Transactions of the American Fisheries Society 144:1091–1110, 2015

DOI: 10.1080/00028487.2015.1054518

Supplement: Juvenile Salmonid Use of Intertidal Habitats in a Northeast Pacific Estuary

Supplementary Table S.1. List of prey taxa identified in juvenile salmon diets and neuston samples from Willapa Bay, and the broader taxonomic groups used in final data matrices and analyses.

Final group	Taxon
Barnacles	Barnacles
	Barnacle exuviae
	Barnacle cyprids
	Barnacle nauplii
Calanoids	Calanoid copepods
	Epilabidocera longipedata
Caprellids	Caprellid amphipods
Cladocerans	Cladocerans
Copepods, other	Copepod adults
	Copepod juveniles
	Cyclopoids
	Poecilostomatoida
Crustaceans, other	Crustaceans
	Crustacean gills
	Ostracods
Decapods	Shrimps(*Crangon* spp.) adults
	Crangon juveniles
	Ghost shrimp
Decapod larvae	*Crangon* larvae
	Crab larva
	Dungeness crab (*Metacarcinus magister*) megalopae
	Ghost shrimp larvae
	Megalopae
	Shrimp larvae
Euphausiids	Euphausiids
Fish	Arrow Goby (*Clevelandia ios)*
	Fish
	Fish eyes
	Fish matter
Gammarids	Gammarid amphipods
	Ampithoe spp.
	Corophium spp.
	Corophium adults
	Corophium juveniles
	Eohaustorius spp.
	Gammarid adults

Final group	Taxon
	Gammarid juveniles
	Grandifoxus spp.
	Photis spp.
	Photis adults
	Photis juveniles
	Phoxocephalidae
Harpacticoids	*Dactylopusia* spp.
	Diarthrodes spp.
	Harpacticoid copepods
	Harpacticoid juveniles
	Laophontidae
Hyperiids	Hyperiid amphipods
Insects	Coleopteran adults
	Coleopteran juveniles
	Collembola
	Dipteran pupal casings
	Dipteran adults
	Dipteran juveniles
	Dipteran larvae
	Hemipteran adults
	Hemipteran juveniles
	Homopteran or hemipteran exuviae
	Homopteran adults
	Homopteran juveniles
	Hymenopteran adults
	Hymenopteran juveniles
	Insects
	Insect juveniles
	Insect exuviae
	Lepidoptera
	Mallophaga
	Neuroptera
	Orthoptera
	Psocopteran adults
	Psocopteran juveniles
	Thysanoptera
	Unidentified insects
Mollusks	Bivalves
	Gastropods
Multiple taxa	Arachnids and homopterans
	Barnacle cyprids, harpacticoids, plants
	Barnacle exuviae, barnacle nauplii, cumaceans, copepod nauplii, and plants
	Caprellids and barnacle exuviae
	Caprellids, *Corophium*, gammarids, and marine invertebrates

Final group	Taxon
	Caprellids, *Corophium*, and isopods
	Caprellids and gammarids
	Caprellids, gammarids, and cumaceans
	Caprellids and oligochaetes
	Copepod juveniles, barnacle exuviae, and plants
	Corophium, gammarids, and Poecilostomatoida
	Corophium, gammarids, tanaids, and *Photis*
	Cumella vulgaris and cumaceans
	Gastropods, barnacle exuviae, and mysids
	Idotea, mysids, and mites
	Mites, cladocerans, Poecilostomatoida, and bivalves
	Poecilostomatoida and barnacle exuviae
Other taxa	Actinotroch larvae
	Chaetognaths
	Eggs
	Foraminiferans
	Jellies
	Other
	Pycnogonid juveniles
	Trematodes
Peracarids	*Cumella vulgaris*
	Cumaceans
	Cumacean adults
	Idotea spp. adults
	Idotea juveniles
	Isopods
	Mysids
	Tanaids
Plants	Plants
Polychaetes, nematodes, and oligochaetes	Nematodes
	Oligochaetes
	Polychaetes
	Unknown worms
Spiders and mites	Arachnids
	Araneida
	Marine mites
	Terrestrial mites
Tunicates	Tunicate larvaceans
	Tunicate larvae

Supplementary Table S.2. Analysis of Shiner Perch countsusing a generalized linear mixed-effects model with a Poisson likelihood as a function of tow (random factor), month, region, and habitat (fixed categorical factors) in Willapa Bay, 2002 (overall model fit: restricted maximum likelihood deviance = 1358; Akaike's information criterion = 1384).

Factor or category	Estimate	SE	*z*	*P*
Intercept	–2.43	0.987	–2.46	0.014
Scale (Flow)	0.028	0.052	0.54	0.591
Month[a]				
July	1.653	0.224	7.39	<0.001
August	1.569	0.222	7.06	<0.001
September	0.717	0.238	3.01	0.002
Region[b]				
Nemah	–1.678	0.963	–1.74	0.081
North Long Island	–1.673	0.958	–1.75	0.081
North Stackpole	0.262	0.880	0.30	0.766
Stackpole	-0.928	0.921	–1.08	0.313
Habitat[c]				
Eelgrass	4.705	0.909	5.18	<0.001
Open, unstructured	–0.004	1.088	–0.00	0.997
Oyster ground culture	3.926	0.913	4.30	<0.001

[a]Estimate for month of June is zero.
[b]Estimate for the Nahcotta region is zero.
[c]Estimate for channel habitat is zero.

Supplementary Table S.3. Analysis of juvenile Chinook Salmon counts using a generalized linear mixed-effects model with a Poisson likelihood as a function of tow (random factor), month, region, and habitat (fixed categorical factors) in Willapa Bay, 2002 (overall model fit: restricted maximum likelihood deviance = 172.5; Akaike's information criterion = 198.5).

Factor or category	Estimate	SE	*z*	*P*
Intercept	1.246	0.364	3.42	<0.001
Scale (Flow)	0.219	0.062	3.54	<0.001
Month[a]				
July	–0.671	0.166	–4.04	<0.001
August	–0.977	0.191	–5.11	<0.001
September	–1.877	0.221	–8.51	<0.001
Region[b]				
Nemah	0.454	0.347	1.31	0.190
North Long Island	0.368	0.344	1.07	0.286
North Stackpole	1.499	0.326	4.60	<0.001
Stackpole	1.602	0.321	4.99	<0.001
Habitat[c]				
Eelgrass	–0.062	0.242	–0.26	0.798
Open, unstructured	–0.033	0.234	–0.14	0.886
Oyster ground culture	0.082	0.228	0.36	0.719

[a]Estimate for the month of June is zero.
[a]Estimate for the Nahcotta region is zero.
[b]Estimate for channel habitat is zero.

Supplementary Table S.4. Linear mixed-effects model analysis of juvenile Chinook Salmon FL (mm; log transformed with a Gaussian likelihood) as a function of day of the year (fixed factor), tow (random factor), region, and habitat (fixed categorical factors) in Willapa Bay, 2002 (overall model fit: restricted maximum likelihood deviance = –844.6; Akaike's information criterion = –756.9).

Factor or category	Estimate	SE	*t*	*P*
Intercept	4.462	0.017	265.5	<0.001
Region[a]				
Nemah	0.004	0.020	0.21	0.837
North Long Island	0.037	0.020	1.99	0.048
North Stackpole	0.034	0.020	1.74	0.083
Stackpole	0.010	0.018	0.56	0.576
Habitat[b]				
Eelgrass	–0.001	0.016	–0.04	0.966
Open, unstructured	0.0146	0.016	0.88	0.380
Oyster ground culture	0.006	0.016	0.36	0.717
Day of the year	0.040	0.005	8.00	<0.001

[a]Estimate for the Nahcotta region is zero.
[b]Estimate for channel habitat is zero.

Supplementary Table S.5. Linear mixed-effects model analysis of juvenile Chinook Salmon weight (g; log transformed with a Gaussian likelihood) as a function of day of the year (fixed factor), tow (random factor), region, and habitat (fixed categorical factors) in Willapa Bay, 2002 (overall model fit: restricted maximum likelihood deviance = 21.64; Akaike's information criterion = 45.64).

Factor or category	Estimate	SE	*t*	*P*
Intercept	1.797	0.073	24.68	<0.001
Region[a]				
Nemah	0.012	0.084	0.14	0.887
North Long Island	0.099	0.083	1.20	0.233
North Stackpole	0.058	0.084	0.69	0.491
Stackpole	–0.030	0.079	–0.37	0.709
Habitat[b]				
Eelgrass	0.067	0.072	–0.93	0.356
Open, unstructured	0.106	0.073	1.45	0.147
Oyster ground culture	0.069	0.072	0.95	0.342
Day of the year	0.137	0.021	6.47	<0.001

[a]Estimate for the Nahcotta region is zero.
[b]Estimate for channel habitat is zero.

Supplementary Table S.6. Analysis of juvenile Coho Salmon density (CPUE; fish/100 m^3) using a generalized linear model with a Poisson likelihood as a function of habitat (fixed categorical factor) in Willapa Bay, 2003 (overall model fit: null deviance = 25.98, df = 19; Akaike's information criterion = 56.27).

Factor or category	Estimate	SE	*z*	*P*
Intercept	–0.199	0.512	–0.39	0.698
Scale (Flow)	–0.059	0.283	–0.21	0.834
Habitat[a]				
Eelgrass	0.665	0.628	1.059	0.290
Open, unstructured	–0.722	0.879	–0.82	0.411
Oyster ground culture	–0.333	0.794	–0.42	0.674

[a]Estimate for channel habitat is zero.

Supplementary Table S.7. Linear mixed-effects model analysis of juvenile Coho Salmon FL (mm; log transformed with a Gaussian likelihood) as a function of tow (random factor), region, and habitat (fixed categorical factors) in Willapa Bay, May 2003 (overall model fit: restricted maximum likelihood deviance = 0.898; Akaike's information criterion = 20.9).

Factor or category	Estimate	SE	*t*	*P*
Intercept	5.010	0.145	34.64	<0.001
Region[a]				
North Long Island	0.080	0.166	0.48	0.641
North Stackpole	–0.125	0.192	–0.65	0.531
Stackpole	–0.020	0.171	–0.11	0.911
Habitat[b]				
Eelgrass	0.197	0.173	–1.14	0.280
Open, unstructured	–0.232	0.216	–1.07	0.308
Oyster ground culture	–0.132	0.198	–0.67	0.520

[a]Estimate for the Nahcotta region is zero.
[b]Estimate for channel habitat is zero.

Supplementary Table S.8. Linear mixed-effects model analysis of juvenile Chum Salmon FL (mm; log transformed with a Gaussian likelihood) as a function of day of the year (fixed factor), tow (random factor), region, and habitat (fixed categorical factors) in Willapa Bay, 2003 (overall model fit: restricted maximum likelihood deviance = –321.8; Akaike's information criterion = –297.8).

Factor or category	Estimate	SE	*t*	*P*
Intercept	4.079	0.044	92.56	<0.001
Region[a]				
Nemah	–0.013	0.062	–0.20	0.838
North Long Island	0.071	0.053	1.33	0.184
North Stackpole	0.090	0.047	1.92	0.056
Stackpole	0.006	0.049	0.12	0.901
Habitat[b]				
Eelgrass	–0.068	0.042	–1.62	0.107
Open, unstructured	–0.022	–0.023	–0.59	0.557
Oyster ground culture	–0.044	0.044	–1.26	0.208
Day of the year	0.095	0.095	10.21	<0.001

[a]Estimate for the Nahcotta region is zero.
[b]Estimate for channel habitat is zero.

Supplementary Table S.9. Analysis of juvenile Chum Salmon counts using a generalized linear mixed-effects model with a Poisson likelihood as a function of tow (random factor), month and habitat (fixed categorical factors) in Willapa Bay, 2003 (overall model fit: restricted maximum likelihood deviance = 1103.03; Akaike's information criterion = 650.3).

Factor or category	Estimate	SE	*z*	*P*
Intercept	1.837	0.149	12.37	<0.001
Scale (Flow)	0.762	0.070	10.88	<0.001
Month[a]				
May	–0.726	0.134	–5.43	<0.001
July	–19.421	613.43	–0.03	0.975
Habitat[b]				
Eelgrass	0.029	0.195	0.148	0.883
Open, unstructured	–0.164	0.211	–0.78	0.437
Oyster ground culture	0.943	0.163	5.80	<0.001

[a]Estimate for month of April is zero.
[b]Estimate for channel habitat is zero.

Supplementary Table S.10. Linear mixed-effects model analysis of juvenile Chinook Salmon FL (mm; log transformed with a Gaussian likelihood) as a function of tow (random factor), region, and habitat (fixed categorical factors) in Willapa Bay, July 2003 (overall model fit: restricted maximum likelihood deviance = –163.2; Akaike's information criterion = –141.2).

Factor or category	Estimate	SE	*t*	*P*
Intercept	4.497	0.037	120.75	<0.001
Region[a]				
Nemah	0.017	0.050	0.34	0.738
North Long Island	0.052	0.043	1.23	0.222
North Stackpole	0.045	0.042	1.06	0.290
Stackpole	–0.002	0.043	–0.04	0.967
Habitat[b]				
Eelgrass	–0.024	0.038	–0.62	0.540
Open, unstructured	0.006	0.033	0.17	0.867
Oyster ground culture	–0.002	0.032	–0.06	0.955

[a]Estimate for the Nahcotta region is zero.
[b]Estimate for channel habitat is zero.

Supplementary Table S.11. Analysis of juvenile Chinook Salmon counts using a generalized linear model with a Poisson likelihood as a function of habitat (fixed categorical factor) in Willapa Bay, 2003 (overall model fit: null deviance = 77.69, df = 19; Akaike's information criterion = 120.33).

Factor or category	Estimate	SE	*z*	*P*
Intercept	2.032	0.175	11.63	<0.001
Scale (Flow)	–0.369	0.126	–2.94	<0.001
Habitat[a]				
Eelgrass	–1.626	0.391	–4.15	<0.001
Open, unstructured	–0.157	0.254	–0.62	0.536
Oyster ground culture	–0.591	0.289	–2.05	0.041

[a]Estimate for channel habitat is zero.

Supplementary Table S.12. Results of indicator species analysis (IV = indicator value) based on counts of the most common taxa in neuston samples collected from Willapa Bay during 2003. Only significant ($P < 0.05$) results are shown.

Class	Taxon	IV	*P*
Region			
Nahcotta	Fish	0.574	0.006
North Stackpole	Gammarids	0.375	0.013
	Mollusks	0.404	0.0131
	Peracarids	0.491	0.007
Stackpole	Other crustaceans	0.348	0.047
Month			
May	Barnacles	0.486	0.020
	Cladocerans	0.819	0.0001
	Decapod larvae	0.677	0.0001
	Insects	0.600	0.001
	Mollusks	0.543	0.005
	Other	0.597	0.004
	Peracarids	0.307	0.006
	Tunicates	0.681	0.0001
Jul	Calanoid copepods	0.442	0.008
	Caprellids	0.410	0.035
	Polychaetes, nematodes, and oligochaetes	0.587	0.010