CARE, FOOD CONSUMPTION, AND BEHAVIOR OF BALD EAGLES USED IN DDT TESTS

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WIDESPREAD concern exists over the decline in numbers of the Bald Eagle (*Haliaeetus leucocephalus*), our national emblem. In the continental United States there were approximately 3,642 Bald Eagles present in 1961, 3,807 in 1962, and 3,547 in 1963, according to January censuses (Sprunt and Ligas, 1963). A study was undertaken to help determine if pesticides may possibly be one of the factors lowering eagle populations.

Feeding experiments were conducted with 27 Bald Eagles in 1962 and 1963 to determine the approximate level of DDT in the diet that might cause death, the rates of accumulation and loss of DDT residues in various tissues, and the effects of DDT on reproductive organs. Results of this work have been reported by DeWitt and Buckley (1962), Buckley and DeWitt (1963), Locke, Chura, and Stewart (1966), and Stickel, et al. (1966).

The purpose of this paper is to present information on care, food consumption, behavior, and symptoms of DDT poisoning of eagles used in the tests.

CAPTURE AND HOUSING

Bald Eagles were captured in November and December of 1961 and 1962 along the Chilkat River near Haines, Alaska, where they congregate each year to feed on late-spawning chum salmon. Many shallow channels are bordered by extensive gravel bars littered with uprooted stumps and other drift. Eagles coming from roost trees along the shore often perch on these snags before proceeding to the water's edge for food. Number 1½ steel traps (single spring and jump type) were loosely wired on snags 1 to 4 feet above the ground and camouflaged with leaves and debris. When the birds alighted and were caught by the toes, the traps pulled free from the snags allowing the birds to fall to the ground. Trap chains stapled to the snag or a drag prevented captured birds from flying off. Captured birds were shipped by air to the Experimental Fur Station at Petersburg, Alaska.

Ten eagles were housed in a wooden shed, 120 × 12 feet, built along a chain-link fence on the west side of the station. Perches made from sections of tree trunks were supported by pipes driven into the ground and spaced 8–10 feet apart and 3–4 feet from the rear wall. The legs of the birds were jessed (Michell, 1959) and the jesses were connected by swivel to a nylon leash that had one end looped around the pipe so birds had free movement up, onto, and around the perches. Cake pans were nailed on top and to one

side of each perch to hold similar pans containing food. Water was offered in metal bowls nailed to the wall behind the perches.

Because of space limitations, several 1963 birds were housed in wire cages ($12 \times 6 \times 5$ feet high) which had small logs on the floor for perches. Food and water were offered in containers placed on the wire floors.

BEHAVIOR

The eagles were visited frequently for care and observation. When first approached, one or more birds gave a cackling warning. Most birds then dropped to the ground and began pulling against their leashes trying to escape. However, one bird usually stayed on its perch even when being fed and another generally stood on the ground in a low crouched position.

Trembling and feather erection, signs of distress, varied in intensity according to the type of disturbance, temperament of the birds, and the degree of adjustment to captivity. Newly captured birds trembled the most. Even after months in captivity they trembled slightly when mildly disturbed.

Feather erection usually accompanied trembling. A fluffing out of head and chin feathers occurred when the birds were mildly disturbed. Additional distress caused the erection of wing and back feathers (to about a 45° angle) and abdominal feathers (to a 90° angle). Birds were frequently observed shaking out their feathers. Typically, the birds would stand on their perches with wings partly outstretched. The feathers were then erected and shaken vigorously for a few seconds. Actual preening was not observed, but some birds occasionally appeared to scratch their bodies with their bills.

The birds usually cleaned their bills by rubbing them vigorously on convenient surfaces such as the top edges of the perches, or food pans. But one bird dug in the ground with its bill and would mouth the soil and debris without swallowing. Another bird rubbed and whittled on the edges of wooden beams behind its perch as high as it could reach. One bird occasionally reached down during a meal to take a talon in its beak, setting the point of the talon in the curve of its upper mandible. Then it pulled on the talon with a side-to-side motion of the head. This may have served to cleanse the inside of the bill, the talons, or both.

Birds frequently exercised their wings while standing on perches or on the ground. When on the ground they pulled against their leashes in a controlled and deliberate manner. The digging action of the talons in these exercises caused deep circular grooves to form around the perches.

When handled, the eagles instinctively attempted to flip over on their backs, and strike with their talons. They were also able to reach up and strike at a hand near their head if the legs were not restrained. In addition, most birds made use of their sharp and powerful bills to defend themselves.

HANDLING

Untethered birds in cages were best caught with a net. A tethered bird could be restrained and then grabbed safely while it was on the ground by walking on the leash up to its immobilized feet. A leashed bird could also be caught by grabbing its outstretched wings, folding them against its body and stepping back away from the perch to keep the legs extended by the leash. The feet could then be tied, or fitted with a snug leather pouch that prevented use of the talons. For further handling, transporting, or force feeding, the bird could be bound in a rectangular piece of cloth which was tied at the chest and around the tail under the legs to hold the wings firmly against the body.

It was necessary to approach and work slowly around the birds because fast movements got them too excited. Their rapid heartbeats could sometimes be heard from several feet away. When handled they emitted high-pitched, ear-piercing screams and panted from their exertion of trying to escape. Only by covering their heads with heavy cloth to blind them could they be calmed and kept relatively immobile during handling.

Certain recommendations can be made for preventing injury at capture and increasing the comfort of experimental eagles in captivity: (1) Modify the steel traps by using lightweight number 4 jaws, padded, combined with a number 1½ spring to catch and hold the birds around the tarsus, thus preventing toe damage during capture. (2) When possible, use large cages with wire floors and wooden perches; insert an inner wall of nylon net, which gives upon impact, in the cages of the more nervous birds. This has been tried and found successful. (3) If birds must be leashed to perches, ample space should be allowed around each perch. (4) Place a second swivel, just after the loop connection around the perch upright, to help decrease leash twisting. (5) Shorten the leashes of the more nervous birds to prevent their gaining momentum enough to sprain a leg. (6) Keep birds isolated and relatively free of disturbance, particularly during feeding periods. (7) Handle birds as little as possible, particularly during the critical adjustment period, unless they are to be properly manned. (Our eagles were not manned because of the number of birds and time limitations.

EARLY ADJUSTMENT AND VOLUNTARY FEEDING

The interim between capture and voluntary feeding on a regular basis was a critical period for the eagles. Prior to the 1963 tests four birds died even after they began taking food voluntarily (Table 1). Important problems of confining wild animals, including those of the transition from freedom to captivity, are discussed by Hediger (1950).

TABLE 1

VOLUNTARY FOOD INTAKE BY 21 NEWLY CAPTURED BALD EAGLES HELD AT THE EXPERIMENTAL FUR STATION, PETERSBURG, ALASKA, FOR THE 1963 TESTS

Day at station first food taken	Day when ground fish taken alone	Bird number
–	–	77[a]
1	1	11A, 14A, 89[b]
6	6	14
7	7	17, 19
8	8	11, 12, 18
9	9	13
10	13, 15	20, 17A[c]
11	11, 12	22, 15
15	19	23
17	18, 23	21[d], 87[e]
18	20	16[f]
19	23 (#86 only)	81[g], 86[h]

[a] Died on 6th day without taking food; [b] Died on 5th day; [c] Successfully force fed on 4th day; [d] Successfully force fed on 16th day; [e] Died on 38th day; [f] Successfully force fed on 16th and 18th day; [g] Unsuccessfully force fed on 16th day but successfully fed on 18th day. Died on 25th day; [h] Successfully force fed on 16th and 18th day. Died on 33rd day.

Encouraging the eagles to feed on ground fish regularly was accomplished by offering whole or parts of fish and mammals simultaneously with ground fish (usually pink salmon). Food was left with the birds day and night so they could sample it at will. Once birds began eating, the daily offering of whole food was decreased until the changeover to ground fish was complete.

Five birds had to be force-fed to give them nourishment and to encourage them to feed. Strips of fish (about 6×1 inches) were forced down the gullet; when the bird began to swallow, its neck was gently massaged until the meal was completely taken. Because of the stress involved, force-feeding was used only as a last resort measure.

DIETS AND FOOD CONSUMPTION

Fish from local canneries was ground, packaged, and frozen for storage, then thawed for use. At various times during the 1962 (March–June) tests the diet consisted of ground salmon, herring, flounder, and supplements. In the 1963 (January–May) tests the basic food was ground pink salmon waste. With little variation the regular diet consisted of pink salmon (99 per cent), liver meal (1 per cent), multiple vitamins (1 teaspoonful per 10 pounds of food) used daily, and Terramycin (1 gram active ingredients per 10 pounds of food) used for periods of about 7 days and omitted for 3 or 4 days.

TABLE 2

FOOD CONSUMPTION OF CAPTIVE BALD EAGLES

Bird number	Age	Sex	DDT dosage level (ppm)[a]	Dosage period (days)	Daily food consumption (grams)	
					Mean ± standard error	Range
1962:						
1	Adult	♂	0	112	314 ± 14	0–700
10	Immature	?	0	112	288 ± 16	0–700
3	Immature	?	10	98[b]	401 ± 17	0–719
6	Adult	♂	10	77[c]	150 ± 19	0–680
2	Adult	♂	160	71[c]	215 ± 18	0–609
9	Adult	♂	160	112	335 ± 14	0–700
5	Adult	♂	800	62[c]	213 ± 20	0–546
7	Immature	♀	800	59[c]	238 ± 25	0–815
4	Adult	♂	4000	23[c]	198 ± 26	8–490
4A	Adult	♂	4000	15[c]	109 ± 35	0–344
8	Immature	♂	4000	18[c]	215 ± 32	0–530
1963:						
15	Adult	♀	0	120	324 ± 9	33–467
12	Adult	♀	10	120	265 ± 9	0–484
13	Adult	♂	10	120	312 ± 8	0–501
20	Adult	♀	10	120	229 ± 8	0–657
22	Adult	♂	10	120	204 ± 13	0–500
11	Adult	♂	10	60	274 ± 14	93–609
14	Adult	♂	10	60	219 ± 14	0–465
17	Adult	♀	10	60	252 ± 15	0–500
23	Immature	♀	10	60	303 ± 19	0–500
14A	Adult	♀	10	60	194 ± 11	0–449
17A	Adult	♂	10	60	254 ± 20	0–492
11A	Adult	♂	10	39[c]	252 ± 23	0–499
16	Adult	♂	10 & 0	60 & 60	292, 258 → 275 ± 11	0–703
18	Adult	♂	10 & 0	60 & 60	232, 176 → 204 ± 9	0–504
19	Adult	♀	10 & 0	60 & 60	229, 196 → 213 ± 11	0–489
21	Adult	♂	10 & 0	60 & 60	287, 252 → 269 ± 12	0–490

[a] Dietary concentration expressed on a dry weight basis, on the assumption of 70 per cent moisture content. Actual moisture content proved to be 65 per cent.
[b] Bird escaped.
[c] Bird died.

A uniform blend of all ingredients, including technical grade *p,p'* DDT dissolved in Wesson oil, was achieved by using a motor driven bread mixer. Food was weighed on a beam balance before and after feeding. Birds were fed about 4:00 PM daily and were generally offered all the food they would eat in about an hour.

In the 1962 tests 11 eagles ate an average of 274 grams per bird day with a range of 109 to 401 grams per day between birds (Table 2). The wide range between birds on 10 ppm DDT (150 to 401 grams) was caused in part by bird 6 being long off feed because of illness. Birds that died ate little or no food immediately before death.

In the 1963 tests 16 eagles ate an average of 254 grams of food per bird day with a range of 194 to 324 grams per day between birds. Average daily food consumption of birds in two 1963 tests was computed as a percentage of average body weight (based on mean of near-capture and death weights). Females on 10 ppm DDT for 120 days ate at the rate of 4.9 per cent of their body weight, whereas the males ate 6.4 per cent. Similarly, females on 10 ppm DDT for 60 days ate 5.0 per cent of their body weight, but the males ate 6.2 per cent. Fevold and Craighead (1958) reported a similar sex difference in Golden Eagles (*Aquila chrysaetos*) and suggested this might result from differences in basal metabolism.

WEIGHT CHANGES

Eagles in the 1962 tests were first weighed at time of capture. Seven adult males averaged 10.7 pounds (range 9.3–12.4), one immature male weighed 10.8 pounds and one immature female weighed 12.4 pounds. These weights are higher than the averages reported for other Alaskan eagles by Imler and Kalmbach (1955).

All 1962 birds, except a control, lost weight between capture and death or sacrifice (Table 3). Weight losses for the seven birds that died on dosage varied from 23 to 49 per cent and were probably a result of impaired health due to DDT poisoning. General health may also have been poor, however, for a control lost 14 per cent and bird 6 on 10 ppm DDT died of a lingering illness. For this reason Terramycin was added to the diet in 1963.

The 1963 test birds were weighed upon their arrival at the fur station 1 to 13 days after capture during which time they ate little and lost an unknown amount of weight. Thus, valid weight comparisons could not be made.

MORTALITY AND SYMPTOMS OF DDT POISONING

Tremors attributable to DDT poisoning (Rudd and Genelly, 1965, and others) were evident in all but bird 6 of the 1962 birds that died. The intensity of tremors varied. Tremors generally were stronger (jerking wings and general incoordination simultaneous with vigorous feather shaking) in birds receiving higher dosages, but one bird on 800 ppm DDT and one on 4000 ppm DDT had only mild tremors (slight quivering of tail, wing, or erected body feathers).

TABLE 3
WEIGHT CHANGES OF 1962 TEST EAGLES

Bird number	Age	Sex	Dosage level DDT (ppm)[a]	Dosage period (days)	Weight (grams)		
					At capture	At death	Per cent change
1	Adult	♂	0	112	4,238	4,252	+ 0.3
10	Immature	?	0	112	4,706	3,955	- 14
3	Immature	?	10	98[b]	4,649	–	–
6	Adult	♂	10	77[c]	4,536	2,211	- 49
2	Adult	♂	160	71[c]	5,642	3,629	- 36
9	Adult	♂	160	112	5,273	4,423	- 11
5	Adult	♂	800	62[c]	4,295	3,289	- 24
7	Immature	♀	800	59[c]	5,642	4,026	- 29
4	Adult	♂	4000	23[c]	4,777	3,671	- 23
4A	Adult	♂	4000	15[c]	5,075	3,444	- 32
8	Immature	♂	4000	18[c]	4,904	3,544	- 27

[a] Dietary concentration expressed on a dry weight basis, on the assumption of 70 per cent moisture content. Actual moisture content proved to be 65 per cent.
[b] Bird escaped.
[c] Bird died.

Tremors and death occurred first for the birds on the highest dosage and progressively later in birds on lower dosages. The 4000 ppm DDT birds showed tremors 12–18 days after dosage began and died at 15–23 days on dosage. It took 34–45 days for tremors to appear on the 800 ppm DDT birds and 59–62 days on dosage for death to occur. Tremors appeared on the 160 ppm DDT birds at 55 days on dosage and one of these birds died at 71 days on dosage. The birds on 10 ppm DDT, including bird 6 that died, showed no evidence of tremors caused by DDT poisoning. The influence on tremors or survival of two days in April when no DDT was fed is not known.

The only test eagle that died in 1963 had lesions suggestive of a serious respiratory disease. None of the 1963 birds exhibited tremors attributable to DDT poisoning.

SUMMARY

Twenty-seven Bald Eagles captured in southeastern Alaska were used in feeding tests to determine the effects of DDT in the diet.

Trapping and housing of eagles are discussed. Various aspects of eagle behavior and handling techniques are also presented. Recommendations are made for preventing injuries and increasing the comfort of captive birds.

The 1962 test birds consumed an average of 274 grams per bird day with a range of 109 to 401 grams per day between birds. Average food intake was 254 grams per bird day for the 1963 test birds with a range of 194 to 324 grams per day between birds.

Weight losses varied from 23 to 49 per cent of normal body weight for the 7 birds

which died in the 1962 tests. Tremors and death occurred first for birds on the highest dosage and progressively later for birds on the lower dosages.

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