Bald Eagle: Supporting Information for State of the River Report

Background

Found exclusively in North America, bald eagles are powerful predators that feed on live or scavenged fish and aquatic birds, along with smaller mammals, amphibians and reptiles. Eagles can live up to 28 years in the wild, and generally stay with one mate, unless the mate dies or disappears. Bald eagle numbers in North America declined by 1950, and further abrupt declines from 1950 to the 1960s led to the classification of this species, in 1967, by the federal government as endangered in 43 of the lower 48 states (Elliott et al. 2002). Environmental contaminants have been considered the primary factor causing the abrupt population decline, which primarily resulted from the impacts of organochlorine pesticides on breeding success (Grier 1982, Elliott et al. 2002). Food is the primary vehicle that moves contaminants into eagle's bodies.

Status and Trends

Since the banning of DDT and other organochlorine pesticides in the 1970s, bald eagle populations have increased throughout most of the contiguous 48 states (Grier 1982). It is estimated that eagle populations in the lower 48 states rebounded from a low of 417 breeding pairs to 9,789 pairs in 2007. By 1995, bald eagle populations had increased to the extent that it was possible to list the species as threatened, rather than endangered, in all of the lower 48 states (USFWS, 2007 fact sheet-
http://www.fws.gov/migratorybirds/issues/BaldEagle/bald_eagle_info-hiquality.pdf). The bald eagle was removed from the federal List of Endangered and Threatened Wildlife and Plants in July 2007 (USFWS http://ecos.fws.gov/tess_public/DelistingReport.do).

In the lower Columbia River, the number of occupied bald eagle nesting territories has increased each year since monitoring began in the early 1970s. In 2007, there were 144 breeding pairs in the lower Columbia River area, up from only 24 in 1987 (Figure 1; Isaacs and Anthony 2008). However, in contrast to other bald eagle populations in Oregon and Washington, the reproductive success of eagles along the lower Columbia River has been well below statewide values (Anthony et al. 1993; Buck et al. 2005). Unlike eagles in other areas, lower Columbia River eagles are year-round residents and do not migrate away from the river in winter.

Poor reproductive success in these bald eagles has been largely attributed to organochlorine pesticides such as DDT and its breakdown products. Once ingested by a bird, DDT can be metabolized or breakdown into DDE. DDE accumulates along with other contaminants such as PCBs in the fatty tissues. During egg development inside the female eagle, DDE is released from storage and affects the ability of the bird to properly supply calcium to the eggshell during shell formation (Lundholm 1997). Due to this disruption in calcium transport, the female then lays eggs that have thinner eggshells than normal. A thin eggshell enhances moisture loss which an embryo otherwise requires for proper development, and it also breaks more easily during incubation. Embryos are killed from both moisture loss as well as eggshell cracking or breaking during incubation or egg manipulation in a nest. In addition, contaminants such as DDT, DDE, PCBs, and dioxins accumulated in the female bird's body are transferred directly from the mother to the egg yolk during egg development. As embryos develop inside eggs after laying, they absorb contaminants along with nutrients from their yolk, and exposure during this sensitive stage can cause deformities or kill the embryo.

Studies conducted by Anthony and co-workers (1993) along the lower Columbia River from 1980 to 1987 on the 24 identified occupied breeding territories found elevated concentrations of DDE and PCBs in bald eagle eggs, in blood samples of eight-to 10-week-old nestlings, and in eagle carcasses collected along the river. The presence of DDE and PCBs in blood of eagle nestlings provided evidence of exposure from contaminated prey from the river. High concentrations of DDE and PCBs in eggs and carcasses were associated with marked eggshell thinning and low reproductive success. Only 39% of the occupied breeding territories were successful in fledging young, and productivity averaged 0.56 young/occupied site. These levels were considerably lower than the statewide average of 62% success and 0.93 young/occupied site for Oregon from 1978 to 1987. DDE and PCB concentrations in eggs in this study were the highest recorded for bald eagles in the western United States, surpassed only by levels found in eagle eggs from the Great Lake States, Chesapeake Bay, and Maine during the 1970's.

In a similar study conducted from 1994 to 1995, researchers evaluated whether organochlorine contaminants continued to accumulate in bald eagles along the lower Columbia River. Examining both established and new nesting pairs at nearly half of the 43 breeding territories then located throughout the lower Columbia River, Buck and co-workers (2005) found that reproductive success differed between older breeding territories versus more recently occupied breeding territories. Eagles at older breeding territories produced about half the number of young as the eagles at newer sites, and reproductive success of eagles at the older territories had not improved in over ten years. Thus, increased productivity of the bald eagle population nesting along the lower Columbia River is a result of greater reproductive success of the new nesting pairs. However, total PCBs and DDE concentrations declined significantly at older breeding territories—34% and 49% respectively--in comparison to concentrations found in the mid-1980's. Although PCBs and DDE declined, egg concentrations still exceeded levels considered protective of the species. Mercury concentrations in eggs did not change between the two studies.

Reproductive success of pairs nesting between river miles 13 to 31 (from about Tongue point to Welsh Island) continued to be well below the normal value of 1 young produced per occupied nest. Concentrations of DDE appeared to have the greatest impact on reproductive success in older nesting pairs. However, PCBs, dioxins, and furans exceeded estimated threshold effect levels at older breeding territories, and may be interacting to further impact reproductive success (Buck et al. 2005).

Future Needs

The sensitivity of bald eagles to toxic contaminants and their position as top predators in the food web make them a useful indicator of aquatic ecosystem health (Environment Canada www.on.ec.gc.ca). Therefore, continued monitoring of bald eagle productivity and contaminant concentrations throughout the Columbia River basin will allow resource managers to address such questions as:

- Is the health of bald eagles improving over time?
- Is the health of the Columbia River system improving over time?
- Are toxics reduction efforts in the Columbia River system associated with increased eagle reproductive success and/or reduced contaminant burdens, especially for those pairs nesting between river miles 13 to 31?

Emerging contaminants such as PBDEs also have been found in eagle eggs and are increasing in organisms across the Columbia River system and in aquatic systems nationwide (Buck et. al 2005, Alaee and Wenning 2002, Rayne et al. 2003). The risk of these emerging contaminants on the health of bald eagles is unknown, and it is important that we improve our understanding of the effects of emerging contaminants of concern.

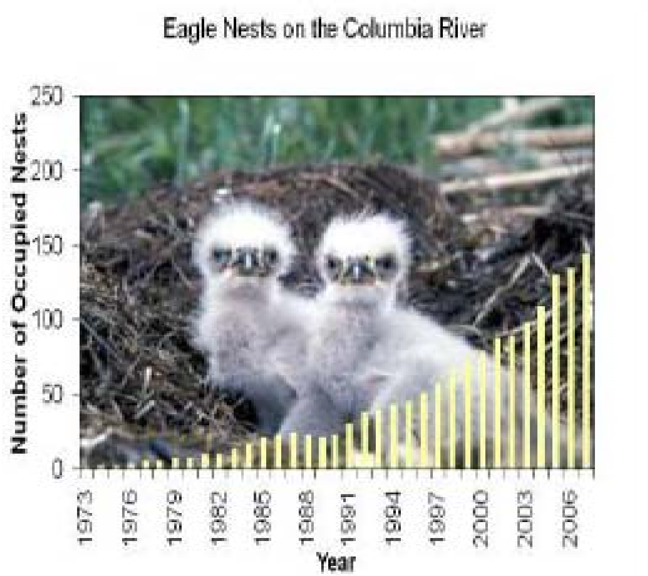

Figure 1: Nesting pairs of bald eagle have increased significantly from near-regional extinction in the 1970s, due to reductions of DDT and other contaminants in the environment (photo courtesy of Peter McGowan, USFWS).

Anthony, R.G. et al. (1993) "Environmental Contaminants in Bald Eagles in the Columbia River Estuary" ***Journal of Wildlife Management*** **57(1):10-19.**
Researchers monitored breeding success of bald eagles and collected eggs, blood, and carcasses of eagles and fish in the Columbia River estuary, 1980-87, to determine if contaminants were having an effect on productivity. High levels of DDE and PCBs were found in eggs and blood from adults; DDE and PCBs were also detected in blood of nestlings, indicating exposure to contaminants early in life. DDE and PCB accumulated with age, and adult eagles had higher levels of mercury (Hg) in blood than young eagles, also indicating accumulation with age. The high levels of DDE and PCBs were association with eggshell thinning and lowered productivity. DDE and PCBs had a deleterious effect on reproduction of bald eagles in the estuary.

Buck, J.A. et al. (2005), "Changes in productivity and contaminants in bald eagles nesting along the lower Columbia River, USA," in *Environmental Toxicology and Chemistry*, 24 (7):1779-1792. Researchers collected partially incubated eggs at 19 of 43 occupied eagle territories along the lower Columbia River from 1994 – 95, and compared productivity and egg contaminants to values obtained in the mid-1980s. They found higher productivity at new nesting sites along the river, yet productivity at 23 older breeding territories had not improved since the previous study. Productivity was lowest (0.42 young per occupied territory or less than half of normal values) for eagles nesting between river miles 13 to 31. Decreases in DDE and total PCBs in eggs from older breeding areas occurred between the study periods, yet eggshell thickness at older territories had not improved. Although total eagle productivity along the lower river increased due to the success of new nesting pairs in the region, egg contaminants remained high enough to impair egg production at older territories and, over time, may alter productivity of new pairs nesting in the lower river.

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Rayne, S., M.G. Ikonomou, and B. Antcliffe. 2003. Rapidly increasing polybrominated diphenyl ether concentrations in the Columbia River system from 1992 to 2000. Environmental Science & Technology 37(13):2847-2854.