

**Electronic Supplementary Material**

**Field, R.D. & Reynolds, J.D. (2011). Sea to sky: impacts of residual salmon-derived nutrients on estuarine breeding bird communities. *Proceedings of the Royal Society of London B.* 278, 3081-3088.**

Appendix 1. Watershed landscape features and three-year mean chum, pink and total (chum + pink) salmon biomass for our 21 study sites.

Site	Estuary area (km <sup>2</sup> )	Watershed catchment area (km <sup>2</sup> )	Stream length (km)	Bankfull width (m)	Chum biomass (kg)	Pink biomass (kg)	Total biomass (kg)
Ada Cove	0.009	1.013	6.48	11.1	3675	121	3796
Bullock Main	0.020	0.330	2.42	10.9	4060	229	4289
Clatse	0.084	3.210	6.82	22.8	5775	4820	10595
Codville	0.015	0.240	0.59	3.3	29	2	32
Evan's East	0.019	2.290	4.20	13.3	4514	246	4760
Fancy Head	0.005	0.160	1.19	5.5	910	100	1010
Fannie Cove	0.054	3.500	5.92	16.9	2981	1359	4340
Fell	0.044	0.700	1.85	10.9	60	1	61
Hooknose	0.108	1.840	5.51	20.2	4590	824	5413
Kill	0.011	0.103	0.98	3.5	964	30	994
Kunsoot Main	0.033	0.569	3.67	13.1	1342	2800	4142
Kunsoot South	0.008	0.150	0.79	1.8	0	3	3
Mosquito Bay	0.030	0.520	6.00	9.7	1870	191	2061
Neekas	0.084	1.760	5.90	17.7	34300	11360	45660
Quartcha-Lee	0.131	4.090	12.92	34.1	13592	1268	14860
Rainbow	0.031	1.370	5.35	15.1	613	5	617
Ripley Bay	0.045	1.608	4.32	14.7	0	0	0
Roscoe Main	0.203	3.360	11.03	23.5	38033	33	38066
Sagar	0.040	3.660	5.20	15.5	10224	494	10718
Troupe North	0.044	0.160	0.44	4.4	7	0	7
Troupe South	0.021	0.180	1.05	4.1	18	1	18

Appendix 2. Detailed description of rationale behind salmon biomass calculations:

At streams where there are at least 3 counts per season, the total number of spawning salmon was calculated using the area-under-the-curve method [5]. For streams that could not be visited on at least 3 occasions, 'peak' counts were used to estimate total salmon

numbers as these were highly correlated with AUC counts (peak mean =  $1430.4 \pm 988.1$ , AUC mean =  $1656.8 \pm 906.0$ ,  $r = 0.88$ ,  $p < 0.001$ ). Data on spawning salmon extend back to the fall of 2006 at all of our sites, and to 1950 for 8 of our 21 sites (see below for comparison).

Our metric of salmon nutrient input was calculated from the three-year mean (2006-2008) of spawning salmon abundance estimates and species-specific regional mass estimates (chum: 3.5 kg, pink: 1.2 kg: [6], Appendix 1). Coho and sockeye salmon were excluded from total biomass estimates for reasons given in the main text. For sites that had several streams entering a common estuary (eg. Quartcha + Lee creeks), spawning salmon biomass estimates were combined where data were available.

We compared three-year mean salmon biomass estimates, for which we had complete data at all of our sites, with various historical mean biomass estimates (10, 20, 30, 40, 50 and ~60 years prior to surveys) for the 8 study sites for which we had historical data, and found that all time periods were highly correlated for total salmon ( $r > 0.88$ ,  $p < 0.001$ ), chum ( $r > 0.79$ ,  $p < 0.001$ ) and pink ( $r > 0.86$ ,  $p < 0.001$ ) biomass. We therefore concluded that a three-year mean estimate of combined chum and pink biomass was an appropriate metric for salmon biomass.

Appendix 3. List of all observed bird species and classification of species into food-type guilds (from [1-4]).

Common name	Scientific name	Guild <sup>a</sup>
American Pipit*	<i>Anthus rubescens</i>	-

American Robin	<i>Turdus migratorius</i>	FR, GN, IN
Bald Eagle*	<i>Haliaeetus leucocephalus</i>	-
Band-tailed Pigeon*	<i>Patagioenas fasciata</i>	-
Black Swift*	<i>Cypseloides niger</i>	-
Brown Creeper	<i>Certhia americana</i>	IN
Chestnut-backed Chickadee	<i>Poecile rufescens</i>	FR, GN, IN
Cedar Waxwing	<i>Bombycilla cedrorum</i>	FR
Common Raven*	<i>Corvus corax</i>	-
Common Yellowthroat	<i>Geothlypis trichas</i>	IN
Dark-eyed Junco	<i>Junco hyemalis</i>	FR, GN, IN
Downy Woodpecker	<i>Picoides pubescens</i>	IN
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	FR
Golden-crowned Kinglet	<i>Regulus satrapa</i>	IN
Golden-crowned Sparrow*	<i>Zonotrichia atricapilla</i>	-
Hammond's Flycatcher	<i>Empidonax hammondi</i>	IN
Hairy Woodpecker	<i>Picoides villosus</i>	IN
Hermit Thrush	<i>Catharus guttatus</i>	IN
Lincoln's Sparrow	<i>Melospiza lincolnii</i>	IN
MacGillivray's Warbler	<i>Oporornis tolmiei</i>	IN
Northwestern Crow*	<i>Corvus caurinus</i>	-
Northern Harrier*	<i>Circus cyaneus</i>	-
Northern Mockingbird*	<i>Mimus polyglottos</i>	-
Northern Rough-winged Swallow*	<i>Stelgidopteryx serripennis</i>	-
Orange-crowned Warbler	<i>Vermivora celata</i>	IN
Osprey*	<i>Pandion haliaetus</i>	-
Pine Siskin	<i>Carduelis pinus</i>	FR
Pacific-slope Flycatcher	<i>Empidonax difficilis</i>	IN
Purple Finch*	<i>Carpodacus purpureus</i>	-
Red-breasted Nuthatch	<i>Sitta canadensis</i>	IN
Red-breasted Sapsucker	<i>Sphyrapicus ruber</i>	IN
Ruby-crowned Kinglet	<i>Regulus calendula</i>	IN
Red Crossbill*	<i>Loxia curvirostra</i>	-
Rufous Hummingbird	<i>Selasphorus rufus</i>	NG
Red-winged Blackbird*	<i>Agelaius phoeniceus</i>	-
Savannah Sparrow	<i>Passerculus sandwichensis</i>	IN
Sharp-shinned Hawk*	<i>Accipiter striatus</i>	-
Song Sparrow	<i>Melospiza melodia</i>	FR, GN, IN
Steller's Jay	<i>Cyanocitta stelleri</i>	FR, GN, IN
Swainson's Thrush	<i>Catharus ustulatus</i>	FR, GN, IN
Townsend's Warbler	<i>Dendroica townsendi</i>	IN
Tree Swallow*	<i>Tachycineta bicolor</i>	-
Varied Thrush	<i>Ixoreus naevius</i>	IN
Violet-green Swallow*	<i>Tachycineta thalassina</i>	-
Warbling Vireo	<i>Vireo gilvus</i>	IN
Western Tanager*	<i>Piranga ludoviciana</i>	-

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Western Wood-pewee*	<i>Contopus sordidulus</i>	-
Willow Flycatcher	<i>Empidonax traillii</i>	IN
Wilson's Warbler	<i>Wilsonia pusilla</i>	IN
Pacific Wren	<i>Troglodytes pacificus</i>	IN
Yellow Warbler	<i>Dendroica petechia</i>	IN
Yellow-rumped Warbler	<i>Dendroica coronata</i>	IN

\*Guilds: IN: insectivores; FR: frugivores; GN: generalists (i.e. consumes seeds, berries and insect prey); NG: species included in non-guild analyses but included in total bird density and diversity calculations.

\*Species that were excluded from analyses. Criteria: Species that were likely not breeding in estuaries were defined as those present on < 2 surveys and were excluded from calculation of bird densities and diversities. Species that were not local breeders but were migrating through our study region were also excluded because we only observed them only during the first survey round in each year. Species that were only present in flocks flying overhead were not included to avoid skewing total numbers of birds for some sites.

Appendix 4. Weighted parameter estimates  $\pm$  the unconditional standard error (SE) from linear regression models evaluating the variance in bird density (number of birds per hectare of forest) and diversity in forests adjacent to estuaries on the Central Coast of British Columbia, summer 2008 and 2009. Salmon and estuary area were  $\log_{10}$ -transformed. Year was a two-level factor with 2009 as the reference year.