Visitor impacts on freshwater avifauna in New Zealand

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Summary

A literature review shows that the impacts of visitor activities on freshwater avifauna have been comprehensively studied overseas but relatively little studied in New Zealand. The published scientific literature is a rich source of this information; however, access to it via the Internet is limited at present. There are many useful lessons from overseas, where there are analogue species and wetland types for most of those that exist in New Zealand.

Since the early 1980s, concerns have been expressed that the impacts of visitor activities on wetlands and their birds in popular New Zealand sites are unsustainable. These sites include lakes, braided riverbeds, lagoons and rapid rivers. With considerable growth in robust outdoor recreation and adventure tourism, increasingly penetrating into remote places, these concerns are becoming stronger and more widespread. However, interviews with conservation managers and examination of case studies show that only very threatened waterbirds at specific sites are managed intensively for conservation, and even then some visitor activities can be very damaging. Waterfowl are relatively well known to managers, but other waterbirds far less so.

Activities involving loud noise, sudden movement or rapid movement are most disruptive. People can be so engrossed in their chosen pursuit that they are oblivious to the impact they may cause. Birds are particularly sensitive during breeding, moulting and times of climate stress. Management techniques proven overseas, and now used in some key New Zealand situations, include zoning for protection and different activities, avoidance of activities at certain times and sites, provision of facilities to direct visitors and ensure their impacts are restricted, education, management through stake-holder partnerships, and the setting of clear visitor guidelines and codes of behaviour. The management regimes for Sinclair Wetlands (Otago) and New Zealand's Subantarctic Islands are excellent models.

Research needs include better information on the current ecological status of freshwater avifauna and the degree of impact of various visitor activities and management techniques, at particular sites.

1. Investigation brief

The investigation brief was to carry out a "state of knowledge review" on "visitor impacts on freshwater avifauna". Specific tasks were to:

- review recent and relevant literature (library and electronic);
- consult with departmental and non-departmental authorities;
- prepare investigation reports and summaries (as specified).

The final report, this document, was to include:

1. A literature review of major summaries, reports, books and papers, including any significant interviews or other personal communications.

2. A comprehensive bibliographic list and other reference material (including key Internet sites and/or networks).

3. Summary of main findings and conclusions.

4. Identification of important gaps in research knowledge and management practices.

5. Recommendations for research and management.

2. Method

I first set the scene (Section 3), then define the wetland habitats (Section 4), the birds dependent on them (Section 5), and the human visitors and their activities (Section 6).

The major part of the report (Section 7) reviews information on the impacts of visitors, obtained from personal interviews and a literature search of both New Zealand and overseas publications. Key references are described in detail, and key points gleaned from other sources are detailed by visitor activity.

Management guidelines drawn from the literature are presented (Section 8), and future research needs are defined (Section 9). A series of generalised conclusions are listed next (Section 10), followed by acknowledgements (Section 11) and literature references (Section 12).

In the light of the literature review, I present four New Zealand wetland case studies that highlight current generic visitor impact issues (Appendix 1). Finally I summarise the range of wetland habitats and visitor impact issues by Department of Conservation conservancy (Appendix 2).

3. Introduction

In 1996 a research need was expressed by the Tongariro/Taupo Conservancy of the Department of Conservation. It concerned the potential impacts of ecotourism on avifauna in the Tongariro Delta wetlands and Tokaanu Bay at the south end of Lake Taupo. Conservancy staff recognised the conservation significance of the wetlands and their birds. They were also aware of the

incipient growth of ecotourism in the area, and wished to elucidate what impacts there might be and how to plan for their management.

That raised the question at a national level: What do we know about the impacts of visitors (of all types) on the freshwater wetland birds of New Zealand? Evidently the answer came:"We don't rightly know." So this review was born.

Historically, New Zealand's wetlands have taken a fearful hiding at the hands of humans, especially in the lowlands and within the last 150 years. They have been regarded as hunting and gathering places, as ownerless playgrounds, as impediments to productive land development, and as convenient larders, mines and dumps. Little thought appears to have been given to their ecological roles and their specialness. As a consequence, their number, area, diversity and ecological quality have been radically diminished. Almost all of the bird species dependent on these habitats have declined in numbers and range since European arrival.

Through regulatory measures, previous hunting pressure has been relieved to the extent that the target birds are not declining (except through hybridism). Many wetlands have been legally protected. There is a growing public awareness of the value of wetlands, and several wonderful wetland restoration and wetland bird recovery projects are up and successfully running. However, there is also a rapidly growing trend towards aggressive kinds of outdoor pursuits, which run counter to conservation and are penetrating ever further into the wilds. Tourism is rapidly growing and contains many of the high testosterone pursuits. As a balance, ecotourism (nature tourism), which relies on a subtle approach and nature in good condition, is also developing, although it has its own impacts.

This report attempts to address the range of current issues. It contains a series of recommendations for conservation management: things that can be done to mitigate the impacts on birds of the growing number of visitors to the freshwater wetlands of New Zealand. It also points to knowledge gaps. I hope it will help change attitudes and help the wet places and their birds.

Of the thirteen Key Steps Forward in "Restoring the dawn chorus: Department of Conservation Strategic Business Plan 1998-2002" (Department of Conservation 1998), this review addresses all except the one relating to marine conservation. By providing the kind of information required to underpin conservation management, it directly addresses important aspects of the following:

1. Better information.

2. Better integration.

3. Expanded restoration and recovery efforts.

4. Increased pest and weed control.

6. A network of protected natural areas.

7. Closer co-operation with landowners and local authorities.

8. Closer integration of historic conservation.

9, Recreational promotion.

10. Upgraded recreational facilities.

11. Greater respect of key groups in the community.

12. More effective working relationships with iwi Maori.

It indirectly addresses:

13. Completed change process (in the sense of indicating necessary skills and focus).

There is a wetland (lawn chorus needing restoration in New Zealand. There is an evening one as well, as those who know wetlands will attest.

4. The wetland habitats

There is a dazzling array of freshwater wetlands still in New Zealand, even though for the last 150 years people have drained, cleared or exploited them in an extractive and heavy-handed fashion. The following list is a broad categorisation of the significant freshwater wetland habitats, from the coasts to the mountains. They are by no means all standing water: in fact, of the total area involved, the majority may be made up of rivers and streams.

Estuary heads

Fresh water is predominant in the zones above tidal reach. Wetland birds often use the whole estuary and breed and roost in the heads. This is often where there is good vegetation cover.

Wetlands of dunes and coastal flats

Lakes, swamps, lagoons and ephemeral wet sites. Often fringed with dense beds of rushes and sedges. Frequented by crakes, rails and many other waterbirds.

River and stream mouths

These are the dynamic zones where flows from the land enter the sea, lakes, or larger flows. They often have beaches, deltas, lagoons and swamps. They are choice feeding, breeding, roosting and loafing sites for wetland birds.

Rivers, streams and creeks

Always there is flowing water. There are pools and rapids. They are swept by floods on occasion. There is a distinct riparian zone, characterised by special vegetation, beaches, backwaters, rocks, gravel, sand, logs and driftwood. Wetland birds live or feed in these systems. They are passageways for birds throughout the landscape.

Braided rivers

Special large systems upon which many birds rely for breeding and feeding. Formed from erosion material washed from the axial mountains. Contain shingle and boulder beds, beaches, spits, islets, rapids, pools, gorges, backwaters and a great variety of vegetation. Are also major passageways, for both birds and people. Naturally dynamic, requiring adaption of the birds to that.

Lowland wetlands

Lakes, swamps, dams and ponds, mostly adjoining farmland. Much modified by human activity, but still valuable for wetland birds. Often fringed by willows; rarely fenced from farm stock.

Upland wetlands

Include big lakes of volcanic or glacial origin, smaller lakes, swamps, ponds and seepages. Also alpine tarns. Provide major habitats and a great variety for wetland birds, and many opportunities for human visitor activities. Often have hinterlands of vegetation where wetland birds feed, hide, nest or roost.

Complementary habitats

Some wetland birds, though dependent on freshwater environments, also use non-wetland habitats such as pasture, cliffs, herbfields, tussock grasslands, peatlands, forests, scrub and coastal systems. The birds are prone to visitor impact in these places, too, although for this review I have deliberately concentrated on visitors to wetlands.

5. The wetland birds

For this review, the birds of prime concern are those that are dependent on any of the above freshwater wetland systems for all or part of their lives, and are an established part of the New Zealand scene. Most are endemic or native, a few are introduced. There are various vagrants or rarities as well, genuine wetland birds, not listed here. They are regarded as peripheral to this story, except that they too are dependent on the existence of a mosaic of ecologically healthy wetlands.

I have followed the naming system used in Heather & Robertson (1996), except where their names are too general to be meaningful in New Zealand or where Maori names have become more predominant. As yet there is no official consistency in usage; hence for some species the Maori name is predominant, whilst for others the predominant name is an English one. The notes on each species are summarised from Heather & Robertson (1996), Marchant & Higgins (1 990,1993), Higgins & Davies (1996) and, for those species most at threat, the individual recovery plans.

Categories of threat are those that have been given by the New Zealand Department of Conservation (Molloy & Davis 1994):

- A,B,C = threatened endemic species,A being most threatened;
- O = threatened in New Zealand but secure elsewhere.

Grebes (Podicicepidae)

Southern/Great crested grebe (Puteketeke) *Podiceps cristatus australis*
Uncommon native. Threat Category O.

South Island only, preferring large clear lakes of glacial origin but sometimes wintering in coastal waterways. Feeds on fish and aquatic invertebrates. Nests constructed on water in woody vegetation. Has declined over much of its former range in historic times. Illegal shooting and human disturbance cause breeding failure.

New Zealand dabchick *Poliocephalus rufopectus*
Uncommon endemic. Threat Category C.

North Island only (formerly also South Island). Prefers smaller wetlands (lakes, dams, ponds). Feeds on aquatic insects. Also nests in water. Apparently little affected by waterfowl shooting, being small and hard to panic. Wave action suspected to seriously affect nests, therefore breeding more successful on smaller sheltered water bodies with marginal vegetation beds and no power boats.

Shags (Phalacrocoracidae)

Black shag/kawau *Phalacrocorax carbo*
Common native.

Widespread in sheltered coastal waters, estuaries, rivers, streams, dams and lakes up to the subalpine zone. Feeds on fish and large freshwater invertebrates. Typically nests in colonies in trees near water. Formerly regarded (erroneously) as a threat to trout fisheries and shot. Breeding may be delayed by disturbance from duckshooting.

Little black shag *Phalacrocorax sulcirostris*
Locally common native.

Found in coastal and inland waterways throughout the North Island, often wintering in the South Island. Feeds mainly on small fish and freshwater crayfish. Typically nests in colonies in trees near water. Sometimes persecuted by fishermen still; occasionally accidentally caught in nets.

Little shag *Phalacrocorax melanoleucos*
Common native.

Found throughout the country in wetlands from sheltered coasts to the subalpine zone. Feeds mainly on small fish and freshwater crayfish. Colonial nester, often in company with other waterbirds, usually in trees alongside freshwater swamps, lakes and rivers. Formerly regarded (erroneously) as a threat to trout fisheries and shot. Sometimes persecuted by fishermen still; occasionally accidentally caught in nets.

Herons, egrets and bitterns (Ardeidae)

White-faced heron *Ardea novaehollandiae*
Abundant native.

Has become established throughout the country since 1865, benefiting from forest clearance. Open country generalist, usually feeding on small animals in or near water. Nests high in trees, mostly but not always near water.

Kotuku/white heron
Uncommon native. Threat Category O.

A widespread cosmopolitan species, though regarded reverentially as their own by the New Zealand public. Feeds mostly on small fish and aquatic invertebrates. Breeds in New Zealand only as a colony at Waitangiroto Nature Reserve in South Westland. Subject of an intensive examination of ecotourism impact (Kazmierow 1996), which concluded that boat traffic adversely affected bird feeding and that visitor viewing had no marked effect on bird behaviour at the colony.

Little egret *Egretta garzetta*
Uncommon migrant.

Occasionally turns up in New Zealand in autumn and overwinters. Does not breed in New Zealand. Prefers tidal wetlands but also found in freshwater systems.

Cattle egret *Bulbucus ibis*
Locally common migrant.

Regularly turns up in New Zealand in autumn and overwinters in coastal and farmland areas. Does not breed in New Zealand.

Nankeen night heron *Nycticorax caledonicus*
Rare native.

Occasional vagrant from Australia. Now established as a small breeding population on the Wanganui River, where subject to boating disturbance. Feeds mainly on fish. Nests high in trees overhanging water.

Australasian bittern *Bolaurus poiciloptilus*
Rare native. Threat Category O.

Widespread, but now mainly in the North Island and in Westland. Has declined much through habitat loss. Solitary, stealthy and cryptic, living in freshwater wetlands fringed with tall dense beds of vegetation. Feeds on fish and other water creatures. Nests in dense reeds or raupo *(Typha orientalis).*

Spoonbills and ibises (Threskiornithidae)

Royal spoonbill *Platalea regia*
Locally common native. Threat Category O.

Vagrant from Australia for at least a century, but now established as small breeding colonies in six sites in New Zealand. Prefers estuaries and shallow lakes, feeding there on small aquatic animals located by feel. Nests in vegetation near water by preference, often with other waterbirds. Intolerant of disturbance and vulnerable to recreational activities, particularly at breeding colonies. A study at Ahuriri Estuary, Hawke's Bay, a regular wintering site, showed that feeding and roosting were disrupted by duck-shooting activities.

Glossy ibis *Plegadis fulcinellus*
Uncommon vagrant.

Regular vagrant to New Zealand, sometimes arriving in small flocks. Frequents damp pasture and muddy margins of freshwater lakes, feeding on small fauna. Extremely wary.

Waterfowl (Anatidae)

Black swan *Cygnus atratus*
Common introduction/native.

Subfossil records indicate past presence in New Zealand, probably terminated by Maori hunting. Introduced for game from Australia in the 1860s, also arrived unaided. Widely hunted now in strict season with limits set regionally. Sometimes nests in water (floating constructions), but mostly on the ground near water. Very long breeding season. Has discrete nesting and moulting areas. Highly mobile. Feeds on submerged aquatic plants and pasture.

Canada goose *Branta canadensis*
Common introduction.

Introduced 1870s-1920s for game. Now abundant in the eastern South Island in particular. Found on coastal and inland lakes. Highly mobile and partially

migratory. Hunted in controlled season; sometimes culled where becoming a nuisance to farms adjacent to wetlands. Feeds on aquatic plants and pasture.

Feral/greylag goose *Anser anser*
Common introduction.

Long domesticated and brought to New Zealand with European settlers. Now well established throughout the country as truly feral flocks at lakes, at estuaries, or on pasture. Grazes on pasture plants.

Paradise shelduck *Tadorna variegata*
Common endemic.

In pre-human times associated with lowland short-tussock grasslands and swamplands; since then has proliferated with forest clearance. Hunted widely in controlled season; very vulnerable to hunting. Small chicks often swept away from parental care on streams and rivers disturbed by people and boats. Feeds on aquatic vegetation and pasture plants. Nests in holes (sometimes high in trees) and under logs. Usually in pairs, but forms large flocks for the summer moult. Has major moulting sites.

Whio/blue duck *Hymenolaimus malacorhynchos*
Uncommon endemic. Threat Category B.

Virtually restricted to white-water streams. Widely distributed in the mountain lands of the two main islands. Strictly territorial. Feeds on in-stream invertebrates, where introduced trout compete for food. Nests near water in hollow logs, cavities or under dense vegetation. Breeding success low and variable. Vulnerable to predation, disruption and desertion if disturbed during breeding. Small chicks may be swept away from parental care on streams and rivers disturbed by people and boats. Dogs a significant threat. Threatened Species Recovery Plan No. 22 (Department of Conservation 1997a).

Mallard *Anas platyrhynchos*
Abundant introduction.

Introduced widely from 1867 onwards for game. Has proliferated dramatically and now threatens grey cluck through hybridisation. Uses a wide variety of wetlands. Widely hunted in regulated season, forming a large portion of the bag. Nests near water. Breeds successfully even in urban situations.

Grey duck (parera) *Anas superciliosa*
Common native.

Widespread but declining through habitat loss and hybridisation with Mallard. Prefers wetlands fringed with forest. Widely hunted in regulated season, forming a large portion of the harvest. Highly dispersive. Feeds on aquatic vegetation and invertebrates. Nests away from water under dense vegetation or in holes.

Grey teal (tete) *Anas gracilis*
Common native.

Widespread. Naturally arrives on occasion from Australia. Frequents coastal and inland wetlands. Protected, though often shot during the duck-shooting season. Highly dispersive and alert. Feeds on aquatic vegetation and invertebrates. Quite high breeding failure rates attributed to predation and chick starvation.

Brown teal (pateke) *Anas aucklandica chlorotis*
Rare endemic.Threat Category C.

Highly dependent on well-vegetated wetlands. Remarkably tame, naive and tolerant of humans. Formerly widely distributed in lowland swamps and swamp forest. Has radically declined within the last century through habitat loss, excessive hunting and predation (including that by dogs). Now fully protected. Stronghold now on Great Barrier Island. Feeds on aquatic invertebrates. Nests under dense vegetation. Threatened Species Recovery Plan No. 19 (Department of Conservation 1996).

Subantaretic teal *Anus aucklandica aucklandica; Anas a. nesiotis*
Rare endemic. Threat Category A. Possibly two species, separate from brown teal and from each other.

Flightless and sedentary. Two populations remain in the wild: predator-free islands in the Auckland Islands, Dent Island, a tiny outlier of Campbell Island. Dependent on freshwater creeks, pools and seepages and the intertidal zone. Decimated in the past by hunting and predation. Human visitation in the wild is confined to researchers and low numbers of well-chaperoned ecotourists. Ridding Campbell Island of rats and cats would allow reintroduction to secure the Campbell Island teal; ecotourism could be a positive in this endeavour. Threatened Species Recovery Plan No. 7 (Department of Conservation 1 993b).

New Zealand shoveler (kuruwhengi) *Anas rhynchotis variegata*
Common native.

Aquatic, specialised for filter feeding. Widely hunted and many shot during regulated season. Partly protected by fast flight, wariness and use of open water of large lakes. Breeds in dense vegetation away from water.

New Zealand scaup *Aythya. novaeseelandiae*
Uncommon endemic.

Unevenly distributed. Fully protected. Totally dependent on freshwater wetlands. Numbers and range much diminished since European arrival. Dives for aquatic plants and invertebrates. Breeds in dense vegetation near water.

Raptors (Accipitridae)

Australasian harrier *Circus approximans*
Abundant native.

Commonly hunts, nests and roosts around wetlands. Strongly territorial but also wanders long-distance. Often killed and persecuted as a perceived threat to sheep, domestic fowl and game animals (including waterfowl). Nests are readily deserted after even minor human disturbance. Owen (1996) presents a case for greater protection of this bird.

Rails, gallinules and coots (Rallidae)

Banded rail (moho-pereru) *Rallus philippensis assimilis*
Locally common native.

Secretive, skulking in the vegetation around wetlands throughout the New Zealand lowlands. Has declined since European arrival. Feeds on small invertebrates, seeds and leaves. Nests in dense grass or rushes. Occasionally struck by vehicles. Often taken by feral and domestic dogs and cats.

Auckland Island rail *Rallus pectoralis*
Locally common native.

Only on Adams Island and Disappointment Island, where it hardly ever encounters people or their agents. Researchers are almost the only visitors.

Spotless crake (puweto) *Porzana tabuensis*
Locally common native.

Secretive and rarely seen. In swamps dominated by raupo and sedges throughout New Zealand. Has declined since European arrival. Feeds on small invertebrates, seeds and leaves. Nests on the ground or on raised swamp tussocks. Occasionally struck by vehicles. Often killed by cats. Claimed to destroy its own eggs when disturbed by people.

Marsh crake (koitareke) *Porzana pusilla*
Locally common native.

Also very secretive, lurking in raupo swamps and higher-altitude wetlands. Has declined much since European arrival. Feeds on small invertebrates and seeds. Nests on raised swamp tussocks. Often taken by domestic dogs and cats.

Pukeko *Porphyrio porphyrio*
Abundant native.

Jack of all trades, adapting well to human-induced landscape changes. Favours rough clamp pasture near wetlands. Sometimes considered a pest of crops and gardens, and consequently regularly shot. Legally harvested during the duck-shooting season. Often struck by vehicles. Feeds on a wide range of swamp plants and animals. Breeds over a long season and semi-socially.

Takahe *Porphyrio mantelli*
Rare endemic. Threat Category A.

Formerly widespread but decimated since human arrival through hunting, habitat loss, predation and food competition from deer. Now naturally confined to the Murchison Mountains in Fiordland, but captive-bred birds form small populations in the nearby Stuart Mountains and on Tiritiri Matangi,Kapiti, Mana and Maud islands. Never far from streams or swamps. Feeds on grasses and fern rhizomes. Nests on the ground. On the islands, is frequently visited by people who come for that reason, and intensively studied and monitored. Vulnerable to predators. Probably doomed without human help. Threatened Species Recovery Plan No. 12 (Department of Conservation 1994).

Australian coot *Fulica atra australis*
Locally common native.

Recent arrival in New Zealand. Now widespread on lakes fringed with raupo and willows, though absent from parts of the country. Highly mobile, forming flocks when not breeding. Feeds on submerged vegetation. Nests on floating platform constructions.

Oystercatchers (Haematopodidae)

Torea/South Island pied oystercatcher *Haematopus ostralegus finschi*
Abundant native.

Breeds inland on braided riverbeds, on lake edges and in subalpine bogs, mostly east of the Southern Alps. After breeding, shifts in flocks to estuaries and sandy beaches of the North Island and northern South Island for the winter. Decline in numbers noted in 19th century attributed to human disturbance; legal shooting caused population decline until protection in 1940, after which numbers increased radically. Feeds on invertebrates and small fish.

Torea/toreapango/variable oystercatcher *Haematopus unicolor*
Uncommon endemic. Threat Category C.

Scattered around the New Zealand coast but occasionally found on lake shores. Legally shot until 1922. Typically nests just above high-tide level. Breeding success seriously impaired by disturbance from people and dogs; human disturbance during incubation leads to incubation failure and increased opportunities for predators, especially gulls and clogs; off-road vehicles damage nests; nests are maliciously destroyed on occasion. Protection from disturbance and predators increases breeding success.

Stilts and avocets (Recurvirostridae)

Pied stilt (poaka) *Himantopus himantopus leucocephalus*
Common native.

Breed prolifically throughout New Zealand, typically near wetlands. Protected, though is a relatively recent colonist and threatens black stilt through hybridism. Human interference and vandalism cause some nest failure.

Black stilt (kaki) *Himantopus novaezelandiae*
Rare endemic. Threat Category A.

Once widespread, but suffered drastic decline and now breeding is confined to braided shingle and wetland margins in the Mackenzie Basin. Threatened with hybridism by pied stilt. Highly vulnerable to breeding failure through human disturbance and predation (Pierce 1996). Anglers and off-road vehicle recreationists known to destroy nests and young. Active management to diminish these impacts has led to markedly improved breeding success. Probably doomed without this human intervention, and still on a collision course with recreationists in its prime breeding area. Winters at river deltas around major lakes, but some birds migrate to northern estuaries. Threatened Species Recovery Plan No. 5 (Department of Conservation 1993a).

Plovers. dotterels and lapwings (Charadriidae)

New Zealand dotterel (tuturiwhatu) *Charadrius obscurus*
Uncommon endemic. Threat Category A (southern population); B (northern population).

Two discrete populations, possibly separate subspecies. Northern population breeds at coastal sandspits and stream mouths from Hawke's Bay northwards. Southern population breeds in the Stewart Island highlands before fanning out around the coast of the lower South Island. Nests and young are highly vulnerable to predation when adults are disturbed by people, off-road vehicles and clogs; nests are sometimes raided by people. Predators include cats and dogs. Active management to diminish these impacts has led to improved breeding success. Lord et al. (1997) found that foraging and related behaviours of northern population chicks were adversely affected by human disturbance, sufficient to impair fledging success. They suggest that chick fledging success would be enhanced if human access to feeding areas adjacent to breeding sites was reduced during the latter part of the breeding season. Threatened Species Recovery Plan No. 10 (Department of Conservation 1993c).

Banded dotterel (tuturiwhatu) *Charadrius bicinctus*
Common endemic. Threat Category C.

Two subspecies. The Auckland Islands subspecies is found only there. The other is found throughout New Zealand and outlying islands. Breeding concentrations are on braided riverbeds, although breeding also occurs where streams and rivers emerge at the coast. Nests and young are particularly vulnerable to destruction and disturbance by people, off-road vehicles and dogs. Predators include mustelids, cats and clogs. Lowest predation rates are on braided river islands. In a very recent paper on breeding success on central South Island braided riverbeds, Rebergen et al. (1998) surprisingly make no mention of human disturbance, and blame losses solely on predators. The Auckland Islands population is subject to low-impact ecotourism visitation at the end of the breeding season.

Black-fronted dotterel *Charadrius melanops*
Locally common native.

Has colonised New Zealand since the 1950s; now well established in many places. Breeds in shingle riverbeds. Occasionally uses lakes and ponds. Feeds on invertebrates. Nests may fail after human disturbance; nests run over by vehicles.

Wrybill *Anarhynchus frontalis*
Locally common endemic. Threat Category B.

Totally dependent on South Island braided river systems for breeding, after which overwinters in North Island estuaries. Shot for sport until 1940s. Feeds on a range of invertebrates. Nesting prone to human disturbance of many types; nesting habitat invaded by exotic weeds. Apparently slowly declining.

Spur-winged plover *Vanellus miles novaehollandiae*
Abundant native.

Another recent arrival; now widespread in open country, usually associated with wetlands. Birds often struck by vehicles; in New Zealand the most serious avian hazard to aircraft; nesting birds disturbed by people, resulting in increased predation and sometimes deliberate egg destruction. Horses sometimes trample eggs.

Gulls and terns (Laridae)

Black-backed gull (karoro) *Larus dominicanus*
Abundant native.

Widespread opportunist, from the sea to the mountains; usually near water. Breeds in coastal colonies or solitarily on coastal rocks and headlands and near mountain tarns. Considered a pest near airports and rubbish dumps. Occasionally becomes entangled in fishing line; occasionally shot illegally; nests disturbed by people (accidentally, deliberately).

Red-billed gull (tarapunga) *Larus novaehollandiae scopulinus*
Abundant native.

Primarily coastal, but also found at central North Island lakes. Breeds in colonies on beaches, headlands, cliffs and islands. Considered a pest near airports and rubbish dumps. Occasionally becomes entangled in fishing line; occasionally shot illegally; nests disturbed by people (accidentally, deliberately).

Black-billed gull *Larus bulleri*
Common endemic.

Mainly inland during breeding season on South Island braided riverbeds. In winter, mainly coastal. Breeds also on North Island beaches and at Lake Rotorua. Nests disturbed by people (accidentally, deliberately).

Black-fronted tern (tarapiroe) *Sterna albostriata*
Common endemic. Threat Category B.

Breeds only on South Island braided riverbeds. Winters around the coast of New Zealand. Subject to human disturbance at nesting, roosting and loafing sites. Breeding colonies vulnerable to predation and weed invasion.

Caspian tern (taranui) *Sterna caspia*
Uncommon native.Threat Category O.

Cosmopolitan. Breeds in coastal sites usually, but some also at inland lake and river sites. Sensitive to disturbance. Records exist of disturbance of a colony by photographers, deliberate nest destruction by motorbike riders, occasional illegal shooting. Some colonies are now fenced to protect from off-road vehicles, people and dogs.

Kingfishers (Aledinidae)

Kotare/kingfisher *Halcyon sancta*
Abundant native.

Widespread in the lowlands, always near water. Not colonial. Feeds on a wide range of small animals; frequently dives after prey. Nests in holes constructed in dead trees, riverbanks, cliffs.

Swallows and martins (Hirudinidae)

Welcome swallow *Hirudo tahitica neoxena*
Abundant native.

Recent colonist, breeding in New Zealand first recorded in 1958. Now widespread in the lowlands near freshwater wetlands. Hawks for insect prey over open water. Nests under bridges, eaves of buildings.

Pipits (Motacillidae)

New Zealand pipit (pihoihoi) *Antkus novaeseelandiae*
Uncommon native.

Widely but patchily distributed in open habitats such as beaches, riverbeds, roadways, rough pasture and tussock grassland, from the coast to the mountains. Strongly territorial and sedentary. Nests on the ground, where vulnerable to disturbance and predation. Feeds on invertebrates. There is evidence that large braided river systems could now be its remaining stronghold.

Old World warblers (Sylviidae)

Fernbird (matata) *Bowdleria punctata*
Locally common endemic. Threat Category B (Stewart Island and Codfish Island subspecies); C (Snares Island subspecies).

Five subspecies, each restricted to a single island and its outliers. Associated with low dense vegetation, usually in or fringing wetlands, from the coast to the subalpine zone. Territorial and sedentary. Has declined in numbers and contracted in range in historical times, through habitat loss and predation. Feeds on small invertebrates. Nests not far above the ground in dense vegetation.

6. The visitors and their activities

People are drawn to water; perhaps, as someone has suggested, it's because we are composed largely of the stuff. Wetlands are certainly popular places to visit. People go to them for all sorts of reasons. Only the most remote and inaccessible of wetlands receive little visitation. The nearer a centre of human population, the greater the level of visitation and use. Lakes and rivers are most popular, swamps and estuaries less so. The humble farm pond is surprisingly popular. Information on the kinds of human use of freshwater wetlands in New Zealand can be found in the following references: Allan & Booth (1992), Cessford & Dingwall (1997), Cromarty & Scott (1996), Devlin et al. (1995), Geden & Ryan (1995), Hughey et al. (1986), Molloy (1983), Montgomery (1991), Moore et al. (1984), O'Donnell & Moore (1983), Robertson et al. (1983), Robertson et al. (1984), Smith et al. (1997), Stephenson (1986), Walls (1994),Ward & Beanland (1996) and Ward & Stewart (1989).

The following is a listing of the activities of visitors to wetlands in New Zealand. They span an array as varied as the wetlands themselves and the birds that live in them.

1. Traditional (Maori) harvest

Governed by traditional rahui and local practices. Far less an activity than in the past, and probably diminishing with time. Food gathering (fish, birds, koura (freshwater crayfish, *Paranephrops* spp.), kakahi (freshwater mussel, *Hyridella menziesi),* watercress, ti kouka (cabbage tree, *Cordyline australis),* etc.). Materials and rongoa gathering (kutakuta *(Eleocharis sphacelata* and *Baumea articulata),* harakeke (NZ flax, *Phormium tenax),* raupo *(Typha orientalis),* medicinal plants, natural dyes, etc.).

2. Hunting

Access is often gained by off-road vehicle. Dogs are often used. Shooting mostly. Widespread and popular.

a) Game-bird hunting (waterfowl, including ducks, geese, swans and shelducks; wetland birds such as pukeko; introduced game birds such as pheasants). Mostly strictly regulated, with seasons, bag limits, species restrictions and hunting rules.

b) Small-game hunting (rabbits, hares, possums, wallabies, etc.). Barely regulated.

c) Larger-game hunting (deer, goats, pigs). Governed by permits.

3. Fishing

Access is often gained by off-road vehicle or boat. Widespread and popular, with both locals and outsiders. Operating right in the thick of wetland bird key habitats.

a) Sport and recreational fishing (trout, salmon, carp, perch, eels, etc.). Mostly line fishing from shore or boat, strictly regulated.

b) Commercial fishing (eels, flounder, etc.). Usually net fishing using boats, somewhat regulated.

4. Water sports and pursuits

A great range of activities. Some are very disruptive (noisy, obtrusive), others less so. Most involve motorised vehicles, if only for access. Widespread, popular and fast growing. Penetrating further into the wilderness as time goes by.

Includes power-boating, jet-skiing, water-skiing, canoeing, rafting, rowing, sailing, windsurfing, body-boarding (rapid-riding), swimming, diving, sight-seeing. Ice-skating too!

5. Off-road vehicle recreation

Widespread, popular and fast-growing. Noisy and obtrusive, often quite damaging to the environment through physical impacts and pollution. Often thoughtless. Particularly disruptive to birds in braided rivers and on beaches. Penetrating further into the wilderness as time goes by. Vehicles include 4WDs, buggies, quads and trail bikes. Mountain bikes enter this category too, although their impact is considerably less.

6. Aerial sports and pursuits

Wetland areas attract a number of aerial activities, mainly because of their provision of open space or their frequent proximity to airports. The amount of small-aircraft traffic is rapidly growing, and penetrating further and further into the wilderness. Frequently noisy and disruptive. Activities include parapenting, bang-gliding, skydiving, microlighting, ballooning, gliding and sight-seeing. Aircraft include helicopters, fixed-wing planes, gliders, microlights, balloons and parachutes.

7. Conservation management

Not always unobtrusive; usually involves vehicles, power tools, firearms and pesticides. However, designed to be to the advantage of the wetland habitat and fauna.

Includes animal pest control, weed control, fencing, species management (protection, monitoring), provision and maintenance of visitor facilities (picnic areas, parking areas, boat ramps, tracks, shelters, hides, toilets, signs and educational panels) and enforcement of rules and regulations.

8. Research

Multi-faceted, including research into wetland bird species, ecosystem processes, fauna, flora, geology, hydrology, palynology, archaeology, etc. Researchers have their own impacts on both birds and wetlands, but most research is designed to be unobtrusive.

9. Outdoor education

Involving school groups, university classes, programmes organised by the Department of Conservation and those by private organisations. If focused on wetlands and birds, likely to be relatively unobtrusive. If there for other reasons, possibly quite disruptive.

10. Picnicking, camping

Frequently associated with other activities. Can be locally high-impact (rubbish, fires, bird disturbance, trampling, pollution, clogs).

11. Walking, tramping and running

People on foot are usually more in time with their surroundings than those travelling by machine. They are often in or near wetlands because they are interested in them and care for them and their wildlife. However, there is a growing trend for people to challenge themselves by fighting against a natural environment. This includes cross-country running and eventing, such as the South Island Coast-to-Coast race. Participants in training for or competing in these events can be remarkably oblivious to their surroundings and peculiarly insensitive to their impacts on birds.

12. Sightseeing, photography, painting, seeking solitude

Widespread. Usually relatively low-impact.

13. Nature study

People visit wetlands to quietly study birds, plants, insects, rocks and landforms out of sheer interest. Their numbers are probably relatively few. There are undoubtedly single-interest zealots too, who wreak a certain amount of ecological havoc in pursuit of their chosen target (the rarer the better).

14. Ecotourism, nature tourism

Water-based, land-based, aerial, vehicular or on foot. Fast-growing, putting pressure on the rare and remote. Usually governed by operating concession conditions, to minimise impact. Has many positive spinoffs.

15. Adventure tourism

Booming as an activity. Part of the nature-challenging trend mentioned in 11. Potentially extremely disruptive in wetland situations, the impacts mitigated somewhat by operating concession conditions. Usually involving machines.

Includes bungee jumping, jet-boating, rafting, canoeing, parachuting, body-boarding (rapid-riding).

16. Horse riding and trekking

Not so benign as it may appear. Rivers and beaches are popularly used. Disruption and crushing of ground-nesting birds is a real risk. Even more so is the importation and spread of weed seeds.

17. Fossicking and gathering

Many rivers and streams are fossicked for gold and other precious metals. Mining or dredging, mostly on a small scale, is also clone. People also search for gemstones and fossils. Firewood gathering is a popular pursuit: noisy and disruptive, it removes dead wood, which plays an important ecological role, from the system. People also gather rocks, gravel, sand and other materials from wetlands, usually on a small scale.

18. Dumping

Some visitors go to wetlands specifically to c1umh cars, household junk, unwanted chemicals and stolen gear. They evidently regard them as free rubbish tips.

19. Farming, forestry and industrial operations

Not regarded as visitor use in this context, although these operations are all found adjacent to or even within wetlands. There are major impacts on wetland birds and their habitats front vehicles, stock, weeds, clogs, noise, chemicals, fires, water extraction, logging, clamming and mining. The wetlands may also be visited for a whole variety of the above-mentioned reasons by people associated with the operations.

7. The impacts

What follows is a review of the information I have tracked down on the impacts of visitors to wetlands on the hirds. It has come from a variety of sources.

7.1 INTERVIEWS

I interviewed the following experts:

John Adams and John Cheyne, Department of Conservation, Napier;

Phil Bradfield and Bronek Kazmierow, Department of Conservation, Hamilton;

Kerry Brown, Department of Conservation,Twizel;

Peter Gaze, Department of Conservation, Nelson;

Wayne Hutchinson, Department of Conservation, Wanganui;

Harry Keys and Cam Speedy, Department of Conservation,Turangi;

John Lyall, Department of Conservation, Hokitika;

Ray Pierce, Department of Conservation,Whangarei;

Brian Rance, Department of Conservation, Invercargill;

Murray Williams, Science & Research Division, Department of Conservation, Wellington.

The ideas, insights and information that came from these interviews are woven into the whole document, notably the species information, the literature review, the case studies (Appendix 1), and the conservancy summaries (Appendix 2).

7.2 THE INTERNET

- **New Zealand**

The obvious places to start, the Department of Conservation web site http://www.doc.govt.nz and the New Zealand Biodiversity Strategy web site http://www.biodiv.govt.nz yielded nothing useful. No other New Zealand web sites containing relevant information were found. I did, though, find out from Internet e-mail that Simon Milne of Victoria University, Wellington, is compiling an extended international literature review on tourism and community development with David Bird from McGill University, Quebec. One of Simon's PhD students, John Hull, has been focusing on tourism and birds. Simon's e-mail address is simon.milne@vuw.ac.nz; John's is jhull@PO-box.mcgill.ca

- **Overseas**

Exploring the Internet internationally yielded much greater reward. The following are the most useful web sites found. They were located via searches using combinations of keywords (water, wetland, birds, waterfowl, impact, disturbance, human, recreation, ecotourism) and via scientific networking.

- **http://www.anca.gov.au/environm/wetlands**

Australian National Wetlands Programme. Has a Wetlands, Waterways and Waterbirds Unit, responsible for wetland and waterbird research, conservation, advocacy, education and policy. Has a series of publications and information packages

- **http://www.greenchannel.com/wwt**

Web site of The Wildfowl & Wetlands Trust, based in the UK. This agency is possibly the most authoritative in the realm of wetland bird research, conservation and education in the world. It puts out a huge amount of information on the UK, European and North American scene, and the web site reflects that. There is detailed information on recent research and management, including that listed under °Man-waterbird conflicts"," Recreational disturbance", "Species action plans", "Lead poisoning", etc. Expert ecological consultancy services are provided by the agency's Wetlands Advisory Service.

- **http://www.cabi.org**

CAB International is a non-profit organisation working internationally in the areas of agriculture, forestry, management of natural resources and related sciences. Its web site http://www.cabi.org/catalog/online leads to the CABABSTRACTS online database, which covers subjects such as the impacts of leisure, recreation and tourism.

- **http://www.amazon.com**

This is a US mail-order book service, which contains lists and reviews of myriad titles about any subject area you can name. It has much on ecotourism, the environment and birds, but little of direct application to wetland birds and visitor impacts on them.

- **http://www.ducks.org**

Web site for Ducks Unlimited, an international agency committed to waterfowl conservation. Not as much useful information as expected; most of it from Canada and focused on education and habitat protection. Ducks Unlimited has a New Zealand branch but if that has a web site it isn't evident.

- **http://www.nj.com/life/audubon**

Site for the New jersey branch of the Audubon Society (USA). I found there an opinion on ecotourism and conservation by the Director of Conservation which made interesting reading. The basic conclusion was that ecotourism, especially the society's brand of avitourism (bird watching), was of great benefit to conservation. The impacts on the resource (birds and bird habitat) were minimal, yet ecotourism boosted local economies and ensured protection of the resource, and ecotourisms, once they grew to know and love the resource, became a force for conservation.

- **http://www.fws.gov**

Site for the US Fish and Wildlife Service. Contains much material on the ecosystem approach to fish and wildlife management. The address http://www.fws.gov/r9nctc/pubs.html led to a list of publications more or less relevant to this review.

- **http://www.nbs.gov**

The National Biological Resources information site for US Geological Survey. A big and relevant site to work in. The keywords "waterfowl+recreation" led to the address http://www.npwrc.usgs.gov/resource/literature/disturb/ which at first glance appeared to be a rich lode of the most enticing information imaginable; an annotated bibliographic listing of publications on "Human disturbances to waterfowl". This turned out to be a single review paper by Dahlgren & Korschgen (1992), with the introduction, each annotated reference, and the bibliography loaded as separate individual sites. The paper is reviewed in the next section of this report.

7.3 THE LITERATURE

The following is a review of the available literature. It has been achieved by a search using the Internet, the Department of Conservation's on-line search facility, word of mouth, and sleuthing amongst the collections held in the libraries of the Department of Conservation and the Queen Elizabeth II National Trust. I have subdivided the key literature into New Zealand and overseas sections.

7.3.1 Key references: Review documents and annotated bibliographies

These are the key documents, as far as this review goes. They cover the ground of visitor impacts on wetland birds in depth. They also lead to an array of further information. They are listed along with other references in the bibliography at the end of the report.

- **New Zealand**

Marchant, S.; Higgins, P. *eds* 1990, 1993 and Higgins, P.; Davies, S. *eds* 1996. The handbook of Australian, New Zealand and Antarctic birds. Vols 1-3. Oxford University Press, Melbourne.

The most detailed compendium of New Zealand bird information that exists. Includes most of the wetland species and makes reference to various kinds of visitor impacts upon them. These bits of information are outlined in the section on the wetland birds earlier in this report.

Cromarty, P.; Scott, D.A. *eds* 1996. A directory of wetlands in New Zealand. Department of Conservation, Wellington.

This document provides the best up-to-date summary of the wetland scene in New Zealand. It includes saline wetlands, and covers the topics of research, legislation, administration, organisations and conservation. There is a list of wetland animals and plants of conservation concern and a comprehensive list of references. Visitor activities and their impacts are not really addressed, but the breakdown of wetland conservation issues by Department of Conservation conservancy is useful and contributes to the conservancy summary appended (Appendix 2). What is shown is the range of wetlands throughout the country, their natural and cultural values, what is at threat and how the wetlands are being managed. The document makes it abundantly clear that New Zealand's wetlands are highly diverse, significant, much-used by people, and not very well safeguarded.

Stephenson, G. 1986. Wetlands: discovering New Zealand's shy places. Government Printing Office Publishing, Wellington.

A delightfully unpretentious little book which takes a plunge into a series of selected wetlands throughout the country. Its coverage of a representative range of wetland types and their natural history is exceptional. Birdlife features prominently.

Collier, K. 1993. A bibliography of some New Zealand riparian literature. Science & Research Internal Report No. 139, Department of Conservation, Wellington.

An annotated bibliography of 61 references dealing with water quality, morphology, fauna, and management. This is good scene-setting stuff for the riparian context. There is not much that addresses visitor impacts, though what there is points to the need for enhanced management to minimise impact and increase visitor "carrying capacity". Techniques suggested are provision of educational material, guiding of visitors, and evaluation of visitor perceptions.

Cessford, G.R.; Dingwall, P.R. 1997. Cessford, G.R. 1997. Impacts of visitors on natural and historic resources of conservation significance, Parts 1 & 2. Science & Research Internal Report Nos 156, 157, Department of Conservation, Wellington.

Part 1 is the proceedings of a national workshop on the subject. It has sections dealing with impacts on wildlife and aquatic impacts. These are fairly generalised, but use a case study example of visitor impacts on whio (blue duck). Impacts include: breeding disruption by crushing of eggs by vehicles or pedestrians, disturbance by dogs, white water recreation disturbance, recreation running disturbance, noise from people and aircraft, and collecting; the introduction of predators by virtue of new tracks and roads, and habitat degradation through the introduction of weeds, fires and trampling.

Other waterbirds affected by such visitor impacts are listed as: crested grebe, black stilt, banded dotterel, wrybill and black-fronted tern. Other aquatic impacts of visitors focused on include: boat wash, diver damage (sediment and

substrate disturbance), pollution (particularly contamination of small enclosed water bodies such as alpine tarns), aquatic weed introduction, disturbance through fishing and hunting (including lead poisoning), and noise. Management responses and research issues are outlined for each, and contribute to the sections on management and research later in this report.

An overview of the situation facing the US Forest Service in North America, the approach taken to managing visitor impacts and the role of research there, is also presented. The lessons for New Zealand are that good monitoring of ecosystem health, visitor impacts and visitor perceptions is very important, and that change processes to minimise visitor impact need to be fair and open.

Part 2 provides a synthesis of the workshop proceedings and shapes the expressed research and information needs into a research action plan. It is by definition generalistic. Its perspectives are woven into the section on research later in this report. Essentially there is an acknowledgement that visitors have all sorts of impacts on ecosystems in New Zealand (including wetlands), that there are some specific concerns for conservation, and that well-directed research is required to guide management responses.

Devlin, P.J.; Corbett, R.A.; Peebles, CJ *eds.* 1995. Outdoor recreation in New Zealand. Vols 1 & 2, Department of Conservation/Lincoln University.

This compact publication is in two volumes: the first is a review and synthesis of the research literature; the second is an extended bibliography containing keywords for each reference. There isn't a lot that refers to wetlands and their birds in New Zealand. The literature includes Montgomery's 1991 study of recreational impacts on waterbirds on Lake Rotoiti, reviewed below. It also includes the study by Rich (1991) in which visitor impacts on whio/blue ducks on the Manganuiateao River (central North Island) were identified. They showed that whio were adversely affected by recreational use: they were disturbed and occasionally snagged in fishing line, and ducklings were swept away to their deaths after disturbance by canoes and rafts. Since the signing of a pact between the Department of Conservation and the rafting companies not to use the river during the whio breeding season, the number of ducklings had ceased to decline. Within New Zealand studies, there has so far been no attempt to ascertain threshold levels of tolerance of recreational use, or to examine use/impact relationships in detail.There are clearly large ga sp concerning knowledge of many species, particularly those most at risk!

The review also examines overseas research on outdoor recreation impacts, suggesting that wildlife response to impacts is highly variable and complex. Impacts are direct (predation, disturbance) or indirect (habitat alteration, toxins, disease, etc). Power boating is regarded as a major direct cause of physical impacts, inboard motors creating less wash than outboards. Motors introduce chemical wastes (fuel, vapour, exhaust) and boat users often leave rubbish. Camping brings sewage, rubbish and habitat modification. People bring viral-parasite-bacterial contamination to water and their activities can create nutrient enrichment, sedimentation, turbidity and accelerated eutrophication. There is a seasonal component to impact, in that species have particularly vulnerable times (usually around breeding and at times when stressed from limited food or shelter).

Devlin et al.'s review states: "Given New Zealand's unique wildlife, with its emphasis on avifauna and marine mammals, much of the overseas literature is of little benefit, because it is focused on different species". I think that statement is quite erroneous. Not only are there close analogues for most of New Zealand's wetland bird species elsewhere, but most of the types of visitor activities are mirrored in other countries, often at an intensity yet to be experienced in this country. We have heaps to learn from overseas studies.

Molloy, LR *ed.* 1983. Wilderness recreation in New Zealand. Proceedings of the FMC 50th jubilee Conference on wilderness. Federated Mountain Clubs of NZ (inc.).

In some ways this is a parent document for Devlin et al. (1995), and one that is highly relevant today because it focuses on the concept of wilderness and visitation: i.e. human use in a minimal impact zone. The recommendations to minimise visitor impact are directly applicable to situations of ecotourism visitation to sensitive environments:

- minimum impact code;
- no aircraft except for essential management and research;
- limits to kinds of recreation and tourism operations (quotas, permits, no motors);
- designation of ;areas whose primary purpose is preservation.

The "design with nature" ethic comes through into this document from an earlier inspirational one (Molloy et al. 1980), entitled "Land Alone Endures". There, outdoor recreation is described as "the orphan of land uses" in that it is rarely planned for or wisely managed. The authors make a plea for sensitive informed design.

Ward, J.C.; Beanland, R.A. 1966. Biophysical impacts of tourism. Information Paper No 56, Lincoln University.

Studies of relevance to conservation in New Zealand are critically reviewed. There are few in total, and only a handful that relate to wetland ecosystems and their fauna. One of these, Montgomery (1991), is reviewed next in this listing. Studies by Johnstone et al. (1985) showed that recreational boating and fishing was responsible for much transfer of aquatic weeds between wetland systems, and that weed control near haul-out sites would substantially reduce that. Howard-Williams & Davies (1988) showed that such weeds had detrimental impacts on natural freshwater ecosystems and influenced bird life (black swans were attracted to weed beds, for example). Norton (1989) considered that the impacts of the Coast-to-Coast endurance event on whio/blue duck were minimal.

Ward & Stewart (1989), in a key study, investigated the impacts of visitors on wetland birds at Lake Alexandrina, a South Island high-country lake, over a seven-year period. They found that birds were harmed and killed by recreational users; that NZ scaup and black swans were displaced by recreational

activity while grebes and ducks were not; that changes in bird distribution with season were apparently independent of human disturbance; and that breeding success of grebes did not seem to be affected by intensity of recreational use. They suggested that increased recreational pressure would affect birds, water quality and marginal vegetation habitat, and that management was required to minimise these impacts, e.g. sewage facilities and restrictions on recreational use.

Montgomery, P.J. 1991. The effects of water-based recreational disturbance on water-birds at Lake Rotoiti, Rotorua. Department of Conservation *Technical Series No. 14.*

This study is regarded as something of a landmark in New Zealand research. The impact on nine bird species, principally of recreational boating, was assessed. The basic findings were as follows:

- water-based recreational activities disturbed all waterbirds; disturbance distances were affected by species, habituation, how close birds were to cover and whether or not they had young;
- the diversity of bird species present was reduced during times of high recreational disturbance;
- shags were most sensitive and Australian coots least sensitive to boating; the effect of disturbance on shag breeding success was not known;
- short-term detrimental effects included: affecting the numbers and distribution of birds on individual waters; keeping birds off preferred habitat (feeding, resting or breeding areas); energy loss for the bird, disturbance often resulting in a change in activity which, during periods of food shortage or high requirements (breeding), may have had a significant effect on bird welfare;
- long-term effects, harder to assess, included: limitation of habitat quality and availability through recreational disturbance; disruption of breeding, resulting in increased predation of nests and chicks;
- wave wash from boats had the ability to destroy nests, particularly those of dabchicks; these birds appeared to be quite rare, yet received little research and no management;
- the ability of waterbirds to accommodate recreational activities depended on there being quiet refuge areas of high-quality habitat readily available to the birds;
- overall, notwithstanding the above, recreational activity - principally boating- seemed to have minimal impact on the waterbirds in the study area.

Kazmierow, B.J. 1996. Ecological and human dimensions of tourism-related wildlife disturbance at the Waitangiroto white heron (kotuku) colony, Westland, New Zealand. Master of Parks, Recreation and Tourism Management thesis, Lincoln University.

This, too, is a landmark study in New Zealand. It is an intensive examination of ecotourism issues at the only known breeding colony of the kotuku in this country. It is doubly valuable for being both an ecological study and a sociological one. The kotuku nest, along with royal spoonbills and little shags, in trees on the banks of the lower Waitangiroto River, South Westland. The colony is within the Waitangiroto Nature Reserve, administered by the Department of Conservation. The Department permits an ecotour concession to take visitors to the colony by boat for viewing purposes, under strict guidelines. Most visitors are extremely interested in the birds and their environment and very aware of their sensitivity to disturbance.

In terms of impact on the birds, the study essentially concluded that boat traffic adversely affected kotuku feeding, but that visitor viewing had no marked effect on kotuku behaviour at the colony. Boat traffic significantly reduced the number of all waterbirds seen on the waterway. Adult kotuku commonly flew in response to passing boats whilst fledged chicks were absent from the boat-affected section of the waterway: a situation considered unacceptable by all stakeholders. Cumulative year-by-year impacts were not able to be addressed, so the researcher recommends long-term monitoring be part of future management. He also recommends minimising the number of boat trips, scheduling trips for times when kotuku chicks are least likely to be using the waterway and considering sensitive land-based approaches as an alternative.

Smith, D.; Hughey, K.; Booth, K. 1997. Impacts of recreational users on the wildlife of braided rivers - a preliminary study on the Tekapo River. Department of Resource Management, Lincoln University.

To my knowledge this is the first systematic study of the impacts of recreational users in braided river systems in New Zealand. It was carried out as a way of assessing the effectiveness of, and guiding, Project River Recovery, a Department of Conservation project aimed at restoration of the braided river habitat and its populations of threatened birds (see Appendix 1), An unforeseen consequence of weed control had been enhanced vehicle access to the riverbed, creating an increase in visitor use. In this study, patterns of recreational use and impact on birds were recorded. Interviews with recreationists were conducted.

The birds breeding in the study area were black-fronted tern, black stilt, banded dotterel, black-billed gull, and wrybill. It was found that recreation in the area conflicted with hird breeding. Most of the visitors were there for angling purposes, travelling either on foot or by off-road vehicle. Walkers had a surprisingly high impact. Vehicle use was largely confined to the available track. Disturbances observed were bird flight, alarm display, and nest destruction. Recreationists actually trod on or drove over nests, destroying eggs or killing chicks. Recreationists generally agreed with bird conservation, though most were unaware that their activities affected nesting birds.

The authors recommend that future research covers a longer period and considers quantitative effects on bird breeding success. They also recommend that interpretation efforts be aimed at anglers and people who use the delta area.

- **Overseas**

Keller, V. 1996. Effects and management of disturbance of waterbirds by human recreational activities: a review. *Game and Wildlife 13*: 1039-1047.

This is a major European overview examining about 300 papers published up to 1994. It was born out of a recognition that the human use of waterways was increasing and that the subject of the impact on waterbirds was controversial (spanning a spectrum from absolute denial of any impact to calls for total bans on all visitor activities). It found that the number of publications on human disturbance had increased markedly in the previous decade, and that in comparison to other birds, waterbirds had been well covered. Almost all studies recorded impacts on the birds: immediate effects on behaviour, habitat use, and physiology; longer-term effects on populations and biological fitness.

In more detail, the types of impacts were:

During the breeding season

- lower density of breeding pairs,
- lower breeding success,
- increased egg losses/predation,
- increased predation of young,
- reduced nest-attendance,
- reduced nest-building,
- changes in activity budget of young,
- changes in habitat use,

Outside the breeding season

- changes in distribution and habitat use,
- changes in activity/energy budget,

The author stresses the need for more studies aimed specifically at the management of sites, drawing on her own experience of research on great crested grebes *(Podiceps cristatus)* in which it was found that boating adversely affected breeding success and that finding the distance thresholds for distur-

bance would allow practical management measures to be applied (Keller 1989). She states that very few studies measuring the distance at which birds react to humans have been clone, and that where birds have developed a degree of tolerance to human activities this has not always been to their advantage. She also points to studies such as those in Denmark, summarised by Madsen (1993), which showed that the availability of good refuges for waterbirds were the key to their well-being.

Scott, DA *ed*. 1982. Managing wetlands and their birds: a manual of wetland and waterfowl management. International Waterfowl Research Bureau, Slimbridge, England.

A comprehensive instruction manual on how to manage wetlands for the benefit of waterfowl. It is based on wide collective experience of human impacts and mitigation practices. Management measures that result in increases in bird numbers or a halt of decline, and those that reduce conflict and visitor impact, are detailed. A summary of these is given in Section 8 of this report.

In general, the amount of disturbance varies according to activity. The following are in decreasing order of degree of disturbance:

1. activities involving rapid movement and loud noise: power-boating, water-skiing, cruising;

2. activities involving movement but little noise: sailing, wind-surfing, rowing, canoeing;

3. activities involving little movement or noise: swimming, diving (subaqua);

4. activities carried out largely from the banks: coarse-fishing, game-fishing, birdwatching, informal,

There is a wide range of susceptibility to disturbance among species, also among sites and seasons.

Dahlgren, R.B.; Korschen, C.E. 1992. Human disturbances of waterfowl: an annotated bibliography. *USDI Fish and Wildlife Service Resource Publication No. 188.*

Already mentioned as available via the Internet, this is a fairly comprehensive NorthAmerican review, focused on visitor impacts on waterfowl (ducks,geese, swans and shelducks). The authors define human disturbance as °a direct event, intentionally or unintentionally created by people, leading to a reaction of alertness; fright (obvious or inapparent); interruption of activities; flight, swimming or other displacements; or death or disablement". Their essential conclusion is, as with Keller (1996), that most human activities in or near wetlands cause disturbance to the bird life there. Disturbances created by boaters, anglers and hunters are regarded as serious in that they displace waterfowl from their feeding grounds, create energetic costs associated with flight, and affect nesting or brooding waterfowl which may lower productiv-

ity. Researcher-caused disturbances are also mentioned; most biologists being familiar with the desertions of female birds during nesting studies. The effects of interactions that disrupt the normal behaviour of birds are subtle and often overlooked, but may be no less harmful than destruction of habitat. Resource managers require information on the types, magnitude and effects of human disturbances on waterfowl.

York, D. 1994. Recreational-boating disturbances of natural communities and wildlife: an annotated bibliography. *USDI National Biological Survey Biological Report 22.*

Another comprehensive North American review, covering much of the same ground but even more usefully. It has arisen out of the need for information to guide management following the drastic increase in recreational boating on inland waters in the United States since the early 1970s. This boating is recognised as one of the more common forms of waterfowl disturbance, and its increase is such that it has created serious compatibility issues for wildlife refuges.

The author points out that as conflicts between boating and resource protection escalate, there is an increasing need for information on waterfowl flush and flight distances, zoning and buffer recommendations, and the disturbance reaction by different taxonomic groups. The bibliography contains 111 annotations on a wide array of boating disturbances. It is arranged with a user-friendly index so that managers can readily go to the information that best relates to their particular circumstances (waterway type, boating activity, bird type). In my opinion it is just about as useful in New Zealand as in the USA.

Liddle, M.J.; Sacorgie, HRA 1980. The effects of recreation on freshwater plants and animals: a review. *Biological Conservation 17*: 183-206.

One of the first serious attempts at a review of the impacts on freshwater biota of the extraordinary increase in outdoor recreational activity, which has happened in liritain as well as elsewhere. It examines a wide range of both water- and shore-based activities. The impacts include:

Water-based activities (boating; greatest impact from motor boats):

- physical impact on vegetation (floating, submerged),
- spread of water weeds,
- increased water turbidity (leads to increase in plankton and decrease in macrophytes),
- bank erosion,
- wildfowl disturbance (feeding, breeding, roosting),
- pollution from engines (fuel, oil and their additives),

- litter (also a source of pollution),
- sewage discharge, including washing wastes.

Shore-based activities (fishing, hunting, camping, swimming, diving, bird watching, picnicking, etc.):

- erosion,
- trampling of vegetation, substrate,
- site works for recreational management (habitat modification),
- disturbance of wildfowl,
- disturbance of fish and other fauna (bird foods or habitat components),
- pollution,
- litter,
- sewage discharge,
- lead poisoning.

The authors conclude that management needs to be based on good information and, where areas are designated for fauna and flora preservation, to keep those aims clearly in mind.

Liddle, M.J. 1997. Recreation ecology: the ecological impact of outdoor recreation and ecotourism. Chapman & Hall, London.

A massive book spanning this subject in detail. Full of data and possessing a huge list of references. In the section on disturbance to waterbirds, the following impacts are discussed:

- children collecting eggs or nests,
- well-meaning observers or photographers attracting such "recreational predators",
- the particularly disruptive effects of power boats,
- disturbance from people jogging, walking and working (dependent on the degree of movement),
- the impact of worm diggers (zero!),
- the disruption of wintering wildfowl by anglers (whether operating from the shore or by boat), driving the birds from preferred feeding and roosting sites,

- sailing (having little effect alone, but quite disruptive in combination with angling),
- combinations of impacts from various other activities,
- flight distance (varying with boat type and amount of available cover),
- breeding success (higher where motor boats not permitted, and where people including researchers - visit least),
- conflict for the use of small islands between birds (nesting) and humans (camping),
- the attraction of predators to nests by people,
- habituation to disturbance (may or may not be beneficial),
- clogs being very disruptive,
- aircraft disturbance (supersonic planes and low flying most disruptive; birds highly sensitive to slow-flying recreational aircraft because they resemble raptors),
- structures built for recreational activities not disruptive except very locally,
- hunting causing timidity and population impact (hence bag limits).

Ream, C.H. 1980. Impact of backcountry recreationists on wildlife: an annotated bibliography. ***USDA Forest Service General Technical Report INT-84.***

Another product of managing agency concern about the ecological consequences of rapid growth in outdoor recreation, this document reviews what is known about the impacts on wild animals (not just birds) in North America. It has been designed to provide information that could help reduce human impact on wildlife.

Subjects not already covered above include:

- aggressive birdwatchers causing nest and territory abandonment,
- critical habitats (e.g. waterholes) where wildlife are especially vulnerable,
- riparian recreational settlement and development causing bird abandonment,
- inappropriate visitor behaviour,
- impact minimisation and mitigation (use of vegetation screening, keeping escape routes clear, education, regulation, etc.),

- "non-consumptive" users actually being consumptive and disruptive:"loving wildlife to death".

The author presents the wise observation that there are fundamentally three approaches to reducing wildlife harassment:

1. people management;

2. wildlife management;

3. habitat modification to affect spatial distribution of wildlife.

She goes on to say that this is easier than it sounds: that the behaviour of both people and animals is complicated and not always predictable. Management must be responsive to the particulars of sites, and take account of vulnerable times of year for wildlife. The best management is likely to be applied by managers who have a sound background in biology, local conditions, and local recreational patterns.

Boyle, S.A.; Samson, F.B. 1983. Nonconsumptive outdoor recreation: an annotated bibliography of human-wildlife interactions. ***USDI Fish and Wildlife Service Scientific Report - Wildlife No. 252.***

A further product of managing agency concern about the ecological consequences to wildlife of rapid growth in outdoor recreation in North America. It too has been designed to provide information that could help reduce the human impact on wildlife in a practical way. It covers a massive range, but is particularly easy to use. 536 books, articles, government publications, organisation reports, theses and dissertations are summarised. There is a superb index of activity and impact keywords. There is also a list of related bibliographies, several of which encompass the impacts of off-road vehicles and roading.

"Nonconsumptive" means not related to harvest or extraction, but as also pointed out by Ream (1980) above, most outdoor recreation activities affect wildlife to the extent that conservation managers have become concerned. Trail-walking, picnicking, wildlife observing, photography, camping, climbing, off-road vehicle use and horse-riding all affect wildlife and its habitat, directly or indirectly. There is a concern about the growth of these activities and the ability of wildlife and habitat to recover from disturbance. A paper byWeeden (1976) dismisses the notion of non-consumptive users, concluding that there is no such thing; there are only consumers who care about wildlife and those who don't. Duffus & Dearden (1990) call for an approach to management of non-consumptive wildlife-oriented recreation that obliges the formulation of management plans in both a social and biological context.

Boyle, S.A.; Samson, F.B. 1985. Effects of nonconsumptive recreation on wildlife: a review. ***Wildlife Society Bulletin 13: 110-116.***

The same authors have taken their bibliographic review a step further towards interpretation of the great body of available information. They have categorised the reports of original studies according to animal type and

whether the impacts were positive, negative or indeterminate. For birds, only four of the 27 reports on hiking and camping show positive effects; for all other activities (boating, wildlife observation and photography, off-road wheeled vehicles, snowmobiles, spelunking, swimming and shore recreation and rock climbing) there were no reported positives and most impacts were negative.

Hiking and camping may affect wildlife through trampling of habitat and disturbance of animals. Large recreational developments introduce disturbances such as air, water and noise pollution, garbage dumps, and potentially high densities of recreationists. Vegetation changes near campgrounds appear responsible for changes in bird species presence, favouring common and widespread species. Wildlife observers and photographers actively seek and approach wildlife and are thus potentially more disturbing. Rare or unusual species are often sought. Human visits to waterfowl nests increase the chances of loss through predation. Colonial nesting birds are particularly vulnerable to disturbance, as breeding populations concentrate in small areas and eggs and young are defenceless when adults are absent. Human disturbance of water bird colonies has been shown to cause nest losses through interspecific predation, intraspecific predation, trampling and nest abandonment. Animals habituated to human presence may become more vulnerable to poaching. Boating affects waterbirds through sight and sound of recreationists, habitat changes caused by vegetation control practices and facility construction, wash impacts, and pollution from boats and recreational facilities. Off-road vehicles have been demonstrated to have severe impacts on wildlife of arid environments through direct mortality, harassment, noise and habitat destruction.

The authors are clearly concerned about the future impact of burgeoning outdoor recreation on wildlife, concluding that whilst motorised pursuits are the most damaging, even the most casual intrusion by a person on foot may significantly affect vulnerable populations. They indicate the need for more systematic quantitative studies of particular situations, to get a handle on the most vulnerable phases for animals and the best management practices to minimise human impacts.

Vaske, J.J.; Graefe, A.R.; Kuss, F.R. 1983. Recreation impacts: a synthesis of ecological and social research. ***Transactions of the 48th North American Wildlife and Natural Resources Conference 1983.***

This study is designed to synthesise existing theoretical and empirical work related to recreational impacts on a comprehensive scale, as a precursor for developing a methodology for practical carrying-capacity estimation in North American National Parks. It is notable for bringing together the ecological and social perspectives.

Wildlife impacts of relevance to this review that are mentioned are harassment (that by dogs especially serious), disruption of feeding and movement patterns,the effects of disturbance on wildlife at times of physiological stress, habitat modification, reduced productivity rates, increased injury and predation rates of young birds, loss of species diversity, vehicular traffic and out-of-vehicle activities (which can be more disturbing when birds are habituated to traffic but not people), and habitat quality and escape cover.

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