Macroinvertebrate Abundance in the Eklutna River, AK: an Estimate of Food Supply for Rearing Salmonids

Report of Findings
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Introduction

Salmon are a valuable resource in Alaska, providing subsistence, economic benefits, and recreational opportunities for many residents. Through proper management and enhancement actions, the production of salmon can be increased, thus increasing the value of the resource. Though enhancement is often an effective tool for increasing salmon production, not all deficiencies can be addressed using standard methods (Dempson et al. 1999). The Eklutna River is currently being studied by the Army Corps of Engineers to determine the feasibility of restoration efforts to enhance salmon production in the river. This study investigates the current food supply for juvenile salmon in the Eklutna River to determine if the river could in fact support increased salmon production. In addition, we have identified several restoration actions that we feel will increase the production capacity of the river.

Methods

Study Area

The Eklutna River is located in southcentral Alaska, approximately 25 miles north of Anchorage. The river is ultimately fed by a series of glaciers in the Chugach Mountains, and is impounded to form the reservoir from which Anchorage receives its drinking water. This study examined four study reaches on the mainstem of the lower river and one on its major tributary, Thunderbird Creek (fig. 1). For much of the study area the river flows through a deep gorge which concentrates all the flow into a single channel; however, in the lower reaches the river spreads out over an alluvial floodplain and fills several shallow ponds and sloughs from previous mining operations. The mainstem carries a high silt load, derived from both glaciers and mass wasting of the gorge walls, while Thunderbird Creek has Clearwater sources.

Benthic Sampling

We collected quantitative samples from 5 study reaches along the river during May of 2007. With the exception of Reach 2, 20 samples, each representing 1ft^2 of substrate surface, were collected from each of the dominant habitats using a surber sampler or a standard D-net. These samples were composited for each habitat in each reach, and preserved in 70% ethanol for laboratory identification. We used a Hess sampler to collect 5 samples from each habitat in Reach 2 due to the prevalence of soft substrates. In addition to benthic samples, pH, conductivity, and water temperature were recorded for each sample reach (table 1).

In the laboratory, samples were subsampled to 300 organisms using 350µm gridded subsampler trays. Insects in Ephemeroptera, Plecoptera, Trichoptera, and Diptera were identified to family level or lower (Merrit and Cummins, 1996). Other orders and all non-insects were identified at higher taxonomic levels. Estimations of benthic invertebrate abundance by habitat in each reach were calculated and these values were then compared to abundances for other local rivers known to support significant returns of salmon. In addition, taxa were assigned a palatability rating of low, medium, or high based upon previous studies of diet and feeding preferences of juvenile salmon (Glova 1984; Hansen and Richards 1985; Sagar and Glova 1987; Amundsen et al. 1999) and the abundance of each class compared by reach and habitat.

Drift Sampling

Drifting macroinvertebrates were sampled in 4 of the 5 reaches during June of 2007 using a series of 3 drift nets deployed across the river. Reach 2 was not sampled for drift because the current was insufficient to allow accurate collection. All nets for a given reach were deployed simultaneously and the sampling time recorded. Generally, nets were allowed to sample for a half-hour; however, in reach 5 it was necessary for the nets to sample a full hour due to the low volume of drift. Nets were deployed in the same locations twice in each reach and samples for each period composited and preserved for laboratory identification. Each time the nets were deployed, the flow and water depth was measured directly in front of each net. In addition, discharge was calculated for each reach while the nets were sampling.

In the laboratory, drift samples were processed in the same manner as the benthic samples except that terrestrial invertebrates were identified to the order level. These data were then used to calculate the density of macroinvertebrates per cubic foot of water.

Results/ Discussion

Benthic

Average benthic density of macroinvertebrates varied widely between reaches; ranging from approximately 67/ft^2 in Reach 4 to over 350/ft^2 in Reach 2 (fig. 2). While the differences between reaches can be explained in part by the inherent variability of macroinvertebrate communities, the habitats sampled and the dominant taxa collected in each reach also provide insight. Reach 2 samples were all taken from pond/slough habitats and consisted almost entirely of Ostracoda, Sphaeriid clams, and Chironomids; of which, the former two are likely unimportant to salmonids due to their size, indigestibility, and tendencies to be obscured in fine sediments. Of the samples taken from flowing reaches, Thunderbird Creek had the highest densities, likely a result of reduced silt, increased flow, more suitable habitat, and presumably increased dissolved oxygen relative to the mainstream. Reach 5 was expected to have a lower average density due to its high turbidity; however, it did not, possibly due to the large number of habitats sampled relative to other reaches.

Figure 3 classifies the composition of each reach's benthos by the assigned palatability ratings. While there is some variation in the palatability between reaches, it is evident that most samples were composed largely of high palatability taxa, with the exceptions of reaches 2 and 5, which were primarily made up of medium palatability taxa. Figure 4 shows the same classification of composition for each habitat type sampled, and it is apparent that the samples taken from the pool and pond/slough habitats tend to have a lower proportion of high palatability taxa. These differences between habitats help to explain the low proportions of high palatability taxa in reaches 2 and 5 as those were the only reaches in which pool and pond/slough habitats were sampled. Based upon these results, it appears that the habitats in which juvenile salmon are most likely to actively feed (riffles, runs, and LWD) support populations of primarily highly palatabe macroinvertebrates, and thus those benthic populations are a potential food source for juvenile salmon. However, the reduced proportion of highly palatable prey in the pool and pond/slough habitats may still play a role in determining the over-wintering capacity of the river. It must also be noted that a summer sampling effort does not necessarily reflect year-round food availability.

Drift

Average drift density ranged from 0.106 organisms per cubic foot in Reach 5 to nearly 0.4 in Thunderbird Creek (fig. 5). The pattern of relatively low drift in the mainstem and high drift in Thunderbird Creek is very similar to that seen in the benthic data, and is likely caused by the same factors discussed above.

Figure 6 classifies the composition of each reaches drift by the assigned palatability ratings. It is evident that while the proportion of low palatability taxa in the drift is slightly higher than it was in the benthos of all reaches, the drift is consistently composed primarily of high palatability taxa. Therefore, it appears that the majority of drifting invertebrates are potential prey items for feeding juvenile salmon.

River Comparison

Due to the inherently high variance in estimates of macroinvertebrate densities, even between samples taken from the same reach, it is difficult to compare measurements from different streams and attain reliable results. However, when accounting for variation, the benthic densities measured in the Eklutna River are similar, though at the lower end of the range, to those from other local rivers known to support significant salmon returns (fig. 7). In addition, the drift densities measured in the Eklutna River have a similar range and higher average than those measured in side channels and sloughs of the Susitna River (LaPerriere 1980) and are much higher than values obtained from tributaries of the Tanana River (fig. 8). Though this data does not definitively show that the river could support increased salmon production, it does indicate that food availability is not likely to be a limiting factor.

Conclusions

It does not appear that the production of salmon in the Eklutna River is limited by food availability; the river’s benthic densities are comparable to those of other local salmon streams, and the drift densities are relatively high compared with the limited available data from other Alaskan salmon rivers. The most likely resource limiting salmon production is the lack of suitable habitat.

Chum and pink salmon populations are generally limited by the amount and quality of spawning habitat, since these species migrate to sea upon hatching. Coho and Chinook, conversely, rear in freshwater habitats for extended periods (i.e., 2 or more years). In most streams, far more fry hatch in any given year than can be supported by the habitat (i.e., spawning habitat is not a limiting factor). As such, these populations are typically limited by the interplay of food availability and instream cover. During summer months, when somatic growth is most rapid, juvenile coho and Chinook establish feeding territories from which competing fishes are excluded. When both food and cover are abundant, individuals will tend to establish smaller feeding territories that, in turn, permit a larger overall population. Since ocean mortality rates are typically much lower than instream mortality rates, increased instream carrying capacity generally leads to increased numbers of returning adults.

We cannot say definitively whether coho and Chinook populations are limited by spawning or rearing habitat in the Eklutna River. However, it appears as though Thunderbird Creek and, during seasonal periods of clear water, the mainstem Eklutna River likely have adequate spawning habitat to stock this small system. Additionally, based on comparisons with nearby salmon streams, food supplies in the Eklutna River seem adequate to support larger populations; however, the low drift rates indicate that much of this prey may not be easily available to juvenile salmon, which feed primarily on drift. Furthermore, since juvenile salmonids are visual feeders, the increased turbidity coming from the gorge may make it more difficult for them to find available food, in the way of drifting insects. Regardless, food resources are not likely the most limiting factor; the Eklutna River, particularly in the mainstem, is largely devoid of instream cover. It is our opinion that supplementing instream cover, through the use of logs, boulders, rootwads, brush, etc., would likely increase the salmonid carrying capacity of the Eklutna River. Another habitat feature that is conspicuously lacking in the Eklutna River is off-channel wintering habitat, which is especially important for the survival of juvenile coho salmon. Creating such habitats and/or ensuring the year-round connectivity of current ponds would likely be beneficial.

Appendix 1: Figures

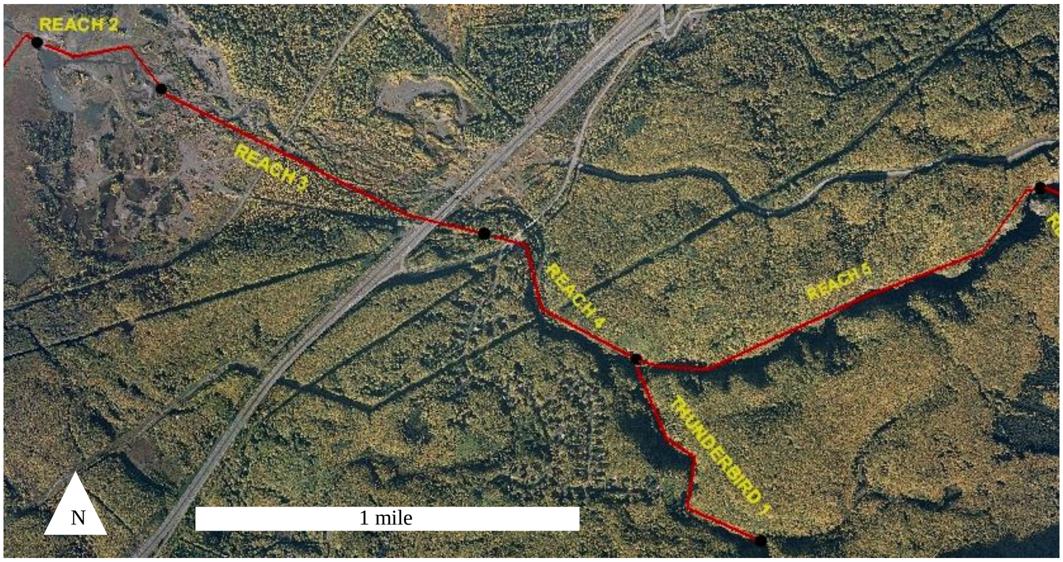

Figure 1: Map of study area showing designated study reaches. White bar is 1 mile long.

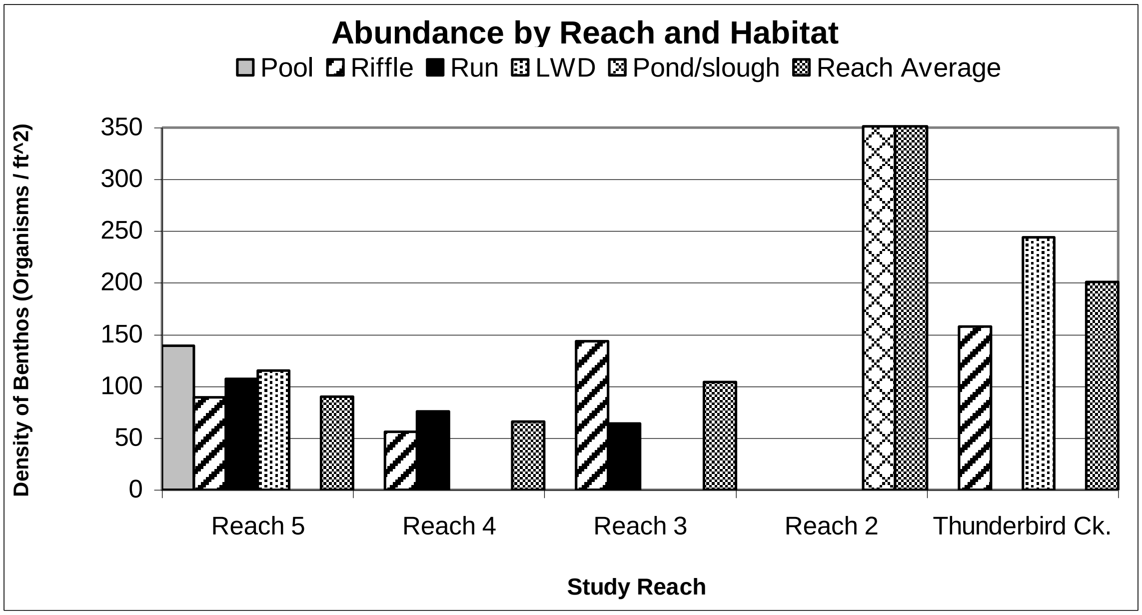

Figure 2: Estimated density of benthic macroinvertebrates by habitat in each reach for the Eklutna River, AK.

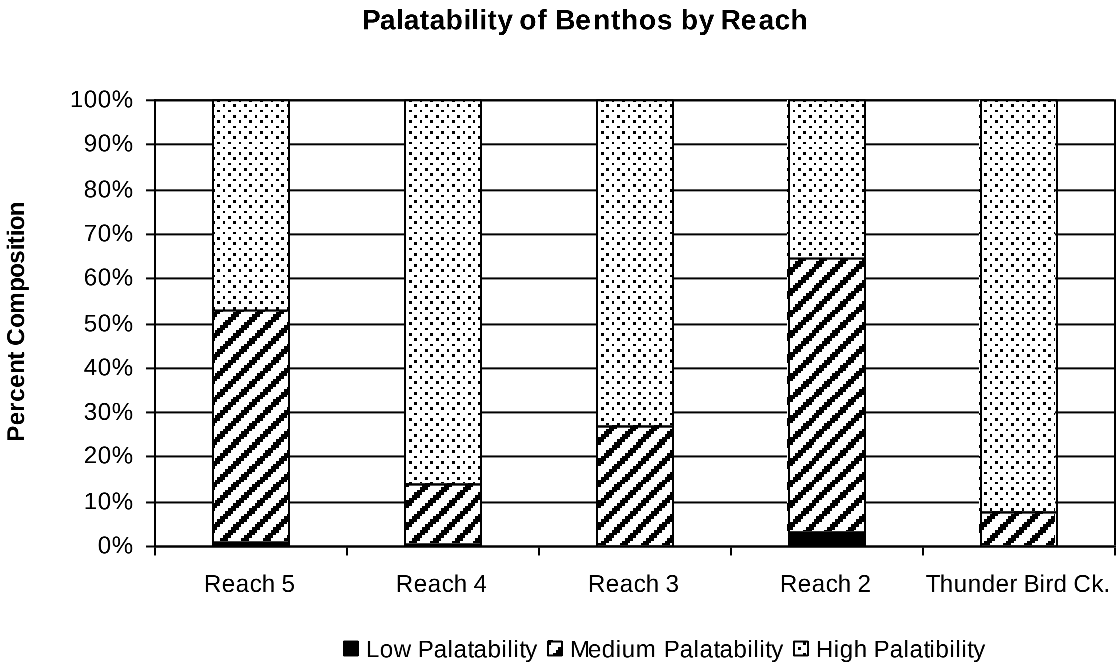

Figure 3: Palatability of benthos by reach in the Eklutna River, AK. Taxa were classified as high, medium, or low palatability based upon published food preferences of juvenile salmonids.

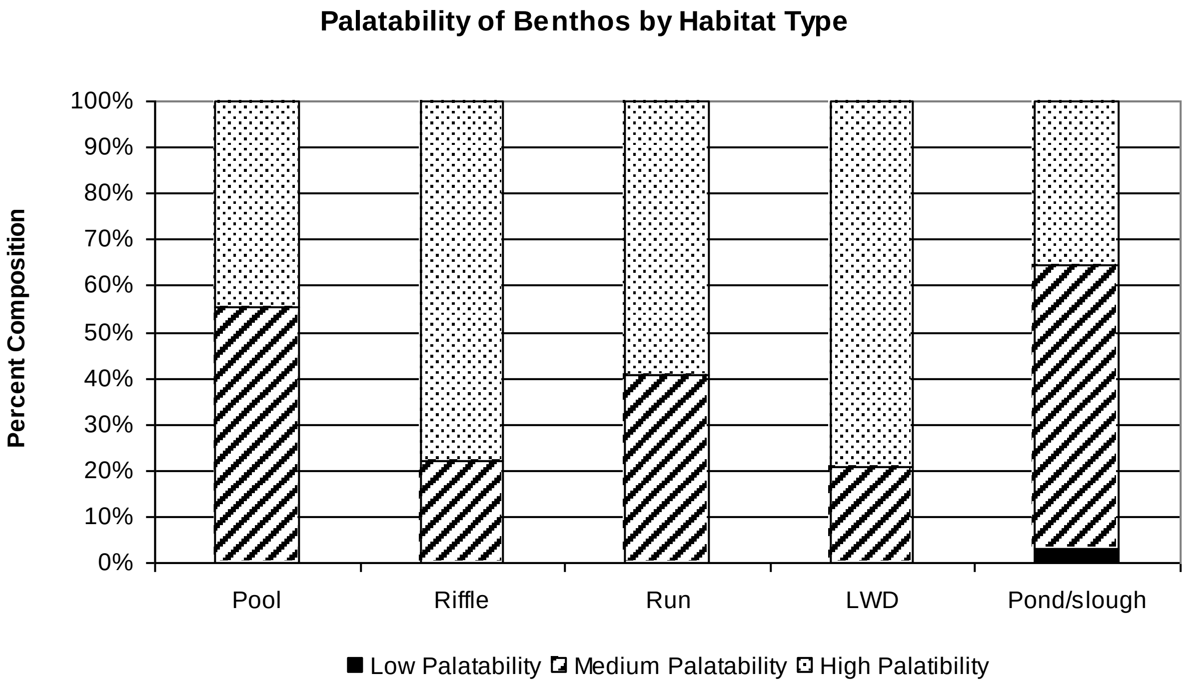

Figure 4: Palatability of benthos in the Eklutna River, AK by habitat type. Taxa were classified as high, medium, or low palatability based upon published food preferences of juvenile salmonids.

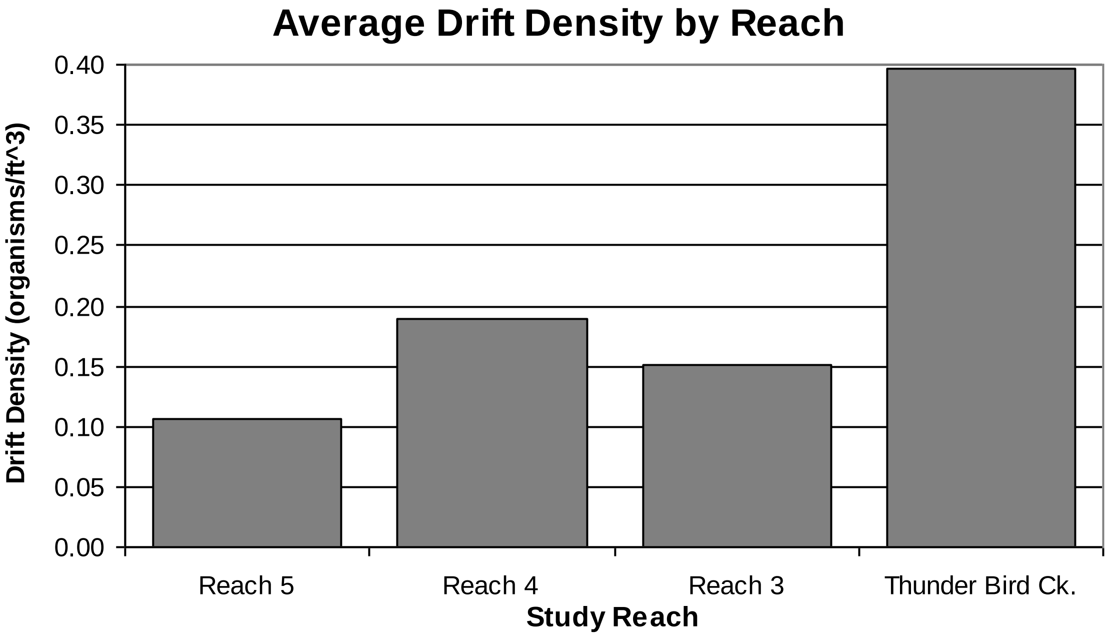

Figure 5: Average drift density for each of the 4 reaches where drift was measured. Eklutna River, AK.

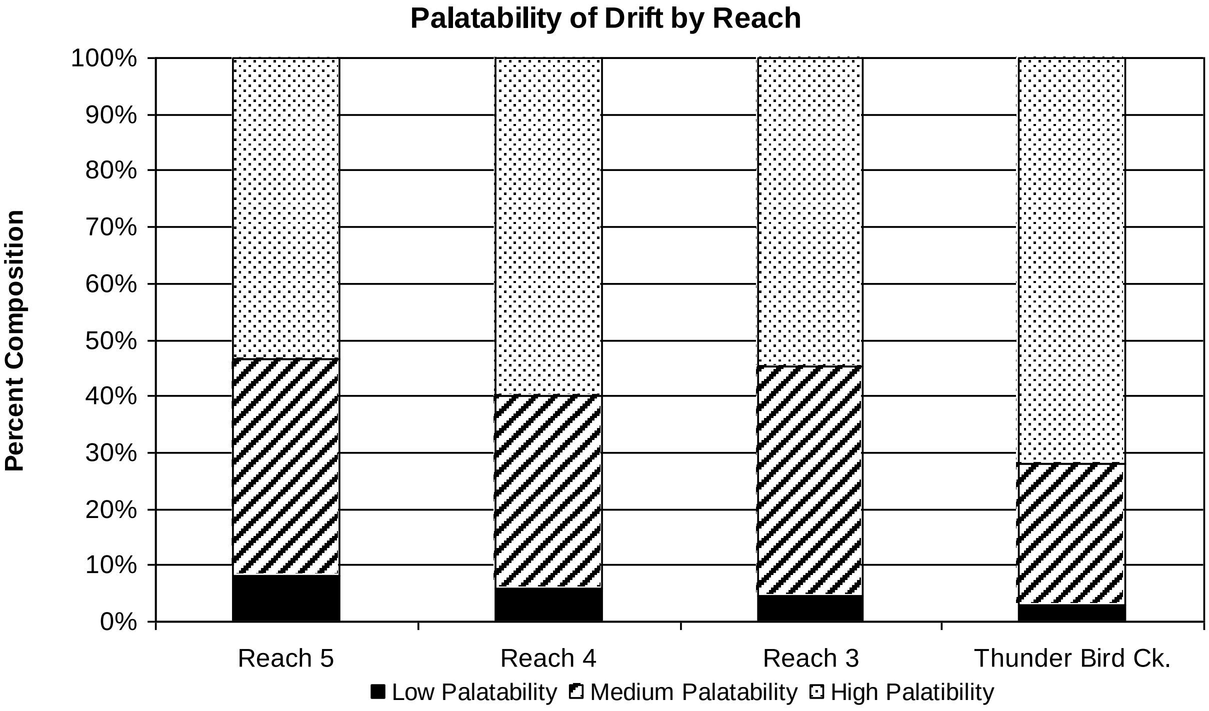

Figure 6: Palatability of drifting macroinvertebrates by reach in the Eklutna River, AK. Taxa were classified as high, medium, or low palatability based upon published food preferences of juvenile salmonids

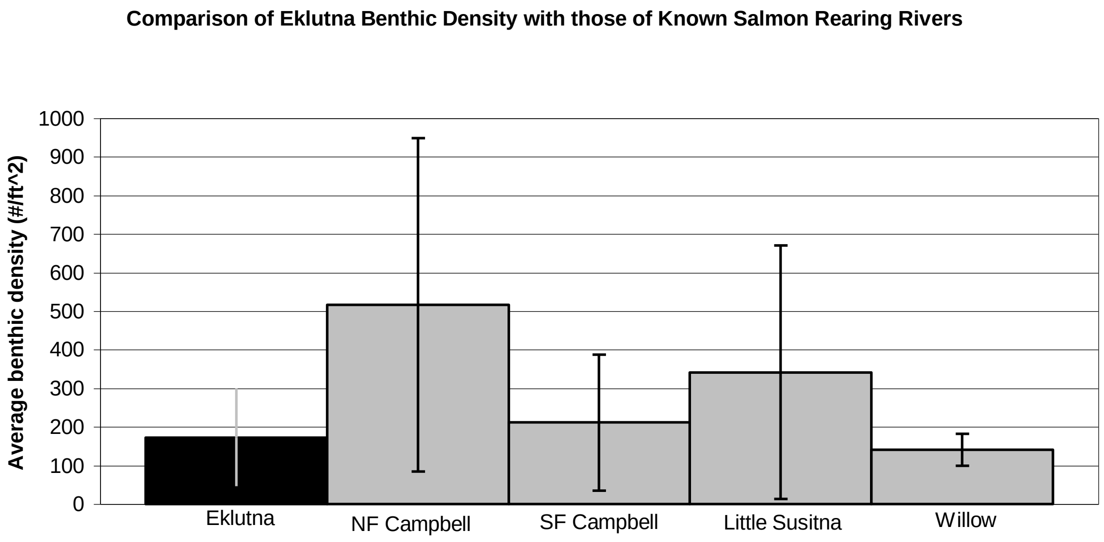

Figure 7: Comparison of the benthic densities of the Eklutna River with those of several local rivers that are known to support significant salmon returns.

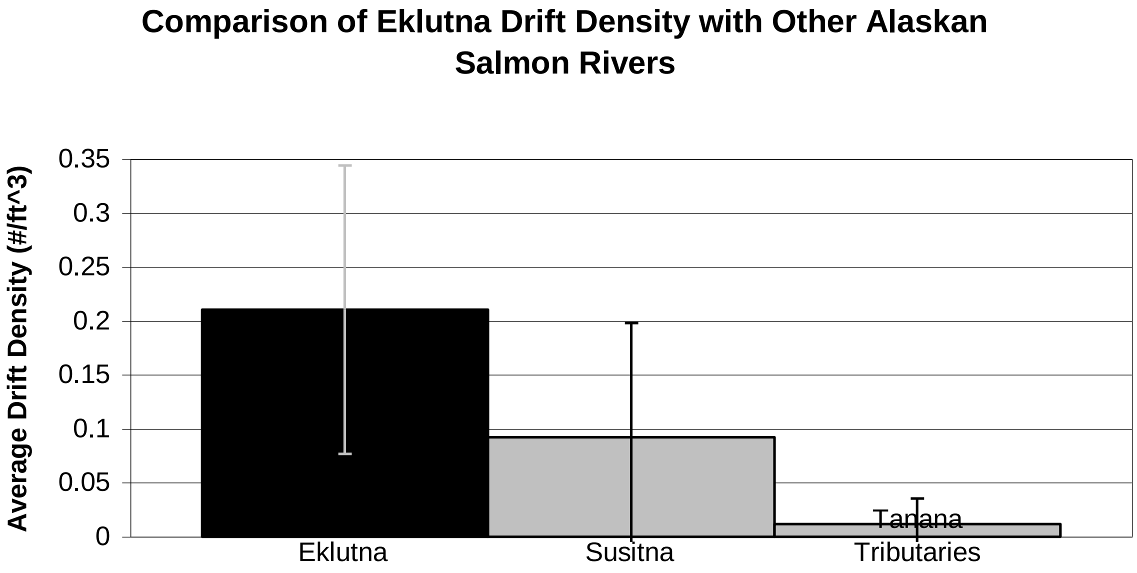

Figure 8: Comparison of drift densities from the Eklutna River, Susitna River side channels and sloughs (Hansen and Richards 1985) and Tanana River tributaries (LaPerriere 1980).

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Appendix 2: Raw Data

Table 1: Summary of physical data for study reaches.

Study Reach	Temp.	pH	Cond.	Discharge (ft3/s)
Reach 5	3.8	8.4	364	5.938
Reach 4	5.3	8.5	368	55.178
Reach 3	5.9	8.4	372	53.850
Reach 2 (pond 1)	8	7.4	405	N/A
Reach 2 (pond 2)	11.2	7.9	425	N/A
Reach 2 (slough)	6.1	8.4	384	N/A
Thunderbird Ck.	4.7	8.4	374	49.260

Table 2: Calculated benthic densities for each taxa by reach and habitat type

Taxa	R5 pool	R5 LWD	R5 run	R5 riffle	R4 riffle	R4 run	R3 riffle	R3 run	R2 pond 1	R2 pond 2	R2 slough	TB riffle	TB LWD
Oligochaeta	39.13	2.25	49.50	3.60	3.17	9.50	18.00	13.25	58.50	33.00	11.14	5.38	
Hydracarina	15.65	19.50	5.63	8.70	0.83	0.50	1.50	1.75	36.00	6.00	4.29	0.49	2.42
Bivalvia									24.00	5.00			
Copepoda											0.86		
Ostracoda	4.42			0.30	1.33		1.13	0.25	282.00	155.00	2.57		
Gastropoda											1.71		
Hirudinea					0.33	0.75		1.50	4.50			2.93	
Hymenoptera													
Carabidae													
Curculionidae													
Hydrophilidae													
UNK Coleoptera						0.50							
Coleoptera						0.50							
Collembolla		0.38				0.50							
Bezzia	14.18	1.88	7.88	3.30					3.00				
Probezzia									9.00				
UNK Ceratopogonidae					0.33					5.00			
Ceratopogonidae	14.18	1.88	7.88	3.30	0.33				12.00	5.00			
Chironomidae	33.75	36.00	14.63	15.30	5.17	13.50	1.13	3.00	91.50	85.00	132.00	16.14	61.88
Chelifera	17.69	6.00	7.88	3.30	0.33	1.50	6.00	4.50				1.47	
Clinocera		0.38											
Oreogeton	0.49	0.38									0.86		
UNK Empididae											0.86		
Empididae	18.98	6.75	7.88	3.30	0.33	1.50	6.00	4.50			1.71	1.47	
Ephydridae													
Muscidae			0.38										
Pericoma	0.49	0.38			0.50	0.75						0.49	0.84
Psychodidae	0.49	0.38			0.50	0.75						0.49	0.84
Sciomyzidae													
Prosimulium	0.49	13.13	1.13	15.00									21.70
UNK Simulidae		0.75	0.75		0.33	1.25							
Simuliidae	0.49	13.88	1.88	15.00	0.33	1.25							21.70
Nemotelus													

Stratiomyidae													
Chrysops									3.00	1.00			
Tabanus													
UNK Tabanidae													
Tabanidae									3.00	1.00			
Dicranota	0.49			0.30	0.33	0.75		0.25					
Tipula								0.25					
Helius													
Hesperoconopa						0.25		0.50					
Hexatoma											3.43		
Pedicia				0.30									
UNK Tipulidae													
Tipulidae	0.49			0.60	0.33	1.00		1.00			3.43		
UNK Diptera		3.38								1.00			
Diptera	67.50	62.25	32.63	37.50	7.00	18.00	16.13	8.50	16.50	92.00	137.14	18.98	84.38
Baetis	3.91	1.50	13.88	2.70	35.67	37.50	79.50	28.00				9.98	111.70
Baetidae	3.91	1.50	13.88	2.70	35.67	37.50	79.50	28.00				9.98	111.70
Drunella					2.50	3.50	3.38	0.75				2.45	
Ephemerella													
Ephemerellidae					2.50	3.50	3.38	0.75				2.45	
Cinygmula		0.38	0.75	1.20		0.75	2.63	0.50				1.96	0.84
Epeorus					0.17		0.38					0.98	2.42
Heptageniidae		0.38	0.75	1.20	0.17	0.75	3.00	0.50				2.93	3.21
UNK Ephemeroptera													
Ephemeroptera	3.91	1.88	14.63	21.90	38.33	41.75	85.88	29.25				96.36	114.92
Hemiptera						0.25							
Prionoxystus													
Cossidae													
UNK Lepidoptera													
Lepidoptera													
Eucanopsis						0.50	0.75					0.98	
UNK Capniidae							0.38						
Capniidae						0.50	1.13					0.98	
Plumiperla		1.13				0.25	1.13						
UNK Chloroperlidae	0.98	0.38				1.50	1.88	1.25			0.86	12.23	
Chloroperlidae	0.98	1.50				1.75	3.00	1.25			0.86	12.23	

Capniidae/Leuctridae													
Leuctridae					1.67								
Zapada	4.42	7.13	4.13	13.80	2.17	1.25	7.13	0.25				8.84	2.89
Visoka	0.49			0.30		0.25							
UNK Nemouridae							0.38	1.00					
Nemouridae	4.89	7.13	4.13	14.10	2.17	1.50	7.50	1.25				8.84	2.89
Isoperla	0.49	0.38		0.90	1.00	2.25	0.75	1.00				4.42	4.82
UNK Perlodidae												0.98	
Perlodidae	0.49	0.38		0.90	1.00	2.25	0.75	1.00				5.38	4.82
Taenionema												0.49	1.67
Taeniopterygidae												0.49	1.67
UNK Plecoptera						0.25	0.38						
Plecoptera	6.36	9.00	4.13	15.00	4.83	6.25	12.75	3.50			0.86	27.88	26.52
Thysanoptera													
Brachycentrus	0.98			0.60									
Brachycentridae	0.98			0.60									
Glossosoma							2.63	4.00					
Glossostomatidae							2.63	4.00					
Ecclisomyia							0.38	0.75					
Onocosmoecus	0.98	0.38		0.30				0.25					0.84
UNK Limnephilidae							0.38	0.25				0.49	
Limnephilidae	0.98	0.38		0.30			0.75	1.25				0.49	0.84
Agrypina													
Phryganea										1.00	0.86		
Phryganeidae										1.00	0.86		
Rhyacophila	0.98	1.88	0.75	2.40	0.33	1.25	1.13	0.50				3.42	12.86
Rhyacophilidae	0.98	1.88	0.75	2.40	0.33	1.25	1.13	0.50				3.42	12.86
UNK Trichoptera					0.17								
Trichoptera	2.93	2.25	0.75	3.30	0.50	1.25	4.50	5.75		1.00	0.86	3.91	13.67
Total	**139.42**	**115.50**	**17.25**	**89.10**	**56.33**	**75.75**	**143.63**	**64.25**	**513.00**	**292.00**	**249.43**	**157.99**	**244.29**

Table 3: Calculated drift densities for all taxa by sample.

Taxa	R5 #1	R5 #2	R4 #1	R4 #2	R3 #1	R3 #2	TB #1	TB #2
Hydracarina	0.009719	0.012232	0.009378	0.021103	0.025893	0.026458	0.008526	0.035714
Bivalvia								
Copepoda	0.000282							
Ostracoda	0.000141		0.003349		0.001126	0.006755	0.010851	0.005952
Gastropoda			0.000670					
Hirudinea								
Hymenoptera	0.002535	0.006116	0.002010	0.000603	0.001689	0.001126	0.004650	0.007440
Carabidae				0.001206				
Curculionidae								
Hydrophilidae	0.000141		0.000670					
UNK Coleoptera	0.003521	0.005037	0.002010	0.001809	0.002814	0.002252	0.000775	0.007440
Coleoptera	0.003662	0.005037	0.002679	0.003015	0.002814	0.002252	0.000775	0.007440
Collembolla	0.003380	0.009354	0.003349	0.002412	0.001689	0.002815	0.003100	0.002976
Bezzia	0.000141		0.000670					
Probezzia								
UNK Ceratopogonidae	0.000141							
Ceratopogonidae	0.000282		0.000670					
Chironomidae	0.005493	0.008635	0.048900	0.042205	0.023641	0.029273	0.073630	0.122022
Chelifera	0.000282			0.001206	0.000563			
Clinocera								
Oreogeton	0.000563		0.000670	0.001206				0.001488
UNK Empididae								
Empididae	0.000845		0.000670	0.002412	0.000563			0.001488
Ephydridae								
Muscidae								
Pericoma	0.000282		0.000670			0.001126	0.000775	0.001488
Psychodidae	0.000282					0.001126	0.000775	0.001488
Sciomyzidae	0.000141	0.000360	0.000670					
Prosimulium	0.000986		0.004019	0.003015	0.001126	0.003941	0.008526	0.011905
UNK Simulidae		0.000720	0.000670	0.000603	0.000563	0.001126		
Simuliidae	0.000986	0.000720	0.004689	0.003618	0.001689	0.005066	0.008526	0.011905
Nemotelus			0.000670					
Stratiomyidae			0.000670					
Chrysops								
Tabanus								
UNK Tabanidae				0.001206		0.001126		
Tabanidae				0.001206		0.001126		
Dicranota			0.000670					0.001488
Tipula								
Helius								0.001116
Hesperoconopa			0.000670					
Hexatoma								
Pedicia								
UNK Tipulidae								0.001488
Tipulidae			0.001340					0.004464
UNK Diptera	0.022114	0.044612	0.009378	0.009044		0.016888	0.031002	0.059523
Diptera	0.030142	0.054326	0.067656	0.059088	0.025893	0.053479	0.113932	0.200890

Baetis	0.003662	0.002159	0.082393	0.050043	0.023641	0.019703	0.085255	0.126487
Baetidae	0.003662	0.002159	0.082393	0.050043	0.023641	0.019703	0.085255	0.126487
Drunella							0.000775	
Ephemerella								
Ephemerellidae							0.000775	
Cinygmula			0.004019	0.000603	0.001126		0.006975	0.007440
Epeorus								
Heptageniidae			0.004019	0.000603	0.001126	0.000000	0.006975	0.008928
UNK Ephemeroptera	0.000563	0.001079						
Ephemeroptera	0.004226	0.003238	0.086412	0.050646	0.024767	0.019703	0.093006	0.135415
Hemiptera	0.029438	0.021946	0.012727	0.010250	0.016324	0.011822	0.022476	0.007440
Prionoxystus								
Cossidae								
UNK Lepidoptera				0.001206			0.001550	0.001488
Lepidoptera				0.001206			0.001550	0.001488
Eucanopsis								
UNK Capniidae								
Capniidae								
Plumiperla						0.000563	0.002325	0.001488
UNK Chloroperlidae			0.004019	0.002412	0.002252	0.001689	0.003100	0.010417
Chloroperlidae			0.004019	0.002412	0.002252	0.002252	0.005425	0.011905
Capniidae/Leuctridae						0.000563		
Leuctridae								
Zapada	0.000845	0.000360	0.001340	0.000000	0.001126	0.001126	0.004650	0.010417
Visoka								
UNK Nemouridae								
Nemouridae	0.000845	0.000720	0.001340		0.001126	0.001126	0.004650	0.010417
Isoperla							0.000775	
UNK Perlodidae								
Perlodidae							0.000775	
Taenionema								
Taeniopterygidae								
UNK Plecoptera								
Plecoptera	0.000845	0.000720	0.005359	0.002412	0.003377	0.003941	0.010851	0.022321
Thysanoptera	0.006620	0.003238	0.016077	0.012059	0.021952	0.014073	0.007750	0.029762
Brachycentrus								
Brachycentridae								
Glossosoma							0.000775	0.000000
Glossostomatidae							0.000775	
Ecclisomyia								
Onocosmoecus	0.000141	0.000720			0.000563	0.000563	0.000775	
UNK Limnephilidae								
Limnephilidae	0.000141	0.000720	0.000000	0.000000	0.000563	0.000563	0.000775	
Agrypina								
Phryganea								
Phryganeidae								
Rhyacophila		0.000360	0.000670				0.001550	0.002976
Rhyacophilidae		0.000360	0.000670				0.001550	0.002976
UNK Trichoptera	0.000141			0.000603			0.000775	

Trichoptera	0.000282	0.001079	0.000670	0.000603	0.000563	0.000563	0.003875	0.002976
Oligochaeta	0.002113	0.001439	0.002010	0.001206	0.003377	0.002815	0.001550	
Total	**0.093808**	**0.118367**	**0.211676**	**0.165807**	**0.153104**	**0.149179**	**0.282893**	**0.508922**

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