Ecological assessment of two islands in west Otago lakes for potential re-introduction of buff weka (*Gallirallus australis hectori*)

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Otago Daily Times, March 19th, 1863
Dr Hector's expedition: Matukituki River.

'While writing about the birds in this part of the country, I wish to make a statement frequently made with respect to the marked poverty of the woods in birds. It is a great mistake, - an altogether erroneous idea. ...

... Wood hens are extraordinarily numerous; ...'

Author's note: buff weka (wood hen) *Gallirallus australis hectori* is named after Dr Hector who travelled the Wanaka district as above.

Abstract

The proposed re-introduction of buff weka *Gallirallus australis hectori* to two islands in west Otago lakes required a detailed ecological evaluation to 1) assess the food resource for buff weka and 2) consider the vulnerability of resident invertebrates, birds and lizards to buff weka. Surveys specifically to address these objectives are reported along with published information. Silver Island and Stevensons Island/Te Peka Karara are within the historic range of buff weka. However, their ecosystems have been much modified by fire and introduced insects, birds, mammals and grasses. Limited evidence suggests that the modification and presence of rodents has removed invertebrates vulnerable to buff weka. Thus there were no snails, millipedes, centipedes, slaters, spiders or insects whose populations were judged as likely to disappear as a result of buff weka introduction. While some larger ground-dwelling invertebrates will become less common on both islands if buff weka are introduced, their value and their community value was judged as likely to continue with some change in community composition and feeding relationships. It is likely that if buff weka are present, New Zealand scaup and Canada geese would fail to nest on Silver Island. Also, gecko and skink populations would decrease on both islands.

Considering climate, vegetation, invertebrates and range of predators already present, we speculate that buff weka could be sustained at low densities. Threats to buff weka on these islands include Australasian harrier, stoat, ?ferret and on Stevensons Island/Te Peka Karara, dogs. Fire is also a risk.

If buff weka are introduced to either island, monitoring research should be carried out to identify impact of buff weka on gecko, skinks, some insects and leaf litter state. A variety of threats to buff weka would also need to be managed.

1. Introduction

In early European time, buff weka (*Gallirallus australis hectori*) were widespread in the eastern South Island of New Zealand but had become extinct over their natural range by the 1920s (Coleman et al. 1983, Beauchamp et al. 1997). Buff weka now only survive through their 'fortunate' introduction to the Chatham Islands (Marchant and Higgins 1993). There are thriving populations on main Chatham Island which survive annual harvests of thousands of birds (Beauchamp et al. 1997). It appears that the species is relatively secure from extinction. However, buff weka have a threatened conservation status of Category 'B' (second priority threatened species, Molloy and Davis 1994). They also have a special status as mahinga kai for Ngai Tahu, Kati Mamoe and Waitaha Maori. Historically, buff weka were an important food and were hunted seasonally in inland Otago and Southland.

Buff weka are terrestrial flightless rails, although they are not shy of water. They feed opportunistically on a wide variety of plants, especially new shoots, fruits

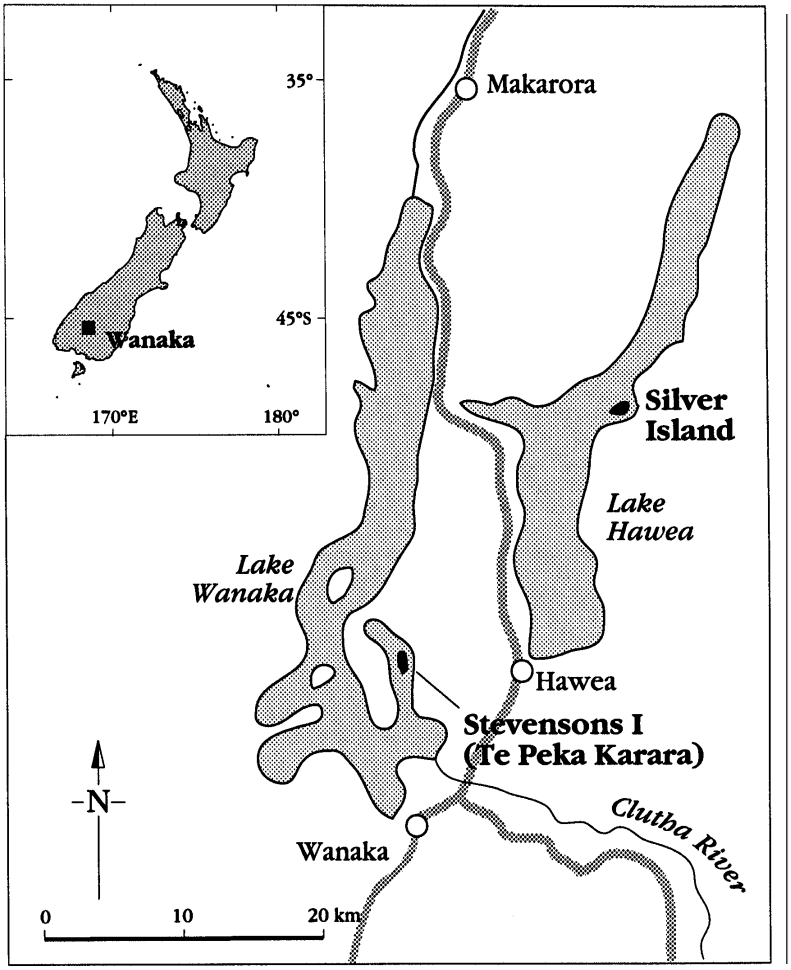
and seedlings, but also detritus generally. Invertebrates greater than 5 mm long such as spiders, slaters, millipedes, beetles, caterpillars, weta and flies are important foods and buff weka can also feed on rats, mice, lizards and animal carrion (Carroll 1963, Beauchamp 1987a; 1987b, Marchant and Higgins 1993).

For cultural and for conservation purposes, the re-introduction of buff weka to Otago is being considered (Cranwell 1996, Beauchamp et al. 1997). As a result of a pilot survey, two west Otago islands (Silver Island and Stevensons Island/Te Peka Karara, figure 1) were proposed as potential release sites (Cranwell 1996). Throughout Otago few sites have the attributes required to support buff weka. Sites must not have native animals vulnerable to weka predation, must be relatively free of predators of weka, have food resources to sustain weka and a capacity to keep them from dispersing. This document draws on information from a number of surveys to report on the ecology of the two islands as an essential background to fulfilling the following objectives: to assess the general food resource available to buff weka and consider the vulnerability of the ecosystems to a weka introduction. Recommendations address the presence of buff weka on the islands. Buff weka interactions with people or the logistics of managing transfers and confining birds to the islands are not discussed.

2. Climate of Silver Island and Stevensons Island/Te Peka Karara

Both islands lie in lakes which are in large north–south trending valleys at low elevation to the east of the South Island Main Divide. A similar mild temperate climate exists for both islands. Lake Hawea (Table 1). has a daily maximum air temperature averaging 27.3 °C in January and 9.8 °C in July. These average 26.1 °C in January and 10.1 °C in July for Lake Wanaka. Extreme minimum air temperatures show a similar trend, with the lowest recording for the month of January 1.3 °C, and the coldest day, averaging -8.3 °C in July for Lake Hawea. The trend is similar for Lake Wanaka (Table 1.). Rainfall is somewhat different with annual rainfall average 790 mm for Lake Hawea and 682 mm for Lake Wanaka. Table 1 shows that, on average, rainfall is evenly distributed throughout the year and that monthly minimum rainfall can be very low at any time of the year for both lakes. Dry periods with no significant rain for six weeks or more are not unusual events (S. Thorne pers. comm.) It appears that Silver Island experiences more rain and more frequent gale force winds than Stevensons Island/Te Peka Karara. Both islands are exposed to the winds that prevail from a north-west direction and have little shelter. Stevensons Island/Te Peka Karara is more protected from southerly winds than Silver Island (S. Thorne pers. comm.).

Figure 1. Stevensons Island/Te Peka Karara and Silver Island.



3. Conservation status, geography and geology of the islands

Silver Island (figure 1) is managed as a scenic reserve by the Department of Conservation. It lies 400 m from the eastern shore of Lake Hawea. The island is 24.7 ha in area and 1.2 km long x 0.4 km wide. Almost all of the terrain is steep, with a south-west to north-east trending ridge crossing the island. Elevation ranges from 348–438 m.a.s.l. Its underlying geology is schist (grade IV; Mutch and McKellar 1964) thickly veined with quartz. Soils are described in Ward and Munro (1989) as upland and high country yellow-brown earths.

Stevensons Island/Te Peka Karara (figure 1) is in the eastern lobe of Lake Wanaka, 150 m from the eastern shore. It is 65 ha in area and 1.4 km long x 0.6 km wide. It has recreation reserve status and is managed by the Department of Conservation. The island has mostly gentle slopes rising to 60 m above the lake which itself is ~ 300 m.a.s.l. Geology is similar to Silver Island; soils are classed as steepland yellow-gray earths - Arrow Soils (Wood 1962). These are thin, dry, friable and very well drained.

TABLE 1. A SUMMARY OF TEMPERATURE AND RAINFALL FOR LAKE HAWEA AND LAKE WANAKA. DATA SUPPLIED BY NATIONAL INSTITUTE OF WATER AND ATMOSPHERE. BASED ON RECORDS MADE OVER >20 YEARS.

LAKE HAWEA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	**YEAR**
Mean total rainfall (mm)	62.9	45.1	69.3	61.5	75.9	64.7	59.9	70.3	73	69.7	66.3	67	**790**
Minimum rainfall (mm)	14.5	3	11.7	13.5	5.3	4.6	16	11	5	9.1	8.7	10.7	**529**
Mean daily max. air temp. (°C)	22.3	22.2	19.6	16	11.4	8.1	7.5	10.1	12.9	15.6	17.9	20.6	**15.4**
Extreme min. air temp. (°C)	1.3	0.8	-0.9	-1.7	-5	-6.3	-8.3	-6.1	-5.9	-3.9	-2	1.1	**-6.7**
Max. days of gale (>90 km/h)	3	2	2	3	3	2	2	4	2	5	8	3	**25**
LAKE WANAKA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	**YEAR**
Mean total rainfall (mm)	56.9	50.1	60.7	56.5	62.7	54.5	52.2	52.8	56.4	63.1	54.7	51.9	**682**
Minimum rainfall (mm)	7.6	1	2.3	3	5.1	3.8	0.8	0	2	0	3.6	9.9	**419**
Mean daily max. air temp. (°C)	23.9	23.4	20.9	17.3	12.2	8.4	8.4	11	14.4	16.8	19.9	21.9	**16.5**
Extreme min. air temp. (°C)	1.4	0.2	-1.7	-4	-7.5	-8.2	-6.7	-5.8	-5.7	-2.9	-2.4	0.6	**-8.2**
Max. days of gale (>90 km/h)	1	1	3	1	1	0	1	1	1	1	1	1	**5**

4. Vegetation and habitat of Silver Island

Silver Island is unique among the islands of Lakes Wanaka and Hawea in having a mountain beech *Nothofagus solandri* var. *cliffortioides* forest remnant on it. However, in common with the other islands, there are also extensive areas of shrubland maturing after fire. These are on the island's northern and western slopes while the beech dominated forests are on the south-east slopes. The beech forest includes kanuka *Kunzea ericoides* and some mature broadleaf *Griselinia litoralis* and putaputaweta *Carpodetus serratus*. The beech understorey is relatively open with leaf litter and much woody debris. The litter is very deep in places and is pocketed among steeper rock banks in other areas. It was dry with little apparent moss during visits in April and October 1997. Shrubland is dominated by kanuka and includes kohuhu *Pittosporum tenuifolium*, *Coprosma linariifolia*, glossy karamu *C. lucida*, prickly mingi mingi *Cyathodes juniperina* and korokia *Corokia cotoneaster*. Ferns, other shrub species and a variety of vine species are also found on the island. *Coprosma* species and Kohuhu, are common through areas of tall kanuka, with lesser amounts of other tree species. The understorey comprises dense prickly mingi mingi, some korokia and native blueberry (*Dianella nigra*) among other shrubs. Around the island edges and on the northern slopes, forest canopy is replaced by open low shrub and grass areas with some lichen and bare rocky soil. During our visits, leaf litter was dry and soils had a powdery appearance beneath shrubs and in unshaded sites. The diverse range of shrubs in this edge vegetation commonly includes kanuka, *Coprosma* species, korokia, prickly mingi mingi, *Helichrysum aggregatum*, manuka *Leptospermum scoparium*, matipo *Myrsine australis*, and kohuhu. Around the exposed rocky shoreline of the island, small areas of strand and aquatic vegetation

are exposed at low lake levels (generally from May to August and from January to March; S. Thorne pers. comm.). Aquatic plants include *Myriophylum triphyllum, Juncus species* and *Eleocharis acuta*. 119 plant species are recorded with 94 species native and 25 adventive. Table 2 shows the variety of fruit-producing herbs, shrubs and trees and their relative abundance and estimated fruiting times. Late summer appears to be a period of largesse for fruit eaters.

The abundance of mistletoes *Ileostylus micranthus*, *Peraxilla tetrapetala* and *Korthalsella salicornioides* growing to ground level, and the presence of the native broom *Carmichaelia arborea*, indicate minimal impact from mammalian browsers and highlight a distinctive feature of the islands vegetation compared with most 'mainland' vegetation. Photos 1–3 (p. 23) show the vegetation on Silver Island.

5. Vegetation and habitat of Stevensons Island/Te Peka Karara

Kanuka forest dominates this island, forming a discontinuous canopy over most of the gentle slopes. There are many small clearings, which have a cover of grasses interspersed with mosses and lichen. The forest understorey usually includes korokia, prickly mingimingi and *Helicrysum aggregatum*. Around the island edges, the kanuka thins out to become mixed shrub-grassland. Shrub diversity is increased in these more open areas and includes manuka, *Coprosma crassifolia,* kohuhu, *C. propinqua,* matipo, weeping matipo, *H. aggregatum* and korokia as common elements—as on Silver Island. Many vine species are found throughout all vegetation types. Table 2 shows that a variety of fruiting shrubs are common with fruit maturing mainly during late summer. Leaf litter has accumulated and is reasonably deep beneath tree and shrub cover, even beneath shrubs surrounded by grass. It was dry when visited in April and slightly moist in October (1997). There are less logs or woody debris here than on Silver Island, and the vegetation is less dense with many trails perhaps induced by people, deer and small mammals. The vegetation cover is regenerating and maturing after fire (fifty years or more in the past) and experiences a variety of animal disturbances. Beaches slope gently into shallow water surrounding the island. Mostly these are bedrock, cobble and gravel. However, the strand area is extensive and areas with finer substrates and emergent macrophyes are significant. 123 plant species are recorded for the island with 84 native and 39 adventive species. Photos 5–7 (p. 25) show the vegetation of Stevensons Island/Te Peka karara.

TABLE 2. FRUIT OCCURRING ON SILVER ISLAND AND STEVENSONS ISLAND/TE PEKA KARARA, ITS RELATIVE ABUNDANCE AND ESTIMATED RIPE TIMES. KEY: R = RARE, O = OCCASIONAL, C = COMMON, A = ABUNDANT.

SHRUB OR HERB	COMMON NAME	SILVER ISLAND	STEVENSONS ISLAND/ TE PEKA KARARA	ESTIMATED PEAK RIPENING TIME
Coriaria arborea	tutu	R		JAN–MAR
Coprosma crassifolia	coprosma	O	R	any time
C. linariifolia	"	C	C	any time
C. propinqua	"	C	A	FEB onwards
C. rhamnoides	"	O		MAR onwards
C. lucida	glossy karamu	C	C	any time
Corokia cotoneaster	korokia	A	A	JAN onwards
Cyathodes juniperina	prickly mingi mingi	A	A	FEB onwards
Gaultheria antipoda	false beech	R		FEB onwards
Ileostylus micranthus	mistletoe	O	R	MAR onwards
Lophomyrtus obcordata		O	R	?
Myrsine australis	matipo		R	any time
Myrsine divaricata	weeping matipo	C	O	any time
Rubus cissoides	bush lawyer	O	O	DEC–FEB
Dianella nigra	native blueberry	C		APR

6. Island faunas

Common skink *Oligosoma maccani* should be present on both islands (Pickard & Towns 1988) but was not noted. The gecko found on both islands is a western Otago form of common gecko *Hoplodactylus maculatus* (Jewel and McFarlane 1997, Hitchmough 1998) which is known from many nearby mainland sites as secure populations. It is likely that the island populations of gecko are at higher density than populations in adjacent mainland sites (T. Jewel pers. comm.). Evidence from chewed poison baits and direct observation indicates mice *Mus musculus* and rats *Rattus rattus* or *R. norvegicus* are present on both islands. These are likely to be consuming litter invertebrates, seed and seedlings (Sturmer 1988, Tann et al. 1991). Stoat traps placed on Silver Island captured three stoats *Mustela erminea* in six months (during 1997). Their presence is likely to be occasional on both Silver Island and Stevensons Island/Te Peka Karara. There are no records of Red deer *Cervus elaphus scoticus*, possum *Trichosurus vulpecula* and rabbit *Oryctolagus c. cuniculus* ever having been on Silver Island. However, all have been found on Stevensons Island/Te Peka Karara. All deer and possums have now been removed (unpublished data). However, it appears that deer from the adjacent mainland continue to be occasional visitors for brief periods of time (less than six weeks, P. Hondalink pers comm.). Possum re-invasion of Stevensons Island/Te Peka Karara is also possible. Rabbits reached plague proportions and damaged vegetation before completely dying out in the early 1990s (Paul Hondalink pers. comm.). Dogs *Canis familiaris* accompanying people are frequent visitors to Stevensons Island/Te Peka Karara.

6.1 BIRDS

Silver Island is used by ground-nesting aquatic birds including Canada goose *Branta canadensis* and New Zealand scaup *Aythya novaeseelandiae*. Rock pigeon *Columba livia* nest in the bluffs. Ground-foraging birds include blackbird *Turdus merula*, starling *Sturnus vulgaris*, white backed magpie *Gymnorhina tibicen* and a variety of finches. As well as the birds listed above, Stevensons Island/Te Peka Karara has song thrush *Turdus philomelas* and California quail *Lophotryx californicus* in the summer months. Blackbird, thrush and quail are likely to be disturbing leaf litter to feed on invertebrates (Heather and Robertson 1996). Other birds common to forest, shrubland and lake areas are encountered on both islands. The Australasian harrier *Circus approximans,* well known for raiding bird nests, is a common visitor to the islands.

6.2 INVERTEBRATES

The information reported here is previously unpublished data from surveys carried out by the authors in April and October 1997 plus survey information gathered by B. Patrick in 1992. Invertebrates were collected from leaf litter (see photo 4, p. 23), pitfall traps placed at the soil surface, by light trapping and by hand searching. A total of 225 species was identified from the two islands. Of these, 83 taxa on Silver Island and 78 taxa on Stevensons Island/Te Peka Karara are available to ground-dwelling birds, lizards and rodents. Species that may be important foods for these ground-dwellers are listed in Table 3.

From the sampling carried out in April 1997, a quantitative analysis of litter was made. For litter invertebrates over 5 mm long, standing crop biomass estimates for each island showed that Stevensons Island/Te Peka Karara (65 ha) had ~4 times as much biomass as Silver Island (24.7 ha). Wetter and warmer weather than that experienced during the sampling periods is likely to add significantly to this food resource. Brockie and Moeed (1986) calculated litter invertebrate biomass per unit area for broadleaf-podocarp forest in the Orongorongo Valley (near Wellington). The values we recorded range from approximately 1.5% (kanuka-shrub mix site) to approximately 20% (beech site) of their estimate. Invertebrate production is also likely to be substantially less.

Many of the invertebrates recorded are characteristically associated with the plant genus on which their larvae feed. For example, the moth *Pasiphila melochlora* is associated with native broom; and the moths *Elvia glaucata* and *Orthenches disparilis* are associated with bush lawyer *Rubus schmideloides* and korokia respectively. This last species was recorded for the first time in Otago on Stevensons Island/Te Peka Karara. The catapillar of the moth *Rhapsa scotosialis* is common in leaf litter, as are fly larvae. The stag beetle *Mitophyllus foveolatus* is found in wood in the beech forest of Silver Island, while another stag beetle, *Holloceratognathus cylindricus* is found in kanuka on Stevensons Island/Te Peka Karara. Some aquatic insect species from the lakes were very abundant over the entire islands. These included the midge *Chironomus ?zealandicus* and caddis *Paroxyethira eatonii* and *Hudsonema amabilis*.

TABLE 3. GROUND-DWELLING INVERTEBRATES THAT MAY BE IMPORTANT FOODS FOR WEKA AND OTHER PREDATORS ON SILVER ISLAND AND STEVENSONS ISLAND/ TE PEKA KARARA.

SPECIES	COMMON NAME	ISLAND
Xanthicnemis zealandica	damsel fly	S,T
Celatoblatta sp.	roach	S,T
Forficula auricularia	Australian earwig	S,T
Pteronemobius bigelowi	cricket	S,T
Conocephalus semivittatus	green grasshoper	T
Phaulacridium marginale	grasshopper	S,T
Sigaus australis	grasshopper	S
Mecodema lucidum	predator beetle	S
Oregus aureus	predator beetle	S
Metaglymma tibiale	predator beetle	S,T
Laemostenus complanatus	predator beetle	T
M*egadromus fultoni/memes*	predator beetle	S,T
Megadromus sandageri	predator beetle	T
Staphylinidae spp.	rove beetle	S,T
Odontria australis	chafer	S,T
Pyronota species	manuka chafer	T
Mimopeus opaculus	darkling beetle	S,T
Curculionidae	weevils	S,T
Chironomus ?zealandicus	midge	S,T
Muscoidea	blowflies	S,T
Oecetis unicolor	lake caddis	S,T
Paroxyethira eatonii	lake caddis	S,T
Rhapsa scotosialis	detritus moth	S,T
other Noctuidae	herb feeders	S,T
Epyaxa rosearia	herb feeder	S,T
other Geometridae	herb feeders	S,T
Gymnobathra sp.	detritus moth	S,T
Heterocrossa sp.	detritus moth	S,T
Leioproctus spp.	native bees	S,T
Vespula germanica	German moth	S,T
Lycosa spp.	wolf spiders	S,T
Dolomedes aquaticus	wolf spider	S,T
Eriophora heroine	Aust. orb web spider	S,T
Pseudoscorpiones		S,T
Diplopoda spp.	centipedes	S,T
Chilopoda spp.	millipedes	S,T
Porcello scaber	slater	T
Annelid spp.	earthworms	S,T

Some insect and spider species present on the islands are vagrants from Australia, e.g. the garden orbweb spider *Eriophora heroine* was very common on both islands as was the painted lady butterfly *Cynthia kershawii*. A nest of German wasps *Vespula germanica* (established from Europe) was found on Silver Island.

The wood-inhabiting fauna of Silver Island appears particularly rich, with many species of long horn beetles, darkling beetles, fly larvae, millipedes and centipedes being encountered in the survey. The mistletoe moth fauna of Silver

Island is also of note, since mistletoes have generally gone from most parts of Otago. A rare predatory ground beetle of conservation concern *Mecodema fultoni/memes* is found on both islands. It is listed as a species that is poorly known (Molloy and Davis 1994). However, it has been found throughout Otago in a number of recent surveys. Large ground-dwelling invertebrates (> 20 mm) were rare on both islands with none being encountered in samples of leaf litter. Amphipod hoppers were not recorded in the litter of either island during all the surveys. This is unusual and cannot be accounted for by the generally dry conditions since a few damp sites remained and were searched (amphipods require moist conditions to live).

In general, Silver Island and Stevensons Island/Te Peka Karara appear to have the insect faunas representative of such habitats in west Otago.

We were assisted in the assessment of vulnerability of species to buff weka predation by information from R. Forster and B. Patrick. Important criteria were invertebrate body size, mobility, habitat (e.g. under bark in litter or in soil) and availability of cover to escape predation. There were no snails, millipedes, centipedes, slaters, spiders or insects whose populations were judged as being likely to disappear as a result of buff weka introduction. While some larger ground-dwelling invertebrates would become less common on the islands if buff weka are introduced, their value and their community value was judged as likely to continue with some change in community composition and feeding relationships. For example, if buff weka were introduced, it may be possible that detritus-feeding centipedes would play less of a functional role in decomposing litter and the much smaller springtail species may play a larger role.

7. Discussion

7.1 POTENTIAL IMPACT OF BUFF WEKA

Buff weka have a natural curiosity and will try to eat anything that seems interesting. As a consequence, any animal smaller than themselves that can be run down, probed for or snapped up is likely to be eaten. A possible exception to this are animals that are distasteful. Beauchamp (1996) found that captive weka rejected New Zealand native frogs *Leiopelma* species after holding them in their beaks. Another exception may be nocturnally-active animals such as some spiders and insects, geckos and rodents, since weka are mainly day active, although some will forage at night (Beauchamp 1987a; Andrew Roberts pers. comm.).

The eggs and young of ground-nesting birds will be vulnerable to buff weka. Thus, New Zealand scaup and Canada geese nests are likely to fail on Silver Island after the introduction of weka. The nests of rock pigeon and, possibly, shags *Phalacrocorax* spp. may be threatened on the bluffs on the Island. There are no recent observations of birds ground-nesting on Stevensons Island/Te Peka Karara, though New Zealand scaup and quail are regular visitors. By inference from numerous observations (Dave King pers. comm.), buff weka would reduce the density of lizards on both islands. Less is known about the interaction of weka and rodents (see Beauchamp et al. 1997).

Large ground-dwelling invertebrates are vulnerable to weka. Weka would, however, be just one of a number of predators. As German wasps, gecko, white backed magpie and rodents are already present. However, buff weka are bold and active by day and may eat invertebrates that shy or night active predators wouldn't. Grasshoppers and crickets would be expected to become less common in the presence of weka. Among the invertebrate species noted so far, few are large and none appear vulnerable. This may be the result of the current modified state of the islands and the existing presence of rodents (Bremner et al. 1989, Ramsay 1978, Richard 1996). The effect of mice and rats on macro-invertebrate abundance by direct predation (Ramsay 1978) and indirect effects e.g., competition for foods (Ramsay 1978) is a possibility on many New Zealand islands. Bremner et al. (1989) found evidence for the hypothesis that the presence of Norway rats on islands leads to an invertebrate community with reduced abundances and where large invertebrates were scarce. In both that study and our surveys, insect species > 20 mm were absent from the litter. Mo Wahu is an island near Stevensons Island/Te Peka Karara in Lake Wanaka. It has a large weta species (*Hemideina maori,* >40 mm) and huhu (*Prionoplus reticularis,* >35 mm) and no rodents (B. McKinlay pers. comm.). This suggests that rodents have had an effect on the large insect faunas on both Silver and Stevensons Island/Te Peka Karara.

7.2 FOOD RESOURCE

Both Silver Island and Stevensons Island/Te Peka Karara are within the historic range of buff weka (Anon 1863, Beauchamp et al. 1997). However, it is apparent that in recent time (the last 100 years) fire and introduced insects, birds, mammals and grasses have together changed the communities present. These elements also play important roles in the existing community. Because this is the case, it is difficult to predict the suitability of these islands as habitat for buff weka. In a South Island context, moderate temperatures and temperature variation are experienced by the islands. Average annual rainfall is also moderate in this context. However, both islands are exposed and experience frequent high winds from the north and periods of drought stress (six weeks or more without significant rain) are likely in any year. These two factors together may be important regulators of general invertebrate activity and production. The rate of growth of shoots, fruit maturation and seed set can also be controlled by such climate variation. Seasonal control of resource availability means that invertebrate activity is minimal during cool winter days and fruit scarce. During spring, many litter invertebrates would be present as juveniles too small for buff weka to find. During mid to late summer, invertebrates would be more available in warmer periods and fruit supply at its best. It should be noted that Stevensons Island/Te Peka Karara has a high proportion of its vegetation as fruit-producing shrubs. The climatic controls on weka food resources are ameliorated to some extent on Stevensons Island/Te Peka Karara by its larger size and by large areas of strand along the shoreline where detritus including lake weeds, seeds, fruits insects etc. wash up. An additional external food source of some significance are the aquatic midges and caddis that emerge from the lake waters.

In our surveys, an approximate quantitative comparison has been drawn between the litter-inhabiting invertebrates of the islands (Edwards, unpublished data). This was done for samples collected in April during a dry period. For litter invertebrates over 5 mm long, standing crop biomass estimates for each island showed that Te Peka Karara (65 ha; ~93 kg AFDM) (AFDM = ash free dry mass) had approximately 4 times as much biomass as Silver Island (24.7 ha; ~24 kg AFDM). Wetter and warmer conditions are likely to add significantly to this food resource. Brockie and Moeed (1986) calculated litter invertebrate biomass per unit area for broadleaf-podocarp forest in Orongorongo Valley, Wellington; our values range from approximately 1.5% (kanuka-shrub mix site) to approximately 20% (beech site) of that estimate. Invertebrate production is likely to be substantially less because of the cooler average temperatures in Otago compared with the lower North Island.

This analysis of food resources suggests that buff weka populations could be sustained on these islands at low densities. It is also likely that periodic food limitation would occur. Various studies of weka (Beauchamp 1987, Coleman et al 1983, Marchant and Higgins 1993) have shown that breeding pairs occupy territories of 1.96 ha (average for Kapiti Island) to >4.5 ha (average for Double Cove, Marlborough Sounds). Thus for Stevensons Island/Te Peka Karara (65 ha) buff weka breeding success might be poor if more than an equivalent 15–20 pairs were established.

7.3 THREATS TO BUFF WEKA

On both islands, Australasian harrier, stoats and, potentially, ferrets *Mustela furo* as occasional visitors pose a threat to buff weka nests and juveniles (Beauchamp et al. 1997). Rats are possible nest predators and competitors, but direct evidence for this is lacking (Beauchamp et al. 1997). Dogs visiting Stevensons Island/Te Peka Karara are clearly a threat (Beauchamp et al. 1997). Fire has helped to shape the current ecosystems on the islands and remains a risk to the success of a buff weka release.

Considering resource availability and threats, we conclude that Stevensons Island/Te Peka Karara could sustain weka with management and with regard to the following recommendations.

8. Recommendations if weka are introduced to Stevensons Island/Te Peka Karara

1) Very little is known about the effect of buff weka on Otago ecosystems and lizards in particular. We recommend that a small buff weka exclosure should be constructed. A comparative experiment, contrasting areas with and with out weka, should be able to identify the impact of buff weka on gecko, skinks, some insects and leaf litter state.

2) Consideration should be given to eradicating rodents from the islands. Such a decision would need to take possible re-invasion into account. If eradication is considered then it should be carried out prior to buff weka introduction.

3) A plan for dog control should be considered.

4) Control systems for stoats and ferrets should be considered, especially during weka nesting periods.

5) Measures for fire prevention should be reviewed.

6) Buff weka could be introduced to Silver Island if, firstly, the presence of weka is considered more important than New Zealand scaup and other birds that nest on the island and, secondly, the island is monitored as in 1) and managed as in 4).

7) A careful analysis of other species that could be introduced to the islands should be carried out, since weka may have an impact on them. For example, should these islands be considered for conservation of kiwi *Apteryx* species or other birds and Otago skink *Leiolopisma otagoense* rather than weka? Could they co-exist with weka?

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10. References

Anon. 1863: Dr Hectors expedition: Successful penetration to the west coast, to within sight of the sea, and eight miles of the shore. February 9th, 1863. Otago Daily Times.

Bathgate, A. 1922: Some changes in the fauna and flora of Otago in the last sixty years. *The New Zealand Journal of Science and Technology 4(6)*: 273–283.

Beauchamp, A.J. 1987a: Unpublished. A population study of the weka (*Gallirallus australis*) on Kapiti Island. PhD thesis, Zoology Department, Victoria University, Wellington.

Beauchamp, A.J. 1987b: The social structure of the Weka (*Gallirallus australis*) at Double Cove, Marlborough Sounds. *Notornis 34*: 317–325.

Beauchamp, A.J. 1996: Weka (*Galliralis australis*) and *Leiopelma* frogs - a risk assessment. *Notornis 43*: 59–65.

Beauchamp, A.J.; Butler, D.J.; King, D. 1997: Unpublished. Draft; Weka (*Gallirallus australis*) recovery plan. Department of Conservation.

Bremner, A.G.; Barratt, B.I.P.; Butcher, C.F.; Patterson, G.B. 1989: The effect of mammalian predation on invertebrate behaviour in south west Fiordland. *New Zealand Entomologist 12*: 72–75.

Brockie, R.E.; Moeed, A. 1986. Animal biomass in a New Zealand forest compared with other parts of the world. *Oecologia 70*: 24–34.

Carroll, A.L.K. 1963: Food habits of the North Island weka. *Notornis 10*: 289–300.

Coleman, J.D.; Warburton, B.; Green, W.Q. 1983: Some population statistics and movements of the western weka. *Notornis 30(2)*: 93–107.

Cranwell, I.J. 1996: Tikanga Atawhai weka translocation project. Department of Conservation, Dunedin.

Heather, B.D.; Robertson, H.A. 1996: The field guide to the birds of New Zealand. Penguin Books, Auckland.

Hitchmough, R. 1998: Species status of Otago *Hoplodactylus maculatus* complex. Department of Conservation. *Conservation Advisory Science Note No. 193*.

Jewell, T.; McFarlane, L. 1997: Unpublished. Research on grey geckos (genus *Hoplodactylus* Fitzinger, 1843) in the Hawea-Wanaka district, 5–9 May 1997. Department of Conservation, Invercargill.

Marchant, S.; Higgins, P.J. (eds.) 1993: *Gallirallus australis* weka in: Handbook of Australian, New Zealand and Antarctic Birds. Melbourne, Oxford University Press.

Molloy, J.; Davis, A. 1994: Setting priorities for the conservation of New Zealand's threatened plants and animals. Department of Conservation, Wellington.

Mutch, A.R.; McKellar, I.C. 1964: Geological map of New Zealand, sheet 19 Haast, New Zealand Geological Survey.

Pickard, C.R.; Towns, D.R. 1988: Atlas of the Amphibians and Reptiles of New Zealand. *Conservation Sciences Publication No. 1*, Department of Conservation, Wellington.

Ramsay, G.W. 1978: A review of the effects of rodents on the New Zeland invertebrate fauna. In: The ecology of rodents in New Zealand nature reserves. Dingwall, P.R.; Atkinson, I.A.E.; Hay, C. Wellington, Department of Lands and Survey.

Richard, C.G. 1996: Unpublished. Introduced small mammals and invertebrate conservation in a lowland podocarp forest, South Westland, New Zealand. MSc thesis, School of Forestry, University of Canterbury, Christchurch: p. 164.

Sturmer, A.T. 1988: Unpublished. Diet and coexistence of *Rattus rattus* (Linnaeus), *Rattus exulans* (Pearle) and *Rattus norvegicus* (Berkenhout) on Stewart Island, New Zealand. MSc thesis, Massey University, Palmerston North: p. 135.

Tann, C.R.; Singleton, G.R.; Coman, B.J. 1991: Diet of the house mouse, *Mus domesticus*, in the Mallee Wheatlands of North-Western Victoria. *Wildlife Research 18*: 1–12.

Ward, G.; Munro, C.M. 1989: Otago II, biological survey of reserves series number 20. Department of Conservation, Wellington.

Wood, B.L. 1962: Geological map of New Zealand, 1:250 000, sheet 22 Wakatipu, New Zealand Geological Survey.

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