ON A REGIONAL MODEL FOR NOCTURNAL HABITAT REQUIREMENTS OF BANDED KOKOPU (GALAXIAS FASCIATUS) IN THE NORTH ISLAND, NEW ZEALAND

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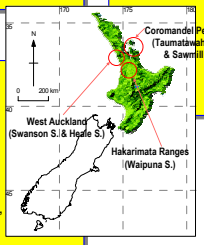
INTRODUCTION

- Often one of the main difficulties in determining an instream environmental flow regime is a lack of habitat suitability criteria data for the species inhabiting waterbodies, e.g., New Zealand waters when reduced flow issues arose (McDowall, 1993)
- *On a regional scale*, successful habitat suitability criteria have been obtained by several authors (Groshens & Orth, 1993; Lamouroux *et al.,* 1999). Regional models are attractive tools for large-scale, multi-site management (Lamouroux *et al.,* 1999)
- Few publications have dealt with both the transferability of habitat suitability criteria and how to assess the validity of regional models for different streams (e.g. Groshens & Orth, 1993, Thomas & Bovee, 1993)
- Concept of "habitat preference": if an organism is found in a higher proportion under the conditions of a particular environment, compared with the total availability of those conditions, then it has actively selected for that set of conditions (Manly *et al.,* 1993).

METHODS

- Fish location: Nocturnal observation by spotlight (cherry red filtered 100 W). At every location, a numbered marker is placed; the number is noted with the group: 0+ (total length < 80 mm) or 1+ (above 80)
- As expected, fish usually moved to the bottom and settled down, allowing our approach and even touching them (see picture).
- Habitat use measurements: depth, nearby cover elements, substrate type, mean column velocity (at 0·6 of column depth) & surface velocity.
- Habitat conditions (availability): Random sampling for the same five variables. Also, an estimation of flow rate was made.



STUDY SITES & SPECIES

- *Galaxias fasciatus* Gray (family Galaxiidae) is the most common large galaxiid and endemic to New Zealand. They are exclusively opportunistic predators, feeding largely on invertebrates. Typical habitats are pools in slow flowing, small 1st-order headwater streams. Typically *it is active at night*.
- Sites: The 5 streams were in three major regions: the Coromandel Peninsula, West Auckland, and West Huntly (the Hakarimata Ranges); they had high densities of Kokopu and were ≤ 2nd order (Strahler). Dates: from October to December, 1997.
- All sites were in native bush; either as mature canopy or as well-established regeneration
- The behaviour of banded kokopu has been studied with respect to both the way one person approaches and the illumination (McCullough & Hicks, 2002)----------> **Table 1**

Photo C. McCULLOUGH

Approach noise	Spotlight colour	Spotlight intensity	Fishes behavioural response
Loud	White	High	Most fish already hidden before spotlighting begins, with any remaining fish being highly agitated and mobile.
Loud	White	Low	
Loud	Red	High	
Loud	Red	Low	
Quiet	White	High	Fish scatter rapidly and will not settle.
Quiet	White	Low	Fish move to bottom, often still unsettled.
Quiet	Red	High	Fish move to bottom, settle slowly.
Quiet	Red	Low	Fish move to bottom, settle quickly.

HAKARIMATA STREAM

FIELD WORK SUMMARY

Table 2. Sample size for the study of nocturnal habitat use by banded kokopu (juveniles and adults separately) and habitat available in the five streams. Estimated current flow is also included.

Stream name	Habitat use		Habitat Available	Gauging (m^3/ s)
	Juveniles	Adults		
Heale	39	8	52	0·0089
Sawmill	2	76	74	0·0028
Swanson	14	31	49	0·0025
Taumatawahine	14	55	70	0·0057
Waipuna	18	34	39	No data

Table 3. Maximum values recorded in microhabitat conditions available (5 sites total)

DEPTH	MEAN WATER COLUMN VELOCITY	SURFACE VELOCITY
0·76 m	0·70 m/s	1·1 m/s

ADULT BANDED KOKOPU NEAR THE POSITION MARKER

RESULTS

1st: POOLING ALL DATA TOGETHER → GENERALIZED HABITAT SUITABILITY CRITERIA (HSC) (category II)

Table 4. Optimal and suitable ranges of each variable that defines the regional model of habitat suitability

Variable	Optimal range	Suitable range
Depth (m)	0·08-0·22	0·02-0·44
Mean water column velocity (m/s)	0·00-0·04	0·00-0·13
Surface velocity (m/s)	0·01-0·06	0·00-0·14
Substrate type	fine gravel-gravel	sand-bedrock

2nd: TESTING OF TRANSFERABILITY OF THE GENERALIZED HSC TO EACH STREAM

ALL RESULTS WERE POSITIVE (p<0·05) FOLLOWING THE PROCEDURES USED BY (I) THOMAS & BOVEE (1993) AND (II) GROSHENS & ORTH (1993)

Table 5. Probability of the chi-square tests performed for testing transferability of the regional model for each stream, in two ways: (I) optimal/usable and suitable/unsuitable or (II) optimal/marginal and suitable/unsuitable.

Stream	Optimal/ Usable	Optimal/ Marginal	Suitable/ Unsuitable
Heale	0·999	1·000	0·994
Sawmill	0·986	0·998	0·998
Swanson	0·968	0·991	0·997
Taumatawahine	0·967	0·999	1·000
Waipuna	0·978	0·990	0·991

Based on previous works, we agree that it is difficult to pass both tests (Thomas & Bovee, 1993; Martínez-Capel, 2000; Martínez-Capel & García de Jalón, unpubl.) and estimate that a confidence level of 90% would be correct for this purpose.

3rd: TESTING OF NON-RANDOM USE OF HABITAT ⇔ MICROHABITAT USE ≠ AVAILABILITY

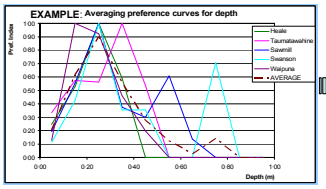
IT IS AN ESSENTIAL CONDITION FOR ASSESSING HABITAT PREFERENCE (Manly *et al.*, 1993)

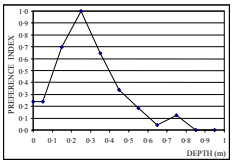
The test for comparing the use and availability was positive in all cases (p<0.05) for velocity; failed in Heale Stream (p=0.052) for depth. Substrate and cover only gave positive results in one stream.

Preference curves are valid for depth & velocity; substrate and cover seem to be randomly used by banded kokopu (i.e. they are not limiting factors).

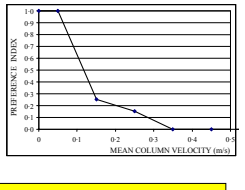
4th: COMPUTED LOCAL PREFERENCE CURVES AND AVERAGING ⇒ GLOBAL CURVES

HERE WE ONLY SHOW INFORMATION FOR JUVENILES AND ADULTS TOGETHER





- Some studies have detected that fishes prefer the maximum depths available; this does not seem the behaviour of banded kokopu
- Depth is related to the size of the fish, so the number of 0+ (N=87) and 1+ (N=204) individuals can be relevant to our results
- Most observations for adults; so, we assumed the range of preferred depths (approximately 0·10-0·40 m with pref. index over 0·5) represents good microhabitat conditions for this species in both life stages
- Preferred velocities are below 0·15 m/s (pref. index>0·5)



5rd: TRANSFERABILITY OF PREFERENCE CURVES (?)

The success of the test based on HSC requires a proper selection of specific conditions by the fish (i.e., a net positive difference between the proportion of habitat used and available conditions). From our point of view, the preference functions based on the same data of habitat use and availability do not need any extra validation on a regional scale, but the transferability of the habitat suitability criteria is satisfactory evidence of their validity.

* McCullough, C.D. and B.J. Hicks. 2002. Estimating the abundance of banded kokopu (*Galaxias fasciatus* Gray) in small streams by nocturnal counts under spotlight illumination. New Zealand Natural Sciences 27: 1-14.

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