Unusual feeding behaviour and habitat use by koaro

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Abstract

Large koaro *(Galaxias brevipinnis)* were observed drift-feeding in the water column and from the surface in a pool in Cave Brook, a tributary of Big River draining the Gouland Downs, Kahurangi National Park, an area free of introduced trout. This contrasts with the habitat commonly perceived as being koaro habitat which are cascades and fast, boulder riffles. It is suggested that sampling limitations of electrofishing may have given a misleading impression of the habitats occupied by this species in the past, and this may have been exacerbated by the presence of trout. The drift-feeding behaviour and pool habitat use exhibited by koaro is similar to that of introduced trout. Where trout have invaded koaro habitat, predation and competitive displacement of koaro by trout seems highly likely.

Introduction

The purpose of this report is to disseminate information on a recent chance observation of unusual feeding behaviour and habitat use by koaro, *Galaxias brevipinnis,* in Cave Brook, a tributary of the Big River draining the Gouland Downs. The observation extends our knowledge of the ecological niche of koaro and has important ramifications for understanding instream habitat use by this species and interactions with introduced trout. It also reveals some potential bias in existing sampling methods for koaro which probably have lead to underestimates of the distribution and range of habitats occupied by koaro in the Kahurangi National Park and elsewhere.

KNOWN DISTRIBUTION AND HABITAT

The taxonomy, basic life histories, and general distribution patterns of New Zealand's native fish fauna have been fairly well described (McDowall 1990). General features of "typical" habitats of most species also have been described (McDowall 1990) but much remains unknown of the behaviours of many species and on the specifics of their habitat use.

Koaro is the second most common, and the most widespread, of the five diadromous galaxiids which comprise the whitebait runs around the New Zealand coastline. It is found in coastal streams throughout the whole country, including Stewart Island, and is also present on the Chatham, Auckland, and Campbell Islands (McDowall 1990). Of all of the galaxiids, it has the greatest ability to penetrate inland and its climbing abilities are legendary (McDowall 1990). In addition to sea-going populations, landlocked (lake) populations also occur, often at considerable altitude.

McDowall (1990) describes the habitat of koaro as generally being rapidly flowing, tumbling, rocky streams in native forest. Although seagoing

populations are usually associated with native forest, populations of koaro in high-country lakes may also be found in tributaries flowing through subalpine tussock grassland. Within these tumbling streams, koaro are commonly believed to prefer swiftly flowing, bouldery rapids where the fish occur amongst boulders on the stream bed (McDowall 1990). In a regional survey of South Westland freshwaters, Taylor (1988) found koaro usually in cascade pools, riffles, and torrents, but significantly less often in runs, and never in sluggishly flowing or standing waters.

Results

NEW OBSERVATION OF HABITAT USE AND FEEDING BEHAVIOUR

Recently, whilst on the Heaphy Track, I observed koaro drift-feeding in a large, slowmoving pool, entirely different habitat to that previously thought utilised by this species. The observations were made near the Gouland Downs Hut from a walkway bridge and from the bank on undisturbed fish in Cave Brook (41°56'S, 172°21'E), a tributary of the Big River, draining the Gouland Downs, Kahurangi National Park. The Big River rises steeply onto the Gouland Downs in a series of gorges and cascades. The pool in which these fish were observed was c. 25 m long by 5 m wide and for much of its length up to 2 m deep. The flow was estimated visually at roughly 0.5 m^3s^{-1}.

About 15 koaro were observed at dusk drift-feeding throughout the water column and from the water surface. Sizes of these fish were estimated visually at c. 150 - 250 mm. These fish initially caught my attention because they were rising, like trout, for surface insects. As I was aware that trout have not been recorded from the upper Big River catchment, I was particularly interested in identifying these fish. On closer inspection they proved to a species of galaxiid. Some appeared to have prominent, splayed, pectoral and pelvic fins which are diagnostic features of koaro. Others, which were larger and observed deeper in the pool, appeared stouter and were swimming quite strongly in the current. It is not known whether these also were koaro or one of the other galaxiid species. Because of their stout build and mid-water swimming behaviour I initially thought that these fish may have been the rare shortjawed kokopu *(Galaxias postvectis)*. Most of the fish observed feeding were easily frightened, swimming quickly to the bottom of the pool and beneath boulders the moment they detected movement on bank. One fish (c. 150 mm) was captured by hand in the shallows of the pool margin after dark and two more larger specimens (c. 200 mm) were observed at close quarters at the same time in torch-light. These three fish all were koaro.

The fact that koaro use pools and slow margins should not really be that surprising because this species also is known to form lake populations (McDowall 1990). The adults of landlocked koaro are thought to live mostly in streams entering these lakes, but there are observations of large koaro actually in the deeper waters of lakes. McDowall (1990) records an interesting personal com-

munication (P Williams) in a high-elevation, North-West Nelson lake where koaro were observed rising to take adult chironomids at the surface, similar behaviour to that which I observed in Cave Brook.

I have observed koaro feeding during daylight in similar slow-water habitat to that in Cave Brook, but on a much smaller scale, in smaller streams (c. 0.1 - 0.2 m^3s^{-1}) in the vicinity of the Heaphy River. These streams are typical of the tumbling, rocky, bushed streams that typify known koaro habitat. However, even in these streams koaro were observed drift-feeding up in the water column in back eddies, tails, and eyes of pools and other slow water habitat adjacent to fast water. The fast, turbulent water and rocks were used as escape cover by the fish when disturbed.

Koaro appear to be negatively buoyant and as a consequence often swim with their bodies downwardly inclined in the direction of the tail. Adults readily sink to the bottom when they stop swimming. Whilst I have often seen juvenile koaro feeding up in the water column I was somewhat surprised to see adults also exhibiting this behaviour as it must be energetically demanding for a negatively buoyant fish. In the smaller streams mentioned above, the larger adult koaro interspersed periods of active drift-feeding in the water column with bouts of resting on the bottom. It is possible that active drift-feeding by adult koaro coincides with periods of abundant invertebrate drift, at which time the fish may range widely in pool, and other slow-water, habitats.

SIGNIFICANCE TO UNDERSTANDING INSTREAM HABITAT REQUIREMENTS OF KOARO

Koaro are easily caught by electrofishing from riffles and cascades and this gives the general impression that these are the habitats in which this species mainly occurs. My observation of koaro in Cave Brook suggests that the commonly held belief that koaro are a fish of cascades and boulder rapids is too restrictive. The apparent habitat preference of koaro for fast, shallow, rocky habitat may be exaggerated by the sampling limitations of electrofishing machines. Alternatively, koaro may move into pools, from the cover of fast, shallow, rocky habitats, to feed at dusk, and during the night, or to exploit temporary abundances of drifting invertebrates.

Recently, habitat preference criteria have been derived for several New Zealand native fish species (Jowett and Richchardson 1995) for assessing species flow requirements with the in-stream flow incremental methodology (IFIM) (Bovee 1982) and similar work is planned for other species in the near future (I. Jowett pers. comm.). In these studies a stratified sampling procedure using electrofishing has been used whereby the fish and accompanying depth, velocity, and substrate measurements are collected from depth stratified lanes or quadrats in runs and riffles (Jowett 1994, Jowett & Richardson 1995). Using this method, Jowett (1994) quantified the habitat preferences of koaro in the Onekaka River, Golden Bay. He found highest densities of koaro in cascades. The habitat preference curves for depth increased to an optimum at c. 0.2 m then declined to 0 at 0.5 m, and for velocity, increased approximately linearly from 0 to 1.5 m s^{-1}. However, the depth range sampled was quite

restricted (0.08 - 0.80 m) owing to the limitations of electrofishing. My observations on koaro habitat use and feeding behaviour suggest that considerable caution should be exercised when interpreting habitat preferences of relatively little understood native fish from such electrofishing data.

Application of the existing habitat preference curves when assessing the flow requirements of koaro in streams may underestimate the depths used by this species. Nevertheless, flow recommendations made from these preference curves may still adequately protect the range of koaro habitat. This is because as they now stand, koaro preference curves emphasise the importance of fast water for this species. Shallow, fast water habitat declines most rapidly when flows are reduced. Deep pool habitat declines the least as flows are reduced. Consequently, as long as adequate quantities of fast, shallow habitat for koaro are retained, adequate quantities of deep, pool habitat should remain.

The unusual feeding behaviour and habitat use by koaro observed in Cave Brook might also be related to the absence of other fish species, particularly trout. In the face of competition and predation by other species, adult koaro may contract their habitat range and stay close to cover. Isolated habitat refuges, such as Cave Brook, where koaro occur in the absence of introduced trout, and most other native fish, provide the best opportunities for studying habitat preferences of this species.

SIGNIFICANCE TO KNOWN DISTRIBUTION OF KOARO IN THE KAHURANGI NATIONAL PARK

In 1992 I was involved in an electrofishing survey of the Big River catchment and other westward draining rivers and streams of the North West Nelson Forest Park as part of a faunal inventory for the then proposed Kahurangi National Park. During that survey, three Big River tributaries, in the vicinity of Cave Brook and all on the Gouland Downs, were sampled using a 90 Watt back-pack electrofishing machine. In total c. 660 m^2 were fished. Only four koaro and five long finned eel were recorded. Our general impression from electrofishing was that koaro were rare on the Gouland Downs, possibly owing to difficult access through the many gorges in Big River on route from the sea. My observations on Cave Brook, subsequent to undertaking this extensive fish survey raises questions over the adequacy of rapid electrofishing surveys, using relatively lowpowered electrofishing machines, for assessing the distribution and relative abundance of native fish. It appears that electrofishing needs to be augmented by alternative, albeit more time consuming, methods such as visual observation (by daylight or spotlight) and perhaps netting and trapping for a confident assessment of species distribution and relative abundance. The less invasive visual observation methods (either from the bank or underwater) have the bonus that they provide valuable information of the natural behaviour and habitat use by the fish.

THE ECOLOGICAL NICHE OF KOARO AND INTERACTIONS WITH TROUT

In the light of what is already known of the behaviour and habitat of koaro, my observations point to this species being a versatile generalist able to exploit a wide range of habitats within bouldery streams. Its drift-feeding behaviour and exploitation of drift lines in pools is very similar to the feeding behaviour of introduced brown and rainbow trout. Where trout have invaded koaro habitat, predation and competitive displacement of koaro by trout seems highly likely. Koaro are known to have been heavily reduced by introduced trout, especially lake populations (McDowall 1990) and I have observed juvenile trout aggressively dominating juvenile koaro in social interactions (personal observation). The relatively high density, and behaviour, of large koaro observed in the pool in Cave Brook gives a indication of how abundant, and visible, koaro might have been throughout New Zealand before the introduction of trout.

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