenity Values

There are at least two reasons why people might rationally believe that in the more distant future they, or their descendants, might have different relative marginal utilities from the present as related to ecosystem restoration. First, ecosystem amenities are generally public goods. So, even if property rights to ecosystems were fully specified, it would be difficult for the owners of these rights to receive compensation for the amenity values they produce. In practice, many ecosystems are subject to common property extraction. Consequently, amenity values derived from ecosystem services are likely to be substantially under-produced in the present. This is why Arrow, Dasgupta, and Maler (2003) suggested a lower, externality-adjusted discount rate for environmental protection expenditures.

A second reason is that commodity production from ecosystems—like all commodity production—benefits from technological change and capital accumulation. As a consequence, the production set of commodities keeps expanding; commodities are becoming less expensive, and real incomes are rising. For example, fish from farms are getting cheaper relative to wild fish harvests, while making the latter also cheaper over time. People see this happening and might rationally expect it to continue. As commodities become ever more abundant, the *relative* value of amenities grows, consistent with a declining discount rate over time for benefits of ecosystem restoration (Weitzman 1994). Settle and Shogren (2004) demonstrated this point empirically using experimental methods to elicit preferences for restoring native over exotic fish species in Yellowstone National Park.

These arguments suggest that the marginal utility of distant future amenities produced by restored ecosystems will generally be greater, relative to today's commodity values, than would be calculated using market-based discount rates. This is consistent with a declining discount rate, or with rising marginal utilities of amenities, which we now illustrate with a simple model.

A Simple Model

Undervalued amenities and inappropriate discounting might, therefore, be seen as two sides of the same problem. To illustrate this point, consider a model in which utility, U, depends in each time period on per-capita commodities, C, and amenities, *A*. Both amenities and commodities are functions of a stock of natural capital, *N*. However, commodities include two components that are perfect substitutes: one that derives from natural capital (*e.g.*, seafood harvests from wild stocks), and the other, let's call it *M*, that is produced by artificial means (*e.g.*, farm, manufacturing, and services production).

If utility over time is subject to a periodic discount factor, ρ, a simple two-period formulation of the model might look like this:

$$U = \mathrm{U}(C^1, A^1) + \rho \mathrm{U}(C^2, A^2), \tag{1}$$

where the superscripts refer to the time period, and:

$$C^i = f(N^i) + M^i;$$
$$A^i = g(N^i),\ i = 1, 2.$$

Consider two investments, based on withholding identical amounts of current consumption, C^1: (1) an investment of x in natural capital that increases N^2 proportionally by an amount δx; (2) an investment of y in artificial capital that expands M^2 by an amount αy. For simplicity, let us assume that $N^2 = N^1 + \delta x$, and that $M^2 = M^1 + \alpha y$. The change in utility is a loss in current consumption of commodities and a gain in future consumption of both commodities and amenities.

A natural capital investment will yield a positive net change in utility if:

$$U_C{}^1 < \rho\delta\, [U_C{}^2 f' + U_A{}^2 g']. \tag{2}$$

The superscripts refer to the time period for evaluating the partial derivatives (since the levels of consumption of *C* and *A* may differ by time period). Correspondingly, the investment in artificial capital yields a positive net change in utility if:

$$U_C{}^1 < \rho\alpha\ U_C{}^2. \tag{3}$$

If we observe people making the positive artificial investment, *y*, based on borrowing in competitive capital markets, then inequalities in equations (2) and (3) imply that the natural investment is also feasible if:

$$\delta\, [f' + (U_A{}^2/U_C{}^2)\, g'] \geq \alpha. \tag{4}$$

Inequality (4) provides a benchmark for assessing the merits of a natural capital investment project without reference to the discount factor, ρ, which is unknown and the subject of controversy. Cost-benefit analyses of natural investments, however, typically consider only whether the commodity production payoff, $\delta f'$, exceeds the opportunity cost of a comparable artificial capital investment, α. The correct comparison would be to compare that payoff, $\delta f'$, to a generally smaller amount, $\alpha - \delta\, (U_A{}^2/U_C{}^2)\, g'$.

The model suggests that the opportunity cost of an investment in natural capital is related not only to the corresponding artificial investment return, α, but to the role of natural capital in creating amenity value. The correct opportunity cost of capital should be adjusted downward by the amount in which the investment in ecosystem restoration increases amenity values in the future period. The more that ecosystem restoration contributes to amenity values, the easier it is to justify it as an efficient investment of resources. Even if restoration adds nothing to commodity values ($f' = 0$), the investment could be justified if amenities are sufficiently scarce.

Concluding Remarks

To deal with the barrier mentioned by Colin Clark during his wrap up of the 2005 NAAFE Forum, we have argued that economists currently look mainly at only production value from marine ecosystems, and then discount these values too heavily. Without taking into account the total economic value of the ecosystem, we are obviously undercounting the benefits. With high discount rates, no matter how large the flow of current value benefits, their present values are quickly reduced to nothing in the NPV equation. We show how adjusting the future benefits upward to include amenity values is equivalent to adjusting the discount rate down. We suggest that adjusting the discount rate derived based on the opportunity cost of capital, by the amount in which the investment in ecosystem restoration increases amenity values, presents an empirically based approach to lowering the 'Clark barrier.'

Marine resource economists can, therefore, contribute to the conversation about discounting by measuring the time-varying amenity values as done in Settle and Shogren (2004). This would provide one fruitful approach to reconciling ecological and economic values. This is not to say that economists never consider amenities in utility functions (for example, Dasgupta 2001, p. 136). Rather, that the connection between amenities as an explicit argument of utility and intertemporal utility outcomes is not strong in the project evaluation literature. If quantification of amenity values is impractical in specific restoration cases, then empirical studies of similar ecosystems in similar economies could nevertheless provide the basis for alternative discount procedures to correct for the undercounting of future welfare with conventional discounting.

The discussion herein illustrates a few obvious points. First, ecosystem restoration is more likely to be economically beneficial to rich, growing economies—those in which amenities are scarce and valuable relative to commodities. An economy that is richer in commodities will value the uncounted marginal amenity production from restored ecosystems more, relative to the counted marginal commodity value. As Weitzman (1994) pointed out, "as an economy develops, the 'terms of trade' turn in favor of the environment," due to scarcity factors (habitat loss) and income elasticity of amenities.

Second, resolving property rights issues to common pool resources will not necessarily improve the economic justification for ecosystem restoration, unless the amenity improvements are explicitly taken into account and the high discount rate problem is tackled.

Third, education by ecologists about the intrinsic value of healthy ecosystems might improve the economic justification for ecosystem restoration—by increasing the degree to which people value the amenities that restored ecosystems could provide. Ecologists argue for intrinsic values of biodiversity. Economists prefer to focus on future uncertainty, positive externalities, and other "hidden benefits." But, as long as such hidden benefits take the form of distant increments to consumption, they will be difficult to justify. We suggest that instead of simply discounting consumption over time, economists need to pay more attention to what affects utility today and tomorrow.

Finally, education by economists on the consequences of high discount rates on our ability to manage marine ecosystems for the long term will help skeptical public decision makers get over their skepticism about the need to adopt alternative discounting approaches.

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