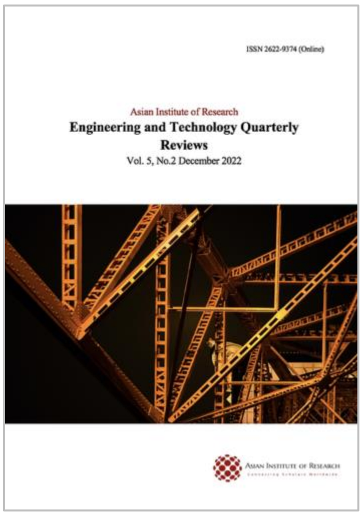

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Importance of Freshwater Biology

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Abstract
Freshwaters have suffered significantly from overfishing, the introduction of foreign species, pollution, flow management, and water extraction as a result of human activity. Many freshwater species' ranges and populations have drastically decreased as a result of these conditions, making them much more susceptible. Freshwater ecologists have been conducting in-depth research on a variety of topics recently, including the status, trends, ecology, and reproduction of endangered species, threats to these species, and the effects of biodiversity loss on ecosystem function, metapopulation dynamics, biodiversity hotspots, and design. The reserve has addressed legal flaws, stakeholder dialogue, and habitat restoration. However, present efforts might not be sufficient to halt the current deluge and imminent extinction of freshwater. We briefly go over four major obstacles to saving freshwater. First, both freshwater species and human usage of freshwater are threatened by climate change. Before natural disasters occur, we must support the thoughtful and sensible planning of technical responses to climate change. We must anticipate ecological and human responses to climate change. Second, since the extinction of freshwater species is already well advanced, freshwater conservationists must now be ready to stop further losses, even if our understanding is still lacking, and to collaborate more successfully with other stakeholders. Third, there is a gap between freshwater ecology and conservation biology that needs to be filled.

Keywords: Biology, Climate Change, Endangered Species, Extinction, Fresh Water

1. Introduction

The last century has seen a sharp increase in human demand for freshwater habitats, posing serious and escalating challenges to biodiversity worldwide. Modern freshwater ecology now places a high priority on documenting biodiversity loss, figuring out its causes, and coming up with solutions.

Since the 1986 release of J-NABS, freshwater conservation science has made significant strides, which we discuss in this article. The North American Benthological Society, J-NABS, and other freshwater scientific societies and publications should be briefly discussed, as well as their past accomplishments and promise for the future. Additionally, we will draw attention to a few areas that, in our opinion, demand special consideration. We must be brief and selective in our treatment, focusing on streams, rivers, and lakes. Wetlands are largely excluded, despite the fact that they are ecologically important, biologically diverse, and threatened by human activity (Junk, 2002).

2. The collision between humans and biodiversity in freshwater ecosystems

Humans have been using fresh water and its environs for thousands of years as a source of drinking water, for irrigation, for transportation, for the production of electricity, for the gathering of plants, fish, and minerals, and as locations for houses, farms, and businesses. The last century has seen a dramatic increase in human use of freshwater ecosystems due to the rapid growth of the human population and the global economy. As a result, there are now significant, widespread, and detrimental ecological effects. Freshwater ecosystems are now enclosed by levees and are dredged and straightened for navigation and flood control. The intake of water, nutrients, organic matter, and sediments to lakes and rivers has also changed as a result of extensive changes to coastal areas and watersheds. Numerous waters have become contaminated or eutrophicated due to excessive nutrient and toxic loadings from these land-use changes and point sources, making it impossible for those waters to support their native biological communities (Smith, 2003). Numerous exotic species that have been introduced by humans into freshwaters around the world have had significant and long-lasting ecological effects. Although they have not yet been fully categorized, freshwater biomes are significantly larger than would be predicted based on the area covered by freshwater ecosystems. In general, freshwaters are a biodiversity hotspot. It becomes obvious that freshwaters in non-glaciated regions can be hotspots of biodiversity when contrasted to these worldwide data when we take into account that a substantial portion of the world's freshwaters are in recently glaciated regions, which have comparatively low biodiversity and endemics.

Few freshwater species have wide geographic ranges, but due to the insular nature of freshwater habitats, many species have evolved that frequently only inhabit a single lake or drainage basin (Strayer, 2006). This has led to a biota with a high degree of endemism and a high rate of species turnover between basins. Because of the high levels of landscape fragmentation and endemism, freshwater species are less able to move easily across the landscape to replace extinct local populations or adapt to climate change, making them more sensitive to human activities. It is really delicate.

Humans' high and increasing demand for fresh water, combined with the rich and native freshwater organisms, has resulted in the extinction or endangerment of many species. The precise scope of this threat is unknown, but we do know that many species and populations are threatened, and that continental freshwater habitats are almost always much more vulnerable than terrestrial counterparts.

It is not uncommon for more than one freshwater species in a taxonomic group to become extinct or endangered in highly developed areas such as Europe and North America (Cutlat and Freehoff 2007). As a result, freshwaters are hotspots for both endangered species and biodiversity. Human activities have destroyed many populations and caused significant range thinning in species that have not yet completely disappeared. Which has the potential to reduce the future survival of many species (Strayer, 2008). Much of the early concern about human impacts on freshwater ecosystems was, at least implicitly, related to biodiversity, and efforts to restore or protect specific freshwater species through harvesting regulation, pollution control, or habitat restoration have a long history. Even at this early stage, however, practical conservation work appears to have been separated from the main body of freshwater ecology: Most limnology textbooks make no mention of biodiversity conservation (Ruttner, 1963).

Freshwater biodiversity conservation came together as a distinct field after the emergence of conservation ecology as a distinct discipline in the 1980s. The formation of the Society for Conservation Biology and its journal Conservation Biology (1987), as well as the publication of widely used textbooks in the field in the 1990s, were key drivers. The rapid growth of non-governmental organizations concerned with the conservation of freshwater biodiversity, such as the Nature Conservancy, World Wildlife Fund, International Rivers Network, and American Rivers. In the United States, legislation such as the Endangered Species Act of 1970 was also instrumental in focusing attention and funding on threatened freshwater species. Similar legal structures exist in Canada, the European Union, and other countries. Many aquatic vertebrates, for example, are classified as protected class 1 and class 2 by the People's Republic of China's Scientific Commission on Endangered Species.

3. Status assessment and study of specific threats

Many recent efforts have been made to assess endangered species' conservation status and identify threats to their survival. The need for such information prior to listing species for protection under the US Endangered Species Act, the Canadian Committee on the Status of Endangered Wildlife in Canada, and similar programs in other jurisdictions motivated this work in large part. Although they are not frequently published in technical journals such as J-NABS, these studies account for a significant portion of all recent research on unioid clams, hydrobid snails, and other species. Since 1960, the International Union for Conservation of Nature has coordinated global species status assessments, which are updated annually in their Red List. The Global Amphibian Assessment and the World Wildlife Fund Living Planet Inventory are two comparable global assessments that include numerous freshwater species. Specific threats to freshwater ecosystems have been highlighted in publications like Rosenberg et al. (2000).

4. Consequences of biodiversity loss for ecosystem function

The relationships between biodiversity and ecosystem performance have been the subject of numerous recent studies. Because they are easier to study experimentally, terrestrial plant communities have received a lot of attention in this research, but freshwater ecologists have also made significant contributions. Ecosystem performance is frequently influenced by species richness and composition, but the size and nature of this effect vary depending on the species that is added to or removed from the ecosystem, the ecological process being researched, and the ecosystem's characteristics. Therefore, despite the possibility of significant anthropogenic biodiversity losses, the effects on freshwater ecosystem functioning are still unknown (Vaughn et al. 2007).

5. Autecological studies of imperiled species

Information on the life history, diet, genetics, physiology, and behavior of endangered freshwater species is required in order to manage and protect their populations. On these subjects, numerous papers have recently been published, greatly advancing our understanding of biology. It is challenging to determine the long-term significance of many of these studies for many at-risk species because a large portion of the data they produced is unlikely to have been used to guide conservation efforts or management decisions.

6. Metapopulation theory and management

The idea of a "metapopulation" as a group of interconnected populations has had profound effects on community ecology and conservation biology, drawing attention to dispersal and fragmentation as critical factors in species survival. Although freshwaters are naturally divided into drainages and habitat fragmentation has increased significantly as a result of dams and other human-made products, metapopulation ecology in freshwaters is different from such activities in other habitats. The study of metapopulations and freshwater fragmentation has yielded interesting conservation results, demonstrating that fragmentation and drainage network geometry can have a significant impact on the persistence of endangered freshwater species and the extinctions and extinctions caused by previous fragmentation have had no effect yet to be completed Additional research in this area is likely to be fruitful and provide insights useful for population management (Fagan 2002).

7. Identification of biodiversity hotspots and reserve design

Conservationists have worked hard to identify geographic areas with high species richness or endemism, and many of these hotspots are now well known. This information is used to prioritize areas for protection as well as to feed formal algorithms that create optimal networks of protected areas that protect the most species while taking up the least amount of space. Despite clear evidence that freshwater organisms are critically endangered and that terrestrial foci frequently overlap with freshwater foci, global biodiversity assessments frequently ignore freshwater species. Similarly, formal algorithms for designing optimal networks of protected sites for freshwater species have rarely been used (Brooks et al. 2006).

8. Restoration ecology

Increased interest in protecting or managing natural ecosystems has been accompanied by a rapid increase in interest in using scientific knowledge to restore or restore damaged ecosystems, which has resulted in the formation of professional societies, journals (Restoration Ecology), and textbooks. The restoration of freshwater ecosystems has also gained popularity. Lake restoration has a strong scientific foundation and is routinely and successfully carried out. The science of restoring running water and wetlands is less developed. Stream and wetland restoration is common, but many projects fail to meet their objectives or are never adequately evaluated (Palmer et al. 2007).

9. Coordination between scientists and other conservation stakeholders

Close communication between scientists and others interested in freshwater resources is required for effective conservation. Much has been written about the importance of such communication and approaches to improving communication between scientists and stakeholders (Barbour et al. 2008). We anticipate that freshwater scientists will collaborate with other stakeholders more than they did in previous years. The debate has shifted from whether scientists should collaborate with other stakeholders to how to make those connections most effectively.

10. Assessment of weaknesses of protective legislation

Legislation for the protection of endangered species has now been in place in many countries for a long time, and its effectiveness can be assessed. A growing critical literature examines the benefits and drawbacks of such rules, and authors have proposed changes to improve their application. Much of this analysis is broad, but some is narrowly focused on freshwater species issues (Biber, 2002).

11. Captive propagation and reintroduction

The ancient practice of breeding game and food species for release into the wild has recently been widely adapted to endangered species. The vast majority of samples are still birds and terrestrial mammals (Morell 2008), but some projects include fish and frogs as well as recent advances in understanding life. Because of the young history and ecology of unionoid mussels, conservationists have been able to reproduce and introduce a large number of these endangered animals. The successful application of captive breeding and reintroduction of any species, whether in a historically known location or not, necessitates careful consideration of genetic and ecological issues (Araki et al. 2007). Attempts to reintroduce a species without changing the factors in the habitat that caused the species' extinction are usually doomed to fail. Many fail reintroduction, and their ultimate contribution to freshwater conservation is unknown.

12. Recent Developments and Future Challenges

We conclude our brief review of recent trends in freshwater biodiversity conservation by looking at four areas where current efforts appear insufficient to meet the challenges that will face us in the coming decades. However, it quickly made its way onto the NABS agenda and now dominates discussions about future conditions and conservation planning in terrestrial, marine, and freshwater ecosystems (Heino et al. 2009). Increased water temperatures, shorter periods of ice cover, and changes in the geographic range or phenology of freshwater fauna have previously appeared as evidence for the start of human-induced climate change in freshwaters (Haino et al. 2009).

Warmer temperatures have a direct impact on the metabolism of thermophilic freshwater microbes, plants, and animals, as well as species with low thermal tolerance. Climate change also causes significant hydrological changes, which are caused by changes in precipitation amount and timing, evaporation and transpiration, and glacier melting. Many models predict that the frequency and severity of floods and droughts will increase. As a result, the size and persistence of flowing and stagnant water will change, causing biodiversity to change.

Most climate change projections predict that temperature increases in the tropics will be smaller than increases further away from the equator, implying that the impacts on tropical biodiversity will be less severe. However, recent predictions from a model developed by Deutsch et al. (2008) indicate that tropical terrestrial species may be more severely impacted by warming than polar species because they are closer to their upper tolerance limits. These effects are expected to be felt by fish and amphibians. Another potential effect of global warming is the inverse relationship between body size at the endothermic stage and the temperature at which growth occurs, which is significant because larger body size during metamorphosis increases adult fitness in amphibians.

Because freshwater habitats are insular, compensatory movement of organisms to cooler habitats farther from the equator or at higher elevations in response to climate change is often not possible, especially for many strictly aquatic species that cannot move through the potentially habitable terrestrial matrix. Websites. In human-dominated landscapes, even flying insects and amphibians may have limited dispersal opportunities. These issues can be especially severe in drainage basins with an east-west orientation, such as the United States' Great Plains. One solution to this problem would be to relocate or assist species of conservation importance in migrating from warmed waters to habitats within their thermal range.

Such actions will be contentious for a variety of reasons, and they may be costly and risky. For example, assisted migration programs typically require detailed species information, which is only available for a small percentage of freshwater species threatened by climate change. It may transmit disease or cause genetic problems in the transferred species and can cause large, uncontrollable environmental or economic issues similar to those caused by alien species. Climate change appears likely to have a significant impact on freshwater biodiversity in the coming century (Hino et al. 2009), but human responses to this climate change could have an impact equal to or greater than the effects of water change itself. Climate change causes or worsens water scarcity and endangers human life and property, all of which encourage engineering solutions to these problems. New dams, dredging, levees, and water diversions could be used to increase water security for people and agriculture while also protecting against flooding. Furthermore, there is growing pressure to build new hydroelectric dams on rivers to meet the energy needs of developing countries or to reduce reliance on fossil fuels. Such engineering responses would have significant environmental consequences and could aggravate the direct effects of climate change. Because many of these projects are likely to be designed and implemented after a disaster, the incentive to rush these projects and bypass normal environmental reviews and regulations is likely to be strong. Projects that are designed and built without adequate consideration for adverse environmental effects can have serious consequences for freshwater biodiversity. In the coming decades, freshwater conservationists will face a number of challenges in preventing damage from unnecessary or poorly designed engineering projects built in response to climate change.

13. The problem of urgency

Major advances in knowledge about the status and threats to freshwater organisms have allowed us to predict that the twenty-first century will be a critical period for the world's freshwater organisms.

We see three indicators of the impending crisis.
First, in known biodiversity hotspots, major extinctions and threats to freshwater organisms are occurring. Some native molluscs, for example, are now extinct in the Moving River basin of the southeastern United States, and dozens more molluscs and fish are critically endangered. Similar extinctions and threats have occurred, including the first human-caused extinction of a cetacean, the baiji, a monotypic freshwater dolphin native to the Yangtze River and found in other large, biodiverse Asian rivers. Spring and groundwater-dwelling species extinction has accelerated as unsustainable water extraction has dried up springs and aquifers containing highly endemic biota in arid regions around the world (Danielopol et al. 2003).

Second, we've already made decisions that will lead to more extinctions in the coming decades. Human population growth, human water use, climate change, the use of man-made nitrogen fertilizers, alien species invasion, the number of dams and hydrological changes, overfishing, and other factors are all on the rise. They are expected to rise further in the near future as sediments and toxins from careless land use practices make their way into rivers.

Pressures on freshwater ecosystems and their inhabitants are likely to increase significantly in the coming decades for these and other reasons. Third, past human actions have most likely resulted in a large debt that has yet to be repaid, though this debt is not well established. That is, even if human impacts on freshwaters remain constant in the future, many populations and species will likely become extinct in the long run. Thus, a significant advance in freshwater biodiversity conservation is the accumulation of strong evidence that freshwater biodiversity loss is an ongoing and ongoing catastrophe, rather than a theoretical or future problem. Now is the time to act. Surprisingly, this evidence has not had the expected impact on the general public, policymakers, most conservation ecologists, and even freshwater ecologists. The urgency of the freshwater conservation situation draws attention to a few specific issues, which we will discuss briefly. First, while the authors of J-NABS and freshwater ecologists in general have shifted toward conservation work in recent years, it appears unlikely that this small shift will be enough to meet the demands of the looming global extinction crisis. To be more effective in conservation, freshwater scientists must shift from doing useful research to doing work that is used by society (Rogers 2008).

Third, while knowledge gaps about freshwater ecosystems are easy to focus on, the urgency of our current situation requires that we not use uncertainty as an excuse for inaction. In endangered freshwater ecosystems, we frequently lack detailed knowledge of life histories, environmental tolerances, ecological interactions, or even species names. These are unquestionably important issues that merit further investigation. However, given the gravity of human impacts and the rapid depletion of freshwater organisms, we must concentrate on what we do know and build management practices on this solid foundation. There are numerous examples of such actions that can benefit freshwater organism conservation. We know that removing all of the water from a river or causing an abnormal flow regime is usually harmful to its inhabitants, and that leaving some water in the river or restoring a more natural flow regime is often the better option (Bunn and Arthington, 2002).The third issue is related to adaptive management, which is sometimes recommended as a useful tool for managing systems that are not fully understood. This approach, which has been popular in recent years, involves stakeholders agreeing on interim management actions, which are then adjusted based on the response of the managed system. Adaptive management has been used in fisheries and environmental flow allocation, among other applications. We make two cautionary remarks about using adaptive management to conserve freshwater biodiversity. When there is insufficient project funding, it is common practice to focus resources on the project itself while reducing or eliminating funding for subsequent monitoring and evaluation.

Because freshwater habitats have more species per area than terrestrial or marine habitats, and because these species are more vulnerable, it is possible that freshwater ecologist’s pioneered conservation biology. They have also mastered today's science. Despite several high-profile publications clearly documenting the endangered status of freshwater biodiversity, freshwater organisms are particularly underrepresented in contemporary conservation biology, and there is no evidence that freshwater ecologists have played a significant role in guiding the field's development. Given the importance of freshwater biodiversity, its critical and declining conservation status, and the potential to use freshwater science to illuminate conservation issues of general importance, freshwater ecologists should help advance the field of conservation ecology rather than simply following it. Plant and vertebrate protection (Hunter and Gibbs 2007).

14. Role of NABS and other freshwater scientific societies

Despite the apparent time and subject matter coincidence between the emergence of J-NABS and the emergence of conservation biology, NABS has not played a leading role in advancing this important field, whereas J-NABS is a leading journal for the publication of articles on biodiversity conservation. NABS meetings, without a doubt, There are numerous conservation-related presentations, including public talks, special sessions, and several specialized sessions. Similarly, J-NABS has undoubtedly published conservation-related articles. However, the majority of these articles have dealt with specialized technical issues rather than general, theoretical, or conceptual issues, and few have been widely cited or can be said to have had much impact on have had outside of it. The lack of mention of J-NABS in textbooks has two troubling implications.

First, it implies that conservationists with interesting things to say should not consider J-NABS as a suitable outlet for their work, despite the fact that the J-NABS editorial board welcomes such articles. Worryingly, conservation professionals do not appear to believe that the basic environmental information in these journals is relevant to conservation.

NABS is not the only organization that has failed to provide adequate leadership in the conservation of freshwater biodiversity. Other major scientific societies and journals concerned with freshwater ecology have also played minor roles. Instead, scientific societies that focus on conservation or ecology, as well as nongovernmental organizations, have taken the lead in freshwater biodiversity conservation.

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Conclusion

(1) Although fresh water constitutes only a small portion of the world's water and covers only one percent of the Earth's surface, it supports at least tens of thousands of species out of approximately two million.
Not surprisingly, given the landscape's position and the value of freshwater as a natural resource, biodiversity loss in terrestrial ecosystems is far greater than freshwater loss.
The decline appears to be severe in some tropical latitudes, affecting large fish and other vertebrates in particular.
(2) Freshwater biodiversity is an important conservation priority during and after the International Water for Life Decade for Action.
If current trends in human demand for water continue and species losses continue at their current rates, the opportunity to conserve significant proportions of remaining freshwater biodiversity before "water for water" disappears.
(3) Threats to global freshwater biodiversity fall into five categories: overexploitation, water pollution, flow modification, habitat destruction or destruction.
Exotic species invasions and their combined and interacting effects on biodiversity are now occurring globally, and are being exacerbated by global scale environmental changes such as nitrogen deposition and climate change. Scientists are becoming more aware of these threats, but they have not been sufficiently integrated into water resource development, necessitating greater dissemination and emphasis.
(4) In many regions, freshwater is subject to intense competition among multiple human stakeholders, and serious conflicts can arise when water resources are limited or cross political boundaries. Endemism, limited geographic range, and non-substitutability complicate biodiversity conservation even more.
(5) Protecting freshwater biodiversity is perhaps the ultimate conservation challenge because it necessitates control over the upstream drainage network, the surrounding land, the riparian zone, and, in the case of migrating aquatic fauna, the downstream habitat.has it. Such requirements are difficult to meet, necessitating the

formation of inclusive management partnerships on appropriate scales. Complex issues concerning the design and management of freshwater protected areas necessitate the active and imaginative attention of researchers.

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