The Importance of Fish to Bald Eagles in Southeast Alaska: A Review

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Fish are the most important prey for Bald Eagles in Southeast Alaska, yet not enough is known about which species are most important to eagles, how and where eagles obtain them and how secure various fish populations are. This study explores those questions and proposes a number of studies that should be conducted to acquire adequate data for making management decisions.

Throughout their range Bald Eagles feed on fish more than any other group of organisms. After reviewing 2,000 references on Bald Eagles, Lincer et al. (1979) concluded that "without a doubt" fish are the primary prey and often represent 80-90% of their diet. Similar statements were made by Stalmaster (1987) and Gerrard and Bortolotti (1988) in their reviews of the life history and biology of the Bald Eagle in North America.

Fish are also the most important item in the diet of Bald Eagles in Southeast Alaska. In a review of literature on Southeast Alaska's Bald Eagles Sidle et al. (1986) concluded that fish are the eagles' dietary mainstay. In an analysis of nearly 500 eagle stomachs collected in Southeast Alaska, Imler and Kalmbach (1955) found that fish averaged 66% of their year-round diet. An even higher percentage of fish (78%) were included among prey brought to nests by adult eagles in the area (Ofelt 1975).

Which species of fish are being eaten by eagles in Southeast Alaska? Which species are most important and how do eagles obtain them? How large are these fish populations now and what can we predict about future populations? Only a couple of dietary studies have been conducted on Bald Eagles in Southeast Alaska. Are these adequate or should more studies be conducted? These questions will be discussed in this paper.

Importance of Fish to Eagles in Southeast Alaska

Bald Eagles feed on a variety of fish species in Southeast Alaska. Usually these feedings occur when fish concentrate in shallow water to spawn. The following species are probably most important to Southeast Alaska's Bald Eagles.

Salmon

All species of salmon are of particular importance to Bald Eagles because salmon enter fresh water to spawn, often in large numbers and then die and wash up along stream and river bars and banks, lake and ocean shores and tidal flats. Compared to most other fish

available to eagles, salmon are large. One carcass may satiate several eagles. The importance of salmon and their use by Bald Eagles is well documented. Several studies, in fact, correlate the abundance of Bald Eagles with the abundance of spawned-out salmon (Servheen 1975, Fitzner and Hansen 1979, Hansen et al. 1984).

The largest concentration of eagles feeding on spawned-out salmon occurs in the Chilkat River near Haines, Alaska. More than 3,000 eagles may feed at one time on the carcasses of chum salmon that spawn in spring-fed stretches of the river. Bald Eagles travel to this river from all over Southeast Alaska and some scientists believe the entire region's carrying capacity for eagles may depend on these salmon (Hansen et al. 1984). The large size of chum salmon (4.5-6.0 kg) and their habit of spawning late (September to November) in several Southeast Alaska rivers, including the Chilkat, make this species especially important to Bald Eagles (Morrow 1980).

Pink salmon may be particularly important to nesting Bald Eagles in Southeast Alaska. Pinks are the most numerous salmon and spawn in more than 2,000 streams throughout the region. They utilize all sizes of streams, even the intertidal portions of streams that have blocks to migrating fish at tidewater. Probably any coastal fish stream within a nesting eagle's territory will contain spawning pink salmon. Most pink salmon spawn at a time when the eaglets are large (July-August) and pink salmon are small enough (1-3 kg) to be carried to the nest (Morrow 1980). Pink salmon may also be particularly important to fledged eagles, as their carcasses would be widely available in mid to late August, when most Southeast Alaska's Bald Eagles fledge (Sidle et al. 1986).

Coho salmon, although not nearly as numerous as pink salmon, are also known to spawn in more than 2,000 streams throughout the region. Coho are one of the latest spawners in Southeast Alaska; many spawn in November and December (Morrow 1980). They spawn when water and air temperatures are dropping and often just before and during ice formation on streams, rivers and lakes. Also, coho spawn when other fish scavengers are either leaving the region (as in the case of gulls) or denning (as in the case of bears). Coho carcasses decompose slowly in the colder water and many become trapped in ice. These carcasses are thus available to eagles in late fall, often during mid-winter and even during spring thaws in some systems. I have observed coho salmon entering the Mendenhall River system near Juneau to spawn in late December. Bald Eagles can often be seen in this area throughout the winter feeding on coho salmon carcasses.

Sockeye salmon in Southeast Alaska usually spawn in systems associated with lakes (Morrow 1980). They choose lake systems because most young sockeye rear for 1 or 2 years in a lake before migrating to sea (Margolis et al. 1966). In Southeast Alaska, 189 lakes are accessible to sockeye salmon (Reed 1971). Although sockeye are restricted to relatively few systems as compared to pink and coho salmon, they are no doubt important to local populations of Bald Eagles. For example, Bald Eagles feed on sockeye salmon in the shallow channels of the Chilkat River delta while the fish are enroute to Chilkat Lake near Haines (Hansen et al. 1984).

Chinook salmon spawn in only 33 streams and rivers in Southeast Alaska and most of

these streams are used by fewer than 1,000 spawners. Most chinook spawning in our three highest producing rivers (the Stikine, the Taku and the Alsek rivers) do so within tributaries in Canada; nevertheless the chinook are no doubt important to local populations of Bald Eagles. Since chinook are the largest of the Pacific salmon, with many weighing between 12 to 18 kg (Morrow 1980), one carcass would satiate several eagles.

The Alaska Department of Fish and Game closely monitors commercial and sport catch and escapement of salmon in Southeast Alaska and most runs are strong. Recent commercial catches of all salmon species in Southeast Alaska have been among the highest on record. The 1989 Southeast Alaska salmon catch was approximately 65.8 million fish and this ranked second only to the 1941 salmon harvest (Geiger and Savikko 1990).

Dolly Varden

Dolly Varden char are the most widely distributed fish in Southeast Alaska. They can be found in all types of fresh and salt water capable of supporting fish (Armstrong and Morrow 1980). The anadromous form of charr is probably the most available as prey for Bald Eagles. These charr concentrate in lakes and larger rivers for the winter (Armstrong 1974), where they may exceed 100,000 in a single lake or river (Armstrong 1965). In April and May I have seen lake outlets completely full of migrating Dolly Varden.

Dolly Varden may be more important in the diet of Bald Eagles than the literature indicates. Eagles were always present during the spring out-migrations of charr at Lake Eva on Baranof Island. Dolly Varden overwinter in the Chilkat River near Haines Baade (1955) and Hansen (1987) mentioned that the breeding eagles of the Chilkat Valley fed upon them.

Successful management of anadromous Dolly Varden is difficult because they move from one freshwater system to another and because each system contains mixed stocks. Over-harvest has apparently occurred in the Juneau area where the sport catch rate dropped considerably over a 10 year period (Armstrong 1979). I have outlined management strategies for the maintenance of Dolly Varden populations in Southeast Alaska (Armstrong 1974).

Pacific Herring

In spring, Pacific herring move inshore in large numbers to spawn in bays and estuaries (Eschmeyer and Herald 1983). They usually lay their eggs on beach rocks, eel grass, kelp, rockweed and pilings at depths between high tide and 36 feet (Hart 1973). In Southeast Alaska, thousands to perhaps millions of herring spawn on a single beach (Alaska Dept. Fish & Game 1978). The peak of spawning is in mid-March (Ibid.) but may occur anytime from February through June (Hart 1973). Bald Eagles, particularly non-breeders, concentrate to feed on spawning herring (Hodges et al. 1979). Up to 300 eagles have been observed feeding on Pacific herring at Klawock in Southeast Alaska (Bailey 1927).

The Alaska Department of Fish and Game conducts detailed stock assessments of Pacific herring and the stocks are strong and well managed. The allowable harvests range from 10 to 20% of these estimates only when they fall above an established threshold level. Otherwise the fishery is closed. The strength of Southeast herring stocks currently is reflected in the 1989 harvest, which was the highest since 1964 (Funk and Savikko 1990).

Eulachon

Eulachon concentrate to spawn in the mainland rivers of Southeast Alaska from March through May (Hart 1973). Most spawn over coarse sand and pea-sized gravel (Morrow 1980) in the lower parts of glacier fed rivers. Since they spawn in relatively shallow water and die after spawning (Eschmeyer and Herald 1983), the eulachon would be accessible to feeding eagles.

An important location where Bald Eagles feed on eulachon is in the Stikine River near Wrangell. During April from 500 to 1,500 eagles gather there to feed on spawning eulachon (Hughes 1982b). On April 13, 1990, 1,073 eagles were concentrated where the eulachon spawn in the Stikine River (Walsh 1990a). This concentration is considered to be the second highest number of feeding eagles in Southeast Alaska and this food supply may be critical to the survival of the area's eagles (Hughes 1982b). Bald Eagles also feed on eulachon in the Chilkat River near Haines (Hansen 1987) and I have observed numerous eagles feeding on them in the mouth of Mendenhall River near Juneau.

Eulachon are harvested commercially in Washington and Oregon, where more than 454,000 kg per year are taken (Morrow 1980). In Southeast Alaska they are harvested only by subsistence fishermen. In 1987, approximately 20,000 pounds of eulachon were taken by subsistence fishermen in Southeast Alaska (Bosworth 1990). More than half of this harvest came from the Chilkat and Chilkoot rivers (Betts 1990).

Pacific Sand Lance

As a source of food for marine birds and mammals, the Pacific sand lance is one of the most important fish in our marine waters (Sealy 1975, Beacham 1986, Armstrong and O'Clair 1987). Sand lance are particularly vulnerable to predators and are flushed easily from the sand when disturbed (Hobson 1986). When not buried they occur in large schools near the water surface in both inshore and offshore marine waters (Eschmeyer and Herald 1983).

Sand lance may be important in the diet of Southeast Alaska eagles. On numerous occasions I have counted between 20 and 80 Bald Eagles feeding on Pacific sand lance during minus tides on the Mendenhall Wetlands near Juneau. On a minus tide the sand lance's burial grounds are often exposed.

Bald Eagles at the mouth of the Mendenhall River feeding on sand lance. Photo by Bob Armstrong

I have observed Bald Eagles walking over these areas. This seems to panic the sand lance, which squirt out of the sand, making them easy prey for the eagles. Concentrations of Bald Eagles near the edge of sandy tidal flats, especially at minus tides, may be feeding on Pacific sand lance.

Other Fish Species

Many other species of fish concentrate to spawn in areas that would make them available to Bald Eagles of Southeast Alaska; however, I could find little or no information on their use by eagles.

Cutthroat and steelhead trout would be available to Bald Eagles when the fish spawn in the spring (Jones 1977a, b). The anadromous cutthroat trout may be available to eagles during their migrations to sea in May and June and again when they return in September and October (Armstrong 1971).

Capelin are vital food for almost all vertebrate creatures of the marine ecosystem of

coastal northeast Canada (Thurston 1988). I believe they are also important forage fish for Bald Eagles and other fish eaters in Southeast Alaska because they spawn in large schools where eagles could get to them and they die after spawning. They move inshore between April and October to spawn on fine gravel or sandy beaches (Eschmeyer and Herald 1983). Capelin have been observed trapped in intertidal ponds on the Mendenhall Wetlands during May and again in July (Bishop et al. 1987). Other smelt, including surf smelt, rainbow smelt, night smelt and longfin smelt, occur in Southeast Alaska and have spawning characteristics that could make them vulnerable to predation by Bald Eagles (Eschmeyer and Herald 1983).

Starry flounders and Pacific staghorn sculpins frequent shallow intertidal sloughs and ponds, sometimes in considerable numbers (Bishop et al. 1987). Sculpins and flatfish have been observed among prey items brought to eaglets in Southeast Alaska (Ofelt 1975) and in eagle stomachs (Imler and Kalmbach 1955). The use of benthic fish, such as flounders and sculpins, has also been documented elsewhere for the Bald Eagle (Cash et al. 1985, Haywood and Ohmart 1986, MacDonald and Austin-Smith 1989). Walleye pollock, other cod species and rockfish also occur in the diet of Bald Eagles in Southeast Alaska (Imler and Kalmbach 1955).

Special Considerations During Nesting

Bald Eagles typically nest near the best foraging areas (MacDonald and Austin-Smith 1989). In Southeast Alaska, Hodges and Robards (1982) found that nests were located in areas where the eagles could most easily obtain fish, such as near the waterfront along exposed coasts and on prominent points and islets.

Availability of fish not only influences the number of eagles breeding in an area but also increases the survival of their offspring. In general, birds that are solitary nesters adjust their breeding density to correspond with available food (Newton 1976). In the Chilkat River Valley, the availability of fish influenced breeding rates, egg laying dates and offspring survival of nesting eagles and caused eagle productivity to fluctuate greatly between years (Hansen et al. 1984).

Nesting eagles are very territorial and defend their territories against other eagles from at least mid-March through August (King et al. 1972). During this time they may seldom forage for fish beyond their territory, which may only be 1-2 km (Stalmaster 1987). The adults typically perch near their nesting sites and wait for fish to appear (Stalmaster 1987, Gerrard and Bortolotti 1988).

Since food abundance in spring strongly influences where, when or if eagles lay eggs (Hansen et al. 1986), fish species available at this time are especially important to the eagles. In Southeast Alaska, the first salmon are not available until July. Pacific herring, eulachon and a few other species concentrate to spawn in spring, but these spawning concentrations are widely scattered and would be available to only a relatively small percentage of the region's nesting eagles. On the other hand, non-breeding eagles, which do not have territories, can search widely for these spring spawning concentrations and probably benefit most from them (Hodges et al. 1987).

Most nesting Bald Eagles are probably dependent on the occasional fish swimming near the surface of the water and the dead and dying fish that float or wash up on the beach within their territory. Most fish species sink to the bottom when they die and probably get scavenged before bacterial action can refloat them.

Whether or not a fish floats after being killed probably depends on the presence or absence of a gas bladder and the type of gas bladder that it has. Some fish have a gas bladder that opens into the esophagus (physostomous condition) while others have a gas bladder that lacks a duct to the esophagus (physoclistous condition). When physostomous fish are handled, as when they are caught and released by fishermen, the gas bladder may collapse and the fish will sink. But when physoclistous fish are brought to the surface their gas bladder expands, hence they usually float after being released.

Of the fish commonly caught by fishermen, only members of the cod family such as walleye pollock and rockfish have a physoclistous condition and float after being killed. Also, walleye pollock are known to float or swim about at the water's surface when they are sick or injured. Most other fish such as salmon, trout, flounders and sculpins, are physostomous and sink after being killed.

Walleye pollock, then, may be easily captured by nesting eagles. In addition, they may be one of the most abundant marine fish in Alaska. They make up 73% of the total harvest of groundfish (Kruse 1988). In the 1960s they were the fish that I most frequently caught while trolling for salmon. Also, I would see them in large numbers swimming about Juneau area boat docks. Pollock have even been observed entering stream mouths during the advancement of tide waters (Armstrong and Winslow 1968).

Walleye pollock are utilized by nesting eagles in Southeast Alaska. Pollock and cod were present in about one-third of the 325 eagle stomachs with fish examined by Imler and Kalmbach (1955). They were the most frequently consumed fish during May and June before salmon spawning began and during a critical time for nesting eagles.

Walleye pollock were abundant in the northern half of Southeast Alaska in the early 1970s, but they essentially had disappeared by 1982 or 1983 (Bracken 1990). This disappearance may have been related to an apparent epizootic that caused an unusual die-off of walleye pollock within the major inside passages and inlets of northern Southeast Alaska during April 1977 (Kingsbury 1977). This noted die-off of pollock may have caused the increasingly higher proportion of adult eagles that failed to breed between 1970 and 1979 (Hansen and Hodges 1985), or the significant drop in the total number of offspring in nests observed between 1972 and 1986 (Hansen 1987). The evidence may indicate a relationship and the importance of walleye pollock and other cod to nesting eagles in Southeast Alaska should be investigated.

How Bald Eagles Obtain Fish in Southeast Alaska

Bald Eagles obtain fish in a variety of ways. In general, non-nesting eagles search for fish; nesting eagles wait for fish to come near their nesting site (Hansen et al. 1984).

According to Stalmaster (1987), Bald Eagles acquire food by stealing prey from others, scavenging on carrion and hunting and killing (Hansen et al. 2008).

Eagles find fish not only by searching themselves but also by following other eagles and other birds to dead fish and concentrations of fish (McClelland et al. 1982, Harmata 1984). Bald Eagles often prefer to acquire fish by stealing from other eagles and other species rather than acquiring it on their own (Stalmaster and Gessaman 1984). On several occasions, I have seen eagles follow river otters and steal their catch. They also steal food from sea otters (White et al. 1971), Ospreys (Hughes 1982a), mergansers and gulls (Stalmaster 1987).

Bald Eagles also take advantage of fish captured, injured, or driven to the surface of the water by other fish predators. They will feed on fish killed by bears and wolves (Gard 1971, Hansen et al. 1984), injured by whales and sea lions (Hyde 1990) and driven to the surface by loons (Dixon 1909), seals (Ofelt 1975) and salmon (Beebe 1974).

Human activities also may provide fish for Bald Eagles. Commercial, sport and subsistence fishermen often catch and release unwanted fish. Many of the released fish are crippled or dead and eagles feed upon them (Beebe 1974, Dunstan and Harper 1975, Hansen et al. 1984, Dennis 1990). Eagles also take advantage of fish and their parts that are discarded by fish hatcheries in Southeast Alaska (Walsh 1990b).

Among all of the different ways that Bald Eagles obtain fish, two in particular are probably more important. (1) The number of salmon carcasses that bears scoop out of rivers and streams seems quite significant. When food is abundant, particularly late in the summer, bears foraging spawned out salmon carcasses tend to eat only the fat-rich brains and eggs, leaving the rest of the carcasses on river bars and banks. The remaining larger portions of the carcasses can then be eaten by Bald Eagles. Many spawned out salmon carcasses originally settle into deep pools. Were it not for the bears they would be difficult or impossible for eagles to obtain.

The widespread commercial, sport and subsistence fisheries in Southeast Alaska must provide an abundance of unwanted fish carcasses for eagles. A high correlation was found between eagle breeding success and the amount of fish caught and discarded by commercial fishermen in central Saskatchewan (Whitefield and Gerrard 1985). In Southeast Alaska most fishing occurs during the eagles' nesting period, from May through August and dead fish from fishing may be crucially important in regulating eagle populations.

Concerns for the Future

Although most fish stocks utilized by Bald Eagles in Southeast Alaska are healthy, I am concerned about their future. The demand for human use of fish in Alaska has increased substantially in recent years. Commercial, subsistence and sport harvests have increased about three-fold since 1976 (Kruse 1988). There is also a trend toward more utilization of other fish species. If commercial utilization of capelin, eulachon and Pacific sand lance were allowed in Southeast Alaska the effects on Bald Eagles could be considerable.

Many other human activities can negatively affect fish. Logging, mining, power developments, urbanization and pollution have all had profound negative impacts on fish populations throughout the nation. The mining industry is rapidly expanding in Southeast Alaska. Release of toxic materials, both accidentally and deliberately, has been commonplace with the mining industry elsewhere (Laycock 1989). Fish assimilate toxic chemicals from their environment and pass them up the food chain to Bald Eagles (Stalmaster 1987).

While contributing significantly to our knowledge of the fish species utilized by Bald Eagles studies need to be supplemented with others if we are to understand the relative importance of different species of fish. Ofelt's direct observations (1975) of the food brought to eaglets at three nests covered only the period between June 30 and August 10 and 38% of the fish could not be identified. Imler and Kalmbach (1955) examined the stomach contents of about 500 eagles killed in Alaska under the bounty program. While their study gave a clearer picture of the year-round utilization of fish by eagles, the examination of stomach contents may be biased toward mammals, birds and larger-boned fish. Small-boned fish such as Pacific herring, Pacific sand lance, eulachon, capelin and other smelt were found only in small numbers in their study. But fine-boned fish are more easily digested by eagles and their remains are more difficult to find because of their small size (Dunstan and Harper 1975).

Other methods may also not yield accurate results. For example, studies of the food habits of White-tailed Eagles in Greenland by Danish ornithologists have revealed several problems associated with examining prey fragments and pellets found near nesting sites (Kampp and Wale 1979, Wille 1979). The Danes assessed prey most accurately when they used automatic cameras to photograph each food item carried to the nest by the White-tailed Eagle adults.

There are several major gaps in our knowledge of the relationship between fish and eagles in Southeast Alaska. Some of these gaps may be critical to future management of Bald Eagles, especially as we develop our land and as we increase our utilization of fish resources. Although any further information on fish as food for eagles will help us to better understand these relationships, we need certain types of data more than others. I believe we should give priority to four kinds of studies:

1. Determine the distribution of nesting Bald Eagles in relation to the fish resources and related activities in Southeast Alaska. We need an overall survey that would plot on a single map: eagle nest locations, salmon streams, herring spawning areas, Dolly Varden wintering areas, tidal flats, locations of commercial, subsistence and sport fisheries and other fish resource information. This information could be gathered from the area management biologists of the Alaska Department of Fish Game Divisions of Commercial, Subsistence and Sport Fisheries. Such a study could help reveal whether prey availability affects the pattern of nest distribution. It could then be used to plan more detailed studies as the need for them is indicated.

2. Determine the species of fish utilized by nesting Bald Eagles prior to the availability of

salmon carcasses. Spring and early summer is important to nesting success. The success of this type of study may require direct observations of nesting eagles. Observations from a boat to determine where and when nesting eagles fish and which fish species they catch could be compared with fish depicted in photographs of the eagles bringing prey to their nests.

3. Determine the importance of fish discarded by commercial, subsistence and sport fishermen to Bald Eagles in Southeast Alaska. At the Northern Regions Conference in Anchorage (1990) a proposal was made that fishermen be required to keep and utilize all fish caught rather than throw unwanted fish overboard. If implemented, what effect would this proposal have on nesting Bald Eagles? Perhaps this type of information could be gathered by observers stationed within or near selected fisheries in the region.

4. Determine the year-round utilization of Pacific sand lance by Bald Eagles. Sand lance burial grounds are often exposed or nearly exposed during minus tides. An ideal study site is a burial ground associated with the Mendenhall Wetlands near Juneau, where numerous eagles feed on sand lance at low tide. This study could be done with a spotting scope without disturbing the eagles and other aspects of food gathering by eagles over tidal areas could also be determined. The utilization of flounder, sculpins and eulachon by eagles could be documented here as well.

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