POPULATION DECLINE AND MANAGEMENT PLAN

FOR THE PEREGRINE FALCON

By

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PREFACE

In an age of rapid advancement many species of wildlife find it hard to adjust to a changing environment. To further aggravate the problem man has ravaged, polluted, and contaminated all habitats in some way. A reversal of the effects that these changes have had on wildlife can only come about through an understanding of the problem. This understanding breeds the predictability of a situation and the subsequent effectiveness of management steps.

The peregrine falcon has suffered a reduction in numbers world wide due to this contamination of its environment. This paper serves to identify the problem and suggest possible management which might affect the continued existence of this species if carried out.

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Scope of Study: This library report summarizes the major works that have been carried out in the study of the peregrine falcon (Falco peregrinus) and outlines several management steps that may be effective in reversing the current decline in population levels that are presently occurring world wide.

Findings and Conclusions: The peregrine falcon has experienced a world wide population crash during the years 1950 to 1965. The status of the present day populations is not widely agreed upon except that at least one and possibly two of the 12 subspecies is now extinct. Chlorinated hydorcarbons have effected an imbalance of the sex hormone endocrine system of these birds. This imbalance has led to thin eggshells, reduced fertility, and generally low reproductive rates, which were less than mortality rates and a population crash was the result. Management of the remaining peregrine populations can be in the form of absolute protection, purging adults systems free of pesticides, holding juveniles in captivity until two years of age and then releasing them, and by establishing captive breeding stocks to produce young which would be released to the wild to augment natural reproduction. Introduction of permanent wild populations by the use of alternative subspecies in areas where total extinction of the population has occurred may be possible after pesticides are eliminated from the world ecosystem and if habitat remains to support them.

ADVISER'S APPROVAL L. Herbert Bruneau

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CHAPTER I

INTRODUCTION

During the years 1950 to 1965, a population crash of peregrine falcons (Falco peregrinus) occurred in parts of Europe and North American on a scale that made it one of the most remarkable recent events in environmental biology. The purpose of this paper is to (1) discuss the endocrinological mechanisms (imbalanced by chlorinated hydrocarbons) that caused the population decline of peregrines world wide, (2) discuss a management plan for existing populations, and (3) discuss a reestablishment program for extinct populations.

Distribution

Peregrines nest in the Arctic of both North America and Eurasia, and as far south as Tasmania, South Africa, and the region of Cape Horn. Their great powers of flight have enabled them to establish nesting populations on the Cape Verde and Falkland Islands in the Atlantic and on the Valcano and Solomon Islands in the Pacific. Despite the presence of extensive cliff formations and large colonies of nesting seabirds, they do not breed on islands north of the Aleutian chain (Cade, 1960:159).

Throughout the world, peregrine populations vary enough in body size and color so that races or subspecies can be recognized by museum specialists. Vaurie (1961) has described 12 to 13 subspecies of the peregrine. Not all authorities agree on this number, but the majority do. Dementiev (1951) has described as many as 22 subspecies and has plotted their distribution on a world map (Figure 1).

It is apparent that four distinct populations of peregrines existed in North America prior to 1940. The first and now extinct population (Hickey, 1969:172) is the subspecies called the "East Coast" anatum. This population was second in body size only to the subspecies pealei which occurs on the coast of British Columbia, Canada. The third in size is the "Rocky Mountain" anatum. This subspecies still breeds in the Rockies. Enderson (1965) found only 13 breeding pairs in 1974 where 47 had been formerly reported (1937-1959). This population is thought to be slightly migratory, only moving to nearby lowlands during winter. This was also the case for both the extinct "East Coast" anatum and for the subspecies pealei. The fourth and most distinct is the "Arctic" or tundrus subspecies (White, 1968). Tundrus is lighter colored, longer winged, generally smaller bodied, and highly migratory. On the Texas coast, tundrus can be seen as individuals move from the Arctic to South America in early winter. The passage of birds through the area is usually during the period 1-14 October (Enderson, 1965:338). Facts such as these have recently led authorities to categorize this "Arctic" population as a separate subspecies (White, 1968:183).

Life History

Nest sites of the peregrine are located on cliffs usually overlooking water or an open valley where shorebirds, seabirds, and terrestrial birds are vulnerable to aerial attack. Ratcliffe (1962: 22) has given the altitude of 170 inland eyries (nest sites) in Britain.

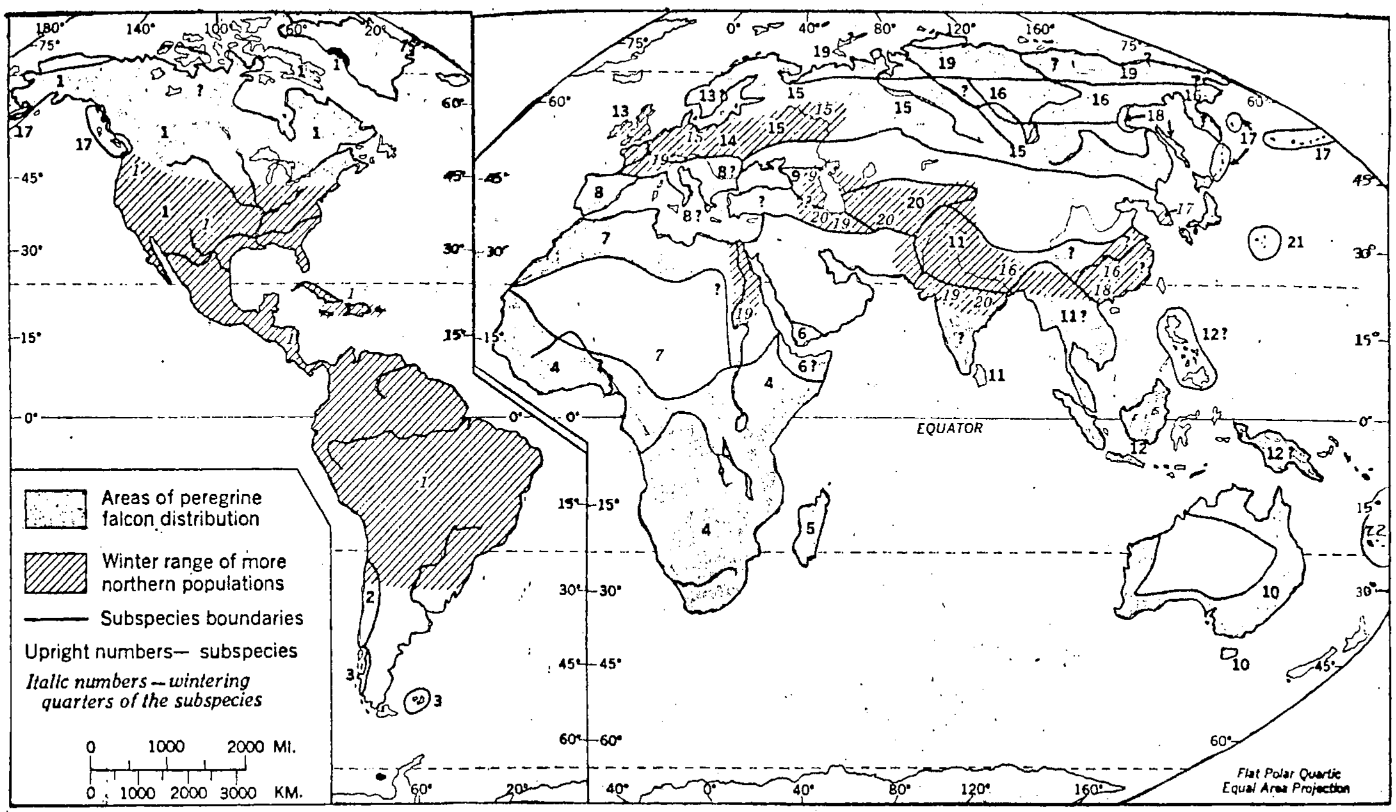

Figure 1. Distribution of the subspecies of Falco peregrinus according to Dementiev (1951). 1. anatum 2. cassini 3. kreyenbrogi 4. perconfusus 5. ranama 6. arabicus 7. pelegrenoides 8. brooki 9. causasicus 10. macropus 11. pergrinator 12. ernesti 13. peregrinus 14. germanicus 15. brevirostris 16. kleinschmidti 17. pealei 18. pleski 19. leucogenys 20. babylonicus 21. fruitii 22. nesiotes. This list remains in a state of flux, some taxonomists would limit it to 12 or 13 races. No. 3 has been proposed as a separate species, as has Nos. 7 and 20 (together). No. 1 is now known to winter as far south as central Argentina and to breed north to Thule. The exact distribution in the Southern Hemisphere remains to be worked out. UW Cartographic Lab (Hickey, 1969:6-7).

Greatest usage was at 1,250 to 1,500 feet (380-460 m), the maximum being 3,000 feet (914 m) due to climatic severity and the minimum elevation governed by accessibility and human interference. Cade (1960:160-161) found the highest Alaskan eyrie at 2,200 feet (671 m) and thought food supplies for the peregrine were ample there up to 3,000 feet (914 m). In western North America, Bond (1946) reported peregrines rarely nested above 5,000 feet (1,524 m) with a few exceptional pairs up to 10,000 feet (3,048 m).

The long-winged peregrine is specialized for one type of hunting. While some genera of raptorial birds soar or hover in the sky and others have evolved short wings and long tails for quick darting and short flights in wooded terrain, the peregrine depends upon direct pursuit in the open. Although its level speed surpasses that of nearly all species of birds, it is skillful (at least as an adult) in seeking the advantage of height from which to launch its attack. Uttendorfer (1952) summarized the literature on the prey known to have been taken by 221 breeding pairs mostly at or near German inland nest sites. Up to the end of 1949, the list had grown to 145 species. Among 6,410 prey occurrences, 2,039 involved common pigeons, 1,209 starlings, 484 lapwings, 298 skylarks, 181 chaffinches, and 170 jays. An unusual phenomenon was reported by Stager (1941) in which he watched several peregrines regularly take Mexican free-tailed bats (_Tadarida brasiliensis_) at the mouth of a cave in southcentral Texas. The peregrines would dive into the column of bats that were emerging from a cave at dusk and reappear from the opposite side of the column, usually carrying a bat.

The peregrine, to some extent, has followed the pigeon into all the great cities of the world, usually in the non-breeding season. During the present century, it has taken advantage of the larger public buildings and skyscrapers. They have been recorded wintering on the towers of the City Hall in Philadelphia (Culver, 1919), the Customs House in Boston (Forbush, 1927), and the Post Office in Washington (Bent, 1938).

Peregrines have eggs that can easily roll away on the hard surface of their cliff shelf nest sites. Consequently, peregrines scrape shallow hollows in soil, decomposed rock, gravel, and mats of vegetation, in which they lay their eggs. Bent (1938:50) describes clutch sizes ranging from one to six eggs with an average of three per nest site.

CHAPTER II

CHLORINATED HYDROCARBONS AND THE DECLINE

As a result of the decline in peregrine falcon populations, a symposium was held to discuss the problem. Joseph J. Jickey (1969) edited Peregrine Falcon Populations, in which he compiled the findings of the Symposium. Populations were declining around the world and the peregrine was not the only raptor with declining populations.

Pesticides were one of the factors that were looked at as a possible cause. At that time, chlorinated hydrocarbons were only suspected. Because of their characteristics and their spread throughout the wild environment, they were likely suspects. Studies were needed to determine if and how these pesticides were accumulating in the fatty tissues of the birds, but it was felt that there was more to the problem than just accumulation in the birds system.

Eldridge G. Hunt (1969) has summarized an evaluation of the pesticide-peregrine situation in California as follows:

> 1. We feel that pesticides are a potential threat to peregrine populations because of a source of pesticide contamination is present in the normal prey species of this falcon, e.g., ducks and shorebirds. However, there are not sufficient data available to determine how serious the threat might be or even how pesticides might be affecting falcons.
>
> 2. What we need now is information on the interrelationships of the peregrine with the various environments in which it lives. All the major factors believed responsible for the decline of the falcon should be evaluated. To give emphasis to evaluating the hazards of pesticides, ecosystems could be selected for study where comparisons of maximum and minimum exposures to pesticides could be made (Hunt, 1969:458-459).

Peakall (1970) stated that the decline in raptorial birds is traceable to a decline in reproduction. The failures have been found to follow similar patterns in the species that were declining. The pattern was delayed breeding or failure altogether, a remarkable thinning of the shells, much breakage of the eggs that were laid, eating of broken eggs by the parents, failure to produce more eggs after earlier clutches were lost, and high mortality among both the embryos and fledglings (Peakall, 1970:73). With this in mind, Peakall tried to discover what was causing the pattern.

Chlorinated hydrocarbons have some definite characteristics that were responsible for the suggestion that pesticides might be a factor in the decline. The characteristics were examined in the process of determining whether or not these pesticides were involved in the decline.

Laycock (1969:38) states that when DDT was introduced, it showed great promise as a pest control agent. It was deadly to many pests, easy to produce, and inexpensive. Gradually, it was noticed that some of the characteristics of DDT made its extensive use questionable. It did not stay where it was put. It flowed in streams and blew in the winds. Like dust, it was readily blown from one place to another. In the rain, it often fell far from where it was originally used.

The fact that it did not breakdown very quickly meant that it accumulated. Laycock reported a half-life estimated at 4 to 16 years. Fulkerson (1970) reported an estimated lifespan of somewhere between 10 and 20 years. All major river basins in the United States, according to the U. S. Public Health Service, are now contaminated with dieldren, endrin, and DDT and its derivatives (Laycock, 1969:38).

Woodwell (1967:30) states that nature has ways of concentrating substances. These chlorinated hydrocarbons and their derivatives are lipid soluble and tend to be stored in the fatty tissue with the highest accumulation of residues in the fat itself. The animals in natural food chains store these substances and the accumulation is increasingly concentrated toward the top of such ecosystems (Figure 2).

Buckley (1969:461) states that many scientists are of the opinion that these pesticides are biologically active materials that can be expected to have some effect on living organisms. Hunt (1969:458) reported that pesticides do not behave the same in different environments. Many times the same pesticide has had a different impact in one ecosystem than in another and may also have different effects on the same animal species when they are found in different habitats. Studies in California have demonstrated that a member of the DDT family applied to an aquatic environment showed up in food chains to a greater degree than a similar compound in an arid terrestrial system.

Woodwell (1967:29) explained several methods nature has of concentrating substances. Studies of radioactive materials have provided a great deal of basic information about pollutants in general, and more specifically, pesticides such as DDT.

Apparently in the middle latitudes, an exchange occurs between the air of the stratosphere and that of the troposphere. This showed that the middle latitudes seem to be where substances accumulate (Woodwell, 1967:24). The total amount of rainfall and amount of fallout were directly proportional. The concentration of pollen in precipitation follows the same pattern as radioactive fallout. These facts

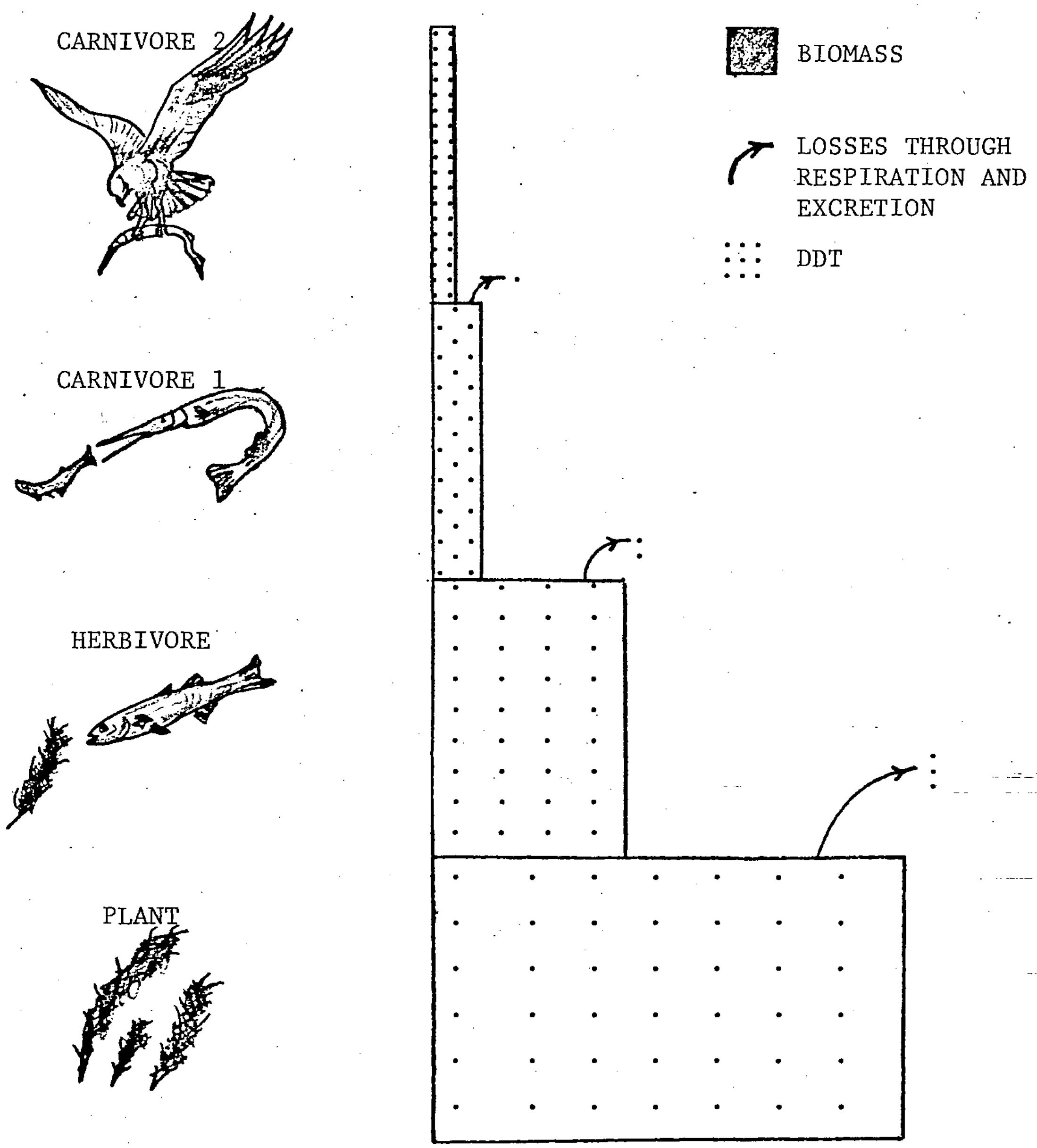

Figure 2. Concentration of DDT residues being passed along a simple food chain is indicated schematically in this diagram. As "biomass", or living material, is transferred from one link to another along such a chain, usually more than half of it is consumed in respiration or is excreted; the remainder forms new biomass. The losses of DDT residues along the chain, on the other hand, are small in proportion to the amount that is transferred from one link to the next (Woodwell, 1969:30).

are important because they indicate that pesticides, which are particles like pollen, probably follow the same pattern as fallout (Woodwell, 1967:26).

Pesticides are also concentrated through food chains. Woodwell illustrated an important factor.

> Of the energy a population of organisms receives as food, usually less than 50 percent goes into biomass; the rest being spent for respiration. This circumstance acts as a concentrating mechanism: a substance not involved in respiration and not excreted efficiently may be concentrated in the tissues two fold or more when passed from one population to another (Woodwell, 1967:28).

Plant and animal life constitute a chain that concentrates DDT in spectacular fashion (Figure 3). At the lowest level, plankton contained 0.04 ppm of DDT; minnows contained 1.0 ppm and a carnivorous schavenging bird (a ring-billed gull) contained about 75 ppm in its tissues (on a whole-body weight basis). Some of the carnivorous animals in this community had concentrated DDT by a factor of more than 1,000 over the organisms at the base of the ladder (Woodwell, 1967:26-27).

Woodwell (1967) found that the higher carnivores were in serious danger of damage from DDT concentration. The mere fact that conspicuous mortality is not observed is no assurance of safety. Reproduction may be disrupted by low concentrations (Woodwell, 1967:31). This would lead to an inconspicuous decline in the species and finally its disappearance. Carnivorous birds are particularly vulnerable. Since they are at the top of food chains, persistent pesticide residues have accumulated to high levels in their bodies.

Regions of population decline coincide with areas of pesticide concentration, especially the chlorinated hydrocarbons. Peregrines are extinct east of the Mississippi River where pesticides were first used

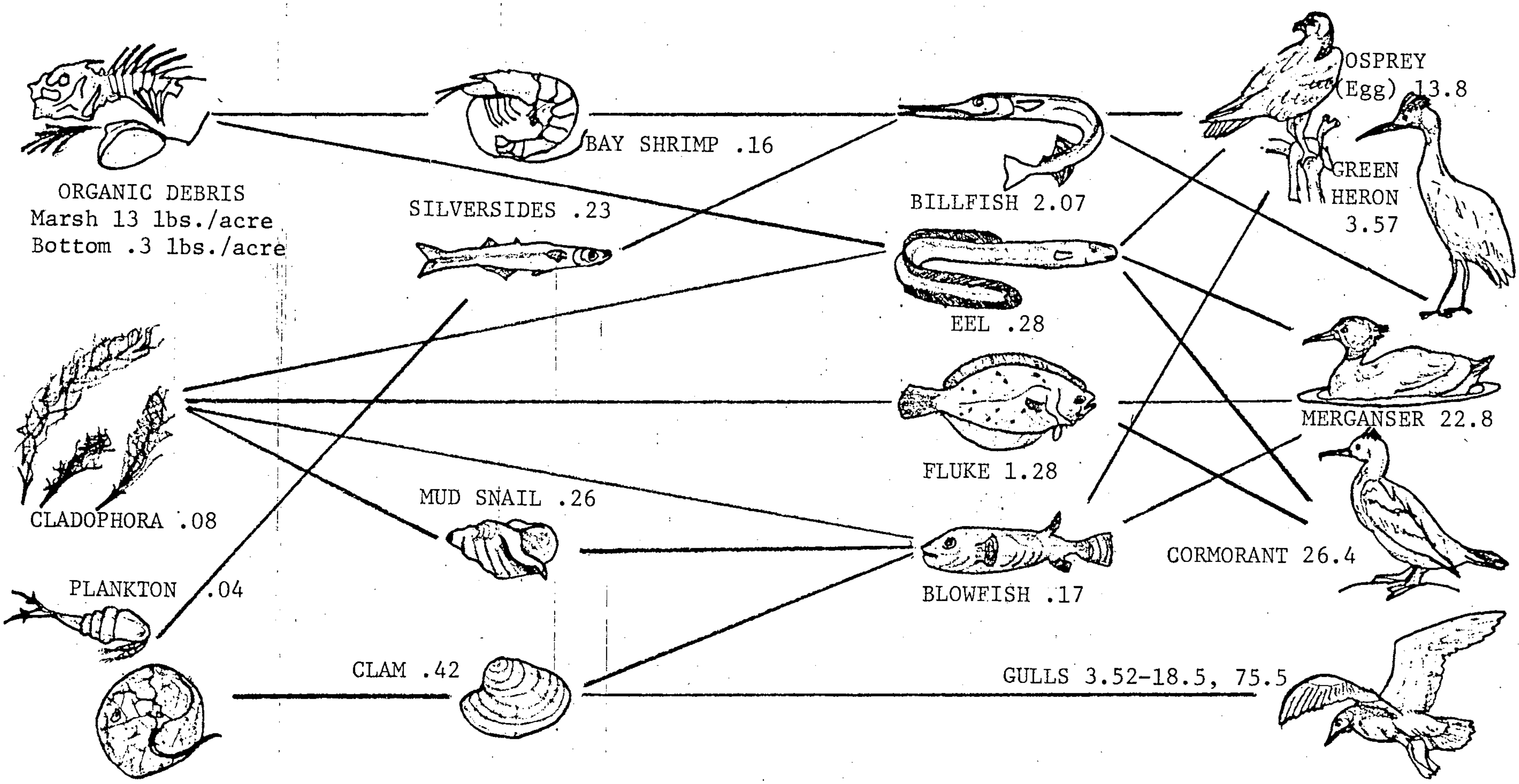

Figure 3. This food web showing some of the plants and animals in a Long Island estuary and along the nearby shore was developed by Dennis Puleston of the Brookhaven National Laboratory. Numbers indicate residues of DDT and its deriviatives (in parts per million, wet weight, whole-body basis) found in the course of a study made by G. M. Woodwell, C. F. Wurster, Jr., and P. A. Isaacon (Woodwell, 1967:25-26).

in the United States (Hickey, 1967:172). The losses in Europe are greatest in Western Europe where pesticides were first introduced. Because of the ability of these chlorinated hydrocarbons to move, even to isolated places where they were not sprayed, fairly high levels of the pesticides have been reported in the peregrines and a decline has begun.

Another possible concentrating factor is the tendency of raptors to select the weaker prey. Some of these weaker prey may well be already dying from pesticides. The Bald Eagle (Halineetus leucocepatus), for example, feeds mainly on dead fish. Eagles are in very great danger. If many of the fish have been killed by pesticides, this feeding habit of the eagle may have built up a concentration of pesticides at a greater pace than in birds with other feeding habits.

The transfer of osprey (Pandion haliaetus) eggs from a failing population to a successful one and vice versa illustrated the nature of the problem (Peakall, 1970:73). The eggs from the successful population were successful in nests of the unsuccessful population. The eggs from the unsuccessful population did no better in the successful population nests than they would have been expected to do in nests of the unsuccessful population. From this experiment, it was evident that the fate of the eggs was determined when they were laid.

Ratcliff (1958), of the British Nature Conservancy, discovered that eggshells of declining populations of peregrines had become thinner over a period between the late 1940's and the early 1960's. The thinner eggshell increased the fragility of the eggs and led to an increase in breakage. This caused reduced numbers of young. The latter discoveries influenced others to start experiments as to who, what, and how. DDT was suspected as a possible cause.

Peakall (1970:74) reports that a mixture of DDT and dieldrin in doses measured in a few parts per million resulted in thinner shells. J. Enderson and D. Berger (1968:151) established that the quantity of DDT in the eggs of prairie falcons in the deserts of the Southwestern United States was related to the mortality rate of embryos and the amount of shell thinning.

Field studies and laboratory experiments suggest that the thinning of eggshells does not increase in direct proportion to the DDE dose. In fact, small doses can produce dramatic effects. This indicates that even small amounts could be harmful to the raptors. Consequently, large concentrations of DDE would be serious because large enough concentrations could lead to total absence of the eggshell. Some food chains are shown in Figure 4.

At the University of Iowa College of Medicine (Peakall, 1970:75), it was accidentally found that chlordane induced rat liver cells to synthesize enzymes that speeded up the metabolism of hexobarbital. The enzymes brought about hydroxylation of the barbituate, thereby making it more soluble in water and hastening its excretion. These enzymes were also found to hydroxylate a wide variety of substances, including sex hormones.

Peakall (1970) and his colleagues at Cornell University explored the effects of chlorinated hydrocarbons on the sex cycles of birds.

> The cycle is initiated by a seasonal or climatic stimulus; the lengthening of daylight in spring in the northern Temerate Zone or rainfall in the arid and tropical regions. These signals cause an increase in

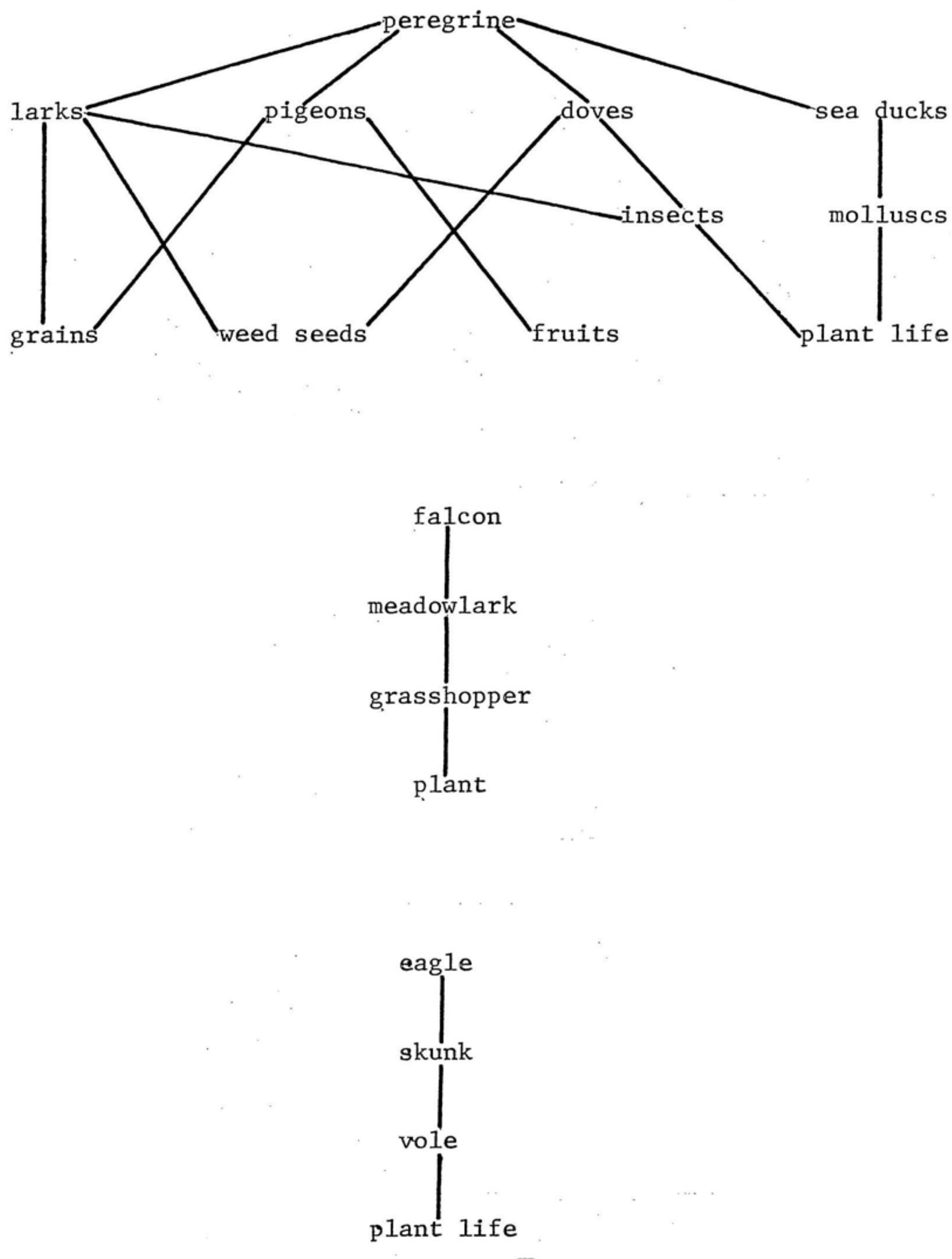

Figure 4. Some simple food chains

> the production of hormones in the nerve cells of the medial eminence of the bird's brain. The bloodstream carries these hormones to the anterior pituitary gland, which in turn dispatches hormones that stimulate the gonads to produce the sex hormones. The sex hormones not only generate physical changes in the reproductive organs and evoke breeding behavior, but also promote the storage of a supply of calcium for the eggs (Peakall, 1970:75).

The first aspect explored was how a pesticide may affect the calcium supply. The Asian pigeon was used for the experiment.

> The female forms the shell of the egg in the uterus within a period of 20 hours, and she needs 240 milligrams of calcium to produce a shell of normal thickness. About 60 percent of the demand is supplied by the bird's food intake; the rest is provided by a storage of calcium in the marrow of the bones. This calcium reserve is laid down in the bone cavities early in the breeding cycle, and the amount of the deposit is controlled by the levels of estrogen in the blood and tissues. Obviously, therefore, a deficiency of estrogen will reduce the bird's calcium reserve (Peakall, 1970:75-76).

This deficiency, however, is not enough to cause the thinning of the eggshell. There must be other causes also.

Birds, proven to have a natural capacity to reproduce, were fed a standard dose of DDT in their food and put in an 8-hour day simulation. Then they were put in a long-day condition with partners. Some birds were examined before they laid eggs, and others were examined immediately afterward. In both cases, the birds had an increase in enzyme activity in the liver. Low levels of estrogen were found in the birds that had not laid eggs and in both experimental and control birds after they had laid eggs. The estrogen level usually falls at egglaying. It was also found that less calcium was stored in bone marrow of the experimental birds than in the marrow of control birds that were not fed pesticides. The shells of the experimental bird's eggs were thin.

The experiments also showed that chlorinated hydrocarbons delay breeding. This was evidently a result of the depression of the estrogen level caused by the induction of liver enzymes by the pesticide. It was also discovered that dieldrin and polychlorinated biphenyls were more powerful in imbalancing enzymes than DDT.

Delayed breeding reduces chances for reproductive success. Most birds breed when food is abundant. This gives the young an optimal chance for survival. When breeding is delayed, the optimal period may be missed.

Pesticides, chlorinated hydrocarbons specifically, were suspected of causing a decline in populations of raptorial birds. Experiments have now proven that chlorinated hydrocarbons can cause delayed reproduction, thereby decreasing chances of successful reproduction. They can cause thin eggshells, which increases chances of egg breakage. This, and the fact that these birds are accumulating the substances, is enough evidence to prove that chlorinated hydrocarbons are a factor in the decline of peregrine falcons and other raptorial birds.

CHAPTER III

POSSIBLE STABILIZATION OF DECLINE

Ratcliffe (1969) has studied peregrines in Great Britain since 1930. From 1930 to 1939, a fairly stable population of 650 pairs of peregrines attempted to breed annually. Prior to 1950, there were only three significant peregrine population changes.

These were:

1. A post medieval decline affecting easily accessible eyries and complete in most regions by about 1860.
2. A slow decline in the western Highland of Scotland, beginning about 1890-1900, and terminating by 1950.
3. Extinction or serious decline over much of southern England, and a few other districts, due to wartime persecution, 1939-1945. Rapid recovery in numbers followed after 1954 (Ratcliffe, 1969:265).

After 1955, there was a wave-like decline that spread from far south to north. By 1962, the peregrine was almost extinct as a breeding species in southern England and Wales. Only a small number remained in northern England and southern Scotland. Since 1962, the population and its breeding success seems to have stabilized at this much reduced level.

Increased use of organochlorinated compounds showed close correlation both geographically and in time with the decline. From the years 1956-1967, the population has shown no indication of any further marked change in overall population status and distribution.

Enderson (1972) discussed his work with the "Rocky Mountain" *anatum* since his last published work (Enderson, 1965). He studied nesting peregrines using an electrically tripped 8mm time-lapse movie camera which takes one frame every 45 to 105 seconds. Information on frequency of visitation to eyries by adults during fledging, food habits, and other aspects of behavior can be extrapolated from the film. In one case, Enderson showed a film in which a prairie falcon (*Falco mexicanus*) set on it's eggs through a late spring snow storm and was completely covered up by snow. After it stopped snowing, the falcon broke through the snow, flew away, and returned to the eggs in just over one minute. Using nesting information, Enderson (unpublished data) suggests that the decline of the "Rocky Mountain" *anatum* has stabilized since 1965. The number of active nest sites has increased slightly during the period 1965-1972.

CHAPTER IV

MANAGEMENT PLAN

What to do?

The crux of the problem of preserving raptorial species lies not so much in restricting man's take from the wild population as it does in maintaining a suitable environment for the birds (Cade, 1971); one free of chemical pollutants and one with sufficient habitat to maintain intact the current breeding stocks.

With the continued use of chlorinated hydrocarbons and with increasing habitat destruction, further declines of most subspecies of peregrines will continue. How then can we prevent the extinction of these subspecies?

1. Give them absolute protection from all uses (research, falconry) to slow extinction (proposed by the Society for the Preservation of the Birds of Prey) (Brewer, 1973).

2. Search for a method to override the detrimental effects of pesticides.

3. Establish captive breeding stocks and release young into their natural range to augment reproduction.

It makes little sense to sit by and allow extinction. As a species is lost, the community diversity will decrease and thereby reduce the stability of the environment a little more. One way to avoid the detrimental effects of pesticides is to hold some of these falcons in captivity and feed them a pesticide free diet. However, if they are not allowed to fly, they will fall into poor physical condition, that if prolonged, can become irreversible. The cost of personnel to operate such a facility would be a further limiting factor on the number of individual birds that could be kept. The establishment of breeding stocks, utilizing small breeding chambers, is fairly economical, but loss of physical condition is still a problem. Peregrines do, however, produce fully healthy young that, if given proper exercise, can attain "natural" physical condition. How can all these problems be overcome?

Dr. Tom J. Cade, Research Director, Lab of Ornithology, Cornell University, New York, has reported what he sees as a sound management plan for the remaining peregrine populations (Cade, 1971). He suggests that some of the young be taken from the wild and be given to falconers who can (1) control the diet (kept free of pesticides), (2) fly the birds to maintain "natural" conditioning, (3) help them in developing their flying abilities, and (4) aid them in learning hunting methods. He cites the following simplified example:

> Given a population of 1000 fledged peregrines, falconers are permitted to trap 100. What will be the impact of a 10% take? If the natural mortality rate after fledging is 50% by the end of their first year, 1000 fledglings will yield 500 yearlings, when there has been no harvesting. With a 10% harvest and <u>no change in natural mortality rate</u>, 900 passagers will yield 450 yearlings. The 100 passagers taken by falconers are only equivalent to a loss of 50 yearlings birds from the wild population. If the natural mortality rate is density dependent (if death rate increases with increased density) it would only require a reduction in mortality rate of about 5% at a population level of 900 passagers to end up with the same 500 yearlings. We do not know whether mortality is density dependent in peregrine populations, but natural mortality factors are influenced by population density (Cade, 1971:56).

He continues to describe a situation where 19 downy young peregrines died because of lack of parental care and suggests that this problem was identified in time to save the young by removing them from the nest immediately. Present laws, however, would not allow these birds to be given to falconers. He suggests that if falconers were given these young that 80% could be saved and used in falconry. At the end of 2 years (breeding age), 40% would still be in captivity and could take care of themselves (with 2 years of hunting behind them). These would theoretically be free of DDT and DDE and could be released in early spring when they could mate and raise a healthy brood of young for at least the first year and probably a second.

The 2-year-old adults that show signs of courtship behavior in captivity could be retained (considering the environment was still polluted) and used in captive breeding projects. Some would breed, producing young that could be used for:

1. Falconry (recreation)
2. Captive breeding (perpetuation)
3. Reintroduction (into similar environments) where a former subspecies has become extinct
4. Release in the area of wild populations to augment natural reproduction

The effects of pesticides are thought to be irreversible over a short period of time. Recently, however, a herd of dairy cattle were contaminated by being fed on a diet of pesticide contaminated oats (Dirks, 1973). The pesticide was purged from the cattle's system in less than one month by feeding corn silage, phenobarbital, and an activated carbon called Darco (Atlas Chemicals, Inc., 1969). Dirks (1973) believes that this treatment may work with raptors, but it has not been tried. If, however, it did work, adult peregrine falcons could be captured and held in captivity for a very short time and their systems decontaminated. How long the treatment would last would determine what time of year the process would have to be carried out. By trapping, purging, and releasing adults on a large enough scale, an increase in reproductive rates, imbalanced by chlorinated hydrocarbons, might be accomplished.

CHAPTER V

REINTRODUCTION PLAN FOR EXTINCT POPULATIONS

When the Decline Ends

When the use of pesticides has stopped, it will take several years before these compounds are cycled out of the food chain. After this, an increase in the number of nesting peregrines of all subspecies that have survived is expected (Hickey, 1969:265).

If "normal" densities are again attained, the peregrines could be removed from the List of Endangered Fish and Wildlife of American (Schreiner, 1973). This possibility, however, seems at present a far and remote one.

Considering that "normal" population densities of _F. p. anatum_ and _F. p. tundrus_ peregrines are reached, then what about the extinct "East Coast" _anatum_? We cannot bring them back after their 1940's extinction from the northern Applachian Mountains (cliff nesters) nor from their 1930's extinction from the central Mississippi Valley (hollow tree nesters) and surely not from their 1920's extinction from south-eastern Kansas (tree nesters) where they were found along the Neosho River.

Dr. Tom Cade (Douglas, 1973) has recently established a breeding stock of peregrines at Cornell University and refined methods of captive propogation to the point that captive breeding is now an established practice rather than an occasional coincidence. Considering present rates of success, he predicts that 2000 captive-bred juveniles will be hatched in 1987 (Douglas, 1973:159). The present Cornell facility has a capacity of 38 pairs of breeders. This limit is expected to be reached this summer when a second record number of young are expected to be produced. Twenty-two eggs were produced by three pairs last year and 20 juveniles were successfully raised. In 1975, the first immatures are slated to be released back to the wild. These juveniles will be released into the wild in the area of their natural populations to augment natural reproduction. Many private individuals have also embarked on captive breeding programs. Some successful ones were carried out by H. Meng (1972), R. Nelson (1972), and J. Campbell and R. Nelson (1973).

Selection of a Suitable Subspecies

The prime prerequisites for reintroduction of extinct populations of peregrines now appears to be more an environment free of pesticides and with ample habitat (adequate nest sites and prey populations) than one of a source of the peregrines themselves.

The small variation among subspecies of peregrines is large enough to allow taxonomists to identify a minimum of 12 subspecies (Varuei, 1961). These variations are mainly in size and coloration of the birds and their habitat requirements. Similar habitats can be found between continents and even within continents where subspecies have been formed through evolution due to reproductive isolation. It seems logical that if the sub-species inhabitating one local environment becomes extinct, and the reason for extinction disappears, the release of a different sub-species from a similar environment would be successful in re-establishing nesting peregrine falcons.

Captive Breeding and Hacking

A plan for re-introduction would involve two major steps, captive breeding and hacking (returning the young to the wild). Captive breeding is no longer a large problem and the successful return of young raptors to the wild (hacking) is a long established practice among falconers (Wood and Fyfe, 1943). To be successful in re-introduction then the young would return and establish permanent breeding stocks. So what remains in the way of such a plan? Funding and the achievement of a pesticide free environment are the present blockades.

The East Coast

A test of the re-introduction plan would be to captive breed _F. p. pealei_ in large enough numbers to make a massive introduction by hacking the young into the former range of the "East Coast" _anatum_ (Figure 5). The big question is, can the subspecies of peregrines adapt to local conditions (climatic and southern temperate) and establish permanent nesting populations by the releasing of juveniles?

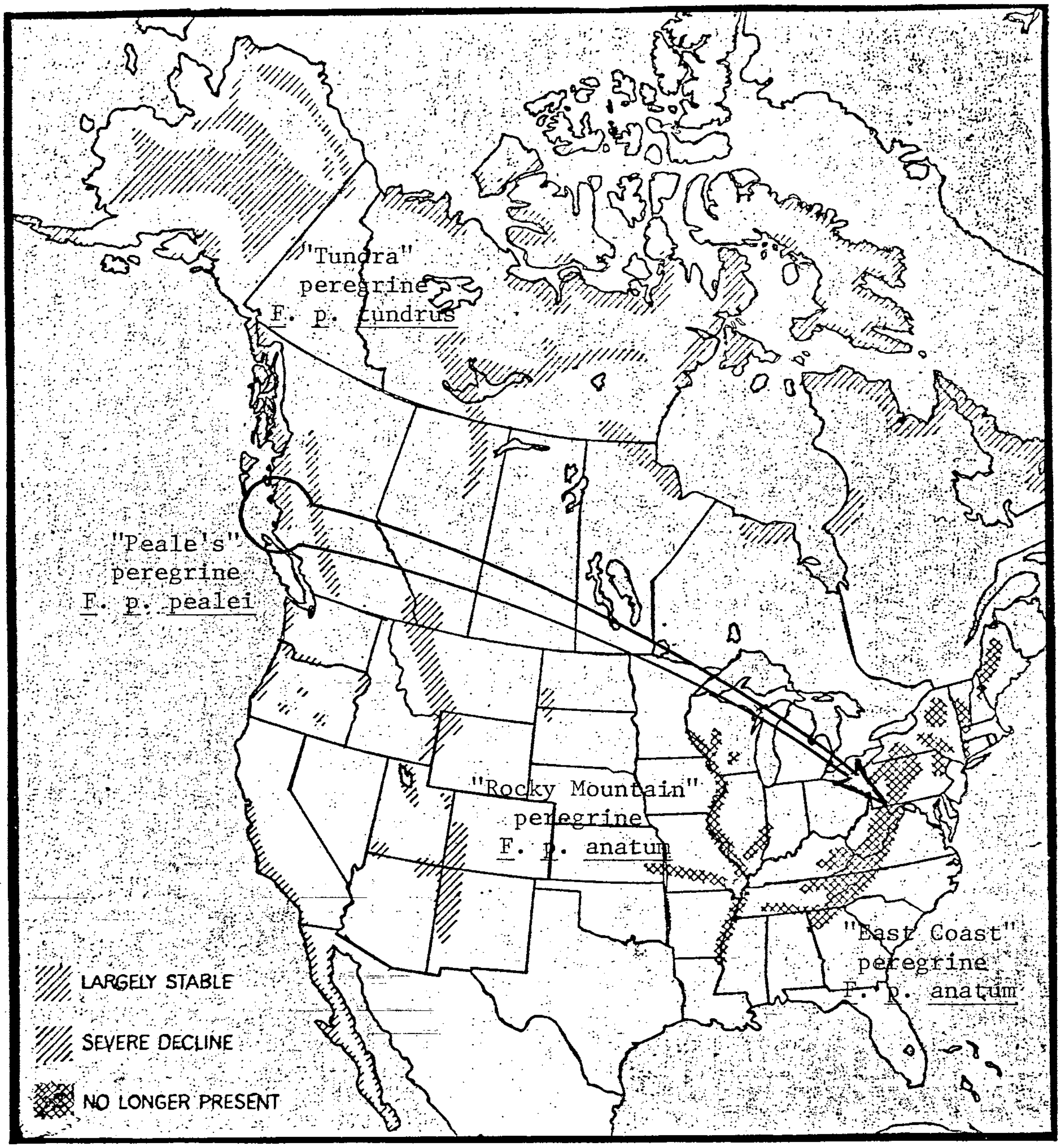

Figure 5. Nesting areas of the peregrine falcon in the Northern Hemisphere of the New World. Shades show the extent of interference with normal reproduction resulting from ingestion of pesticides by the falcons. The circle represents the Peal's peregrine (F. p. pealei) that may be transplanted into the "East Coast" peregrines (F. p. anatum) former range (Peakall, 1970:74).

CHAPTER VI

SUMMARY AND CONCLUSIONS

The peregrine falcon has experienced a world wide population crash during the years 1950 to 1965. The status of the present day populations is not widely agreed upon except that at least one and possibly two of the 12 sub-species is not extinct.

Chlorinated hydrocarbons have effected an imbalance of the sex hormone endocrine system of these birds. This imbalance has led to thin eggshells, reduced fertility, and generally low reproductive rates, that are less than mortality rates and a population crash was the result.

Management of the remaining peregrine populations can be in the form of absolute protection, purging adults body systems free of pesticides, holding juveniles in captivity until 2 years of age and then releasing them, and by establishing captive breeding stocks to produce young that would be released to the wild to augment natural reproductive rates.

Reestablishing wild peregrine populations by stocking alternative sub-species in areas where extinction has occurred may be possible if habitat remains after pesticides are eliminated from the ecosystem.

Will any of the ideas presented in this paper ever be used? Cade (1971) has presented his management plan to the Portland Wildlife Conference meeting on falconry (RRF News 5(2):83-87, 1971); the National

Audubon Society joined with the North American Falconers Association in support of regulations permitting the take of raptors from the wild; and the President of the United States signed a treaty with the President of Mexico protecting all migratory birds and game animals (50 Stat. 1311) (T. S. 912). This treaty gave migratory birds complete protection except as permitted by the Secretary of the Interior by appropriate regulation. This clause left falconry under the regulation of the federal government rather than the state government, as formerly deligated. Interim Falconry Regulations were published and they permit the take of all raptors except endangered species for research and falconry purposes. Endangered species will be allowed to be taken only by special permits issued by the Secretary of the Interior. It is expected that a program such as the one suggested by Cade (1971) will be implemented in the near future. As things appear now, we may be on the road to sound and progressive management of raptorial birds that was not even dreamed of as possible a few years ago and the peregrine may soon reap the benefits.

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