PREDATOR ECOLOGY AND MANAGEMENT;
Report on a Symposium
by Byron E. Harrell

As part of the 31st Annual Midwest Fish and Wildlife Conference, a symposium with the above title, sponsored by the North Central Section of the Wildlife Society, was held on Wednesday, December 10, 1969, from 8:45 a.m. to 5:00 p.m. at the St. Paul Hilton Hotel, St. Paul, Minnesota. The Chairman of the symposium was Albert W. Erickson of the Museum of Natural History, University of Minnesota. Session Chairmen and Discussion Leaders included Frederick W. Stuewer, Glen C. Sanderson, Charles Kirkpatrick, Melvin I. Dyer, Donald R. Progulske, L. David Mech, A. T. Cringan, and Forest Stearns. Dr. Erickson made some introductory and concluding remarks. The papers and transcripts of the questions and answers are scheduled to be published by the University of Minnesota Press.

History and Philosophy of the Predator in Wildlife Management. The first paper of this first session by Roger Latham (Pittsburgh Press) was *Historical Review of the Predator in Wildlife Management.* There were three eras in predator management: defensive era when predators were a danger, a protection era when livestock and game were protected from predators, and an ecological era beginning about 1930 and still developing toward understanding the role of predators; each of these, of course, overlapped with the others. He indicated that controls in relation to wildlife go back to the Middle Ages and recognized as landmarks the role of recognition of coccidiosis in control of Red Grouse cycles by Elton in 1933 and the outlawing of pole traps in Germany in 1933 as well as educational programs there in the value of predators and attempts to breed *Bubo bubo* to reintroduce it. The understanding of the Kaibab history was also important in understanding the role of predators. In the early 1900s in America programs of state and federal trappers and hunters of wolves, coyotes, and eagles were begun especially in the West, mostly in relation to livestock. In the 1920s to 40s attention was extended to predators that harass game. Most of these programs have declined. The bounty system in America developed in the early part of the century, peaked in the 30s and 40s, now considerably declined. The system has professional opponents because it is costly and ineffective, and also because it is non-selective especially as related to small predators. New environmental controls of predators include judicious planting (as multiflora rose for quail). Other controls such as "birth-control pills" remain to be developed. The big area is concerned with control of small predators which is still always temporary and needs much more study. In answer to a question Latham indicated the importance now of esthetic aspects in the preservation of large cats in Africa for example.

The second paper by David Pimentel (Cornell University) was *Mechanisms and Theory of Predation.* He noted that predators play an important role in our environment; nearly all animals feed on other organisms. Errington thought that predators live only on the surplus (primarily the weak, sick, or young). The biological control entomologists feel the effects are extremely important. Pimentel agrees with the surplus view but defines surplus as those individuals not needed for maintenance of populations, or perhaps better referred to as interest. In that terminology a predator cannot feed on capital and survive; this would also be true of parasites. The number of prey eaten increases in an S-shaped curve to a point of satiation. The number of a prey species tends to vary and on a graph forms a series of hills and valleys in time; the predator shows similar curves but displaced to the right (later in time) showing certain causal relations and implications on reproductive rates on predators. As an example of more general significance he presented a diagram indicating insect density and its "prey" vegetation. The vegetation has an influence on the insect population but the insect density also exerts pressures on plants which can bring about genetic changes; this example can be generalized to both predator and parasite situations. Such feedback situations tend to select for only operating on interest. In predator-prey interactions there are three kinds of effects: a) they can and do directly control prey populations; b) there are effects through indirect mechanisms; c) the predators effect little or no control. Examples of (a) include aphid lions and aphids (get outbreak of prey when predator eliminated as with pesticides), mongoose and Norway rat in West Indies (introduced in 1870s, lowered Norway rat populations, Mongoose turned to ground nesting wildlife, and a tree nesting rat increased), and the Mountain Lion-Mule Deer relation in the Kaibab. Examples of (b) are voles which are fed on by a variety of predators (this has led to territorialism which provides sufficient cover, thus population size, surplus is forced out especially vulnerable for predation) and Errington's Mink and Muskrats (when cover, food, or lodges in short supply some forced to margin with less cover, these fed on by predator; removal of predator will not increase prey population). Examples of (c) include Lynx-hare (numbers of hare not controlled; Lynx mirrors the hare population; see later Nellis and Keith paper), Mongoose-tree rat (not controlling), and Barn Swallow-insects (if up to 2 swallows per acre then 4000 insects per acre per day, cannot control 4-5 million insects per acre). In summary: predators feed on surplus prey; predators must not feed on capital, there is a delicate balance in supply and demand; in some cases there is control of prey species populations either direct or indirect; in some cases there is no control. Questions were asked if this not important factor as a cause of territory, some don't fit; may be other factors, probably this in Muskrats, area fruitful for research. On a question on feeding on capital he indicated that it may be temporary but only until a new population level is set.

Predator Biology. The second session was opened by a paper by Tom Nichols (U.S. Forest Service) and Dwain Warner (University of Minnesota) on *Intensity of Barred Owl Habitat Use as Determined by Radio-Telemetry.* Ten Barred Owls were automatically tracked for 1182 days and 28,000 locations were sampled from a total of 2 million. The 70 gram transmitters operated at a 3 mile maximum for 200 days with a continuous signal; the feather covering aided in the winter. The University of Minnesota Cedar Creek tracking station has two rotating antenna 1/2 mile apart; a computer map based on 1.6 acre squares was placed over a habitat map. Samplings every 30 minutes each day and 15 minutes in night of three home ranges were analyzed (he thought gaps unbiased). There were definite preferences of oak woods over mixed hardwoods over cedar swamp over oak savanna, etc. In the two most preferred habitats they were present on 18,629 times opposed to an expected 9,000. These areas were suitable: good for hunting by sight or sound, less brush, mice of different genera, dry leaves, homes for prey, hollow trees for owl nests, numerous perches. There were few observed fixes in open areas; they often moved back and forth between "islands." A July-September home range was 258 acres. There was a comment by a listener that the favored owl habitats were the least secure for Ruffed Grouse and that often young move to these less secure habitats and are lost. On a question on activity, birds were noted if they had moved in last 15 minutes but no details available. Yes was answer to question as to whether the owls could have been feeding over the open areas on the wing. There was a question on the bias of automatic tracking stations (Minnesota and Illinois) towards non-moving data (a tuning problem) and whether the gaps were at random. Most gaps were equipment failure, therefore no bias; fixes were at 45 second intervals, only perched bird data were used; therefore there was some bias.

The last paper of the second session was on *Pesticides and Raptor Populations in California* by Steven G. Herman (University of California, Davis) who gave the paper, Monte N. Kirven (San Diego Natural History Museum), and Robert Risebrough (University of California, Berkeley). Raptors are especially vulnerable to pesticides, they are at the top of the food chain, are long lived with low reproductive potential. Use of large amounts of persistent pesticides may lead in raptors to accumulations of large amounts, thus they may be good indicators. There are a variety of important chemicals: DDE (a metabolite of DDT; no evidence of further breakdown in biological systems), dieldrin, aldrin (convert as dieldrin), endrin (widely used but only occasionally in California), heptachlor (not used much; all of these are chlorinated hydrocarbons), polychloronated biphenyls (PCBs produced in manufacture of plastics, paints, and rubber), 1080 (affects Golden Eagles on a local basis), Mercury (as seed dressing, no data on California), lead (occasionally large amounts in waterfowl), organophosphates (no accumulation), toxophene, mesoxychlor, lindane.

One of the important effects is egg shell thinning which first showed up in the 1947-52 period and is demonstrated in Herring Gulls, Cormorants, White Pelicans, Peregrine Falcons, and Prairie Falcons and has been experimentally produced in American Kestrels and in Mallards; the effect is closely correlated with reduced reproductive success; there are several theories on its functioning. In 1964 12 million pounds of DDT were used in California as well as others; now the DDT is reduced but some will remain in the environment for decades. There are 17 hawks, 2 vultures and 11 species of owls in California as listed in a 1944 publication. Howard Leach in the California Department of Fish and Game has initiated efforts to evaluate population changes in raptors; there is also effort to get egg residue and shell thickness data. The Berkeley laboratory of the Institute of Marine Resources has been very important especially in the separation of PCBs for the last two years with the work of Risebrough. The White-tailed Kite which had become quite rare has in a number of places become quite abundant, often congregates in winter. There was no specific productivity data but young are common. Of 15 eggs none over 1.5 ppm wet weight even though in pesticide areas. Low level probably due to diet and short life of main prey, *Microtus californicus*. Goshawks from the higher mountains have never been common. There is no data on population changes, but some are known not to have produced young; sample residues are not yet complete. Endrid has been used on conifer seeds in this area. Cooper's Hawk populations vary; in some areas productivity is good. In San Diego some populations on city streets and college campuses. An immature from San Diego which was sick and died had 85 micrograms DDE and 2140 micrograms PCB which are high but may be partly due to emaciated condition. Three eggs from different clutches in 1969 there were two from remote coast with 20 ppm and 1 ppm DDE lipid base and from San Diego 449 ppm. Egg thicknesses of first two were .40 and .36 and the third .29. Sharp-shined Hawks are rarely in California and there is little data. The second most common hawk is the Red-tailed Hawk; breeding is up, but it needs more study. Residues of 15 eggs are consistent with geography and pesticide usages. There is little data on Red-shouldered Hawks. Swainson's Hawks are not common and residues are low; they probably are holding their own. Harris's Hawks are probably now gone. Golden Eagles are holding their own with a low population; one residue was 2 ppm wet weight. There is a possible 1080 problem. The principal decline is in Bald Eagle, Osprey, and Peregrine Falcon. Bald Eagles were formerly common along rivers, lakes, and coasts and on channel islands. They are now gone on the channel islands although shooting and interference may have contributed. Residues of two adults were 60 and 211 ppm wet weight and fat base. There is no recent egg shell data. The importance of marine pollution is shown by the Brown Pelicans from Anacapa Island where all of the thin eggs collapsed in 1969 and some residues were 2500 ppm lipid base. There is some productivity data at Eagle Lake and in Lassen County: 37 active nests, 21 successful with 40 young. The changes in Peregrine Falcon populations are very serious. Bond in 1940 indicated about 100 nesting pairs which was probably so up to 1945. The first thin shelled Peregrine eggs were reported in 1947 in California, Massachusetts, and Great Britain, but there was no perceptible decline until 1951. There was a 60-70% decline of population in 1950-55 period with decreased productivity. Now there are about 5 nests with young of which 3 died. Lipid base residues of an adult that died on the nest were 2600 ppm DDE, 1980 ppm PCB, and 700 ppm on developing eggs. In the California Valley some are seen which are thought not to be migrants, so there might be some to provide for increase if DDT is stopped. On questioning by J. Hickey on why he is optimistic, Herman noted the decrease in pesticide usage, but Hickey found no changes in gulls and alewives after decreases in usage. None of the other papers in this session were directly related to raptors: *Red Fox Spacing Mechanisms in Relation to Waterfowl Predation* (Al Sargent), *Dispersal and Mortality of Red Foxes in Iowa and Illinois* (R. L. Phillips, R. Andrews, G. L. Storm, and R. A. Bishop), and *Reproduction and Population Structure of Wolverines in Alaska* (R. A. Rausch and Art Pearson).

Since the author of one of the papers in the Predator Management session was absent, an additional paper in Predator Biology was added: *Prey Catching Behavior of the American Kestrel* by Rollin Sparrowe (Missouri Wildlife Research Unit). He described an experimental study to quantify ability to catch prey under differing circumstances. Involved are perceptual abilities and whether the raptor is opportunistic (Errington) or uses a search image (L. Tinbergen). He used 17 wild caught and 3 hand reared birds and 6000 capture observations. The birds were manned and weight controlled to keep in condition. Response to prey models under various conditions were taped from closed circuit TV, noting type of action and time. Differences in experience and between wild and hand-raised birds were noted.

Predator Prey Interactions. In this session three papers were on mammalian predators: *Lynx Population Responses to Prey Densities* by C. Nellis, S. Wetmore, and L. Kieth (University of Wisconsin), *Wolf Movements and Predation Impact on a Deer Population in Eastern Ontario* by G. Kolonowsky (Ontario Department of Lands and Forests), and *Ecology of Coyotes in Northern Utah and Southern Idaho* by Frank W. Clark and Frederick H. Wagner (Utah State University). L. Korschgen (Missouri Department of Conservation) gave the paper: *Avian Predator-Small Mammal Interrelationships in Missouri*. It is based on large pellet samples over a period of years of Great Horned Owls, Barred Owls, Screech Owls, Short-eared Owls, and Red-tailed Hawks. Cottontail Rabbits were utilized by Great Horned Owls 67.5% (varied 26-94%), higher when fewer small mammals. Usage was only poorly related to rabbit abundance. Cotton Rats were taken about 14% but varied from 0-52%; the species was unknown in Missouri before 1945 and had rapid build up and crashes at 8 year intervals. Each crash year there were severe winters, but in the Southeast crashes are related to epizootic diseases. Populations of Meadow Mice varied, peaking with Cotton Rats and utilized 7.6% (0-27%); cycles were not distinguishable and affected by droughts. Other mammals were utilized 5.6% and birds 4.9% (only 23 poultry and 2 pheasants, so only 0.1% game birds). Barred Owl utilization was as follows: Meadow Mice 20%, Cotton Rats 18% (absent 1953-55, 61, 64), White-footed Mice 14%, Cottontail 20%, birds 14% (max. 35%), other mammals 4%, crayfish 3%. Screech Owls fed mostly on mice and rats. Red-tailed Hawk utilization was: Meadow Mice 32% (max. 82%), Cotton Rats 27% (max. 65%), Cottontail 25%, squirrels 6.6%. In summary these raptors fed predominately on rabbits and small rodents; the feeding on rabbits was not especially affected by presence of other foods.

A fifth paper in this session was not on raptors but the methods and principles are applicable to birds of prey: *Estimating Predator Impact on Prey Populations as Illustrated by Woodpecker Predation on Engelman Spruce Beetles*, by J. R. Koplin (Humboldt State College, California). In food habits studies estimates of numbers of prey taken relatively little known. The effect of Northern Three-toed Woodpeckers, Hairy and Downy Woodpeckers on spruce beetles was approached by getting estimates of energy requirements and numbers and energy from spruce beetles in stomachs. He gave a series of formulae with the following abbreviations: P.P.--Predatory potential; G.E.--Gross energy required; P.E.--Energy content of beetle; T.R.--Turnover rate in stomach per day; Sc.--Stomach capacity; T.--temperature; C.R.--consumption rate; N.P.--Number of prey in stomach. The predatory potential is expressed by (1) P.P. = G.E./P.E. The average rate of turnover is expressed as (2) T.R. = G.E./(Sc.)(P.E.). The gross energy requirement is a linear function of temperature, (3) G.E. = aT + To, thus, (4) T.R. = aT + To/(Sc.)(P.E.) which can be further expanded. The consumption rate is expressed as (4) C.R. = (T.R.) (N.P.); the impact of consumption rate and predator density are fairly uniform. Estimates were also made of excrement energy and energy of physical action. Data were collected on the woodpeckers at three different periods at 10 hours photoperiod, on the energy in the larvae, and on the stomach capacity. On the basis of this data he was able to make certain calculations comparing them with the observed. The details did not survive into my notes, but the magnitude of the closeness of the similarities is impressive enough for us to await with interest the finished papers, in one case 125,000 calculated and 133,000 observed and in another 838,000 and 901,000. The application of energetics to other predators such as raptors is essential to the understanding the quantitative aspects of predation and these methods have great potential applicability.

Predator Management. The final section omitted the scheduled paper by Jack H. Berryman (Bureau of Sport Fisheries and Wildlife), *Predator Control: How, When, Where, Extent, and Cost?* There was also a mammal paper by Fred Knowlton (Bureau of Sport Fisheries and Wildlife), *Biological Facets of Coyote Control*. Of partial concern to raptors was the paper *The Current Status of Bounties* *and Their Influence on Predator Populations* by H. C. Laun (Stephens College). He began taking annual surveys 12 years ago gathering data from states (in some states, only record in counties as 100 counties in Illinois) and additional sampling of individuals. Bounties peaked at about $2 million in 1960, now politically less popular although there was a slight upsurge in 1967-69. In ten years there were 47% Coyotes, 39% Red Fox, 6-7% Wolves, 4% Bobcats, remainder 30 other species, so raptors if any are very minor. Most bounties are in the North Central States, and very little in the Southeast. Some political support is based on acceptance as a form of welfare. Over 90% of the funds is from general tax funds although there are additional hidden costs. Professionals surveyed were 100% against bounties. The reasons given for those that support the system were (1) increased game, (2) money rewards, and (3) tradition. Fraud is a problem especially next to states that do not pay. An interesting observation was that most claimants were 40 years old or more.

The final paper, *A Scientific Position on Predator Management*, by Robert McCabe (University of Wisconsin), Edward L. Kozicky (President, Wildlife Society, and Olin-Mathienson), and Robert Lennon (Bureau Sport Fisheries and Wildlife) was the present state of a report for a National Academy of Science subcommittee. The notes on this were very sketchy since there were available copies which however were in much shorter supply than the demand. The old aim of extinction has now waned. Some of the points he listed in a scientific approach were: (1) define the predator problem and the need; (2) identify completely with the problem; (3) identify other species and conditions; (4) know the predator life history; (5) consider direct and indirect control; (6) if there is a control decision, funding should be carefully planned; (7) the program should be well organized with adequate feedback; etc. An evaluation of past examples of predator controls on these criteria was given.

A summary of the whole symposium was made by Maurice Hornocker (Bureau of Sport Fisheries and Wildlife). In addition to brief statements on each paper he mentioned a number of areas where research still needed (e.g., biology and ecology, self-regulation, genetic differences, long range effects on both predator and prey, socio-economic aspects). He stressed the importance of species biology. He mentioned some history of predator management and mentioned the difficulty of change in practices. He also mentioned alternatives of reduction control such as avoidance or prevention, sports hunting, and no control. [It is hoped that the value of this summary to RRF members is greater than the violence done to the contributions of the participants. BEH].

At other sessions of the Midwest Fish and Wildlife Conference there were other papers on Red Fox and Wolves and one on raptors: *Post Fledging Activities of Great-Horned Owls as Determined by Telemetry* by Thomas C. Dunstan.