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World Island Flora: Conservation Initiatives and Intervention Gaps

Anne Ruthzl V. Binalayo [1]
1 – Bayawan National High School

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Abstract

This paper reviews the status of flora biodiversity in island ecosystems and conservation efforts done to mitigate various ecological disturbances- invasive species, deforestation, climate change etc. Island ecosystems is among the most vulnerable type of ecosystems as influenced by their size, isolation, and topography. Potential threats for destruction and extinction of floral species have increased over the past decade resulting to greater interest in studies as to resolve ecological issues that are observed and recorded. Discussion on the effectivity and challenges experienced by conservation efforts on islands outlines specific and general concerns that are needed to be addressed. There have been relevant advances in determining the relationships between island characteristics and biodiversity. A comprehensive discussion on the interconnectivity of these characteristic influences, threats to the biodiversity, and conservation initiatives is included in this review. Intervention gaps in the conservation efforts in the different islands identified is also discussed.

Keywords: *Island flora, biodiversity conservation, invasive species management, climate change impacts, intervention gaps*

Introduction

Islands are important when it comes to maintaining high flora diversity in the world since most oceanic islands- due to their size, distance, and period of isolation from large land masses that produce adaptive plant specializations- have a high proportion of endemic species (Lowry, 2010). They cover approximately only 5% of the global land area yet support approximately 20% of terrestrial plant and vertebrate species (Courchamp et al, 2014). Moreover, it is estimated that 33% of known threatened plants are island endemics (Nurse, 2014). An estimated 17% of all flowering species is also found on islands (Tershy et al, 2015).

Various studies have suggested multiple phenomena that greatly affect island biodiversity. Natural factors like island topography and isolation (Steinbauer et al., 2016); exposure to hurricanes (Morrison, 2014); coastal erosion and animal mediated plant dispersion (Magnusson et al., 2014); have been studied and correlated with the ability of plants to colonize and become established on islands. Moreover, findings show that island colonization by humans greatly affect biodiversity leading to faster rates of extinction (Fisher, 2010). Human interference has compromised the unique characteristics of islands such as fragility,

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isolation, and high endemism. Tourism ventures have threatened fragile small island ecosystems with biodiversity loss from the scope and size of alteration they bring about (Oduber et al., 2015). In 2016, Kew- a world famous center for botanical and mycological knowledge- stated that 1 in 5 plant species are threatened with extinction.

There have been various recorded threats to island biodiversity. Biological invasion is one of the significant issues faced by island ecosystems which result to notable decline of native populations (Gil et al, 2011). The introduction of invasive species is also seen to be one of the most destructive to ecosystems since the impact of this becomes relatively irreversible once they have established and proliferate profusely (RBG Kew, 2016). Introduced plant species have exceeded the number of native and endemic species in many Pacific Islands (Meyers, 2014). Anthropogenic activities such as tourism which greatly alter the environment in fragile small island areas (Oduber et al, 2015). Climate change is another issue that is seen to create impending threat towards island ecosystems. Habitat shifts, migration, or even extinction is among the possible effects of climate conditions depending on the species physiological tolerances (Dawson et al, 2011). Sea-level rise, erosion, and saltwater intrusion imposes threat to flora of low-lying islands (Church & White, 2011). All these ecological disturbances may affect all types of ecosystems. However, islands have 14 times greater density of critically endangered terrestrial species which makes them priority for integrated conservation efforts (Tershy et al, 2015).

With this, this review paper seeks to answer the following questions:

1. What conservation interventions are made to mitigate the ecological threats on small island flora?

2. What are the intervention gaps in the conservation initiatives for small island flora?

Methods

Journals used in this review was retrieved and accessed through Google Scholar.

Journals were chosen according to the following criteria:

1. Published journal written or translated to English.

2. Studies that included flora conservation on islands published on or after 2010.

Discussion

Conservation Interventions on Small Islands

Kueffer & Kinny (2017) claim that island conservation is both urgent and cost-effective as islands host a great concentration of threatened unique cultural, biological, geophysical values which provide livelihood for millions of islanders. Moreover, they are seen to be real-world laboratories that allow scientific innovation and integration of both local and generalized knowledge.

Invasive Species Management/ Eradication

Invasive species management has become a priority intervention in many island conservation initiatives due to the considerable potential harm established invasive species can bring to native ecosystems and biodiversity (Tobi, 2018), eradication feasibility, economic cost, and reinvasion potential (Courchamp, 2014). The increasing rate if species loss, economic consequences, native plant displacement, and its

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consequences to habitat and resource supply for native animals has further emphasized the impact of biological invasion in human existence (Sheppard et al, 2016). Macinnis-Ng et al (2021), have recognized the improvement of conservation outcomes in many biodiversity hotspots by virtue of the rapid advances in eradicating invasive species from small islands.

New Zealand has been identified to be at the forefront of conservation practice capitalizing on invasive species management (Simberloff, 2019). The hopes of achieving largescale eradication, reinvasion management and food web absorption prevention of invasive species, are seen to be opportunities for improved conservation management in the location (Macinnis-Ng et al, 2021).

Invasive species management approach towards biodiversity conservation has given positive outcomes to Surprise Island, an island in New Caledonia, which has been successful in eradicating an invasive plant species (Cassytha filiformis). Courchamp et al (2014) has noted the definite relief in local species protection this eradication has made in preventing possible local extinction of certain local species. Additionally, the initiative has provided benchmark knowledge on conservation that could be applied on other islands.

The introduction of invasive tree species to Green Mountain, the main area on Ascension Island, led to the extinction many of the fern species has transformed from a fern dominated ecosystem to a cloud forest. Conservation intervention in terms of in-vitro collection of fern spore to address the threat to fern species extinction in the area. The development of detailed protocols for spore collection to help conserve the genetic diversity of ferns is seen to potentially help other rare and threatened plants (Barnicoat et al, 2010).

Biodiversity Conservation through Policy, Legislation, and Partnerships

Not all efforts towards biodiversity conservation are hinged on invasive species management programs. There are those that utilize legislation and polices to improve conditions of island ecosystems. The Pacific Island countries and territories (PICTs) of Oceania has utilized regional policy and learning frameworks to combat biodiversity loss and environmental degradation. By adopting a range of policy and legislative instruments at both local and national levels, the PICTs has slowly paved a way for them to answer to habitat loss and degradation, overexploitation, pollution, etc (Jupiter et al, 2014).

The Solomon Islands have been affected by extensive deforestation leaving it with only 10% of its primary forests. Commercial activities is regulated and protection of elevated primary forest were done. These regulations allow economic gains while maximizing the biodiversity value in these islands (Katovai et al, 2012).

Baider et al (2010) has identified island ecosystems that have been greatly impacted by invasive species and past habitat destruction in the Western Indian Ocean such as those in the granitic Seychelles and the Mascarene Islands. It has been difficult for these islands to establish conservation efforts due to lack of human and financial resources in conservation research and management. However, there has been recorded advances in all islands in terms of plant conservation as all have were able to produce conservation strategies such as ecosystem restoration and establishment of Conservation Management Areas (CMAs). Ex-situ conservation techniques have also been utilized in all islands.

Conservationists in Hawaii has also utilized ex-situ techniques like the use of co-located seed banks, micropropagation, and greenhouses for the successful rescue and conservation of many threatened Hawaiian species. The essential role of partnerships with external organizations has also been emphasized in the success of implemented conservation efforts (Werden et al, 2020).

The conservationists in New Zealand have also recognized the value of partnerships, specifically with indigenous people, in improving their conservation initiatives. The Mātauranga Māori of New Zealand has

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contributed to their greater understanding on climatic conditions and its interactions with ecosystems (Macinnis-Ng, 2021).

Regardless of the level of success of conservation initiatives, there are various identified intervention gaps that decrease the effectivity of determined protocols and programs.

Intervention Gaps in Island Conservation

The ecological conservation efforts described above focused on primary issues surrounding island diversity today and lack a futuristic and preemptive layer in the different approaches. There is a clear lack of account of the impacts of climate change in conservation efforts, despite the realities of rising of sea-levels and temperature which pose clear and direct effects to flora diversity (Courchamp et al, 2014). This can be attributed to the fact that there are more pressing issues (e.g. invasive species) that exist today compared to the indirect ecological impacts of climate change to biodiversity response (Macinnis-Ng, 2021).

Therefore, there is a need to bridge the gap on the lack of long-term information and reduce the uncertainties of on the ecological implications of climate change ((Macinnis-Ng, 2021). One way to address data deficiencies in these conservation efforts is the use of collected information from geographically distributed databases found in unusual places like those from indigenous groups (Simberloff, 2019). Through the provision of complete datasets and ecological information on these threatened island ecosystems, steps towards proper prioritization of islands for conservation intervention related to climate change influences can be done (Courchamp, 2014).

Assessment of species with greatest risk of extinction from future climate change should be done to streamline conservation efforts (Courchamp et al, 2014). This is also a possible direction towards improving invasive management programs on islands by collecting information on introduced species and how they affect native species and various habitats (Tsang et al, 2019). Research focused on functions of island ecosystems should be done to identify future pathways for invasion and training programs for biosecurity purposes. Keppel et al (2014) also asserts the need for regular state of environment reporting for education and management effectiveness to better the understanding of the conditions of our biodiversity and ecosystem.

The lack of financial and human resources has also been raised as an issue in effective ecosystem conservation efforts (Baider et al, 2010; Martin et al, 2010). Therefore, there is a need to have species-mapping with the emphasis on the identification of areas with high richness, endemism, and threat (Christodoulou et al, 2018) to address the concern on limited resources. Martin et al (2010) have created a method to rank taxa for conservation priority in term of protection priority and management feasibility. Knowledge gaps are also addressed by this procedure by identifying high scoring taxa on conservation priority with little information on threats and can be candidates for further research.

Conclusion

The most common conversation concern among reviewed journals was on resolving the issues on invasive species on island ecosystems. Various invasive species management programs were implemented through direct eradication procedures to ex-situ protocols, and through policy and partnerships with locals and NGOs, which exhibited different levels of success. Similarly, intervention gaps were also prevalent in the many conservation initiatives- including knowledge or information gaps pertaining to indirect climate change disturbances and financial and human resource limitations- which affected the effectivity of these conservation programs.

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