A Discussion of Horseshoe Crab Management in Five Countries: Taiwan, India, China, United States, and Mexico

Jim Berkson, Chang-Po Chen, Jayant Mishra, Paul Shin, Braddock Spear, and Jaime Zaldívar-Rae

Abstract A panel of five international experts was convened during the International Symposium on the Science and Conservation of Horseshoe Crabs to compare and contrast horseshoe crab management in their countries. The panel members each responded to a series of questions prepared by a facilitator. All five speakers stated that habitat degradation and destruction were a major threat to the horseshoe crab population(s) in their country. Pressure for economic development often hindered efforts to preserve and protect coastal habitats. Public education was viewed as an important step toward the implementation of effective management actions. The urgent need for conservation was viewed to be a strong, motivating factor to strengthen international management efforts.

1 Introduction

The International Symposium on the Science and Conservation of Horseshoe Crabs, which took place in June of 2007 in New York, was the first meeting to bring together horseshoe crab researchers, managers, educators, activists, and enthusiasts from over nine countries to meet and share information. The majority of the nations where horseshoe crabs are extant were represented by individuals who gave presentations about their work.

While horseshoe crabs have been able to survive over 200 million years without being managed, that is no longer the case. Horseshoe crab populations are facing stressors which are impacting their survival at a magnitude and on temporal and spatial scales unlikely experienced by the species at any time in its history. These stressors are human-caused. Horseshoe crab conservation now requires the management of humans causing these stressors.

J. Berkson (✉)
National Marine Fisheries Service, Southeast Fisheries Science Center,
RTR Unit at Virginia Tech, Blacksburg, VA, USA
e-mail: Jim.Berkson@NOAA.gov

J.T. Tanacredi et al. (eds.), *Biology and Conservation of Horseshoe Crabs*,
DOI 10.1007/978-0-387-89959-6_29,

During the Symposium, speakers discussed the capture and use of horseshoe crabs for purposes including fisheries bait, Limulus Amebocyte Lysate (LAL) production, and human consumption. Speakers discussed the horseshoe crab's important role in the complex and rapidly changing coastal ecosystem. There were also presentations about the horseshoe crab's dependence on specific types of habitat for critical life stages. It was pointed out that achieving and maintaining a sustainable catch, conserving an ecosystem under stress, and maintaining essential habitat all require effective management.

The Symposium's Steering Committee thought it is important to include a discussion of management-related issues presented by an international panel of horseshoe crab experts both at the Symposium and in this book developed from the Symposium. The format was set up as a facilitated panel. Jim Berkson took the role of facilitator and developed a list of questions for the panelists. Chang-Po Chen (Taiwan), Jayant Mishra (India), Paul Shin (China – Hong Kong), Braddock Spear (United States), and Jaime Zaldívar-Rae (Mexico) were asked to serve on the panel. Although other countries with extant horseshoe crab populations were represented at the Symposium, not all were invited to participate on the panel due to time constraints.

This chapter has been written to summarize the participants' answers to the discussed questions. Both the panel discussion at the Symposium and this Chapter allow us to learn about management-related issues in each country and, more importantly, to compare and contrast the situations among the countries.

2 Questions

Panelists were asked a series of questions to better understand the role management plays or has the potential to play in their countries. Panelists were first asked about the status of the horseshoe crabs in their countries and the greatest threats to the populations. Next, a series of questions was asked about management. Finally, panelists were asked to address whether they were optimistic or pessimistic about the future of the horseshoe crab populations in their countries.

2.1 What is the Current Status of the Horseshoe Crab Population(s) in Your Country?

Chang-Po Chen, Taiwan: Horseshoe crab populations are largely thought to be in decline. Adults are only occasionally caught by trawling and spawners are not seen on beaches as in the past. Juvenile populations in nursery areas have also declined.

Jayant Mishra, India: Horseshoe crabs in India are found along the north-eastern coast of India in good numbers. Two species of horseshoe crabs are found in India: *Tachypleus gigas* and *Carcinoscorpius rotundicauda*. No research has been done to determine the actual population density.

Paul Shin, China (Hong Kong): Anecdotal records from local villagers reveal the presence of adult horseshoe crabs coming to the shores for spawning some 40–50 years ago. However, no mating pairs have been recorded or observed in recent years. We have no information on adult horseshoe crab populations in Hong Kong waters. At times, fishermen obtain adults (one or two animals) as bycatch from their trawling activities in Hong Kong as well as mainland Chinese waters. Horseshoe crabs can still be found in markets and restaurants. We do have juvenile horseshoe crabs (*Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*) on some of the shores in the western waters of Hong Kong. At present, it is noted that even the juvenile horseshoe crab populations on the shores in Hong Kong are declining, for both species.

Braddock Spear, United States: Currently, there is no serious threat to the population of horseshoe crabs as a whole, but depletion in areas of heavy, localized harvest remains a concern. The overall status of horseshoe crab populations is largely dependent on localized or regional dynamics (e.g. harvest pressure, water pollution, habitat availability). Many of the populations along the Atlantic coast of the U.S. faced heavy harvest pressure from the late 1980s through the 1990s. Since then harvest has been restricted through regulation allowing the populations to stabilize or grow.

Jaime Zaldívar-Rae, Mexico: There are no estimates of population sizes in Mexico. However, Dr. Samuel Gómez of the Institute of Biology, National Autonomous University of Mexico, stated in 1979 and 1993 that Mexican *Limulus* populations were declining rapidly based on his experience of some 30 years with the species. This was probably the key opinion which resulted in the horseshoe crab being included in the Mexican list of species at risk (Official Norm 059-SEMARNAT-2001). *Limulus polyphemus* is listed as being "in danger of extinction".

2.2 What Are the Greatest Threats Facing the Horseshoe Crab Population in Your Country?

Chang-Po Chen, Taiwan: Horseshoe crabs are negatively affected in Taiwan by habitat loss and water pollution. The lack of knowledge among administrators and policymakers about horseshoe crabs and the threats against them is a major contributor to the problem. This is occurring on a national scale.

Jayant Mishra, India: The greatest threat to horseshoe crab populations in India is the destruction of beaches where the adults spawn. Although there are no major threats to the populations from the biomedical industry or

from large-scale fisheries, spawning animals are taken off the beaches in some areas, causing a serious concern. Both the habitat destruction and the removal of spawning animals are localized problems which can be managed by increasing the awareness and involvement of the people who are directly or indirectly involved with the coastal environment. In recent times global climate change may also be playing a major role in the form of an increasing number and/or intensity of natural calamities in the form of super cyclones and tsunamis, which destroy the coastal environment and breeding beaches.

Paul Shin, China (Hong Kong): Urbanization, land reclamation, and other forms of economic development leading to habitat loss along the coast are the greatest threats to horseshoe crabs in Hong Kong. This all stems from the large number of people in Hong Kong. These disturbances mainly affect the juvenile horseshoe crab nursery grounds and spawning activities. Habitat degradation affects not only horseshoe crabs but also the entire ecosystem. Note that there is no target fishery on horseshoe crabs in Hong Kong waters. However, adult horseshoe crabs are served as special dishes in some seafood restaurants.

Braddock Spear, United States: Currently, the greatest threat to horseshoe crabs is loss of suitable habitat. The crabs depend on particular beach types to spawn successfully. As coastal development and erosion reduce spawning habitat, horseshoe crabs have reduced opportunities to reproduce. Harvest or exploitation of horseshoe crabs is less of a threat, as it is believed to be under control. Habitat degradation affects a suite of species and threatens inter-tidal and coastal ecosystems. Many different species of fish, shellfish, crustaceans, birds, and others depend on beaches and near shore waters at some point in their lifecycle.

Jaime Zaldivar-Rae, Mexico: The greatest threats to horseshoe crabs are anthropogenic habitat modification including urbanization of pristine coastline, destruction of mangrove forests, and filling in of coastal lagoons; natural habitat modification such as the impacts of hurricanes and increasing sea levels due to climate change; potential impacts of the shrimp trawl fishery on bottom conditions in the shallow portions of the continental shelf; and pollution generated by the oil industry and agricultural activities in the Southern portion of the Gulf of Mexico. Different regions are affected by different threats.

2.3 Do Pathways for Management Exist at the Present Time and What Are the Biggest Obstacles to Management?

Chang-Po Chen, Taiwan: Many pathways exist for the government to take management action, but it takes a long time and strong lobbying to convince the policymakers to take action. The main obstacle for helping horseshoe crabs in Taiwan is convincing the government that conservation issues are as important as economic development.

Jayant Mishra, India: Horseshoe crabs inhabit 620 km of coastline in India. The greatest obstacle to their management is their large range of distribution. Addressing threats across such a large area may require the involvement of others outside the government, such as Non-Governmental Organizations (NGOs) and local bodies, to make the management successful.

Paul Shin, China (Hong Kong): In addition to legislation under the Environmental Impact Assessment Ordinance, there is one other pathway for management. In Hong Kong, horseshoe crab spawning and nursery grounds can be designated as a Site for Special Scientific Interest (SSSI). The aim of a SSSI designation is to ensure that full account is taken when development or change in land use is proposed. Economic development often out-weighs environmental concern in Hong Kong, and like other areas, it is difficult to balance the diverse interests.

Braddock Spear, United States: The Atlantic States Marine Fisheries Commission (ASMFC) has set up an effective process to manage the harvest of horseshoe crabs. Pathways for protecting spawning habitat are more localized at the county and township level. The biggest obstacles now are the competing interests that exist in coastal areas. State and local planning and zoning authorities must balance the heavy pressure to develop coastal lands with the need to preserve ecologically important and unique areas

Jaime Zaldívar-Rae, Mexico: Pathways exist in that fairly adequate legislation is in place, and several important populations are within federal and state protected areas. Problems also exist, however, in that funding is often limited to carry out the different management actions required in protected areas, staff in government agencies is limited, and law enforcement is often weak and inconsistent. The biggest obstacle to management is the strong economic interests associated with coastal areas (the tourism and oil industries, fisheries, real estate development) which are critical for the Mexican economy, and, as a result, have strong political and financial influence. State governments are under strong pressure to find options for economic development and the creation of jobs. Thus, their priorities frequently oppose those of conservation agencies, including those of the Federal Government. In addition, the efforts of governmental agencies for economic development and conservation are often not coordinated and even opposed. There needs to be more local involvement in the creation and implementation of management plans.

2.4 What Management Actions Are Currently in Place to Deal with the Threats?

Chang-Po Chen, Taiwan: To combat the threats to horseshoe crabs in Taiwan, a small protected area has been set up in Kinmen. An NGO is also doing work to restore the horseshoe crab populations.

Jayant Mishra, India: No proper management plans are in place to deal with the threats to horseshoe crabs.

Paul Shin, China (Hong Kong): No management plans are in place directly for horseshoe crabs, but other management plans address the threats to horseshoe crabs. We have four marine parks and one marine reserve in Hong Kong, but their primary functions are for other purposes such as protection of corals, the Chinese white dolphins, and/or biodiversity. The Environmental Impact Assessment Ordinance (EIOA) requires any large development projects to undergo an environmental review, and ecologically sensitive areas, such as horseshoe crab nursery grounds, will be examined carefully so as to minimize any adverse impact resulting from such development projects.

Braddock Spear, United States: The Atlantic States Marine Fisheries Commission implemented a state-by-state quota management system in 2000. Since then the Commission has taken further action to restrict harvest in the most important region for the species, Delaware Bay. In 2001, the National Marine Fisheries Service created the first marine reserve of a known horseshoe crab habitat area spanning the continental shelf outside the mouth of Delaware Bay. It outlawed harvest of crabs migrating to the continental shelf before returning to the Bay to spawn. Also, individual states have protected areas of particular importance to the horseshoe crabs along their coasts.

Jaime Zaldívar-Rae, Mexico: No management plans are in place directly aimed at horseshoe crabs. However, the Mexican Commission for Protected Natural Areas (CONANP) administers several coastal protected areas that encompass horseshoe crab habitats along coasts of the Yucatan Peninsula. These areas include monitoring and recovery programs particularly geared toward improving the health of coastal water bodies and certain organisms such as shorebirds, waterfowl, and sea turtles. Horseshoe crab populations can potentially benefit from these protected areas as well. At the present time the protected areas are under-funded and under-staffed, but budgets are improving steadily.

2.5 What Role Will Public Education Play in the Management of Your Country's Horseshoe Crab Population(s)?

Chang-Po Chen, Taiwan: Education will be a key factor in changing the people's value systems needed for horseshoe crab conservation. Only a large force working together will achieve change and convince the government that ecosystems, such as those crucial to horseshoe crabs, are worth protection.

Jayant Mishra, India: Education of the public is the best possible way to protect horseshoe crabs. At this time, it is also the only way.

Paul Shin, China (Hong Kong): Public education will play a significant role to make people aware of the threats and plight of horseshoe crabs in Hong Kong and/or mainland Chinese waters. Of particular importance is informing the younger generations of the situation of horseshoe crabs and why we should protect and conserve their populations. Once educated, people can move forward to voice their concerns to the local legislators. An official webpage aimed at informing the public on the importance of conserving horseshoe crabs has been set up by the government. Public education must be an ongoing effort.

Braddock Spear, United States: Public education can help local residents understand the importance of horseshoe crabs and protecting their habitat. The residents can then become empowered and pressure state and local decision makers to make management choices that will, at the very least, not threaten horseshoe crab populations.

Jaime Zaldívar-Rae, Mexico: Public education is critical and still not widespread. With the exception of coastal cities, coastal communities are becoming smaller and their influence and capacity are becoming weaker. Thus, pressure on governmental agencies and the large interests in the area will increasingly have to come from urban societies, which are geographically, socially, and environmentally distant from the coasts. The only way to involve urban and coastal societies, and hopefully, turn them into strong advocates for the conservation of coastal ecosystems will be to make them aware of the relevant issues and their potential role in addressing such issues. With poor coastal communities, it is not enough to instill a sense of awe and fascination with horseshoe crabs and their habitat. We must find ways to convincingly demonstrate that conservation can mean financial benefits to these communities.

2.6 What Can Other Scientists and/or Organizations Do to Help You Achieve Your Management Goals?

Chang-Po Chen, Taiwan: Scientists banding together and supporting one another will help. We need to include NGOs and as many people as possible. The key is to just keep moving forward and do something, rather than contemplating or planning alone.

Jayant Mishra, India: Scientists can help by sharing their knowledge and experiences to develop a global management plan.

Paul Shin, China (Hong Kong): They can help in providing advice from their experience on the conservation and management of horseshoe crab populations, collaborating on research studies, and sharing data and information. They can also join together to exert a concerted international effort to conserve these animals. One specific international effort could be to work together with many organizations to help list horseshoe

crabs (especially for the Asian species) on the IUCN or CITES endangered species list. This could help stop the import/export of horseshoe crabs between countries, such as between Malaysia and Thailand, and could raise the status of horseshoe crab species worldwide. This will require the collection of data, in terms of population status, etc., to support the case.

Braddock Spear, United States: Other scientists and organizations can continue to conduct research and monitor the species. More research can focus on the little known juvenile life stage on the Atlantic coast of the United States. Others can also help to educate the public and decision makers about the importance of the species in the ecosystem, as well as the species' habitat needs.

Jaime Zaldívar-Rae, Mexico: Efforts in Mexico will greatly benefit from close cooperation with scientists and managers working with horseshoe crabs in the United States, where most of the work on *Limulus polyphemus* has been done. Mexico also needs the help of international agencies, NGOs, and individuals to develop research and management programs, and to find the financial resources to carry them out.

2.7 Do You Have Any Suggestions as to Where the Funding Can Be Found for Additional Research, Monitoring, and Public Education?

Chang-Po Chen, Taiwan: The pharmaceutical companies who produce lysate from the blood of horseshoe crabs receive tremendous profits from the species and should be willing and able to provide the funding.

Jayant Mishra, India: Funding from government sources for monitoring and public education is crucial. However, more participation should be requested from private bodies as well.

Paul Shin, China (Hong Kong): In Hong Kong, there is the government Environment and Conservation Fund which supports projects such as conservation of horseshoe crabs locally. The Ocean Park Conservation Foundation, a non-profit organization, also funds projects locally as well as in the Asia Pacific region.

Braddock Spear, United States: Funding agencies or organizations are becoming increasingly focused on supporting research and education that encompasses more than one species. Research and monitoring that covers an ecosystem or parts of a system tend to be more attractive. Scientists and researchers may have more success at obtaining funding if they incorporate horseshoe crabs research into more comprehensive studies.

Jaime Zaldívar-Rae, Mexico: We will have to explore the "traditional" national and international sources, because so far no one has tried to

attract these financial resources to the study and management of horseshoe crab populations in Mexico. However, we will also have to be creative to find new and original sources of funding. This includes joining forces with other organizations that deal with the same geographic areas, ecosystems, and habitats where horseshoe crabs live, to gain access to large funds and optimize their use. We will also have to involve other elements of society such as large companies, the government, and the general public in funding programs aimed at supporting conservation.

2.8 Are You Optimistic or Pessimistic About the Future of the Horseshoe Crab Population(s) in Your Country?

Chang-Po Chen, Taiwan: The troubling situation of horseshoe crabs in Taiwan does not lend itself to optimism. However, we cannot afford to be sit back and be pessimistic. We must work together to ensure that horseshoe crabs can survive.

Jayant Mishra, India: I am very optimistic about the future of horseshoe crabs in India, in general. However, I am cautious because of the possibility of the exploitation of horseshoe crabs for lysate and because of the likely effects of global climate change.

Paul Shin, China (Hong Kong): I am pessimistic about the future of the horseshoe crab populations in Hong Kong as continuing economic developments and pressure for urbanization will inevitably affect the habitats of the spawning and/or nursery grounds for horseshoe crabs. We have very little information on where the animals are living or on their abundance.

Braddock Spear, United States: I am optimistic. The progress we have made in managing horseshoe crabs over the past 10 years shows much promise for the species. A species that has been on this planet for 300–400 million years must have unique capabilities to adapt to a changing environment.

Jaime Zaldívar-Rae, Mexico: I am optimistic in some sense. There is still time to thwart some of the biggest threats, and efforts toward that goal are becoming more common and are beginning to involve many sectors of society. However, both the magnitude and the pace of some of the threats are alarming and likely to surpass any efforts for conservation and management. Rather than leading to pessimism, this should instill a good dose of realism and a sense of urgency among conservationists, managers, and our society as a whole.

3 Summary

While the status of horseshoe crab populations varies from country to country, there is reason for serious concern for the populations in several countries including Taiwan, China, and Mexico.

A majority of the speakers talked about how the basic data required to assess the status of the horseshoe crab populations in their countries have not been collected. The primary source of information on population status currently comes from anecdotal information, information that does not lend itself to the development of sound, scientifically based, stock assessments, or effective management strategies. Given the need for management, development and implementation of research and monitoring plans to collect basic population data should be a high priority.

Horseshoe crabs continue to be caught for human consumption in Asia, but the catch numbers are not documented. In some countries they are caught solely as bycatch because their numbers are too small for a directed catch. The US population continues to be caught for use as bait and the production of Limulus Amebocyte Lysate.

Habitat degradation and loss was mentioned by all five of the speakers as the primary threat facing the horseshoe crab populations in their countries. This threat is not unique to horseshoe crab populations, but impacts the entire ecosystem. Managing horseshoe crab populations will ultimately come down to effectively managing the ecosystems in which they live.

The majority of the speakers mentioned that pathways existed for management in their countries, but the actual implementation of effective management was hindered or blocked due to interests related to economic development. The conflict between conservation and development is not new, nor unique to horseshoe crabs. The intensity of this conflict may be greatest for coastal communities, which in many parts of the world are seeing the highest levels of human population growth.

Protecting spawning and nursery habitat must be a primary focus of management actions internationally. This is underway to some degree in most of the countries through the creation of protected areas, although the current level does not appear to be sufficient in most cases. With regard to economically challenged coastal communities, win–win solutions must be found in which conservation measures will benefit the local communities financially, to give them an incentive to conserve. For example, protected areas can bring in substantial tourism revenue if planned appropriately.

All of the speakers agreed that public education must take place in order to make the citizenry and policymakers understand the importance of horseshoe crab persistence. It is hoped that as the public becomes more aware, their influence may more effectively counter the economic interests hindering or opposing conservation efforts. Given that the problems facing horseshoe crab conservation are ecosystem in nature, education should focus at least partially on the importance of ecosystem health and services. Education cannot be limited to coastal communities, as many people including existing and potential conservationists live in inland cities and, as a group, have a great deal of political clout.

The speakers stressed that information transfer is needed from countries with more experience to countries with less experience in topics such as horseshoe crab research, management, and public education. The creation of more international collaborations among scientists and organizations is also desired. A priority

should be placed on holding regularly scheduled meetings, like this Symposium, and identifying and securing the funding to allow for maximum participation.

Speakers brought up a diverse set of potential funding sources for future work. It was pointed out that we need to be more creative in our efforts to find funding and that we may want to look for international sources, sources that would be interested in efforts across national boundaries, and/or sources more interested in funding ecosystem-level work.

In the end, speakers' outlooks for the future of horseshoe crab conservation ranged from optimistic to pessimistic. It is likely that a number of factors were involved in each speaker's outlook. These may include the following: the current status of the population, the magnitude and pace of the stresses on the population, the amount of research and monitoring in place available for the development of scientifically based management policies, and the presence of management policies. For example, Braddock Spear from the United States expressed optimism regarding the large US horseshoe crab population, where considerable monitoring and research is in place, as are commercial fishery harvest restrictions. In contrast, Paul Shin from China expressed pessimism regarding the population in Hong Kong, where historical populations can no longer be found, no information exists on abundance or distribution, and the pressures of urbanization and economic development are overwhelming the ability to conserve. Effective management brings with it optimism about the future.

Ultimately, we cannot rely on the horseshoe crab and its historical resilience to guarantee its continued survival. As with so many other species, the impacts of our society on the natural world are occurring at a pace with which many of the most resilient species have not been able to adapt. As we are observing in countries such as China and Taiwan, there is no substitute for suitable spawning and nursery habitat. When populations can be found in local restaurants but not local waters, there is serious cause for concern. If there is a battle that needs to be waged to see necessary management implemented, horseshoe crab enthusiasts do not need to wage it alone. The concern is at a larger scale. Those concerned with the plight of the horseshoe crab, who recognize the need for research, monitoring, public education, funding, and ultimately, sound management practices, can join forces with the myriad of individuals and groups calling for the conservation of coastal ecosystems.

We should be encouraged by the calls of our international speakers to not let the current state of affairs dissuade our efforts, but rather encourage us to work harder, with a sense of urgency to find ways to move forward toward effective management.

Acknowledgments The authors would like to thanks Staci Hudy of the Virginia Tech Department of Fisheries and Wildlife Sciences for her help compiling the responses of the speakers into the document. Sheila Eyler of the US Fish and Wildlife Service and Gary Kreamer of the Delaware Division of Fish and Wildlife took valuable notes during the panel discussion which were used in the writing of this chapter. All junior authors of this chapter were listed alphabetically. The authors would also like to thank the organizers of the Symposium and the editors of the book for their invitation to participate.