Notornis, 2005, Vol. 52: 1-5
0029-4470

Roost habitat of a North Island blue duck (*Hymenolaimus malacorhynchos*) population

B. R. BAILLIE
Forest Research, Private Bag 3020, Rotorua, New Zealand. *brenda.baillie@forestresearch.co.nz*

A. B. GLASER
Department of Conservation, Opotiki Area Office, P. O. Box 326, Opotiki, New Zealand.

Abstract A survey was undertaken in the Te Waiiti Stream, Bay of Plenty, in summer 2002/2003, to identify blue duck (*Hymenolaimus malacorhynchos*) roost habitat. Thirty-six roosts were identified along 18.5 km of stream channel, averaging three roosts per blue duck pair. Stable undercut banks were most commonly used as roost sites (42%), followed by log jams along stream banks (25%). Large woody debris (LWD) was a component of 50% of the roost sites, and there was a positive relationship between LWD loadings in the stream channel and number of LWD roosts. All roosts provided overhead and lateral cover, most likely an adaptive response to current and historic avian predators, and all were located at the water's edge. The location and composition of roosts provided easy access to the stream channel, discrete cover for rearing juveniles and for moulting, and daytime shelter. There were indications that channel morphology characteristics in the lower section of the survey reach may be limiting roost habitat availability and blue duck occupancy. Suitable roost habitat is a year-round requirement for blue duck and should be considered when evaluating their habitat.

Baillie, B.R.; Glaser, A.B. 2005. Roost habitat of a North Island blue duck (*Hymenolaimus malacorhynchos*) population. Notornis *52(1)*: 1-5.

Keywords Blue duck; *Hymenolaimus malacorhychos*; roost; riparian; woody debris; Te Waiiti

INTRODUCTION

Blue duck, or whio (*Hymenolaimus malacorhynchos*), is a nationally endangered waterfowl (Hitchmough 2002) which lives on fast-flowing rivers and streams in New Zealand. It is one of only four duck species world-wide adapted to living year-round on rivers (Williams & McKinney 1996). Early records indicate that blue duck was once widespread throughout the North and South Islands of New Zealand (Kear 1972; Fordyce 1976; Worthy & Holdway 2002). They have disappeared from many parts of their former range and remaining populations are fragmented and mainly confined to headwaters of catchments in eastern and central North Island, West Coast and Fiordland. The decline in blue duck populations has been attributed to loss of habitat through land-use change, loss of riparian vegetation, flow modification, introduced mammalian predators and direct human disturbance (Adams *et al.* 1997). Blue duck's inherent low reproductive rate, irregular breeding success, and poor juvenile recruitment and survival rates contribute to the difficulty in sustaining long-term viable populations.

Blue ducks form long-term pair bonds and defend year-round territories of approximately 1 km in length (Eldridge 1986; Veltman *et al.* 1991; Williams 1991). They currently occupy a wide range of habitats and, in Collier *et al.*'s (1993) study, were found on river systems with gradients ranging from 12-106 m/km, altitudes from 82-1050 m a.s.l., channel widths 8-60 m, and native riparian vegetation ranging from 0-100%. Blue duck tend to inhabit river systems that provide adequate aquatic invertebrate food supplies, riparian cover, and sites for nesting, moulting, and brood-rearing habitat. (Collier *et al.* 1993; Adams *et al.* 1997).

Roost habitat is also an important year-round requirement for blue duck, providing cover and concealment from aerial predators when resting and sleeping, but there is little quantitative information on the composition or location of roost sites. Anecdotal evidence suggests that large woody debris (LWD; >10cm diameter, >1m in length) recruited from riparian trees entering the stream system, often provides roost sites for blue duck. During blue duck surveys, the authors have observed that birds regularly occupied, or were flushed out from under, individual logs, log jams, and large root wads. Williams (1979) also noted that blue duck roost amongst log jams or beneath streamside vegetation during the day. As a high proportion of known blue duck populations occupy rivers where native forest riparian vegetation is

Received 4 August 2004; accepted 5 December 2004.
Editor Y. van Heezik

present (Collier *et al*. 1993), we hypothesise that LWD will be an important component of blue duck roost habitat. However, as LWD loadings tend to decrease with increasing channel width (Bilby & Ward 1989), we expected the role of LWD in roost habitat to decrease with increasing distance downstream.

In an initial survey of headwaters of Takaputahi River, a tributary of the Motu River in Bay of Plenty, North Island, the majority of blue duck roost sites were located in undercut banks formed by root systems of trees, principally willows (*Salix* spp.), or log accumulations (Glaser 2004a). However, the blue duck population in the Takaputahi River headwaters was too small for the requirements of this study and Te Waiiti Stream with its larger blue duck population was selected instead. This study outlines the results of the survey in Te Waiiti Stream to (i) identify and quantify blue duck roost habitat in a forested catchment and, (ii) determine the role of LWD in providing roost habitat.

METHODS

Site description

The study site was along approximately 18.5 km of Te Waiiti Stream in the headwaters of Waimana River within Te Urewera National Park (survey start 177° 10' 37"E, 38° 21' 41"S; survey end 177° 08' 14"E, 38° 21' 41"S). The stream's catchment area above the survey end point was approximately 8740 ha. The underlying geology is greywacke. The main forest type in the Te Waiiti catchment is mixed rimu (*Dacrydium cupressinum*)/tawa (*Beilschmiedia tawa*) with additional beech (*Nothofagus* sp.) along the ridges and patches of tawa and rimu/ matai (*Prumnopitys taxifolia*)/hardwood along the valley floor (Nicholls 1974). Dominant riparian species were tawa and kamahi (*Weinmannia racemosa*) with kamahi more common in the upper reaches of the stream, along with occasional hinau (*Elaeocarpus dentatus*), rewarewa (*Knightia excelsa*) and rimu. Understorey riparian species included whitey wood (*Melicytus ramiflorus*), toetoe (*Cortaderia* sp.), tutu (*Coriaria arborea*), wineberry (*Aristotelia serrata*), marble leaf (*Carpodetus serratus*), kanuka (*Kunzea ericoides*) and tree ferns, primarily *Dicksonia squarrosa*, with occasional *Cyathea smithii*.

Monitoring of the blue duck population on Te Waiiti Stream began in 1999. Extensive stoat trapping is undertaken in this area and annual assessments of blue duck productivity are made in conjunction with the Northern Te Urewera Ecosystem Restoration (NTUERP) Mainland Island Project to provide a measure of the effectiveness of predator control. In the first three years of predator trapping (1999-2002) there was an increase in total blue duck numbers, from 34 birds to 74 birds, reflecting an increase in both adult and juvenile birds (Glaser 2004b).

Blue duck roost survey

The initial survey in December 2002 to identify blue duck numbers was carried out using the standardised walk-through method of Studholme (2000). Surveying was conducted during early morning (0600-1000hrs) and late evening (1600-1930hrs) using one or two people. Each section of Te Waiiti Stream was surveyed at least twice to include a morning and evening period and at least one of these surveys was aided by a trained bird locator dog.

Roost sites in current use were identified by the dog scenting along the river margins during periods of the day when the birds were least likely to be on the river feeding (1000hrs-1600hrs). Blue ducks were not always present in the roosts, but faeces, feathers and feather scale or dust identified them. Repeat surveys in late December 2002 and January 2003 identified additional roost sites not located in the initial survey.

The location of each roost site was recorded as a NZMS 260 (1:50,000) map series grid reference and its distance downstream from the start of the survey area was subsequently determined. Roost position in the channel was categorised as either bank edge or in-channel. Roost type included; undercut bank, log jam (log accumulations), log (individual log), root plate, or rock cave. A photograph and additional descriptive notes were taken for each roost site, noting, in particular, the vegetation composition immediately above the undercut banks.

Woody debris

To determine whether woody debris loadings in the stream channel were influencing roost density and type, eighteen 200 m transects were spaced at 1 km intervals along the study reach. Channel widths were taken at 20 m intervals along each 200 m transect and averaged for each transect to determine whether channel width was influencing woody debris loadings. Within each transect all LWD in the stream channel and immediate bank edge was counted and assessed for grouping (single, clumped, log jam), and location (bank edge, instream or suspended).

RESULTS

Channel width

Mean channel width was 15.7 m increasing from 5.6 m at the start of the survey site to 23.1 m 13 km downstream, with widths ranging from 13.8 - 20.5 m for the remaining 5 km of the survey area. There was a strong positive linear correlation between channel width and increasing distance downstream from the start of the study reach for the first 13 km of the reach length (Fig 1: $r^2 = 0.82$). However for the remainder of the reach length, channel widths decreased.

Large woody debris

LWD loadings in the stream channel varied, ranging from 0 to 74 pieces/transect and averaged 19 pieces/transect. The majority of pieces were located along the channel edge (75%), the remaining pieces were either lying in the stream channel (19%), or suspended across the stream channel (6%). Most of the pieces were single or in loose clumps (64%) and 36% of pieces were in log jams. LWD loadings (no. of pieces/m^2 of transect) decreased significantly with increasing distance downstream and increasing channel width (log relationship, r^2 = 0.56, $F_{1,16}$ = 19.89, P < 0.001 and r^2 = 0.03, $F_{1,16}$ = 6.83, P = 0.02 respectively).

Blue ducks

In total, 67 birds were found along the survey area: 12 pairs, 40 juveniles, a single male and female and one fledgling. On average there were 0.67 blue duck pairs/km and the majority of pairs were dispersed along the first 13 km of the study reach, with only two pairs located in the last 5.5 km (Fig. 2).

Roosts

Thirty-six roosts were located along the survey area, an average of three roosts/pair. Individual territory boundaries for each pair were unknown so it was not possible to identify number of roosts per individual pair. All roosts were located at, or very close to, the water's edge with 92% located along the channel bank edge, and only two roost sites in the middle of the channel. All roost sites provided lateral and overhead cover.

Undercut banks were the most commonly used roost sites (42%), followed by log jams (25%) (Fig. 3) and LWD was a component of 18 (50%) roost sites. The root systems from riparian vegetation were an important factor in providing stable undercut banks. The main species involved were tree ferns, kamahi, tawa, marble leaf, and hinau. Roosts were located, on average, 0.5 km apart (range 0 -1.8 km), with the majority less than 0.8 km apart. Roosts were fewer and more widely distributed in the lower part of the study area averaging 1.1 km between roosts in the last 5.5 km of the study reach (Fig. 2). The birds were utilising either rock caves or log jams as roost sites in this part of the river system. Regression analysis found a positive relationship between the density of roosts where LWD was a component and LWD loadings in the stream channel (r^2 = 0.27, $F_{1,16}$ = 5.81, P = 0.03) and a weak relationship with increasing distance downstream (r^2 = 0.20, $F_{1,16}$ = 3.97, P = 0.06).

DISCUSSION

Native forest riparian vegetation and in-stream LWD were both important components of blue duck roost habitat in Te Waiiti Stream. Root systems

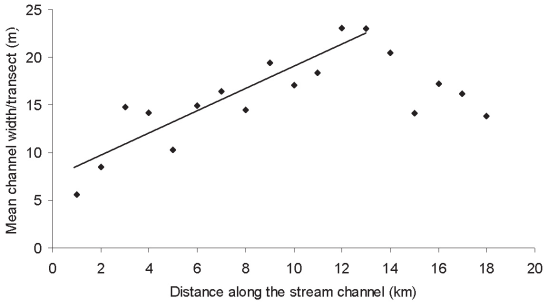

Figure 1 Mean channel widths along the Te Waiiti Stream channel, linear relationship shown for the first 13 kilometers only, y=1.196x+7.0107.

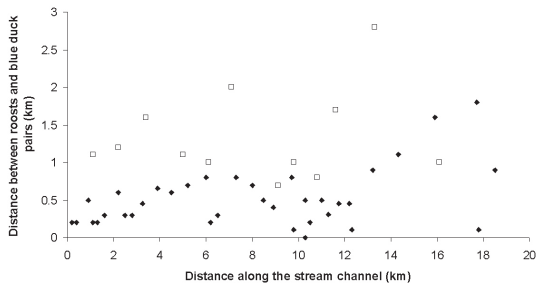

Figure 2 Distribution of blue duck pairs and roosts along Te Waiiti Stream.

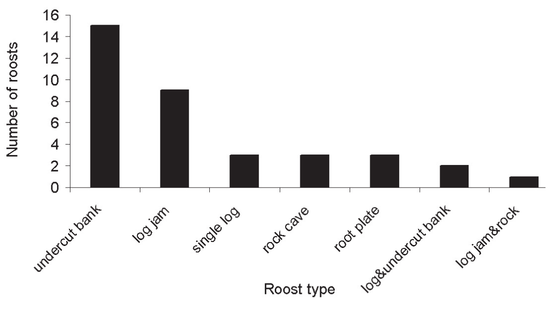

Figure 3 Composition of blue duck roosts on Te Waiiti Stream.

of trees and shrubs provided stable undercut banks and overhead cover for the birds, accounting for approximately half the roost sites identified in the survey. The native forest riparian vegetation was also delivering large structural pieces of wood to the stream system, providing roost habitat in the form of log jams, individual logs and large root plates. The location of these LWD pieces was also a factor contributing to their suitability as roost habitat. Fluvial processes in the Te Waiiti River system had realigned a large proportion of LWD pieces along and parallel to the bank edge, the same area of stream channel where blue ducks were roosting. LWD loadings did show an expected decrease with increasing channel width and distance downstream (Bilby & Ward 1989). The results also confirmed a link between LWD loadings in the stream channel and LWD as a component of roost habitat. However, LWD did not appear to be factor limiting roost availability as the blue duck utilised other sites such as undercut banks and rock caves.

Blue duck pairs were utilising more than one roost site in Te Waiiti Stream, the roosts varying from a single log to a complex labyrinth of holes in a root plate. The location and number of roosts were dependent on the area that pairs inhabited and the availability of suitable alternative sites. All roosts were located at, or close to, the water and roost use is likely to change during the year in response to variable flow regimes. The most likely reason for the location of the roosts would be ease of access direct to the stream.

The roosts also provided the birds with lateral and overhead cover so that they were not visible from the stream channel. As blue duck are usually most active around dawn and dusk (Williams 1985; Veltman & Williams, 1990), these roosts provide concealment and thermal insulation for a large portion of the day when moulting, rearing juveniles, and resting out of the heat. Areas where blue duck have been consistently found have been associated with these roosts, particularly roosts that have persisted over time (Glaser 2004b).

The requirement of overhead cover could also be an evolutionary adaptive response to avian predators. Crepuscular behaviour, cryptic colouration, and use of diurnal overhead cover to reduce visibility from above, all features of blue duck, are adaptive responses to avian predators that hunt mainly by sight (Worthy and Holdaway 2002). Most likely predators were New Zealand falcon, or karearea (*Falco novaeseelandiae*), Australasian harrier, or kahu (*Circus approximans*), and the now extinct Eyles's harrier (*Circus eylesi*). Collier *et al.*, (1993) suggested that one of the reasons for blue duck residing predominantly on native forested rivers was that the tall vegetation may be providing visual lateral security. Locating roosts at or close to the waterline may have been an appropriate defense or escape mechanism in the past, when discreet entry and egress from roost sites outweighed the risk of floods flushing out and fragmenting newly hatched broods. This strategy has limited success against introduced mammalian predators, which hunt predominantly by smell.

In the lower third of the study reach there was a reduction in duck and roost density (Fig. 2). While the Te Waiiti population has expanded (150% increase in pairs and 155% increase in juveniles since 1999; Glaser 2004a), the birds have not colonised the lower section of this river. Here, channel interaction with the riparian vegetation was restricted where channel morphology alternated between narrower gorge sections controlled by bedrock and wider sections where the stream broadened out with wide gravel bars. Undercut bank roost sites were absent in this lower portion of the reach and other suitable roost habitat adjacent to the water edge was scarce. Other environmental factors considered to influence blue duck distribution such as gradient, substrate, suitable feeding habitat, channel width and native riparian vegetation appeared to be within the range of other blue duck sites (Collier *et al*. 1993) indicating that channel morphology was limiting roost availability, which in turn may be constraining the duck's distribution. Further studies in streams of differing channel morphology would provide a test of this conclusion.

While blue ducks appear to favour habitats with native forest riparian vegetation (Collier *et al*. 1993), they have successfully established populations in environments where native forest riparian vegetation is scarce e.g., Manganui-a-te-ao River, and parts of Takaputahi River where some blue duck territories are fringed with willows. Given the wide variety of habitats utilised by blue ducks, they appear to be opportunistic in exploiting whatever material is available for roost sites as long as it provides cover and discreet entry and exit routes.

Current populations may not give an accurate picture of what constitutes favourable blue duck habitat, however. Distribution may be a result of past stochastic and anthropogenic events (Godfrey 2003). Prior to human settlement, and when most of New Zealand was forested, blue duck were widespread and most likely extended into the mid- and lower reaches of river systems (Kear 1972; Fordyce 1976). Today, the lower river systems have been heavily modified by land clearance, reduced water quality and river stability, and are rarely inhabited by blue ducks. It is likely that in pre-human times native forest riparian vegetation and instream LWD were integral components of blue duck habitat.

Williams (1991) and Collier *et al.* (1993) have identified physical characteristics of rivers currently occupied by blue duck and more recently Godfrey *et al.* (2003) identified territory length and food availability as key factors influencing blue duck behaviour and energy expenditure. Te Waiiti Stream, by supporting a robust and expanding population of blue ducks, points to the possible importance of native forest riparian vegetation and associated LWD, through the provision of roost sites, as an important component in blue duck habitat evaluation.

ACKNOWLEDGEMENTS
We would like to thank Jane Haxton, Mike Paviour and Michelle Gutsell (Department of Conservation, Opotiki) for assisting with the survey in the Te Waiiti, Khan (blue duck locator dog), Sonny Biddle (local landowner), and Murray Williams and Kevin Collier for reviewing and providing constructive comments on the manuscript.

LITERATURE CITED

Adams, J.; Cunningham, D.; Molloy, J.; Phillipson, S. 1997. Blue duck (Whio) *Hymenolaimus malacorhynchos* recovery plan 1997-2007. Wellington, Department of Conservation.

Bilby, R. E.; Ward, J. A. 1989. Changes in characteristics and function of woody debris with increasing size of stream in western Washington. *Transactions of the American Fisheries Society 118*: 368-378.

Collier, K. J.; Moralee, S. J.; Wakelin, M. D. 1993. Factors affecting the distribution of blue duck *Hymenolaimus malacorhynchos* on New Zealand rivers. *Biological Conservation 63*: 119-126.

Eldridge, J. L. 1986. Territoriality in a river specialist: the blue duck. *Wildfowl 37*: 123-35.

Fordyce, R. E. 1976. Distribution and habitat of the blue duck, *Hymenolaimus malacorhynchos*, in the South Island, New Zealand. *Mauri Ora 4*: 79-85.

Glaser, A. B. 2004a. Blue duck monitoring Opotiki area 2002. Opotiki Area Office, Department of Conservation.

Glaser, A. B. 2004b. Blue duck monitoring Opotiki area 2002/2003. Opotiki Area Office, Department of Conservation.

Godfrey, J. D. 2003. Potential use of energy expenditure of individual birds to assess quality of their habitats. Pp. 11-24 *in*: Williams, M. (*comp.*) *Conservation applications of measuring energy expenditure of New Zealand birds: Assessing habitat quality and costs of carrying radio transmitters. Science for Conservation 214*.

Godfrey, J. D.; Bryant, D. M.; Williams, M. 2003. Energetics of blue ducks in rivers of differing physical and biological characteristics. Pp. 35-68 *in*: Williams, M. (*comp.*) *Conservation applications of measuring energy expenditure of New Zealand birds: Assessing habitat quality and costs of carrying radio transmitters*. *Science for Conservation 214*.

Hitchmough, R. (comp). 2002. New Zealand threat classification systems lists-2002. *Threatened species occasional publication 23*. 210p.

Kear, J. 1972. The blue duck of New Zealand. *The Living Bird 11*: 175-92.

Nicholls, J. L. 1974. Urewera forest class map. Forest Service Mapping Series 6, Sheet no. 7, 2nd Edition. New Zealand Forest Service, Wellington, New Zealand.

Studholme, B. 2000. Blue duck (whio). Survey of the distribution and abundance of blue duck (whio) in Kahurangi National Park. *Occasional Publications No. 46*. Department of Conservation, Nelson.

Veltman, C. J.; Triggs, S.; Williams, M.; Collier, K. J.; McNab, B. K.; Newton, L.; Haskell, M.; Henderson 1991. The blue duck mating system – are river specialists any different? *Acta XX Congressus Internationalis Ornithologici*: 860-867.

Veltman, C. J.; Williams, M. 1990. Diurnal use of time and space by breeding blue duck *Hymenolaimus malacorhynchos*. *Wildfowl 41*: 62-74.

Williams, M. 1979. Detecting the presence of blue duck from its faecal sign. *Notornis 26(3)*: 306-307.

Williams, M. 1985. Blue duck. *In*: Robertson, C. J. (*ed) Reader's Digest complete book of New Zealand birds*. Reader's Digest, Sydney. 149p.

Williams, M. 1991. Social and demographic characteristics of blue duck *Hymenolaimus malacorhynchos*. *Wildfowl 42*: 65-86.

Williams, M.; McKinney, F. 1996. Long-term monogamy in a river specialist – the blue duck. Pp. 73-90 *In*: Black, J. M. (*ed*) *Partnership in birds: The study of monogamy*. Oxford, Oxford University Press.

Worthy, T. H.; Holdaway, R. N. 2002. *The lost world of the moa: Prehistoric life of New Zealand*. Canterbury University Press, Christchurch, New Zealand. 718p.