WHALING IN THE PRESENCE OF ECOLOGICAL AND MARKET LINKAGES AND THE THREAT OF BOYCOTTS

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ABSTRACT

The activity of commercial whaling is contentious, drawing the ire of animal rights and conservation groups, who threaten boycotts of whaling nations' products. Whaling also has opportunity costs: in addition to existence value, whales provide nonextractive use values, *i.e.* whale watching. On the other hand, proponents of whaling argue many whale stocks are now plentiful enough to support sustainable commercial harvests, and some empirical evidence suggests that whales, as predators, may have an adverse effect on yields from commercial fisheries such as cod. In addition to moral and normative considerations, the components of a nation's decision whether or not to engage in whaling are the rent potentially emerging from the whaling industry *per se*, the ecological and market linkages to the commercial fishery and tourism industries, and the potential for whaling-induced boycotts of other goods the country produces. We present a bioeconomic framework for analyzing these tradeoffs and use graphical representations to explore potential optima with regard to whaling, whale-watching, and fishing. The qualitative implications of this model are ambiguous: oe can conceive of scenarios where some whaling is optimal and even where subsidization of whaling is rent-maximizing, but in many cases market pressure against whaling makes it most efficient not to engage in this activity.

Keywords: International markets; fishery; whaling; tourism; boycott

INTRODUCTION

Large marine mammals, such as the great whales, are valued by human beings for many different reasons. Beginning with the Basques in the 11th century, whales were viewed historically as a resource to be exploited for whale oil and a variety of other products, including the harvest of their meat as a source of food protein. Overexploitation of many of the world's whale stocks led to a series of increasingly stringent conservation measures in the 20th century, culminating in a worldwide moratorium on commercial harvests, beginning in 1986.

At the time nations were debating the imposition of the whaling moratorium, a new ecotourism industry began to take shape, focused on viewing whales in their natural habitats. This industry grew from a minor activity from as early as 1955 to a $1 billion industry worldwide by the late-1990s (Hoyt 2000). Whale-watching now is offered in nearly 500 communities around the world, with more than nine million trips taken annually.

As whale stocks begin to recover, whaling advocates continue to pressure the International Whaling Commission (IWC) to relax its moratorium. The IWC was established to manage dwindling whale stocks, and the moratorium was implemented as a conservation measure, not as a permanent prohibition of whaling. Regardless of this management role, the resumption of whaling on recovered stocks is by no means assured. The political reality of the situation is that some nations favor sustainable harvests and others favor preservation (Aron *et al*. 2000). In the meantime, small numbers of whales of some species continue to be taken by nations refusing to sign onto the moratorium, and, under IWC rules, by special permit to further scientific research and by indigenous peoples for subsistence.

Those who promote the growth of whale-watching as a nonconsumptive use of whales are concerned about the threat of future relaxation of the whaling moratorium and the resumption of commercial whaling by some nations (Bjorgvinsson 2002). If the moratorium is lifted, it seems unlikely that whale stocks will be threatened

significantly by the resumption of commercial whaling, because limits would be placed on allowable catches. Whale-watching proponents are concerned as much about the *notion* of whaling as they are about the *numbers* of takes (Hoyt and Hvenegaard 2002). They worry that just the knowledge that whaling is sanctioned by a nation might discourage ecotourists from making visits (Parsons and Rawles 2003). Indeed, in some small countries like Iceland, most whalewatchers are foreign tourists and there are concerns that the larger tourist industry could be affected adversely (Alvarez 2003).

In this paper, we analyze the tradeoffs between commercial fisheries, whaling, tourism – including whale-watching, and other parts of the economy. We develop a bioeconomic framework for determining the efficient intensity of whaling – if indeed maintaining a whaling industry is cost-effective at all – in the presence of market forces that affect the sustainable rents emerging from such an industry.

Whaling and Tourism

Table 1 presents data on average catches of large baleen whales by several countries during the fifteen year period 1988-2002 (IWC 2004). Only Norway, exercising its legal right to object to the IWC moratorium, has reported commercial catches of large whales (minkes) in recent years. Small artisanal fisheries for baleen and toothed whales, including dolphins, occur in many locations, but there are few published reports on these fisheries. For example, in the Danish Faroe Islands, the local government has compiled statistics showing that as many as 1,000 long-finned pilot whales, a small toothed whale species, are killed each year in the drive fishery (ENS 2002). Other artisanal fisheries certainly exist, such as those in the Philippines and in Indonesia for Bryde's whales, but the existence of such fisheries often is difficult to validate, and catch data are virtually nonexistent.

Most of the countries listed in Table 1 are permitted under IWC authority to catch a limited number of large whales for aboriginal subsistence purposes. For example, the Alaskan Eskimo and the native peoples of Chukotka (Russia) are allowed to catch up to 280 bowhead whales during 2003-2007. Annual bowhead catches are limited to 67 per year, and unused quota of up to 15 whales may be carried over from year to year. During 2003-2006, a quota of 620 eastern North Pacific gray whales is allowed (with no more than 140 in one year); most of these are taken by Russian native peoples, but a few are now being taken by the Makah people of Washington State.

Several Caribbean Island countries, including St. Vincent and the Grenadines, St. Lucia, Antigua and Barbuda, Dominica, Grenada, and St. Kitts and Nevis, are permitted by the IWC to harvest small toothed whales and dolphins for aboriginal subsistence purposes. Data on these harvests are reported infrequently, if at all. Much of the whaling in these small island nations is virtually unregulated, and reports sometimes surface of the killing of larger whales, including orcas, Bryde's whales, and sperm whales (Sutherland 2001). The Bequians of St. Vincent and the Grenadines are allowed to harvest up to four humpback whales per year for aboriginal subsistence purposes. Concerns have been voiced over the killing of females with calves, which is not permitted. Japan has argued unsuccessfully for many years for an IWC allocation of aboriginal subsistence quota for the residents in four of its coastal villages.

Other countries, including most prominently Japan but also including Iceland and Norway in the late 1980s and early 1990s, have caught limited numbers of baleen whales under IWC scientific permits. One rationale for whaling as a form of scientific research is to gain a deeper understanding of the relationship of the whale stocks to the ecosystem of which they are a component. Scandinavian fishery scientists have been especially concerned about the potential effects of larger whale stocks on commercially important species of fish, including cod, herring, and capelin. Simulation models have been developed to analyze these effects (Schweder *et al.* 2000; Bogstad *et al.* 1997; Stefansson *et al.* 1997), but the results are preliminary and not yet fully in agreement. Even so, Flaaten and Stollery (1996) develop a bioeconomic model to estimate the cost to the cod and herring fisheries of allowing minke whale stocks to grow larger.

Table 2 contains data on the importance of whale-watching to locations or countries involved in whaling. The data are from 1998, and include locations for which we have precise take data (*e.g.*, aboriginal subsistence catch of bowhead whales in Alaska); those for which we have precise historical take data but which are not now involved in whaling (*e.g.*, commercial catch of fin whales in Iceland); those not now involved in whaling but contemplating resumption of whaling (Iceland, Tonga); and those for which we have imprecise or

unsubstantiated data on takes (*e.g.*, the small island developing states in the Lesser Antilles). Most of these data were compiled by Hoyt (2000) in a report to the International Fund for Animal Welfare (IFAW). For each location, we present the number of trips, the direct expenditures (ticket receipts), the future potential of whale-watching as an industry, whale-watching direct expenditures as a percent of tourist receipts, and tourist receipts as a percent of gross national product.

The data suggest locations where we expect whaling and whale-watching might come into conflict. Such locations include those with a high potential for growth of the whale-watching industry as well as a tourist industry important to the local economy, or where whale-watching is important to the tourism sector, or both. Small developing island states, such as those in the Caribbean where whaling is an artisanal custom, but where it may be difficult to argue that it is conducted for aboriginal subsistence purposes, may be the best examples. Environmental groups, such as Sea Shepherd, argue that tourists will be dissuaded from visiting these destinations if whaling continues (Sutherland 2001). Others, such as Greenpeace, actively promote whale-watching as an alternative to whaling, hoping the former will be seen as a substitute for the latter, and relying upon the assumption that the two uses are mutually incompatible.

Consumer Boycotts and Trade Sanctions

The potential exists for whaling to impose an external cost on a country's economy, particularly on ecotourism activities, such as whale-watching, that are closely linked to marine mammals (Hoyt and Hvenegaard 2002). For example, Bjørndal and Conrad (1997) find losses to Norwegian exporters on the order of $1-2 million (2004 dollars) as a consequence of Norway's decision to resume the commercial harvest of minke whales in 1993, although these losses are thought to be only short-run. While the scale of external effects and their incidence might be debated (Moyle and Evans 2001), there seems to be general agreement that they exist.

Reduced tourist visits or lower numbers of whale-watching trips also would be evidence of the external costs of whaling. The contraction of tourist demand as a consequence of a particular policy or activity is a type of consumer boycott. In 2002, several environmental groups demonstrated in opposition to whaling and urged tourist boycotts at the International Tourism Exchange exhibition in Berlin. An ongoing internet survey conducted by ScubaPoll.com suggests overwhelming support among respondents for a travel boycott to Caribbean nations that "sell IWC votes to support Japan's brutal slaughter of whales." An important characteristic of this kind of boycott is that it is focused on a market (tourism) other than the market for the offending product (whale meat).

It is unknown whether the scale of the external effect is a function of the type of whaling that takes place. For example, we might expect that the effect would be larger for a country that allows commercial whaling (Norway) than for a location in which aboriginal subsistence whaling is permitted (Alaska), but this hypothesis would need to be tested.

The boycott concern has arisen most recently in the case of Iceland, which resumed the scientific whaling of minkes in 2003. Hoyt (2000) reports that IcelandAir experienced several vacation cancellations after the government's decision in the late 1990s to resume whaling. The government of Iceland has argued that whaling and whale-watching can coexist, and this decision has been supported by scientists at Iceland's Marine Research Institute. Nevertheless, Asbjorn Bjorgvinsson, Director of the Husavik Whale Centre and Chairman of the Icelandic whale-watching association, claims that "[i]f whaling is resumed, it could devastate whale watching in Iceland" (Bjorgvinsson 2002)[1]. In particular, he argues that the symbiotic relationship between humans and minkes, who have become friendly with the whale-watch boats, would be exploited by the whale hunters to the detriment of the whale-watch industry. This argument is reinforced by a recent survey of whale-watchers on the Isle of Mull, off the coast of Scotland. In that survey, Parsons and Rawles (2003) find that more than 90 percent of respondents would not go whale-watching in a country that hunted whales.

International trade sanctions are a more formal means for putting in place and enforcing the boycott of another nation's products as a consequence of a policy to engage in whaling. In the United States, under provisions of the Fishermen's Protective Act, the Secretary of Commerce may "certify" other nations for "engaging in trade or taking" which "diminishes the effectiveness" of the IWC. Once certified, the US President may direct the Secretary of Treasury to prohibit the importation of a country's products into the United States. This law, known as the Pelly Amendment, has been used to certify nations about a dozen times during the last 30 years

to discourage their commercial whaling. None of these certifications has led to the imposition of trade sanctions, but the threat of sanctions has resulted in changes to the offending policies of the target nations in several cases (Charnovitz 1994).

It's likely that the imposition of Pelly Amendment trade sanctions could come into conflict with international trade law, unless the target nation is engaged in the export of endangered species or the sanctions are imposed as a countermeasure for the breach of an international environmental treaty (McDorman 1997). The latter justification cannot be invoked where a target nation is not a party to the IWC (Canada) or has legally objected to the IWC moratorium (Norway). Further, the economic effects of such sanctions, if imposed on the sale of seafood from fisheries that are ecologically linked to the whales, may depend critically upon the biological and economic interactions among the species (Shulz 1997).

A BIOECONOMIC MODEL

We develop a bioeconomic model of a whaling industry with linkages to a commercial fishing sector, a whale watching/ecotourism market, and a market for "other goods" not directly related to whaling, but potentially affected by a boycott. Our analysis is based on the canonical static Schaefer model, with the steady-state revenue function modified to reflect costs and benefits other than those emerging from whale harvesting *per se*. The optima from the resulting modified yield curves are compared with those from the canonical model.

Consider a single species of whale whose biomass W evolves subject to a logistic growth function and the conventional Schaefer form of whale harvest, linear in stock and effort (E):

$$\dot{W} = rW\left(1-\frac{W}{K}\right) - h_W; \quad h_W = qEW \tag{1.1}$$

The catchability coefficient q reflects the availability of whales to the harvest technology. The whale stock reaches equilibrium level W_{SS} for a given E:

$$\dot{W}(E) = 0 \quad \Rightarrow \quad W_{SS}(E) = K\left(1-\frac{qE}{r}\right) \tag{1.2}$$

To model the categorical, or qualitative, response of consumers to the presence of a whaling industry in addition to a quantitative response that varies with E, we define the binary variable I_W, such that $I_W = 1$ if there is an active whaling industry (i.e. if $E > 0$) and $I_W = 0$ if $E = 0$.

Whaling alone

Considering whale harvest in isolation, the planner in the whaling nation strives to maximize[2]

$$\Pi_{SS}(E) = pqEW_{SS}(E) - c_w E\,. \tag{1.3}$$

The wage associated with whaling effort is constant at c_W. Substituting (1.2), the maximization of (1.3) with respect to E gives

$$E_0^* = \frac{r}{2q}\left(1-\frac{c_w}{pqK}\right). \tag{1.4}$$

Substituting (1.4) into (1.3) gives the maximum sustained rents, or MEY, emerging from whale harvest as a function of biological and economic parameters:

$$\Pi_{W0}^* = \frac{r\left(pqK - c_w\right)^2}{4pq^2K}\,. \tag{1.5}$$

Linkage 1: Commercial fishing with whales as predators

As discussed above, some proponents of whaling claim that whale stocks impose a negative externality on commercial fisheries through predation. Consider a fish stock *X* that also grows logistically, with growth rate *g* and carrying capacity *L*, and is harvested with a Schaefer technology with harvest effort *F* and catchability coefficient *m*. This stock is subject to predation by whales which, like fishing mortality, manifests itself in a simple multiplicative function of whale and fish stocks. The efficiency of whales as predators is captured by the parameter α. The dynamics of the commercial fish stock therefore follow

$$\dot{X} = gX\left(1-\frac{X}{L}\right) - mFX - \alpha XW \,. \tag{1.6}$$

The level of fishing effort which maximizes steady-state rents is derived analogously to E_0^* in (1.4) above, and is a function of the whale stock: $F^*(W) = (g/2m)\left(1-\alpha W - c_f/2p_f mL\right)$. The indirect objective function for the commercial fishery is

$$\Pi_{F0}^*(W) = p_f mF^*(W) X_{SS}\left[F^*(W)\right]. \tag{1.7}$$

The impact on commercial fishery rents shifts the whaling yield curve upward as shown (with different magnitudes) in very valuable fishing industry.

Figure 1. The curves TR_i combine revenues from whaling with increases (of different magnitudes) in fishery rents due to reduction of the whale stock from its carrying capacity:

$$TR_{WF}(E) = TR_W(E) + \left[\Pi_{F0}^*(W) - \Pi_{F0}^*(K)\right]. \tag{1.8}$$

Achieving MEY in the combined system requires a whale harvest greater than that used when the fisheries interaction is ignored (E_1^*, E_2^*, E_3^* corresponding to TR_1, TR_2, TR_3 respectively). While MEY for isolated whale harvest in the face of positive costs always occurs on the left half of the yield curve, the optimal level of whale harvest in the joint maximization may drive the whale stock below MSY (for TR_2, TR_3), and may indeed be greater than E_{OA}, the *open-access* level of whaling (for TR_3). This latter case would suggest the central planner may want to subsidize whaling activity, eliciting entry beyond that under open-access. This result holds only for extreme levels of whale predation combined with a very valuable fishing industry.

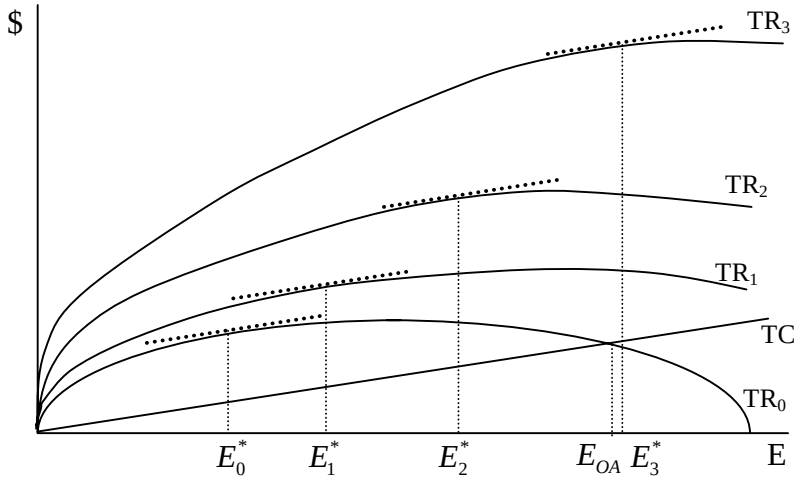

Figure 1: Steady-state whale revenue inclusive of benefits to the commercial fishing sector. The shape of the fishing benefit function determines the optimum harvest effort relative to the whaling-only optimum MSY, and the open-access outcome.

The significance of the fisheries linkage also depends critically upon the efficacy of fisheries management. In our example above, we assume that fishing and whaling are managed jointly by a central planner pursuing MEY arising from the system. If the fishery sector is less than optimally managed, increases in fishery rents owing to whale stock reductions are smaller. In the extreme case of an open-access fishery sector, where rents are dissipated, whaling confers no benefits through the fishery industry.

Linkage 2: Whale-watching

The negative response of consumers of whale watching (or ecotourism) services, *WW*, to whaling can be modeled as a downward shift of their marginal willingness to pay (*MWTP*) for these services. The *MWTP* schedule and the marginal cost curve give rise to market equilibrium and corresponding surplus S_{ww}. The *MWTP* response is partially qualitative or categorical, *i.e.*, it drops when a whaling industry is present at all; and partially quantitative, in that MWTP falls on that margin with whaling effort due to the fact that (a) the stock of whales falls, so probability of sighting is lower; and (b) whale-watching is more visible to the tourists. Figure 2 shows the reduction from WTP_0 to WTP_ε as the result of having a whaling industry at all; and subsequent marginal increases in whaling effort shift the WTP incrementally further down (e.g. to WTP_{dWW}). Corresponding surplus losses are shaded in the figure.

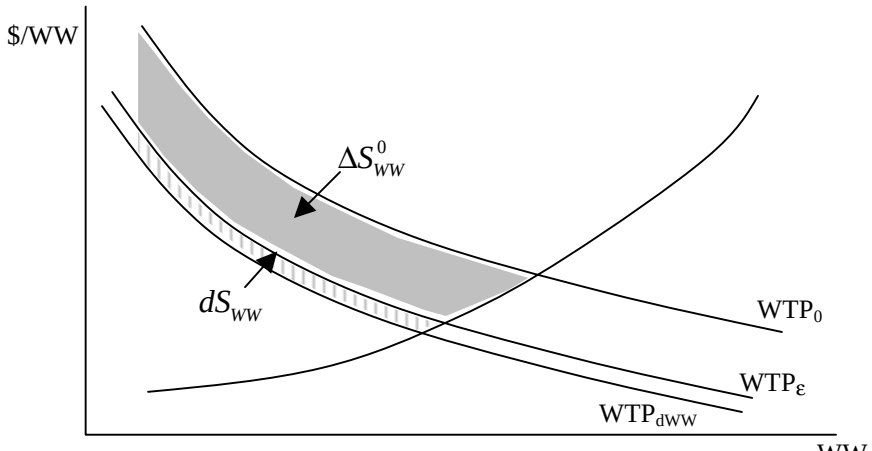

Figure 2: The market for whale-watching (ecotourism) services (WW) as affected by whaling activity, with resultant losses in surplus (gains from trade). ΔS^0_{ww} **is the intercept of the loss function, and** dS_{ww} **represents a marginal loss in rents due to an increase in whaling (via both stock and effort).**

Figure 3 shows the yield-effort curve for whaling, given the response of whale watchers to this activity. The revenue function for whaling is shifted down in a parallel fashion to capture consumers' categorical revulsion to whaling, and tilted down with a monotonically increasing divergence as effort increases to capture the quantitative effects. The former shift (TR^F_{WW}) causes no change in the marginal incentives for whaling, but does alter the average revenue and hence is more likely to lead to a shutdown of the whaling industry. The latter effect (TR^V_{WW}) decreases the rent-maximizing whaling effort to E^*_{WW} from the partial equilibrium optimum E^*_0.

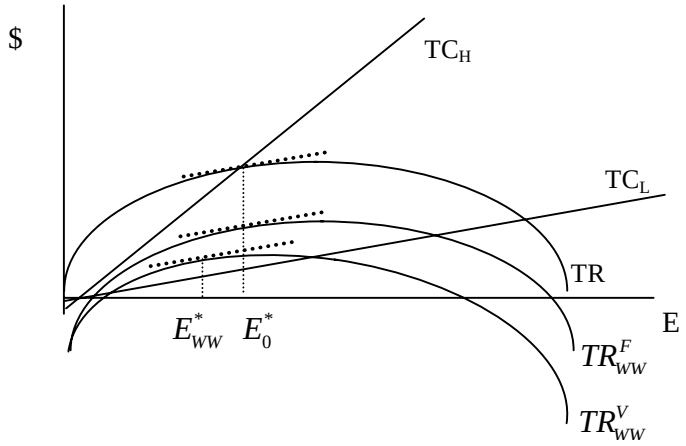

Figure 3. Yield-effort diagram for whaling, taking into account fixed (TR^F_{WW}) and variable (TR^V_{WW}) impacts on the whale-watching industry. Whaling industry shutdown is rent-maximizing in both cases for a sufficiently high wage (TC_H).

Linkage: Export ("other goods") industry

Whaling activity can affect the demand in some unrelated industry ("other goods," or OG) through a boycott, organized for example by a non-governmental organization (NGO), or by trade sanctions vis-à-vis the market in question, imposed by another state, as via the Pelly Amendment. Both boycotts and sanctions effectively reduce demand for OG: either directly in the case of a boycott or import quotas, or indirectly via the imposition of an import tariff.

Because boycotts are costly to organize, publicize, etc., we expect them to occur only when the cost of whaling activity to the constituency of the NGO is deemed sufficiently high to warrant the investment. Trade sanctions also need to be credible (see Gordon et al. 2001): A government will only impose sanctions only if it perceives that the lost existence value (or other costs) borne by its citizens as a consequence of whale harvesting is sufficiently high to offset lost gains from trade. Neither boycotts nor sanctions will be imposed, therefore, until whale harvest exceeds a threshold $\bar{h}$; demand (*WTP*) in the OG market $WTP\left(q, h_w\right) = WTP_0\left(q\right)$ for $h_w \le \bar{h}$. Once the threshold level of whale mortality (harvest rate) is reached, *WTP* drops discontinuously once the boycott is triggered, and then is non-increasing in harvest, i.e. $\partial WTP\left(q, h_w\right)/\partial h_w \le 0$ for $h_w > \bar{h}$. Analogous to the case of whale watching, surplus may stay constant or may decrease with whale harvest mortality, *e.g.*, due to increased adherence to the boycott by consumers or to more severe import quotas or higher tariffs.

The total revenue function for whaling, inclusive of the loss due to a boycott, is given by the piecewise continuous function

$$TR_{SS}\left(E\right) = ph_{SS}\left(E\right) - \phi\left[h_{SS}\left(E\right)\right]; \quad \phi\left(h_W\right) = \begin{cases} 0 & h_W \le \bar{h} \\ C_B\left(h_w\right) & h_W > \bar{h} \end{cases} \tag{1.9}$$

and is depicted in

Figure 4. When harvest is below $\bar{h}$, which is the case at both the left and right ends of the yield curve, the revenue curve is unchanged. There is a discontinuous drop in the revenue function at $h_w\left(E\right) = \bar{h}$, in the center

portion of the yield curve. The total revenue curve TR_2 reflects boycott costs that are constant above the threshold, leading to either no change in the effort optimum E_0^* or (as is the case in the figure as drawn) a new local optimum at $\overline{E}$. TR_2 depicts boycott costs that increase with harvest, with either $\overline{E}$ or E_1^* optimal.

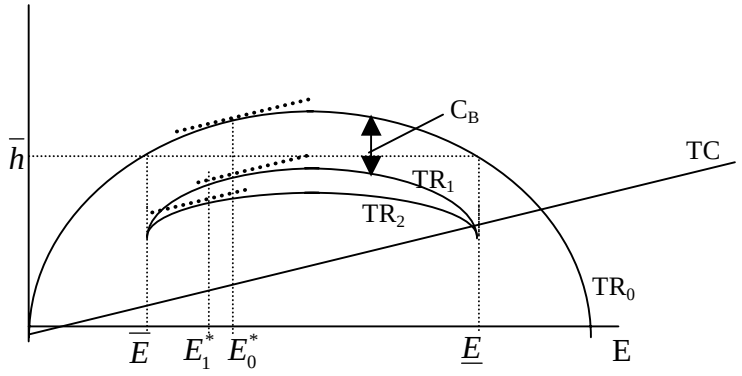

Figure 4. Yield diagram in the case of boycotts (or sanctions) triggered by reaching a threshold harvest mortality. TR_1 represents a boycott of constant cost, and TR_2 depicts a boycott that increases with whale harvest.

Discussion

The decision whether to engage in whaling or not, and the intensity of whaling to be allowed, is multi-dimensional. In addition to considerations of efficiency criteria vis-à-vis the management of the whale stock, a central planner in charge of such a decision must take into account economic and ecological linkages between the whale stock and other resource and markets. In addition to these factors, which can presumably be incorporated into a joint optimization, there are existence values (both of the whales and the cultural significance of whaling) that are more difficult to quantify, as well as other moral or political considerations. It is unlikely that any country will strive solely for economic efficiency in ignorance of these other factors.

We do not attempt, therefore, to "answer the whaling question" here in any normative sense. Our objective is to highlight the types of impacts whaling might have on a nation's economic efficiency. We employ a fairly simple bioeconomic model to explore the linkages between whaling, commercial fishing, ecotourism, and the whaling nation's other outputs that may be subject to boycotts or international trade sanctions.

The impact of whaling on commercial fisheries is a function of the standing stock of whales, which prey upon commercial fish stocks and alter their dynamics. As whaling effort increases, lower standing whale stocks are maintained, and fishery rents increase. This linkage increases the marginal benefits of whaling and, in extreme cases (likely to arise only in theory), may lead the central planner to subsidize the entry of whaling firms beyond the open-access point or even to extirpate the predatory whale stock.

The costs of whaling imposed on the ecotourism market may depend upon both the presence of a whaling industry as well as the amount of whaling effort (as this determines the visibility of whaling to tourists). Because the cost of the latter effect is monotonically increasing in whaling effort, it acts counter to the effect on commercial fishery rents. The categorical response of ecotourists to whaling shifts the whaling revenue curve downward; while this effect down not affect the marginal benefit function for whaling, it does introduce the potentially optimal corner solution of shutting down whaling altogether.

The third linkage we consider is with the "other goods" market, where either a boycott facilitated by an NGO or a trade sanction imposed by another country reduce rents when whale harvest mortality exceeds a given threshold value. As with the ecotourism linkage, there is a categorical effect of whaling – a discontinuous and

parallel downward shift of the revenue function in the region where harvest exceeds the threshold – as well as a flattening of the revenue function, symmetrical about the MSY point, corresponding to increasingly effective boycotts or increasingly stringent sanctions as whale mortality increases. Unlike the ecotourism effect, which is a function of whaling *effort* (*i.e.*, an input to the whaling industry), the boycott effect is a function of the *output* of whaling and is therefore symmetrical around the MSY point of the yield curve.

The net effect of the bioeconomic factors considered is ambiguous, owing to the fact that commercial fishing rents increase with whaling activity whereas rents in the ecotourism and other goods markets decrease. The balance of these tradeoffs therefore remains an empirical question; countries with valuable fish stocks that are the preferred prey of whales are likely to find it more cost-effective to engage in whaling, whereas those with large ecotourism sectors or trade relations especially vulnerable to boycotts or sanctions should be less willing to engage in whaling at all, or at least to reduce its intensity. The modifications of the Schaefer model presented here can elicit marginal changes in the internal optimum or discontinuous switches to corner solutions, either at a shutdown of the whaling industry or at a level of whaling corresponding to the threshold at which boycotts are triggered. In our model, we explore the effect of changes in the stock of whales, via commercial fishery stocks as well as the *WTP* for whale watching services; the flow of inputs into the whaling industry, which adversely affects the demand for ecotourism; and the flow of outputs (harvest) from whaling, which triggers boycotts or sanctions above a certain threshold. These effects alter the steady-state revenue curve for whaling in different ways and have distinct effects upon the internal optimum for whaling as well as the entry-exit decision.

The efficiency of whaling and the relevance of a bioeconomic approach is likely to be outweighed in the policy arena by normative moral considerations, such as a balance between the existence value for whales and that of the cultural heritage embodied in their capture. Our analysis has little relevance for cases where very small takes are allowed to perpetuate tribal or other customs or where scientific research is the purported goal. Rather, our analysis would be more usefully applied in cases where nations are deciding about the existence and intensity of a commercial whale harvest with an emphasis on rents and economic efficiency at a national scale. The approach used here also could be applied to other areas where nonextractive and extractive uses come into conflict, such as duck hunting and bird watching, moose hunting and moose viewing, and the culling of seal populations that prey upon salmon or other commercial fish stocks.

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Endnotes

[1] Interestingly, Hoyt (2000) suggests that, during the 1990s, a heightened awareness generated by debates in Iceland over the possible resumption of whaling resulted in increased business for the whale-watch industry. In essence, the debate served as a publicity vehicle to attract tourist attention to whale-watching. Bjorndal and Conrad (1997) also suggest that boycotts against Norway for its resumption of the minke whale hunt in 1993 may have had a positive effect on tourism due to increased publicity.

[2] We limit our analysis to conditions for achieving maximum economic yield (MEY), predicated on the dynamic system above reaching equilibrium. This static approach is tantamount to an assumption of zero discount rate, and ignores the approach to equilibrium. A full dynamic analysis of the system (i.e. through an application of control theory and the maximum principle) would yield qualitatively similar results at the expense of analytic transparency.

Table 1: Countries Involved in the Harvest of Large Baleen Whales during 1988-2002

Country		Average Catches during 1988-2002								
		Fin	Humpback	Sperm	Sei	Brydes	Gray	Minke	Bowhead	Total
Japan	S	0	0	1	3	10	0	429	0	442
Norway	S,C	0	0	0	3	3	0	307	0	313
Greenland (Denmark)	AS	14	<1	0	<1	0	0	135	0	150
Russia	AS	0	0	0	0	0	102	<1	<1	102
United States	AS	0	0	0	0	0	<1	<1	49	49
Iceland	S	9	0	0	1	0	0	0	0	10
Saint Vincent and the Grenadines	AS	0	1	0	0	0	0	0	0	1
Canada	AS	0	0	0	0	0	0	0	<1	<1
TOTAL		23	2	1	7	13	102	871	50	1068

[Data on whale catches are average numbers of catches of whales of each species over the fifteen year period from 1988-2002. Source: International Whaling Commission (2004). Key: S = scientific whaling; C = commercial whaling; AS = aboriginal subsistence whaling. Norway engaged in scientific whaling from 1988 to 1992 and in commercial whaling thereafter. The IWC distinguishes between aboriginal subsistence fisheries in East and West Greenland, which have been combined together in this table. The majority of Greenland takes occur in the West Greenland fishery.]

Table 2: Whaling Locations and the Importance of Whale-watching

Location	Target Species	WW Tourists (000s)	WW DEx ($m)	Hoyt's WW "Potential"	WW DEx/TR %	TR/GNP %
Alaska (United States)	bowhead; beluga	77	89	5	5.77	6.25
Iceland	fin; sei; (minke)	30	3	5	1.71	2.40
Tonga	(humpback)	2	0.06	5	0.39	7.91
Dominica	unidentified small whales and dolphins	5	0.13	5	0.34	16.44
Canada	bowhead; narwhal	1,076	27	5	0.31	1.47
Japan	minke; sei; Bryde's whale; sperm whale; false killer whale; orca	103	4	5	0.10	0.09
Norway	minke; sei; Bryde's whale	22	2	5	0.07	1.40
Saint Vincent and the Grenadines	humpback; Bryde's whale	0.6	0.03	4	4.86	25.74
Grenada	unidentified small whales and dolphins	2	0.09	4	0.15	20.33
Indonesia	orca	41	1	4	0.02	2.45
Greenland (Denmark)	minke; fin, sei; humpback; orca	3	1	4	n.a.	n.a.
Saint Lucia	short-finned pilot whale; pygmy killer whale; false killer whale; bottlenose dolphin; Atlantic spotted dolphin; Fraser's dolphin; Common dolphin	0.1	0.004	3	0.16	50.54
Washington State (United States)	gray whale	52	3	3 (est.)	0.04	4.45
Russian Federation	gray whale; minke; bowhead	0.1	0.3	2	0.004	1.75
Faroe Islands (Denmark)	long-finned pilot whale; northern bottlenose whale	<1	<<1	2	n.a.	n.a.
Saint Kitts and Nevis	unidentified small whales and dolphins	0.05	<<1	1	0.00	28.13
Antigua and Barbuda	unidentified small whales and dolphins	n.a.	n.a.	n.a.	n.a.	n.a.
Cape Verde Islands	humpback	n.a.	n.a.	n.a.	n.a.	n.a.

[Whale-watching, tourist, and national accounts data are from 1998 (as reported in Hoyt 2000). Data on target species are from the International Whaling Commission (2004), the International Fund for Animal Welfare (2004), and Sutherland (2001). Key: Target species in parens are under consideration for the resumption of whaling. Hoyt's whale-watching potential scale is: 5 = outstanding potential; 3 = considerable potential; 1 = modest potential; WW = whale-watch; DEx = direct expenditures (whale-watch ticket sales); TR = total tourist receipts; GNP = gross national product. Data on tourist expenditures and gross state product for Alaska and Washington State are from the US Bureau of Census (2004).]