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ORGANOCHLORINE RESIDUES, EGGSHELL THICKNESS, AND REPRODUCTIVE SUCCESS OF SNOWY EGRETS NESTING IN IDAHO

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ABSTRACT.—During 1979, 19 Snowy Egret (*Egretta thula*) eggs were collected at two colonies in Idaho and analyzed for organochlorine residues. DDE was detected in all eggs, DDT in 63%, and DDD in 53%. Eggshell thickness was significantly and inversely correlated with concentrations of these pesticides, especially DDE. In the colonies studied, reproductive success was below the rate required to maintain current population levels. Females that laid eggs containing residues of DDE greater than 5 ppm had more eggs disappear or break, fewer eggs hatch, and significantly thinner eggshells than females less contaminated with DDE. DDE contamination appears to be the primary factor responsible for reproductive failures in Snowy Egrets nesting in Idaho. Circumstantial evidence suggests that Snowy Egrets are being exposed to high levels of DDE while they overwinter in Mexico.

Snowy Egrets (*Egretta thula*) nesting in the eastern United States have been found to be contaminated with organochlorine pollutants (Faber and Hickey 1973, Ohlendorf et al. 1974, Ohlendorf et al. 1979). These substances have been shown to be related to changes in eggshell quality among Snowy Egrets nesting in Louisiana (Faber and Hickey 1973). I am unaware of any studies that demonstrate an association between organochlorine residues and reproductive failures or population declines in Snowy Egrets.

During 1978, I found that Black-crowned Night-Herons (*Nycticorax nycticorax*) nesting in Idaho were contaminated with relatively high levels of DDE (Findholt 1981). Therefore, I sought to determine whether Snowy Egrets breeding in the same colonies as Black-crowned Night-Herons were also contaminated with DDE and other organochlorines. In addition, I measured shell thickness of Snowy Egret eggs that were analyzed for organochlorines and collected data on the reproductive success of this species for one year. This information is the first available on the effects of organochlorines on the nesting success of Snowy Egrets breeding in the western United States.

STUDY AREAS

All data were collected between 29 April and 2 July 1979. The three colonies that I studied were located in artificial water impoundments and, during the nesting season, were subjected to severe water losses owing to demands for irrigation. Total numbers of nesting pairs were determined by counting all active nests in each colony.

Minidoka National Wildlife Refuge (NWR) is 16 km east of Rupert, Minidoka Co., Idaho, and the Refuge colony that I studied was on Gull Island, Lake Walcott Reservoir. The colony contained 132 nesting pairs of Snowy Egrets, 329 nesting pairs of Double-crested Cormorants (*Phalacrocorax auritus*), 37 nesting pairs of Great Blue Herons (*Ardea herodias*), one to two nesting pairs of Cattle Egrets (*Bubulcus ibis*), 147 nesting pairs of Black-crowned Night-Herons, and approximately 3,000 nesting pairs of California Gulls (*Larus californicus*). Snowy Egrets nested on the periphery of Gull Island in or underneath dense shrubs, predominantly golden currant (*Ribes aureum*).

At Blackfoot Reservoir, 29 km north of Soda Springs, Caribou Co., Idaho, I located 47 nesting pairs of Snowy Egrets on a small unnamed island. Nesting associates included Great Blue Herons (15 to 20 nesting pairs) and Black-crowned Night-Herons (77 nesting pairs). Most Snowy Egret nests were in black cottonwood (*Populus tricocarpa*) or willow (*Salix* sp.). Double-crested Cormorants, California Gulls, and Ring-billed Gulls (*Larus delawarensis*) nested elsewhere at Blackfoot Reservoir.

I counted 13 nesting pairs of Snowy Egrets at Mud Lake Wildlife Management Area (WMA), 45 km northwest of Idaho Falls, Jefferson Co., Idaho. Snowy Egrets were nesting with 119 breeding pairs of Black-crowned Night-Herons. A few Great Blue Herons were also nesting in this colony but most Great Blue Heron nests were west of it. Other colonial waterbirds nesting on the wildlife management area included Double-crested Cormorants, White-faced Ibis (*Plegadis chihi*), and California Gulls. Snowy Egret nests at Mud Lake WMA were located in willows.

METHODS

ORGANOCHLORINE ANALYSIS

One randomly selected fresh egg was collected from each of 9 nests at Blackfoot Reservoir and 10 nests at Minidoka NWR when clutches were complete. Also, I gathered eggs from nests that were started during the early part of the breeding season in both colonies. Because I found so few nests at Mud Lake WMA, I did not collect any eggs at that colony. All eggs were wrapped in aluminum foil, secured in plastic bags, and refrigerated until transferred to the Patuxent Wildlife Research Center, Laurel, Maryland, for analysis of organochlorine residues. Volumes of intact eggs were measured to the nearest 1.0 ml by water displacement. Residue concentrations were adjusted to fresh wet weight, assuming a specific gravity of 1.0 (Stickel et al. 1973). Organochlorine residues were identified and quantified with a Hewlett-Packard 5753 gas-liquid chromatograph equipped with a Ni^{63} detector and a 1.83-m glass column packed with 4% SE- 30/6% QF-1 on 100–120 mesh Supelcoport. Polychlorinated biphenyl (PCB) levels were determined by comparing total peak area with Aroclor 1254 or 1260. Sensitivity of detection was 0.1 ppm for pesticides and 0.5 ppm for PCBs on the gas chromatograph. Residues in 10% of the samples were confirmed with an LKB gas-liquid chromatograph/mass spectrometer. For a more detailed discussion of methods used to determine organochlorine residue concentrations see Chromartie et al. (1975) and Ohlendorf et al. (1978). Shells of all eggs that were analyzed for organochlorines were retained for measuring their thickness.

EGGSHELL THICKNESS

Eggshell thickness, including membranes, was measured to the nearest 0.01 mm with a dial-gauge micrometer when eggshells were thoroughly dried. Three measurements were taken at the greatest breadth of each eggshell and averaged to yield a single value for each egg. These data were compared to shell thicknesses from 37 complete fresh or slightly developed clutches of Snowy Egret eggs collected before 1947 from northern Utah. The eggs from Utah represent the closest geographic location to the colonies in Idaho where data were available. I assume that these eggs represent the pre-1947 eggshell thickness of Snowy Egrets nesting in southeastern Idaho.

REPRODUCTIVE SUCCESS

Data were collected at Snowy Egret colonies located at Minidoka NWR, Blackfoot Reservoir, and Mud Lake WMA. Each colony was visited every 7–10 days, contingent upon favorable weather conditions. To aid relocation of nests, I labeled active nests by wiring sequentially numbered aluminum tags to branches near nests. I also marked nests with colored plastic flagging. A nest was considered active if it contained one or more eggs. On an average, I made six observations at each nest and I recorded the number of eggs or young present during each visit. Fresh eggs were numbered with colored wax pencils. Because I was interested in determining the fate of all eggs laid, I first visited the colonies before egg-laying. Most visits to colonies lasted from 3–5 h. The longer visits occurred when young were banded with U.S. Fish and Wildlife Service leg bands. Young in all colonies were monitored 7–10 days. Data on reproductive success were gathered from nests that were begun throughout the breeding season. The nests from which eggs were collected for organochlorine analysis were divided into two groups, the "low" DDE and "high" DDE groups. Nests were assigned to the "low" DDE group if the egg collected from that nest contained less than 5 ppm DDE and "high" DDE group if the egg contained more than 5 ppm DDE. Custer et al. (1983) found a possible effect of DDE levels above 5 ppm on hatching success in the Black-crowned Night-Heron. I chose to use 5 ppm DDE as the dividing level because it resulted in two nearly equal-sized groups of nests. Several factors related to the effects of organochlorines, particularly DDE, on reproductive success were compared between the two groups. These included clutch size, hatching success, egg disappearance or egg breakage, egg infertility or embryonic mortality, and survival of nestlings.

STATISTICAL ANALYSIS

Prior to statistical analysis, individual organochlorine residue values (residue value + 1) were transformed to logarithms base 10 as suggested by Blus et al. (1972) and Ohlendorf et al. (1978). After calculating these values, I took their antilogs and then subtracted 1 from that value. The addition of 1 to each value enabled me to transform zero values.

RESULTS AND DISCUSSION

ORGANOCHLORINES

All of the eggs contained measurable quantities of DDE (Table 1). DDT was found in 63% of eggs and DDD in 53% of eggs. Dieldrin, PCBs,

TABLE 1. Organochlorine residues (ppm fresh wet weight) in 19 Snowy Egret eggs collected in Idaho during 1979.[a]

Organochlorine	Location: Blackfoot Reservoir ($n = 9$)	Minidoka NWR ($n = 10$)
DDE	(9) 4.8 (0.42–33)	(10) 4.2 (0.62–26)
DDD	(6) 0.16 (0–0.84)	(4) 0.12 (0–0.48)
DDT	(6) 0.47 (0–1.4)	(6) 0.46 (0–1.8)
Dieldrin	(2) 0.11 (0–0.85)	(2) 0.02 (0–0.17)
Heptachlor epoxide	(1) 0.04 (0–0.43)	(1) 0.03 (0–0.35)
Oxychlordane	(1) 0.04 (0–0.45)	(1) 0.02 (0–0.19)
cis-chlordane	(1) 0.01 (0–0.13)	(1) 0.03 (0–0.32)
cis-nonachlor	(1) 0.01 (0–0.10)	N.D.[b]
Endrin	N.D.	N.D.
Toxaphene	N.D.	(1) 0.04 (0–0.49)
HCB	N.D.	N.D.
Mirex	N.D.	N.D.
PCBs	(1) 0.08 (0–1.0)	(3) 0.19 (0–1.1)

[a] Values are in the following order: (n with residues), geometric mean, (extreme values).
[b] N.D. = none detected.

and the remaining pollutants were detected in 21% or less of the eggs and occurred at low concentrations. The DDT-related compounds (DDE, DDD, and DDT) were positively intercorrelated but were not correlated with dieldrin or PCBs (Table 2). Eggshell thickness was significantly and inversely correlated with DDE, DDD, and DDT levels (Table 2). The highest correlation coefficient was between shell thickness and DDE concentration.

Because all eggs that were collected for organochlorine analysis were taken from nests that were started during the onset of the breeding season and because sample sizes were small, I was unable to analyze for possible seasonal variation in organochlorine levels in egg contents. Seasonal changes in organochlorine levels in eggs have been detected in Black-crowned Night-Herons (Custer et al. 1983) and Common Terns (*Sterna hirundo*; Gilbertson 1974). In contrast, no relationship was found between date of first egg laid and organochlorine levels in Eurasian Sparrowhawks (*Accipiter nisus*; Newton and Bogan 1978). A change in organochlorine concentrations in eggs as the breeding season progresses may possibly indicate the source of contamination (Gilbertson 1974, discussed later).

EGGSHELL THICKNESS

Mean shell thickness of the 19 eggs analyzed for organochlorine residues was 0.215 mm (SE = 0.0047). Mean thickness of 146 eggshells (37 clutches) collected in northern Utah before 1947 was 0.222 mm (SE = 0.0020). No significant difference in eggshell thickness was detected between recent eggshells and archival eggshells (t-test, $P > 0.05$). Conversely, eggshells in the "high" DDE group were 13.4% thinner than those in the "low" DDE group, and 9.5% thinner than mean shell thickness in northern Utah before 1947 (Table 3). In the "low" DDE group, eggshells were 4.3% thicker than the mean thickness of archival eggshells.

CLUTCH SIZE

Snowy Egret clutches averaged 3.7 ± 0.38 eggs (range 3–4 eggs, $n = 9$) at Mud Lake WMA. At Blackfoot Reservoir the mean clutch size was 4.3 ± 0.26 eggs (range 3–5 eggs, $n = 30$)

TABLE 2. Correlation matrix including eggshell thickness and the five most common organochlorine chemicals in 19 Snowy Egret eggs.

	Pearson Product-Moment Correlation Coefficient[a]: DDE	DDD	DDT	Dieldrin	PCBs
DDD	0.862[b]				
DDT	0.825[b]	0.716[b]			
Dieldrin	0.165	0.180	0.045		
PCBs	0.384	0.406	0.067	0.251	
Thickness	−0.898[b]	−0.704[b]	−0.700[b]	−0.296	−0.331

[a] All residue values were coded by adding 1.0 to each value and transformed to logarithms base 10 prior to statistical analysis.
[b] $P < 0.001$.

TABLE 3. Comparison of parameters associated with reproductive success in female Snowy Egrets having different levels of DDE contamination.

	"Low" DDE group	"High" DDE group	P[a]
Nests[b]	10	9	
Eggs[c]	27	29	
Clutch size[d]	4 (3–5)	5 (4–5)	>0.05
Eggs disappeared or broken	4 (15%)	13 (45%)	<0.05
Eggs addled or infertile	1 (4%)	2 (6%)	>0.05
Eggs hatched	22 (81%)	14 (48%)	<0.05
Young survived 7–10 days	21 (95%)	12 (86%)	>0.05
Thickness[d]	0.232 (0.200–0.250)	0.201 (0.181–0.215)	<0.05
DDE[e]	1.1 (0.42–4.8)	7.5 (5.0–33)	

[a] Based on chi-square or Mann-Whitney *U*-test.
[b] Nests were assigned to the "low" DDE group if the egg collected from that nest contained less than 5 ppm DDE and "high" DDE group if the egg contained more than 5 ppm DDE.
[c] Does not include eggs that were collected for organochlorine residue analysis.
[d] Median (extreme values).
[e] Median (extreme values); residues in ppm fresh wet weight.

and at Minidoka NWR the mean clutch size was 3.7 ± 0.19 eggs (range 2–7 eggs, $n = 85$). Mean clutch size at Minidoka NWR was significantly smaller than the 4.2 ± 0.27 eggs (range 2–6 eggs, $n = 37$) in northern Utah before 1947 (ANOVA, Student-Newman Keuls multiple range test, $P < 0.05$). Although I found no relationship between clutch size and DDE levels, egg disappearance or egg breakage was associated with DDE contamination (Table 3). Because nests were examined at 7–10-day intervals and egg loss was common, I probably underestimated the true mean clutch size in all colonies. At Minidoka NWR, the true mean clutch size may have been more severely underestimated than in the other two colonies because I visited that colony less frequently during the egg-laying period and therefore found fewer eggs in nests.

Smaller apparent clutch sizes in Great Egrets (*Casmerodius albus*) have also been related to high incidence of egg disappearance associated with DDE residues (Pratt 1972).

HATCHING SUCCESS

In each colony, a major factor responsible for low hatching success and subsequent reproductive failures was loss of eggs before hatching (Table 4). High incidence of egg disappearance or egg breakage was associated with DDE concentration (Table 3). Eggs probably became broken during incubation because of thin shells induced by DDE, and they were later discarded. I found no evidence of deliberate egg destruction as reported in Gray Herons (*Ardea cinerea*) contaminated with DDE (Milstein et al. 1970, Prestt 1970). Residue levels of DDE in eggs from the four unsuccessful nests in the "high" DDE group ranged from 19 ppm to 33 ppm. All remaining eggs in these nests disappeared. In three of these nests, one egg was found dented or cracked before it disap-

TABLE 4. Fate of Snowy Egret eggs laid, and survival of chicks in each colony.

	Colony		
	Minidoka NWR	Blackfoot Reservoir	Mud Lake WMA
Number of eggs			
Laid	316	128	33
Hatched	195 (62)[a]	84 (66)[b]	19 (58)
Lost to predators	3 (1)	1 (1)	
Addled or infertile	28 (9)	4 (3)	
Cracked or dented	17 (5)	4 (3)	
Wind[c]		4 (3)	
Found broken (cause unknown)	4 (1)	3 (2)	
Disappeared	59 (19)	16 (12)	14 (42)
Collected	10 (3)	12 (9)	
Number of chicks that survived 7–10 days	168 (86)	75 (89)	18 (95)

[a] Percent of eggs laid or chicks that survived.
[b] Total percentage does not equal 100% because of rounding.
[c] Nest with eggs was destroyed by strong wind.

peared. In the only unsuccessful nest in the "low" DDE group all eggs disappeared when the nest was destroyed by strong winds accompanying a storm. In another nest in the "low" DDE group, one egg that was found dented later disappeared. The egg collected from this nest contained 4.8 ppm DDE. The maximum DDE level in an egg from a successful nest was 7.5 ppm; this value overlaps with the 95% confidence interval calculated for the mean DDE level of all 19 Snowy Egret eggs analyzed for organochlorines.

Alternatively, as suggested by Fox and Donald (1980) for Merlins (*Falco columbarius*), DDE burdens in egrets may have reduced nest attentiveness resulting in higher loss of eggs because of predation. High incidence of egg disappearance associated with organochlorine contamination, particularly DDE, has resulted in reproductive failures in the Great Egret (Pratt 1972), Common Tern (Fox 1976), Merlin (Fox and Donald 1980), and other species. In contrast, predation may also have accounted for the disappearance of some eggs laid by Snowy Egrets that were relatively uncontaminated with DDE. Although I did not observe predation of egret eggs during visits to the colonies, potential avian predators that were frequently seen included Ring-billed Gulls, California Gulls, Black-billed Magpies (*Pica pica*), and American Crows (*Corvus brachyrhynchos*).

An unusually large proportion of eggs at Minidoka NWR were addled or infertile (Table 4). Although I did not distinguish between addled and infertile eggs, most eggs at Minidoka NWR were probably addled. It seems unlikely that 9% of these eggs were infertile as this would be an excessive waste of energy. I found no relationship between numbers of addled or infertile eggs and DDE levels. Laboratory experiments on American Black Ducks (*Anas rubripes*) and Mallards (*Anas platyrhynchos*) fed DDE resulted in increased embryonic mortality (Heath et al. 1969, Longcore et al. 1971). Also, high incidence of embryonic mortality has been found in field studies on Herring Gulls (*Larus argentatus*; Keith 1966) and Common Terns (Fox 1976) contaminated with DDE. Although I visited Minidoka NWR shortly after sunrise, the eggs may have become addled from exposure to intense sunlight. Snowy Egret nests at Blackfoot Reservoir and Mud Lake WMA were shaded by dense vegetation.

Because nesting success was not affected by the removal of one egg from each nest in Black-crowned Night-Herons along the Atlantic Coast (Custer et al. 1983), I made no adjustments for the 9 (Blackfoot Reservoir) or 10 (Minidoka NWR) egg samples in calculating hatching success.

SURVIVAL OF CHICKS

The number of Snowy Egret chicks that survived the initial 7–10-day period after hatching was 168 (86%) at Minidoka NWR, 75 (89%) at Blackfoot Reservoir, and 18 (95%) at Mud Lake WMA (Table 4). In an experimental study on Black Ducks, mortality of young ducklings was significantly greater in hens fed DDE compared to the control group (Longcore et al. 1971). In this study, survival of Snowy Egret chicks was unrelated to DDE concentration (Table 3). Of the 37 chicks that died in all colonies, 23 (62%) disappeared. Having searched intensively for all dead chicks, I assume that predation was the most likely cause of mortality in chicks that disappeared. Starvation probably accounted for the remaining deaths since most chicks that were found dead were thinner and much smaller than nest mates that survived.

In Snowy Egret chicks that died before the age of 15 days in a colony on Long Island, New York, mortality also resulted from predation and starvation (St. Clair Raye and Burger 1979). In addition, accidents accounted for a small proportion of the mortality.

NESTING SUCCESS

The mean number of chicks that survived 7–10 days per nesting attempt was 2.0 at both Minidoka NWR and Mud Lake WMA, and 2.5 at Blackfoot Reservoir. Because my data are estimates of nesting success per nesting attempt instead of per female, actual reproductive success in these colonies is probably slightly higher. Snowy Egrets may renest successfully, which can compensate for failure of initial nesting attempts (Findholt, unpubl.). In contrast, I probably overestimated nesting success compared to estimates by the Mayfield method (Mayfield 1961, 1975; Hensler and Nichols 1981). Erwin and Custer (1982) found that, compared to the traditional method of calculating nesting success (the method that I used), the Mayfield method gave estimates of between 0.07 and 0.46 (mean 0.20) chicks fledged per nest lower for Black-crowned Night-Herons. Also, Snowy Egret chicks were only monitored for 7–10 days, which represents less than half the time before egrets normally fledge (Bent 1926). Significant losses of chicks may occur after they are 7–10 days old and before fledging (H. M. Ohlendorf, pers. comm.). Using Ryder's (1978) mortality rates of Snowy Egrets calculated from band-recovery data in North America and assuming that Snowy Egrets begin breeding at two years of age, I determined

TABLE 5. Simplified table demonstrating that 3.2 chicks need to fledge per nesting female Snowy Egret in order to maintain a stable population.[a]

Age category		Years after initiation of colony 1	2	3	4	5
Adults	200	138	157	151	152	152
One-year-olds		90	62	70	68	68
Chicks (fledged)	320	221	251	242	243	243

[a] Mean annual mortality rates for chicks, 72%; for one-year-olds and adults, 31% (Ryder 1978). Assumptions made: only adults breed, equal proportions of males and females reach breeding age, and no recruitment or emigration occurs. A stable population is reached four years after the colony is established by 200 adults.

that 3.2 egret chicks must fledge per nesting female in order to sustain current population levels (for calculations see Table 5). The productivity required to maintain population levels of Snowy Egrets is probably slightly below this figure because some egrets may breed the first year (Bent 1926). Therefore, excluding recruitment or higher nesting success during subsequent years, Snowy Egret populations may possibly decline in the three Idaho colonies.

SOURCE OF CONTAMINATION

The ratio of DDE or total DDT (DDT + analogs) concentration to PCBs has been used to characterize ecosystems and determine whether birds have been contaminated in breeding areas or on wintering grounds (Risebrough et al. 1968, Faber et al. 1972, Fox 1976, Schmitt et al. 1981). Although data have not been collected on organochlorine residues in fish from reservoirs where Snowy Egrets breed, organochlorine levels have been determined in fish from tributaries of the upper Snake River and at trend stations throughout Idaho (A. E. Murrey, pers. comm.). All Snowy Egret colonies in this study are located within the greater upper Snake River watershed. The total DDT: PCB ratio in fish ($n = 27$) collected from the upper Snake River ecosystem during 1978–1979 was 2:1 and was similar for fish collected at trend stations throughout Idaho ($n = 57$). The total DDT:PCB ratio was 58:1 for 19 Snowy Egret eggs analyzed for organochlorines. Therefore, it seems unlikely that the high level of DDE detected in Snowy Egret eggs is the result of contamination in breeding areas. Band-recovery data indicate that most Snowy Egrets nesting in Idaho overwinter in Mexico (C. H. Trost, pers. comm.), where DDT is still being used extensively and indiscriminately (Smith 1979, Weir and Schapiro 1981).

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Weather and Bird Behavior.—Norman Elkins. 1983. T & A D Poyser, Colton, England. 239 p. $32.50. Source: Buteo Books, P.O. Box 481, Vermillion, SD 57069. Birds are affected by weather not just during migration but at all times. These effects have received much attention from ornithologists but in this book they are considered from the standpoint of a meteorologist (and amateur birder). Elkins begins with an explanation of the basic features of atmospheric circulation, emphasizing the interrelationships of meteorologic processes. Subsequent chapters survey the effects of weather on flight, feeding, breeding, comfort, and most of all, on migration. The closing chapters treat the consequences of extreme weather and the special problems faced by seabirds. The book uniquely brings together a great deal of material about birds' habits and interprets it in the light of weather conditions. Although most of the examples cited concern birds of the western Palearctic in Eurasia and Africa, their meaning can easily be applied to birds of the Americas. The writing itself is clear and nontechnical, so the book should catch the interest of ornithologists in diverse fields and at several levels of expertise. It is illustrated with diagrams, weather maps, photographs, and nice pen-and-ink drawings by Crispin Fisher. Selected bibliography, tables of supplementary information, and indexes.

Behavior of Fledgling Peregrines.—Steve K. Sherrod. 1983. The Peregrine Fund, Inc., Ithaca, NY. 202 p. Paper cover. $10.00. Source: The Peregrine Fund, 1424 N.E. Frontage Rd., Fort Collins, CO 80524. The period immediately after a young bird leaves its nest and starts learning to fend for itself is one of the most critical times in its life, yet scientifically the least known. Such ignorance is of more than academic import in the case of endangered species in which young birds raised in captivity are released into the wild. Sherrod therefore conducted a study to document and describe the activities of fledgling peregrines, to determine the roles of the parents in these activities, and to examine the ontogeny of the falcons' hunting behavior. Using radio telemetry as well as direct observation, he monitored four families of wild peregrines (two each in Greenland and Australia) plus three broods of falcons hacked in The Peregrine Fund's eastern release program. This book presents his findings, organized into chapters on: leaving the nest, behavior in flight, the act of killing, food transfers, aggression, and the duration of the dependency period. Copious details and data are reported, including many passages from field notes. Three long appendices describe additional behavior of the young peregrines that is outside the scope of the main story. Many drawings by Karen Lynn Allaben-Confer usefully depict the actions and postures of the birds. The book is of immediate benefit, of course, to the peregrine program, yet it will also interest falconers and ornithologists who work with other kinds of hawks. References.