

**A REVIEW OF THREATS TO ISLAND ENDEMIC
RAILS**

by

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TABLE OF CONTENTS

LIST OF TABLES		vi
LIST OF FIGURES		vii
ABSTRACT		viii
Chapter		
1	INTRODUCTION	1
2	METHODS	5
3	RESULTS	7
	Island Endemic Rails.....	7
	Isabelline Waterhen (<i>Amaurornis isabellina</i>).....	7
	The Bush Hen (<i>Amaurornis olivacea</i>).....	7
	The Sakalava Rail (<i>Amaurornis olivieri</i>)	8
	The Snoring Rail (<i>Aramidopsis plateni</i>)	8
	Inaccessible Rail (<i>Atlantisia rogersi</i>).....	9
	The Madagascar Wood Rail (<i>Canirallus kioloides</i>).....	9
	Zapata Rail (<i>Cyanolimnas cerverai</i>).....	10
	The White-Throated Rail (<i>Dryolimnas cuvieri</i>).....	10
	The Hawaiian Coot (<i>Fulica alai</i>)	11
	The Gough Moorhen (<i>Gallinula comeri</i>)	12
	The Tasmanian Native Hen (<i>Gallinula mortierii</i>)	13
	Samoan Moorhen (<i>Gallinula pacifica</i>)	13
	San Cristobal Moorhen (<i>Gallinula silvestris</i>)	14
	Weka (<i>Gallirallus australis</i>).....	14
	The Calayan Rail (<i>Gallirallus calayanensis</i>)	15
	The New Britain Rail (<i>Gallirallus insignis</i>).....	16
	New Caledonian Rail (<i>Gallirallus lafresnayanus</i>).....	16
	Okinawa Rail (<i>Gallirallus okinawae</i>).....	16
	The Guam Rail (<i>Rallus owstoni</i>).....	17
	The Roviana Rail (<i>Gallirallus rovianae</i>)	17
	Sharpe's Rail (<i>Gallirallus sharpie</i>)	18

Lord Howe Woodhen (<i>Gallirallus sylvestris</i>)	18
The Barred Rail (<i>Gallirallus torquatus</i>).....	19
Bare-eyed rail (<i>Gymnocrex plumbeiventris</i>)	20
Blue-faced Rail (<i>Gymnocrex rosenbergii</i>)	20
Talaud Rail (<i>Gymnocrex talaudensis</i>).....	21
The Invisible Rail (<i>Habroptila wallacii</i>).....	21
The Galapagos Rail (<i>Laterallus spilonotus</i>).....	21
The Brown-Banded Rail (<i>Lewinia mirifica</i>)	23
The Auckland Islands Rail (<i>Lewinia muelleri</i>)	23
New Guinea Flightless Rail (<i>Megacrex inepta</i>)	23
Woodford’s Rail (<i>Nesoclopeus woodfordi</i>)	24
The Takahe (<i>Porphyrio hochstetteri</i>).....	24
The Henderson Crake (<i>Porzana atra</i>)	25
Andaman Crake (<i>Rallina canningi</i>)	26
Forbe’s forest Rail (<i>Rallina forbesi</i>)	26
The White-Striped Forest Rail (<i>Rallina leucospila</i>)	26
Mayr’s Forest Rail (<i>Rallina mayri</i>)	27
Chestnut Forest Rail (<i>Rallina rubra</i>)	27
Madagascar Rail (<i>Rallus madagascariensis</i>)	27
Slender-billed flufftail (<i>Sarothrura watersi</i>).....	28
Threat Analysis.....	39
Predator Analysis.....	41
Threat status versus island size and distance to a mainland.....	43
4 DISCUSSION.....	44
Island size versus distance to a mainland	47
Implications for Conservation and Management Strategies	47
REFERENCES	48

LIST OF TABLES

Table 1. Summary Table of Endemic Rails.	29
Table 2. Island Summary Table.....	33
Table 3. Rails grouped by similar geographic regions highlighting the alien species present on each.....	38

LIST OF FIGURES

Figure 1. Threats currently affecting island endemic rail populations.	40
Figure 2. Percentage of Rails affected by predators.	42

ABSTRACT

I conducted a literature review on the number, distribution, conservation status, and principle threats to island endemic rails in an attempt to prioritize which species may be in need of greatest conservation action. Presently, there are 134 species in the family Rallidae, 41 of those are island endemic. Island endemic rails are affected by 42 different types of threats. Predation by alien mammalian predators was the greatest threat to island endemic rail species, with 30% of the rail species affected, followed by habitat degradation and infrastructure development affecting 22% of species. *Rattus* spp. were found to be the mammalian predator affecting rail population the most followed by the domestic cat (*Felis catus*) and the cane toad (*Bufo marinus*). I also examined the islands that host endemic rail species to see how island size and distance to a mainland effects rail species. Critically endangered rails comprise 7.3% of all island endemic rail species that occur on less than 3% of the total islands that host island endemic rails. Islands that host critically endangered rails were the smallest islands that host rails and were the furthest from a mainland. They averaged less than 7200 km² and are 385 km² away from a mainland. Several oceanic islands have been conducting research on the eradication of rats. Removal of mammalian predators not only decreases predation and thus can increase rail numbers, but it also facilitates restoration of habitat. Seven percent of the island endemic rail species were listed as data deficient, making it hard to see which threats affect these species or to see a population trend for these species which are important factors needed to begin conservation efforts to help these species. Establishing monitoring

protocols for each species and island would provide information needed to create conservation and management plans for endemic rail species.

Chapter 1

INTRODUCTION

Island endemic species have greater extinction rates than mainland populations. The extinction rate for island populations is 40 times greater than for continental mainland populations and islands contain 39% of all threatened bird species (Trevino et al 2006). Seventy-five percent of animal extinctions since the 1600s have been island species (Frankham 1998). Consequently, only 20% of the world's bird species inhabit islands but 90% of bird species driven to extinction in historic times have been island dwellers (Frankham 1998). With high extinction probabilities understanding the specific threats to the remaining island endemic rail species is a conservation priority.

Island populations are small, closed populations often distinct from large, open populations (Temple 1985). Island populations are prone to extinction because of the relatively low rates of population growth, their naïveté to predators, their small population size, and the limited land area (Steadman and Martin 2003). Small and closed island populations have limited immigration or emigration and generally have relatively small population numbers due to the spatial limitations of an island. Because small populations are subject to environmental, demographic, and genetic stochasticity (Temple 1985 and Frankham 1996), these events can effect small populations more than large populations due to their lack of individuals to buffer against extinction. Environmental stochasticity refers to a deviation in birth and death rates in response to such factors as weather, natural catastrophes, disease, or predation

(Temple 1985). Demographic stochasticity arises from chance events that alter survival and reproductive success in a population (Temple 1985). Genetic stochasticity results in a change in genetic structure of a population by reducing diversity and increasing the amount of recessive alleles in population (Temple 1985). Island populations are small which leads to reduced genetic diversity (Reed 2007). Carrying capacity can also be a limiting factor in island populations and is directly related to island area. Also, smaller islands tend to support fewer species than larger islands (Whittaker et al 2008) and large islands are often able to provide refuge from stressors like mammalian predators (Blackburn 2004).

Islands are valuable research sites to study endemism and speciation and for modeling natural selection (Trewick 1997). In a study done by Grant and Grant (2003), 14 species of Darwin's finches were studied to examine divergent natural selection. These finches, all stemming from the same parent population, slowly diverged from each other after colonizing a new island. These species diverged due to food differences in their new environment creating 14 new different beak sizes. This is just one example of how populations of species can colonize islands and through natural selection diverge creating new traits not seen in the parent population. After a species successfully colonizes an island, it begins to diverge from its mainland parent population and has a lower intrinsic rate of growth. A low intrinsic rate of growth is often manifested in lower clutch sizes. This means that a population has less of a chance of recovery once its numbers are depleted due to a lack of ability to have large clutch sizes. Another example of divergence from a mainland population is the evolution of flightlessness in many endemic rail species (Trewick 1997, Olson 1973, McNabb and Elis 2006). If island birds evolve in the absence of predation they loose

predator avoidance behaviors (Temple 1985 and Taylor 1998). Of all the island endemic Rail species, 57% of them are flightless (Taylor 1998).

Another explanation for why island populations are so vulnerable is outlined in the island biogeography theory. This theory was first proposed by MacArthur and Wilson (1967) and states that islands isolated from mainland populations have fewer species and a greater risk of extinction (Trevino et al 2006). This model established a theory that immigration declines as a function of isolation (distance) and extinction rates should decline as a function of increasing area (Whittaker et al 2008). A new model of island biogeography was proposed by Whittaker et al. (2008) that included more emphasis on oceanic island systems. This model has three underlying premises; the most important of which are the biological processes premise and the evolutionary responses premise (Whittaker et al 2008). The biological process premise states that equilibrium for island biota is reached when immigration and extinction rates are equal (Whittaker et al 2008). The evolutionary response states that large islands have populations with more diverse lineages compared to smaller islands whose populations interact with closely related species (Whittaker et al 2008).

The family Rallidae, of the avian order Gruiformes, was used to study the effects of threats on island endemic populations. The avian order Gruiformes is distributed worldwide and is comprised of large to small wading and terrestrial birds. Its largest family is Rallidae with 134 extant species (Taylor 1998) which includes the rails, coots, and gallinules and the world's smallest living flightless bird, the Invisible Rail (*Habroptila wallacii*). Birds in Rallidae are predominately aquatic but can be found in forests, marshes, grasslands, and remote oceanic islands (Taylor 1998 and

Livezey 1998). The morphology of rails is unique incorporating a short laterally compressed body, short, broad, rounded wings, well developed long slender legs, a long neck, a short tail, and often includes a brightly colored bill. The plumage is often cryptic with browns and greys (Taylor 1998).

The objective of this effort was to provide a review of the existing information on the number, distribution, conservation status, and principle threats to island endemic rails in an attempt to prioritize which species may be in need of greatest conservation action.

Chapter 2

METHODS

This study was conducted as a literature review. However each habitat that hosted island endemic rails was studied and that study area included islands all over the world from Cuba to Madagascar to New Zealand. A full list of each island studied can be found in Table 2.

A list of all endemic rail species was composed utilizing the International Union for Conservation of Nature (IUCN) red list and a guide to rails (Taylor 1998). A rail was classified as being island endemic only if it was solely found on islands. If the rail was also found on a mainland it was excluded from the study. Once it was determined which rails were island endemic, a data set was compiled using scientific literature, IUCN red list, and Taylor 1998. A list of these data can be found in Table 1.

Upon completion of these data, a list of threats from the IUCN red list was exported for each rail species showing which rail species was affected by which threat. The threats used were based on the IUCN hierarchical classification of causes of species decline. When using this, assessors are asked to indicate the threats that triggered the listing of the taxon concerned at the finest level possible. These threats could be in the past, ongoing or in the future, using a time frame of three generations or ten years, whichever is the longer (not exceeding 100 years in the future) as required by the Red List Criteria. Currently there are 85 threats causing species listing on the IUCN Red List and 42 of those effect rails. The top threats to rails were

hybridization, land management, changes in native species dynamics, fire, persecution, alien species, competitors, extraction, natural disasters, pollution, pathogens, harvest, accidental mortality, agriculture, habitat loss, infrastructure development, and predation, and can be found in Figure 2. These data were calculated by first seeing which species was affected by each threat, then an average was taken of each threat to see which had the highest percentage, or highest influence on the rail population. This was done for each species on each island so the threats average is representative for each population, not just for each individual species. Figure 2 shows these data with the threats affecting rails on the y-axis and the percent of the population influenced on the x-axis. Once the major stressor to rails was determined as predation, the same strategy of calculating the percentage affected was employed on a variety of predators. Utilizing the IUCN red list, each rail was examined to see if it was affected by a specific predator. An average was taken of each predator type to see which percentage was highest and affecting rail species the most. Next each island was examined to examine whether island size and distance to mainland had an effect on the current status of each island rail population.

Chapter 3

RESULTS

Island Endemic Rails

Isabelline Waterhen (*Amauornis isabellina*)

The Isabelline waterhen is a least concern species endemic to Celebes Island in Indonesia which is part of the Sulawesi archipelago (Table 1). Population estimates have yet to be determined. This species is olive brown with a white throat and with brownish-green feet (Taylor 1998). This rail is found in grassland habitat near streams and rivers with edges of forest (Taylor 1998). The alien species on Celebes Island are the domestic cat (*Felis catus*), rats (*Rattus* spp.), and mice (*Mus* spp.) (Table 2).

The Bush Hen (*Amauornis olivacea*)

The Bush hen is a least concern species found on 21 islands in the Philippine islands in the Philippines (Table 1). These are the Celebes, Basilan, Batan, Bohol, Calayan, Cataduanes, Cebu, Leyte, Luzon, Marinduque, Masabate, Mindanao, Mindoro, Negros, Panay, Polillo, Sabtang, Samar, Sibuto, Siquijor, and Ticao Islands (Table 1). Ten of these 21 islands are plagued with the Cane toad (*Bufo marinus*) (Table 2). Population estimates have yet to be determined. This rail has dark plumage with a dark olive-brown head and upper wings (Taylor 1998). The habitat of

this rail is in grasses near water, scrub vegetation (Taylor 1998), and forests (Sibley 1951 and Diamond 1971).

The Sakalava Rail (*Amaurornis olivieri*)

The Sakalava Rail is endangered with a population estimate of between 250 and 999 individuals and is declining (Bird life international). This species has dark grey plumage with dark brown scapulars and underwing-coverts, and a greenish-yellow bill (Taylor 1998). It is found in patches of floating vegetation and grassland vegetation near water (Taylor 1998). The Sakalava Rail is endemic to Madagascar (Table 1) which is home to alien species such as the cattle egret (*Bubulcus ibis*), rock pigeon (*Columba livia*), destructive trailing ant (*Monomorium destructor*), pharaoh ant (*Monomorium pharaonis*), and the crazy ant (*Anoplolepis gracilipes*) (Table 2). Species endemic to Madagascar are currently suffering from wetland degradation, agriculture and aquaculture, annual and perennial non-timber crops, biological resource use, hunting and trapping, natural system modifications, and fires (IUCN Red List).

The Snoring Rail (*Aramidopsis plateni*)

The Snoring Rail is listed as vulnerable due its declining population numbers which are currently at 2,500 individuals (bird life international). This flightless rail is mostly grey with orange-chestnut patches on the sides of its neck (Taylor 1998). Its habitat is lowland and highland forest with dense of vegetation near water (Taylor 1998). The snoring rail is endemic to the Sulawesi Island in the Sulawesi archipelago in Indonesia (Table 1). Species endemic to Sulawesi are in danger from the effects of habitat loss and fragmentation, clear cutting, agriculture,

predation, harvesting, and invasive species (IUCN Red List). The alien species found on Sulawesi are rats (*Rattus* spp.), mice (*Mus* spp.) and the domestic cat (*Felis catus*) (Table 2).

Inaccessible Rail (*Atlantisia rogersi*)

The Inaccessible Rail is the smallest flightless rail in the world. Though this species has an estimated 8400 individuals, it is listed as vulnerable due to the fact that it is located on one small island (Bird life international), Inaccessible Island. This rail is found in all habitats on the island but numbers are highest in areas with coastal tussock grass (Taylor 1998). The Inaccessible Rail feeds mainly on invertebrates (Taylor 1998). This rail is endemic to Inaccessible Island in the Tristan de Cunha archipelago (Table 1) and is threatened by natural disasters and predation (IUCN Red List). The alien species on Inaccessible Island are goats (*Capra aegagrus hircus*) (Table 2).

The Madagascar Wood Rail (*Canirallus kioloides*)

The Madagascar Wood Rail is listed as least concern species with population estimates between 1000 and 2000 individuals (bird life international). This rail is a medium size species with chestnut and olive brown coloring (Taylor 1998). This rail is found in rainforest habitat with an open understory with leaf litter and feeds on insects, amphibians and seeds (Taylor 1998 and Bird Life International). This species is endemic to Madagascar (Table 1). Madagascar is threatened with forest destruction (Bird life international) and predation (IUCN Red List). The alien species on Madagascar are the cattle egret (*Bubulcus ibis*), rock pigeon (*Columba*

livia), destructive trailing ant (*Monomorium destructor*), pharaoh ant (*Monomorium pharaonis*), and the crazy ant (*Anoplolepis gracilipes*) (Table 2).

Zapata Rail (*Cyanolimnas cerverai*)

The Zapata Rail is an endangered species with a decreasing population trend and population estimates between 250 and 999 individuals (bird life international). This rail is blue and brown (Bird life international) and has been observed in tall grass habitats, swamps, and Lakes (Garrido 1985). This rail is also nearly flightless (Bond 1942 and Pregill and Olson 1981), able to fly only short distances while dragging its legs (Bond 1942). The Zapata Rail is endemic to Cuba (Table 1). Species found on Cuba are threatened with dry season burning (bird life international), agriculture, and predation (IUCN Red List). The alien species on Cuba are Javan deer (*Rusa timorensis*), pigs (*Sus scrofa*), the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), and snails (Table 2).

The White-Throated Rail (*Dryolimnas cuvieri*)

The White-Throated Rail is a least concern species as well as the last surviving flightless bird of the western Indian Ocean (Penny and Diamond 1971) with a population estimate of 5100 to 7500 individuals (bird life international). It is a medium sized rail with white undertail coverts with a dark olive green upper body (Wanless and Hockey 2008). The rail is found in mangroves and low lying dense grasses and scrub vegetation (Penny and Diamond 1971 and Huxley and Wilkinson 1977). The white-throated rail is diurnal (Wanless and Hockey 2008). These rails are carnivorous, insectivorous, and scavengers (Penny and Diamond 1971) and their diet includes arthropods and snails and will hunt geckos, skinks, and crabs (Wanless and

Hockey 2008 and Penny and Diamond 1971). The White-Throated Rail is endemic to Madagascar and Aldabra Island of the Seychelles Archipelago (Table 1). The alien species on Aldabra Island include goats (*Capra aegagrus hircus*), the domestic cat (*Felis catus*), and rats (*Rattus* spp.), and the alien species on Madagascar include the cattle egret (*Bubulcus ibis*), rock pigeon (*Columba livia*), destructive trailing ant (*Monomorium destructor*), pharaoh ant (*Monomorium pharaonis*), and the crazy ant (*Anoplolepis gracilipes*) (Table 2).

The Hawaiian Coot (*Fulica alai*)

The Hawaiian Coot is listed as vulnerable with population estimates between 2000 and 4000 individuals (bird life international). This bird has a large frontal shield and a color morph distinguishable by the presence of a red shield (Engilis and Pratt 1993). This rail is found in arid and semi-humid regions where there is a body of brackish or fresh water surrounded by vegetation and this species has been seen to feed on guava seeds and plant stems (Schwartz and Schwartz 1952). The Hawaiian Coot is endemic to the Hawaiian Islands of Hawaii, Kaua'i, Maui, Molokai, Niihau, and O'ahu (Table 1). These islands suffer from the effects of Residential & commercial development, housing & urban areas, commercial and industrial areas, tourism & recreation areas, agriculture & aquaculture, annual & perennial non-timber crops, agro-industry farming, biological resource use, hunting & trapping terrestrial animals, intentional use (species is the target), natural system modifications, other ecosystem modifications, pollution, agricultural & forestry effluents, and herbicides and pesticides agroindustry farming, industry, tourism, infrastructure development, habitat loss, predation, subsistence harvest and local trade, agriculture pollution, and pathogens and parasites (IUCN Red List). Alien

species on Hawaii include the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), mongoose (*Herpestes Javanicus*), goats (*Capra aegagrus hircus*), pigs (*Sus scrofa*), brown tree snake (*Boiga irregularis*), brown rat (*Rattus norvegicus*), black rat (*Rattus rattus*), house mouse (*Mus musculus*), cattle egret (*Bubulcus ibis*), cane toad (*Bufo marinus*), pigeon (*Columba spp.*), mute swan (*Cygnus olor*), tiger mosquito (*Aedes albopictus*), crazy ant (*Anoplolepis gracilipes*), and axis deer (*Cervus axis*). Alien species on Kaua'i are unknown. Alien species on Maui are the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), house mouse (*Mus musculus*), pacific rat (*Rattus exulans*), brown rat (*Rattus norvegicus*), black rat (*Rattus rattus*), and the cane toad (*Bufo marinus*). Alien species on Molokai include the domestic dog (*Canis lupus familiaris*), pigs (*Sus scrofa*), cane toad (*Bufo marinus*), house mouse (*Mus musculus*), pacific rat (*Rattus exulans*), brown rat (*Rattus norvegicus*), black rat (*Rattus rattus*), and Axis deer (*Cervus axis*). Alien species on Niihau are unknown. Alien species on O'ahu are the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), house mouse (*Mus musculus*), brown rat (*Rattus norvegicus*), pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), pigs (*Sus scrofa*), and the cane toad (*Bufo marinus*). (Table 2).

The Gough Moorhen (*Gallinula comeri*)

The Gough Moorhen is listed as vulnerable with a population estimate of 9000 individuals (bird life international). This medium sized rail is black in color and is commonly found in fern-bush habitats (bird life international). This rail feeds on plants, seeds, and invertebrates (bird life international). The Gough Moorhen is endemic to Gough Island and Tristan da Cunha Island in the Tristan da Cunha Archipelago (Table 1). The alien species on Gough island is the house mouse (*Mus*

musculus) and on Tristan da Cunha Island, the alien species include rats (*Rattus* spp.), mice (*Mus* spp.) the domestic cat (*Felis catus*), goats (*Capra aegagrus hircus*), and possums (Table 2). Species endemic to these islands suffer from the effects of predation, habitat destruction, and harvest (IUCN Red List).

The Tasmanian Native Hen (*Gallinula mortierii*)

The Tasmanian Native Hen is a least concern species with unknown population estimates. This rail is found in areas that have a blend of open pasture, dense vegetation cover, and water. (Goldizen et al 1998). In some populations frequent mate-sharing occurs (Goldizen et al 1998 and Putland and Goldizen 2001). The Tasmanian Native Hen is endemic to Maria and Tasmania Islands in the Tasmania Archipelago (Table 1). This species is currently facing threats from predation (IUCN Red List). Alien species on Maria Island include the brown rat, mice (*Mus* spp.), the domestic cat (*Felis catus*), and ungulates (Table 2). Alien species on Tasmania Island include goats (*Capra aegagrus hircus*), the domestic cat (*Felis catus*), pigeons (*Columba* spp.), ferrets, parakeets, and the red fox (*Vulpes vulpes*) (Table 2).

Samoan Moorhen (*Gallinula pacifica*)

The Samoan Moorhen is a critically endangered species with a decreasing population of less than 50 individuals (bird life international). This rail has a blue neck, olive-green upperparts, and a black rump (bird life international). This bird is found in primary forests and feeds on insects (bird life international). The Samoan Moorhen is endemic to Savai'i Island in the Samoa Island archipelago in Samoa (Table 1). This island is threatened with hunting, predation, and slash-and-burn

cultivation (IUCN Red List). Alien species found on this island include the domestic cat (*Felis catus*), rats (*Rattus spp.*), pigs (*Sus scrofa*), and the domestic dog (*Canis lupus familiaris*) (Table 2).

San Cristobal Moorhen (*Gallinula silvestris*)

The San Cristobal Moorhen is a critically endangered species with a population estimate of less than 50 individuals (bird life international). This rail is a dark blue and slate color with olive and brown colored upper-parts (Taylor 1998). The habitat for this species is dense undergrowth in forests with an unknown diet (Taylor 1998). The San Cristobal Moorhen is endemic to San Cristobal Island of the Solomon Island archipelago (Table 1). This island is threatened from the effects of hunting, logging, invasive species, habitat alteration, and predation. The Alien species on this island are feral pigs (*Sus scrofa*) (Table 2).

Weka (*Gallirallus australis*)

The Weka is a vulnerable species with population estimates between 120,000 to 187,000 individuals (bird life international). This rail has a long tail, a thick bill, and several different color morphs (Taylor 1998). This species is found in a variety of habitats but most frequently occurs in forest, woodland, grassland, and shrub habitat and is an opportunistic and omnivorous feeder (Taylor 1998). The Weka is flightless, extremely rare, and has been seen to exhibit aggressive behavior (Murphy 1951). The Weka is endemic to New Zealand on Chatham, Kapiti, Kawau, Mokoia Pakatoa, Pitt, Rakitu, South Island, Stewart, and Whanganui Islands and Macquarie Island in Australia (Table 1). Threats to this species include habitat degradation, drought and flood, poison baits used for control of mammalian species,

disease, and predation (IUCN Red List). The alien species on Chatham Island include the domestic cat (*Felis catus*), the pacific rat (*Rattus exulans*), the brown rat (*Rattus norvegicus*), and the black rat (*Rattus rattus*). The alien species on Kapiti Island include rats (*Rattus* spp.), mice (*Mus* spp.), the domestic cat (*Felis catus*), goats (*Capra aegagrus hircus*), and possums. The alien species on Kawau Island include the black rat (*Rattus rattus*). The alien species on Macquarie Island include ducks, the domestic cat (*Felis catus*), rats (*Rattus* spp.), mice (*Mus* spp.) and rabbits. The alien species on Mokoia Island include mice. The alien species on Pakatoa Island include the brown rat (*Rattus norvegicus*). The alien species on Pitt Island include the black rat (*Rattus rattus*), pacific rat (*Rattus exulans*), and the domestic cat (*Felis catus*). The alien species on Rakitu Island include cattle, sheep, goats (*Capra aegagrus hircus*), and brown rats (*Rattus norvegicus*). The alien species on South Island include red deer (*Cervus elaphus*), the domestic cat (*Felis catus*), and ferrets. The alien species on Stewart Island include the domestic cat (*Felis catus*), pacific rats (*Rattus exulans*), brown rats (*Rattus norvegicus*), and black rats (*Rattus rattus*). The alien species on Whanganui Island are unknown. (Table 2).

The Calayan Rail (*Gallirallus calayanensis*)

The Calayan Rail is a vulnerable species with population estimates between 250 and 999 individuals (bird life international). The Calayan Rail is endemic to the Calayan Island in the Philippine Island archipelago (Table 1). The alien species on this island is the cane toad (*Bufo marinus*) (Table 2). Threats to this species include transportation and service corridors, roads and railroads, and hunting (IUCN Red List).

The New Britain Rail (*Gallirallus insignis*)

The New Britain Rail is a near threatened species with a decreasing population and population estimates between 2500 and 9999 individuals (bird life international). The habitat of this rail is damp forests and mountain valleys (Taylor 1998). It is endemic to New Britain Island in the Bismarck Archipelago in Papua New Guinea (Table 1). Alien species on New Britain Island are pigs (*Sus scrofa*), the pacific rat (*Rattus exulans*), and the cane toad (*Bufo marinus*) (Table 2).

New Caledonian Rail (*Gallirallus lafresnayanus*)

The New Caledonian Rail has population estimates of less than 50 individuals and is a critically endangered species due to the fact that the species has not been recorded with accuracy since 1890 (bird life international). The New Caledonian Rail is endemic to New Caledonia Island in the New Caledonia archipelago in France (Table 1). Alien species on New Caledonia are Javan deer (*Rusa timorensis*), feral pigs (*Sus scrofa*), the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), and snails (Table 2). Threats to this species include predation by introduced and invasive species and hunting (IUCN Red List).

Okinawa Rail (*Gallirallus okinawae*)

The Okinawa Rail is an endangered species with a decreasing population and population estimates of 720 individuals (bird life international). This rail is dark olive-brown with a black throat and is found in evergreen forest with dense undergrowth (Taylor 1998). The Okinawa Rail is endemic to Okinawa Island in the Ryukyu archipelago in Japan (Table 1). The alien species on Okinawa are the domestic cat (*Felis catus*), the bullfrog (*Rana catesbeiana*), crazy ants (*Anoplolepis gracilipes*), and rats (Table 2). This species is threatened with logging, dam

construction, road building, forest loss and fragmentation, and predation (IUCN Red List).

The Guam Rail (*Rallus owstoni*)

The Guam Rail was listed as endangered in 1984 and the last rail was seen in the wild on Guam Island in 1986 (Fontenot et al 2006). It is a large rail with dark brown coloring over its head, back, rump, tail, and black and white barring on the wings (Jenkins 1979). Male Guam rails are larger than females (Jenkins 1979 and Fontenot et al 2006). This rail is found in all habitat types in Guam except Wetlands but is most common in an environment with mixed woodland and brush (Jenkins 1979 and Fontenot et al 2006). They forage at night and eat mainly snails, slugs, seeds, flowers, orthoptera, dermaptera, and lepidoptera. The Guam Rail was endemic to Guam and an introduced population has been started on Rota Island in the Mariana archipelago (Table 1). Alien species on Guam Island include pigs (*Sus scrofa*), brown tree snake (*Boiga irregularis*), Philippine rat snake (*Coelognathus erythrurus*), the domestic dog (*Canis lupus familiaris*), chickens, Philippine deer, carabao (*Bubalus bubalis*), cane toads (*Bufo marinus*), and monitor lizards (Table 2). Alien species on Rota Island include cane toads (*Bufo marinus*), the domestic cat (*Felis catus*), pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), and pigs (*Sus scrofa*) (Table 2). The primary threat to the Guam Rail and cause of its extinction on Guam was predation by the Brown Tree Snake (*Boiga irregularis*) (IUCN Red List).

The Roviana Rail (*Gallirallus roviaanae*)

The Roviana rail is a near threatened species with population estimates between 2500 and 9999 individuals (bird life international). This species is a dark

chestnut brown with a slightly reddish mask through the eye and a white chin and throat (Diamond 1991). The majority of accounts on this species have been by natives (Diamond 1991). The Roviana rail is called a 'kitikete' by natives and is nearly flightless (Diamond 1991). Its habitat is described as forest and this rail is omnivorous and feeds on worms, seeds, vegetable matter, and small crabs (Diamond 1991). The Roviana Rail is endemic to Kolombangara, New Georgia, and Rendova Islands in the Solomon Islands archipelago (Table 1). Alien species on Kolombangara Island are pig species (*Sus scrofa*) (Table 2). Alien species on New Georgia are pigs (*Sus scrofa*) and the pacific rat (*Rattus exulans*) (Table 2). Alien species on Rendova Island are unknown.

Sharpes Rail (*Gallirallus sharpie*)

Sharpes Rail is a data deficient species with unknown population estimates. Habitat and feeding habits are unknown. Sharpes Rail is endemic to Borneo, Java, and Sumatra Islands in Indonesia. Alien species on Borneo are unknown. Alien species on Java Island are the brown tree snake (*Boiga irregularis*), pigeons (*Columba spp.*), the pacific rat (*Rattus exulans*), and the crazy ant (*Anoplolepis gracilipes*) (Table 2). Alien species on Sumatra include the rock pigeon (*Columba livia*) and the brown tree snake (*Boiga irregularis*) (Table 2). Threats to this species include AgroIndustry farming, logging, dams, and harvesting for fuel (IUCN Red List).

Lord Howe Woodhen (*Gallirallus sylvestris*)

The Lord Howe Woodhen is an endangered species with population estimates of 200 individuals (bird life international). This species is a medium to

large flightless rail found in forest habitat (Taylor 1998). The Lord Howe Woodhen is endemic to Lord Howe Island in Australia (Table 1). Alien species on Lord Howe Island include the domestic dog (*Canis lupus familiaris*), the black rat (*Rattus rattus*), and feral pigs (*Sus scrofa*) (Table 2). Threats to this species include hunting, climate change and weather, flooding, and predation (IUCN Red List).

The Barred Rail (*Gallirallus torquatus*)

The Barred Rail is listed as least concern due to its large range though population estimates for this species have not yet been quantified (bird life international). The Barred Rail is endemic to 41 islands in Indonesia, the Philippines, and Papua New Guinea. These islands are Bantayan, Basilan, Biliran, Bohol, Bongao, Boracay, Buad, Camiguin, Carabao, Cataduanes, Cebu, Dinagat, Fuga, Leyte, Luzon, Mangole, Marinduque, Masbate, Mindanao, Mindoro, Muna, Negros, New Guinea, Palawa, Pan de Azucar, Panay, Peleng, Polillo, Romblon, Salawati, Samar, Sanana, Seho, Semirara, Siargao, Sibuyan, Siquijor, Sulawesi, Taliabu, Ticao, and Verde Island (Table 1). The main alien species on these islands is the cane toad (*Bufo marinus*), with the exception of New Guinea Island that has the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), pigeons (*Columba spp.*), the crazy ant (*Anoplolepis gracilipes*), sweet potato whitefly (*Bemisia tabaci*), and the cane toad (*Bufo marinus*), and Sulawesi Island that has rats (*Rattus spp.*), mice (*Mus spp.*) and the domestic cat (*Felis catus*) (Table 2).

Bare-eyed rail (*Gymnocyrex plumbeiventris*)

The Bare-eyed Rail is a least concern species with a large range but population estimates for this species have yet to be quantified (bird life international). This species is a medium to large rail identified by pink coloration around the eye (Taylor 1998). This rail occurs in secondary growth forest which comprises a small portion of the islands where this rail occurs (Diamond 1971). The Bare-eyed Rail is endemic to Bacan, Halmahera, Karkar, Misool, Morotai, New Guinea, and New Ireland Islands in the Moluccas, New Guinea, Bismarck, and Aru Islands archipelagos in Papua New Guinea and Indonesia (Table 1). Alien species on Bacan, Misool, and Morotai Islands are unknown. Alien species on Halmahera is the Indian monitor lizard. Alien species on Karkar are pigs (*Sus scrofa*) and the cane toad (*Bufo marinus*). Alien Species on New Guinea are the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), the pacific rat (*Rattus exulans*), pigeons (*Columba spp.*), the crazy ant (*Anoplolepis gracilipes*), the sweet potato whitefly (*Bemisia tabaci*), and the cane toad (*Bufo marinus*). Alien species on New Ireland are pigs (*Sus scrofa*). (Table 2).

Blue-faced Rail (*Gymnocyrex rosenbergii*)

The Blue-faced Rail is a vulnerable species with a decreasing population and population estimates between 2500 and 9999 individuals (bird life international). This species is easily identified by the blue coloration around the eye and is found in primary and secondary forest and abandoned rice fields (Taylor 1998). The Blue-faced Rail is endemic to Banggai and Celebes Islands in the Sulawesi archipelago in Indonesia (Table 1). Alien species on Banggai Island are unknown but alien species on Celebes Island includes rats (*Rattus spp.*), mice (*Mus spp.*) and the domestic cat

(*Felis catus*) (Table 2). Threats to this species include habitat destruction, degradation, and fragmentation, logging, agriculture and infrastructure development, and predation (IUCN Red List).

Talaud Rail (*Gymnocrex talaudensis*)

The Talaud Rail is an endangered species with population estimates between 1000 and 2499. Habitat for this rail includes wet grasslands, and swampy secondary growth patches at the edge of forests (Taylor 1998). The Talaud Rail is endemic to Celebes Island in the Sulawesi archipelago in Indonesia (Table 1). Alien species on Celebes Island include rats (*Rattus* spp.), mice (*Mus* spp.) and the domestic cat (*Felis catus*) (Table 2). Threats to this species include habitat degradation, agricultural development, trapping, predation, logging, and timber extraction (IUCN Red List).

The Invisible Rail (*Habroptila wallacii*)

The Invisible Rail is a vulnerable species with a decreasing population and a population estimate of between 2500 and 9999 individuals (bird life international). The Invisible Rail is endemic to Halmahera Island in the Maluku archipelago in Indonesia (Table 1). The alien species on Halmahera is the Indian monitor lizard (Table 2). Threats faced by this species are habitat loss and fragmentation, predation, agriculture and aquaculture, and hunting (IUCN Red List).

The Galapagos Rail (*Laterallus spilonotus*)

The Galapagos Rail is a vulnerable species with a decreasing population and population estimates of between 5000 and 10000 individuals (bird life international). This rail has crimson irises, a black bill, and white spotting over the

body and wings (Franklin et al. 1979). The call of this rail has been observed as loud and peculiar (Estes et al. 2000). The Galapagos Rail is found solely in moist highland areas (Franklin et al. 1979 and Harris 1973). This species feeds throughout the day by removing food items directly from the ground, not by digging with its feet and eats primarily invertebrates including dragonflies, moths, hemipterans, ants, spiders, isopods, amphipods, snails, and seeds (Franklin et al. 1979). The Galapagos Rail is endemic to Fernandina, Floreana, Isabela, Pinta, San Cristobal, Santa Cruz, and Santiago Islands in the Galapagos Island archipelago in Ecuador (Table 1). Alien species on Fernandina include rats (*Rattus* spp.), mice (*Mus* spp.) and the domestic cat (*Felis catus*). Alien species on Floreana include the crazy ant (*Anoplolepis gracilipes*) and the destructive trailing ant (*Monomorium destructor*). Alien species on Isabela include the domestic dog (*Canis lupus familiaris*), goats (*Capra aegagrus hircus*), the domestic cat (*Felis catus*), and the brown rat (*Rattus norvegicus*). Alien species on Pinta and San Cristobal include rats (*Rattus* spp.), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), and goats (*Capra aegagrus hircus*). Alien species on Santa Cruz include cattle, goats (*Capra aegagrus hircus*), the domestic cat (*Felis catus*), pigeons (*Columba* spp.), and pigs (*Sus scrofa*). Alien species on Santiago include rats (*Rattus* spp.), mice (*Mus* spp.) the domestic cat (*Felis catus*), and rock pigeons (*Columba livia*) (Table 2). Threats to this species include introduced predators, habitat destruction by introduced herbivores, small holder farming, agriculture and aquaculture, inbreeding, and natural disturbances (IUCN Red List). It is suggested that further research be done on this species and further population surveys be conducted (Franklin et al 1979 and Gibbs et al 2003).

The Brown-Banded Rail (*Lewinia mirifica*)

The Brown-Banded Rail is a data deficient species with population estimates unknown (bird life international). This rail is identifiable by pink to buff spots on its upperwing coverts (Taylor 1998). The Brown-Banded Rail is endemic to Luzon and Samar islands in the Philippines (Table 1) though breeding there has not been confirmed (bird life international and IUCN Red List). Alien species on these two islands include the cane toad (*Bufo marinus*) (Table 2). Threats to this species include harvesting for food and for native culture (IUCN Red List).

The Auckland Islands Rail (*Lewinia muelleri*)

The Auckland Islands Rail is vulnerable due to its small range and has a population estimate of 2000 individuals (bird life international). The Auckland Islands Rail is endemic to Adams and Disappointment Islands in the Auckland Islands archipelago in New Zealand (Table 1). Threats to this species include the possible threat of predation from introduced species from neighboring islands (IUCN Red List).

New Guinea Flightless Rail (*Megacrex inepta*)

The New Guinea Flightless Rail is a near threatened species with population estimates unknown (bird life international). This flightless rail has a large frontal shield and a short tail and is found mangrove forests, swamp forests, and bamboo thickets (Taylor 1998). The New Guinea Flightless Rail is endemic to New Guinea Island in the New Guinea archipelago in Indonesia (Table 1). Alien species on New Guinea include the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), pigeons (*Columba spp.*), crazy ant (*Anoplolepis gracilipes*), sweet potato whitefly (*Bemisia*

tabaci), and the cane toad (*Bufo marinus*) (Table 2). Threats to this species include logging and predation (Bird life international).

Woodford's Rail (*Nesoclopeus woodfordi*)

Woodford's Rail is a near threatened species due to its moderately small range and population (bird life international). Population estimates for this species are between 10000 and 19999 individuals (bird life international). This rail is large, flightless, elusive, and hard to find unless first hearing a vocalization (Kratte et al 2001). It has been found in both mature forests (Sibley 1951 and Kratte et al 2001) and river edge habitats (Kratte et al 2001). The coloration has been recorded as almost all black (Peters 1932 and Sibley 1951) and also white spotting in the remiges, underwing coverts, and undertail coverts (Kratte et al 2001) has been noted.

Woodford's Rail is endemic to Bougainville, Guadalcanal, and Santa Isabel Islands in the Solomon Island archipelago in the Philippines (Table 1). Alien species on Bougainville include the domestic dog (*Canis lupus familiaris*), the pacific rat (*Rattus exulans*), and the black rat (*Rattus rattus*). Alien species on Guadalcanal include the domestic dog (*Canis lupus familiaris*), mice (*Mus spp.*), pigs (*Sus scrofa*), the pacific rat (*Rattus exulans*), the black rat (*Rattus rattus*), and the cane toad (*Bufo marinus*). Alien species on Santa Isabel include the destructive trailing ant (*Monomorium destructor*). (Table 2). Threats to this species include predation, hunting, habitat degradation, and logging (IUCN Red List).

The Takahe (*Porphyrio hochstetteri*)

The Takahe is the world's largest flightless rail species. This species is endangered with population estimates between 150 and 220 individuals (bird life

international). This herbivorous rail starts breeding at 2 years of age, produces an average clutch of 2 eggs and forms long term pair bonds (Jamieson et al 2003). The Takahe is endemic to Kapiti, Mana, Maud, and Tiritiri Matangi Islands in New Zealand (Table 1). Alien species on Kapiti include rats (*Rattus* spp.), mice (*Mus* spp.) the domestic cat (*Felis catus*), goats (*Capra aegagrus hircus*), and the brushtail possum (*Trichosurus vulpecula*). Alien species on Mana include the domestic dog (*Canis lupus familiaris*), pigs (*Sus scrofa*), and ungulates. Alien species on Maud include rats (*Rattus* spp.), and the domestic cat (*Felis catus*), species. Alien Species on Tiritiri Matangi include the brushtail possum (*Trichosurus vulpecula*), the domestic cat (*Felis catus*), rabbits, the pacific rat (*Rattus exulans*), ungulates, mustelids, and the weka (*Gallirallus australis*) (Table 2). Threats to this species include agriculture and aquaculture, agro-industry plantation, invasive species, storms and flooding, and predation (IUCN Red List).

The Henderson Crane (*Porzana atra*)

The Henderson Crane is a vulnerable species due to its small range (bird life international). Population estimates for this species are 6200 individuals (bird life international). Henderson crane plumage is black (Sikas et al 2002, Jones et al 1995, and Graves 1992) in both male and female (Jones et al 1995). This rail is found in thick to open forest (Jones et al 1995) carpeted with a thick layer of leaf litter (Graves 1992). The Henderson Crane is endemic to Henderson Island in the Pitcairn Island archipelago (Table 1). Alien species on Henderson Island are rats (*Rattus* spp.), and the Weka (*Gallirallus australis*) (Table 2). Threats to this species include predation, diseases, and exotic plant introductions (bird life international).

Andaman Crane (*Rallina canningi*)

The Andaman Crane is a near threatened species with a declining population, a small range, and population estimates between 10000 and 25000 (bird life international). The Andaman Crane is endemic to Great Coco, Little Coco, North Andaman, and South Andaman Islands in the Andaman Islands archipelago in India (Table 1). The alien species on these islands is the pacific rat (*Rattus exulans*) (Table 2). Threats to this species include habitat destruction and degradation, trapping, introduced predators, and forest clearing for settlements, cultivation, road construction, and other infrastructural projects (bird life international).

Forbe's forest Rail (*Rallina forbesi*)

Forbe's Forest Rail is a least concern species with unknown population estimates (bird life international). The Forbe's Forest-Rail is endemic to New Guinea Island in Indonesia. Alien species on this island include the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), pigeons (*Columba spp.*), crazy ant (*Anoplolepis gracilipes*), sweet potato whitefly (*Bemisia tabaci*), and the cane toad (*Bufo marinus*) (Table 2).

The White-Striped Forest Rail (*Rallina leucospila*)

The White-Striped Forest Rail is a near threatened species due to the belief that it is declining though population estimates are unknown (bird life international). This rail occurs in the interior of montane forest (Taylor 1998). The White-Striped Forest Rail is endemic to New Guinea in Indonesia (Table 1). Alien species on this island include the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), pacific rat (*Rattus exulans*), black rat (*Rattus*

rattus), pigeons (*Columba spp.*), crazy ant (*Anoplolepis gracilipes*), sweet potato whitefly (*Bemisia tabaci*), and the cane toad (*Bufo marinus*) (Table 2). Threats to this species include forest loss, hunting, and predation (bird life international).

Mayr's Forest Rail (*Rallina mayri*)

The Mayr's Forest Rail is a data deficient species with an unknown population estimate (bird life international). The Mayr's Forest Rail is endemic to New Guinea of the New Guinea archipelago in Indonesia (Table 1). Alien species on New Guinea include the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), pigeons (*Columba spp.*), crazy ant (*Anoplolepis gracilipes*), sweet potato whitefly (*Bemisia tabaci*), and the cane toad (*Bufo marinus*) (Table 2).

Chestnut Forest Rail (*Rallina rubra*)

The Chestnut Forest Rail is a least concern species with unknown population estimates. The Chestnut Forest Rail is endemic to New Guinea (Table 1). This rail is the smallest of the *Rallina* species and can be found in the interior of montane forest (Taylor 1998). Alien species on New Guinea include the domestic dog (*Canis lupus familiaris*), the domestic cat (*Felis catus*), pigs (*Sus scrofa*), pacific rat (*Rattus exulans*), black rat (*Rattus rattus*), pigeons (*Columba spp.*), crazy ant (*Anoplolepis gracilipes*), sweet potato whitefly (*Bemisia tabaci*), and the cane toad (*Bufo marinus*) (Table 2).

Madagascar Rail (*Rallus madagascariensis*)

The Madagascar Rail is a vulnerable species with a decreasing population and population estimates between 2500 and 10000 individuals (bird life international).

The Madagascar Rail is endemic to Madagascar (Table 1). Alien species on Madagascar include the cattle egret (*Bubulcus ibis*), rock pigeon (*Columba livia*), destructive trailing ant (*Monomorium destructor*), pharaoh ant (*Monomorium pharaonis*), and crazy ant (*Anoplolepis gracilipes*) (Table 2). The major threat to this species is habitat loss from agriculture and logging (IUCN Red List).

Slender-billed flufftail (*Sarothrura watersi*)

The Slender-billed Flufftail is an endangered species with population estimates between 250 and 999 individuals. This rail can be found in small elevated wetlands (Taylor 1998). The Slender-billed Flufftail is endemic to Madagascar (Table 1). Alien species on Madagascar are the cattle egret (*Bubulcus ibis*), rock pigeon (*Columba livia*), destructive trailing ant (*Monomorium destructor*), pharaoh ant (*Monomorium pharaonis*), and crazy ant (*Anoplolepis gracilipes*) (Table 2). Threats to this species include agriculture, aquaculture, annual and perennial non-timber crops, and small-holder farming (IUCN Red List).

Table 1. Summary Table of Endemic Rails. This Table compiles information on Species Name, IUCN Category, Bird Mass, Population Estimates, and island name, country, and archipelago.

<i>Scientific Name</i>	<i>Common Name</i>	<i>IUCN Category</i>	<i>Male Mass</i>	<i>Fem Mass</i>	<i>Adult Mass</i>	<i>Pop Est Low</i>	<i>Pop Est High</i>	<i># islands</i>	<i>Island Name</i>	<i>Archipelago</i>	<i>Country</i>
<i>Rallina mayri</i>	Mayr's Forest Rail	DD	126	119		0	7	1	New Guinea	New Guinea	Indonesia/Papua New Guinea
<i>Amaurornis isabellina</i>	Isabelline Waterhen	LC						1	Celebes	Sulawesi	Indonesia
<i>Amaurornis olivieri</i>	Sakalava Rail	EN				250	999	1	Madagascar	Madagascar	Madagascar
<i>Aramidopsis plateni</i>	Snoring Rail	VU				2,500	10000	1	Sulawesi	Sulawesi	Indonesia
<i>Atlantisia rogersi</i>	Inaccessible Rail	VU	41.8	36.9		8,400	8400	1	Inaccessible	St. Helena	UK
<i>Canirallus kioloides</i>	Kiolooides Rail	LC				1000	2000	1	Madagascar	Madagascar	Madagascar
<i>Cyanolimnas cerverai</i>	Zapata Rail	EN				250	999	1	Cuba	Cuba	Cuba
<i>Gallinula pacifica</i>	Samoan Moorhen	CR				0	50	1	Savai'i	Samoa Islands	Samoa
<i>Gallinula silvestris</i>	San Cristobal Moorhen	CR	450			0	50	1	San Cristobal	Solomon Islands	Solomon Islands
<i>Gallirallus calayanensis</i>	Calayan Rail	VU				250	999	1	Calayan	Philippine Islands	Philippines
<i>Gallirallus insignis</i>	New Britain Rail	NT				2500	9999	1	New Britain	Bismarck	Papua New Guinea
<i>Gallirallus lafresnayanus</i>	New Caledonian Rail	CR				0	50	1	New Caledonia	New Caledonia	France
<i>Gallirallus okinawae</i>	Okinawa Rail	EN	434.5			720	720	1	Okinawa	Ryukyu	Japan
<i>Gallirallus owstoni</i>	Guam Rail	EW	241.1	211.9				1	Guam and Rota	Mariana Islands	US
<i>Gallirallus sylvestris</i>	Lord Howe Woodhen	EN	536	456		130	130	1	Lord Howe		Australia
<i>Gymnocrex talaudensis</i>	Talaud Rail	EN				1000	2499	1	Celebes	Sulawesi	Indonesia
<i>Habroptila wallacii</i>	Invisible Rail	VU				2,500	9999	1	Halmahera	Moluccas	Indonesia

Table 1. Continued

<i>Scientific Name</i>	<i>Common Name</i>	<i>IUCN Category</i>	<i>Male Mass</i>	<i>Fem Mass</i>	<i>Adult Mass</i>	<i>Pop Est Low</i>	<i>Pop Est High</i>	<i># islands</i>	<i>Island Name</i>	<i>Archipelago</i>	<i>Country</i>
<i>Megacrex inepta</i>	New Guinea Flightless rail	NT			1200			1	New Guinea	New Guinea	Indonesia/Papua New Guinea
<i>Porzana atra</i>	Henderson Crake	VU	80.1	33.1			6200	1	Henderson	Pitcairn Islands	UK
<i>Rallina forbesi</i>	Forbes's Forest Rail	LC	89.5	91				1	New Guinea	New Guinea	Indonesia/Papua New Guinea
<i>Rallina leucospila</i>	White-Striped Forest-Rail	NT			119			1	New Guinea	New Guinea	Indonesia/Papua New Guinea
<i>Rallina rubra</i>	Chestnut Forest-Rail	LC						1	New Guinea	New Guinea	Indonesia/Papua New Guinea
<i>Rallus madagascariensis</i>	Madagascar Rail	VU	148			2500	10,000	1	Madagascar	Madagascar	Madagascar
<i>Sarothrura watersi</i>	Slender-Billed Flufftail	EN	26.5			250	999	1	Madagascar	Madagascar	Madagascar
<i>Dryolimnas cuvieri</i>	White-throated Rail	LC	276	258		5100	7500	2	Aldabra and Madagascar	Seychelles Islands and Madagascar	Seychelles
<i>Gallinula comeri</i>	Gough Moorhen	VU				9,000	9000	2	Gough and Tristan de Cunha	Tristan da Cunha	UK
<i>Gallinula mortierii</i>	Tasmanian Native-Hen	LC	1334	1251				2	Maria and Tasmania	Tasmania	Australia
<i>Gallirallus sharpei</i>	Sharpe's Rail	DD						2	Borneo, Java, Sumatra	Java and Sumatra	Indonesia
<i>Gymnocrex rosenbergii</i>	Blue-Faced Rail	VU				2,500	9999	2	Banggai and Celebes	Sulawesi	Indonesia
<i>Lewinia mirifica</i>	Brown-Banded Rail	DD				0	200	2	Luzon and Samar	Philippine Islands	Philippines
<i>Lewinia muelleri</i>	Auckland Island Rail	VU		63	93	2000	2000	2	Adams and Disappointment	Auckland Islands	New Zealand
<i>Gallirallus roviae</i>	Roviana Rail	NT				2500	9999	3	Kolombangara, New Georgia, Rendova	Solomon Islands	Solomon Islands

Table 1. Continued

<i>Scientific Name</i>	<i>Common Name</i>	<i>IUCN Category</i>	<i>Male Mass</i>	<i>Fem Mass</i>	<i>Adult Mass</i>	<i>Pop Est Low</i>	<i>Pop Est High</i>	<i># islands</i>	<i>Island Name</i>	<i>Archipelago</i>	<i>Country</i>
<i>Nesoclopeus woodfordi</i>	Woodford's Rail	NT				10,000	19999	3	Bougainville, Guadalcanal, Santa Isabel	Solomon Islands	Papua New Guinea; Solomon Islands
<i>Porphyrio hochstetteri</i>	Takahe	EN	2936	2555		150	220	4	Kapiti, Mana, Maud, Tiritiri Matangi	New Zealand	New Zealand
<i>Rallina canningi</i>	Andaman Crake	NT				10000	25000	4	Great Coco, Little Coco, North Andaman, South Andaman	Andaman Islands	Myanmar and India
<i>Fulica alai</i>	Hawaiian Coot	VU				2,000	4000	6	Hawaii, Kaua'I, Maui, Molokai, Niihau, O'ahu	Hawaiian Islands	US
<i>Gymnocrex plumbeiventris</i>	Bare-Eyed Rail	LC			320			7	Bacan, Halmahera, Karkar, Misool, Morotai, New Guinea, New Ireland	Moluccas, New Guinea, and Bismarck	Indonesia and Papua New Guinea
<i>Laterallus spilonotus</i>	Galapagos Rail	VU			40	5,000	10000	9	Fernandina, Floreana, Isabela, Pinta, San Cristobal, Santa Cruz, Santiago	Galapagos Islands	Ecuador
<i>Gallirallus australis</i>	Weka	VU	978	725		120,000	187,000	11	Chatham, Kapiti, Kawau, Macquarie, Mokoia, Pakatoa, Pitt, Rakitu, South Island, Stewart, Whanganui	New Zealand	New Zealand
<i>Amauornis olivacea</i>	Bush-Hen	LC	302.5	250				21	Celebes, Basilan, Batan, Bohol, Calayan, Cataduanes, Cebu, Leyte, Luzon, Marinduque, Masabate, Mindanao, Mindoro, Negros, Panay, Polillo, Sabtang, Samar, Sibuto, Siquijor, Ticao	Sulu and Philippine Islands	Philippines

Table 1. Continued

<i>Scientific Name</i>	<i>Common Name</i>	<i>IUCN Category</i>	<i>Male Mass</i>	<i>Fem Mass</i>	<i>Adult Mass</i>	<i>Pop Est Low</i>	<i>Pop Est High</i>	<i># islands</i>	<i>Island Name</i>	<i>Archipelago</i>	<i>Country</i>
<i>Gallirallus torquatus</i>	Barred Rail	LC		241				41	Bantayan, Basilan, Biliran, Bohol, Bongao, Boracay, Buad, Camiguin, Carabao, Cataduanes, Cebu, Dinagat, Fuga, Leyte, Luzon, Mangole, Marinduque, Masbate, Mindanao, Mindoro, Muna, Negros, New Guinea, Palawa, Pan de Azucar, Panay, Peleng, Polillo, Romblon, Salawati, Samar, Sanana, Seho, Semirara, Siargao, Sibuyan, Siquijor, Sulawesi, Taliabu, Ticao, Verde	Philippine Islands, Moluccas, Sulawesi, New Guinea, and Irian Jaya	Indonesia, Philippines, and Papua New Guinea

Table 2. Island Summary Table. This table summarizes information on each island that hosts an endemic rail and includes latitude and longitude, island area, distance to the nearest continent, nearest continent, and alien species present.

<i>Island Name</i>	<i>Lat</i>	<i>Long</i>	<i>Area(km2)</i>	<i>DistContinent(km)</i>	<i>Nearest Cont</i>	<i>Alien Species Present</i>
Adams	-50.88333	166.08333	97.3	2	Australia	
Aldabra	-9.34858	46.36178	188	420	Africa	Jarvan deer, pigs, dogs, cats, snails
Bacan	-0.61667	127.51667	1899.8		Australia	
Banggai	-1.61667	123.56667	260.7	2	Australia	
Bantayan	11.1916	123.72942	114.44	15	Asia	dogs, Black rat, Feral pigs
Basilan	6.5738	122.03829	1234.2	16.8	Asia	rats, mice, cats
Batan	20.37161	121.93593		115	Asia	
Biliran	11.58332	124.46419	501.2	36	Asia	
Bohol	9.82563	124.23188	4117.3	21	Asia	
Bongao	5.02878	119.75998		0.4	Asia	Cane toad
Boracay	11.97184	121.9274		1	Asia	
Borneo	-1.10612	114.14399	743330	125	Asia	
Bougainville	-6.32786	155.31583	9317.8	50	Australia	dogs, cats, pigs, Pacific rat, Black rat, pigeons, Crazy ant, Sweet potato whitefly, Cane toad. **Brown tree snake invasive but native
Buad	11.85535	121.47418		14.5	Asia	
Calayan	19.33156	121.46847	196	50	Asia	Cane toad
Camiguin	9.17322	124.72988			Asia	
Carabao	12.06347	121.93593		6.7	Asia	
Cataduanes	13.70887	124.24216	1522.9	15	Asia	Cane toad
Cebu	10.60794	123.88578	4467.5	10	Asia	
Celebes	-1.84791	120.52791	174600	125	Australia	rats, mice, cats
Chatham	43.53	176.31	900	600	Australia North	feral pigs
Cuba	21.52176	-77.78117	105805.5	80	America	Cattle egret, Rock pigeon, Destructive trailing ant, Pharaoh ant, Crazy ant
Dinagat	10.12826	125.60955	769.2	7	Asia	
Disappointment	-50.61667	166.01667	4	8	Australia South	
Fernandina	-0.38243	-91.5146	642	5	America South	Indian monitor lizard
Floreana	-1.28333	-90.43333	173	55	America	rats, mice, cats
Fuga	18.87482	121.3656			Asia	Cane toad

Table 2 Continued

<i>Island Name</i>	<i>Lat</i>	<i>Long</i>	<i>Area(km2)</i>	<i>DistContinent(km)</i>	<i>Nearest Cont</i>	<i>Alien Species Present</i>
Gough	-40.3181	-9.9353	66.6	350	Africa	dogs, cats, cattle, House mouse, Brown rat, Pacific rat, Black rat, pig, Cane toad,
Great Coco	14.10867	93.37303	20	56	Asia	rats, Weka
Guadalcanal	-9.57733	160.14558	5336	55	Australia	dog, Pacific rat, Black rat
Guam	13.4443	144.79373	541	80	Asia	cats, bullfrog, Crazy ant, rats
Halmahera	0.52447	128.00478	17780	250	Australia North	rats, mice, cats
Hawaii	19.89868	-155.66586	10458	3750	America South	Cattle egret, Rock pigeon, Destructive trailing ant, Pharaoh ant, Crazy ant
Henderson	25.066667	-130.1	37.3	200	America	possum, cat, rabbit, Pacific rat, ungulates (goat), mustelids, Weka
Inaccessible	-37.29911	-12.68479	14	40	Africa South	rats, mice, cats
Isabela	-0.82924	-91.1353	4640	30	America	Crazy ant, Destructive trailing ant
Java	-7.61453	110.71225	126700	25	Australia	
Kapiti	-46.06696	170.01992	19.7	8	Australia	cats, Pacific rat, Brown rat, Black rat, Destructive trailing ant
Karkar	-4.53054	145.99451	400	16	Australia North	Indian monitor lizard
Kaua'i	22.08333	-159.5	1434.6	120	America	dogs, cats, mongoose, goats, pigs, Brown tree snake, cattle, sheep, Brown rat, Black rat, House mouse, Cattle egret, Cane toad, pigeon, parakeet, Mute swan, donkeys, Tiger mosquito, Crazy ant, Axis deer
Kawau	-36.42094	174.86333	22	2	Australia	rats, mice, cats, goats, possum
Kolombangara	-7.97768	157.06392	687.8	10	Australia	Cane toad, cat, Pacific rat, Black rat, pig
Leyte	9.71506	122.89868	7367.6	1	Asia	
Little Coco	13.98724	93.23212	5	15	Asia	Pacific rat
Lord Howe	-31.55533	159.08212	14.6	600	Australia	Rock pigeon, Brown tree snake (invasive but native)
Luzon	16.56623	121.26264	109964.9	375	Asia	rats, mice, cats, Carrier pigeon
Macquarie	-54.59472	158.89556	122.5	1200	Antarctica	Black rat
Madagascar	-18.76695	46.86911	587713.3	370	Africa	Cattle egret, Rock pigeon, Destructive trailing ant, Pharaoh ant, Crazy ant, goats, dogs, cats, pigs, Pacific rat, Black rat, pigeons, Sweet potato whitefly, Cane toad. **Brown tree snake invasive but native
Mana	-41.09513	174.86913	2.17	3	Australia	rats, mice, cats, cattle, goats, possum
Mangole	1.83212	125.95878	1228.5	2	Australia South	Cane toad
Maria	-42.64515	148.06497	115.5	50	America	rats, mice, cats, goats, possum

Table 2 Continued

<i>Island Name</i>	<i>Lat</i>	<i>Long</i>	<i>Area(km2)</i>	<i>DistContinent(km)</i>	<i>Nearest Cont</i>	<i>Alien Species Present</i>
Marinduque	13.36423	121.94731	915.9	18	Asia	Cane toad
Masbate	12.01472	123.88578	4047.7	35	Asia	Cane toad
Maud	-41.02607	173.88706	3.09	1	Australia North	dogs, pigs, ungulates, House mouse (Formerly, eradicated in 1990)
Maui	20.79836	-156.33192	1903.3	48	America	unknown
Mindanao	7.85568	125.86242	97530	650	Asia	
Mindoro	13.11623	121.07937	10571.8	15	Asia	Cane toad
Misool	-1.87	130.17	2033.6		Australia	pig, Cane toad
Mokoia	-38.08336	176.30002	1.35	3.2	Australia North	ducks, cats, rats, mice, rabbits
Molokai	21.14439	-157.02263	677.9	13	America	dogs, cats, pigs, House mouse, Pacific rat, Brown rat, Black rat, Cane toad
Morotai	2.34	128.5	2266.4	18	Australia	
Muna	-5.09705	122.49636	2889	25	Australia	Cane toad
Negros	9.71506	122.89868	13074.5	5	Asia	Cane toad
New Britain	-5.22437	151.5432	37800	90	Australia	Cane toad
New Caledonia	-20.9043	165.61804	16648.4	1100	Australia	pigs, Pacific rat, Cane toad
New Georgia	-8.1262	157.54479	2036.7	60	Australia	Pacific rat
New Guinea	-5.85587	140.87971	785753	155	Australia	Cane toad, Pacific rat, dogs, cats, pigs, Black rat, pigeons, Crazy ant, Sweet potato whitefly. **Brown tree snake invasive but native
New Ireland	-4.28533	152.92059	7404.5	35	Australia North	dogs, cats, pigs, Pacific rat, Black rat, pigeons, Crazy ant, Sweet potato whitefly, Cane toad. **Brown tree snake invasive but native
Niihau	21.89214	-160.15749	182.8	28	America	Axis deer,
North Andaman	13.27236	92.95756	2780.7	1	Asia North	Pacific rat
O'ahu	21.43891	-158.00001	1583.3	110	America	unknown
Okinawa	26.2124	127.68093	1199.5	100	Asia	Javan deer, feral pigs, dogs, cats, snails
Pakatoa	-36.79612	175.19394	0.24	1.2	Australia	mice. formerly rats, goats, sheep but eradicated 1990.
Palawan	9.44623	118.39294	12188.6	150	Asia	dogs, cats, pigs, Pacific rat, Black rat, pigeons, Crazy ant, Sweet potato whitefly, Cane toad. **Brown tree snake invasive but native
Pan de Azucar	10.9719	121.22543			Asia	Cane toad
Panay	11.32091	122.53727	12011.1	18	Asia	Cane toad
Peleng	-1.38	123.25	2345.6	16	Australia	Cane toad

Table 2 Continued

<i>Island Name</i>	<i>Lat</i>	<i>Long</i>	<i>Area(km2)</i>	<i>DistContinent(km)</i>	<i>Nearest Cont</i>	<i>Alien Species Present</i>
Pinta	0.6	-90.75001	60	25	America	dogs, goats, cats, Brown rat
Pitt	-44.13197	-176.37053	62	20	Australia	Brown rat
Polillo	14.86096	121.92456	628.9	23	Asia	Cane toad
Rakitu	-36.7151	174.94388	3.5	2.5	Australia	Black rat, Pacific rat, cats
Rendova	-8.56289	157.29623	411.3	10	Australia	pig, Pacific rat
Romblon	12.5294	122.28807	34.9	11	Asia	Cane toad
Rota	14.15468	145.2187	95.7	80	Asia	pigs, Brown tree Snake, Philippine rat snake, dogs, chicken, Philippine deer, carabao, Cane toad, Monitor lizard
Sabtang	20.30084	121.86765		5	Asia	Cane toad
Salawati	-1.10667	130.86639	1622.9	1	Australia	
Samar	12.05	125.11667	12849.4	175	Asia	Cane toad
San Cristobal	-10.57375	161.80969	3190.5	45	Australia	cats, rats, pigs, dogs
San Cristobal	-0.8	-89.4	558	65	America	rats, cats, pigs, ungulates (goats), other birds
Sanana	-2.2337	125.937	557	6	Australia	Cane toad
Santa Cruz	-0.6333	-90.38333	986	30	America	rats, cats, pigs, ungulates, other birds (Rock dove)
Santa Isabel	-8.04551	159.21407	3664.8	80	Australia	dog, mouse, pig, Pacific rat, Black rat, Cane toad
Santiago	-0.2667	-90.7	585	25	America	cattle, goats, cats, pigeon, pigs
Savai'i	-13.65979	-172.43194	1717.6	10	Australia	goat, cats, pigeon, ferret, parakeet, Red fox
Seho	-1.99109	124.34214		3	Australia	
Semirara	12.0319	121.38847	75		Asia	
Siargao	9.71311	125.63992		4	Asia	
Sibutu	4.81803	119.47596	109.4	34	Asia	Cane toad
Sibuyan	12.41276	122.5599	465	35	Asia	Cane toad
Siquijor	9.19988	123.59519	343.5	19	Asia	
South Andaman	11.61006	92.68114	1210.7	1	Asia	Pacific rat
South Island	-43.96952	170.09819	151215	50	Australia	cattle, sheep, goats, Brown rat
Stewart	-46.99727	167.83721	1746	30	Australia	Red deer, cat, ferret
Sulawesi	-1.84791	120.52791	174600	125	Australia	Cattle egret, Rock pigeon, Destructive trailing ant, Pharaoh ant, Crazy ant
Sumatra	-0.58972	101.34311	470000	20	Asia	Brown tree snake, pigeon, Pacific rat, Crazy ant

Table 2 Continued

<i>Island Name</i>	<i>Lat</i>	<i>Long</i>	<i>Area(km2)</i>	<i>DistConti nent(km)</i>	<i>Nearest Cont</i>	<i>Alien Species Present</i>
Taliabu	1.8	124.8	2913.2	136	Australia	rats, mice, cats
Tasmania	-41.7072	146.149	65021.8	50	Australia	Brown rat, Mouse, cats, ungulates
Ticao	12.53707	123.6847	332	9	Asia	
Tiritiri Matangi	-36.60124	174.88936	1.96	4	Australia	rats, cats
Tristan da Cunha	-37.112222	-12.282222	103.2	35	Africa	mice (house mouse)
Verde	13.5518	121.07364		1	Asia	
Whanganui	-36.78333	175.43333	2.83	1	Australia	cats, Pacific rat, Brown rat, Black rat

Table 3. Rails grouped by similar geographic regions highlighting the alien species present on each

Region	Scientific Name	Common Name	Alien Species
Indonesia/ Papua New Guinea/ Philippines/ Solomon Islands	<i>Rallina mayri</i>	Mayr's Forest Rail	Rats, mice, cats, dogs, brown tree snake, pigeon, pacific rat, crazy ant, Indian monitor lizard, black rat, sweet potato whitefly, cane toad, pigs, destructive trailing rat
	<i>Amaurornis isabellina</i>	Isabelline Waterhen	
	<i>Aramidopsis plateni</i>	Snoring Rail	
	<i>Gallirallus calayanensis</i>	Calayan Rail	
	<i>Gallirallus insignis</i>	New Britain Rail	
	<i>Gymnocrex talaudensis</i>	Taloud Rail	
	<i>Habroptila wallacii</i>	Invisible Rail	
	<i>Megacrex inepta</i>	New Guinea Flightless Rail	
	<i>Rallina forbesi</i>	Forbe's Forest-Rail	
	<i>Rallina leucospila</i>	White-Striped Forest-Rail	
	<i>Rallina rubra</i>	Chestnut Forest-Rail	
	<i>Gallirallus sharpei</i>	Sharpe's Rail	
	<i>Gymnocrex rosenbergii</i>	Blue-Faced Rail	
	<i>Lewinia mirifica</i>	Brown-Banded Rail	
	<i>Nesoclopeus woodfordi</i>	Woodford's Rail	
	<i>Gymnocrex plumbeiventris</i>	Bare-Eyed Rail	
	<i>Amaurornis olivacea</i>	Bush-Hen	
	<i>Gallirallus torquatus</i>	Barred Rail	
	<i>Gallinula silvestris</i>	San Cristobal Moorhen	
	Madagascar	<i>Gallirallus rovianae</i>	
<i>Amaurornis olivieri</i>		Sakalava Rail	Cattle egret, rock pigeon, destructive trailing ant, pharaoh ant, crazy ant
<i>Canirallus kiolooides</i>		Kiolooides Rail	
<i>Rallus madagascariensis</i>		Madagascar Rail	
<i>Sarothrura watersi</i>	Slender-Billed Flufftail		
Australia and New Zealand	<i>Gallirallus sylvestris</i>	Lord Howe Woodhen	Brown rat, red deer, cats, pacific rat, black rat, rats, mice, goats, possum, dogs, pigs, ungulates, house mouse, rabbits, weak, red fox,
	<i>Gallinula mortierii</i>	Tasmanian Native-Hen	
	<i>Lewinia muelleri</i>	Auckland Island Rail	
	<i>Porphyrio hochstetteri</i>	Takahe	
UK	<i>Gallirallus australis</i>	Weka	
	<i>Atlantisia rogersi</i>	Inaccessible Rail	Goats, house mouse, rats, mice, cats, goats, possum, weak
<i>Porzana atra</i>	Henderson Crane		
Cuba and United States	<i>Gallinula comeri</i>	Gough Moorhen	Java deer, pigs, dogs, cat, snails, mongoose, goats, brown tree snake, brown rat, black rat, house mouse, cattle egret, cane toad, pigeon, mute swan, tiger mosquito, crazy ant, axis deer, pacific rat, Philippine rat snake, Philippine deer, carabao, monitor lizard
	<i>Cyanolimnas cerverai</i>	Zapata Rail	
	<i>Gallirallus owstoni</i>	Guan Rail	
	<i>Fulica alai</i>	Hawaiian Coot	
Samoa France	<i>Gallinula pacifica</i>	Samoan Moorhen	Cats, rats, pigs, and dogs Java deer, feral pigs, dogs, cats, snails
	<i>Gallirallus lafresnayanus</i>	New Caledonian Rail	
Japan	<i>Gallirallus okinawae</i>	Okinawa Rail	Cats, bullfrog, crazy ant, and rats
Seychelles	<i>Dryolimnas cuvieri</i>	White-Throated Rail	
Myanmar and India	<i>Rallina canningi</i>	Andaman Crane	Pacific Rat
Ecuador	<i>Laterallus spilonotus</i>	Galapagos Rail	
			Rats, mice, cats, crazy ant, destructive trailing ant, dogs, goats, brown rat, pigs, ungulates, pigeons

Threat Analysis

The total number of threat categories listed on the IUCN that have the potential to cause a species listing is 85. Of those, 42 threats, or 49.4% of these threats effect rails. Of the 17 overarching threat categories analyzed, predation is the threat that has the biggest impact on the rail population. 29.9% of rails are affected by predation (Figure 2). The next biggest threats were infrastructure development with 21.7% rail population affected and habitat loss with 21.0% rail population affected

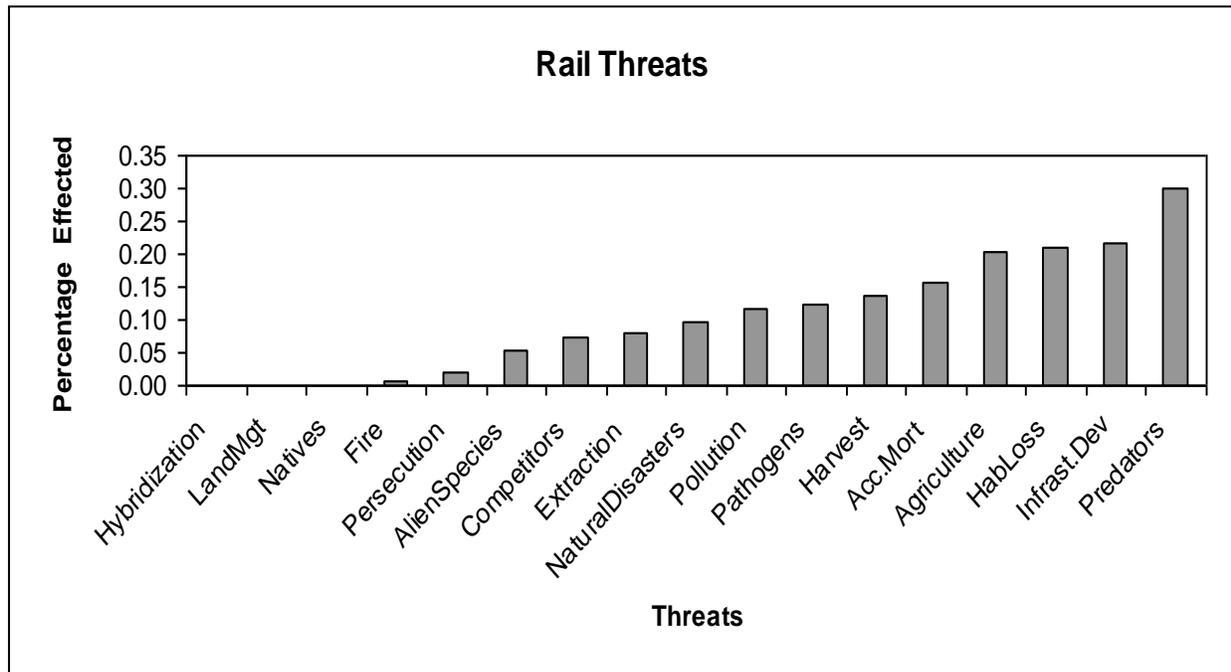


Figure 1. Threats currently affecting island endemic rail populations.

Predator Analysis

Of the 13 predators examined, Rats (*Rattus* spp.) were found to have the biggest effect on rails with 34% of all rail populations affected by them. Of those, 15% were Pacific rats (*Rattus exulans*), 11% were Black rats (*Rattus rattus*), and 5% were brown rats (*Rattus norvegicus*). Cane Toads (*Bufo marinus*) and Cats (*Felis catus*) were next affecting 26.5% percent of the rail population (Figure 3). Of the islands analyzed, 87 of the 112 islands, 78%, have predators that have the potential to prey on endemic rails (Table 2).

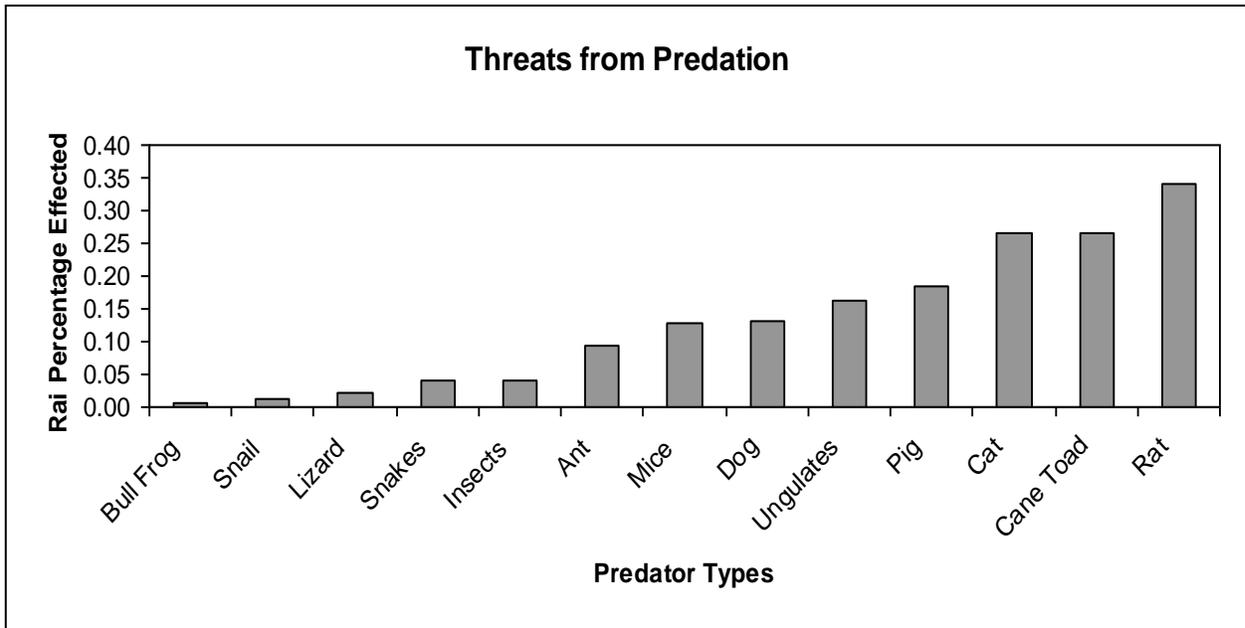


Figure 2. Percentage of Rails affected by predators.

Threat status versus island size and distance to a mainland

There are twelve vulnerable rails, 29.3% of all endemic rail species, and they occur on 36 islands which is 32% of the total islands that host endemic rails. These islands average to be less than 32000 km² in size and on average are less than 212 km² from a mainland. There are six near threatened rails, 14.6% of all endemic rail species, and they occur on only 11 islands which is only 10% of the total islands that host endemic rails. The islands that host near threatened rails average to be less than 126000 km² and on average are less than 57 km² from a mainland. There are only three critically endangered rails, 7.3% of all endemic rail species, and they occur on only 3 islands, less than 3% of the total islands that host endemic rails. Islands that host critically endangered rails average to be less than 7200 km² and are 385 km² away from a mainland. There are seven endangered rails, 17.1% of total endemic rail species, and they occur on 9 islands, 8% of the total islands that host endemic rails. These islands average to be less than 146000 km² and are less than 167 km² from a mainland.

Chapter 4

DISCUSSION

The threat faced by the largest percentage of endemic rail population is predation. Currently rats are the predator with the largest effect on rails. Rats have invaded up to 90% of the world's islands, and can survive in a multitude of environments from sub-polar to tropical (Towns et al. 2009). The reason for the increase in the number of rats on islands may be due to an increased amount of human settlement. Many of the islands that host endemic rails are unpopulated remote islands. The arrival of humans on oceanic islands has led to the extinction of significant proportions of native biota (Hutton et al. 2007) and human colonization is associated with habitat destruction and fragmentation, overexploitation of populations, and introducing predators (Blackbourn 2004). With the addition of humans, many mammalian predators are brought with them, either accidentally or purposively. Included with these pests were rats, transported accidentally through the invention of modern transport and exploration (Hutton et al. 2007).

Alien predators are able to successfully thrive in island ecosystems for a variety of reasons. The majority of the islands do not have other mammalian predators thus alien species have little risk of predation or competition (Courchamp and Sugihara 1999). Also, many islands do not have many parasites that will infect an alien species (Courchamp and Sugihara 1999). Since many of the birds on these islands have evolved without predators, they do not possess predator avoidance behavior and are an easy prey item for the alien species.

One way to decrease the effects of mammalian predation would be to eradicate the predator species. Once the predator is removed it is likely the prey species will be able to rebound and recover. An example of this can be seen on Taranga Island where Pacific rats (*Rattus exulans*) were abundant throughout the entirety of the island. The presence of Pacific rats negatively affected Tuatara (*Sphenodon punctatus*). After aerial distribution of pesticide, Pacific rats were eradicated and the proportion of juvenile Tuatara increased by 40% (Towns et al 2006). Overall Tuatara species responded positively to the removal of Pacific rats and increased in population density, changes occurred in demography of adults, the proportion of juveniles increased, and the condition of adults changed as well (Towns et al 2006).

Other rat eradication efforts have been tested. The Black rat (*Rattus rattus*) predaes on the eggs on the Bonin Petrel on Midway Atoll and has had serious effects on their numbers. 500,000 petrels were seen in the late 1930s and after the introduction of the Black rat, petrel numbers declined to 25,000 in 1945 and 5,000 breeding pairs in 1979 (Seto and Conant 1996). Rodenticide was applied via bait stations in 1993 and 1994 (Seto and Conant 1996). Results of this study found that predation by the Black Rat (*Rattus rattus*) negatively affected Bonin petrel reproductive success and in areas of low rat density, pesticide was effective at full rat eradication (Seto and Conant 1996).

Another threat facing endemic rails is habitat destruction. Birds, especially endemic species, are an indicator species used in ecosystem management (Reed 1995). If island birds go extinct that implies that the oceanic islands hosting them are in poor quality. Ecosystem management protects natural communities by

managing large landscapes to protect species integrity (Reed 1995). Protecting species habitat addresses the root of the problem and is a proactive management type that strives to fix a problem before it even becomes an issue. If proper habitat restoration and ecosystem management was implemented on remote oceanic islands it would help restore the health of rail populations by giving them the proper tools needed for nest building, food acquisition, and mate procurement.

Eradication of mammalian predators can be used in combination to reduce predation and to also facilitate habitat restoration. An example of this can be seen on Santiago Island in the Galapagos with the Galapagos Rail. Between 1998 and 2006, pigs, goats, and donkeys were eradicated from Santiago Island and over 17,000 pigs and 70,000 goats were removed (Donlan et al. 2007). In 1986 to 1987, 18 rails were seen on Santiago Island and after the eradication on Santiago Island, 279 rails were recorded in 2004 to 2005 (Donlan et al. 2007). The removal of these alien species has also facilitated growth of native plants. Other islands such as New Zealand and Lord Howe Island have undergone massive alien species eradication efforts to protect their native rails, the Takahe and the Lord Howe Woodhen, respectively (Donlan et al. 2007). However, islands such as the Fernandina Island in the Galapagos has low rail numbers even though the island has no history of invasive predators. This leads to the conclusion that it is important to know what exactly is threatening the rail species so you can best treat the problem. With many of the rails being data deficient species, it is important to do an in depth assessment of each rail species to establish concrete data with population estimates and threats.

Island size versus distance to a mainland

Critically endangered rails are the group that occur the farthest from a mainland, an average of 385 km². These rails also occur on only one island each, a total of only three islands. Not surprisingly, these rails also occur on the smallest islands, and average of less than 7200 km² in area. Seeing as this group is least in abundance, occurs the farthest from a mainland, and occurs on the smallest of the islands that host endemic rails, this group is the group with the highest conservation concern.

Implications for Conservation and Management Strategies

In order to save island endemic rail populations new management and conservation strategies need to be implemented. The first step to saving these species would be to implement a population assessment strategy and a monitoring plan. Once monitoring protocols are established and accurate population estimates are taken, efforts can be focused on those populations that are lowest and found on the smallest islands. Then predation should be addressed and eradication plans can be assessed. Conservation efforts should then be focused on habitat restoration.

Some rails are classified as endangered when confined to a single area but others are vulnerable. This is dependent on size of island and threats to the specific island. An accurate census would be useful to see exactly how many rails are on each island. Then population numbers can be compared to island size to see which species are the most vulnerable. Those species that have the smallest numbers, are found on the least number of islands and the smallest islands, are the ones that are in need of the greatest and most immediate conservation action.

REFERENCES

- BirdLife International (2009) Species factsheets downloaded from <http://www.birdlife.org> on 19 April 2010.
- Blackburn, T.M., P. Cassey, R.P. Duncan, K.L. Evans, and K.J. Gaston. 2004. Avian extinction and mammalian introductions on oceanic islands. *Science*. 305:1955-1958.
- Bond, J. 1942. Additional notes on West Indian birds. *Proceedings of the Academy of Natural Sciences of Philadelphia*. 94:89-106.
- Courchamp, F.C, and G. Sugihara. 1999. Modeling the biological control of an alien predator to protect island species from extinction. *Ecological Applications*. 9(1):112-123.
- Diamond, J. 1991. A new species of rail from the Solomon islands and convergent evolution of insular flightlessness. *The Auk*. 108(3):461-470.
- Diamond, J.M. 1971. Comparison of Faunal Equilibrium Turnover Rates on a Tropical Island and a Temperate Island. *Proc. Nat. Acad. Sci. USA* 68(11): 2742-2745.
- Donlan, C.J. et al., Recovery of the Galápagos rail (*Laterallus spilonotus*) following the removal of invasive mammals. *Biol. Conserv.* (2007), doi:10.1016/j.biocon.2007.05.013
- Ebenman, B., A. Hendenstrom., U. Wennergren, B. Ekstam, J. Landin, and T. Tyrberg. 1995. The relationship between population density and body size: the role of extinction and mobility. *Oikos*. 73(2):225-230.
- Engilis, A., and T.K. Pratt. 1993. Status and population trends of Hawaii's native waterbirds. *Wilson Bulletin*. 105(1):142-158

- Estes, G., K.T. Grant, and P.R. Grant. 2000. Darwin in Galapagos: His footsteps through the Archipelago. *Notes and Records of the Royal Society of London*. 54(3):343-368.
- Fontenot, D.K., S.P. Terrell, K. Malakooti, and S. Medina. 2006. Health assessment of the Guam rail (*Gallirallus owstoni*) population in the Guam rail recovery program. *Journal of Avian Medicine and Surgery*. 20(4):225-233.
- Frankham, R. 1998. *Inbreeding and Extinctions: Island Populations*. *Conservation Biology* 12:665-675
- Franklin, A.B., D.A. Clark, and D.B. Clark. 1979. Ecology and Behavior of the Galapagos Rail. *The Wilson Bulletin*. 91(2):202-221.
- Garrido, O.H. 1985. Cuban endangered birds. *Ornithological Monographs*. 36:992-999.
- Gibbs, J.P., W.G. Shriver, H. Vargas. 2003. An Assessment of a Galapagos Rail Population over Thirteen Years (1986 to 2000). *Journal of Field Ornithology*. 74(2):136-140.
- Goldizen, A.W., A.R. Goldizen, D.A. Putland, D.M. Lambert, C.D. Millar, and J.C. Buchan. 1998. "Wife-sharing" in the Tasmanian native hen (*Gallinula mortierii*): is it caused by a male- biased sex ratio. *The Auk*. 115(2):528-532.
- Grant, R. and P.R. Grant. 2003. What Darwin's finches can teach us about the evolutionary origin and regulation of biodiversity. *Bioscience*. 53(10):965-975.
- Graves, G.R. 1992. The endemic land birds of Henderson island, southeastern Polynesia: notes on natural history and conservation.
- Harris, M.P. 1973. The Galapagos Avifauna. *The Condor*. 75(3):265-278.
- Hutton, I. et al. 2007. Reassembling island ecosystems: the case of Lord Howe Island. *Animal Conservation*. 10(1):22-29.
- Huxley, C.R. and R. Wilkinson. 1971. Vocalizations of the alibaba white-throated rail *Dryolimnas cuvieri alabranus*. *Proc. R. Soc. Lond. B*. 197(1128):315-331.
- IUCN 2006. *2006 IUCN Red List of Threatened Species*. <www.iucnredlist.org>. Downloaded on 1 June 2009.
- Jamieson, I.G., M.S. Roy, and M. Lettink. 2003. Sex-specific consequences of recent inbreeding in an ancestrally inbred population of New Zealand Takahe. *Conservation Biology*. 17(3):708-716

- Jenkins, J.M. 1979. Natural history of the Guam rail. *The Condor*. 81(4):404-408.
- Jones, P., S. Schubel, J. Jolly, M. de L. Brooke, and J. Vickery. 1995. Behavior, natural history, and annual cycle of the Henderson island rail *Porzana atra* (Aves: Rallidae). *Biological Journal of the Linnean Society*. 56:167-183.
- Kratter, A.W., D.W. Steadman, C.E. Smith, C.E. Filardi, and H.P. Webb. 2001. Avifauna of a lowland forest site on Isabel, Solomon islands. *The Auk*. 118(2):472-483.
- Livezey, B.C. 1998. A Phylogenetic Analysis of the Gruiformes (Aves) Based on Morphological Characters, with an Emphasis on the Rails (Rallidae). *Phil. Trans. R. Soc. Lond. B*. 353(1378):2077-2151.
- MacArthur, R. H. and Wilson, E. O. 1967. *The Theory of Island Biogeography*. Princeton, N.J.: Princeton University Press.
- McNab, B.K. and H.I. Ellis. 2006. Flightless rails endemic to islands have lower energy expenditures and clutch sizes than flighted rails on islands and continents. *Comparative Biochemistry and Physiology, Part A*. 145:295-311.
- Murphy, R.C. 1951. The impact of man upon nature in New Zealand. *Proceedings of the American Philosophical Society*. 95(6):569-582.
- Olson, S.L. 1973. Classification of the Rallidae. *The Wilson Bulletin*. 85(4):381-416.
- Penny, M.J. and A.W. Diamond. 1971. The white-throated rail *Dryolimnas cuvieri* on aldabra. *Proc. R. Soc. Lond. B*. 260(836):529-548.
- Peters, J.L. 1932. A new genus for *Rallus poeciloptera*. *The Auk*. 49(3):347-348.
- Pregill, G.K. and S.L. Olson. 1981. Zoogeography of West Indian vertebrates in relation to Pleistocene climatic cycles. *Annual Review of Ecology and Systematics*. 12:75-98.
- Putland, D.A., and A.W. Goldizen. 2001. Family dynasties in the Tasmanian native hen (*Gallinula mortierii*). *Behavioral Ecology and Sociobiology*. 51(1):26-32.
- Reed, D.H. 2007. Extinction of island endemics: it is not inbreeding depression. *Animal Conservation*. 10:146-147.
- Reed, J.M. 1995. Ecosystem management and an avian habitat dilemma. *Wildlife Society Bulletin*. 23(3):453-457.

- Responses of Tuatara (*Sphenodon punctatus*) to removal of introduced Pacific rats from islands. 2006. Towns, D.R., G.R. Parrish, C.L. Tyrrell, G.T. Ussher, A. Cree, D.G. Newman, A.H. Whitaker, and I. Westbrooke. *Conservation Biology*. 21(4):1021-1031.
- Schwartz, C.W. and E.R. Schwartz. 1952. The Hawaiian coot. *The Auk*. 69(4):446-449.
- Seto, N.W.H. and S. Conant. 1996. The Effects of Rat (*Rattus rattus*) Predation on the Reproductive Success of the Bonin Petrel (*Pterodroma hypoleuca*) on Midway Atoll. *Colonial Waterbirds*. 19(2):171-185.
- Sibley, C.G. 1951. Notes on the birds of new Georgia, central Solomon islands. *The condor*. 53(2):81-92.
- Slikas, B., S.L. Olson, and R.C. Fleishcer. 2002. Rapid, independent evolution of flightlessness in four species of pacific island rails (Rallidae): an analysis based on mitochondrial sequence data. *Journal of Avian Biology*. 33:5-14.
- Steadman, D.W. and P.S. Martin. 2003. The late quaternary extinction and future resurrection of birds on pacific islands. *Earth Science Reviews*. 61: 133-147.
- Taylor, Barry. *Rails: A guide to the Rails, Crakes, Gallinules and coots of the world*. New Haven and London: Yale University Press, 1998.
- Temple, S. 1985. *Why endemic island birds are so vulnerable to extinction*. Bird Conservation 2:3-6. University of Wisconsin Press, Madison. London University Press.
- Towns, D.R. et al. 2009. *Predation of seabirds by invasive rats: multiple indirect consequences for invertebrate communities*. *Oikos*. 118(3):420-430
- Trevino, H.S., A.L. Skibiell, T.J., Karels, and F.S. Dobson. 2006. Threats to avifauna on oceanic islands. *Conservation Biology*.
- Trewick, S.A. 1997. Flightlessness and phylogeny amongst endemic rails (Aves: Rallidae) of the New Zealand region. *Phil. Trans. R. Soc. Lond. B*. 352:429-446.
- Wanless, R.M., and P.A.R. Hockey. 2008. Natural history and behavior of the Aldabra rail (*Dryolimnas [cuvieri] aldabranus*). *Wilson Journal of Ornithology*. 120(1):50-61.

Whittaker, R.J., K.A. Triantis, and R.J. Ladle. 2008. A general dynamic theory of oceanic island biogeography. *J. Biogeogr.* 35:977-994.