Whales, Science, and Protected Area Management in British Columbia, Canada

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INTRODUCTION

When the mandate of a protected area includes the conservation of free-roaming animals, there is a need for the inclusion of specific autecological and synecological information in both the initial design and management stages for the area. Similarly, when the scenario includes human interaction, as virtually every protected area does, there is a requirement for social science information. The human element can no longer be managed under the simple models that have characterized the human dimensions of protected area management in the past.

Perhaps nowhere are the problems of matching wild animal ecology, human dimensions, and the administrative simplicity of area protection more clearly contrasted than in the case of marine parks and reserves. This paper will focus on the specific case of establishing reserves to protect whales. Management of wild whales has historically depended on a theoretical exercise in population modeling that carried little relevance to reality (Holt 1985). As a result of flawed theoretical foundations, managers incorrectly estimated sustainable harvest and failed to protect large whale stocks from the risk of extinction (Holt and Talbot 1978). As our interactions with whales changed over the past 25 years, we have expanded the current paradigm to include protection of both whales and habitats (e.g., U.S. National Park Service 1984; Canadian Parks Service 1988), recovery of endangered populations (U.S. National Marine Fisheries Service 1989), and the management of recreational nonconsumptive use (Duffus and Dearden 1991).

At this juncture, the difficulty with reserving areas in the marine environment comes to its problematic apogee: setting aside an ecologically significant volume of ocean for a species group whose spatial domain is unknown. And, within that, to impose management plans that mediate human interaction at levels suitable to the maintenance of healthy population functions. This somewhat daunting task has been attempted in several cases. In the Gulf of St. Lawrence, on Canada's east coast, endangered beluga whales *(Delphinapterus leucas)* have had areas set aside and human behaviors mediated to try to protect a failing relict population (Canada Department of Fisheries and Oceans 1989). Similarly, in Hawaiian waters U.S. federal authorities attempted to establish a national marine sanctuary over humpback whale *(Megaptera novaeangliae)* calving and nursing areas, although local authorities blocked the sanctuary's establishment as a barrier to development and commercial fisheries. The International Whaling Commission allowed a non-whaling zone to be established in the Indian Ocean. Mexico established a national park over the gray whale *(Eschrichtius robustus)* calving lagoons at Laguna Oje de Libre.

This paper will focus on the role of science in the establishment of management measures for two concentrations of whales on the Pacific coast of Canada, where recreational use and resource management conflict have progressed to the point where the public has called for intervention. By focusing on these cases, the paper will endeavor to illuminate some of the important contributions science can make to the design and management of marine protected areas.

CASE STUDIES

Whales concentrate at two locations on the Vancouver Island coast. Gray whales migrate north from the wintering areas along Baja California (Mexico) to the summer feeding grounds in the Bering Sea. Those that do not undertake the entire migration with the bulk of the eastern Pacific population spend the summer feeding in the bays and inlets along the western coast of Vancouver Island (Figure 1). The research described here focuses on individual and small groups feeding and traveling in the southern reaches of Clayoquot Sound. Killer whales also form a summer feeding aggregation on the northeast coast of Vancouver Island in Johnstone Strait. Small matrifocal subpods use a core area at Robson Bight for various periods throughout June, July, August, and September to take advantage of migratory Pacific salmon *(Onchorhyncus* spp.*)* stocks as the pass through the narrow Johnstone Strait.

At both locations, recreational whale-watching has developed over the past decade; as well, other water and land uses have the potential to affect the local ecosystems. At the gray whale site, no protective designation has been made over marine areas for the conservation of the whales, while British Columbia has created a provincial ecological reserve covering a small part of the marine area used by killer whales. In the former case, we will discuss the use of scientific information applicable to the design of a reserve; in the latter, the use of science in the management of the existing reserve.

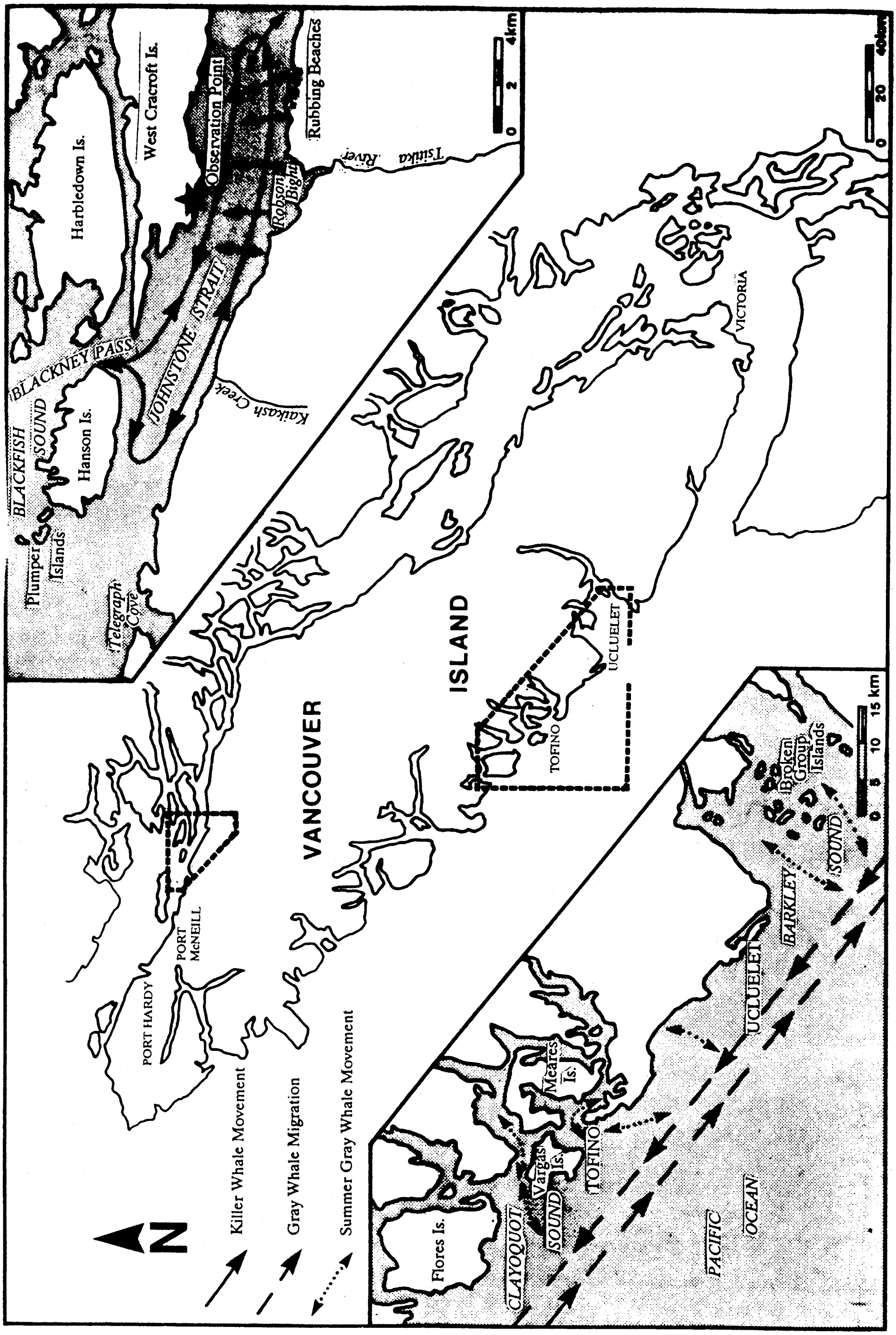

Figure 1. Whale concentrations in Vancouver Island coastal waters, British Columbia, Canada

Gray whales of Clayoquot Sound

As gray whales leave the main migratory group along the Vancouver Island coast, they distribute themselves to take advantage of economical feeding opportunities from a number of sources. Feeding behavior of the species is known from several locales, although the mechanisms of food selection and the predator-prey dynamics are poorly understood. In Clayoquot Sound, whales exhibit several feeding strategies that have implications for their spatial distribution. They either feed on suprabenthic swarming invertebrates, or feed on benthic organisms in the substrate itself (Guerrero 1989). When food sources have been located and are deemed substantial, a feeding whale may attract others, creating aggregations of four to six animals. Using the marginal value theorem (Charnov 1976), an optimal foraging strategy dictates that the decision to stay in one site is a product or the quality and quantity of the food, balanced against surrounding feeding opportunities. Another factor in the understanding of spatial behavior is the avoidance of disturbance. If whales are disturbed, they may be induced to switch feeding sites. Perhaps the most common source of potential disturbance is recreational whale-watching vessels from the commercial fleet in the nearby settlement of Tofino.

Research data regarding the influence on whales by vessels is inconclusive. Some observational studies suggest gray whales are disturbed by whale-watching activity, but they generally lack scientific veracity because of flaws in research design. Whale-watching, primarily via commercial charter vessels, has grown rapidly in this area. Peaks of activity occur during the spring migration in March and April, and during the summer between July and September. There is little other water-based activity at this time in the southern portions of Clayoquot Sound except for small vessel traffic. Other potential threats that arise from the larger region include debris pollution, oil discharge, and land-based pollution, primarily suspended sediment from forestry operations.

The designation of a protected area for the summer aggregation would be desirable in both an ecological and human sense. Although gray whales are the only large whale to show significant population recovery from commercial whaling, and now reach near-historical numbers, they still require protection. The migration route, summer feeding areas, and calving areas all overlap with areas of significant human activity. Within the range of this population, the whales pass near heavily industrialized areas, cities, several fisheries, heavily used vessel traffic routes, and recreational areas. In addition, the whales experience the natural mortality forces of predation and disease. Summer feeding aggregations likely represent juvenile or anestrous individuals, and pairs of cows and calves (Swartz 1986). It is therefore beneficial to separate these animals from the breeding nucleus as a short-term measure against catastrophic losses in other population pools, and, in the long term, as a source of genetic diversity in the population.

Planning and design of a whale reserve in Clayoquot Sound has several data requirements. Initially, spatio-temporal patterns should be established to locate areas where different behavioral sequences occur. Feeding areas, resting areas, travel corridors, and predator-avoidance sites will create the spatial blueprint for an area designation. This is then extended into the depth dimension to ascertain the submarine topography, materials, and ecosystem characteristics. Within each three-dimensional space, planners can then implement mediating measures for human activities. The initial step is to describe the range and timing of activities within the boundary, then develop plans for buffering the reserve from outside impacts. Thus, behavioral, ecological, and biophysical data requirements include gray whale time budgets, substrate types, feeding ecology, differential use of space, and human activities and their impacts.

Our current research program developed a preliminary database of time budget and use of space. Whales were visually located on 33 days between 4 July and 26 August 1991. Location and behavior were recorded at all times, and data were subsequently mapped to provide a basis for further study. In 1992, we will record and map the location of all whales encountered. Maps of the ocean bottom, including substrate materials, and prey distribution will be created using combinations of bottom samples and side-scan sonar as well as direct observation and mapping. The whale and biophysical data will be analyzed on a GIS system to develop an understanding of the feeding ecology and spatial system. This will not only provide us with the spatial interaction dimensions of one important site, but a preliminary understanding of the variables that constitute habitat for the summer feeding aggregations. If these can be further mapped on a regional basis, coupled with historical information on whale movement pattern, then some estimate may be forthcoming of other areas suitable for protection to conserve and manage the whales, and recreational use.

Killer whales of Johnstone Strait At the second site, killer whales have been studied for about 15 years (Bigg et al. 1989). The aggregation is part of a range contraction in a group of 180 whales, known as the "northern resident community," who congregate during the salmon migration in Johnstone Strait. At this time, the 17 subpods of the resident ecotype, which feeds primarily on fish, enter the strait on an irregular basis, travelling in cycles throughout the local region that range from daily to bi-monthly. Certain subpods are rare visitors, while others are sighted daily. Outside of the Johnstone Strait core area little is known about their movements and behaviors.

The resident whales frequent two small beaches on the Vancouver Island shore where they rub on the gravelly substrate, and, in travelling to and from the beaches, spend time in a small bay and the outer estuary of the Tsitika River. The ecology of the site-organism relationship is unclear. Various researchers have pointed to behavioral and acoustic phenomena associated with the sites, although none have specifically postulated any cause-and-effect link between site and behavior, nor has there been any research into the "criticalness" of any particular phenomenon. Interestingly, the site is the focus of numerous research projects, and the core of recreational whale-watching. The little that we do know about the whales' microrange characteristics is at least in part an artifact of limited research outside of the core area. Furthermore, since feeding is primarily on mobile prey in a deep water column, feeding ecology has remained poorly known.

Because of the frequency of use and affinity for these sites, the area was deemed critical and set aside as an ecological reserve by British Columbia. This measure holds a fairly limited potential to protect a marine area. It is a provincial designation, yet the federal government has jurisdiction over marine shipping, fisheries, and marine mammals. The only matters on which the provincial government is authoritative are recreational use and land use on adjacent shorelines and in the nearby Tsitika River valley. Unfortunately, the ecological reserve's land area is small and narrow, providing few buffering services to the marine area. All shipping, fishing, and management of the killer whales are beyond the protective capabilities of the designation. Therefore, the boundary is highly permeable, and buffers of outside impacts are almost non-existent.

Managers need to use detailed knowledge regarding the nature of interaction between whales and fisheries, of both general and whale-watching vessel traffic, and of the ecological links between the presence of killer whales and biophysical characteristics, including those related to water quality and the shoreline. Some work has attempted to analyze whale response to whale-watching vessels. Research has tended to focus on a few measures of whale response. Kruse (1991) concluded that whales travel faster in the presence of whale-watching vessels, although the conclusion is not based on the data presented. Further, Kruse presents no reasoning as to the effect of a small change in swimming speed over a short period of time. Simple presence or absence is the current focus of government research, though the research model does not include use with any other parts of daily range, or ecological variables (Briggs 1991). The potential for intervening cause-and-effect linkages is high. Our past research, relying on simple behavioral categories, has been similarly unable to discriminate between behavior sequences taking place when whale-watching vessels are present as opposed to being absent. Our current research is aiming to establish the range and magnitude of change in several observable behaviors and link these to potentially disturbing influences.

None of the research has yet gone beyond the focus on recreational vessels, leaving unstudied the entire issue of influence by fishing vessels—which are ubiquitous in the core area during the summer. Other studies in this area were largely unsuccessful in linking fisheries data to whale presence (Nichol 1990), and no studies have been done to ascertain links between beach morphology, freshwater inflow, or water quality of the nearby Tsitika River. Currently, forestry operations are carried out in adjacent uplands that have the potential to influence the shore environments.

The scientific knowledge on which the provincial ecological reserve designation is based, and upon which its management is predicated, is almost non-existent. The whales do use the site and the two beaches to a varying degree each summer. Beyond that, there has been no research into the entire seasonal spatial domain, nor the relationships between this so-called critical space and other space in the whales' daily range. Rather, the philosophy behind establishing such a small protected area within a larger range is what we term a "requiem" reserve—a place of rest. Unfortunately, since we know little of the nature of disturbance, especially that associated with underwater acoustics (the main subsurface sensory mode of killer whales), we have no way to validate the reserve's capacity to provide rest.

The total lack of a scientific foundation may or may not obviate the utility of the reserve. It is known that, for whatever reason, the whales do congregate there during an important feeding period. That may make it a high priority for protection. On the other hand, the fallacy of tokenism—that is, giving the public the appearance of protecting an important whale habitat when neither the importance of the site to whales nor the veracity of the protection is established—creates a political "success" that may mask an ecological failure. Clearly, calling this a "killer whale reserve" is only justified in a semantic sense.

Human Dimensions of Whale Reserves

Human dimensions of marine area protection may have little relevance for some sites; in others, information requirements may be sophisticated. In both cases, there is a need for social science information because recreational use and resource conflict are priority management issues. Research areas run the gamut from policy and institutional analysis, regional economic and total economic value studies, social impact assessment, to recreational satisfaction and motivation.

Management programs arise out of policy milieux that frequently cross jurisdictional boundaries. With the advent of Exclusive Economic Zones, nations have taken on varying degrees of management authority in open waters and over some species that migrate through the EEZ. Federal states, such as Canada, frequently have arrangements with coastal provinces to allocate jurisdiction over resources among the most competent and appropriate administrative body. Using Canada as an example, there are frequently cross-jurisdictional aspects to many programs, and a working knowledge of these sometimes-informal processes are fundamental to understanding how protected area management fits into the wider scope of resource management.

A frequent management concern that develops at the initial planning stages of a protected area involves the potential costs and benefits to the local area. In the marine case, protected areas may intersect with existing fishing interests, transportation routes, or allowable effluent deposition. Thus, protection may incur costs. Equally, protection may provide revenues to local areas as visitor-service requirements expand. Both regional economic impact, as well as more complete valuation techniques, will be useful planning tools to fit the protected area into the existing local system, and to inform players in various economic sectors of potential influences for mitigation or development purposes. Both the examples discussed in this paper have significant economic aspects produced by recreational use and burgeoning nature tourism. In both cases, significant infrastructure and monies are transferred into the service sector of what were formerly economies based on the primary sector. Certain marine activities such as whale-watching generate fairly high indirect benefits to local economies, as the activity is generally non-substitutable, creating steep demand curves.

Foregone opportunities may be part of management plans. In the case of the Johnstone Strait killer whales, economic activity in the adjacent forests and changes in fishing behavior may place costs on existing area users. A cost-benefit comparison would reveal not only the magnitude of the economic trade-offs, but also identify which sectors gain or lose. In both that case and the gray whale case, designation alters (or would alter) commercial whale-watching behavior, though in the long run it may support the longevity of whale-watching and provide opportunities to enhance the product.

The social domain of marine protected areas includes aspects in common with terrestrial sites. Relationships between visitors and host communities, and stress on host facilities, as well as recreational behavior, may be more specialized due to the marine component and types of use involved. Duffus and Dearden (1990) provide a framework for analyzing non-consumptive use in terms of both the site and the use by analyzing variables associated with the growth of use and specialization of the users. Management of use behavior is simpler if the motivation, satisfaction, and nature of demand is known. Plans can use fairly standard tools such as zoning, interpretation, and licensing for commercial recreational purveyors to adjust the fit of the protected area to the local environment.

CONCLUSIONS

Marine protected areas require more specialized planning than do terrestrial areas. Most of their complement of plants and animals go about their lives hidden from human view. Similarly, many environmental changes, such as water quality, may go undetected. Within the human domain, most visitor patterns and their associated impacts are relatively new and thus in need of study. The case described here, reserving areas for the benefit of particular species, introduces a set of more detailed problems. Theoretical development of biological principles for conservation is still new in terrestrial protected areas (e.g., Shafer 1991), and most marine species are less well known. Baseline research, as well as theory building, will therefore be required; this poses a significant cost and delays initiating scientifically based design principles and management plans in the marine sphere. Nevertheless, reserves set aside without attention to scientific principles will be less able to fulfill the protection mandate, and may become a burden in the future when adjustments are necessitated by more critical examination.

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