Arrow habitat analysis

Table 1: SEFA[1] physical habitat model outputs for habitat for algae, invertebrates and fish at eight flows. Green shading indicates: greater than 80% habitat retention compared to natural 7dMALF at Cornwall Street (1,700 L/s); orange shading 80-50% habitat retention; and red less than 50% habitat retention. Nuisance algal taxa in underlined bold have reversed colour shading.

Taxa and habitat available	750 L/s	850 L/s	900 L/s	1050 L/s	1190 L/s	1360 L/s	1530 L/s	1700 L/s
Algal taxa	**44 % MALF**	**50 % MALF**	**53 % MALF**	**62 % MALF**	**70 % MALF**	**80 % MALF**	**90 % MALF**	**100 % MALF**
Diatom habitat (m^2/m)	1.232	1.469	1.573	1.851	2.050	2.338	2.543	2.561
Diatom habitat available compared to MALF	*48.0%*	*57.4%*	*61.4%*	*75.2%*	*80.0%*	*91.3%*	*99.3%*	*100%*
Didymo habitat (m^2/m)	3.055	*3.147*	*3.180*	3.246	*3.282*	*3.244*	*3.142*	*3.042*
Didymo habitat available compared to MALF	*100.0%*	*103.5%*	*104.5%*	*106.7%*	*107.9%*	*106.6%*	*103.3%*	*100%*
Long green filamentous habitat (m^2/m)	1.268	*1.112*	*1.082*	1.029	*0.964*	*0.929*	*0.896*	*0.866*
Long green filamentous habitat available compared to MALF	*146.0%*	*128.3%*	*124.9%*	*118.8%*	*111.3%*	*107.3%*	*103.5%*	*100%*
Short filamentous habitat (m^2/m)	2.659	*2.486*	*2.429*	2.278	*2.103*	*1.919*	*1.712*	*1.556*
Short filamentous habitat available compared to MALF	*171%*	*159.8%*	*156.1%*	*146.4%*	*135.2%*	*123.3%*	*110.0%*	*100%*
***Phormidium* habitat (m^2/m)**	4.346	4.410	4.437	4.501	4.548	4.572	4.578	4.558
***Phormidium* habitat available compared to MALF**	*95.0%*	*96.8%*	*97.3%*	*98.7%*	*99.8%*	*100.3%*	*100.4%*	*100%*
Invertebrate habitat								
Food producing habitat	2.174	2.205	2.210	2.183	2.13	2.039	1.911	1.824
Food producing habitat available compared to MALF	*119%*	*120.9*	*121.2%*	*119.7%*	*116.8%*	*111.8%*	*104.8%*	*100%*
Deleatidium habitat	2.69	2.739	2.758	2.799	2.819	2.815	2.884	2.748
Deleatidium habitat available compared to MALF	*98%*	*99.7%*	*100.4%*	*101.9%*	*102.6%*	*102.4%*	*104.9%*	*100%*
Aoteapysche habitat	0.929	1.044	1.097	1.245	1.373	1.478	1.593	1.664
Aoteapysche habitat available compared to MALF	*56%*	*62.7%*	*65.9%*	*74.8%*	*82.5%*	*88.8%*	*95.7%*	*100%*
Pycnocentrodes habitat	2.279	2.246	2.226	2.153	2.080	2.002	1.884	1.787
Pycnocentrodes habitat available compared to MALF	*128%*	*125.7%*	*128.5*	*120.5%*	*116.4%*	*112.0%%*	*105.4%*	*100%*
Trout								
Brown trout spawning	0.63	0.42	0.374	0.271	0.212	0.172	0.134	0.118

[1] System for Environmental Flow Analysis

Brown trout spawning habitat available compared to MALF	*533.9%*	*356.0%*	*316.9*	*229.7%*	*179.7%*	*145.8%*	*113.6%*	*100%*
Brown trout <100 mm habitat	2.496	2.446	2.423	2.364	2.32	2.222	2.097	2.001
Brown trout <100 mm habitat available compared to MALF	*127.4%*	*122.2%*	*121.0%*	*118.1%*	*85.7%*	*110.4%*	*104.8%*	*100%*
Brown trout adult habitat (Hayes & Jowett)	0.533	0.627	0.621	0.593	0.534	0.471	0.391	0.352
Brown trout adult habitat available compared to MALF	*151.4%*	*178.1%*	*176.4%*	*168.5%*	*151.7%*	*133.8%*	*111.0%*	*100%*
Rainbow, brown trout adult habitat (Wilding)	0.592	0.626	0.640	0.677	0.703	0.719	0.729	0.728
Rainbow, brown trout adult habitat available compared to MALF	*81.3%*	*86.0%*	*87.9%*	*93.0%*	*96.6%*	*98.7%*	*100.1%*	*100%*

Downstream habitat predictions

The habitat model represents the habitat available in the Arrow River downstream of the State Highway 6 bridge. The model predictions can be used to represent habitat availability downstream to the Kawarau River. As the 7dMALF increases from Cornwall Street (1,700 L/s) to Kawarau River (1,900 L/s) it can be expected that the absolute habitat available as presented in Table 1 will be the same for any given flow but the percentage comparisons of the habitat available to that provided at the 7dMALF will alter (Figures 1-3). The degree of change in the percentage comparisons will be greatest for the habitat predictions with the steepest slopes between 1,700 L/s and 1,900 L/s.

Algal biomass

Algal growth and biomass accumulation depend on: the nutrients present in the water; water temperature and sunlight/shading, as these all influence the growth rate of algae. In addition, the presence of large algal biomasses requires a period of stable river flow that allows the algae mats and filaments to accumulate, this is generally referred to as the accrual period. Growths can be scoured by high flow events and if these are frequent the algal biomass will not reach nuisance levels.

To predict algal growth rates the present modelling method requires three years of nutrient concentration data, water temperatures and algal biomass measurements. For the Arrow River this sampling work is underway with the first year of sampling nearly complete. Once sufficient data are collected the algal growth model can be developed. One caveat with algal biomasses and nutrients is that for most algae increased nutrient concentrations will accelerate algal growth. However, didymo is known to form thick mats when dissolved phosphorus concentrations are low so didymo can reach nuisance levels in low nutrient conditions.

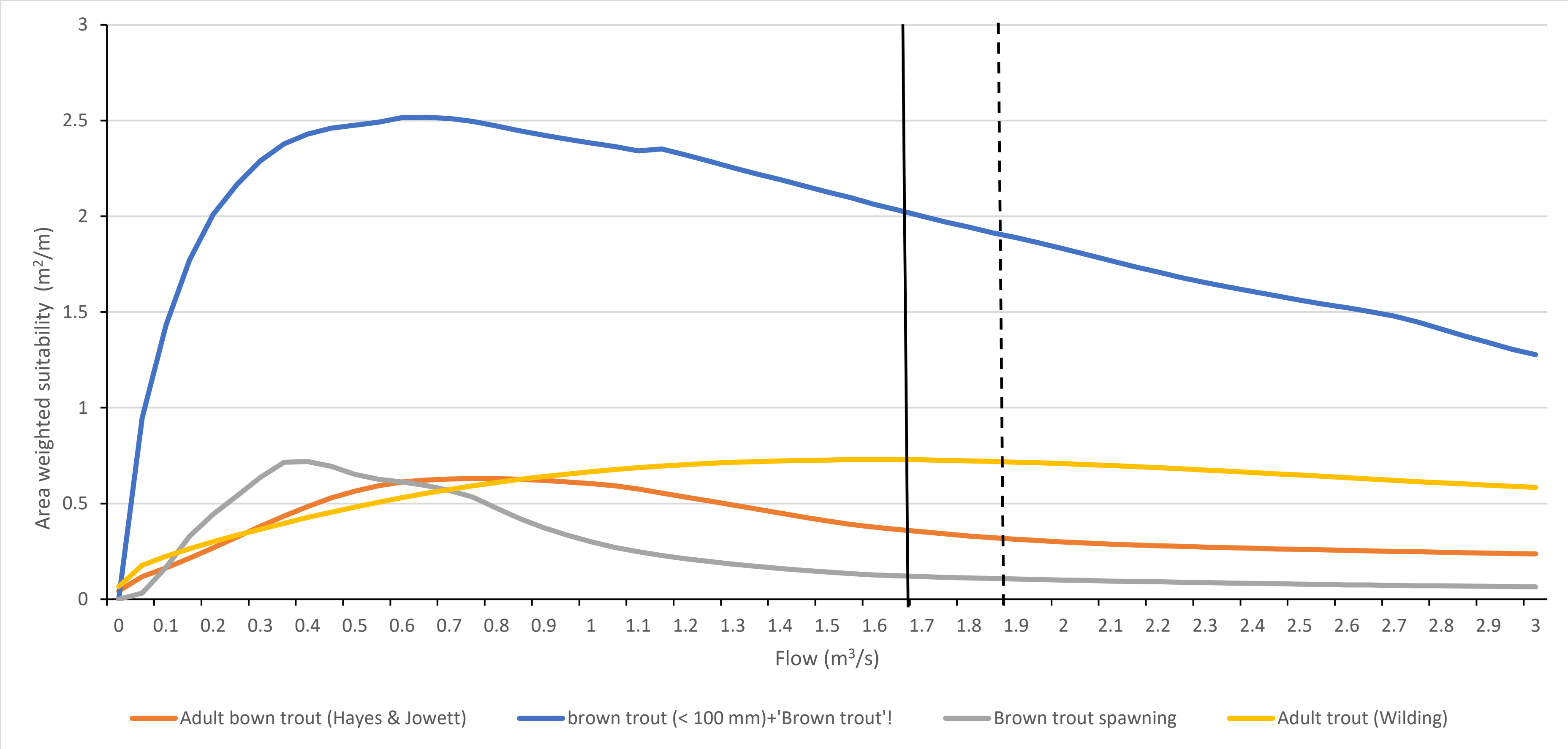

Figure 1: The predicted habitat versus flow relationship for brown trout in the Arrow River. Solid vertical line indicates 7dMALF at Cornwall Street, dashed vertical indicates 7dMALF at the Kawarau River confluence.

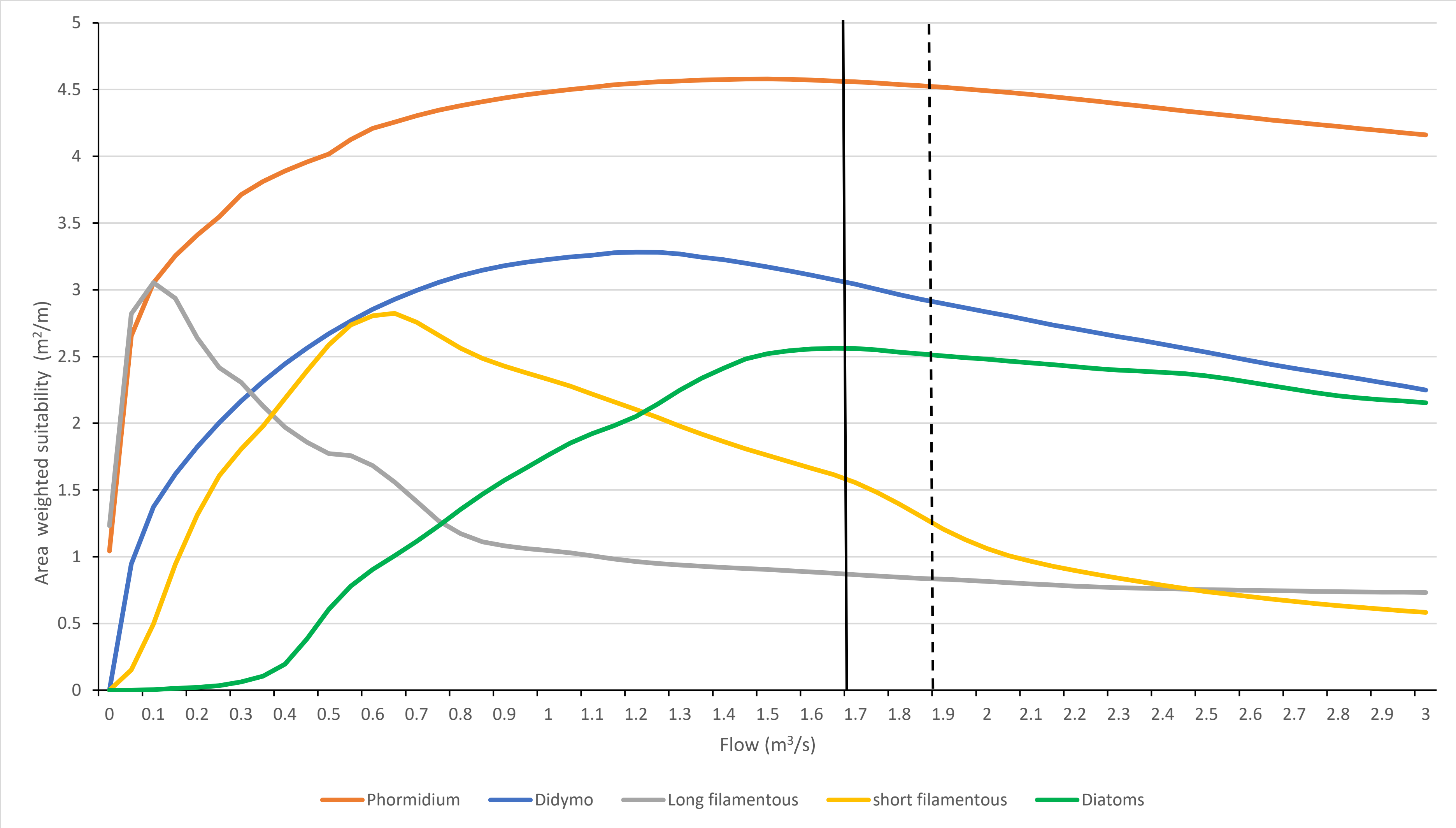

Figure 2: The predicted habitat versus flow relationship for algal taxa in the Arrow River. Solid vertical line indicates 7dMALF at Cornwall Street, dashed vertical indicates 7dMALF at the Kawarau River confluence.

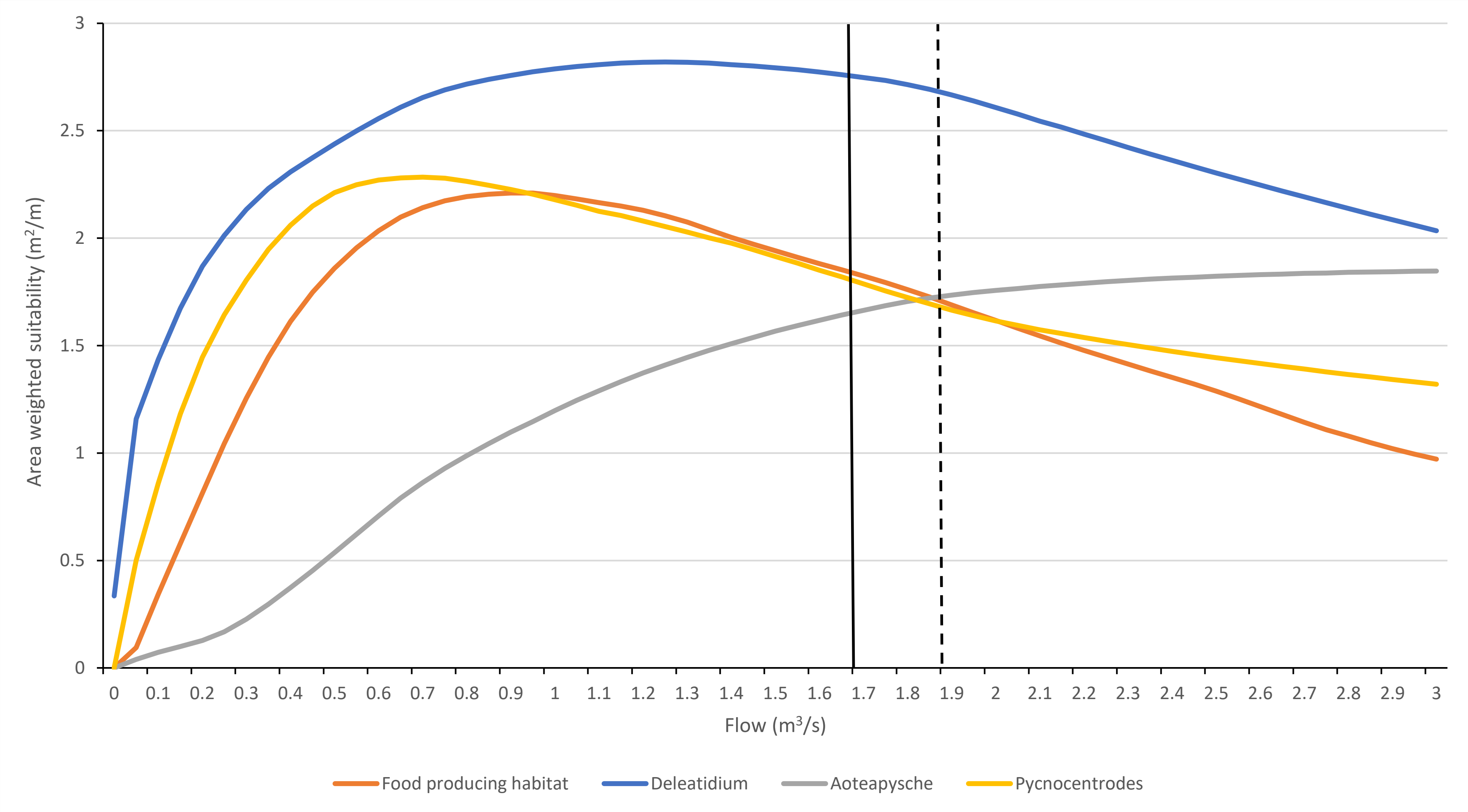

Figure 3: The predicted habitat versus flow relationship for selected macroinvertebrates in the Arrow River. Solid vertical line indicates 7dMALF at Cornwall Street, dashed vertical indicates 7dMALF at the Kawarau River confluence.

References for habitat preferences curves used in SEFA models

Fish

Hayes, J.W., Jowett, I.G. (1994). Microhabitat models of large drift-feeding brown trout in threeNew Zealand rivers. *North American Journal of Fisheries Management* 14:710-725.

Jowett, I.G.; Richardson, J. (2008) Habitat use by New Zealand fish and habitat suitability models. *NIWA science and technology series*, 132 p.

Wilding TK (2012) Regional methods for evaluating the effects of flow alteration on stream ecosystems. PhD thesis, Colorado State University, Fort Collins, CO.

Invertebrates

Jowett, I.G., Richardson, J., Biggs, B.J.F., Hickey, C.W., Quinn, J.M. (1991) Microhabitat preferences of benthic invertebrates and the development of generalised D*eleatidium* spp. Habitat suitability curves, applied to four New Zealand rivers. New Zealand Journal of Marine and Freshwater Research, 25: 187-199.