

Conserving endangered marine organisms: causes, trends and challenges

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Abstract. Increasing demand for marine resources in recent decades for human needs has led to intensified exploitation. This increase accelerates the process of extinction of various marine resources. In order to avoid extinction, it requires conservation measures of marine resources appropriately. This paper provides an overview of causes of extinction, trends and challenges in the conservation of endangered marine organisms. The success of conservation measures is highly dependent on various stakeholders such as governments, communities, the private sector and academics. Differences of the interest of these parties often lead to the failure of conservation programs. In general there is an increasing public awareness of the importance of protecting the diversity of marine resources and avoiding extinction of marine organisms, especially endangered organisms. The existence of comprehensive actions, legislation and improved coordination among government, community, private sector, and academics will significantly improve the success in overcoming all the challenges.

Keywords: conservation, endangered species, extinction

1. Introduction

Two centuries ago, it was believed that marine species would not be extinct simply because being utilized by humans [1]. Human ability to exploit marine resources was considered only a small portion. However, with so many changes taking place in the world, such as science and technology, population growth as well as changes in the sea itself, then the statement is no longer appropriate. Recent report shows that between 20% and 25% of species both marine and non marine taxa are at risk of extinction [2].

Population growth around the world over the past two decades continues to rise significantly [3], it was expected to be close to 9 billion people on the year 2050. Increasing population of the world will affect the carrying capacity of the earth [4]. It also requires increased food availability for consumption [5]. Given that the main food source is a natural resource [6], then certainly there will be increased pressure on the natural resources [7]. Increasing pressure will cause damage to habitats and ecosystems at various places in the world [8].

Destruction on habitats and ecosystems has been widely reported in all forms of the ecosystem and it occurs worldwide [9]. In general, the damage caused by various factors, among others, is the excessive use of natural resources for the purpose of economic growth [10] use of equipment and methods that are



not environmentally friendly [11], pollution [12-13] and other nature phenomenon [14]. The negative impact resulting from a variety of habitats and ecosystems destruction was widely reported mainly included in the economic and social aspects [15]. One of the effects that result from the above is the increase in the extinction rate of organisms.

The extinction of the organism occurs both marine organisms [16], terrestrial [17] and air [18]. This process occurs primarily caused by human behavior associated with utilizing such an organism as well as habitat destruction. This article looks at the causes, trends and challenges in regard to how we conserve marine species with high possibility to extinct.

2. Extinction of an organism

Many studies have listed causes of the extinction of an organism or population, such as high trophic level, low population density, slow life history and small geographical range size [19], climate change and habitat destruction are the main factors of biodiversity loss [14]. In addition, exploitation, habitat loss, invasive species and other threats (such as climate change, pollution, and disease) are the main causes of extinction [16]. While human population density and proximity to markets have significant influence on vulnerability to extinction of coral reef fishes [20].

The extinction of an organism or population is basically influenced by two factors, namely the level of vulnerability and the existence of the threat. Both of these factors must exist before extinction occurs. The relationship of these two factors is as follows:

$$E = V \times T \quad (E = \text{Extinction}, V = \text{vulnerability}, \text{ and } T = \text{threat})$$

It means that when the organism or populations in less vulnerable, then despite the threat, extinction is not going to happen, and vice versa.

2.1. Extinction Vulnerability

Vulnerability of extinction is influenced by internal factors of the organisms or populations. These factors are given to the organisms because its part of their biological characteristics.

2.1.1. Size of the animals

Larger body size organisms generally have smaller population density [19]. They also can be easily spotted by predator, including human, and with similar effort predator will get bigger yield. Therefore, larger body size animals have greater vulnerability than smaller ones and possibly also have higher future loss than expected [21, 22]. Although, it was found that intermediate body size organisms attain higher population densities [23, 24], however, these scientists believe that small size organisms have least vulnerable compare with others. This hypothesis has been proved in various kind of organisms, such as birds, mammalian [25], mammalian [26, 27, 28], crustacean [29], as well as other carnivores [30].

2.1.2. Reproduction

Capability to reproduce by an organism will directly influence the vulnerability extinction of the organism [22]. Reproduction rate of an organism will determine its population size. Species with less ability to produce offspring, will have higher vulnerability of extinction then those with higher number of offspring. Although the predation rate is high enough, then it is likely not the entire population will be depleted. Conversely, if the member of the population is low, vulnerability to extinction of organisms would be larger.

2.1.3. Endemic species

Endemic organisms are known as those that exist only in one geographic region. These organisms are found only in certain areas by the distribution of a very limited and easily recognized by predators. With limited range area, then these species are easy prey to predators. Therefore, they are small range species,

and tend to have higher risk of extinction. Fish with small ranges have higher vulnerability of extinction [16]. Similarly, extinction of two genera of endemic Mexican fish, *Zoogoneticus* and *Skiffia*, as well as endemic plants from Brazil have been reported [31, 32].

2.1.4. Migratory species

Migratory species are species that travel to other locations periodically. This trip could be related to the reproductive process that often occurs seasonally. The trip generally carried long distances and can occur between nations. Migratory species is found in terrestrial, avian and aquatic organisms, and they constitute a significant part in biodiversity [33]. Given the long and frequent migration, then long-distance migrants, are recognized as suffering serious population declines, because its often exposed to a potentially wide array of threats across their range. Approximately 21% of marine migratory species are categorized as Critically Endangered, Endangered or Vulnerable [34]. While 48% of these species are threatened, Near Threatened or Data Deficient. They also found that among all marine migratory species, sea turtles are the most threatened group (85%), followed by seabirds (27%), cartilaginous fish (26%), marine mammals (15%) and bony fish (11%).

2.2. Extinction Threats

Threats of extinction are influenced by external factors or the organisms or populations.

2.2.1. Human population density

Increasing the number of people directly increasing food needs, and the need for it is highly dependent on natural resources [35]. The high demand of natural resources as a result of the increase in population (population pressure) will increase possibility to extinction of species, including fish [20]. Figure 1 shows significant increase in both the number of human population in the world with the increasing number of species extinction [36].

Increase in population and economic growth increases demand for fish products [37]. The increase in population is also considered to affect biodiversity. The extinction rate of organisms increased by 7% in 2020 and 14% in 2050, as a result of population growth alone [38].

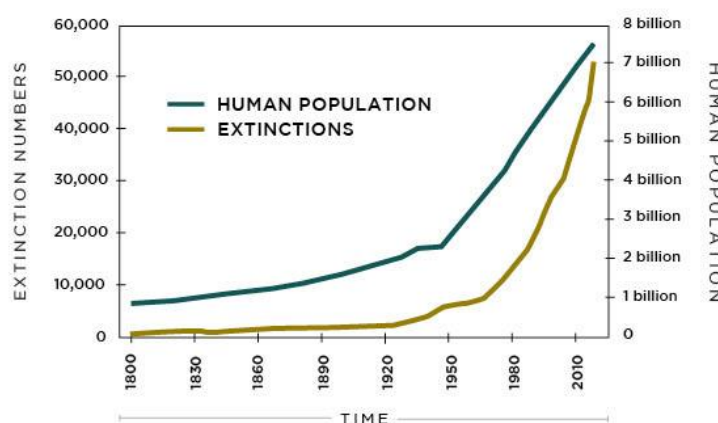


Figure 1. Increasing human population and species extinction [36]

2.2.2. Habitat loss

Increasing demands for human needs especially for shelters as well as other activities have caused habitat change. Changing of habitat will directly reduce the number of organism or even depletion in the worst case. It is believed that habitat destruction is the main cause of organism extinction [39]. For example, it has been reported declining of reptile species in global scale due to several factors including

habitat loss [40]. Changing in habitat due to surface mining activity has threatened plants in Brazil [32]. Similarly, it was found that habitat loss is important cause for organism extinction and recovery in Canada [41]. There is also report that states that among various organisms, fish are organisms that obtain the highest threat of becoming extinct due to habitat loss in Singapore [42].

2.2.3. *Over exploitation*

Over exploitation of the natural resources will directly increase the rate of extinction of the population. This is mainly caused by the fact that exploitation of natural resources does not take into account the population's ability to recover, it will accelerate the loss of the entire population, and causing the extinction. It has been warned that the damage and loss of terrestrial species can also occur in the oceans [43]. Other scientists found that although fish populations already depleted, however, fishing pressure still continue which will caused fishing induced extinction [44].

2.2.4. *Environmental Factors*

Living organisms is greatly influenced by environmental conditions that support all biological processes and the life of the organism. Therefore, changes to the surrounding environmental factors, will affect various life processes of the organism. The organism's ability to respond to changes in the environment, will affect susceptibility to extinction. If the changes were drastic and deadly, it is possible there will be a mass mortality of the population of these organisms. Although, environmental factors are included as stochastic threats of extinction, however, some of these factors effects biological processes related to extinction such as reproduction, development and growth. For example, environmental parameters, especially water temperature affects reproduction of European flat oyster (*Ostrea edulis*) [45]. Similarly, it has been reported that salinity, temperature and light conditions affect reproduction and development of a tropical marine copepod *Nitocra affinis f. californica* Lang [46]. In addition, changes in environmental parameters such as water pollution will definitely significantly influence population which will lead to extinction [47].

2.2.5. *Invasive species*

Invasive species is known as organisms being introduced in an ecosystem that does not occur naturally [48]. These introduced species will survive even reproduce, when they find habitat which similar with their native. They become invasive when they rapidly increase their population and spread and harm the ecosystem. Invasive species is believed as a threat which increases susceptibility to extinction of an organism [49]. This will happen if the new organism affects directly against a variety of existing endogenous organisms. The arrival of a new organism will increase competition for space and food. In addition, if the new organisms are predators on organisms that already exist, it will increase the vulnerability of extinction. This opinion has been questioned by [50] who suggested that this opinion has not been enough proved scientifically. So they suggested to conduct more detail research to get the right answer.

2.2.6. *Wildlife Trade*

Wildlife trade is “any sale or exchange by people of wild animal and plant resources” [51]. Wildlife being traded in many different forms including live animals, meat, bones, or other part of the organisms and they have high economic value. This wildlife being used either as pets or ornamental organisms, source for medicine, food, etc. [51]. Trading on marine organisms have increased with people's interest in ornamental organisms [52], and it is believed that 1.5 and 2 million people in the world keep ornamental fish in their aquarium. They also stated that this live animal trade has high economic value which worth US\$200-330 million annually. Ornamental organisms will be more expensive if the organism is unique and rare. The organism is increasingly scarce the price will be higher. The pressure on a population will increase in the event of high interest to the particular organism.

2.2.7. Climate change

One of recently occurring threats of biodiversity is global warming [53] and also induces species extinction. Climate change which is caused by global warming has been known to produce changing in distribution and abundance of organisms. Initially, it was thought that physiological tolerance ability of the organism to high ambient temperatures is the cause of extinction related to climate change, however, it was found that it is not the case [54]. Instead, species interaction, in particular decreasing availability of food is the important cause. In other study, predicted that based on mid-range climate-warming scenarios for 2050, approximately 15–37% of terrestrial species will be 'committed to extinction' [55].

3. Conservation Trends

Rapid developments in science and technology around the world have both positive and negative impacts on the environment. Within the last two decades there has been a tendency to increase awareness concerning the environment. Many environmental issues were brought to economic and political matters. Cases related to the destruction of the environment have become the public's attention through the media.

Understanding the community on the importance of conservation issues is increasingly encouraging. This is mainly due to the increased awareness about the importance of protecting the environment itself. In addition, efforts have been made by many parties to improve the environment through conservation. There are several trends noticeable in regard to conservation: Community awareness; Government policy; Development of related science and the interest of scientists; Media cover. These changes were greatly influenced by improvement of education, rapid development of science and technology.

3.1. Community awareness

People are more aware about the importance the environment and conservation. This can be shown among others is the development of environmental groups with all their activities. It has been reported that community awareness on environmental issues was significantly influenced by their education [56]. They found that perception, knowledge, awareness, and attitude of educated respondents in regard to regional and global environmental problems were much better than those from community group. They also suggested the importance of education either formal or informal to the community on environmental issues. One of the education methods that can be used is by mobile learning [57], or through workplace experiences [58].

3.2. Government policies

Awareness of environmental issues has also increased at the government level. This is shown from the policies that take into account environmental aspects. Environmental understanding by the government is influenced both from within and outside country. The influence of the pioneer country who started their environmental policies have a profound effect on follower countries, so often happens "in common policy" of many countries [59]. Several types of policies that support the conservation of endangered marine organisms include: increasing the number of marine protected areas (MPA); banning all types of destructive fishing methods; as well as providing related and necessary regulations.

3.3. Development of related science and the interest of scientists

Community awareness on environmental issues including endangered species has influence the development of related science. Researchers have a major role, especially for the government in determining environmental policy. A good policy should be based on results of scientific studies. In this regard, it is important that scientists have to maintain their credibility on negotiating the relationship between scientific objectivity and political advocacy [60]. In addition, the number of scientific publications related to environmental issues has increased significantly. Meaning that related science is developing and more scientists interested in this issue. It has been reported that since the 1990s the number of papers published by four mainstream conservation journals (Conservation Biology, Biological Conservation, Biodiversity and Conservation and Oryx) has increased by 133% [61].

However, the current required more attention to the types of organisms that are less attractive, given that most of the research is still carried out on a charismatic taxa.

3.4. Media coverage

Media (electronic, non-electronic and social media, including television, newspaper, magazine, facebook, etc.) have a major role in spreading environmental issues to the public [62, 63]. Various environmental problems, including issues related to violations of protected organisms, widely reported in the media. Publication in the media covers many issues, among other things on how the protected organism should be treated, including the mechanisms and stages of filing animals to be protected.

4. Conservation challenges

Despite increased awareness related to the environment and conservation of endangered species, it seems there are still some obstacles that must be overcome. Five noticeable challenges that we have to deal: Increasing pressure; Law enforcement; Quality of MPA; Action programs; Genetic resources. In order to overcome these challenges, there are four parties that have to get involve, i.e. government, private sector, community and academics. These parties have to act accordingly related to different challenges.

4.1. Increasing pressure

Although public awareness related to the issue of the environment has improved, as well as the various government policies that takes into account the interests of the environment, but the pressure on the environment and ecosystems remains high. The rapid development of the private sector with various activities, have led to changes or loss of habitat [64]. For example, coastal area reclamation and mangrove deforestation that is usually used for business development, such as tourist area, shopping mall, hotels and resident [65]. Actions that can be done is to increase global awareness and global policy and strategy in order to reduce pressure. This activity will involve several parties namely the government, community and private sector.

4.2. Law enforcement

The government has provided various regulations related to the environment, including with regard to the regulation of organism protected. Various regulations are not only to be disseminated to the public, but they also must be considered and implemented in daily activities of general public. The rapid process of development as well as increased economic demands has caused violations of the laws [66]. Various violations are often committed by many parties concerned including company, whether intentionally or not. This would be detrimental to both the environment and the organism is protected, but also to the general public. Therefore we need a great effort to implement the various rules with all its consequences. Enforcement of environmental laws needs to obtain a special attention by the government. In addition, various other laudable actions such as corruption, collusion, conspiracy, bribery related to environmental issues should also be eliminated. The activities are closely linked to the government, community and private sector

4.3. Quality of MPA

MPA (Marine Protected Areas) have a major role in preserving marine resources [67]. MPA is not only a place of refuge from a variety of marine organisms, but also a place for foraging and reproduction of marine organisms and other biological processes. So the MPA should be a safe area for a variety of marine organism particularly from human disturbance. Another role of the MPA is a source of recruitment for marine organism populations both within and outside the MPA [68]. Therefore, it is necessary to develop a lot of MPA with an area sufficient to function optimally. However MPA in large numbers become less meaningful, if the MPA does not have good quality. For example, the Indonesian government plans to establish MPA for 20 million hectares in 2020 is regarded as a very good policy [69]. The MPA is expected to have good quality, both in terms of the environment, the facilities, as well

as management. Therefore, it needs skillful human resources, facilities and funding as well as a suitable regulation. Various parties involved in this case are the government and academic.

4.4. Action programs

Increased awareness of both the public and the government regarding the importance of the environment and marine organisms protected, need to be supported with clear program of action. The program should support the preservation of the environment and reduce the causes of extinction, especially the threat of extinction organism. In addition, this action program should also comprehensively cover various matters related to both technical and non-technical. The program should also develop an activity that can be run at the lowest level in the society to the government and other parties. Some aspects that can be done in this regard is the provision of adequate funding, skillful personnel, activities and good management. The action program will involve all stakeholders including government, community, private sector and academia.

4.5. Genetic resources

Genetic resources have not been given good attention, especially on the regulation and action programs. Policies concerning the determination of organisms protected if only rely on the ability to identify taxonomically based morphology, for now inadequate [70]. This will lead to misguided policy. Therefore it is very important to consider genetic biodiversity on the determination of extinct organisms [71]. Actions that can be done is to the make sure that genetic resources should be included in the new regulation by government prepare. This action requires the involvement of the government and academics (universities).

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