

Tsuboi, J., Morita, K., Koseki, Y., Endo, S., Sahashi, G., Kishi, D., Kikko, T., Ishizaki, D., Nunokawa, M. and Kanno, Y. 2020. Spatial covariation of fish population vital rates in a stream network. – Oikos doi: 10.1111/oik.07169

## Appendix 1

Table A1. Percent stream unit in section T1 and A for charr, and section T2, F and G for masu salmon. Number of units are shown in parentheses.

Section	Percent stream unit			
	Cascade	Pool	Riffle	Rapid
T1	44.1 (11)	4.2 (3)	40.7 (17)	10.9 (4)
A	52.4 (5)	16.3 (4)	31.3 (5)	0
T2	63.8 (9)	27.4 (10)	8.8 (4)	0
F,G	49.1 (6)	34.7 (6)	13.6 (2)	2.5 (1)

Table A2. Observation matrix corresponding to the first two dimensions of  $\Theta$  for charr and salmon. For charr, Trib refers to section T1 and  $M_{\text{conn}}$  (Mainstem connected location) is section A. For salmon, Trib refers to section T2 and  $M_{\text{conn}}$  refers to section F and G.  $M_{\text{frag}}$  (Mainstem fragmented location) is section B through E for both species.

		Observation at time $t$						
		Juvenile Trib	Juvenile $M_{\text{conn}}$	Juvenile $M_{\text{frag}}$	Adult Trib	Adult $M_{\text{conn}}$	Adult $M_{\text{frag}}$	Not seen
True state at time $t$	Juvenile in Trib	$p_1$	0	0	0	0	0	$1-p_1$
	Juvenile in $M_{\text{conn}}$	0	$p_1$	0	0	0	0	$1-p_1$
	Juvenile in $M_{\text{frag}}$	0	0	$p_1$	0	0	0	$1-p_1$
	Adult in Trib	0	0	0	$p_2$	0	0	$1-p_2$
	Adult in $M_{\text{conn}}$	0	0	0	0	$p_2$	0	$1-p_2$
	Adult in $M_{\text{frag}}$	0	0	0	0	0	$p_2$	$1-p_2$
	Dead	0	0	0	0	0	0	1

Table A3. Annual number of individuals marked for the first time and recaptured with a mark for charr (a) and salmon (b). For charr, Trib refers to section T<sub>1</sub> and M<sub>conn</sub> (Mainstem connected location) is section A. For salmon, Trib refers to section T<sub>2</sub> and M<sub>conn</sub> refers to section F and G. M<sub>frag</sub> (Mainstem fragmented location) is section B through E for both species. Individuals could never be recaptured as YOY because YOY transitioned to  $\geq$  age 1+ in a year. No individuals were newly marked in 2010, except  $\geq$  age 1+ charr in the tributary (section T1), due to logistical constraints.

(a) Charr

		2009	2010	2011	2012	2013	2014	2015	2016	2017
Juvenile										
Trib	Marked	115	–	51	59	7	79	115	93	–
	Recap	0	0	0	0	0	0	0	0	0
M <sub>conn</sub>	Marked	12	–	16	65	15	92	101	102	–
	Recap	0	0	0	0	0	0	0	0	0
M <sub>frag</sub>	Marked	18	–	32	38	18	19	78	41	–
	Recap	0	0	0	0	0	0	0	0	0
Adult										
Trib	Marked	35	6	29	8	8	3	10	19	–
	Recap	0	27	13	13	23	14	31	72	67
M <sub>conn</sub>	Marked	13	–	6	4	4	3	7	12	–
	Recap	0	7	1	5	10	4	20	37	23
M <sub>frag</sub>	Marked	19	–	9	3	3	0	3	3	–
	Recap	0	8	0	9	14	3	9	40	17

(b) Salmon

		2009	2010	2011	2012	2013	2014	2015	2016	2017
Juvenile										
Trib	Marked	0	–	60	0	8	55	16	70	–
	Recap	0	0	0	0	0	0	0	0	0
M <sub>conn</sub>	Marked	0	–	69	0	46	58	26	54	–
	Recap	0	0	0	0	0	0	0	0	0
M <sub>frag</sub>	Marked	21	–	79	234	58	243	34	0	–
	Recap	0	0	0	0	0	0	0	0	0
Adult										
Trib	Marked	0	–	8	0	28	0	2	1	–
	Recap	0	0	0	12	2	0	13	8	27
M <sub>conn</sub>	Marked	0	–	29	1	26	4	7	11	–
	Recap	0	2	0	23	5	9	29	14	9
M <sub>frag</sub>	Marked	8	–	16	25	19	1	18	0	–
	Recap	0	3	0	27	32	7	47	21	0

Table A4. Summary of annual survival and movement probabilities (Table 3) of charr and salmon (posterior mean and 95% credible interval). Trib: section T1 and  $M_{\text{conn}}$ : Mainstem connected (section A) for charr. Trib: section T2 and  $M_{\text{conn}}$ : Mainstem connected (section F and G) for salmon.  $M_{\text{frag}}$  is Mainstem fragmented (section B through E) for both species.

(a) Charr

State	Parameter			
	Survival	Movement		
		To Trib	To $M_{\text{conn}}$	To $M_{\text{frag}}$
Juvenile in Trib	$\phi_1$ : 0.35 (0.31-0.40)	$\psi_1$ : 0.92 (0.87-0.95)	$\psi_2$ : 0.06 (0.03-0.11)	$\psi_3$ : 0.02 (0.00-0.05)
Juvenile in $M_{\text{conn}}$	$\phi_2$ : 0.30 (0.24-0.35)	$\psi_4$ : 0.04 (0.01-0.08)	$\psi_5$ : 0.71 (0.62-0.08)	$\psi_6$ : 0.25 (0.17-0.34)
Juvenile in $M_{\text{frag}}$	$\phi_3$ : 0.28 (0.22-0.35)	0	0	1
Adult in Trib	$\phi_4$ : 0.38 (0.32-0.43)	$\psi_7$ : 0.97 (0.92-0.99)	$\psi_8$ : 0.02 (0.00-0.05)	$\psi_9$ : 0.01 (0.00-0.15)
Adult in $M_{\text{conn}}$	$\phi_5$ : 0.18 (0.12-0.25)	$\psi_{10}$ : 0.09 (0.01-0.24)	$\psi_{11}$ : 0.91 (0.75-0.99)	$\psi_{12}$ : 0.00 (0.00-0.02)
Adult in $M_{\text{frag}}$	$\phi_6$ : 0.10 (0.05-0.16)	0	0	1

(b) Salmon

State	Parameter			
	Survival	Movement		
		To Trib	To M <sub>conn</sub>	To M <sub>frag</sub>
Juvenile in Trib	$\phi_1: 0.40 (0.30-0.54)$	$\psi_1: 0.81 (0.71-0.90)$	$\psi_2: 0.19 (0.10-0.29)$	0
Juvenile in M <sub>conn</sub>	$\phi_2: 0.27 (0.19-0.38)$	$\psi_3: 0.04 (0.00-0.10)$	$\psi_4: 0.96 (0.90-1.00)$	0
Juvenile in M <sub>frag</sub>	$\phi_3: 0.29 (0.22-0.37)$	$\psi_5: 0.01 (0.00-0.04)$	$\psi_6: 0.11 (0.06-0.16)$	$\psi_7: 0.88 (0.82-0.93)$
Adult in Trib	$\phi_4: 0.17 (0.09-0.27)$	$\psi_8: 0.84 (0.60-0.98)$	$\psi_9: 0.16 (0.02-0.40)$	0
Adult in M <sub>conn</sub>	$\phi_5: 0.11 (0.06-0.16)$	$\psi_{10}: 0.06 (0.00-0.22)$	$\psi_{11}: 0.94 (0.78-1.00)$	0
Adult in M <sub>frag</sub>	$\phi_6: 0.09 (0.06-0.14)$	$\psi_{12}: 0.00 (0.00-0.02)$	$\psi_{13}: 0.16 (0.04-0.36)$	$\psi_{14}: 0.83 (0.64-0.96)$