PREDATORS AND SALMON

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Should Predators Be ignored

It is hard to understand why the role of predators has been ignored in the process of restoring salmon. Considering that a partial list of salmon predators would include at least 137 different vertebrate, the impact of predator populations has a major effect on the salmon population[1]. The list in the footnoted reference contains at least 53 birds, 20 mammals, 4 amphibians, 3 reptiles and 57 other species that prey on salmon. Missing from this list are at least seven mammals including man and all the fish predators.

There are at least 26 fish species that are known to prey on salmon are walleye, catfish, carp, small-mouth bass, large-mouth bass, shad, sculpin, bull trout, rainbow trout, cutthroat trout, white sturgeon, tuna, pacific hake, bullet mackerel, chub mackerel, wahoo, ling cod, pacific perch, pacific barracudas, Coho salmon, sockeye salmon, Chinook salmon, chum salmon, steelhead, whitefish, and squawfish.

Bird predators include, rhinoceros auklet, Brandt's cormorant, double crested cormorant, olivaceous cormorant, pelagic cormorant, American crow, northwestern crow, American dipper, harlequin duck, bald eagle, golden eagle, great egret, northern gannet, common goldeneye, burrow's goldeneye, pigeon guillemot, Clark's grebe, pied-billed grebe, western grebe, Bonaparte's gull, Heermann's gull, California gull, glaucous gull, glaucous-winged gull, herring gull, ring-billed gull, Thayer's gull, western gull, black-crowned-night heron, great blue heron, belted kingfisher, blacklegged kittiwake, common loon, pacific loon, red-throated loon, black-billed magpie, common merganser, red breasted merganser, common murre, ancient murrelelt, marbled murrelet, osprey, American white pelican, brown pelican, tuffed puffin, common raven, sooty shearwater, artic tern, Caspian terns, common tern, elegant tern, Forster's tern.

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[1] Cederholm, C. J. et al, 2000, Pacific Salmon and Wildllife Ecological Contexts, Relationships and Implications for Management, Wildlife-Habitat Relationships in Oregon and Washingotn, Page 35

Mammals include harbor seals, northern fur seals, Guadeloupe fur seal, elephant seal, California sea lions, Stellar sea lions, river otter, Pacific striped dolphin, White-sided dolphin, harbor porpoise, Dall's porpoise, killer whales, fin whales, humpback whales, Baird's beaked whale, Cuvier's beak whales, sperm whales, pilot whales, gray wolf, black bear, grizzly bear, mink, mountain lion, bobcat, raccoon, water shrew, and man to name a few. The above list brings the known number of salmon predators to 160 different species. Without a doubt, the populations of these various predators have a profound effect on the number of salmon in our rivers. Most of these species are on the endangered list, which forces us into the realization that endangered species are causing the extinction of other endangered species.

Estimating the Kill

At this point, it is constructive to estimate the magnitude of salmon being killed by these predators. The number of salmon being killed depends on, the number of predators (Np), total intake of food (I), the percentage of the intake that consists of salmon (Ds), and the amount of the salmon ingested.

$$Kill = (Np)\ (I)\ (Ds)\ /(A)$$

Each of these factors has varying amounts of uncertainty, which leaves considerable room for maneuvering. The truth lies somewhere in between. Obviously, this is an enormous task if applied to the 160 plus predators. Much of the needed data for those 160 predators is not known. However, we can get an idea of the magnitude of this number by estimating the kill by pinnipeds, Caspian terns, cormorants and gulls in the Columbia River.

PINNIPED KILL

To arrive at the pinniped kill first, it is necessary to determine the total number of pinnipeds (Np). As you can see from table 1, the total numbers of seals and sea lions depends on the geographical area you consider. If you want to minimize the number, you can do so by considering only a small area like say the Columbia River, or from Netarts Bay to Grays Harbor. Current estimates by Fish and Wildlife tend to look only at the pinnipeds in the Oregon estuaries.

Number of Pinnipeds

This assumption minimizes the number of salmon killed. The killing of salmon in confined waters is easier to observe and is better documented. Taking salmon in the open ocean is more difficult for the seals and sea lions, and is not often observed, but that does not mean that it doesn't happen. Now, we know that the salmon do not stay in the area of the Columbia River, but migrate long distances along the continental shelf spending considerable time in near-shore water and migrate extensively into the North Pacific[2]. We also know that sea lions migrate considerable distances up and down the coast during the year. Seals and sea lions are attracted to large concentrations of salmon. By nature,

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[2] Brannon, Ernest L., 1999, The ESA listing of Puget Sound Chinook and the NMFS Status Review, Center for Salmonid and Freshwater Species at Risk. Haggerman Fish Culture Experiment Station, Univ. of Idaho, page 4.

salmon travel in schools and are therefore always concentrated. Therefore, this migration exposes salmon to larger numbers of predators. How many Oregon salmon are killed by Alaskan seals and sea lions is unknown. How many northern fur seals exist is unknown.

Species & Location	Estimated Population	Annual Increase	Total Population
California Sea Lions			
Oregon	10,500	5%	
Washington & California	235,000	5%	
British Columbia[3]	11,000	5%	
SE Alaska	Unknown		
Total			300,000
Northern Sea Lions			
Oregon	800	5%	
Washington	Unknown	5%	
British Columbia	38,000	5%	
SE Alaska	200,000	5%	
Total			250,000
Northern Fur Seals			
Harbor Seals			
Oregon	15,000	7%	
Washington	57,000	8%	
California	43,000	6%	
British Columbia[4]	177,000	6%	
SE Alaska	Unknown		
Total			310,000
Netarts to Grays Harbor	28,000	11%	

The numbers in Table 1 come from various sources. Actual numbers of northern sea lions are as yet unavailable, but current estimates of the numbers are around 238,000[5]. It is unlikely that northern sea lions make it to California, but the fact that they exist in Oregon indicates that they must also be in Washington[6].

The Amount of Food Consumed

The amount of total food consumed (I) by a seal or sea lion depends on the sex, body weight and species. Using data from Federal Fish and Wildlife fact sheets and other

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[3] Biggs, M., 1985, Statust of Stellar Sea Lion and California Sea Lion in British Columbia, Can. Spec. Publ. Fish. Aquat. Sci **77**

[4] Olesiuk P. et al., Recent Trends in the Abundance of Harbor Seals in the Straits of Georgia, based on Scat Analysis. Can. Tech. Rep. of Fish and Aquat. Sci., no. 1730.

[5] Olesiuk, P. and Biggs, M., 1988, Seals and Sea Lions on the British Columbia Coast, Pacific Biological Station, Naniamo, B.C., Department of Fishereies and Oceans.

[6] Beach, R., et al., 1985, Marine Mammals and their Interaction with Fisheries of the Columbia River and Adjacent Waters, Third Annual Report, Washington Department of Wildlife.

published reports; the present daily biomass required by each of the species to maintain body weight can be estimated. See Table 2. The Fish and Wildlife Commission assumes that California sea lions consume 15 lbs. of biomass per day, a very conservative approach, which leads to a significant underestimate of the salmon killed[7]. For example, pinnipeds in the middle of a school of salmon would be prone to gorging and may consume more than three times the biomass required to maintain body weight, increasing their capacity to as much as 130 lbs. of biomass per day. For the calculations done here we will assume a 5lb higher but still conservative daily biomass consumption.

Species	Biomass Range in lbs.	Gorging Biomass in lbs.	Biomass Assumed in lbs.	Annual Biomass in lbs
California Sea Lion[8]	10 to 25	75 to 30	20	7,300
Northern Sea Lion	11 to 45	130 to 33	40	14,600
Harbor Seal[9]	6	18	6	2,200
Northern Fur Seal				

Precentage of Diet that is Salmon

The next factor required for the estimate is the percentage of the sea lion's diet that is salmon (Ds). This of course depends, to a great extent, on the amount of salmon available. All of the studies to determine the percentage of the diet comprised of salmon were made after the 1970's when the salmon population was severely depressed. Obviously, the pinnipeds are not going to eat salmon if they are not available. This is shown by the variance in the diet for harbor seals from 4 to 60 %. This large difference can be only explained by preference or by availability. It is unlikely that a seal would turn down a salmon meal if it were available. "When salmon are available, seals consume them in quantity[10]."

Further, the methods used for food habit studies tend to under estimate consumption of large fish such as salmon. For example, one method used to determine the percent of salmon in the diet consists of counting the number of salmon ear bones in the skat and stomach contents of predators. Other methods using gill rakers and teeth began in 1996 to help get a more realistic count and increased the estimates by 25 percent[11]. Note however, that gill rakers and teeth are still a part of the head. Many

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[7] _____, NOAA-NWFSC Tech Memo 28: Impact of Sea Lions and Seals on Pacific Coast Salmonids.

[8] Olesiuk, P. and Biggs, M., 1988, Seals and Sea Lions on the British Columbia Coast, Pacific Biological Station, Naniamo, B.C., Department of Fishereies and Oceans.

[9] Kaczynski, V. Palmisano, 1992, Oregon Wild Salmon and Steelhead Trout, A Review of the Impact of Management and Environmental Factors, Oregon Forest Industries,

[10] Parks, D. L., 1993, Effects of Marine Mammals on Columbia River Salmon Listed under the Endangered Species Act, Tech Rep. 3 of 11, BPA page 4

[11] _____, NOAA-NWFSC Tech Memo 28: Impact of Sea Lions and Seals on Pacific Coast Salmonids.

times, the head of the salmon is not eaten. A well fed Penniped consumes only the protein rich egg sack, thus, the true percentage of salmon in the diet may be considerably higher.

Table 3 lists the maximum and minimum percent of salmon in the diet for the common varieties of seals and sea lions using current practice. Again, Fish and Wildlife studies select low values for the percent of salmon in the diet.

Species	Max Percentage	Min Percentage
California Sea Lion[12]	29	6
Northern Sea Lion[13]	10	10
Harbor Seal[14]	60	4
Northern Fur Seal		

The Amount of Salmon Consumed and Wasted

The last variable is the amount of salmon that is consumed or wasted by the pinniped. A hungry seal or sea lion will consume almost all of a salmon, but as their need for food lessens, the animals eat only the choice parts such as the egg sack. The egg sack of the salmon is the most nutrient rich part of the fish and requires only a couple of bites of salmon or less than a pound. Fish and Wildlife estimates of pinniped kill assume the entire salmon is eaten.

Thus, we find the Fish and Wildlife used conservative estimates on each of the variables, which will obviously produce a number considerably below the actual number of fish eaten let alone destroyed by attacks where the fish is damaged but not eaten. It would be difficult to defend this conservative approach on a scientific basis.

Uncertainty

It should be apparent by now that there exists a high level of uncertainty involved in estimating the number of salmon destroyed by predators. It is not in anyone's best interest to overestimate or underestimate these numbers. However, if we make reasonable but still conservative assumptions we might be able to better estimate the extent of the problem.

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[12] _____, NOAA-NWFSC Tech Memo 28: Impact of Sea Lions and Seals on Pacific Coast Salmonids.

[13] Olesiuk, P. and Biggs, M., 1988, Seals and Sea Lions on the British Columbia Coast, Pacific Biological Station, Naniamo, B.C., Department of Fishereies and Oceans.

[14] Kaczynski, V. Palmisano, 1992, Oregon Wild Salmon and Steelhead Trout, A Review of the Impact of Management and Environmental Factors, Oregon Forest Industries,

Species	Population (Dp)	Annual Intake 365(I) in lbs	Salmon in Diet (Ds)	Amount Ingested (A) in lbs	Total Kill In millions
California Sea Lions	300,000	7,300	0.2	7	60
Northern Sea Lions	250.000	14,600	0.10	10	40
Northern Fur Seals					25[15]
Harbor Seals	310,000	6,570	0.20	5	80
Total					190

Reality Check

If the numbers in table 5 seem large, consider that 60 million fish consumed by 300 thousand California sea lions is 200 fish per year by each animal. Two 75-day salmon runs per year means that each sea lion needs to consume a little more than one fish per day. The larger male sea lions can consume 2.5 fish per day without gorging. Consider also that most of the time at least half of the fish is left to scavengers, which results in three fish per day killed. Other Fish and Wildlife documents report that sea lions have been observed killing as many as 4.1 salmon per hour[16]. Since sea lions are not restricted to an 8 hour day, that could be as many as 40 per day.

Compounding the Problem By competing for Food.

Thus, these numbers are well within the realm of possibility and these four species alone could easily be responsible for the loss of 190 million salmon per year. Compounding this problem is that these four species of predators are also responsible for a substantial reduction in the salmon's food supply because they also prey on anchovies, herring, and other food sources common to the salmon and are protected by the Marine Mammal Protection Act. The purpose for this protection is unclear because the population of California sea lions is at a historic high.

TERNS, CORMORANTS AND GULLS

The National Marine Fisheries Service indicates that terns, cormorants and gulls in the Columbia estuary have increased from a few hundred nesting pairs to well over 30,000[17]. These three bird species are credited with killing over 40 million juvenile salmon in 1997 in the Columbia Basin alone. The blame for this killing was placed on the Corps of Engineers for piling spoil near the channel, which provided the nesting sites. While the problem may be the nesting site, it may also be too many terns. The Audubon Society successfully defeated the Corps of Engineers plan to harass the terns by showing that forcing the protected terns to Sand Island would not solve the problem and that their

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[15] In 1984, Northern Fur Seals were responsible of killing about 10.5 million young salmon off the coast of Oregon. Considering a six percent per year increase in population over the last 16 years would produce a total kill today around 25 million.

[16] _____, NOAA-NWFSC Tech Memo 28: Impact of Sea Lions and Seals on Pacific Coast Salmonids.

[17] Collis, Ken and, Adamany, Stephanie, Robe, Daniel, D., Craig, David P., Lyons, Donald E., 1998, Avian Predation on Juvenile Salmonids in the Lower Columbia River.

special interest in birds outweighs their social obligation to save another endangered species.

According to a three year study conducted by Daniel Roby, Larry Davies, and Carl Schreck of Oregon State University, 8,000 nesting pairs of Caspian terns consumed as many as 20 million smolt per year[18]. This is about 1250 salmon smolt per bird. To put the tern kill into perspective, we know that between 0 and 10 percent of the smolts that pass through turbines are killed[19]. Therefore, if we pass 50,000 smolts through a turbine, 5,000 will die, thus one turbine causes the same number of deaths as four terns. Caspian terns are not native to the Oregon Coast, but are protected by federal law - the Migratory Bird Act, which was passed in 1918 and amended in 1936, 1960, 1967, 1974, 1978, 1986, 1989 and 1998. It is obviously in need of another amendment. Cormorants, gulls and many other birds that prey on salmon are also protected. Cormorants are at historic highs.

OTHER PREDATOR KILLS

The numbers of other salmon predators, like bears, eagles and terns, have increased significantly in the last century. The Alaskan Fish and Game Service estimates that a single bear eats between 10 and 20 salmon per day during salmon runs. Eagles have recently been taken off the endangered species list. In 1963, only 800 eagles existed in the lower 48 states; presently there are over 11,000 birds, an increase of over 1300 percent. Salmon is a major food source for eagles. The common murre population in Oregon alone has been estimated at 40,000 birds. Studies indicate that each murre can consume 100 smolts per month[20]. Thus, the species could easily account for 10 million smolts.

Total Kill

Thus, as shown in the above pages, the seven predators that have verifiable numbers of kill are responsible for killing close to 230 million salmon per year. salmon[21]. Although one can argue with the predator kill numbers somewhat, and maybe it would be possible to eliminate or add 100 million, but then you will have to add the kill from the other 153 predators not included in this number. The potential kill is enormous; 500 million salmon could easily be killed each year by predators.

Compare this current kill with the best yearly human catch in the Columbia River in 1883 of 2.3 million. In 1883, we killed 1% of the predator kill. Today the human take is orders of magnitude smaller.

Another way to approach the number of salmon killed by predators is to look at the entire ecosystem as a black box. The long time rule of thumb for hatchery efficiency

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[18] Collis, Ken and, Adamany, Stephanie, Robe, Daniel, D., Craig, David P., Lyons, Donald E., 1998, Avian Predation on Juvenile Salmonids in the Lower Columbia River.

[19] Espenson, Barry, 2000, Test Show Turbine Bennifits, Columbia Basin Bulletin, March 10, 2000 NWPPC, Page 5

[20] Mathews, D. R., 1983, Feeding Ecology of the Commom Murre, Uria Aalge, off the Oregon Coast, MS Thesis Univ. Of OR., Eugene OR.

[21] Lichatowich, James A., Morbrand, Lars. E., 1995, Analysis of Chinook Salmon in the Columbia River from an Ecosystem Perspective, page ix

is a 2.7 % return, which indicates a 97.3% loss[22]. Rules of thumb often have safety factors built into them. This rule of thumb can be examined by concentrating on a single pair of salmon. Thus, the number of salmon going into the system is just the number of eggs carried by a single female salmon and the percent of fertilization. The number of eggs varies according to species and size. Table 6 lists the average number of eggs for each species and their variability.

Species	Average Number of Roe	Variability
Pink	1700	±300
Coho	3000	±1500
Chum	3000	±1500
Chinook	5000	3000 to 12000
Sockeye	3500	±1500
Steelhead	3500	±1500

It can be seen that the data varies to such a degree that the percent of fertilization drops out of the equation. It is not necessary to know what goes on in the box. All we need to know is the number of salmon going in and the number coming out, the difference is the number of salmon that perish inside the system. For example, consider that a pair of Chinook produces about 5000 fertilized eggs. In a balanced system, where the Chinook population is going neither up nor down, those 5000 eggs must return to the river a single pair of salmon. That means if 4 salmon return out of each batch the population would double each year.

CONCLUSION

It seems strange that we have somehow reached an opinion that it is fine for other animals to slaughter each other, but if humans harm an animal, it is punishable with fine and imprisonment. This policy started in the early 1900 and has now grown out of hand.

Conservation and lost of salmon

Whereas the conservation movement had good intentions, it is naive to think that increasing one species would not seriously affect another. It is one thing to protect a species and another thing to feed them. The result is that the salmon's food supply over the last 100 years has decreased and the total number of salmon predators has been on the rise.

To illustrate this point, let us examine the fall and rise of just two of the salmon predators, seals and sea lions, off the Pacific coast. In the last hundred years, harbor seals alone have increased from around 100 animals to over 310,000, California sea lions from 1000 to over 300,000[23]. Some investigators feel that the number of California sea lions

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[22] Kaczynski, V. W., 1998, Marine Survival of OPIA Hatchery Coho Salmon related to Marine Temperatures, Proc. Of the 49th Annual Pacific Northwest Culture Conference. Pages 131-147

[23] _____, NOAA-NWFSC Tech Memo 28: Impact of Sea Lions and Seals on Pacific Coast Salmonids, Page 1

today exceeds any historic estimate[24]. Thus, from around 1100 animals in 1911 the numbers have grown until today there are over 850,000 if the northern fur seals and northern sea lions are included. Over the same period, the population of the six fish we have historic data on has plummeted to less than 10% of their maximum numbers. See Figure 21.

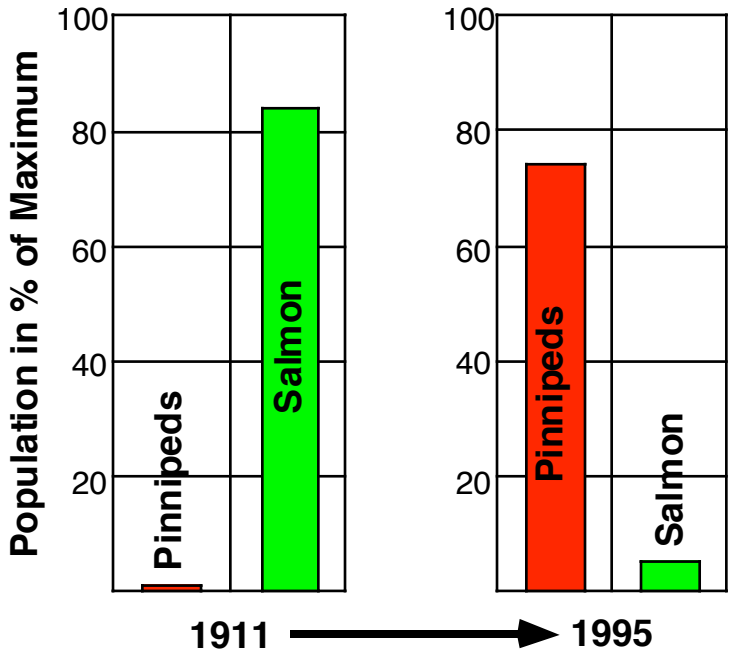

Figure 21. Population changes during the 20th century

To believe that these facts are unrelated is myopic and irresponsible. The blame for the loss of these salmon has be placed by environmentalist on human activity. What is ironic is that human activities have indeed caused the decline of salmon, but it is not the activities of logging, farming or hydropower, but the activities of over zealous environmentalist and animal right groups. In 1900, the pendulum was far to the right, now it is far to the right. We need to stop the pendulum in the middle and reduce the number of predators.

[24] _____, NOAA-NWFSC Tech Memo 28: Impact of Sea Lions and Seals on Pacific Coast Salmonids, Page1