Research article

Science and Conservation of Aquatic Animals in Thailand

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Abstract Conservation policy, plans and implementation require the integration and management of a multitude of disciplines including the natural, physical and social sciences, law, economics and government policy. This study describes several major steps to implement a conservation plan for degraded rivers in Thailand and provides new approaches to assist in repairing degraded freshwater fish communities. Conservation of aquatic animals requires an understanding of their environmental requirements, preferences and species associations to accompany existing tactics to improve physical and chemical conditions of rivers. At present this ecological information is dreadfully inadequate in Thailand. Some freshwater environments in Thailand are currently experiencing an alarming decline in biodiversity. As a result, scientists and managers should undertake immediate management techniques to protect what remains of these aquatic systems. First step in conservation is to recognize a need and this is not likely to be easy. Effective conservation projects are likely to be lead by a committee representing a wide range of expertise including ecology, policy, law, economics and sociology along with appropriate government representatives. Second step is to determine objectives and an implementation strategy. Each river is dynamic and unique. Conservation may be approached and applied in different ways depending on human and financial resources, timeframe, information and severity of resource depletion, including recovery, rehabilitation, restoration and replacement. A third step might include restructuring the biotic community in a degraded river once the physical damage or source of contamination has been contained and the chemical and physical conditions repaired. Conservation planning is an activity in which social, economic and political imperatives may modify, sometimes drastically, scientific prescriptions. This interaction need not be all one way.

Keywords bioenvironmental associations, ecosystem dynamics, conservation, species richness, aquatic animals, Southeast Asia

INTRODUCTION

Ecosystems are complex and temporally dynamic and need to be understood to implement conservation plans and actions. Conservation plans for degraded aquatic systems should at the outset clearly define temporal objectives recognizing available finances as well as physical, chemical and biological resources information. Success is likely to be enhanced by incorporating human values and needs within the ecosystem model. The specific applicability of these broad principles is context-specific because all ecological systems are unique as a function of their location, physical and chemical environment and current level and type of human use.

The outcomes of conservation efforts commonly depend on how and by whom problems are framed. Conservation biology focused mostly on regional issues in the early years; however, recognition of the impact of human activities on global climate and potential consequences has contributed a new level of urgency and understanding. While conservation biology is part of a multifaceted and interdisciplinary social-ecological system, social factors are likely to be the more forceful and manipulable. This means solutions to conservation problems require integrated and holistic management taking into consideration relevant aspects of sociology, local and regional politics, law and economics.

Mainland Southeast Asia has undergone rapid social and economic changes in recent decades and with these has been a precipitous rise in the degradation of natural resources. In Thailand, forest cover, coastal mangroves, coral reefs and many aquatic and terrestrial animals have declined in distribution and numbers, in some cases dramatically (Aksornkoae, 1996; Nabhitabhata and Chan ard, 2005; Sanguansombat, 2005; Ahmed et al., 2007). Certainly, Thailand has cause for the conservation concern that is recognized within several governmental departments, including the Royal Forest Department, Fisheries Department, Ministry of Natural Resources and Environment as well as a number of small nongovernmental groups scattered throughout the country. A multitude of threats to species and habitats as a consequence of human activities can lead to widespread environmental losses (New, 1998). Conservation is one response to environmental losses associated with anthropogenic activities. Science is required to help in the planning and implementation of conservation actions. Perhaps of no less importance is knowledge and cooperation from local people in concert with guidance and assistance from the appropriate governmental and non governmental leaders. This study describes several major steps to implement a conservation plan for degraded rivers and provides a new approach to assist in repairing degraded freshwater fish communities.

METHODOLOGY

First step in conservation is to recognize a need and this is not likely to be easy. Effective conservation projects are likely to be lead by a committee representing a wide range of expertise including ecology, policy, law, economics and sociology along with appropriate government representatives. Almost certainly there will be contrasting views of objectives and solutions within any such committee.

There is no international or even national standard that can be applied to determine a conservation need. Perception of the level of degradation varies among those making the assessment, their background and agenda. Recognition of a biological need for conservation of aquatic ecosystems or habitats can be difficult. Historically, water quality monitoring has relied on chemical testing which provides no information on water quality resulting from non-chemical activities. Physical alterations such as habitat destruction, flow and discharge are undetected by chemical monitoring. Water quality might better be evaluated from the occurrence and abundance of aquatic organisms that inhabit rivers. These organisms provide a direct association with water quality as they continuously integrate the direct and interactive effects of all environmental variables and stresses, making them holistic indicators of water quality. A comprehensive bioassessment model is important for all geographic regions and one should be developed specifically for Thailand waters in recognition of Thai species distributions and habitat characteristics.

Second step is to determine objectives and an implementation strategy. Each river is dynamic and unique. There are many causes of degradation: physical, chemical and biological, so conservation needs and solutions can be expected to be complex and uneven in cost. For example, conservation of a situation in one river may require relatively simple physical changes to improve bank stability, reduce erosion and turbidity, possibly leading to increased habitat diversity and enhanced plant and animal diversity and abundances. In another river, chemical contamination may have replaced many indigenous plant and animal species with invasive organisms. The source of chemical contaminants may be outside the jurisdiction of those wishing to implement the conservation project further complicating the process.

Objectives should consider time, cost and completeness of conservation area. Important to conservation projects is a clear understanding of the ultimate target. If for example, a community decided their once beautiful river had become polluted and needed to be changed, one important question would have to be "changed to what and how quickly"? Aquatic conservationists recognize there can be degrees of change to an ecosystem or its components. Perhaps the simplest change is called 'recovery' which simply means to stop the source of whatever is negatively affecting the condition of their river and let it regain its former condition through natural processes. This has the advantage of low cost but is slow and species that may no longer inhabit the river may not be available or unable to repopulate the river. Another target might be 'rehabilitation'. This is understood to include changing parts rather than the entire degraded river. Advantages include relatively low cost and being able to evaluate partial rather than a complete conservation effort. A third category is 'restoration' which is to return an ecology or river to the way it was before being changed by human activity. A special category is called 'replacement' which is to improve a degraded river by adding components that were not present in the original river. This might include different species or improved habitat such as enlarged riffles, pools or spawning areas. Closely related to this is understanding the chemical, physical and biological conditions prior to its degraded conditions and in the absence of this information how it can be hindcasted. We must remember that in rivers, in the absence of anthropogenic influences, a harmonious association between the chemical and physical characteristics and the resident biota has evolved over long periods of time. It is unreasonable to expect biotic associations with abiotic factors to suddenly change in accord with human resources and timeframes. Indeed, experience has found aquatic biota to be constrained within specific physical and chemical ranges, although the number of species for which this information is known is alarmingly small. Thus, if we wish to conserve, restore or rehabilitate river biota it is incumbent on the conservationists to understand the environmental needs of the targeted biota. Without doing so is almost certain to lead to failure. Obviously then conservationists must know what species are present at the outset of a conservation plan and the reason for managing fish species.

A third step might include restructuring the biotic community in a degraded river once the physical damage or source of contamination has been contained and the chemical and physical conditions repaired. This is likely to require information on all of the species that used to live there. Guidelines to estimate total number of species within taxonomic groups are now available. If a river has only recently become degraded then it is likely some local residents can be helpful in recalling at least some of the former taxa and their relative abundances. This is most likely for taxa considered to be useful to local residents such as fish and plants of medicinal or food value. In rivers degraded for decades custodial memories may have been lost or at least faded, however, under these conditions science can help. Recently, the relationship between fish species number and river length has been examined for several regions in Thailand. Number of fish species in relation to river size was determined by electrofishing sites selected by a randomized stratified procedure based on river order. Number of potential sites within each order was based on cumulative length relative to total. With adequate sampling equipment and experience most rivers can be sampled by two people within a few days. Total number of species was estimated by the non parametric Jackknife method (Krebs, 1989; Smith and Jones, 2005).

Companion information needs that are useful to conservation programs include environmental conditions necessary to sustain target species. In this regard it would seem enormously beneficial to the conservation of rivers in Thailand to have a national compendium of baseline information for all taxa of plants and animals and effective and efficient technologies available for the implementation of approved conservation practices. Of course this would be complicated by a large and diverse array of abiotic and biotic interactions. Until such information becomes available recent scientific investigations have provided some useful guidelines. Practical studies of associations between fish species, their abundances and significant physical and chemical environmental conditions have been undertaken for rivers in several regions of Thailand (Beamish et al., 2006; Beamish and Sa-ardrit, 2007). These studies have been conducted in rivers throughout Thailand and include measurements of a large number of physicochemical factors at each of an even larger number of sites together with quantitative sampling of resident fish species and their abundances. This information was then analyzed using canonical correspondence analysis (CCA) to identify significant habitat variables and fish species associations, described in an ordination diagram in which species are represented by coded numbers and, significant physicochemical variables, by vectors.

RESULTS AND DISCUSSION

Number of fish species estimated by our laboratory for the relatively pristine nine rivers sampled in central, southern and western Thailand increased in relation to their length (Fig. 1). However, the increase in species diversity was less than predicted from a direct relation with length. Furthermore, there is a suggestion of regional differences in species diversity with western rivers appearing to sustain more species per unit of length than in other regions.

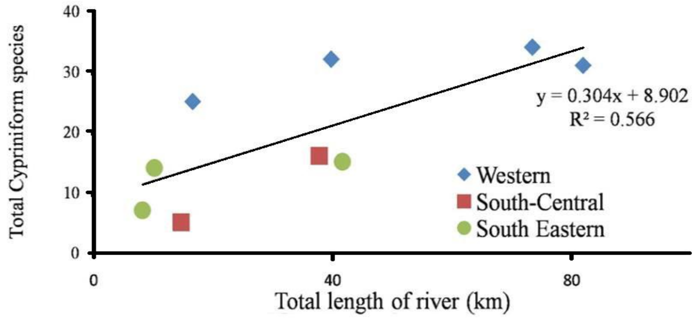
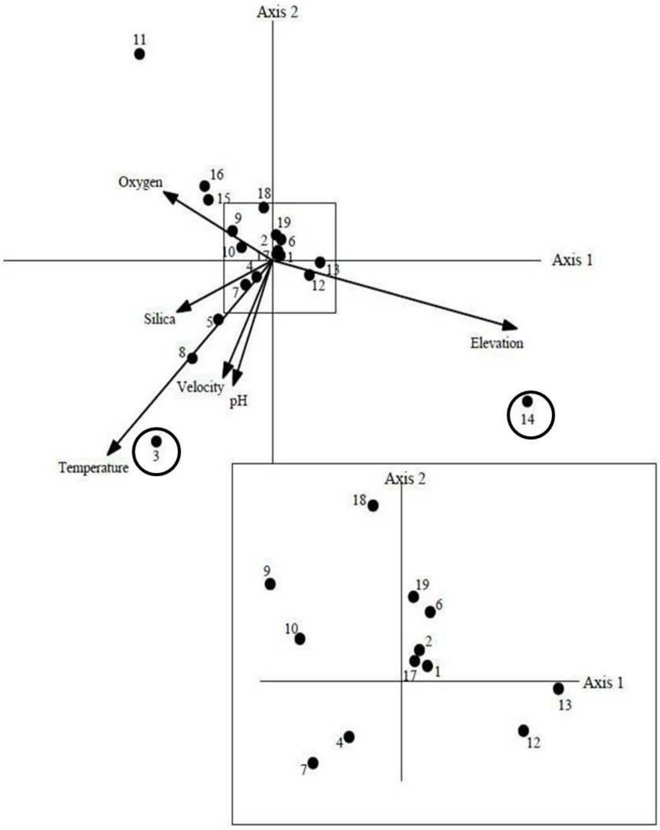


Fig. 1 Relationship between total number of cypriniform species and river length in Western, South-Central and South Eastern river systems

This is important preliminary information for the conservation of fishes in degraded rivers that emphasizes a need to estimate baseline species numbers for more rivers from throughout Thailand. Wherever information on species numbers prior to habitat degradation is not available from records or local residents, regressions such as that in Fig. 1 can provide a simple method for hindcasting potential target numbers.

Associations between fish species and statistically important chemical and physical environmental variables have been described in our laboratory for several regions of Thailand. One example of the extent to which balitorid species vary in their association with environmental conditions was demonstrated in several rivers in Thailand (Plongsesthee, 2011; Fig. 2). The distribution and abundance of balitorid species in these rivers was significantly related to several factors with elevation and temperature being of primary importance followed by dissolved oxygen, silica, pH and water velocity. The extent of influence by each environmental factor varies among fish species. For example, distribution and abundance of *Schistura balteata* (#14 in Fig. 2) *is* positively associated with elevation and negatively, dissolved oxygen while the occurrence and abundance of *Balitora kwangsiensis* (#3 in Fig. 2) is associated positively and primarily with temperature and secondarily with pH and water velocity. Other species were variously associated with the other significant environmental factors highlighting the importance of identifying and understanding the environmental conditions most suitable for each species. Information on species associations and the important environmental variables provide essential baseline data especially in the absence of pre-degradation information and should be of great benefit to conservation efforts of degraded rivers in Thailand.

Conservation of aquatic animals requires an understanding of environmental requirements and species associations to accompany existing tactics to improve physical and chemical conditions of rivers. Some environmental factors have long been known or accepted to be beneficial for fish or habitat conservation and can be implemented with simple technology, relative ease and low cost, such as current deflectors and embankment protection with boulders, gabions or tree plantings. Deflectors can be designed for a variety of purposes (Gore, 1985) including deepening and narrowing channels, scouring pools, altering water velocity and chemistry, and removing silt from spawning gravels and critical areas for benthic invertebrate production.



Name		ID
Acanthocobitis	*botia*	1
Acanthocobitis	*zonalternans*	2
Balitora	*kwangsiensis*	3
Homaloptera	*bilineata*	4
Homaloptera	*confuzona*	5
Homaloptera	*sexmaculata*	6
Homaloptera	*smithi*	7
Nemacheilus	*binotatus*	8
Nemacheilus	*masyae*	9
Nemacheilus	*pallidus*	10
Nemacheilus	*platiceps*	11
Schistura	*sp.*	12
Schistura	*aurantiaca*	13
Schistura	*balteata*	14
Schistura	*kohchangensis*	15
Schistura	*crocotula*	16
Schistura	cf *sexcauda*	17
Schistura	cf *malnerti*	18
Tuboroschistura	*baenzigeri*	19

Fig. 2 Distribution of Balitoridae species from lightly exploited rivers in Thailand with respect to significant habitat variables identified by canonical correspondence analysis on axes 1 and 2, for each, the vector length and direction (Plongsesthee, 2011)

Generally dams are to be avoided in conservation strategies. The key ingredient to all habitat-improvement technologies is an understanding of aquatic ecology in concert with the conservation objectives and resources along with the development of practical tools that can be used to determine environmental requirements of aquatic animals and species associations in undisturbed and environmentally threatened rivers. This is of critical importance for conservation in Thailand now and in the future.

CONCLUSION

Conservative principles need to be developed, approved, implemented and managed to perpetuate aquatic resources for the benefit of all humankind. An understanding of the needs of flora and fauna must be acquired because without this information conservation efforts may prove unproductive. At present this ecological information is dreadfully inadequate in Thailand. Some freshwater environments in Thailand are currently experiencing an alarming decline in biodiversity. As a result, scientists and managers should undertake immediate management techniques to protect what remains of these aquatic systems. Conservation planning is an activity in which social, economic and political imperatives may modify, sometimes drastically, scientific prescriptions. This interaction need not be all one way.

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