

The Decline, Recovery and Future of the Bald Eagle Population of the Chesapeake Bay, U.S.A.

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ABSTRACT

The Chesapeake Bay Bald Eagle (*Haliaeetus leucocephalus*) population may once have exceeded 3000 breeding pairs. During the 17th and 18th centuries, much of the shoreline forest used by eagles was destroyed by extensive land-clearing for agriculture. Shooting also took a toll. In the 1940's, DDT and dieldrin were introduced into the bay ecosystem, reducing eagle production from approximately 1.6 young per pair of adults in 1936 to 0.2 young per pair in 1962. Shooting continued to be a problem and, by 1970, the population had declined to 80-90 pairs. Following the end of DDT and dieldrin use in the 1970's, the reproductive rate increased to 1.3 young per pair in 1986-1990. Minimum known alive survival rates determined by radio-tagging exceeded 86% in 1984 - 1990. These rates led to a rapid increase in the population, which numbered about 250 pairs by 1992. However, studies of the habitat use of radio-tagged eagles indicated that the birds avoid shoreline with buildings and other human activity. The amount of developed area in the watershed is projected to increase > 70% by 2020. Modelling suggests that the population will continue to increase for about 10 to 25 years and then decline precipitously as habitat destruction continues.

INTRODUCTION

The Chesapeake Bay is an estuary on the east coast of the United States. Formed as the post-pleistocene Atlantic rose to flood the lower reaches of the Susquehanna River, the bay is 320 km long and 50 km wide, with a surface area of 5700 km².

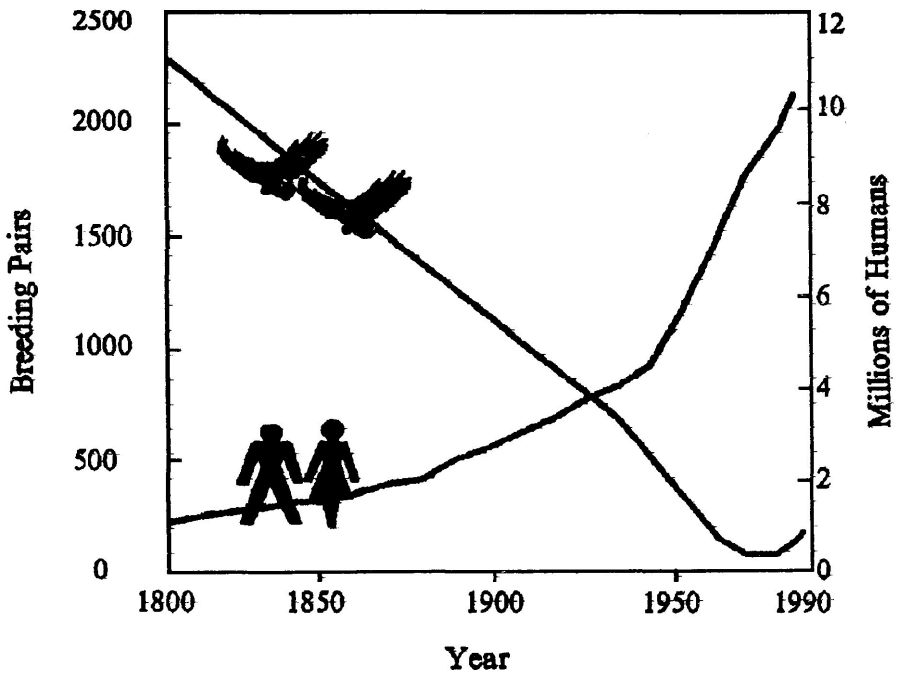
It is an extremely rich ecosystem. The Bay's productivity so impressed early European visitors that incredible tales were told of fish so abundant that they could be scooped up by hand as they swarmed at the water's surface. A canoe, it was said, could be filled in an hour using this technique. The ancient forests that lined the shores were dark and forbidding, causing one explorer to liken them to a "retreat of some ancient Druids." The 13,000-km long shoreline was perfect sea eagle habitat.

The Bald Eagles inhabiting the area before European settlement were uncoun-
ted, of course. However, we can roughly estimate the number of breeding pairs present if

we assume that the densities in the pristine Chesapeake were similar to densities in Alaska today (about 1 pair per 4 km of shoreline; Hodges and Robards 1982). The 13,000 km of bay shoreline, then, would have supported more than 3,000 pairs of eagles. In addition, the offspring of these birds and migrants from the north and south would have been present at various times of the year.

The first census-based estimate of the population did not occur until 1936 (Taylor *et al.* 1982), so the nature of the decline from early abundance must be deduced from our knowledge of eagle requirements and human history. During the 17th and 18th centuries, settlers flooded into the bay region.

Figure 1. Population trends for Bald Eagles and humans in the Chesapeake Bay region. The curve from pristine times to 1936 was drawn by connecting our estimate of the original population with the 1936 estimate. .



These people and their successors began the systematic destruction of the coastal forests occupied by the eagles. The deforestation was so extensive that it altered the hydrology of the Bay's tributaries and caused unusually destructive flooding in the

18th century (Middleton 1953). Undoubtedly, many eagle nests, roosts and perches were lost during this period of forest destruction. Moreover, predators of all types were considered vermin and eagles were killed whenever possible. This destruction of eagles and their habitats very likely contributed to the reduction of eagle populations as early as the 17th and 18th centuries. The curve representing the eagle's decline prior to 1936 (Figure 1) was constructed by connecting our rough estimate of the pristine population (3000 pairs in 1600) with the 1936 estimate (600 pairs) of the breeding population.

The population continued to decline after 1936, apparently because of shooting and habitat destruction. After DDT was introduced in 1946, this pesticide accelerated the species' decline (Wiemeyer *et al.* 1984). The reproductive rate of the Chesapeake eagles dropped from 1.6 young per pair in 1936 to only 0.2 young per pair in 1962. By 1970 the population had declined to a low of about 80-90 pairs.

The use of DDT in the United States decreased through the 1960's for a variety of reasons, and all crop uses were banned at the end of 1972 (Environmental Protection Agency 1975). Following the elimination of DDT, reproduction improved, reaching an average rate of 1.3 young per pair in 1986 - 1990 (Buehler *et al.* 1991a). Survival also was excellent (86%, Buehler *et al.* 1991a), apparently due, in part, to a decline in the shooting rate (Fraser 1985). This combination of good reproduction and good survival resulted in a marked population increase. While the pace of this increase has been impressive (12.6%, Buehler *et al.* 1991a), we believe that it will be followed by a rapid decline unless the rate of shoreline development declines. In this paper we briefly review the effects of disturbance, including shoreline development, on Bald Eagle distribution, and explain why we expect a long term decline in the Chesapeake eagle population.

EFFECTS OF DISTURBANCE ON FORAGING EAGLES

By means of aerial surveys of the shoreline, on which eagles, boats and people were counted, Buehler *et al.* (1991b) demonstrated that Bald Eagles were found less frequently on 250m shoreline stretches that were occupied by people or boats than would be expected if eagles chose shoreline without regard to human presence. Moreover, shoreline surveys and radio-telemetry indicated that foraging eagles avoided shoreline that contained buildings. Logistic regression analyses showed that the probability of shoreline use by eagles was negatively related to building density. Shoreline with more than 1 building/ hectare was very rarely used, and may be considered of little potential value to Bald Eagles (Buehler *et al.* 1991b, 1992).

Results from the Chesapeake are consistent with results from other areas. On the Columbia River, Oregon, McGarigal and Anthony (1991) noted that adult eagles foraging within their nesting territories avoided areas occupied by boats. Stalmaster and Newman (1978) reported that human traffic near river channels in western

Washington reduced eagle use. Moreover, they noted that when birds were disturbed by the presence of humans, they typically flew to more remote sections of the river. Smith (1978) noted that boat and pedestrian traffic near the shores of Jordan Lake, North Carolina, resulted in lower eagle densities on the disturbed shoreline than on the less disturbed portions of the shoreline. Moreover, Smith demonstrated that eagle densities on the shoreline were lower on the weekends when human traffic was high than on week days when human traffic was low. Most of the shoreline of Jordan Lake was rarely used by eagles, apparently because of high human density.

EFFECTS OF HUMAN DISTURBANCE ON NESTING AND ROOSTING EAGLES

Although eagles sometimes nest successfully even when disturbed, they often move to more remote locations the following year (e.g. Broley 1947). This is probably why Andrew and Mosher (1982) found that Chesapeake nests were farther from houses than from randomly selected points. Moreover, active nests on the Chesapeake are farther from the water than older, inactive nests (Jaffee 1980). Fraser *et al.* (1985) found that newly constructed nests near developed lakeshores in northern Minnesota were farther from the shoreline than new nests in undeveloped areas. In addition, Minnesota nests were farther from houses than from randomly selected points.

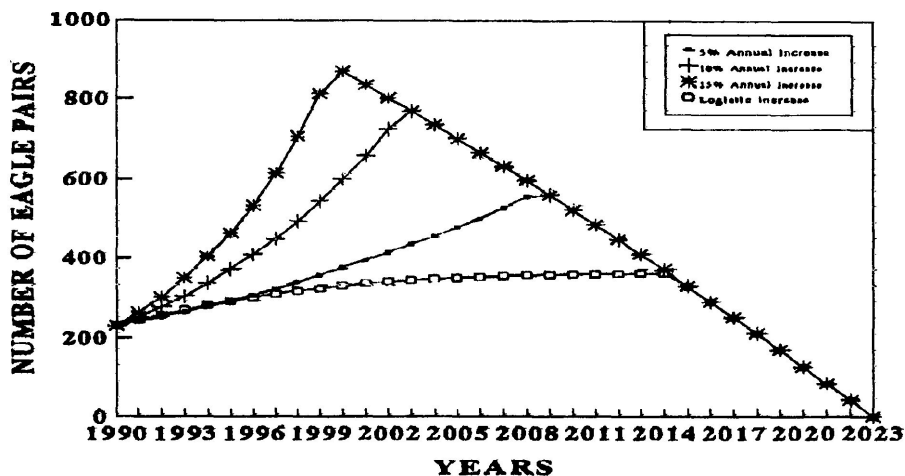
Bald Eagles on the Chesapeake Bay roost communally about 60% of the time and roost by themselves the rest of the time (Buehler *et al.* 1991c). Like perches and nest sites, solitary and communal roost sites are farther from roads and buildings than expected at random, (Buehler *et al.* 1991c). Thus, eagles appear to avoid humans during all phases of their life history on the Chesapeake Bay.

LONG TERM EFFECTS OF SHORELINE DEVELOPMENT ON CHESAPEAKE NESTING EAGLES

We modelled the expected changes in the Bald Eagle populations using current estimates of the population increase, exponential and logistic population growth models, and survival estimates based on radiotelemetry. Based on the distribution of nests along the shoreline in Alaska (Hodges and Robards 1982), we assumed that nesting Chesapeake eagles require 4km of undisturbed shoreline to forage effectively. We used a shoreline length for the Chesapeake Bay of 13,000km and assumed that by 1990, 6,292km of shoreline were already unavailable to eagles because of shoreline development and that another 2,028 km were unusable for other reasons such as lack of perch trees (Buehler *et al.* 1991b). We assumed that habitat would be lost at the rate of 1.014%/year based on Gray *et al.* (1988).

Results of this effort predicted a continued increase in the Chesapeake breeding population for about 10 to 25 years followed by the rapid decline due to habitat development (Figure 2). The modelled population increases at first, because it is far

Figure 2. Four projections of changes in the Chesapeake Bay Bald Eagle breeding population.



below the specified carrying capacity. In all models, the population increased until it reached the carrying capacity, and then decreased as habitat was lost. The more rapid the increase of the modelled population, the sooner it reached carrying capacity and started to decline.

These models are admittedly crude. They do not, for example, account for the effect of nest protection measures or of refugia such as state and federal wildlife refuges, which will slow the actual rate of decline. On the other hand, the models assume that habitat will be lost in territory-sized parcels. Thus, the loss of 4 km of habitat equates to the loss of 1 territory in the model. In fact, shoreline habitat is being lost in pieces smaller than 4 km. Thus, a 4 km habitat loss is lost as a number of fragments of several territories and hastens the decline of the bay's carrying capacity. Because approximately 85% of the Chesapeake eagle nests are on private land (Cline 1986), enforcement of protective measures are difficult at best.

MANAGEMENT RECOMMENDATIONS

We believe that if Bald Eagles are to continue to breed on the Chesapeake Bay over the long run, a significant amount of additional habitat must be set aside to remain wild. These areas should be large undeveloped blocks, containing forested shoreline adjacent to shallow water with abundant fish and waterfowl (Fraser *et al.*

1991). The highest priority for protection should be given to areas which currently are used by Bald Eagles. At the current rate of habitat loss, we have only a few years to protect the remaining undeveloped shoreline.

While setting aside shoreline will be expensive, it will produce a variety of benefits. Other wildlife species such as the wood duck (*Aix sponsa*), the river otter (*Lutra canadensis*), and the belted kingfisher (*Ceryle alcyon*) would benefit. Perhaps as important, humans would benefit culturally. When European settlers arrived on the Chesapeake Bay in the 17th century, they found the shorelines covered by the giant trees of an old growth forest (Middleton 1953). We have many museums and reconstructed settlements which allow us to admire the culture that those settlers carved out of the forest. In contrast, we have few opportunities to study the unspoiled forest-bay ecosystem which gave the colonists the raw materials on which they thrived. By setting aside some large tracts of shoreline as natural areas, we would be creating ecological museums which could benefit generations to come and, at the same time, sustain the Bald Eagle and other wild species.

REFERENCES

- ABBOTT, J. M. 1978. Chesapeake Bay Bald Eagles. *Delaware Conservationist* 22:3-9.
- ANDREW, J. M., & J. A. MOSHER 1982. Bald Eagle nest site selection and nesting habitat in Maryland. *J. Wildl. Manage.* 46:383-390.
- BROLEY, C. L. 1947. Migration and nesting of Florida Bald Eagles. *Wilson Bulletin* 59:3-20.
- BUEHLER, D. A., J. D. FRASER, J. K. D. SEEGAR, G. D. THERRES & M. A. BYRD 1991. Survival rates and population dynamics of Chesapeake Bay Bald Eagles. *J. Wildl. Manage.* 55:608-613.
- BUEHLER, D. A., T. J. MERSMANN, J. D. FRASER & J. K. D. SEEGAR 1991. Effects of human activity and shoreline development on Bald Eagle distribution in the northern Chesapeake Bay. *J. Wildl. Manage.* 55:282-290.
- BUEHLER, D. A., T. J. MERSMANN, J. D. FRASER & J. K. D. SEEGAR 1991. Nonbreeding Bald Eagle communal and solitary roosting behavior and roost habitat on the northern Chesapeake Bay. *J. Wildl. Manage.* 55:273-281.
- BUEHLER, D. A., S. K. CHANDLER, T. J. MERSMANN, J. D. FRASER & J. K. D. SEEGAR. 1992. Nonbreeding Bald Eagle perch habitat on the northern Chesapeake Bay. *Wilson Bull.* 104:540-545.
- CLINE, K. W. 1986. Chesapeake Bay Bald Eagle banding project. Tenth progress report, 1986. National Wildlife Federation, Washington, D.C. 49 pp.
- ENVIRONMENTAL PROTECTION AGENCY 1975. DDT: a review of scientific and economic aspects of the decision to ban its use as a pesticide. U. S. Environmental Protection Agency, Washington, D. C. EPA-540/1-75-022.
- FRASER, J. D. 1985. The impact of human activities on Bald Eagle populations. In J. M. Gerrard & T. N. Ingram, (eds.) *The Bald Eagle in Canada*, pp. 68-84. White Horse Plains Publishers. Headingly, Manitoba.
- FRASER, J. D., L. D. FRENZEL & J. E. MATHISEN 1985. The impact of human activities on breeding Bald Eagles in north central Minnesota. *J. Wildl. Manage.* 49:585-592.
- FRASER, J. D., G. D. THERRES, D. A. BUEHLER & J. K. D. SEEGAR 1991. Bald Eagle profile, pp. 21-1-21-9. In S. L. Funderburk, J. A. Mihursky, S. J. Jordan & D. Riley (eds.) *Habitat requirements for Chesapeake Bay Living Resources*. Chesapeake Research Consortium, Solomons, MD.
- GRAY *et al.* 1988. Population growth and development in the Chesapeake Bay watershed to the year 2020. The report of the Year 2020 Panel to the Chesapeake Executive Council. U.S. Environmental Protection Agency, Chesapeake Bay Liaison Office, Annapolis, MD: 73 pp.

GRIER, J. W. 1982. Ban of DDT and subsequent recovery of Bald Eagles. *Science* 218:1252-1235.

HODGES, J. I. AND F. C. ROBARDS 1982. Observations of 3,850 Bald Eagle nests in southeast Alaska, pp. 37-46. In W. N. Ladd & P. F. Schempf, (eds.) *Raptor management and biology in Alaska and Western Canada*. U.S. Fish and Wildlife Service publ. FWS/AK/Proc-82.

JAFFEE, N. B. 1980. Nest site selection and foraging behavior of the Bald Eagle (*Haliaeetus leucocephalus*) in Virginia. M.S. Thesis. College of William and Mary, Williamsburg. 113 pp.

MCGARIGAL, K., R. G. ANTHONY, F. B. ISAACS 1991. Interactions of humans and Bald Eagles on the Columbia River Estuary. *Wildlife Monograph* 115.

MIDDLETON, A. P. 1953. *Tobacco coast - a maritime history of Chesapeake Bay in the colonial era*. Johns Hopkins University Press, Baltimore. 508 pp.

SMITH, T. J. 1988. The effect of human activities on the distribution and abundance of the Jordan Lake-Falls Lake Bald Eagles. M.S. Thesis. Virginia Polytechnic Institute and State University. 100 pp.

TAYLOR, G. J., J. M. ABBOT, M. A. BYRD, D. R. PERKUCHIN & S. N. WIEMEYER 1982. *The Chesapeake Bay Bald Eagle Recovery Plan*. U.S. Fish and Wildlife Service. Boston, Mass. 81 pp.

WIEMEYER, S. N., T. G. LAMONT, C. M. BUNCK, C. R. SINDELAR, F. J. GRAMLICH, J. D. FRASER & M. A. BYRD 1984. Organochlorine pesticide, PCB, and mercury residues in Bald Eagle eggs, 1969-1979, and their relationships to shell thinning and reproduction. *Archives Environmental Contamination Toxicology* 13:529:549.

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