Conservation Biology

Conservation Focus: *Priorities for Policy-Relevant Conservation Research: a View from SCB Regional Sections*

Major Conservation Policy Issues for Biodiversity in Oceania

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Abstract: *Oceania is a diverse region encompassing Australia, Melanesia, Micronesia, New Zealand, and Polynesia, and it contains six of the world's 39 hotspots of diversity. It has a poor record for extinctions, particularly for birds on islands and mammals. Major causes include habitat loss and degradation, invasive species, and overexploitation. We identified six major threatening processes (habitat loss and degradation, invasive species, climate change, overexploitation, pollution, and disease) based on a comprehensive review of the literature and for each developed a set of conservation policies. Many policies reflect the urgent need to deal with the effects of burgeoning human populations (expected to increase significantly in the region) on biodiversity. There is considerable difference in resources for conservation, including people and available scientific information, which are heavily biased toward more developed countries in Oceania. Most scientific publications analyzed for four threats (habitat loss, invasive species, overexploitation, and pollution) are from developed countries: 88.6% of Web of Science publications were from Australia (53.7%), New Zealand (24.3%), and Hawaiian Islands (10.5%). Many island states have limited resources or expertise. Even countries that do (e.g., Australia, New Zealand) have ongoing and emerging significant challenges, particularly with the interactive effects of climate change. Oceania will require the implementation of effective policies for conservation if the region's poor record on extinctions is not to continue.*

Keywords: Oceania, extinctions, conservation policy, hotspot, extinction causes

Principales Cuestiones de Políticas de Conservación de la Biodiversidad en Oceanía

Resumen: *Oceanía en una región diversa que comprende Australia, Melanesia, Micronesia, Nueva Zelanda y Polinesia, y contiene seis de las 39 regiones de importancia para la biodiversidad del mundo. Tiene un*

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triste registro de extinciones, particularmente para aves en islas y mamíferos en Australia. Las principales causas incluyen la pérdida y degradación de hábitat, especies invasoras y sobreexplotación. Identificamos seis procesos principales de amenaza (pérdida y degradación de hábitat, especies invasoras, cambio climático, sobreexplotación, polución y enfermedades) con base en una revisión exhaustiva de literatura y desarrollamos un conjunto de políticas de conservación para cada uno. Muchas políticas reflejan la necesidad urgente para tratar con los efectos de las poblaciones humanas en rápido crecimiento sobre la biodiversidad. Hay considerable diferencia en recursos para la conservación, incluyendo gente e información científica disponible, que están fuertemente sesgados hacia los países más desarrollados en Oceanía. La mayoría de las publicaciones científicas analizaron cuatro amenazas (pérdida de hábitat, especies invasoras, sobreexplotación y polución) en cuatro países desarrollados: 88.6% de las publicaciones de Web of Science fueron de Australia (53.7%), Nueva Zelanda (34.3%) e islas Hawaianas (10.5%). Muchos países insulares tienen escasos recursos o experticia. Aun los países (e.g., Australia, Nueva Zelanda) que los tienen enfrentan significativos retos actuales y emergentes, particularmente con los efectos interactivos del cambio climático. Oceanía requerirá de la implementación de políticas de conservación efectivas sí el triste registro de extinciones en la región no debe continuar.

Palabras Clave: Oceanía, extinciones, políticas de conservación, áreas de biodiversidad, causas de extinción

Introduction

Earth is experiencing its sixth great extinction event, uniquely attributable to humans, and our impact in the Pacific has been particularly dramatic. The extinction of birds (>1200 species) on oceanic islands in the Pacific (Blackburn et al. 2004) provides one of the clearer global examples.

We divided Oceania, with its remarkable diversity and endemism, into five subregions that reflect the area's human cultures and colonization (Steadman 1995): Australia, Melanesia, Micronesia, New Zealand, and Polynesia (Fig. 1, Table 1). The region has six of the recognized 39 world hotspots for biodiversity (Mittermeier et al. 2004) and three of the world's four global hotspots for predatory fishes (Worm et al. 2003). More than 40 million km^2 of ocean are not within any country's exclusive economic zone, limiting governance except at an international level. The region has suffered widespread loss of species and ecosystems.

Humans have directly or indirectly caused extinction of fauna, including half of modern mammal extinctions in Australia (Johnson 2006), and loss of bird species accompanied the spread of humans throughout the Pacific (Steadman 2006). Only fractions of the original vegetation remain on many Pacific islands and New Zealand (Myers et al. 2000).

We considered six major threatening processes driving biodiversity decline in the terrestrial, freshwater, and marine environments of Oceania, accounting for interactive and cumulative effects. We identified proportions of assessed species of amphibians, birds, mammals, and all plants, dominated by vascular plants, affected by the first four threatening processes among countries (Table 1). We identified the more important conservation policies, primarily for governments, for effective conservation.

Habitat Loss and Degradation

Loss and degradation of habitat threatens more terrestrial species than any other process, including >80% of threatened species assessed (critically endangered, endangered, vulnerable) for most countries (Table 1). In Australia agriculture has modified or destroyed about 50% of all woodland and forest ecosystems (ABS 2006), and about 70% of remaining forests are ecologically degraded from logging (Roxburgh et al. 2006). Increasing human populations and intensification of cultivation in many Pacific island countries have depleted forest habitats, and commercial logging and lack of awareness have significantly affected biodiversity. For freshwater ecosystems, regulation and diversion of water from rivers has substantially affected Australian freshwater ecosystems (Kingsford 2000) and Pacific islands (Parrish et al. 1978). Most natural lowland biotic communities on floodplains and wetlands in New Zealand and temperate Australia have been lost (Jones et al. 1995; Keith 2004). Marine environments are adversely affected by dredging and trawling, dynamite, and cyanide (Zann 1994). Two broad options exist to combat habitat loss and degradation: protected areas and reducing threats. Protected areas should be governed by conservation planning (Pressey et al. 2000) that allows for dispersion of fauna (Recher 2007). Almost 12% of land in Australia and 30% in New Zealand is protected, but much is nutrient poor and elevated, which biases representation. Elsewhere, the protected area is generally low. Marine protected areas include <5% of reefs in Australia; targets of 30–50% are recommended (Hughes et al. 2003). Because threats such as logging, fishing, and mining occur in protected areas in Melanesia and Polynesia, these areas often offer little biodiversity protection. In Fiji most conservation effort is focused on 1.3 million km^2 of marine environments, but little is legally protected (A. Tawake, paper presented at the Application of Ecosystem

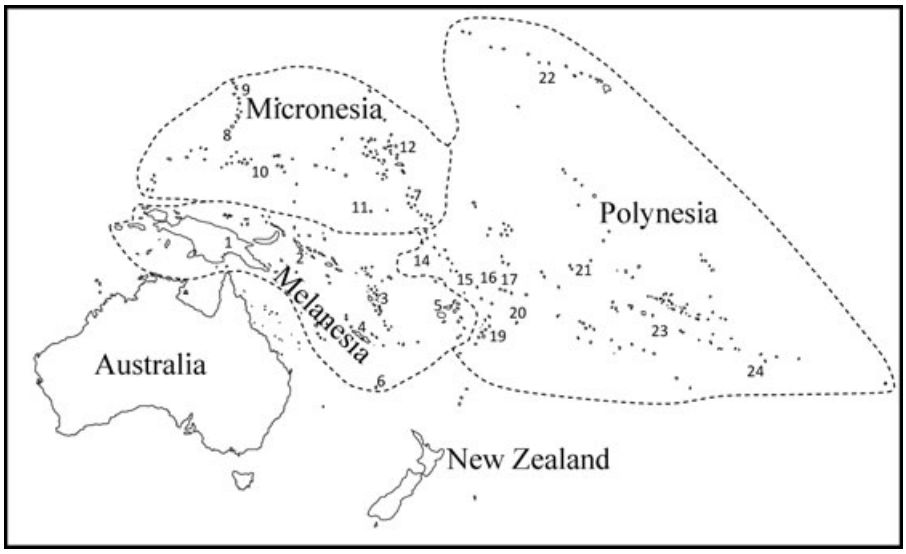

Figure 1. Five major subregions in the Australasian and Pacific region. Names of island groups and countries in Table 1 match numbers in this figure.

Approaches to Protected Areas Convention of Biodiversity -CBD workshop [2006]). Freshwater protected areas, usually poorly represented in the reserve system, are primarily included in terrestrial protected areas, where they are seldom effectively managed (Kingsford et al. 2004).

Policy Recommendations

1. Implement legislation, education, and community outreach to stop or reduce land clearing, mining, and unsustainable logging through education, incentives, and compensation for landowners that will encourage private conservation.
2. Establish new protected areas for habitats that are absent or poorly represented. This includes protection of at least 10% of the terrestrial land area (IUCN Class I-IV), accepting that 10% may be inadequate (Watson et al. 2008) or unachievable; protection of 30–50% of marine habitat types to avoid collapse of fish stock; involvement of local communities in protected-area establishment and management; and connection of protected areas across the landscape.
3. In threatened ecosystems (e.g., wetlands), establish large-scale restoration projects with local communities that incorporate conservation and connectivity.
4. Establish transparent and evidence-based state of environment reporting on biodiversity and manage threats within and outside protected areas.
5. Protect free-flowing river systems (largely unregulated by dams, levees, and diversions) within the framework of the entire river basin and increase environmental flows on regulated rivers.

Invasive Species

Invasive species, particularly vertebrates and vascular plants, have devastated terrestrial species of Pacific Islands (Steadman 1995, 2006) and have caused 75% of all terrestrial vertebrate extinctions on oceanic islands (Atkinson 1989). Introduced vertebrates have contributed to mammal and bird extinctions in Australia (Dickman 1996). Invertebrate predators and competitors have also caused extinction of diverse and endemic land snails (Cowie & Robinson 2003). Invasive species threaten terrestrial biodiversity in New Zealand, Polynesia, Australia, Melanesia, and Micronesia (Table 1).

Invasive plants have colonized New Zealand and Australia (>2500 species [ASOE 2006], representing approximately 11% of native plant species). There are 43 invasive freshwater fish species in Australia, which exceeds invasives in other vertebrate groups (Koehn & McKenzie 2004). Introduced salmonids have caused the decline of native fishes (McDowall 2006) and frogs (Kats & Ferrer 2003). Invasive species have colonized most coastal environments in the region (e.g., >129 exotic species in Australia, Hayes et al. 2005). Many invasive weeds, vertebrate pests, and fishes were introduced by government, agriculturalists, horticulturalists, and hunters.

Prevention of invasion is more cost-effective than eradication (successful on some islands). Progress on the control of exotic species in freshwater and marine environments is poor. Freshwater exotic fishes are often deliberately introduced, and marine exotic species may invade from ballast water discharge.

Policy Recommendations

1. Avoid deliberate introduction of exotic species, unless suitable analyses of benefits outweigh risk-weighted costs, by improving regulation of aquarium, nursery, agricultural, and pet trades; ensuring consistent legal definitions for invasive species; and implementing biosecurity across the region.
2. Implement control of invasive species by assessing effectiveness of control programs and determining invasion

Table 1. Summary of four major threats[a] identified by IUCN (2007) to selected amphibians, birds, mammals, and plants in Oceania, expressed as the number of assessed species affected (www.iucnredlist.org downloaded 31 August 2007[b]) and current and future (2050) human populations.

Subregion	Island group[c]	Human pop. millions (% increase by 2050)[d]	All assessed species					Assessed threatened species					No. WoS citation[f]
			species[e]	HL %	IS %	OE %	P %	species[e]	HL %	IS %	OE %	P %	
Australia		20.743 (35)	370	66	23	7	18	153	80	40	9	30	12,956
Melanesia			388	61	11	12	3	152	83	17	17	3	
	Papua New Guinea 1	6.331 (76)	349	56	6	14	2	113	86	9	23	0	528
	Solomon Islands 2	0.496 (93)	87	78	18	13	1	38	74	29	18	0	121
	Vanuatu 3	0.226 (101)	24	83	21	21	0	16	88	25	31	0	72
	New Caledonia 4	0.242 (49)	88	83	17	14	8	65	83	17	14	8	282
	Fiji 5	0.839 (8)	37	84	27	24	5	25	84	32	24	4	329
	Norfolk Island 6	NA	16	38	63	13	19	16	38	63	13	19	58
Micronesia			43	74	44	37	7	32	75	56	31	6	
	Palau 7	0.02 (30)	11	91	45	55	9	5	100	80	40	0	50
	Guam 8	0.173 (40)	11	64	64	27	18	8	75	88	13	13	226
	Northern Mariana Islands 9	0.084 (81)	20	60	65	30	10	17	65	76	24	12	31
	Micronesia, Federated States 10	0.111 (21)	21	90	38	48	10	16	88	50	44	6	264
	Nauru 11	0.01 (10)	2	50	50	50	0	2	50	50	50	0	21
	Marshall Islands 12	0.059 (56)	2	0	100	50	50	2	0	100	50	50	123
	Kiribati 13	0.095 (59)	4	25	75	50	0	4	25	75	50	0	29
New Zealand			89	52	66	9	19	68	46	69	4	21	5,855
Polynesia		4.179 (25)	270	82	87	6	2	254	82	88	6	2	
	Tuvalu 14	0.011 (9)	1	0	100	100	0	1	0	100	100	0	11
	Wallis and Futuna islands 15	0.015 (13)	8	25	75	38	13	8	25	75	38	13	13
	Samoa 16	0.187 (15)	12	83	33	33	0	11	82	36	36	0	99
	American Samoa 17	0.067 (69)	11	45	64	45	18	10	50	60	40	10	76
	Tokelau 18	0.001 (<0.001)	1	0	100	100	0	1	0	100	100	0	9
	Tonga 19	0.1 (23)	5	80	100	60	0	4	75	100	75	0	75
	Niue 20	0.002 (−50)	7	0	57	29	0	7	0	57	29	0	10
	Cook Islands 21	0.013 (−8)	16	31	63	13	6	15	27	60	13	7	99
	Hawaiian Islands 22	1.276 (14)	209	89	93	3	2	199	90	93	3	2	2,539
	French Polynesia 23	0.263 (36)	35	40	80	14	3	32	41	78	13	0	200
	Pitcairn 24	<0.001	15	33	73	20	0	14	36	71	21	0	18

[a] *Abbreviations: HL, habitat loss; IS, Invasive species; OE, overexploitation; P, pollution. Categories are not exclusive. No IUCN data were available for species threatened by disease and human-forced climate change. Data were unavailable for some island groups.*
[b] *IUCN classifications were derived (see Venter et al. 2006).*
[c] *Numbers are locations on Fig. 1.*
[d] *Populations in 2050 based on a medium population projection (UNDESA 2007). Data for Hawaii for 2005 and projected 2030 (www.census.gov/population/projections/SummaryTabA1.pdf) (NA, not available).*
[e] *Nonrandom sample of species assessed for threats with vagrants or species with doubtful occurrences excluded.*
[f] *Web of Science (WoS) citations were number of citations for each country in a search for the four threats.*

potential; developing cost-effective technologies for control (biological control and gene-pool manipulation); eradicating invasive species from islands (and some large land masses) with concentrated populations of endemic or threatened species.

3. Establish regulations and enforcement for exchange or treatment of ocean ballast and regularly implement antifouling procedures.

Climate Change

Climate change profoundly affects the world's biodiversity. Carbon dioxide concentrations have almost tripled since the 1990s (Raupach et al. 2007). Australian average temperatures have increased, particularly since 1950, which has increased drought severity (Nicholls & Collins 2006) and affected fire and flooding. The oceans are warming and becoming more acidic, frequently bleaching large coral reefs (Hughes et al. 2003). Species' distributions have shifted poleward and to higher elevations, which may affect restricted endemics (Hughes 2000). Sea-level rise (28–43 cm by 2100) is affecting people and environments on Pacific islands (Legra et al. 2008). Freshwater swamps are already affected by saltwater intrusion (Mulrennan & Woodroffe 1998). Many species will need to disperse, changing the structure and composition of communities.

Policy Recommendations

1. Reduce global greenhouse gas emissions.
2. Identify, assess, and protect important climate refugia (ecological and evolutionary).
3. Ameliorate the impacts of climate change through strategic management of other threatening processes.
4. Develop strategic plans for priority translocations and implement when needed.

Overexploitation

Illegal logging and wildlife harvesting affect many ecosystems and species, although full impacts are not well known (Table 1). Overfishing threatens many marine species in the Pacific, where there is dependence on subsistence fisheries. Commercial fisheries have increased catch levels relative to total stock (Francis et al. 2004) and bycatch, which kills large numbers of seabirds, marine mammals, noncommercial fish species, and seafloor invertebrates. Fish and corals are harvested for the aquarium industry and seashells are collected (Wabnitz et al. 2003).

Control of harvesting of exploited species—through rarely used ecosystem-based approaches—is essential to allow for reproduction and recruitment. Implementation and enforcement of fishing regulations, including restrictions on size, fishing season, and gear, can protect habitats, bycatch species, and spawning stock. Nevertheless, much of the marine area is high-seas jurisdiction, where about 10% of the world's seamounts of high biodiversity occur and are vulnerable to fishers. International agreements exist for the high seas (e.g., marine turtles, seabird mortality, marine mammals, migratory, pelagic fish), but their effectiveness is unknown.

Policy Recommendations

1. Implement restrictions on harvest of overexploited species to maintain sustainability. These restrictions should be devised with local involvement and promoted through education.
2. Implement an ecosystem-based approach for fisheries, based on scientific data, that includes zoning the ocean (no-take areas, inclusion, and exclusion of different fisheries); banning destructive fishing (e.g., benthic trawling, cyanide, and dynamite); adopting precautionary fishing principles that include size limits, quotas, and regulation with sufficient resources based on scientific assessments of stocks and; reducing bycatch through regulation and education.
3. Implement international mechanisms to increase sustainability of fisheries by supporting international treaties for fisheries protection in the high seas with proper enforcement and denial of vessel docking for illegal fishing; avoiding perverse subsidies and improve labeling of sustainable fisheries; and licensing exports of aquarium fish taken from captive breeding programs or areas effectively managed for conservation.
4. Ensure conservation of species (e.g., turtles, corals) receives legislative and education support within Pacific island nations.
5. Control unsustainable illegal logging and wildlife harvesting through local incentives and cessation of international trade.

Pollution

Pollution affects up to 20% of all assessed terrestrial species (Table 1). Mining, cold-water dams, and increasing salinity affect freshwater biodiversity, and runoff, sedimentation, and soil erosion have devastated many island coral reefs and lagoons. For many Pacific island communities, rapid development and population growth has outstripped capacity to deal with waste. Plastics and discarded or lost fishing gear pollute shorelines and marine waters (Gregory 1999) and negatively affect seabirds and marine animals.

Policy Recommendations

1. Decrease pollution through incentives and education; reduce and improve treatment of domestic, industrial, and agriculture waste; and rehabilitate polluted areas.
2. Strengthen government regulations to stop generation of toxic material from mining efforts that affects freshwater and marine environments.
3. Establish legislation and regulations and financial bonds (international) to reinforce polluter-pays principles.
4. Establish regulations, education programs, clean ups, labeling, and use of biodegradable packaging to reduce discarded fishing gear and plastics.

Disease

Wildlife diseases (e.g., avian malaria) cause population decline and extinction, which affects endemic species. Frogs are declining or extinct where infected by chytridomycosis (Hero et al. 2006). The root-rot fungus, *Phytophthora cinnamomi*, introduced into Australia has destroyed plant communities (Shearer et al. 2007). Disease also affects marine ecosystems (e.g., mass mortality of pilchards [*Sardinops sagax*]). Populations of the world's largest marsupial predator, the Tasmanian devil [*Sarcophilus harrisi*], have crashed from an infectious facial cancer (McCallum & Jones 2006). Prevention and control of disease are paramount because disease causes rapid species' declines.

Policy Recommendations

1. Establish early-detection programs for pathological diseases and biosecurity controls to reduce translocation.
2. Identify causes, risk-assessment methods, and preventative methods for diseases.
3. Establish remote communities of organisms (captive) not exposed to disease in severe outbreaks.
7. Focus efforts of nongovernmental organizations on small island states on building indigenous capacity for conservation.
8. Base conservation on risk assessment and decision support.
9. Establish the effectiveness of conservation instruments (national and international) and their implementation.

Implementation Capacity

The global population was 6.67 billion (2007) and may increase to 9.19 billion (UNDESA 2007). Most countries in Oceania will experience population increases (Table 1), which will significantly affect the conservation of biodiversity. Threats will be amplified by increasing human populations and consumption. Active conservation varies across the region with wealth, education, media coverage, and political will. Policy depends on good scientific information, but investment in conservation biology in the region is thinly spread, uncoordinated, poorly resourced, and heavily skewed toward developed countries (Morton et al. 2009). Of the more than 24,000 publications identified from Web of Science for four threats (habitat loss, invasive species, overexploitation, and pollution), 88.6% were from three countries: Australia (53.7%), New Zealand (24.3%), and Hawaiian Islands (10.5%) (Table 1). Disparate databases and publications provide little assessment of trends. Many governments have focused on development, and local leadership, expertise, and funding in conservation are seldom nurtured, which ensures little conservation leverage. Many small, island states have limited resources and are often dwarfed by big nongovernmental organizations who can distort conservation priorities by targeting international conventions and particular species. Global conventions and multilateral agreements are signed, but implementation is generally poor.

Policy Recommendations

1. Establish regional population policies based on ecologically sustainable human population levels and consumption.
2. Ensure that all developments affecting the environment are adequately analyzed for impacts over the long term.
3. Promote economic and societal benefits from conservation through education.
4. Determine biodiversity status and trends with indicators that diagnose and manage declines.
5. Invest in taxonomic understanding and provision of resources (scientific and conservation) to increase capacity for conservation.
6. Increase the capacity of government conservation agencies.

Conclusion

Generally, prevention is considerably more cost-efficient and less risky than cure. There is good information about most threats with clear policy choices for conservation. Although our region has an extremely high level of species extinction, there is now sufficient knowledge to implement effective policy, but implementation depends on education, political will, community aspirations, social and economic capacity, and scientific understanding that vary with cultural and political institutions. Policy depends primarily on government and implementation capacity. Education and building knowledge within communities about conservation and environmental protection are critical. Conservation biologists and conservation organizations also need to be better informed of the choices available, the consequences (ecological and cultural) of different actions, and of needs and rights of indigenous communities. Unfortunately, as knowledge of what to do for conservation has increased so have the threats, which increases the urgency for effective policy. Without effective policy Oceania's already poor record on extinctions will worsen.

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