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Proceedings of the Third Expert Consultation Meeting on Bald Eagles in the Great Lakes Basin, February 25 to 26, 1992, International Joint Commission, Windsor, Ontario

Great Lakes Science Advisory Board. Ecological Committee. Biological Effects Subcommittee

Michael Gilbertson

Great Lakes Science Advisory Board Ecological Committee's Biological Effects Subcommittee

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Edited by
Michael Gilbertson
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DISCLAIMER

This report to the Chairpersons of the Science Advisory Board and the International Joint Commission was carried out as part of the activities of the Ecological Committee's Biological Effects Subcommittee. While the Commission supported this work, the specific conclusions and recommendations do not necessarily represent the views of the International Joint Commission, the Science Advisory Board or its committees.

PREAMBLE

The bald eagle in the Great Lakes is fast becoming accepted as an important indicator of ecosystem quality. The release of organochlorine chemicals during the past 45 years has dominated the ecology of the Great Lakes and through bioaccumulation in food chains caused widespread population declines in fish-eating birds. Bald eagles were among the first species to be affected and were locally extinct by the time that such insensitive species as the herring gull showed serious reproductive failure in the 1960s and early 1970s. The situation with respect to organochlorine chemicals has improved enormously since those catastrophic days and the insensitive species, such as the herring gull, which has been used as the standard indicator for about 20 years, no longer show gross effects such as a high incidence of embryo mortality and congenital abnormalities. There has thus developed a need for a much more sensitive indicator.

The bald eagle is, in many ways, ideal. It is widely distributed in the Great Lakes basin and is indigenous. There is an extensive amount of literature on the biology of the species, particularly relative to the effects of organochlorine chemicals. This species is at the top of the Great Lakes foodweb and thus, is one of the most contaminated organisms in the basin. While eggs, young and adult birds cannot be routinely sampled because the species is endangered, sufficient information can be obtained from field observations of breeding birds and from occasional collections of unhatched eggs and dead chicks. Above all, there is an extensive network of dedicated bald eagle biologists and a background of historic data stretching over 27 years to the pioneering work of Sergej Postupalsky.

The Great Lakes Water Quality Agreement between Canada and the United States contains provisions for developing lake ecosystem objectives. The Parties to the Agreement are actively considering the bald eagle as a suitable organism for indicating restoration of the integrity of the Great Lakes Basin Ecosystem. Under the draft Great Lakes Water Quality Initiative (U..S. EPA, Great Lakes National Program Office, 1991), which uses mathematical models of bioaccumulation and toxicity measures of certain organochlorine chemicals in the Great Lakes food chains to derive water quality criteria, the values calculated for the protection and restoration of the Great Lakes bald eagle are among the most stringent and several orders of magnitude lower than previously published objectives or criteria.

This third roundtable on bald eagles sponsored by the International Joint Commission, confirmed the rapidly improving status of the species in the Great Lakes basin at inland territories. However, along many of the shoreline sites, there is still a serious incidence of reproductive impairment and failure. One particular example is the catastrophic failure of the Ohio population in the Sandusky basin in 1991. Lake Ontario continues to be so toxic that despite suitable habitat, no birds have yet been able to reestablish territories. There is still a long way to go in protecting the Great Lakes from continuing releases of organochlorine pollutants.

As a result of the strong endorsement, by the participants at this third meeting, of the value of the bald eagle as an ecosystem indicator, a joint memorandum was sent to the Binational Executive Committee from senior representatives of the U.S. Fish and Wildlife Service, the Canadian Wildlife Service, and the Ontario Ministry of Natural Resources, requesting the Parties to the Agreement to name the bald eagle as a lake ecosystem objective. Initial indications are that this request will get a sympathetic hearing and this, in turn, could make programs for the continued research and monitoring of Great Lakes bald eagle populations more secure. Recently several calculations of the water quality criteria needed to protect human health have been made. It seems, however, that for organochlorine pollutants, restoration of the bald eagle population on the Great Lakes shoreline would also be protective of human health. Thus, the bald eagle could become not only a national symbol but also an indicator of ecosystem integrity.

1.0 EXECUTIVE SUMMARY MONITORING UPDATE: POPULATION STATUS, TRENDS AND ANALYTICAL DATA

1.1 STATUS, TRENDS AND ANALYTICAL DATA FOR ONTARIO BALD EAGLES

Pud Hunter, Ontario Ministry of Natural Resources, West, Aylmer, Ontario

Irene Bowman, Ontario Ministry of Natural Resources, North York, Ontario

Edward Addison, Ontario Ministry of Natural Resources, Maple, Ontario

Paul Prevett, Ontario Ministry of Natural Resources, London, Ontario

In 1990, 576 active bald eagle nest sites were known to the Ontario Ministry of Natural Resources (OMNR) across the province. As of 1991, OMNR recognized no more than perhaps 20 of these active nest locations to be along Ontario's Great Lakes shoreline.

Along the Ontario side of Lakes Superior and Huron, there is limited knowledge about the distribution and contaminant levels of nesting bald eagles. At present, we know of perhaps no more than ten nest sites along these shorelines. Although sightings of eagles in the "lower-agricultural portion" of Lake Huron have increased, all active nest sites remain in the "upper" Lake Huron habitats. Unfortunately, because we have no previous accurate survey data, we have no measure as to whether the numbers of these shoreline nesting eagles are increasing or decreasing.

Our annual studies and banding project in the Lake Erie region have continued. Birds and nest sites are monitored for population growth and reproductive health and where available, addled eggs are sampled for contaminant residue levels. Our project includes such partners as the Canadian Wildlife Service (CWS) and U.S. government, universities of Michigan State and Windsor, and the Royal Ontario Museum. Contaminant residue levels of toxic PCB congeners in the Lake Erie eagles are considered to be health threatening and reduce reproductive success and survival. In cooperation with Ontario Hydro, local landowners and naturalist clubs, we recently constructed a second artificial nest platform that shows promise of becoming our second successful attempt at maintaining a specific location as an active nesting territory. The Lake Erie-associated eagles have recovered from three active nests with zero-young fledged in 1980 to ten active nests producing 11 fledglings in 1991. This small population continues to demonstrate a precarious recovery probably reflecting population augmentation and recruitment from other areas.

Along the Canadian side of Lake Ontario, we do not have nesting eagles. However, a recent 1992 CWS-OMNR aerial survey did determine that potential habitat does remain in good supply for nesting opportunities.

Regarding a general trend along the Great Lakes shoreline: unfortunately, we do not have the nesting information to determine whether the eagle populations are increasing or declining; nor, the contaminant residue level information to determine if the birds' health is improving or not. We consider the increased sighting reports of bald eagles along the Ontario shorelines, the general reduction of total contaminant residue levels in addled eggs and eaglets produced along the Lake Erie shoreline as well as the fragile repopulation of the Lake Erie region by the eagles as a possible indication of an improving Lake Erie ecosystem and bald eagle population health from 1980 to 1991.

1.2 MINNESOTA: POPULATION STATUS AND TRENDS OF MINNESOTA'S BALD EAGLES

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Mary Miller, Minnesota Department of Natural Resources, Nongame Wildlife Program, Minneapolis, Minnesota

Information on Minnesota's bald eagle breeding population is collected by the U.S. Forest Service, the National Park Service, the U.S. Fish and Wildlife Service, and the Minnesota Department of Natural Resources (MNDNR) Nongame Program. This information is compiled by the MNDNR Nongame Program. We are reporting from that compilation (Miller and Pfannmuller, 1991).

Statewide nesting surveys have been conducted in Minnesota since 1973, at which time there were 115 young produced, an average of 0.98 young per occupied breeding area and an average brood size of 1.59.

Since then, the number of occupied breeding territories has increased, exceeding 200 for the first time in 1982, and surpassing the northern states recovery goal of 300 in 1987. Minnesota has exceeded the recovery goal every year since then. In 1991, Minnesota had 477 occupied bald eagle nesting territories, of which 311 (65%) were successful, an increase of 9% over 1990. The 1991 figures do not include Voyageurs National Park as this data was unavailable at the time of this report.

The percentage of occupied territories has remained fairly consistent since 1973 when it was 62%. The number of successful territories increased from 71 in 1973 to 311 in 1991. The lowest rate of success was 61% recorded in 1974, and the highest rate was 76% in 1976.

The number of young produced in Minnesota has also increased dramatically from 134 in 1973 to 482 in 1991 (not including Voyageurs National Park). However, neither the young-per-occupied breeding area, nor the average brood size, have shown a sustained increase. The young-per-occupied-breeding area increased from 0.98 in 1973 to a high of 1.40 in 1983. In six of the eight years between 1979 and 1986, the young-per-occupied breeding area exceeded 1.2 although since 1988 that number has consistently decreased (from 1.11 in 1988 to 1.01 in 1991). However, it has remained above the northern states recovery goal of 1.0. During this time, the average brood size has remained stable. The low being 1.25 in 1974 and the high 1.83 in 1981. In 1991, the average brood size was 1.55.

Significant concentrations of nesting eagles are found in the Chippewa National Forest where there were 160 occupied breeding territories in 1991, accounting for 100 of the 311 successful breading areas in the state, the Superior National Forest which had 101 occupied breeding territories in 1991 and Voyageurs National Park which had 28 occupied breeding territories in 1990. There are records of two nesting territories within five miles of the Great Lakes shoreline in Minnesota. Currently, only one of those territories is active.

In recent years, the nesting range of bald eagles has expanded in Minnesota. Two nests have become active in the western part of the state. The most dramatic expansion has occurred along the Mississippi River where there are now 20 active territories. The most surprising development has been the rapid expansion of eagles into the Twin Cities metropolitan area where there are now approximately 12 occupied territories. Some of these territories are located in the heart of the urban area such as the Pigs Eye Lake nest which is one mile from downtown St. Paul, directly under the landing path of Holman airfield. Other nests are located on the Mississippi and Minnesota rivers in residential areas. The eagles seem to be choosing sites in which the nest trees are isolated from disturbances (such as on small islands) even if the nests (and birds) themselves are highly visible from the shoreline.

Wintering Populations

In addition to nesting populations, Minnesota also has significant numbers of migrating and wintering eagles. Since 1979, Minnesota has participated in the National Wildlife Federation's midwinter bald eagle survey. In 1987, a standardized route was established which includes parts of the Mississippi and Minnesota rivers. In 1991, there were 109 eagles counted along this route. However, this should not be considered the total wintering population for this part of the river. Ground surveys are not an effective way of counting wintering birds in this area.

Aerial surveys of the Mississippi River between St. Paul and the Iowa border were conducted for the last four winters by Joan Galli of

the Minnesota Department of Natural Resources' Nongame Program to monitor numbers, ages and locations of eagles.

Contaminant Analysis

Blood collection from nestlings for contaminant analysis has occurred along the Mississippi River, Trout Lake in the northern part of the state, Voyageurs National Park and the Chippewa National Forest. Bill Bowerman will summarize the analysis of these samples later at this meeting (page 16, this report).

1.3 POPULATION STATUS AND ADDLED EGG CONTAMINANT TRENDS OF WISCONSIN'S BALD EAGLES WITH A FOCUS ON LAKE SUPERIOR

Michael W. Meyer, Wisconsin Department of Natural Resources, Madison, Wisconsin

Wisconsin's bald eagle population continued to rapidly increase in the early 1990s. The number of occupied territories increased from 109 in 1974 to 414 in 1991. The number of nesting pairs grew at an average annual rate of 11% in the past five years. The reproductive rate has increased from a statewide average of 0.96 ± 0.03 young/occupied territory (1973-1976) to 1.30 ± 0.07 young/occupied territory (1985-1989); 1989 was the last year annual statewide productivity flights were flown. Many of the new nesting territories were established in regions which already had the greatest density of nesting eagles. In 1985, 56% of the state's nesting pairs were found in a five-county area, and 34% (68 of 200) of the new territories located between 1985-91 were in the same five counties. The greatest concentration of nesting eagles occurred in Vilas and Oneida counties (1991 = 112 occupied territories; one occupied territory per 18 square miles). Only 25 occupied territories were located in the southern half of the state in 1991 (nearly all were associated with the Wisconsin, Mississippi and Fox rivers), however, this was a 400% increase since 1985, the most rapid rate of increase in the state.

The total PCB, DDE and dieldrin content of Wisconsin bald eagle eggs collected from 1976 to 1979 (n = 37; total PCB = 17.4 ± 3.4 ppm fresh weight; DDE = 5.5 ± 0.8 ppm fresh weight; dieldrin = 0.7 ± 0.1 ppm fresh weight) were significantly greater than the levels in eggs collected from 1983 to 1987 (n = 36; total PCB = 5.5 ± 0.8 ppm fresh weight, DDE = 2.4 ± 0.3 ppm fresh weight; dieldrin 0.2 ± 0.1 ppm fresh weight). Unlike organochlorine (OC) residues, the total mercury content of Wisconsin bald eagle eggs did not decline (1976-79 = 0.17 ± 0.02 ppm; 1983-87 = 0.18 ± 0.02 ppm). All nests containing eggs with elevated OC residues were located near waterbodies with Wisconsin Department of Natural Resources (WDNR) fish consumption advisories (the Great Lakes and the Menominee, Wisconsin, Mississippi and Fox Rivers), while the least amount of OCs were found in eggs collected from nests on inland lakes remote from agricultural or industrial activity.

Historical records indicate that up to 28 bald eagle breeding territories once existed along Wisconsin's Lake Superior shoreline, however, only four were occupied in the 1960s and 1970s. From 1970 to 1982, Wisconsin's Lake Superior bald eagles were less productive (0.35 young/occupied territory) and addled egg contaminant levels were greater than inland nesting bald eagles. The DDE concentrations of Wisconsin Lake Superior addled eggs (13-29 ppm fresh weight) were near or in excess of the level associated with complete reproductive failure in other bald eagle populations (>15 ppm DDE). Total PCB concentrations were greater near Duluth (67-98 ppm) than in the Apostle Islands National Lakeshore (7-12 ppm fresh weight); p,p'DDE levels were highly elevated at all sites (13-29 ppm fresh weight).

The number of bald eagles nesting along Wisconsin's Lake Superior shoreline increased dramatically over the past decade. The number of occupied territories increased from six in 1983 to 18 in 1991; likely a result of recolonization from the rapidly expanding inland population and a decline in prey contaminant levels. Also, fish abundance increased dramatically in the Apostle Islands in the 1980s. Lake herring biomass increased from an estimated 562 g/hectare in 1978 to a peak of 33,820 in the mid 1980s (U.S. FWS, unpubl. data) and lake whitefish abundance more than doubled. The influence of the increase in fish abundance on the number and productivity of Apostle Islands bald eagles is unknown.

1.4 MICHIGAN: INLAND/GREAT LAKES

Tom Weise, Michigan Department of Natural Resources, Lansing, Michigan

Historic records exist of about 400 pairs of bald eagles in the State of Michigan. The present recovery goal is 300 pairs and the present population is about 180 pairs in 1991. In the early 1970s, productivity on a statewide basis was about 0.5 to 0.7 fledged young-per-occupied-nest. By 1978, it had increased to about 0.9 and at present, it is about 1.0. In 1975, there were only six or seven nests within five miles of the Great Lakes, but by 1988, the number was up to about 40 nests. Generally, the proportion of nests that are productive in inland Michigan is over 50%. In 1975, only 14% of the nests on Michigan shorelines on the Great Lakes were productive, but this has increased to about 50% in recent years. The number of young-per-occupied-nest is about 1.0 in inland sites. In 1975, productivity in Great Lakes sites in Michigan was only about 0.3 young-per-occupied-nest, but present productivity is about 0.7 young-per-occupied-nest. It is estimated that between 200 and 300 birds overwinter in the State of Michigan.

1.5 POPULATION STATUS AND MANAGEMENT OF THE BALD EAGLE IN OHIO

Mark C. Shieldcastle, Gildo M. Tori and Denis Case, Ohio Department of Natural Resources, Crane Creek Wildlife Research Station, Oak Harbor, Ohio

The Ohio Division of Wildlife began a restoration program for the bald eagle in 1979. The breeding population had dropped to a low of four breeding pairs. Eaglet production had not topped the .75 eaglet/nest since data collection began in 1959. For the most part, eagles were incapable of hatching eggs. The four-fold restoration program initiated in 1979 included education, rehabilitation of injured birds, nest-site improvement and population augmentation. The public education attempt centred on the importance and protection of bald eagles. Man-made nest bases were placed in strong trees in territories having poor nests to reduce the potential of losing an active nest at a critical time. Probably the most important aspect of the program in the recovery of the Ohio bald eagle population was population augmentation through fostering. Throughout the 1980s, one in five eaglets fledged in Ohio were captive-reared young placed in active wild nests. This resulted in population growth during the entire decade.

Growth in the population is encouraging as breeding pairs have increased and the western Lake Erie marshes have emerged as a significant fall staging area for non-breeding eagles. However, there are severe concerns for the population at this time. Egg hatchability has increased with the reduction of DDT and dieldrin in the past decade, but levels still remained above accepted safe levels. Of more serious concern is the possible trend of nestling deaths that have occurred in 1990 and 1991. In the Lake Erie marsh region, four out of 14 nestlings died in the first four weeks of life in 1990 and eight out of 12 in 1991. This, coupled with rising levels of PCBs in addled eggs, has caused concern about the future of the Ohio population. Ongoing research of fledgling habitat use of the Lake Erie marshes has raised concerns about abundance of suitable habitat. All indications are that this age class will not tolerate human disturbance to any great degree. Once independent, the fledglings have all gravitated to secure refuges away from direct human contact. The carrying capacity of these areas are not known and could be a possible limiting factor.

1.6 STATUS, PROBLEMS AND PROGNOSIS FOR NEW YORK STATE BALD EAGLES

Peter Nye, New York State Department of Environmental Conservation, Wildlife Resources Center, Delmar, New York

Historically, New York State was home to numbers of breeding bald eagles along and near both Lake Erie and Ontario. Over 75 historic nesting locations have been identified for breeding eagles statewide, approximately one-third of which could be classified as being on or near these Great Lakes. The preponderance of these 25 historic lake sites were located on or near Lake Ontario, commensurate with the greater amount of habitat available on this lake versus Lake Erie in New York.

By 1976, New York contained only one pair of breeding bald eagles, though this pair

was nonproductive due to DDT contamination. In that year, a major restoration effort was launched in New York, largely using wild eaglets from Alaska, Michigan, Minnesota and Wisconsin, in an attempt to repopulate the state. Four sites were used to release 198 eagles in New York between 1976 and 1988. Two of these sites were within the Great Lakes drainage.

By 1991, 16 bald eagle breeding territories were confirmed in the state, ten of which successfully fledged 16 young. Although none of our "new" territories are directly on either Lake Erie and Lake Ontario, one is within about eight kilometres. This pair is not known to feed on Lake Ontario during the breeding season but are suspected to use it during non-breeding times. An egg was collected from this pair in 1985 and a few analytical results obtained. Other eggs have been collected and analyzed, and no startling contaminant problems have yet been identified.

Active eagle releases have ended but the population continues to grow at an annual rate of between 15 and 30 percent. Several potential nesting sites have been identified on or very near to both Lake Erie and Lake Ontario, which I believe will be occupied as the population continues to expand.

Future plans are for additional egg contaminant analyses as the opportunity arises, and for collection and analysis of eaglet blood, during banding.

1.7 BALD EAGLE NESTING SURVEY: PENNSYLVANIA

Daniel Brauning, Pennsylvania Game Commission, Montgomery, Pennsylvania

(Presentation by Peter Nye)

1991 was the most successful nesting season of any since before the population crash. A total of six nests successfully fledged 12 young (see table 1), more than were naturally-produced since well before 1960 (see figure 2). In addition to active and successful nests, two pairs in Crawford County failed following hatching and an additional pair there attempted, but never established incubation. The pair in Lancaster County, although successful last year, apparently took a break this year and never established incubation. In total, nine pairs of bald eagles attempted nesting this year (figure 1), in addition to several other pairs and individuals around the state where nesting has not been established.

TABLE 1. Summary of successful next sites

Location	Nests	Young
Crawford County	2	5
Butler County	1	3
Tioga County	1	1
Dauphin County	1	2
York County	1	1
TOTALS	6	12

On the basis of identifying eagle leg bands, it is known that six of the nine active nests this year involved at least one of the adult pair which had been released in a hacking effort (see table 2). The origin of other birds is not known. Nine of the 12 young produced in 1991 came from nests with a least one hacked adult. Clearly, without Pennsylvania's and New York's hacking programs, bald eagle annual production would be insufficient to maintain the population and the species would be nearly extirpated in Pennsylvania.

TABLE 2. 1991 Summary of marked bald eagles (Compiled by Brenda Peeples and Dan Brauning)

LOCATION	BANDED BIRDS	ADDITIONAL EAGLES
Duck Farm	?	Male, female
Erie NWR	One adult is marked	Two juveniles
Ford Island	?	One adult
Glades	Both adults PA hacked	Two adults, 5 Im., One Sub-Adult
Haldeman Island	Both adults PA hacked	Three juveniles
Hartstown	Female NY hacked 1979	One male, three juveniles
Pine Creek	Female hacked, unknown	Two juveniles
Safe Harbor	?	?

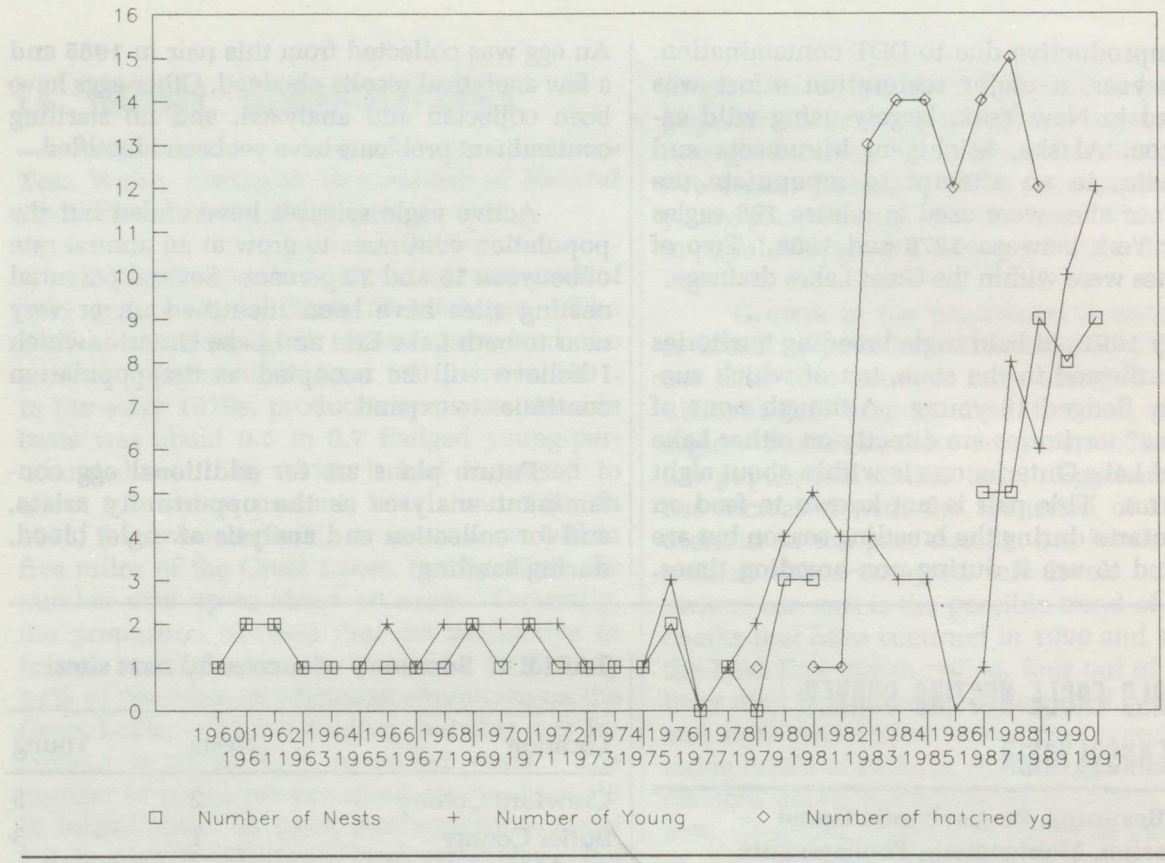

Figure 1. Pennsylvania bald eagle productivity

TABLE 3. 1991 Nesting chronology summary **(compiled by Brenda Peoples and Dan Brauning)**

LOCATION	INCUBATION	BROODING	EAGLETS	FLEDGING
Duck Farm	March 4	April 8	April 12	July 1
Erie NWR	April 14	-	-	-
Ford Island	March 24	April 29	-	-
Glades	March 13	April 18	April 21-30	July 9-11
Haldeman Island	March 6		mid April	early July
Hartstown	February 9	March 25	April 2-8	June 16-19
Pine Creek	April 2		mid May	early August
Safe Harbor	March 10		April 19	?

Nesting was initiated over a broad timeframe this year (see table 3). Incubation was initiated by successful pairs over a six-week period. The majority of nests are begun in March. The Hartstown pair have consistently begun nesting early. They initiated incubation two weeks before any other eagle pair. The brooding dates reflect the behaviour change of a sitting adult several days after eggs hatch following the 35-day incubation. Eaglets can typically be seen reaching for food within a week. Fledging occurs an incredible 12 weeks after hatching.

The Pine Creek pair were particularly late this year, yet successfully fledged one young. The importance of getting an early start is dramatically illustrated by this year's nest at Pine Creek. That young did not fledge until early August. With many additional weeks after fledging necessary for a young eagle to become independent, the fall and winter months rapidly approach for a young hatched later than early May.

The prospects for Pennsylvania's bald eagle breeding population appear excellent.

Productivity since 1989 has been above 0.7 young-per-active-breeding-pair (see table 4), the rate generally thought to be necessary to maintain a stable bald eagle population (Sprunt et al. 1973). The nesting population can expect to continue growing as a result of the hacking program until 1994, when the last hacked young will have reached breeding age. At that point, population growth will depend strictly upon natural production and immigration. It appears that the transition will be a smooth one, since natural eaglet production in 1991 reached the level at which young were being hacked during the 1980s. Most significantly, the increase in young per nesting attempt reflects a healthy population.

TABLE 4. List of breeding eagle pairs for past five years

	Years with an active nest, hatched/fledged					
NEST SITE	1987	1988	1989	1990	1991	TOTAL
Blackjack	//	-	-	-	-	-
Crossingville	-	-	-	//	//	-
Cussewago	-	-	0/0	//	0/0	-
Duck Farm	1/1	2/2	0/0	2/2	2/2	7
Erie NWR	-	2/0	0/0	//	0/0	1
Ford Island	1/0	3/2*	0/0	//	0/0	2
Glades	-	-	-	0/0	3/3	3
Haldeman Island	-	-	-	2/2	2/2	4
Hartstown	3/0	3/3	3/3	2/2	3/3	11
Muddy Run	-	-	1/1	1/1	//	2
Pine Creek	?	1/1	0/0	1/1	2/1	3
Safe Harbor	-	-	2/2?	2/1?	1/1	4
TOTAL	1	8	6	10	12	38
Ave. young/attempted	0.33	0.45	.75	1.2	1.4	0.9
Ave. young/successful	1	2	2	1.3	2. 0	1.7
Percent pairs successful	25	80	38	64	55	31

* young introduced into nest from outside source
// inactive nest

Pennsylvania's own production, as well as immigration from growing populations in neighbouring states assures a growing breeding population, barring unforeseen disasters. A simple population prediction model suggests that the following population growth should be expected over the next four years.

	1991	1992	1993	1994	1995
Number of nests	9	11	13	14	14
Number of young	9	10	11	12	12

Assumptions for the projection above include: a 50% mortality in the first year of life, 10% thereafter; 80% of adult pairs will attempt nesting; an average of 51% of nesting pairs will be successful; and that 1.7 young will be produced per successful pair. Reproductive rates are based on data gathered on bald eagle nests during the past five years. Actual population parameters vary considerably, as illustrated in 1991 when an average of two young were produced per successful pair, producing three more young than predicted by the model.

1.8 POPULATION STATUS OF BALD EAGLES IN INDIANA

John Castrale, Indiana Division of Fish and Wildlife, Mitchell, Indiana

The bald eagle was extirpated as a nesting species in Indiana by the early 1900s. The location of nesting areas has shifted from extensive wetlands in northwestern Indiana to multi-purpose reservoirs and larger rivers in the forested region of south-central Indiana. Approximately 100 bald eagles winter in Indiana but numbers have been increasing since 1972. Restoration of a nesting population began in 1985, and 73 young bald eagles were released from 1985 to 1989 at a location in south-central Indiana. Nesting attempts were first noted in 1989 and the first successful reproduction since 1898 was documented in 1991. Two successful nests and three other areas with nesting activity or pairs were noted in 1991. The origin of nesting eagles in Indiana are birds obtained from Wisconsin (five individuals) and Alaska (one) and released in Indiana, a captive-born eagle that had been released in Tennessee and an unknown component (three). Other released eagles are just entering reproductive age and the nesting population should continue to increase in the next few years. Ultimately, the nesting population in Indiana will be limited by the quantity and quality of habitat, and the ability to tolerate human disturbance.

2.0 ENVIRONMENTAL CONTAMINANTS IN BALD EAGLES

2.1 A REANALYSIS OF EFFECTS ON REPRODUCTION

Stanley N. Wiemeyer, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, Maryland

Bald eagle eggs that were collected from several areas in the United States between 1968 and 1984, primarily after failure to hatch, were analyzed for organochlorine pesticides, polychlorinated biphenyls and mercury. Data from these eggs were used to reassess the relationships among contaminant concentrations, reproductive outcome and shell thickness. Fifteen percent shell-thinning was associated with 16 ppm DDE (wet weight) for eggs collected early in incubation, a relatively unbiased sample. Reproductive outcome, measured as a mean five-year young production at sampled breeding territories, was normal (about 1.0 young-per-occupied-territory) when eggs at sample territories contained <3.6 ppm DDE. However, production was nearly halved (0.53) when DDE residues were between 3.6 and 6.3 ppm and halved again (0.27) when DDE residues were between 6.3 and 12 ppm. There appears to be a threshold level of DDE above which productivity declines markedly. Residues of various contaminants were highly intercorrelated; however, DDE was most closely related to shell thickness and productivity followed by DDD + DDT and total PCBs.

Mean five-year production at sampled territories, where eggs were collected after failure to hatch, was consistently below actual overall production of young in the sampled populations. Data relating contaminant concentrations to mean five-year production are applicable only for territories where eggs are collected after failure to hatch because such territories are not representative of all nesting bald eagles in a given population.

2.2 REPRODUCTIVE IMPAIRMENT OF BALD EAGLES ALONG THE GREAT LAKES SHORELINES OF MICHIGAN AND OHIO, AND ASSOCIATION WITH CONTAMINANT RESIDUES IN ADDLED EGGS

David Best, U.S. Fish and Wildlife Service, East Lansing, Michigan

The Great Lakes bald eagle population has rebounded since the early 1960s with increasing numbers of breeding pairs and rates of productivity. However, reproduction is still impaired along the shorelines of Michigan and Ohio, and at inland sites accessible to runs of anadromous Great Lakes fish. Nests along the Lake Michigan and Lake Huron shorelines exhibit the lowest reproductive rates, and are below the 0.7 young fledged per-occupied-breeding-area associated with population stability. The poor reproductive effort cannot be attributed to the level of breeding experience in breeding pairs. Experienced Great Lakes breeding pairs reproduce at levels similar to inexperienced pairs, and significantly lower than experienced pairs from inland breeding areas. The data suggest that the increased numbers of pairs in the coastal breeding population are a result of immigration of surplus birds from inland areas.

Forty-six addled eggs collected from 1986 to 1990 in Michigan, Ohio and interior Alaska show higher levels of total PCBs, p,p'-DDE and dieldrin for shoreline sites versus inland and control sites. The concentrations of these contaminants are inversely correlated to measures of productivity for four shoreline beaches and four inland realms. Nests along the Lake Michigan and Lake Huron shorelines yield the highest contaminant residues in addled eggs. Total PCBs and dieldrin have higher coefficients of determination than p,p'-DDE. The association between poor productivity and elevated egg residues is consistent with a previous nationwide study identifying residue levels associated with normal reproduction. It is believed that PCBs, especially planar dioxin-like congeners, may be the primary reason for the lowered productivity along the Great Lakes.

2.3 THE USE OF BLOOD PLASMA TO MEASURE ENVIRONMENTAL CONTAMINANTS IN BALD EAGLE POPULATIONS IN THE LAURENTIAN GREAT LAKES, NORTH AMERICA

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Bald eagles *(Haliaeetus leucocephalus)* in North America suffered a great post-World War II population decline, due primarily to the DDT metabolite p,p'-DDE. Since the ban of DDT in the early 1970s, bald eagle populations have increased throughout most of their range. This recovery, however, is not uniform in all subpopulations. Bald eagles nesting within 8.0 km of the Great Lakes coastlines have significantly lower productivity (0.71 young-per-occupied-nest) than those nesting in more interior areas (1.01 young-per-occupied-nest). Concentrations of PCBs and p,p'-DDE in blood plasma of nestling eagles have much greater concentrations from areas near the Great Lakes (PCBs mean 2183.3 ppb; p,p'-DDE mean 60.9 ppb) than those collected from more interior areas (PCBs mean 23.7 ppb) than those collected from more interior areas (PCBs mean 23.7 ppb; p,p'-DDE mean 10.0 ppb). Greater concentrations of contaminants in nestling blood plasma from Great Lakes influenced nests indicate localized sources of contamination. No significant differences were found in age or sex of nestlings and plasma organochlorine concentrations. This appears to be a good method to supplement egg collection in determining the reasons behind low bald eagle reproduction in eagles nesting near the Great Lakes.

2.4 HERRING GULLS AS A SURROGATE FOR BALD EAGLE EXPOSURE

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There are three reasons why we have investigated the possible use of herring gull eggs as a surrogate for bald eagles. First, bald eagle eggs cannot be collected on a routine basis because the species is endangered. Second, there are spatially and temporally comparable samples from both species by which to investigate the relative contamination of eagles and herring gulls. Finally, there is a well-developed pharmacokinetic model of contaminations for the herring gull which might be adapted for the bald eagle. The ratios for most locations are surprisingly close to unity though at some locations the ratios deviate markedly from unity. The ratios for the pesticides are fairly constant but more variation is found in the ratios for PCB. It was concluded that, based on the database and modelling available for herring gulls, these may be used as a predictive tool for a first approximation of the levels required for restoration of the bald eagle population throughout the Great Lakes.

2.5 EVALUATING THE SUITABILITY OF OSPREYS AS MONITORS OF CONTAMINANT-RELATED BIOLOGICAL EFFECTS ON THE GREAT LAKES

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In 1991, the Canadian Wildlife Service, in conjunction with the Ontario Ministry of Natural Resources, initiated studies of ospreys in the Great Lakes drainage basin to evaluate the suitability of this species as a sensitive monitor of contaminant-related biological effects. Following general population increases in the post-DDT era, reasonable numbers now breed along some Lake Huron shorelines, as well as scattered pairs around Lake Superior and at the

northeastern end of Lake Ontario. Reproductive output (mean numbers of young fledged per-occupied-nest (Y/ON) in 1991 was higher in the two Lake Huron study areas, St. Marys River (1.36 Y/ON) and Georgian Bay (1.24 Y/ON), than in the inland reference area on the Kawartha Lakes (1.03 Y/ON). All values were within the range, calculated for populations elsewhere, thought to be required to maintain stable numbers. Egg predation by raccoons may have been particularly high in the reference area.

Eggshells were not significantly thinner than the pre-DDT value, and DDE levels in most eggs were below the "critical" level of 4 ppm wet weight, which has been associated with 15% average shell thinning. For most organochlorine (OC) contaminants, the highest levels (geometric means, ppm wet weight) in eggs were found in Lake Huron (e.g. DDE 1.7 - 1.8; mirex 0.02 - 0.03), but S PCB levels were highest in the Kawartha Lakes' eggs (5.1 ppm). Geometric mean OC levels (ppb wet weight) in chick plasma were highest in Georgian Bay (DDE 46; mirex 0.9; S PCB 79), but the maximum plasma concentration of S PCBs were from nests in Goose Bay, Kawartha Lakes (up to 339 ppb). Despite a broad agreement between eggs and plasma in the relative degree of contamination among study areas, comparisons at 12 nests where both an egg and chick plasma were sampled, revealed a significant correlation for only mirex. Work in 1992 will focus on confirming results from 1991 study areas, examining the role of possible confounding factors such as food and nest-site availability, and weather conditions, and determining OC levels and reproductive parameters in a more remote, "cleaner" reference area.

2.6 CAUSES OF MORTALITY IN BALD EAGLES FROM THE GREAT LAKES STATES

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From January 1, 1990 through December 31, 1991, 87 bald eagles found dead in the Great Lakes region were submitted to the National Wildlife Health Research Center for necropsy. Of those, 15 were decomposed or otherwise unsuitable for postmortem examination. The leading causes of mortality in the remaining 72 were trauma (16; 22%), lead poisoning (13; 18%), gunshot (8; 11%) and electrocution (8; 11%). Emaciation of unknown etiology was diagnosed in eight (11%) birds, three (4%) died of infectious disease, three (4%) of nonspecific causes, one (1.4%) was trapped, and no diagnosis could be reached in 12 (17%). The four leading causes of mortality were quite similar to those reported for 1985-1989. However, a variety of toxins were identified during 1985-1989 and reported in the poisoning category, whereas lead was the only cause of poisoning identified in 1990 and 1991. These data should not be interpreted to represent actual proportional causes of mortality in bald eagles because of sample bias.

3.0 FUTURE REHABILITATION AND MANAGEMENT PLANS

3.1 REHABILITATION AND MANAGEMENT PLANS FOR ONTARIO BALD EAGLES

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The bald eagle continues to be protected in Ontario by the Endangered Species Act. As of 1990 and with a record 563 active nests known to the Ministry in the north, the bald eagle is considered to be doing well; but, with only an approximately 20 nests around the Great Lakes basin and 13 nests known south of Lake Nipissing, the species is considered in need of management assistance.

The Ontario Ministry of Natural Resources (OMNR) will be providing this assistance under new circumstances. We are presently in year-two of a five-year provincial reorganization designed to streamline and facilitate our programs to field offices; we have a new shift in wildlife policy as outlined in "MNR: Direction '90s (1991)" that will guide our resource management activities into the 1990s; our Minister is presently considering the publicly-prepared publication "Looking Ahead: A Wildlife Strategy for Ontario (1991)" which will reorient and revitalize the provincial wildlife program into the 21st century; Canada has a new Bill C-42 law: The Wild Animal and Plant Protection Act to protest wild animals, plants, and in particular, endangered species from illegal trade. It also provides some protection for Canadian ecosystems, and Ontario is presently reviewing a revised Fish and Game Act.

The Ministry is preparing a recovery plan for Ontario's bald eagle. The major components of the plan include population censusing, monitoring to determine the state of the population and success of recovery efforts as well as managing the population for further improvements in: reproduction and survival; habitat evaluation and improvement; public education; and the encouragement of cooperative projects, as well as the coordination of regional recovery efforts. Because the northern population appears stronger than the Great Lakes shoreline and southern population, differential management may be necessary. A tentative objective for the plan is to double the number of active eagle nests in southern Ontario by the year 2004.

The Ontario Ministry of Natural Resources looks forward to working, learning and financially sharing the necessities of the tasks with our partners: landowners, private and public sector interest groups, universities and governments in Ontario, Canada, Michigan and the United States. In particular, we and our partners are looking forward to an active involvement over the next three years with the consortium of Great Lakes interests; all the Great Lakes states and the Great Lakes Protection Fund. We acknowledge the opportunities to be acquired from this cooperative involvement in the investigation of Great Lakes ecosystem health, through bald eagle toxicological health research. The extent of our funding commitments for bald eagle research will remain uncertain due to the current economic recession and the, as yet, unidentified priorities of reorganized directions for wildlife management.

Within these contexts, our immediate challenge at present is to identify unknown nest sites along the shorelines of Lake Superior and Huron. Within OMNR's 1991-92 fiscal year, we have funded an aerial-nest survey along the north shore of Lake Huron in our present Sudbury and Espanola districts. Espanola district itself has in excess of 1,300 km (808 miles) of shoreline. We are hopeful the survey can be done for the 1992 nesting season so that the resources and expertise of the consortium can assist us in evaluating this endangered species during their three-year term of funding.

In southern Ontario's Lake Erie region, OMNR anticipates continuing our partnership

approach to monitor the population status, breeding success and contaminant residue levels and contaminant monitoring as well as management projects to protect nesting habitat and enforcing the Endangered Species Act.

3.2 LAKES ERIE AND ONTARIO HABITAT SURVEYS

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In January 1992, we used a Cessna aircraft to survey all the mainland and insular shoreline of Lake Erie and Lake Ontario, the Niagara River and the St. Lawrence River (the latter eastward to the Ivy Lea bridge) for potential nesting habitat for bald eagles. Woodlots up to one mile (1.6 km) from the shoreline were rated for: 1) suitable nesting trees (trees large enough to sustain an active nest and have easy access by eagles); 2) suitable foraging areas (proximity to water and availability of foraging perches free of human disturbances); and 3) level of potential human disturbances (proximity to buildings, roads, campgrounds, etc.). Habitat was rated as poor, fair, good and excellent. We did not attempt to census or locate currently-known nests of individual eagles.

Most of the shoreline on both the U.S. and Canadian sides of the study area was not suitable as bald eagle nesting habitat due to development and agricultural practices. We identified 170 areas of potential habitat on Lake Erie (including the Niagara River), 112 (65.9%) of those areas rated poor, 21 (12.4%) areas rated as good or excellent. Eight of the good or excellent areas were located in the Sandusky Bay area and offshore islands of Ohio; another eight were located between Amherstburg and Morpeth (Ontario), including the Canadian islands in western Lake Erie. Other areas included the northern portion of Michigan shorelines (1), the Long Point - Turkey Point area (west of Port Dover, Ontario (3), and Grand Island (1) in the Niagara River. These evaluations, which showed that most of the good-to-excellent habitat was located in the Sandusky and Long Point to Amherstburg areas, accurately reflected the known distribution of active eagle nests (pairs) within the Lake Erie study area: nine in the Sandusky area (M. Shieldcastle, personal commun.) and ten in the Long Point to Amherstburg area (P. Hunter, personal commun.). Those are all the active eagle nests in the area covered by this survey.

On Lake Ontario (and the St. Lawrence River), 239 areas were identified. Over 50% (129) of these areas rated as poor, while 17.6% (42) rated as good or excellent. Most of the latter areas occurred in the Cape Vincent to Oswego (New York; 19) area and in the Colborne to Kingston (Ontario; 9) area which includes the Canadian islands off Prince Edward County. The Canadian and the United States portions of the St. Lawrence River (east to Ivy Lea) had six and seven areas, respectively, that rated good or excellent. The final area in this category was located west of Oswego (New York). There are no known eagle nests within the Lake Ontario study area. However, a very large stick nest, believed to be that of a bald eagle, was discovered on Main Duck Island. This will be verified this spring. The Duck Islands are a known historical nesting site for bald eagles.

The significance of this survey is that it confirms that there are several areas which rank as good-to-excellent habitat for nesting by bald eagles on Lake Ontario. This is significant from a lake restoration or remediation standpoint because it suggests that, although there are no eagles now nesting within the Lake Ontario study area, the habitat is there. Given time, bald eagles can be expected to repopulate the eastern end of the lake. Their eventual return to Lake Ontario, coupled with successful breeding, would indicate a certain degree of restoration of the Lake Ontario ecosystem. Eagles were once relatively common nesters on Lake Ontario but their populations declined earlier in this century with the deterioration of environmental conditions. In a Lake Erie context, the survey confirms much of what we already know. The good-to-excellent nesting areas for bald eagles are located almost exclusively in the western end (half) of the lake on both the U.S. and Canadian shores.

3.3 CAUSES OF INJURY, MEDICAL REHABILITATION AND FUTURE MANAGEMENT OF MINNESOTA'S BALD EAGLES

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We present here a summary of the cause of admission for 368 bald eagles admitted to the Raptor Center at the University of Minnesota, between 1980 and 1989. The most common cause of injury to all eagles was miscellaneous trauma (30.7%), followed by leg-hold trap injuries (23.6%), shooting (15.5%), toxicity (primarily lead poisoning, 6.8%), disease (6.8%) and vehicle collisions (3.8%). This compares with 56% miscellaneous trauma, 23% vehicle collisions, 5% shooting and 3% leg-hold trap injuries for all other raptors admitted during this time period.

The numbers of eagles admitted per year with projectile injuries increased during the decade (42 = 0.72, df - 8) from two in 1980 to ten in 1987. The percentage of eagles admitted with projectile injuries also increased (42 = 0.59) from 5.9% in 1983 to 22.5% in 1988.

We examined whole-body radiographs of 263 birds taken at the time of admission for the presence of bullet fragments and shotgun pellets indicating that these birds had been shot at some time prior to their admittance. Seventy-one (27%) of the radiographs showed evidence of the eagle having been shot.

Age classes were not affected equally by injury-causing events (p = 0.033). Leg-hold trap injuries were sustained by 30.8% of the adults admitted and only 23.9% of the immature (after hatch-year - preadult) and 15.5% of the hatch-year birds. Projectile injuries, on the other hand, affected 22.8% of the immature, 17.8% of the hatch-year and only 9.0% of the adult birds. Of the radiographs examined, 24% of the hatch-year birds, 30% of the immatures and 30% of the adults showed bullet fragments or shotgun pellets. We believe this indicates that young eagles are shot more frequently than adult birds.

We measured Pb levels in 203 birds admitted during the same period. Values between 0.2 - 0.6 ppm were classified as subclinical exposure, 0.61 - 1.2 ppm as clinical lead poisoning and >1.2 ppm as "fatal" exposure. Blood pH levels above 0.2 ppm were found in 34.5% of the eagles tested.

The majority (54%) of the eagles were admitted during the months of September through December. During these months 83.9% of the trapped eagles and 80.7% of the shot eagles were admitted.

Research and management of bald eagles is ongoing in Minnesota. Winter roost and feeding sites along the Mississippi River are currently being identified and monitored. This program, done in cooperation with the Wisconsin Department of Natural Resources and the U.S. Fish and Wildlife Service, has involved the Minnesota Department of Natural Resources' (MNDNR) Nongame Program, The Raptor Center at the University of Minnesota and volunteers.

106 habitat management plans for eagle breeding territories have been completed since 1984 by MNDNR Nongame wildlife personnel. Each plan characterizes the general breeding area and nest site and describes the behaviour and nesting history of the resident pair. Most of these plans have been prepared for nests located on private lands. These efforts have been scaled back recently because of the species population growth. An abbreviated field review sheet will replace the more detailed nest management plan on state land.

Winter roosts and feeding areas are going to be incorporated into the state Natural Areas Heritage Database. Additionally, steps are now underway to purchase or protect critical roosts.

To help restore eagle populations to other areas of the country, four eagle chicks per year are taken from Minnesota nests and sent to other states for reintroduction. Over the years, New York, Pennsylvania, Tennessee, Missouri, Arkansas and Georgia have been recipients of Minnesota chicks.

3.4 AN UPDATE ON THE BREEDING ECOLOGY OF APOSTLE ISLANDS BALD EAGLES: RESULTS OF A PILOT STUDY

Michael Meyer, Wisconsin Department of Natural Resources, Monona, Wisconsin

The number of occupied Wisconsin Lake Superior bald eagle territories increased from six in 1983 to 18 in 1991. Reproductive performance improved from 0.5 young/occupied territory (n=6) in 1983 to a peak of 1.4 young/occupied territory (n=14) in 1989 and 1.0 young/occupied territory (n=18) in 1991. While no addled eggs were collected along Wisconsin's Lake Superior shoreline after 1981, the PCB and DDE content of addled eggs collected throughout Wisconsin in the mid 1980s average 50% and 75% less than that of eggs collected in the 1970s indicating that Wisconsin eagles were consuming less contaminated prey. Additionally, the severe eggshell thinning (13-20%) observed in the 1970s in Wisconsin Lake Superior addled eggs was not found in eggshell fragments collected from lakeshore nests in the mid 1980s (0-8%), however, the samples are biased.

Though Wisconsin Lake Superior bald eagle productivity improved over the past decade, over 50% of the nests failed in 1983 and again in 1990. Nestling serum samples collected in 1989 indicate that these eagles are still consuming PCB and DDE-contaminated prey (Bowerman, unpublished data); commercial fishing wastes and herring gulls are likely sources. It is interesting to note that May of 1983 and 1990 were the coldest (based on National Ocean and Atmospheric Administration (NOAA) recording stations in Superior, Bayfield and Madeline Island) during the past ten years. Lake Superior eaglets hatch in early to mid May and are brooded into June, thus are most susceptible to thermal stress during this period. Nestlings found dead along Wisconsin's Lake Superior shoreline, 1984-87, were emaciated, while nestlings found dead at inland nests were not. Energy deficiencies, due to greater thermo-regulatory costs and/or lower energy intake rates may contribute to the lower productivity and survival of Wisconsin Lake Superior nestlings. The Lake Superior nestlings also had greater tissue organochlorine (OC) levels, thus OC toxicity may also be involved in reduced performance.

In 1991, interior versus Lake Superior nest observations were conducted to determine whether prey delivery rates differed between sites. National Park Service staff conducted 197 hours of direct observations at successful Apostle Island National Lakeshore (APIS) nests while Wisconsin Department of Natural Resources personnel conducted 248 hours of observations at inland nest sites. The daily prey delivery rate was lower at the APIS (2.7 deliveries/16 hours of observations versus 4.2 deliveries/16 hours observation) at the inland nests, however, there were fewer young/nest at the APIS. Within the APIS, prey delivery rates were greater at the inner islands (total 114 observation hours; average 3.4 deliveries/16 hours observation) than at the outer islands (total 83 observation hours; average 1.1 deliveries/16 hours observation). Eagles nesting on the inner islands may have a more predictable prey base because they have access to warm-water fisheries and commercial fishing wastes. Eagles nesting on the inner islands are also more productive (1.2 young/occupied territory) than those nesting on the outer islands (0.7 young/occupied territory).

Preliminary data indicate that weather, OC contaminants and prey availability may all influence the reproductive performance of this subpopulation of Great Lakes bald eagles. Because bald eagles bioaccumulate organochlorine contaminants, this population may become less productive as it ages; >50% of 1991 occupied territories were initiated within the past five years. Continued research and long-term monitoring of Lake Superior bald eagles are required to understand which factors have the greatest impact on productivity and survival. The Western Lake Superior Region Resource Management Cooperative (WLSRRMC) helped coordinate the 1991 Wisconsin Lake Superior bald eagle monitoring program and will provide oversight in the future. WLSRRMC is currently comprised of 17 members (eight federal, two state, one native American, six academic) and may soon enlarge to include the Minnesota Department of Natural Resources (MNDNR) and a resource management agency from Ontario. The Wisconsin Department of Natural Resources (WIDNR), University of Wisconsin (UM), National Park Service (NPS), and University of Minnesota (UM) received a 1992 research grant from the Great Lakes Protection Fund to support investigations into the impacts of habitat and environmental variables on Great Lakes bald eagle productivity. This research will develop and

validate methodologies for determining bald eagle food habits, nesting provisioning rates, incubation and brooding behavioural constraints and nestling energy requirements at Great Lakes and inland nest sites. WDNR/UM/NPS/UW will coordinate research activities with the Pesticide Research Center, Michigan State University, who are conducting research on Great Lakes bald eagle distribution, habitat availability and contaminant exposure as it relates to productivity and nesting adult turnover rates.

3.5 REHABILITATION AND MANAGEMENT PLANS FOR MICHIGAN BALD EAGLES

Bill Bowerman, Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan

In Michigan, the state is going to continue conducting two aerial surveys to estimate all eagle nest sites and productivity. The Great Lakes Protection Fund funded the cooperative group comprised of Wisconsin Department of Natural Resources, University of Wisconsin, University of Minnesota and Michigan State University. We are going to continue blood collection from eagles in nests around the shorelines. We will survey habitat as potential eagle nest sites along all the remaining Great Lake shorelines and complete a habitat survey on the Hiawatha National Forest in the upper peninsula.

The team from Michigan State University is going to continue to band about 90% of the eaglets, including colour banding. For the last three years, the Michigan team has colour-banded eagles: the first year, they only used a purple band with silver numbers; the last two years, we have used black bands on Great Lakes nest sites and purple bands in interior nest sites. We will continue to supply the bands for Ontario and Wisconsin.

Management plans for the eagle- nesting territories in Michigan are primarily on the three national forests and there are also a couple of nesting plans that are in other areas that the Department of Natural Resources has designated, such as state forest land, where oil drilling and other human conflicts may occur. Dave Best and Tim Kubiak will still be collecting addled eggs in Michigan for analysis.

3.6 FUTURE PLANS FOR THE BALD EAGLE IN OHIO

Mark C. Shieldcastle, Gildo M. Tori and Denis Case, Ohio Department of Natural Resources, Oak Harbor, Ohio

The bald eagle success story in Ohio has now had a shadow cast upon it. As discussed earlier, the Ohio population had made a comeback in spite of continued habitat degradation. However, under the surface, there are many questions. Fledgling research has shown an avoidance of human-use areas resulting in very restricted fledgling habitat. The toxic level of Lake Erie continued to be unacceptable and of great concern is the emerging trend of nesting mortality.

The Ohio Division of Wildlife has identified 1992 as a critical year. If the present trend of nestling mortality continues, it is our desire to acquire the necessary samples to begin providing answers that can be dealt with. Because of the endangered status of the bald eagle, we as the wildlife agency, have always taken a conservative path. We did not want to contribute to nest failure. However, now faced with a new problem in nestling mortality, we must reassess this approach. We must acquire any young that die to determine the cause and this will mean being more aggressive at the nest site. It means stepped-up monitoring of what may already be the most intensively monitored eagle population on the continent. Adult behaviour and the lack of visibility of the young will be clues to the health of those young and we will react accordingly. We are very interested in the camera testing that will be conducted in Wisconsin and hope to duplicate their monitoring techniques on at least a couple of our nests.

The future management of the bald eagle in Ohio will depend greatly on what transpires in 1992. If the trend in nesting mortality continues, we need to determine the cause. Every attempt will be made to collect failed eggs and nestling mortalities. Analysis of already collected eggs from the past decade and the lone eaglet collected in 1991 will be studied. Radio tagging of fledglings will continue in 1992, and hopefully, with active radioed birds being incorporated into the breeding population, food habits and feeding territories can be mapped. Once we can identify the problem, we can then begin to plan a solution.

3.7 PROGNOSIS FOR NEW YORK STATE

Peter Nye, New York State Department of Environmental Conservation, Delmar, New York

Active eagle releases have ended but the population continues to grow at an annual rate of between 15 and 30 percent. Several potential nesting sites have been identified on or very near both Lake Erie and Lake Ontario, which I believe will be occupied as the population continued to expand.

Future plans are for additional egg contaminant analyses as the opportunity arises, and for collection and analysis and eaglet blood, during banding as appropriate.

3.8 FUTURE PLANS FOR BALD EAGLE NESTING SURVEY IN PENNSYLVANIA

Daniel Brauning, Pennsylvania Game Commission, Montgomery, Pennsylvania

The following study plan has been recommended for 1992:

Annual evaluation of reproductive success to monitor eagle population levels and determine future management activities. Volunteers and conservation officers will be requested to monitor central Pennsylvania nest sites again next year and a temporary employee should again be hired to monitor nesting eagles in the northwest.

3.9 MANAGEMENT FOR BALD EAGLES IN INDIANA

John Castrale, Indiana Division of Fish and Wildlife, Mitchell, Indiana

Current management of bald eagles in Indiana consists of helicopter surveys of wintering numbers during January, and nesting surveys in suitable habitat during the spring. The small population size of nesting bald eagles permits frequent monitoring of individuals nests. Management plans have been written for individual nests to delineate agency responsibilities and protection strategies. Attempts are made to identify individual adults, and nestlings are banded with green leg bands. Efforts are being made to obtain baseline information on contaminant levels of Indiana's young bald eagle population. Two addled eggs from a single nest in 1990 and blood and feathers from three eaglets in two nests in 1991 were obtained for analysis. Research has been initiated to identify areas most suitable for wintering and nesting bald eagles in Indiana.

4.0 TRACKING LOCAL AND SEASONAL MOVEMENTS OF WINTERING BALD EAGLES FROM ARIZONA AND MICHIGAN WITH SATELLITE TELEMETRY

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In 1990, two wintering, third-year, female bald eagles (*Haliaeetus leucocephalus*) were captured in Arizona and Michigan, and fitted with 95 gram, backpack, satellite transmitters and conventional 8 gram tailmount transmitters. The Arizona eagle ranged over three-million ha between January 24 and March 26 (35 degrees north) and used at least 23 different roost locations in the ponderosa pine forests of northcentral Arizona. From March 3 to 27, the Michigan eagle covered 6.5 million ha between Lake Michigan and Lake Huron (45 degrees north). Both birds migrated 400 km north on March 27, the Michigan eagle to remain north of Lake Superior (50 degrees north) within a 24 million ha summer range. The Arizona eagle migrated 3,020 km in 37 days (15 days migrating >100 km north interspersed with 22 days of local or non-northward movements) to a 4.7 million ha summer range along Great Slave Lake in June. Movements of these eagles are discussed in the context of weather, prey, terrain and interspecific variation. Advantages and limitations of satellite telemetry for large raptor study are also considered.

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