

*Resource Management and Optimization*

1991, Volume 8(3-4), pp. 127-141

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Printed in the United States of America

# TRADITIONAL RESOURCE MANAGEMENT SYSTEMS

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The Western view of humans as entitled to dominate and utilize nature at will, elaborated during the age of European expansion, recognized no limits to the exploitation and modification of ecosystems. This view has gradually changed since the mid-nineteenth century. Nevertheless, the science-based techniques of resource management that have since been developed are applicable almost entirely to single species populations in highly simplified ecosystems. On the other hand, a diversity of traditional cultures have elaborated management systems more consistent with the ecosystem view and current ecological theory. The paper explores the synthesis of traditional and scientific ecology.

## 1. INTRODUCTION

Human influence on natural systems has often been portrayed as destructive. It is only relatively recently that ecologists have started to appreciate how traditional peoples use their resources without destroying them. For many marine ecologists, Johannes' *Words of the Lagoon* (1981) brought this point home. Several studies have documented systems of traditional knowledge (Ruddle and Johannes, 1985; McNeely and Pitt, 1985; Freeman and Carbyn, 1988). Others showed that community-based resource management systems worked because of the presence of appropriate common property *institutions*, not merely because of a superabundance of resources (McCay and Acheson, 1987; Berkes, ed., 1989). Particularly rich case studies came from agroecosystems, showing how traditional peoples interacted or co-evolved with (Norgaard, 1984) their environment, modifying nature but actively maintaining it in a diverse and productive state.

Different human societies have elaborated a striking diversity of ways of working with nature. Many of these are ecologically adaptive, but this is not to say that all of them make ecological sense. Some certainly do not, and some may have become ecologically maladaptive. The point, however, is that the diversity of traditional resource use practices represents a pool of human experience spanning many millennia and many cultures. The conservation of this rapidly diminishing pool of experience, a kind of cultural diversity, is as pressing as the conservation of biological diversity.

The irony is that, as scientists are beginning to appreciate folk ecology and its implications, a monolithic vision of modern management is engulfing these traditional systems. This is an underlying theme of the present paper, which proceeds through a number of interrelated themes. First, different world-views are examined in relation to the evolution of ecologically prudent resource use practices. Second, the paper examines traditional views of the world as an interacting community of beings. This leads to a discussion of belief systems and prescriptions for restricted resource use and a synthesis of some resource management 'rules of thumb' that emerge from that experience.

The paper then reviews similarities between old and new conservation prescriptions and explores the questions of why modern scientific resource management has been so ineffectual in bringing about ecologically sustainable use and how the science of ecology may fit into a new synthesis of old and new environmental wisdom. In keeping with the holistic approach developed in the paper, an eclectic diversity of examples, not just from the marine environment but also from terrestrial and freshwater environments, is used.

# Traditional Resource Management Systems

Madhav Gadgil

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## 2. Ecological Prudence

It is generally known that the way in which various societies approach the utilization of their natural resource base depends on their perception and experience of how it responds to patterns of resource use. For example, if the resource base is perceived as fluctuating in a capricious fashion regardless of how it is used, a society would tend to impose few restraints on its use. Some hunting-gathering and herding societies are likely to behave in this fashion. Societies that perceive their resource base as infinite, and in fact ever-expanding by virtue of technological advances, are even less likely to observe any resource use restraints. Agrarian societies colonizing new lands, as during European settlement of new overseas territories, or the early industrial societies confident of the ability of technology to take care of any problems of resource exhaustion that may arise, adopt this approach.

It is when the resource base is perceived as well-demarcated, finite and sensitive to the resource-use pattern that societies are most likely to stress restrained, sustainable patterns of resource-use. Many horticultural societies, or those combining fishing with horticulture, have developed sustainable resource-use practices, and it is possible to

examine the conditions under which ecological prudence has presumably evolved. These societies are characterized by plant cultivation without the use of the plough or iron implements. Particular methods of cultivation tie them to a specific, rather restricted locality for extended periods of time. Given a simple technological base and an inability to engage in large-scale land clearance, these horticulturists live in small communities of a few hundred individuals, cultivating small plots of land surrounded by extensive tracts of land under natural vegetation. Consequently hunting, fishing and gathering of a whole variety of resources from a finite territory is critical to their subsistence. Such communities are linked together in societies of very modest size, around 100 and 6,000 for simple and advanced horticultural societies, respectively.

Prudent resource use is likely to be of survival value for such societies, for they are often in acute territorial conflict with neighbouring societies. At the same time, any serious resource shortages, even if short-lived and seasonal, are apt to seriously weaken the ability of these societies to withstand assaults on their territories by their neighbours. Such societies may therefore be in danger of cultural, if not genetic, extermination if they exhaust their resource base. This may have favoured the evolution of cultural traditions of prudent use.

### **3. "Community of Beings" vs. "Dominion over Nature"**

Many horticultural societies seem to have elaborated a world-view which provides the underpinning for a whole range of practices of restrained resource-use. They often either have no conception at all of a single supreme creator, or believe that such a creator has little concern with human affairs. Instead they impute sacred qualities to a number of landscape elements, plants and animals in their own immediate surroundings. Indeed, their world is perceived as a community of beings: rocks, rivers, trees, birds and beasts with whom humans are linked in a variety of ways. Rivers may be seen as mothers, altruistically bestowing waters that are valued; trees as demons that need to be placated by offerings so that they will reciprocate by not harming people; antelopes as brethren for whose killing one must apologize.

It appears that horticultural societies are characterized by a number of conditions conducive to the evolution of a "community of beings" world-view: small community size, the presence of extended kin groups, repeated social interactions, and a geographically well-defined resource base. However, many other non-industrial societies also show many or most of these characteristics. In fact, many rural societies of the contemporary world do this as well.

It is not surprising, therefore, that a "community of beings" world-view is not restricted to horticulturists. In general, these beliefs go back to the pantheistic tradition dominant before the rise of monotheistic religions. Such pantheistic traditions still exist in some modern hunter-gatherer groups. They existed in pre-Christian Europe, survived for a time in the Christian mysticism of St. Francis, and their remnants may still be found today, for example in rural Irish society. Similarly, under Islam pantheism is in the traditions of many cultures, including many in Africa and North Asia. It is seen also among the native peoples of Australia and the Americas.

By contrast, there is no identification with nature in the "dominion over nature" world-view. The roots of this world-view, however named, have been hotly debated. It may be argued that this world-view derives from the Judaeo-Christian tradition and early European science, as well as from the values and perspectives that emerge from the Industrial Revolution.

If the "community of beings" world-view can be characterized as an "I — thou" relationship between humans and nature, the "dominion over nature" world-view is characterized as an "I — it" relationship. Nature is viewed as clockwork and is considered to exist separately from humans. It can be studied by taking it apart and by asking

systematic, testable questions. It can be brought under control and made to yield human benefits. Economic growth is seen as a consequence of somehow freeing these limitless resources. Productive activity, therefore, is seen as a process of overcoming environmental constraints.

Resource management science in the employ of the "dominion over nature" world-view has given us the MSY concept to maximize fish yields and has paved the way for the giant trawlers, seiners and drift-netters of today. It has also given us such management techniques as clear-cutting large tracts of land and predator control. Utilitarian approaches such as these have clashed not only with the "community of beings" world-view but also with the naturalist-ecological tradition in the West.

Regier *et al.* use the term "conventional exploitative development" to refer to the utilitarian ideology which has dominated resource management science in the West. They have pointed out that more ecologically sensible alternatives are available, and further, that these alternatives are beginning to take a foothold in some parts of the West (Regier *et al.*, 1989). Some of these alternatives are consistent with traditional ecological views.

#### **4. Traditional Ecosystem Views**

Many traditional societies view physical as well as biological components of the environment and the human population as being linked together in a web of relationships. This is akin to the modern ecosystem view of the natural world. By ecosystem view we mean a holistic view that takes into account all ecosystem components and their interactions, including those involving human societies.

The beginnings of the ecosystem concept in Western science go back to von Humboldt's writings of 1807, but traditional ecosystem ideas may extend as far back as the ancient Sumerians, according to one review of the historical development of the concept. One particular ecosystem concept, that of a watershed managed as a unit with interacting components of water, land, plants and animals, crops up in several ancient cultures. There are written records going back nine centuries to show that Swiss communes controlled watersheds and used watershed resources in an integrated fashion. In Japan the use of the watershed ecosystem idea goes back at least to the 1600s. There are records showing that in the Ottoman Empire Sultan Mehmed II instituted watershed conservation measures (prohibition of overgrazing, prohibition of tree-cutting, river bank stabilization, and the revegetation of the catchment area) in the river basin supporting Constantinople (later Istanbul) when he captured that city in 1453. Table 1.1 summarizes a diversity of traditional ecosystem views and practices from a variety of different cultures and geographical areas. Amerindians of the west coast of North America 'managed' their salmon fisheries and a number of other marine resources, depending on the area, through a variety of traditional practices, rituals and taboos signifying respect. The key to this management system was the territorial control of resources. By the early 20th century, however, these native systems were overpowered by commercial salmon fishing interests and open-access conditions created in place of communal management.

Although there was much variation in resources use practices from area to area, the general picture is that of a nested system of rights. For example, the entire Nass River watershed in northern British Columbia was claimed as traditional land by the Nishga tribe. Each Nishga community used one part of the watershed. Some fisheries were conducted communally, but specific salmon fishing sites were controlled by individuals on behalf of 'house' groups or the local divisions of clans. Thus there was a hierarchy of control of resource use rights, from the watershed level down to specific fishing sites.

Table 1.1

## A Summary of Some Traditional Ecosystem Views

System	Country/region	Reference
Watershed management of salmon rivers and associated hunting and gathering areas by tribal groups and kin groups	Amerindians of coastal British Columbia, Canada	Williams and Hunn, eds (1982)
Delta and lagoon system management for fish culture ( <i>tambak</i> in Java), and the integrated cultivation of rice and fish	South and South-east Asia, especially Indonesia	Lasserre and Ruddle (1983)
<i>Vanua</i> (in Fiji), which refers to land-water area and its water, soil, plants, animals and human occupants seen as an interrelated whole	Parts of Oceania, including Fiji, Solomon islands	Baines (1984) Hviding (1989)
The caste system, in which different endogamous groups hold exclusive rights and responsibilities for the use and management of specific resources	Indian subcontinent	Gadgil (1985a, 1985b)
The integrated resource management system ( <i>dina</i> ), in which farming, grazing and fishing territories are shared by different social groups through reciprocal arrangements for access	Mali, Africa	Moorehead (1989) Fay (1989)

In Southeast Asia, the use of brackish water fish-ponds (*tambaks*) dates back as far as the 15th century. Since delta and lagoon systems often extend inland, fish cultivation in *tambaks* can be integrated with rice culture. These rice irrigation systems (*subaks*) are not merely autonomous local-level management units. In Bali, for example, *subaks* are part of a water temple system, and the entire regional terrace ecosystem is managed as a unit (Lansing, 1987). Thus, the integration of *tambak* and *subak* systems for combined rice and fish cultivation, as practised in some areas, is a sophisticated application of the relatively recent ecological idea of the coupling of land and water systems.

The terms *vanua* in Fiji and *puava* in the Solomon Islands refer to the intimate association of individuals with land, reef, lagoon, and all that grows on or in them. *Vanua* refers to a land-sea continuum, but it has social-cultural as well as biological-physical dimensions. As Hviding puts it, *puava* is "a defined, named area of land and in most cases sea. A *puava* in the widest sense includes all areas and resources associated with a *butubutu* (descent group) through ancestral rights, from the top of mainland mountains to the open sea outside the barrier reef".

The caste system of the Indian subcontinent may also be seen as a traditional ecosystem approach. Caste groups may be considered a human-ecological analogue of 'species' specializing on different resources. Caste society, which crystallized around the 5th century, promoted sustainable resource use by restricting access to many specialized resources of a given locality to members of just one endogamous group (some 40,000 of them in total). Both rights to and responsibilities for the use of a specific resource vested in one group. This improved the feasibility of the long-term conservation of that resource.

Further, just as the resources of a specific area are linked together, members of different endogamous groups were also linked together in a network of reciprocal exchange and mutual obligations. The overall picture is one of an ecosystem in which different human groups assumed specialized but interconnected 'niches', interconnected not only functionally but also culturally through time-honoured practices and reciprocal

obligations (Gadgil, 1985b; Gadgil and Malhotra, 1983)

The *dina* system of Mali also provides for integrated resource management through resource specialization by different groups. The system was formalized in the 19th century by codifying the then existing resource management systems into grazing, fishing and farming territories. Resource specialists were ethnic or tribal groups and much fewer in number than in India. In the inland delta of the Niger river, for example, the Bozo people specialized in shallow water fishing whereas the Somono people specialized in net fishing. The farmers consisted of four ethnic groups, and among the herders the Fulani people were the dominant group. Detailed rules of access governed productive activities and provided for reciprocal rights for the various groups. Fishing, for example, was regulated by "masters of the water", who supervised the use of allowable techniques, set opening dates for different fisheries, could extend fishing rights to outsiders (for a tithe) and conducted ceremonies for water deities.

There is relatively little historical information about how these various ecosystem approaches developed. Geertz, however, has traced some 400 years of the history of paddy rice culture in Indonesia. He found that as the system developed from less intensive modes of agriculture, productivity was increased through the building of dikes, terraces and irrigation canals. Water was managed for weed control and nutrient retention. At the same time, the developing irrigation technology necessitated the parallel development of appropriate common property institutions for collective action. The users established ways of collective decision-making and resource management, since the maintenance of the irrigation work and the security of food production depended upon the cooperation of all participants. Thus Norgaard (1984) comments, "contrary to the view of growth as a process of overcoming environmental constraints, the coevolutionary perspective emphasizes an increasingly important, and frequently more complex, interaction between man and his environment".

Such a view, whether in *subak* maintenance or in the management of Pacific salmon stocks, is ecologically more sensible than the conventional developers' view of achieving dominion over nature. Closely linked, two-way feedback interactions and reciprocal responses of the social system and the natural system, or coevolution, is an appropriate paradigm under which resource management activities can be structured. In general, traditional resource management fundamentally differs from the utilitarian approach in emphasizing interaction and co-existence rather than control, and by incorporating personal — spiritual components instead of an impersonal I — it relationship with nature.

## **5. Restraints on Resource Use**

These various traditional ecosystem approaches require a belief system which includes a number of prescriptions for restrained resource use. It is of course possible that such apparent restraint may have nothing to do with long-term conservation of the resource base. A harvester interested in the calculus of immediate return may still not use a resource if the net gain obtainable from it is below a certain threshold, or lower than the net gain obtainable from alternative resources. We must therefore examine each supposed instance of restraint to assess whether it could involve such a discontinuation of resource use, for instance, because the cost of harvest has increased excessively.

The range of practices pertaining to restrained resource use by human groups may be classified under ten broad categories:

- i. There may be a quantitative restriction by harvesters on the amount of harvest of a given resource stock of a species or from a given locality. The imposition of such quotas implies that harvesting is halted at resource densities greater than those at which individuals would find the net gains too low to continue. As a corollary, these quotas are likely to enhance total yields on a long-term basis, at the sacrifice of some immediate return. These are therefore likely to be genuine

instances of restraint

- ii. Harvesting a certain resource may be abandoned when resource densities decline. In parts of New Guinea, for example, the hunting of birds of paradise is temporarily abandoned if their populations decline. Such a response is expected from harvesters attempting to maximize short-term net gain, since a fall in resource density would progressively increase the cost of harvesting. It is possible, though perhaps less probable, that harvesting may be abandoned well before this level is reached, in the interest of long-term yields. Such management has been documented by Feit for Canadian subarctic hunter-trapper-fishermen.
- iii. Harvesting from a certain habitat patch may be abandoned if yields from that patch are reduced. Thus in the Torres Strait, fishing may be stopped in regions where fish yields are known to have declined. This again is the response expected from a forager attempting to maximize immediate net returns, and could be related to long-term resource conservation only if concrete quantitative evidence is available that harvesting is abandoned before returns reach a value low enough to justify abandoning it.
- iv. Harvesting of a certain species may be abandoned in a certain season. Illustrative here is the taboo in many Indian villages on hunting certain animals in the four months from July to October. In the Torres Strait, hunting and fishing are carried out in phases with appropriate tides, winds, seasons and sea conditions, which renders them highly sporadic over time. It is possible that this is a consequence of returns that are too low to justify harvesting for immediate gains in a particular season. Conversely, if in fact net returns in that season are expected to be relatively high, it is likely to be a conservation measure.
- v. Harvesting from a certain habitat patch may be abandoned in certain seasons or years. In James Bay certain fishing grounds are regularly rotated or fallowed and the same is done with goose hunting areas, creating, in effect, a shifting sanctuary system. Again, this could possibly be a response to an excessively low level of net gain from that habitat patch in that season or at those times. This should be verified by comparing it with net gains in other seasons, and if possible by a quantitative assessment.
- vi. The harvest of certain life history stages by age, sex, size or reproductive status may be prohibited. For example, in the village of Kokre-Bellur in the southern Indian state of Karnataka, birds breeding at a heronry may be left unmolested, though they may be hunted elsewhere and in other seasons. Similarly, Cree Amerindian waterfowl hunters in the James Bay coastal wetlands avoid critical goose feeding areas and do not hunt during the breeding season. If such protected stages appear to be critical to population replenishment, and if they are likely to yield net gains as high as or higher than the unprotected stages, it is reasonable to assume that this measure is designed specifically to conserve the resource. On the other hand, if these stages are likely to yield lower net returns in comparison with the unprotected stages, then they might be left out of the harvest simply in the interest of maximizing immediate net gains.
- vii. The harvest of certain species may be prohibited. Some species are never harvested because of the relative difficulty of procuring them or the risk of injury during hunting, or they may carry parasites that can affect humans. If these conditions do not operate, then conservation can indeed serve the long-term interests of human resource use if the species thus protected enhances the availability of other species that are harvested. This is likely for some widely protected species such as trees belonging to the genus *Ficus*, but less likely for a wide variety of species protected as totemic by given tribal groups.
- viii. Certain habitat patches may either never be harvested or may be subject to very low levels of harvests through strict regulation. It is extremely difficult to arrive at workable prescriptions on quantitative quotas, closed seasons or protected life history stages that would decidedly guard against resource decimation. Providing refugia (sacred groves, sacred ponds, etc.) may then be the most easily perceived and most efficient way of guarding against resource depletion (Gadgil and Vartak, 1976).
- ix. Certain age-sex classes or social groups may be banned from employing certain



harvesting methods or from utilizing certain species or habitat patches. Thus in New Guinea adult males are banned from hunting rodents, and on Fanafuti atoll in the Pacific, turtle meat was taboo to all except the king (Rappaport, 1984; Zann, 1985). This could contribute towards long-term resource conservation by moderating the total amount harvested. It could also assist in long-term conservation by restricting access to a limited number of individuals who may more readily use the resource in a prudent fashion. It is of course quite possible that such restrictions merely benefit certain segments of the community in positions of power without serving the interests of long-term conservation.

## 6. Some Rules of Thumb

It is increasingly realized that precise prescriptions for the prudent use of living resources are difficult and that detailed quantitative ones might be impossible to arrive at in the present state of our knowledge (Clark, 1985). This is particularly so if the entire prey population is continually subject to harvesting. By contrast, some simpler general prescriptions for averting resource collapse may be feasible and yet have a significant effect in enabling sustainable use. These are five: (i) Provide total protection to some habitat patches, representing different ecosystems, so that resource populations are always maintained above some threshold level; (ii) provide total protection to some selected species so that community level interactions are minimally disrupted; (iii) protect such life history stages as appear critical to the maintenance of the resource population; (iv) provide total protection to resource populations at certain times; and (v) organize resource use in such a way that only a relatively small group of people controls access to a particular resource.

Modern ecological and evolutionary theory does indeed suggest that such prescriptions are likely to assist in avoiding resource collapse, although they would by no means ensure harvest at maximum sustainable yield levels. In his classic experiments on prey — predator cycles of protozoans, Gause showed that prey extinction could be effectively avoided only by providing the prey a refugium, an area of the experimental arena inaccessible to the predator, where the prey could maintain a minimal population and from which other areas could be colonized (Gause, 1969). Sacred groves, sacred ponds, and stretches of sea coast or coral reefs from which all fishing is prohibited are such refugia.

Modern ecological theory also stresses the significance of some species that serve as 'keystone resources' or mobile links in maintaining the overall functioning of the community (Terborgh, 1986). The tree genus *Ficus*, to which belong species such as the banyan and the *peepal*, widely protected in Asia and Africa, is one such keystone resource genus. Contemporary ecological theory also points to the fact that certain stages in a population are of higher "reproductive value" and therefore more significant for permitting continued population growth. Pregnant does and nesting birds, again often protected by humans, are such stages. Finally, there is a rapidly growing body of literature to show that sustainable resource-use develops when a particular group has both control over and responsibility for a particular resource (Berkes, ed. 1989). Recent work on the evolution of cooperative behaviour emphasizes that restraint is more likely to evolve in groups of smaller numbers of individuals in repeated social interactions (Joshi, 1987; Berkes and Kence, 1987).

It thus appears plausible that over the course of human history there have been human groups whose interests were strongly linked to the prudent use of their resource bases, and that such groups did evolve appropriate conservation practices. These practices were apparently based on simple rules of thumb that tended to ensure the long-term sustainability of the resource base. These rules would necessarily have been approximate. They would have been arrived at through a process of trial and error, with the continued acceptance of practices which appeared to keep the resource base secure, coupled with the rejection of those practices which appeared to destroy it. Practices observed by other social groups may also have been adopted if they appeared to lead to

the persistence of a whole range of practices, some beneficial from the point of view of resource conservation, but also others that were neutral, and perhaps some that once were beneficial or neutral but became harmful due to changed circumstances

Some hunter-gatherer, horticultural and simple fishing societies institutionalized a number of such measures of resource conservation through their religious belief systems. The nomadic herder as well as technologically more advanced agrarian and early industrial societies became progressively less concerned with the well-being of their resource base, and consequently abandoned a number of these practices. The mainstream monotheistic traditions of the more recent Middle Eastern religions rejected them with great vehemence as pagan practices; however, the religions of the East — Buddhism, Jainism, Taoism and Hinduism — absorbed several of these practices, partly as religious beliefs, partly as accepted customs

## **7. Scientific Prescriptions**

The modern scientific tradition arising in the advanced agrarian societies of Christian Europe began with a strong faith in man being apart from nature and fully entitled to the unrestrained exploitation of natural resources (White, 1967). The relatively late development of the science of ecology and resource management may be related to this. Resource management science did not begin until the second half of the 19th century, when the finite nature of the world's resource base first began to be evident to European civilization with the closing of the many frontiers along which European expansion had been in progress during the previous three centuries. Only then did scientific prescriptions for restrained resource use make a slow appearance. However, these new prescriptions for preservation in many ways merely paralleled the pre-scientific prescriptions typical of earlier modes

- i. Just as there were quantitative restrictions on the amount of fuelwood extracted by a family from a community woodlot, or on the number of animals to be grazed on a fodder reserve, there are now quantitative prescriptions as to the amount of timber to be removed during the course of selection cutting from a designated patch of forest, or regarding the number of tigers that may be shot by a licence holder in a given year
- ii. Just as Torres Strait islanders stop fishing a particular species when its population density falls below a certain level, the International Whaling Commission has banned the hunting of certain species of whale whose populations have been severely depleted
- iii. Just as certain coastal fishing areas are fallowed by traditional societies when yields become very low, there have been prescriptions to 'rest' certain forest areas, for instance, in India after the excessive harvests of the Second World War
- iv. Just as there is a traditional ban on hunting in certain seasons, there are closed seasons for mechanized fishing and for timber extraction.
- v. Just as certain life history stages are traditionally given protection, for instance breeding birds at heronries in many villages in peninsular India, the younger, growing stock in a forest is supposed to be spared all extractive pressure
- vi. Just as certain methods of harvest, e.g. poisoning of streams, may be traditionally forbidden, there are regulations forbidding fishing with destructive or overly efficient gear
- vii. Just as certain habitat patches, for instance sacred groves or sacred ponds, may be fully protected from any harvest, there are prescriptions for keeping certain forest areas such as national parks totally free from human interference, for watershed conservation, maintenance of biological diversity and other ecological functions
- viii. Just as certain species are totally protected from hunting or felling, e.g., monkeys or *Ficus* trees in Indian villages, complete national or international protection may be extended to certain endangered species such as the California condor or the

whooping crane.

- ix. Just as north-west Pacific coast Amerindian societies controlled access to the most productive marine resources, contemporary techniques for salmon management in Alaska and elsewhere include access and entry limitations.

Perhaps most important of all, just as many societies developed systems for integrated resource management, the ecosystem approach now provides a guide towards more sustainable resource use.

## 8. Conclusion

Scientific prescriptions thus often resemble or parallel 'pre-scientific' prescriptions based on traditional ecological knowledge and simple rules of thumb. Indeed, considering the track records, one could argue that the scientific prescriptions of industrial society show little evidence of progress over simple rule-of-thumb prescriptions. Similarly, one could argue that government enforcement of these scientific prescriptions represents little progress compared with the earlier enforcement of procedures based on religion or social convention.

To many it is a paradox that with all its power, modern science seems unable to halt and reverse the depletion of resources and the degradation of the environment. Part of the reason for this paradox may be that scientific resource management, and Western reductionist science in general, developed in the service of the utilitarian, exploitative "dominion over nature" world-view of colonialists and developers. It is best geared to the efficient utilization of resources as if they were boundless. This is a legacy of the *laissez-faire* doctrine of Adam Smith and still persists in the neoclassical economic theory of today (Daly and Cobb, 1989).

Thus modern resource management science is well suited by design for conventional exploitative development but not for sustainable use (Regier *et al*, 1989). The task then is to rethink and reconstruct a new resource management science that is better adapted to serve the needs of ecological sustainability and the people who use resources. To do this, there is a need to conserve both biological and cultural diversity, which are tied together (Gadgil, 1987; Norgaard, 1987); there also is a need to conserve the diversity of traditional resource management practices and systems.

During the past century the diversity of resource management systems has been replaced by a monolithic scientific management vision — one that often has not led to sustainable outcomes. Such a trend is clearly maladaptive, but the indigenous, adaptive systems have in the mean time suffered as well. Each of the traditional ecosystem approaches summarized in this paper has been impacted by colonialists or developers. Contrary to conventional wisdom, these systems did not collapse primarily because of population pressure. For example, Johannes (1978) has shown for the Pacific islands case, and Rogers (1979) for Alaska, that traditional systems collapsed because of outside interference and the forced institution of open-access conditions at a time when local populations were actually *declining*. Population pressure is real, of course, but in many cases it comes *after* local systems collapse and local resource users lose control, not before.

The rejection of a monolithic scientific resource management vision does not mean the rejection of all Western science. There are excellent examples of how modern and traditional management can be brought together successfully, as in Japanese inshore fisheries (Ruddle, 1989). Rather, as Regier (1975) suggested, the task is to develop a flexible approach by conserving what is useful in Western science and nurturing some of its more radical components. Ecology as a science concerned with the whole (rather than its parts) is one of the components. It stands at the fringe of Western scientific traditions because, together with a select few disciplines such as systems science, quantum physics, gestalt psychology, operations research, ecology is holistic. As such, ecological

thinking is sympathetic to the mode of thinking of the ancient traditions of East Asian, African and Amerindian cultures. Especially important in this regard, ecology is concerned with diversity and adaptiveness.

All these put ecology in a unique position to be the cornerstone of a new science of resource management that synthesizes the best of old and new wisdom towards a more sustainable future. But ecology would first have to extricate itself from the older, utilitarian "control over nature" tradition of resource management. For ecology's involvement with that tradition is very real (Worster, 1977). The challenge posed by Theodore Roszak (1972) is still relevant, albeit in a somewhat different context: "The question remains open: Which will ecology be, the last of the old science or the first of the new?"

## 9. References

- Almstedt, R.L., 1968. 'Diegueno Tree: An Ecological Approach to a Linguistic Problem'. *International Journal of American Linguistics*, 34, pp. 9-15.
- Baines, G.B.K., 1984. 'Traditional Resource Management in the Melanesian South Pacific: A Development Dilemma'. In Fikret Berkes, ed., *Common Property Resources, Ecology and Community-Based Sustainable Development*, Belhaven Press, London.
- Bartlett, H.H., 1940. 'History of the Generic Concept of Botany'. *Bulletin of the Torrey Botanical Club*, 67, pp. 349-62.
- Berkes, F., 1982. 'Water-Fowl Management and Northern Native Peoples with Reference to Cree Hunters of James Bay'. *Musk-Ox*, 30, pp. 23-35.
- , 1977. 'Fishery Resource Use in a Subarctic Indian Community'. *Human Ecology*, 5, pp. 289-307.
- , 1985. 'Fishermen and "The Tragedy of the Commons"'. *Environmental Conservation*, 12, pp. 199-206.
- Berkes, F. and A. Kence, 1987. 'Fisheries and the Prisoner's Dilemma Game: Conditions for the Evolution of Cooperation among Users of Common Property Resources'. *Middle Eastern Technical University Journal of Pure and Applied Sciences*, 20, p. 209.
- Berkes, F., ed., 1989. *Common Property Resources, Ecology and Community-Based Sustainable Development*, Belhaven Press, London.
- Berkes, F. and M.M.R. Freeman, 1986. *Canadian Inland Seas*, Elsevier, Amsterdam.
- Berlin, B., 1972. 'Speculations on the Growth of Ethnobotanical Nomenclature'. *Language and Society*, 1, pp. 51-86.
- , 1973a. 'First Ethnobotanical Expedition of the University of California to the Upper Marañon River, Amazonas'. *Peru Report No. 1*, Language Behavior Research Laboratory, Berkeley.
- , 1973b. 'Folk Biology'. In C. Sturtevant, ed., *Handbook of North American Indians*, Smithsonian Institution, Washington, D.C., in press.
- Berlin, B., D.E. Breedlove and P.H. Raven, 1966. 'Folk Taxonomies and Biological Classification'. *Science*, 154, pp. 273-75.
- , 1968. 'Covert Categories and Folk Taxonomies'. *American Anthropologist*, 70, pp.

———, 1973a 'General Principles of Nomenclature in Folk Biology'. *American Anthropologist*, 75, pp 214-42

———, 1973b 'Pinciples of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan Speaking People of Highland Chiapas, Seminar, New York

Berlin, B , D E. Breedlove, R.M Laughlin and P H. Raven, (in press). 'Lexical Retention and Cultural Significance in Tzeltal-Tzotsil Ethnobotany' In, M S. Edmonson, ed , *Meaning in the Mayan Languages*, Mouton, The Hague

Borgerhoff-Mulder, 1988 'Behavioural Ecology in Traditional Societies'. *Trends in Ecology and Evolution*, 3, pp 260

Brendt, R M , 1962 *Excess and Restraint*, University of Chicago Press, Chicago

Buck, C.D , 1949. *A Dictionary of Selected Synonyms in the Principal Indo-European Languages*, University of Chicago Press, Chicago

Bulmer, R , 1970 'Which Came First, the Chicken or the Egghead?', In Popuillon and P. Mavausa, ed , *Exhanges et Communication : Melanges offerts a Claude Levi-Strausse a l'occasion de son 60eme Anniversaire*, Mouton, The Hague

Bulmer, R. and M. Tyler, 1968 'Karam Classification of Frogs'. *Journal of Polynesian Society*, 77, pp. 333-85

Capra, F , 1982 *The Turning Point*, Bantam, New York

Clark, C W , 1985. *Bioeconomic Modelling and Fisheries Management*, Wiley, New York

Daly, H.E and J B. Cobb Jr , 1989. *For the Common Good*, Beacon, Boston

Demory, B , 1972. 'The Word "Tree" in the Hokan Language Family' Department of Anthropology, California State University, Long Beach

Dennler, J.G , 1939. 'Los nombres indigenas en Guaraní de los mamíferos de la Argentina y países limitrofes y su importancia para la systematica'. *Physis*, 16, pp 225-44

Diamond, J M., 1966 'Classification System of a Primitive People' *Science*, 151, pp 1102-4

Eaton, P., 1985. 'Customary Land Tenure and Conservation in Papua New Guinea'. In J.A McNeely and D. Pitt, eds , *Culture and Conservation. The Human Dimension in Environmental Planning*, Croom Helm, Dublin

Fay, C., 1989. *Cahiers des Sciences Humaines*, 25, pp 213

Feit, H.A , 1986. *Native People and Renewable Resource Management*, Alberta Society of Professional Biologists, Edmonton, pp 49-65

Freeman, M.M R and L.N Carbyn, eds , 1988. *Traditional Knowledge and Renewable Resource Management in Northern Regions*, University of Alberta, Edmonton

- Friedrich, P., 1970 *Proto-Indo-European Trees*, University of Chicago Press, Chicago.
- Gadgil, M., 1985a 'Social Restraints on Resource Utilization: The Indian Experience' In J.A. McNeely and D. Pitt, eds., *Culture and Conservation: The Human Dimension in Environmental Planning*, Croom Helm, Dublin
- , 1985b 'Cultural Evolution of Ecological Prudence' *Landscape Planning*, 12, pp 285-99
- , 1987 'Diversity: Cultural and Biological'. *Trends in Ecology and Evolution*, 2, pp 369
- , 1989 'The Indian Heritage of a Conservation Ethic'. In B. Allchin, F.R. Allchin and Thapar, eds., *Conservation of the Indian Heritage*, Cosmo Publications, New Delhi
- Gadgil, M. and K.C. Malhotra, 1983 'Adaptive Significance of the Indian Caste System: An Ecological Perspective' *Annals of Human Biology*, 10, pp 465-78
- Gadgil, M. and V.D. Vartak, 1976 'Sacred Groves of Western Ghats of India'. *Economic Botany*, 30, pp
- Gajdusek, D.C. and V. Zigas, 1957 *New Engl J Med*, 257, pp 974
- Gatschet, A.S., 1890 'The Klamath Indians of Southwestern Oregon'. *Contributions to North American Ethnology*, Vol. II, Pt. II, US Geographical and Geological Survey, Rocky Mountain Region, Washington, D.C.
- , 1899 "'Real," "True", or "Genuine" in Indian Languages' *American Anthropologist*, 1, pp 155-61
- Gause, G.K., 1969. *The Struggle for Existence*, Hafner, New York
- Geeertz, C., 1963 *Agricultural Involution*, University of California Press, Berkeley
- Gliessman, S.R., E.R. Gancia and A.M. Amador, 1981 *Agroecosystems*, 7, p 173
- Greene, E.L., 1909. *Landmarks of Botanical History*, Smithsonian Miscellaneous Collection, Washington, D.C.
- Gurpinar, T., 1978. *Yabani Bitkilerimiz*, Redhouse, Istanbul
- Harrington, J.P., W.W. Robbins and B. Freire-Marreco, 1916. 'Ethnobotany of the Tewa Indians'. *Bureau of American Ethnology Bulletin*, 55
- Hasler, A.D., ed., 1974 *Coupling of Land and Water Systems*, Springer Verlag, New York
- Hunn, E.S., 1973. 'Tzeltal Folk Zoology: The Classification of Discontinuities in Nature' Ph.D. thesis, University of California, Berkeley
- , 1970. *Cognitive Processes in Folk Ornithology: The Identification of Gulls*, Language Behavior Research Laboratory, Berkeley
- Hviding, E., 1989 *Traditional Marine Resource Management in the Pacific*, Unesco, Jakarta

- Irvine, D., 1989. *Advances in Economic Botany*, 7, p. 223
- Johannes, R.E., 1978. 'Traditional Conservation Methods in Oceania and Their Demise' *Annual Review of Ecology and Systematics*, 9, pp. 349-64
- , 1981. *Words of the Lagoon*, University of California Press, Berkeley
- Joshi, N.V., 1987. 'Evolution of Cooperation By Reciprocation within Structured Demes' *Journal of Genetics*, pp. 66-9
- Kay, P., 1971. 'On Taxonomy and Semantic Contrast' *Language*, 47, pp. 866-87
- Lansing J.S., 1987, *American Anthropologist*, 89, 326
- Lasserre, P. and K. Ruddle, 1983. 'Traditional Knowledge and Management of Marine Coastal Systems' *Report of the Ad Hoc Steering Group*, Unesco, Paris
- Lenski, G. and J. Lenski, 1978. *Human Societies*, McGraw Hill, New York
- Major, J., 1969. *The Ecosystem Concept in Natural Resource Management*, Academic Press, New York, pp. 9-19
- Martynov, A., 1988. *Arctic Anthropology*, 25, p. 12
- Mayer, E., 1963. *Animal Species and Evolution*, Harvard University Press, Cambridge
- , 1941. *List of New Guinea Birds*, American Museum of Natural History, New York
- McCay, B.J. and J.M. Acheson, eds., 1987. *Human Ecology of the Commons: Introduction to the Question of the Commons*, University of Arizona Press, Tucson
- McNeely, J.A. and D. Pitt, eds., 1985. *Culture and Conservation: The Human Dimension in Environmental Planning*, Croom Helm, Dublin
- Moorehead, R., 1989. Changes Taking Place in Common Property Resource Management in the Inland Niger Delta of Mali'. In F. Berkes, ed., *Common Property Resources: Ecology and Community-Based Sustainable Development*, Belhaven Press, London, pp. 256-72
- Nietschmann, B., 1985. 'Torres Strait Islander Sea Resource Management and Sea Rights'. In K. Ruddle and R.E. Johannes, eds., *The Traditional Knowledge and Management of Coastal Systems in Asia and the Pacific*, Unesco, Jakarta
- Norgaard, R.B., 1987. *Ecological Modelling*, 38, p. 107
- , 1987. *Economic Development and Cultural Change*, 32, p. 525
- Omari, C.K., 1990. In *Ethics of Environment and Development*, Belhaven Press, London
- Rappaport, R.A., 1984, *Pigs for the Ancestors*, Yale University Press, New Haven.
- Raven, P.H., B. Berlin, and D.E. Breedlove, 1971. 'The Origins of Taxonomy' *Science*, 174, pp. 1210-13
- Regier, H.A., 1975. *A Balanced Science of Renewable Resources*, University of

Washington Press, Seattle

Regier, H.A., R.V. Mason and F. Berkes, 1989. 'Reforming the Use of Natural Resources'. In F. Berkes, ed., *Common Property Resources: Ecology and Community-Based Sustainable Development*, Belhaven Press, London

Rogers, G.W. 1979 'Alaska's Limited Entry Program: Another View' *Journal of the Fisheries Research Board of Canada*, 36, pp 738-88

Roszak, T., 1972, *Where the Wasteland Ends*, Doubleday, Garden City

Ruddle, K., 1989 'Solving the Common-Property Dilemma: Village Fisheries Rights in Japanese Coastal Waters'. In F. Berkes, ed., *Common Property Resources: Ecology and Community-Based Sustainable Development*, Belhaven Press, London

Ruddle, K. and R.E. Johannes, eds., 1985 *The Traditional Knowledge and Management of Coastal Systems in Asia and the Pacific*, Unesco, Jakarta

Smith, E.A., 1983 'Anthropological Applications of Optimal Foraging Theory: A Critical Review'. *Current Anthropology*, 24, p. 625

Stross, B., 1969. 'Language Acquisition by Tenejapa Tzeltal Children' Ph.D. thesis, University of California, Berkeley

Tanner, A., 1979 *Bringing Home Animals: Religious Ideology and Mode of Production of the Mistassini Cree Hunters*, Hurst, London

Terborgh, J., 1986 'Keystone Plant Resources in the Tropical Forest'. In M.E. Soule, ed., *Conservation Biology — The Science of Scarcity and Diversity*, Sinauer Associates, Inc., Publishers, Sunderland

Trager, G.L., 1939 "'Cottonwood" = "Tree": A Southwestern Linguistic Trait'. *International Journal of American Linguistics*, 9, pp 177-18

Ullman, S., 1966 'Semantic Universals'. In J.H. Greenberg, ed., *Universals of Language*, MIT, Cambridge

White, L., 1967 'The Historical Roots of Our Ecologic Crisis'. *Science*, 155, pp 1203-07

Williams, N.M. and E.S. Hunn, eds., 1982. *Resource Managers: North American and Australian Hunter Gatherers*, AAAS Selected Symposium 67, Washington, D.C.

Worster, D., 1977 *Nature's Economy*, Cambridge University Press, Cambridge

Wyman, L.C. and S.K. Harris, 1941. 'Navajo Indian Medical Ethnobotany'. *University of New Mexico Bulletin*, 366, Anthropological Series 35

Zann, L.P., 1985 'Traditional Management and Conservation of Fisheries in Kiribati and Tuvalu Atolls'. In K. Ruddle and R.E. Johannes, eds., *The Traditional Knowledge and Coastal Systems in Asia and the Pacific*, Unesco, Jakarta