RESULTS OF A RING-NECKED PHEASANT LIBERATION ON ELIZA ISLAND, WASHINGTON

by

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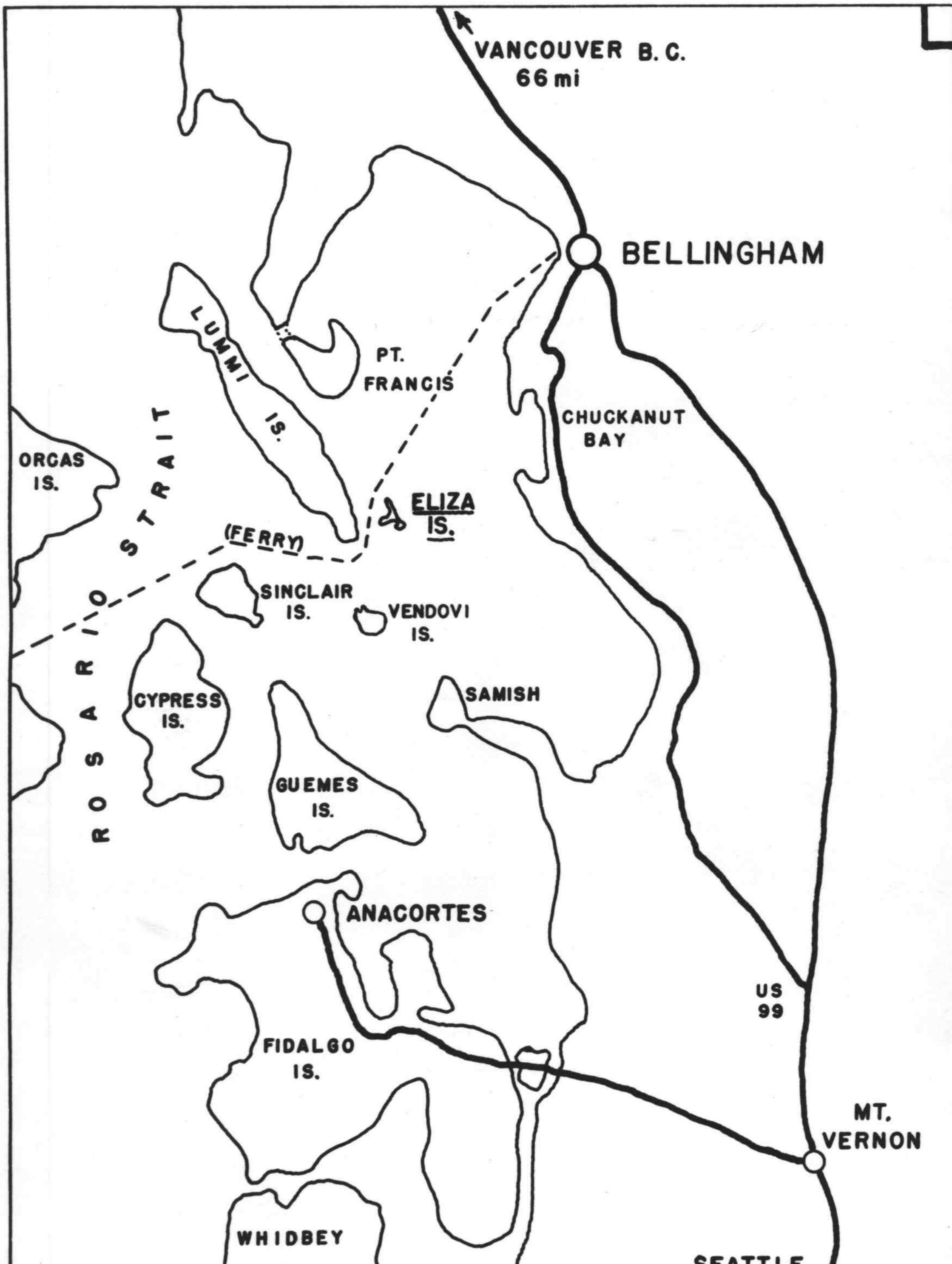

Figure 1. Sketch map showing regional location of Eliza Island.

RESULTS OF A RING-NECKED PHEASANT LIBERATION ON ELIZA ISLAND, WASHINGTON

INTRODUCTION

The material presented in this report was gathered between June, 1947 and March, 1948 in a study of a known population of liberated ring-necked pheasants on Eliza Island, Washington.* The primary purpose of the investigations was to determine the feasibility of liberating pheasant hens during the summer season immediately following the egg-laying period at the game farm. Eliza Island, in an accessible location at the entrance to Bellingham Bay (Figure 1), was chosen as the experimental area because it offered a variety of cover types representative of pheasant habitats in this region, and because its size and physical isolation made possible a controlled study without the restrictions of captivity. The project was financed by the Oregon Cooperative Wildlife Research Unit,** and was under the supervision of Mr. Arthur S. Einarsen, Biologist, United States Fish and Wildlife Service.

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* Oregon Cooperative Wildlife Research Unit and Washington State Game Commission cooperating.

** United States Fish and Wildlife Service, Wildlife Management Institute, Oregon State Game Commission, Oregon State College, Agricultural Experiment Station, and Agricultural Research Foundation, cooperating.

Under current practices in Oregon, year-old penned pheasant hens are specially fed at the game farm during their natural egg-laying period to produce large numbers of eggs for controlled hatching under domestic hens. In this program eggs are removed regularly and an individual pheasant averages 40 to 50, but may lay as many as 60 or 70 eggs between the last of March and the first of June. When this activity nears its completion, the question arises as to whether these same birds should be liberated immediately or held over at the farm until the following spring. The answer involves several broad considerations, such as: Would there be any nesting in the wild during the remainder of that season? If so, to what degree? Would reproduction be successful, and if so, what would be the net gain, if any?

In finding the answers to these questions, the controlled nature of the Eliza Island experiment has made possible the gathering of significant quantitative data which is the basis for this report, and in addition conditions were such as to encourage various other pertinent observations of the pheasant population, which will be discussed in general. Some indication of the value of a study such as this may be found in the statement of Kimball (1948) who, in discussing the recent widespread decline of pheasant populations, has said:

"The factors which apparently could have caused the low rate of increase are as follows:

1. Low productivity (a decrease in the number of fertile eggs laid)
2. Egg mortality
3. Juvenile mortality

"It is one or a combination of these factors which has caused a catastrophic decline in our pheasants; yet, paradoxically, these are the factors about which we know the least. If a small fraction of the millions of dollars lost because of the pheasant decline had been spent studying these factors our problems would be nearer solution."

THE AREA

HISTORY

Among the early visitors to Puget Sound were many Spanish explorers who have bequeathed their names to posterity in the labeling of numerous physical features of the region. Among them was one Lt. Francisco de Eliza, in whose honor a small island at the eastern edge of the San Juan group was later named. Through the years, however, this derivation of the name has been forgotten locally, and most residents of the area now assume that Eliza Island bears the name of another woman honored as many are in the naming of local fishing craft.

For many years, the owners of the island have been Pacific American Fisheries Incorporated, whose home office is in South Bellingham. Up until 1934, most of the salmon pack of Puget Sound was taken in large permanent fish traps at strategic locations through the islands, but in recent years these traps have been prohibited, and the fishing done with boats and gear of various types. During the heyday of the fish trap, however, "P.A.F." (as the company is known locally) found Eliza Island to be a valuable and strategic property in their operations and the island was intensively developed as a base for the construction and repair of fish traps, boats, and other gear. A large dock and marine ways were constructed; web houses, paint sheds, and other buildings were erected; and a large reduction plant was put into operation converting offal from the local canneries into commercial fertilizers. During this period, there were several hundred people living on the island in bunkhouses or family residences, but when fish traps were banned, the importance of the Eliza base faded and its population diminished. When a fire swept through the establishment in 1938, all activity ceased, and the resident population was reduced to a single watchman who stayed on until the island was again put to use as a bombing range for military aircraft during the recent war.

As shown in Figure 6, the several buildings are now reduced to a few charred foundations or still fewer standing remnants, and the ravages of winter storms have rendered the dock and ways almost useless. Other than by local campers and picnickers, there had been no further use or development after the war's end until the present series of wildlife experiments and demonstrations were undertaken by the Oregon Cooperative Wildlife Research Unit through lease of the island from the Pacific American Fisheries Corporation. A scow and tug made available by that company brought equipment and a landing party of the unit to the island on March 14, 1947, and research and development activities have been carried on constantly since that date.

At one time in its varied history, Eliza Island is said to have supported a poultry ranch, and during the period of intensive use by P.A.F., the residents are known to have kept various forms of poultry and livestock, including hogs and rabbits. Some of these latter animals escaped, and in a few years time the island supported a thriving population of domestic rabbits gone wild. The increasing numbers of these animals threatened to do real damage to the island's vegetation, and it finally became necessary to poison the entire area. The success of the operation is confirmed by the numerous rabbit skeletons to be found under every building and scattered here and there through the woods, and an interesting feature of the island's ecology, which may be traceable to some degree to this poisoning episode, is the apparent scarcity of rodents and other common mammals.

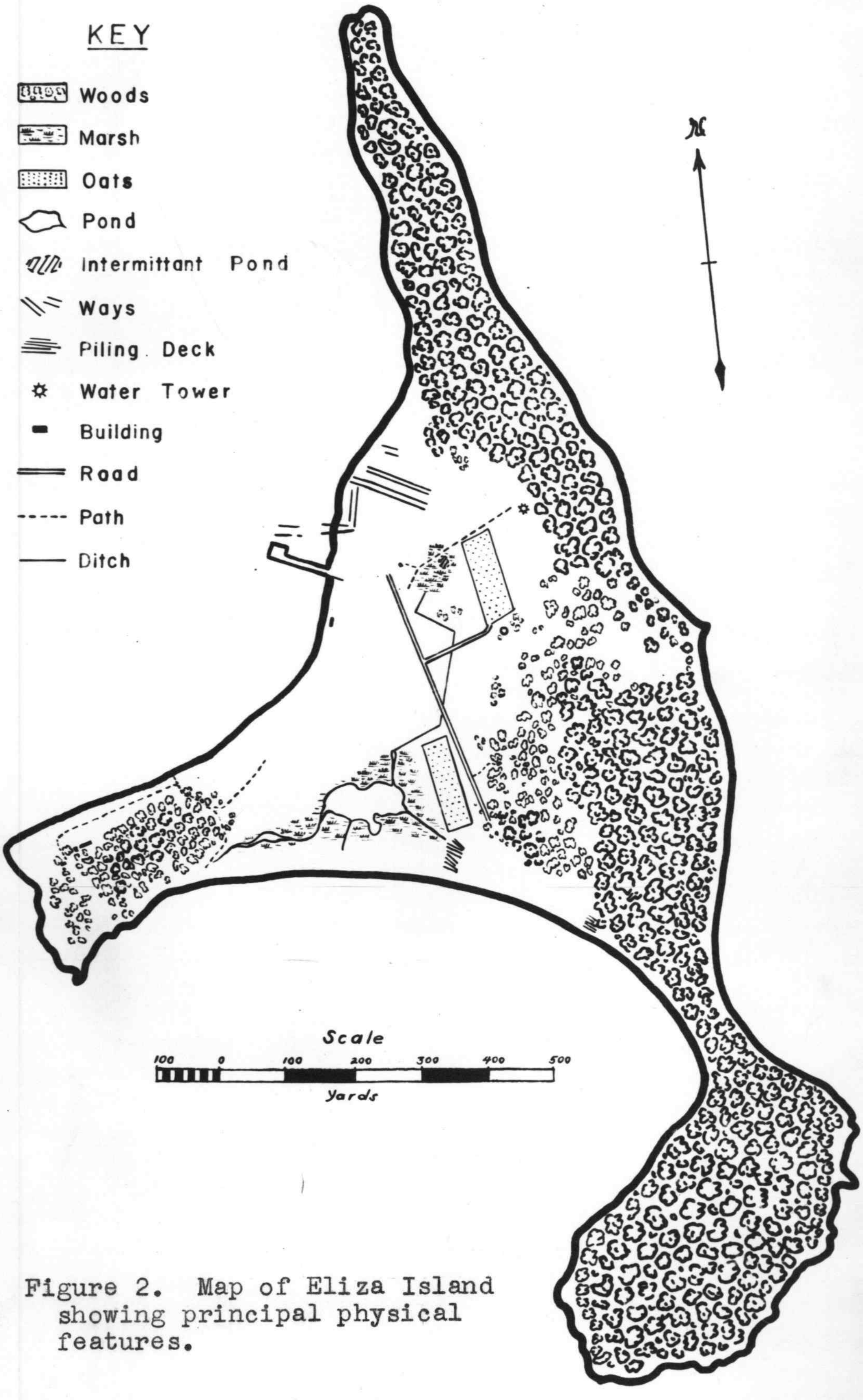

Figure 2. Map of Eliza Island showing principal physical features.

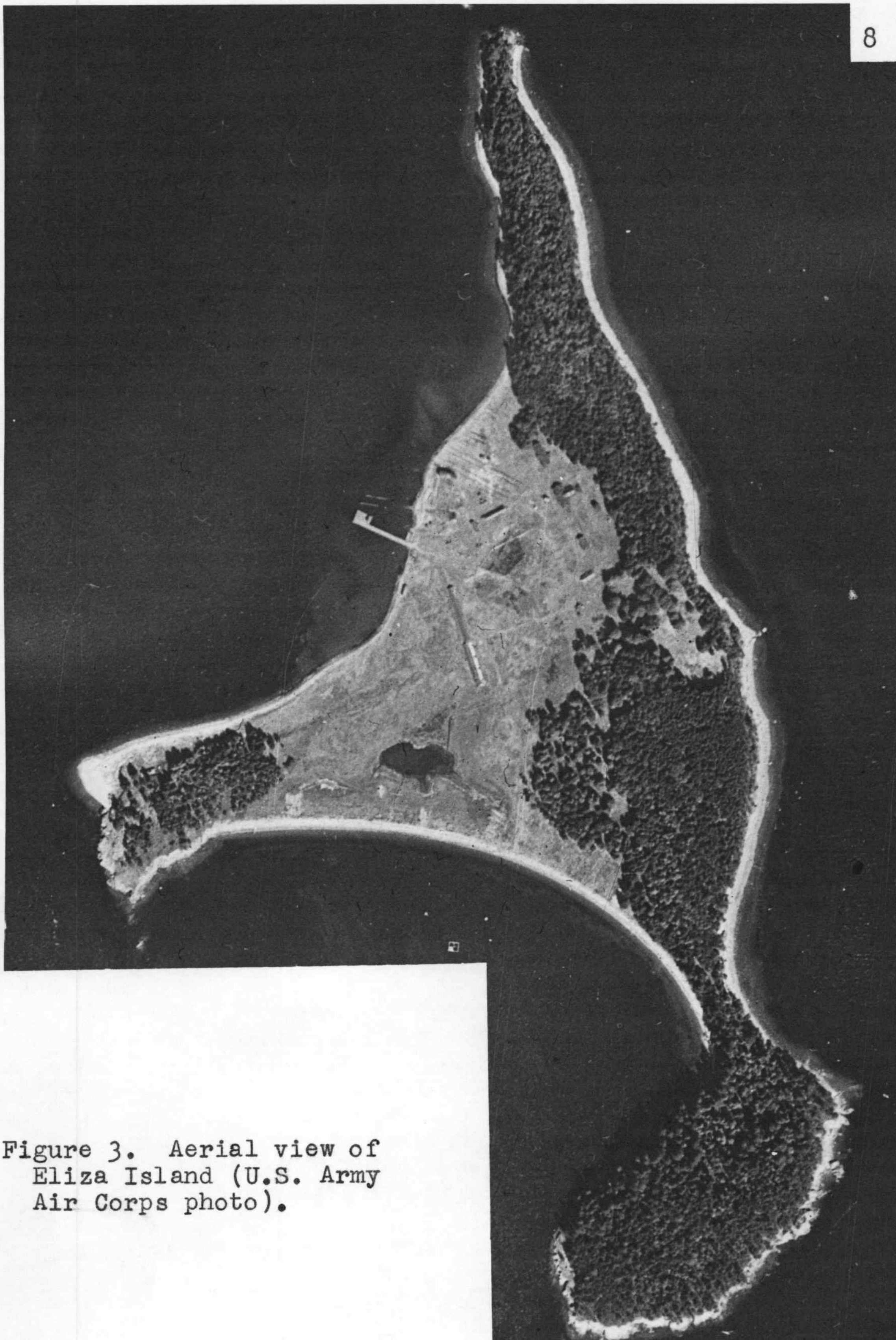

Figure 3. Aerial view of Eliza Island (U.S. Army Air Corps photo).

DESCRIPTION

PHYSICAL DESCRIPTION. Eliza Island is shaped very much like a distorted capital "T" with the vertical axis running east and west and the horizontal axis running north and south (Figures 2 and 3). The longest extremity is in the north-south direction where it measures a little over one mile. In the east-west direction the distance is a little over one half mile. Because of this distinctive shape, the various areas of the island readily fall into the designations of: "North Point," "South Point," "West Point," "Central Flat," etc., and these terms are used frequently in referring to general areas of the island.

The total map area of the island is approximately 158 acres, of which about two-thirds is wooded. Table 1 gives a detailed breakdown of the various cover types in acres. The broadest expanse of area occurs at the junction of the two axes, where merging shorelines have created about 60 acres of open flat with low beach lines and a soil composed largely of sea-deposited gravel, shells, etc. A brackish lagoon occupies the southern portion of the flat, and it is connected by a system of drainage ditches with a small fresh water swamp in the northern part. Toward the west, the flat narrows into an elevated, wooded point about 100 yards wide, and toward the east it lifts gradually to a fertile wooded ridge which runs the length of the island

TABLE 1

APPROXIMATE AREAS OF GROSS COVER TYPES ON ELIZA ISLAND*

Gross Cover Type	Acres	%
Swamp	0.5	0.3
Lagoon	1.5	0.9
Scattered, open canopy woods	16.0	10.1
Closed canopy woods	80.0	50.7
Open, unwooded	60.0	38.0
Totals	158.0	100.0

*Planimetered from aerial photo.

rising to a maximum height of 60 feet on the bulbous, hooked, south point. On the east side of the island and on the north and south points this ridge creates high steep banks with slopes that probably increase the actual land area to somewhat more than 158 acres. Toward the west, the nearest land is Lummi Island, about four-fifths of a mile away, and toward the east the mainland, in the vicinity of Chuckanut Bay, lies over three miles distant (Figure 1). It can readily be seen from Figure 4 that, shaped as it is, the island affords some safe shelter from any storm, and it is often used for this purpose by passing boats.

In transforming a deserted island into an active experiment station, it was necessary to create living facilities for the resident personnel, quarters for visitors, and storage space for boats and other equipment. The bulk of construction materials used in this work were salvaged on

Figure 4. Oblique view of Eliza Island from the Northwest.

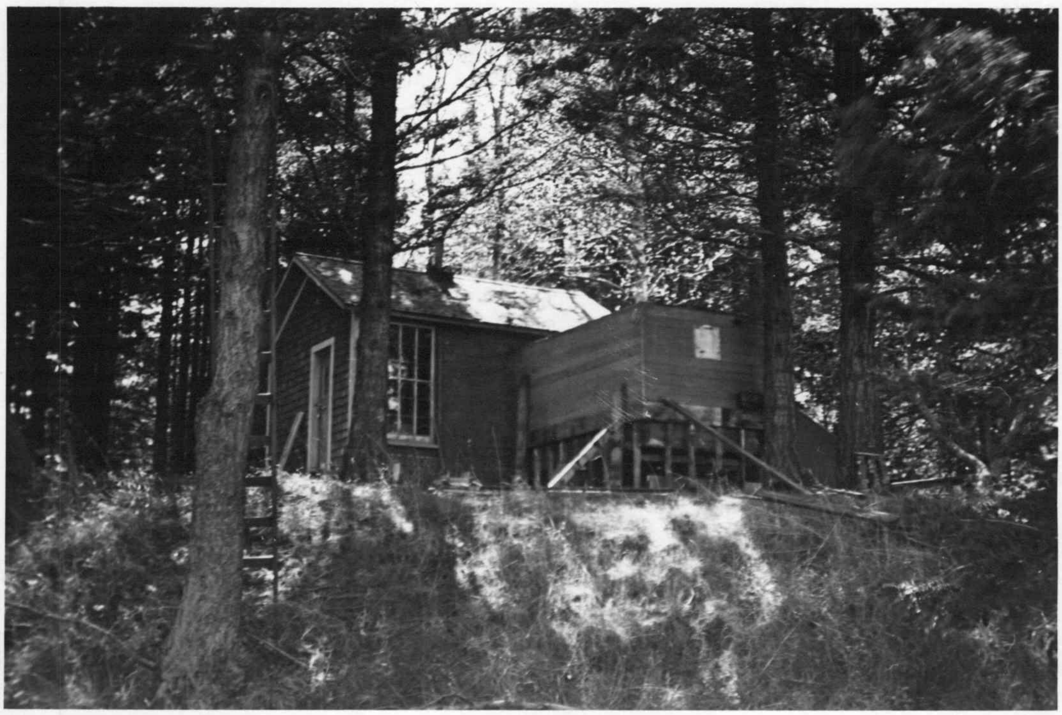

Figure 5. The main cabin under construction.

the island, and insofar as possible, standing structures were restored and altered to provide the desired facilities. In establishing the permanent quarters, it was fortunate that a suitable building was available in a very desirable location on the end of the ridge overlooking the central flat from the west. This was rebuilt, with an added room and other improvements (Figure 5), and in the months to follow proved to be of great strategic value in observing the activities of both pheasants in the flat area and visitors in the north and south bays. Throughout the report, this building will be referred to as "the main cabin," and the visitors' quarters located at the tip of the west point will be referred to as the "west cabin." The locations of other buildings and reference points are shown on the map, Figure 2.

CLIMATIC DESCRIPTION. Although Eliza Island is located in the coastal rain belt, it has surprisingly low annual precipitation. There are many occasions when rain clouds leave the island dry, passing over it to drop their contents on the mountainous mainland or on higher neighboring islands. Even during the rainy winter season it has been difficult to obtain enough water for household uses from eaves troughs installed on the buildings. Violent storms and weeks of foggy, overcast weather are common during the winter, but the spring and summer months bring long periods of sunny skies and fair weather. Although a complete annual record is not available, it is thought that rainfall at Eliza probably does not greatly exceed 20 inches per year. Figure 7 gives a record of gross daily weather conditions during the study.

The general climate of the Puget Sound region may be described as follows:* The rainiest month is likely to be December, and the driest, July. The average precipitation is 36 inches. Winter temperatures average 40 degrees with a daily average minimum of 35 degrees. Summers average 61 degrees with a daily average maximum of 74 degrees. Crop seasons average 207 days, with first frosts usually occurring in November, and the last frosts in March. Wind velocities have a yearly average on the coast of greater than twelve and one half miles per hour, with occasional seasonal bursts of hurricane intensity. Some of the San Juan islands in the "dry belt," which has only about 20 inches of rainfall annually, are so arid that a species of prickly cactus flourishes. However, most of the islands are heavily wooded, and a temperate climate, together with a favorable average rainfall, has encouraged cultivation of the larger bodies of land.

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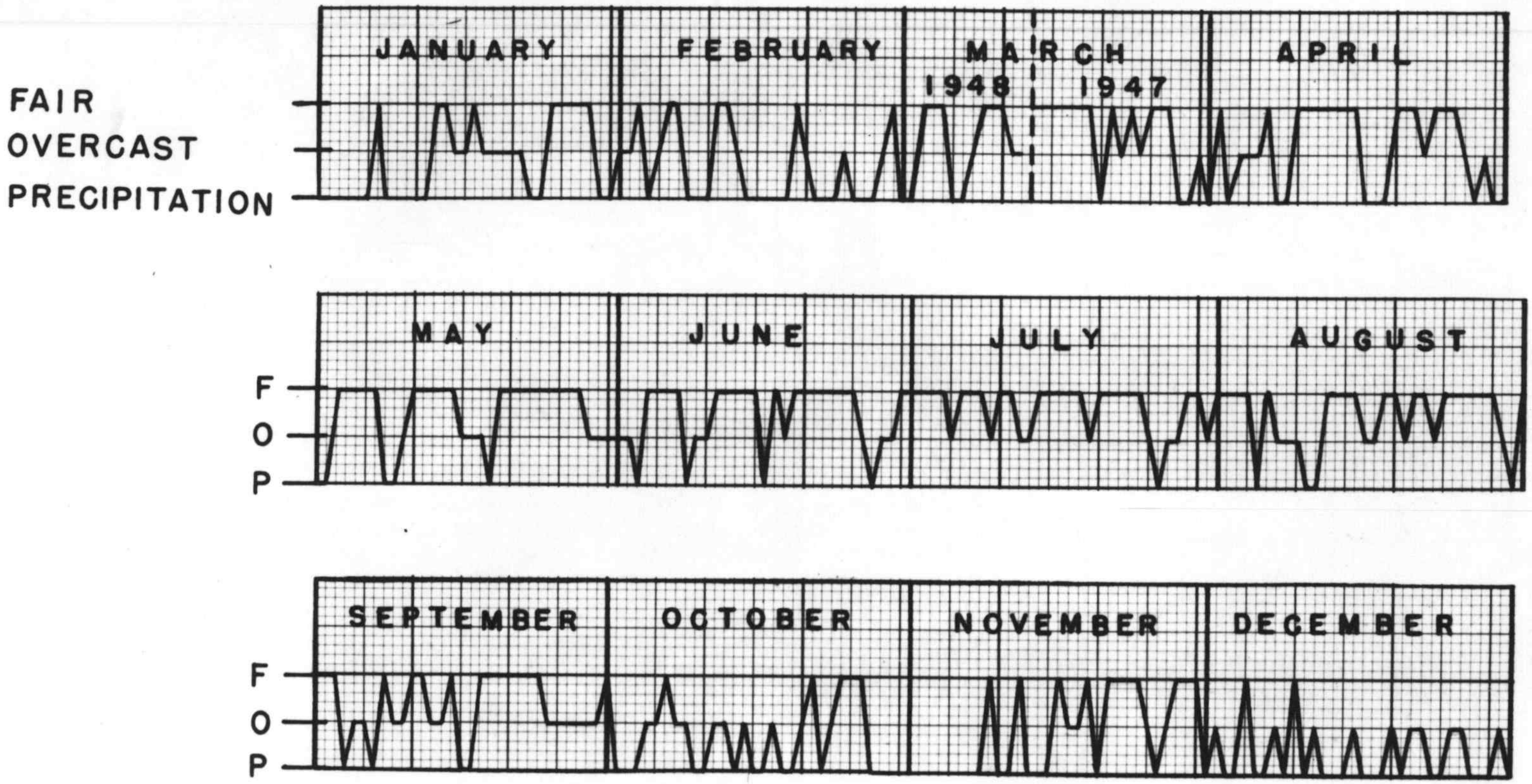
*From: Washington--A Guide to the Evergreen State, Compiled by workers of the Washington Writer's Project of the WPA, Binfords and Mort, Portland, Oregon, 1941, 687 pp.

Figure 6. Part of the panorama seen looking toward the west end of Eliza Island from the water tower.



ONE YEAR RECORD OF DAILY WEATHER CONDITIONS
AT ELIZA ISLAND, WASHINGTON
MARCH 13, 1947 TO MARCH 12, 1948

FIGURE 7

BIOLOGICAL DESCRIPTION. The dominant tree growth in the wooded portions of the island is Douglas fir,* with occasional groups of cedar, and scattered hemlock and yew. Most of the timber is second growth averaging less than one foot d.b.h., but the south point supports a remnant stand of virgin cedar and fir, much of which is over-mature and decaying. Several great dead snags rise over this point, and these, together with a few others scattered along the banks to the north point, provide favorite perches for hawks, eagles, and great blue herons. The wooded areas are generally without underbrush except along the margins where reproduction and shrubby growth are common. Most of the exposed banks are covered with a dense growth of salal, replaced in some sections by Oregon grape, giant vetch or stunted fir growth.

Big-leaf maple, the principal hardwood present, is found with red alder, serviceberry, snowberry, honey suckle, red-flowering currant, and other trees and shrubs on the west point and adjoining the central flat on the east. In the latter location, it is dominant approximately midway of the north-south ridge, creating about two acres of park-like area with scattered mature hardwoods and a ground cover of luxuriant grasses. Along the sea-side banks another common hardwood is the showy madrone.

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*Scientific names of plants mentioned are listed in Table 7.

The central flat itself is composed of a great variety of ground cover types, few of which have any substantial continuous area. The brackish lagoon is surrounded by a marshy area of varying wetness, the typical plants being: salt-grass, pigweed, wild barley, goose-grass, marsh pea, etc. Threading through the flat proper are many low, irregularly-shaped swales, also of varying wetness. The wetter swales are characterized by salt-grass, low sedges, rushes, etc.; while the dryer areas support a thick growth of aster, bent-grass, hair-grass, silver-weed, squirrel-tail barley, etc. The dry portions of the flat are of varying fertility. The area toward the east margin, about 16 acres sloping upward to the ridge, supports a luxuriant growth of rank orchard grass interspersed with bracken fern, clumps of evergreen and wild blackberry, Canadian thistle, etc., similar to that shown in Figure 8. The more central portions have a less luxuriant growth of grasses with many weeds such as plantain, yarrow, and sow-thistle interspersed (Figure 10). Here, however, is found a widespread and rank growth of alfalfa plants, some of which mature into sizeable bushes (Figure 9). In contrast, some of the surrounding gravelly areas are almost bare of vegetation, supporting only a few scattered specimens of fireweed, dock, and other wasteland types.

The dominant vegetation in the swamp area (Figure 12)

Figure 8. Thick growth of grass, weeds, and bushes regularly used as escape cover.

Figure 9. Typical rank growth of alfalfa and grass in center of flat.

Figure 10. View of flat from the West. Open area in foreground used regularly as crowing ground.

Figure 11. North oat patch in late summer.

is a very large sedge, with a few scattered cat-tails and an understory of spike-rush, water celery, and horse-tail in the dryer portions. Along the low beaches, the drift-wood is interspersed in many places with a luxuriant growth of purple beach pea which produces a large annual crop of seeds.

During the first 11 months of wildlife investigations at Eliza Island, the only resident mammals actually observed were bats, and although some of the pheasant kills exhibited the characteristics of a mammalian predator, it was not until March 11, 1948 that the presence of this mammal was finally confirmed with the discovery of a feral housecat living in one of the abandoned buildings. It is impossible to determine exactly how long this cat had been present, but in view of the animal's dainty habits and persistent secre-tiveness it is conceivable that it had been present and escaped detection during the entire period. Continued ob-servation and the extensive use of traps revealed no trace of the expected rodent population, however, and the general absence of avian predators prior to the arrival of the pheasants may have reflected this condition.

In the past, black-tailed deer are said to have been irregular visitors to the island after swimming the channel from neighboring Lummi Island where a sizeable herd is often persecuted by hunters and poachers. Several tame deer lived

Figure 12. Fresh water swamp. During dry season, wet area in center was covered with tracks of pheasants after water.

Figure 13. Remnants of web house where melting tar trapped five pheasant chicks.

on the island while the P.A.F. establishment was in operation, but these were trapped and removed by the Washington State Game Commission before bombing practice was begun during the war. Another interesting visitor that arrived via this water route was a solitary river otter that appeared on the beach in the south bay one evening in March. It was quietly observed for some time as it consumed a freshly-caught flounder and then leisurely swam across the bay toward the south point. When next seen, the circumstances were less pleasant. It had met a violent death from some undetermined cause and the remains were discovered washed up at the high tide mark on the south point.

The earlier rumored existence of a racoon was confirmed with the discovery of a skull and skeletal remains of this animal under one of the buildings, but the only other trace of animal life observed was the bleached skull of a mole, Scapanus townsendi, discovered on top of the duff in the wooded area, and this may have been deposited in the pellet of some visiting predator.

The island supports a normal population of passerine birds characteristic of the region, and in addition, the surrounding waters play host to various species of resident and migrating waterfowl. During the early spring months especially, all of the bays are alive with surf scoters in their courtship activities. At least one pair of mallards raised a brood on the lagoon, and as the season advanced, other mallards, and large groups of juvenile and adult great blue herons became regular visitors to that area. Shorebirds of various species, murrelets, guillemots, gulls and cormorants, etc.; all are to be seen by the interested observer at Eliza.

Among the larger birds frequenting the island are the bald eagle already mentioned, an occasional turkey vulture, kingfishers, nighthawks, crows, a pileated woodpecker, and at least two pairs of nesting bandtail pigeons. These latter interesting birds were joined by others of their kind in migration in the early fall.

As mentioned earlier, the common raptors were not in evidence during the first few months of occupation. The first hawk observed was an immature marsh hawk seen on July 7th. It is interesting to note that this bird, through its characteristic appearance and flight route, was identified at various times over neighboring terrain in such a manner as to indicate that it was pursuing a well-defined hunting route about eight miles in diameter which included Eliza Island at regular intervals. Later in the summer, sparrow hawks were seen regularly. Two red-tailed hawks were observed for the first time on August 17th, and on August 22nd, two Cooper's hawks were added to the list of predators. Both of these species continued to be present and active for the rest of the season, and later in the year, the sharp-shined hawk also appeared. Although definite evidence of the great horned owl was not obtained until late summer, it is thought that it was probably present during the entire season. The condition of certain early pheasant kills, and the characteristic activities of crows at various times pointed to this conclusion.

Among the lower vertebrates, casual observation revealed an abundance of the common garter snake, Thamnophis ordinoides; the presence of Hylidae, "Peepers;" a toad, Bufo boreas; and a stickleback, in the lagoon.

Figure 14. Discharging pheasant crates on the float at Eliza Island.

PROCEDURE

THE RELEASE

The pheasants used in the experiment were secured from the State Game Farm at Corvallis, Oregon. They were of the _Phasianus colchicus torquatus_ strain (Gabrielson and Jewett, 1940), and were typical birds that had been producing eggs during the preceding two months. They would ordinarily have been liberated at about this same time. One hundred year-old hens, and ten year-old cocks were leg-banded and loaded into crates on the afternoon of June 3, 1947. The long trip to Bellingham was completed during the hours of darkness with a minimum of disturbance for the birds, and the crates were loaded aboard the mail boat, "Osage," early in the morning of June 4th. After an hour's trip across the bay, the crates were again unloaded on the float at Eliza Island (Figure 14) where they were quickly carried ashore and located in previously prepared liberated positions as shown in Figures 15 and 16.

In order to encourage an undisturbed dispersal of the birds, the crates were placed at some distance from each other, in a line against a bank below the main cabin. Each crate was adjacent to suitable cover to furnish shelter, and water was provided outside each crate to supply any immediate need. At 10:00 a.m. the doors were opened gradually and

Figure 15. Pheasant crates in liberating positions below main cabin.

Figure 16. Close-up of crate.

the birds were left unmolested to depart at their leisure.

For some time, there were no attempts to escape made, but after about 15 minutes of suspense, the plan for a quiet dispersal was quickly forgotten. At the sound of the first enterprising bird's departing flight, a great many of the others became either alarmed or impatient and the air was filled with an outburst of flying birds. The remainder soon had their freedom and by 10:30 a.m. the last bird had left the area. This abrupt reaction by the entire group of birds is quite possibly a very characteristic behavior pattern induced by a sympathetic nervous response to the first bird's flight. Similar behavior may be readily observed in groups of domestic poultry, and has often been noted with other pheasants in similar circumstances.

During the liberation two hens inadvertently flew out over the north bay, but almost immediately both of them glided down to the water's surface without further attempt at flight. In the water, they floated bouyantly until rescued by a boat held in readiness for just such an eventuality. A third hen also landed in the water but immediately swam the short distance to some projecting rocks and quickly ran up the beach none the worse for her experience. All of the birds took full advantage of the available cover, and observers coursing the island later in the day found them well distributed and already extremely difficult to see in spite of their short experience in the wild.

THE STUDY

Throughout the study, natural conditions of habitat and environment were maintained as nearly as possible. There were no attempts made to control or discourage predators, and the activities of human residents were so managed as to have no greater effect than that to be found in typical pheasant range elsewhere. The only large scale manipulation of cover occurred in the spring planting of two fields of oats and vetch, which provided a closer approximation of agricultural habitat and at the same time furnished a source of winter food for later experiments.

After the study was well under way, several food and water stations were established temporarily to sample the pheasants' need for these items, but the small scale of the sampling did not alter the general environment. In determining usage at these stations, a four or five foot circle of earth was bared, with the food or water placed in the center. Fine dust scattered over the exposed earth clearly revealed the tracks of any birds approaching, and periodic checks gave a good indication of the degree of usage. Soft mud placed around natural watering areas were also used to obtain the same type of information, and the mud of the swamp, drainage ditches, and lagoon, gave a consistent record of the birds' movements in those areas.

In making general day to day observations, several methods were used. Constant and systematic foot coverage of all parts of the area produced factual information of nests, predator kills, etc., tending to be proportionate to the numbers of hours spent in the search. This was not always the case, however, for on many days, a casual walk would result in the discovery of several nests or other vital data. Additional interesting observations were also made from certain vantage points overlooking the central flat. One of these was the remains of a large water tower in an ideal location on the hillside near the margin of woods at the east edge of the open flat. Figure 6 shows a portion of the panoramic view as seen from this tower looking west. Another was the tall frame of the marine ways in the northeast corner of the flat, and a third and very strategic one was the cabin itself from which many observations of crowing, feeding, brood behavior, etc. were made. In all cases, a pair of Navy 7 x 50 binoculars proved to be almost indispensable.

During the later stages of the experiment, bird dogs were occasionally used to assist in the foot coverage of the area. These presented a certain problem of control, but they demonstrated their value time and time again in indicating the presence and activities of birds that an observer alone could not hope to be aware of. One of the dogs even proved to be adept at discovering predator kills, and although the stubbornness of this particular animal often caused tempers to flare, all would be quickly forgiven when it casually indicated the presence of some long-hidden remains.

Twice during the study, when several people were present on the island, drive censuses were attempted. The shape of the island itself is conducive to this technique, but although noise-makers were used and the area covered systematically, neither drive was very successful. This was chiefly due to the small number of people involved and the exceptionally heavy ground cover from which the birds could not be readily driven. Here again, the dogs proved to be of much value and were far more efficient than the men with noise-makers.

The one inescapable conclusion that became increasingly obvious as the study progressed, was that a single observer is capable of discovering all the facts only on a tract of extremely small size. Eliza Island's 158 acres seemed negligible compared to the size of many areas that have been reported upon at great length in detailed publications, but it quickly became apparent that even in that restricted area, under constant observation, the known facts would be only a small proportion of the entire biological picture. For this reason it should be further emphasized that this study was concerned with the measurable reactions of a known segment of pheasant population, and the deductions therefrom, rather than the broad considerations of pheasant behavior in general.

THE HARVEST

The greatest value of the Eliza Island study lies in the accurate numerical basis of the results. To achieve this accuracy, it was necessary to determine exactly the number of birds remaining at the close of the experiment, just as the exact number at the start was determined by a controlled release. The only sure way of doing this was to remove all the remaining birds in some manner.

As a conservation measure and an experiment, an attempt to accomplish this through live-trapping was made. Previous experiences with trapping in this mild climate had been only partially successful due to the pheasants' lack of interest in baits, but this further attempt was planned to learn more of the possibilities as an aid in research. A trap of seine netting was erected in a suitable area on October 16th, then left open and heavily baited for a week. Trapping operations were then begun and continued for a period of two weeks during which time 19 birds were taken. Some of these escaped from the holding pens, and others died of injuries, so that the final total of birds retained was nine. One unusual case of trapping mortality occurred when a coopers hawk entered the trap and killed an adult hen that was within. The hawk was extremely frustrated when it discovered that it too was trapped, and was quite indignant when finally released.

After the attempt at live-trapping had been carried on for two weeks, it became evident that this method of removal would never be successful to the extent required, and plans were made to harvest the remaining birds through a controlled hunt. On November 8th, this hunt took place with conservation officials from the states of Oregon and Washington, and leaders of local sportsmen's groups taking part. Complete data were gathered concerning the activities of each shooter, and when compiled and interpreted should yield some valuable facts in regard to efficient harvest procedures, crippling losses, the size of shot to use in preventing pheasant waste and many other undetermined facts.

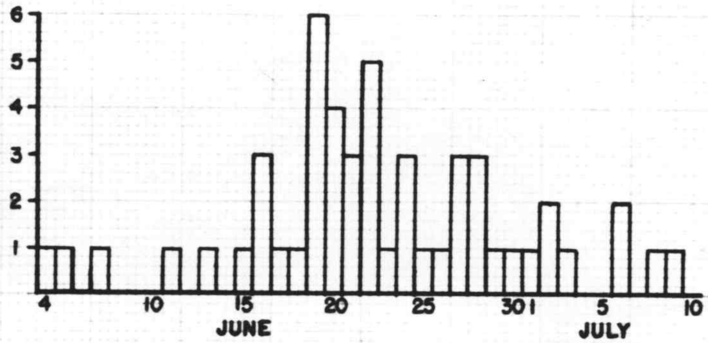
The controlled hunt lasted most of one day, but the seven shooters were able to collect only 18 birds. Three dogs were in use, and the island was hunted systematically by three different groups of shooters simultaneously, but the pheasants ably demonstrated their power of survival by becoming extremely elusive even in this first exposure to hunting. During the days that followed, the two resident biologists, with the help of one dog, hunted almost continuously. However, it was not until December 5th, almost a month later, that they were able to reduce the surviving population to one bird. This bird, an adult hen, had been very successful in avoiding the hunters day after day, and it was a fitting climax that this last survivor was finally killed on December 13th, by an avian predator, in a significant demonstration of nature's ultimate efficiency.

RESULTS

GENERAL OBSERVATIONS

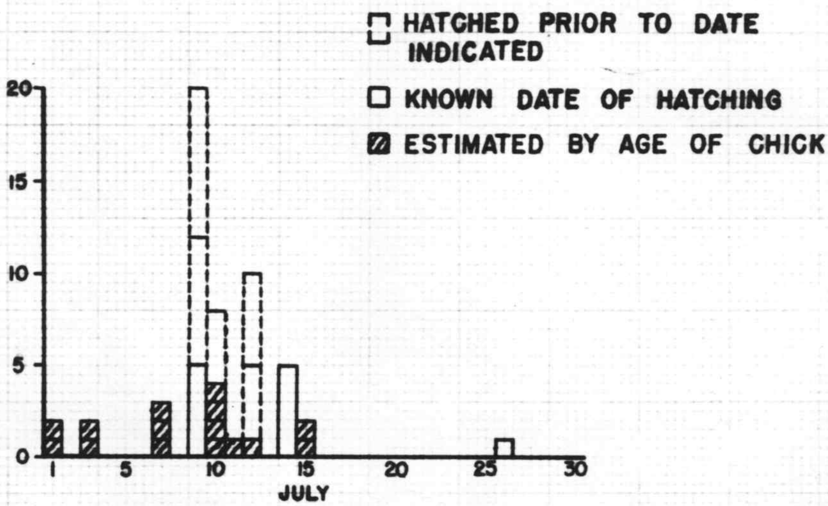
CROWING. At the time of the liberation, the question of how soon and how well the pheasants would adapt themselves to life in the wild was raised. The answer came before seven hours had elapsed, with the lusty crowing of a cock in the late afternoon sunshine, on the flat. This marked the beginning of crowing activities that continued sporadically from June 4th until June 16th, when they showed an abrupt increase. The peak, as indicated by the record of crowings heard, came on June 19th, and activity thereafter tapered gradually to an end on July 9th. Isolated crowing was again heard on August 2nd and September 12th, but regular crowing activities covered a period of five weeks, with the peak at the end of the second week following liberation. Figure 18 gives a graphic presentation of this data.

The term "crowing area" has received widespread use in describing the territorial behavior of the cock pheasant during the breeding season. With this in mind, a location record was kept of all crowing activities observed or heard at Eliza Island. It was found that some areas did seem to be frequented regularly by the cocks engaged in crowing. In many instances, the birds were actually observed in this



FREQUENCY OF CROWING ACTIVITIES
BY DATES

FIGURE 18



DISTRIBUTION OF HATCHING ACTIVITIES
BY DATES

FIGURE 17

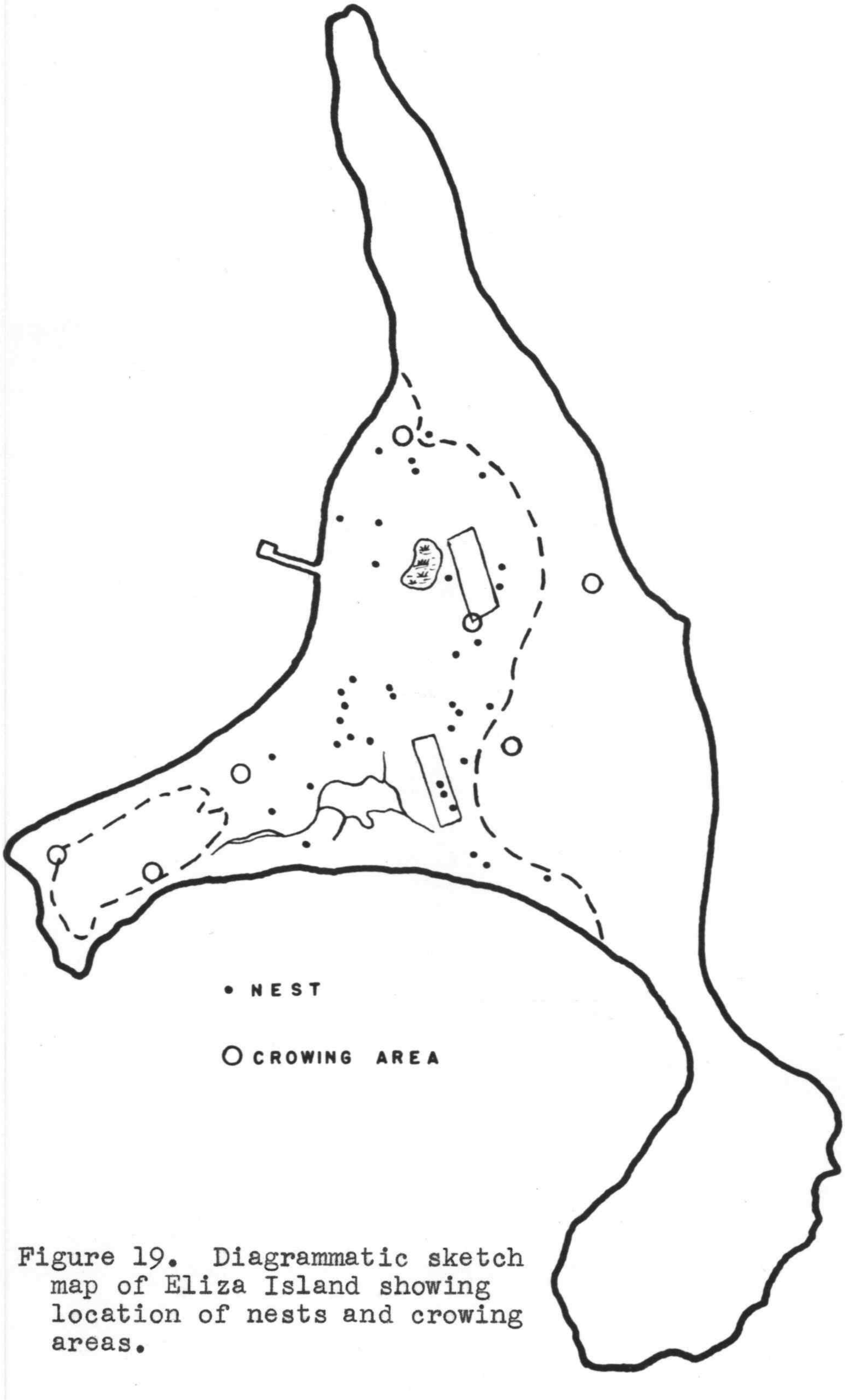


Figure 19. Diagrammatic sketch map of Eliza Island showing location of nests and crowing areas.

activity and it became obvious that certain specific locations were favored and returned to time and time again, presumably by the same bird. The approximate location of the principal crowing areas recorded have been indicated on the map, Figure 19. In some cases, each cock had one or more alternate locations within the general vicinity, and the areas shown indicate only the approximate centers of activity. Some areas, such as the portion of the flat shown in Figure 10, were of considerable extent, while others ranged from the more restricted space shown in Figure 21 to a definite spot such as the exposed rock in Figure 20. Crowing was heard throughout the daylight hours but was at its height during the first few hours after sunrise. It decreased to a minimum during the middle of the day, and then increased to a moderate peak during the early evening hours.

It is somewhat difficult to interpret the status of these areas in their broader sense of a territory; including a necessary variety of cover types for nesting, loafing, escape, etc., and defended by each individual cock. On numerous occasions however, actual fighting, as well as other forms of dissension between individual cocks, was observed, and these were undoubtedly manifestations of territorial competition. The most common indication was the typical "scolding" cluck of the cock which apparently

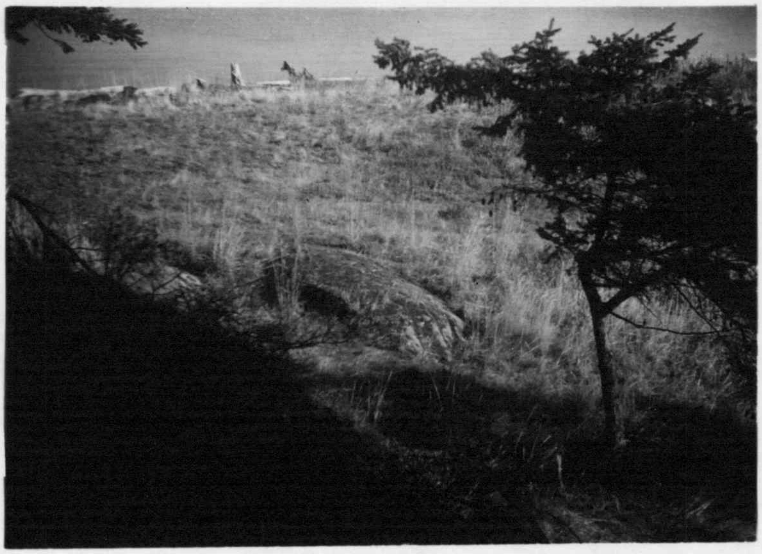


Figure 20. Favorite crowing spot on exposed rock below main cabin.

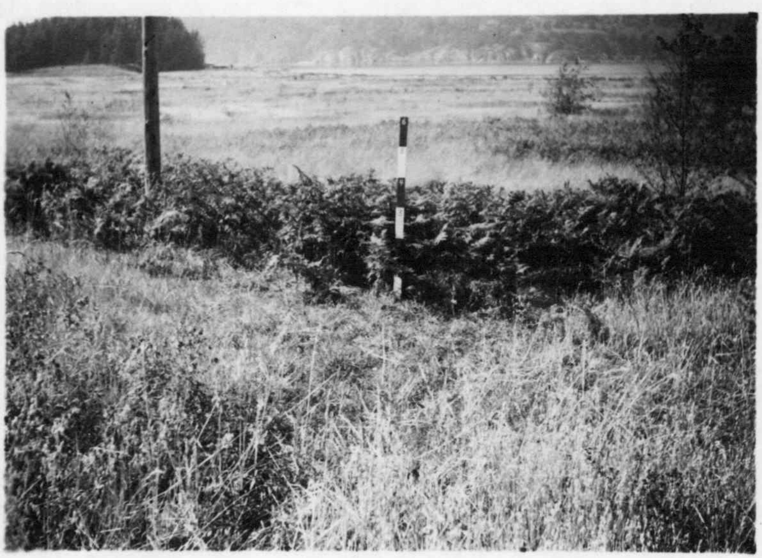


Figure 21. Another well-used crowing ground at southwest corner of north oat patch.

expresses alarm, anger, or both, depending on the circumstances. On some days, during the height of the crowing season, this scolding could be heard almost constantly as cocks in various parts of the island engaged in what were apparently oral battles. In several instances, these periods of argument were climaxed by a short chase as one or the other of the birds gained the upper hand. Quite often, too, such a chase was preceded by short demonstration flights of one or both of the cocks.

MATING. The pheasant cock engages in a typical courtship behavior consisting of plumage display, strutting, and an exaggerated bobbing motion (McAtee, 1945). While no actual instances of mating were observed during the Eliza Island study, several cocks were witnessed in the above mentioned bobbing activity before one or more hens, and on two other occasions cocks were seen to pursue hens for short distances. The most common number of hens seen in company with a cock was two, but on June 22nd a cock appeared with a group of six hens on the flat below the main cabin. This cock was first observed at 7:15 p.m., thereafter crowing almost continuously at about three minute intervals until 8:00 p.m. During this period, the six hens moved about, feeding on the tips of grasses, while the cock crowed at four different locations in the vicinity without apparent regard for the hens surrounding him.

These observations are perhaps some indication of the type of mating and harem behavior existing among the liberated population, but inasmuch as the hens had all been producing eggs at the game farm prior to the release, their nesting activities were perhaps independent of the typical mating behavior that would be an important factor with a wild population. Even with these birds, however, a lack of normal mating behavior may have been one of the basic causes of abnormal nesting discussed later.

FOOD AND WATER. To test the birds' need for food and water, several experimental plots were established as explained earlier. Results indicated that food was not a critical item but that standing fresh water, especially during the dryer weeks in July and August, was in great demand. During the driest period of two or three weeks, standing water disappeared from the swamp and drainage ditches up to the lagoon itself, and the unusual abundance of pheasant tracks in the mud throughout the swamp, (Figure 12) and in the ditches testified to the birds' search for water. There is no indication, however, that the shortage of readily available fresh water during the short dry period was of serious consequence, and during much of the rest of the year, standing water is more than plentiful.

A representative series of droppings was collected weekly throughout the study, and these, together with samples collected during subsequent experiments will, when eventually analyzed, provide a record of year-round pheasant food habits. Frequent observations of feeding birds and the more obvious materials contained in droppings however, gave some indication of food preferences during the study itself. The most definite preference noted was for the achenes of sow-thistle (Sonchus sp.), a composite growing commonly over the flat. Many times birds were observed persistently jumping upward to reach seeds remaining on the upper stems of this plant. The seeds of various standing grasses on the flat were also commonly eaten, together with the grasshoppers and other insects found abundantly in the area. As the planted oats matured, they became a favorite food item for the older chicks as well as for most of the adult birds, and toward the end of summer, large numbers of pheasants congregated in the oat fields daily. The north patch, (Figure 11), consisting of pure oats, was apparently greatly favored as a feeding area over the south patch which contained a heavy mixture of vetch. The very abundant blackberries were also heavily utilized during the period of their availability in late summer.

POPULATION BEHAVIOR. As indicated in Table 1, the island's open, unwooded areas, apart from the lagoon and swamp, consist of only about 60 acres. Undoubtedly the brushy banks and the scattered openings here and there throughout the wooded areas and along the margins add several acres to the total area which may be considered as pheasant habitat. In practice, however, the scattered distribution of these areas restricted their actual use, and with a liberated population of 110 birds it is obvious that the pheasant density necessarily exceeded one bird per habitat acre and probably approached two per acre. Under similar circumstances on Protection Island, it was found that intolerance became evident when a density of two birds per acre was reached (Einarsen, 1945) and Leopold (1939) has indicated that populations of over one bird per acre in North America cannot be expected except on certain extra-rich ranges such as the South Dakota wheat belt.

It is not surprising, then, that the Eliza Island population was found to exhibit many characteristics that may be attributed to abnormal density. Persistent appearance of birds at all extremities of the island, in locations that could be reached only by traversing unfavorable habitat, was one indication of an acute tendency to spread. An individual cock was also observed one evening as it slowly made its way along the north beach, stopping regularly at the water's edge and gazing into the distance with what was apparently an obvious urge to find some way of leaving the island. Still other indications of over-population, concerned with nesting and mortality, will be discussed under those topics.

REPRODUCTION

EGG-LAYING. The hens that were liberated in this experiment engaged in a large amount of what might be termed "extra-curricular" egg-laying. The first indication of this was the quantity of eggs discovered in the shipping crates after the birds were liberated. Thirty-four loose eggs were found after less than 24 hours of occupation. This of course, is not surprising, inasmuch as the hens were taken directly from game farm egg production activities. After their release, however, they apparently continued to deposit eggs at random, and 29 "dropped eggs" were found at various places over the island. In view of the difficulty of discovering single eggs in thick cover, and the likelihood of their being destroyed by crows before being found, it is safe to assume that there were many other such eggs dropped in addition to the 29 found.

A second form of extra-curricular egg deposit was in what Stoddard (1931) originally called "compound sets." These are the result of two or more hens laying eggs in the same nest or location and are well known with pheasants as well as quail. Hamerstrom (1936) recorded their occurrence in Iowa, with as many as 31 eggs in one nest, and Einarsen

Figure 22. Typical cloacal dropping or "clocker" deposited by an incubating hen.

Figure 23. Characteristic appearance of a deserted nest.

(1945) has reported "community nests" from Protection Island with from 18 to 38 eggs. Other investigators have also reported similar instances, usually referring to them as "dump nests." Ordinarily this type of nest is not incubated, and if a normal nest is "parasitized" in this manner, it will often be deserted by the original hen. At least five of these nests were discovered during the Eliza Island study (Table 2). They contained from five to 13 eggs apiece, and only two of them produced any hatch. Several individual nests contained eggs with embryos in varying stages of development; an indication of their cooperative origin. Examples of these are shown in Figures 24 and 25.

Here again is a situation difficult to analyze. There are three possible interpretations of these extracurricular egg-laying activities: they are normal; they are abnormal and the result of too high a population density; or they are abnormal and the result of the condition of the birds involved. Many investigators have reported the presence of dropped eggs, usually early in the nesting season. Leopold (1939) has said that single eggs are sometimes dropped at random by all game birds. Therefore, the appearance of dropped eggs in itself is not indicative, and any interpretation would rest on quantities involved; a measurement for which we have no standard. The

Figure 24. A small "community nest." These eggs appeared in pairs and were frequently moved about but never incubated.

Figure 25. A more typical community nest with 13 eggs. Notice piled-up arrangement in nest.

number of community nests found, however, does have significance when we make comparisons. Randall (1940) in a Pennsylvania nesting study discovered only two dump nests in a total of 257 nests recorded and in an Iowa nesting study, Baskett (1941) found one dump nest in 72 studied; Buss (1946) found one in 350 studied. Other investigators have either recorded no dump nests, or merely mentioned them as an insignificant proportion of the total. A comparison of these findings with the minimum of five dump nests in a total of 37 found at Eliza Island indicates that the latter proportion is obviously abnormal. In addition, some of the five other nests labeled as desertions (Figure 23) may also have been the result of dumping or similar activities. This would further emphasize the abnormal condition of Eliza Island nesting.

Speaking of Protection Island, Einarsen (1945) says:

> "As the population increased, single eggs dropped at random were more frequently found. Hen pheasants established community nests which resulted in many wasted eggs, as no attempt was made to incubate them. Abandoned nests.....were frequently recorded. This did not occur when pheasant populations were smaller."

Buss (1946), in reporting a study of the ovaries from 70 pheasant hens collected in the spring from an abnormally dense wild population in Wisconsin, says:

> ".....preliminary data show that many of these hens had been laying continuously, and that the total eggs ovulated by each hen far

> exceeded the average number found in nests. The condition of the ovary and the number of eggs ovulated at the time the hens were collected, indicated that many of them had not paused long enough in their egg laying to incubate a clutch."

These statements, when added to other observations of intolerance in the Eliza population confirm what would seem to be the obvious conclusion regarding the abnormal egg-laying activity: That it was primarily the result of population density.

In considering the possible effect that condition of the birds might have on nesting, it is believed that size of clutch is indicative. If the dropped eggs and community nests had been the result of a physiological condition encouraging abnormal egg production after being liberated, it is reasonable to assume that the average clutch in normal nests would be large. As shown in Table 2, however, this was not the case. Compared with an average clutch size of between 10 and 11 eggs recorded in Oregon (McAtee, 1945) the average clutch of 5.9 eggs per normal nest at Eliza is definitely small. Density, then, would seem to be the primary cause of the abnormal egg-laying activities.

The small average clutch, however, may well be the result of the condition of the birds. Errington and Hamerstrom (1937) reported a decrease in size of clutch as the season progressed, from 13 eggs in April to eight in

TABLE 2

QUANTITATIVE NESTING RESULTS

Information	No. of Nests Involved*	Results
Number of nests located	37	37
Number of community nests	37	5
Number of desertions**	37	5
Total eggs layed in nests	37	245
Average clutch in normal nests	26	5.9
Fertility (168 eggs, 139 fertile)	26	82.7%
Total number of eggs hatched	25	127
Nesting success (25 nests)	37	68.0%
Hatching % of eggs in all nests	37	51.9%
Hatching % of eggs in normal and successful nests only	21	83.2%
Number of dropped eggs outside nests	--	29

* In computing average clutch; only normal nests were considered. Community nests, desertions, and nests in which the number of eggs could not be accurately determined, were omitted. In computing fertility, the decomposed condition of many eggs made determination difficult and the result can be no more than an approximation. Community nests and desertions were included, but nests in which fertility was uncertain were omitted.

** Nests that were labeled as deserted were those that were apparently unsuccessful for reasons other than community origin.

September. Randall (1940) reported a decrease from 15 eggs in April to 7.7 in July, and a similar shrinkage to an average of 6.6 eggs in September has been reported from Ohio (McAtee, 1945). These reports all refer to wild populations and are interpreted to indicate that renesting attempts result in a smaller clutch in proportion to the lateness of the season. Birds that have produced large numbers of eggs at the game farm for over two months before liberation undoubtedly encounter the same limiting influences that face a wild hen renesting late in the season, and for this reason it does not seem likely that birds liberated under these circumstances can be expected to produce a normal-size clutch.

The above paragraphs have indicated that normal nesting during the Eliza Island study was inhibited by two factors: density, and the condition of the game-farm birds. In attempting to evaluate the final results in terms of feasibility of liberating such birds, it will therefore be necessary to determine the extent to which each factor was responsible in curtailing over-all production of pheasants. Later experiments with other birds will be the only sure method of doing this, but the following suggestion by Buss (1946) seems pertinent to the problem:

> ".....The tendency to lay eggs without incubating them might vary with population density, and it might be one of the variables which lie behind an inverse relation between breeding gain and breeding population."

The inverse relationship referred to above has long been suggested by Errington (1945), who has shown that with many wild populations, the per cent of reproductive gain decreases when population density increases, and vice versa. This phenomenon was originally discussed as a result of mortality factors, but as suggested above it may well be connected with nesting behavior.

NESTING. Table 2 gives a summary of quantitative nesting results found during the Eliza Island study. The footnotes are descriptive. The total of 37 nests were found over a period of eight months, but the majority were found during one month's time, and there is little likelihood that additional nests will be discovered following the winter season. This does not mean that all of the nests have been discovered, however, for it is certain that only a part of the total nests present were found. Unfortunately, there is no known method for determining what this proportion is, and the best that can be said is that those recorded are believed to represent a large percentage of the total.

Most nesting studies in the past have made some attempt to analyze nest distribution by cover types and as related to distance from "edges." Because of the over-all similarity of nesting cover on Eliza Island, and the great diversity of sub-types within this cover, the first

Figure 26. Characteristic appearance of an incubated nest.

Figure 27. The same nest after hatching.

consideration is subject to modification, and the second consideration is of little value. In very few places within nesting cover on Eliza Island is an edge more than a few feet away.

Table 3 gives the occurrence of nests within the general cover types found on the island. The three types sub-labeled hayfield, fencerow, and wasteland, have been so designated because of a general resemblance to what would correspond to that type in agricultural areas. A nest located in the alfalfa type was so designated whether it was found in a continuous growth of plants or merely under one isolated individual. The swale type also varied, from a solid growth of low sedges to a thick, hummocky growth of tall grasses, but it was all definitely swale as opposed to dry farmland types. As might be expected, the types offering the thickest cover were preferred and in choosing between the two oat fields, the one with a mixture of vetch and therefore, thicker cover, was the one used. Figure 19 shows the general distribution of nests found on the island.

As seen from the figure, most of the nests were found in the open flat areas. In addition, they were actually further concentrated within the various sections of thicker cover on the flat. With 37 nests in an area of less than 60 acres, the over-all nesting density was more

TABLE 3

OCCURRENCE OF NESTS BY COVER TYPES

Cover Types	No. of Nests	% of Nests
Alfalfa	3	7
Oats and vetch	3	7
Thin grass (hayfield type)	5	14
Thick grass (fencerow type)	9	24
Grass and weeds (wasteland type)	10	29
Swale	7	19
Totals	37	100

than one per two acres and the concentrated grouping resulted in a much greater density over smaller areas. In the center of the flat, one group of four nests was found with an average interval of only nine yards between nests. They could be enclosed by a rectangular area of one thirty-fifth of an acre. If this distribution prevailed over a large area it would result in a nesting density of 140 per acre! Several other nests were also found close together, the closest pair being separated by less than 15 feet.

There were five nests discovered that have been labeled as desertions. In only one of these cases were the circumstances known. This one was caused inadvertently by the observer searching for nests in thick alfalfa cover. The hen had been sitting on a nest in the center of a dense alfalfa bush while the observer searched in the vicinity, and it was not until she was actually kicked out by his foot that her presence was discovered. She was never seen to return, and later examination showed that the three eggs in the nest were very fresh and had not started development. This incident took place on July 13th, and probably represents the latest record of starting a nest during this study. The four remaining desertions were so designated for want of evidence to indicate community status or otherwise. In arriving at these conclusions, an incubated nest was distinguished by an orderly single-layer arrangement of the eggs while a dump nest ordinarily contained eggs piled up irregularly in more than one layer if not incubated, and if incubated, the varying stages of embryo development within the nest were usually diagnostic.

With the exception of about 10 pairs of nesting crows, Eliza Island was apparently free of the usual causes of nest destruction, and while the crows did eventually discover many of the dropped eggs (Figure 28), they are not known to have destroyed any of the nests. The only nest that was possibly molested, was one where the hen had evidently been attacked, if not killed, two eggs broken and emptied, and a third left with tooth punctures. This was in the area of cat activity, and it is tentatively attributed to that animal. Other than this,

Figure 28. A "dropped egg" opened by a crow.

Figure 29. Characteristic appearance of a normal hatched nest. Note the neatly halved shells.

the birds were able to nest and incubate without facing the usual hazards of heavy nest predation, mowing machines, and other farm activities.

The actual date of hatching is known for only a few nests that were under regular observation when hatching occurred. With several others, hatching is known to have been before a certain date, and a third indication of hatching date was the age of a few young chicks for whom the date of death was known. These three indicators have been plotted together in Figure 17 in an attempt to determine the period during which the bulk of the hatching took place. The results show that the height of this activity apparently occurred between the 9th and 14th of July. An exception is one nest, discovered on June 28th, which contained a single egg that was carefully incubated by the hen until successfully hatched on July 20th; a period of 23 days under observation. The nest that was deserted on July 13th would also have been an exception.

If the data in Figure 17 is further analyzed, it gives the time at which incubation started in these specific nests, and if the number of eggs in each nest is compared with the rate of egg-laying, it gives an indication of the dates on which the hens started to nest. If only the number of eggs that actually hatched is used, inaccuracy due to possible community participation is avoided, and a computation based on a laying rate of one egg per day will indicate a minimum period of clutch-laying. The results of these computations show that at least one nest was started before June 8th--four days after liberation--another one day later, another on the 11th, and the bulk of them before the 16th--a week and a half after liberation. Admittedly, the data used in these computations is too meagre to support authoritative conclusions, but it is cited here as one of the indicators of these unseen pheasant activities.

Another well known indicator is the characteristic cloacal dropping or "clocker" which is deposited by an incubating hen after a long period on the nest. As shown in Figure 22, these clockers are easily distinguished by their unusual size and shape, and are unmistakable in the field. During the nesting period these were common throughout the central flat area, but none were observed prior to June 17th. If their appearance on this date marked the beginning of incubation, the date of hatching would fall on July 10th or 11th; the same period indicated by the other data.

Table 2 shows that, as nearly as could be determined, 127 eggs were hatched in nests discovered during this study. Only 25 of the 37 nests contributed to this hatch, however, for a success ratio of 68 per cent of the nests. This is a high success ratio compared to the 37 per cent cited by Buss (1946) and Baskett (1941), and the 20 per cent success cited by Randall (1940). These comparisons are not significant, however, because of the absence of farming activities as a mortality factor in the Eliza study. When the above reports are corrected to disregard the effect of these activities as cited in their mortality records, the success ratios then become 75, 50, and 68 per cent respectively, and tend to indicate that the Eliza ratio is normal. However, when the lack of nest predators and other destructive agencies on Eliza Island is compared with their abundance in these other studies, the Eliza ratio would appear to be less favorable. Perhaps the explanation for this lies in the abnormal nesting behavior mentioned earlier.

There are also two other possible factors to consider. Randall (1940) found that, in a Pennsylvanis nesting study, the percentage of infertile eggs was higher in late clutches than in early ones, and it is said that late-season eggs on the game farm hatch fewer and weaker chicks (Pheasant Breeders' Manual, 1939). Both of these factors, although of limited importance individually, may have contributed to the poor reproduction of the Eliza Island birds.

Figure 30. Hen pheasant freshly killed by Cooper's Hawk. Notice typical opening through side of abdomen. (Picture by Daniel Nelson)

Figure 31. An old kill showing the same characteristic.

MORTALITY

PREDATION. Information about predation on a wild population is not easily obtained. Before anything can be determined, it is first necessary to discover the evidence of predation. When this consists of only a few scattered feathers, or a dismembered carcass hidden under thick cover or even buried, the observer does not readily record the greater proportion of kills. When a kill is found, he is faced with the still more difficult task of interpreting the evidence to determine the species of predator. In most cases, a decision as to the type of predator, bird or mammal, is the best that can be done, and even this is not always possible. The scarcity of published information on the technics of predator determination is a good indication of the difficulty and uncertainty of the task.

In making determinations during the Eliza Island study, the methods of diagnosis suggested by Einarsen (n.d.) and Darrow (1938) have been followed. The knowledge of which predator species were present was one of the most important guides, as it must always be. The location and general technic of the kill were the next most important indicators, and lastly, the clues left by the predator in the form of characteristic tooth or bill marks etc., carefully observed in the field and later in the laboratory, were used to confirm the diagnosis.

A typical example of a Cooper's hawk kill is shown in Figure 30. The hawk has entered through one side of the abdomen to reach the entrails first--a very characteristic action. In old kills that are more completely eaten this habit may still be recognized, as is shown in Figure 31 where the body is intact except for the ribs on the side where the opening was made. The kill of a mammal, particularly a cat, is not likely to be found as well composed as that of a Cooper's hawk. Figures 32, and 33, show typical mammal kills that were greatly broken up and bore characteristic tooth marks identifying the predator. Some more obvious mammal chewing and tooth punctures are shown in Figure 34, and the typical bill marks left by an avian predator are shown in Figure 37.

The first pheasant found killed by a predator was an adult cock discovered on June 20th. Evidence about the kill indicated that it had been made within the few days preceding--this being about two weeks after the liberation. The next predator kills were two adult hens, found on July 23rd. They were old when found and probably occurred during the earlier part of July. During the last week in July, the first instances of juvenile pheasants killed by predators were discovered, and thereafter, both adult and juvenile kills were found regularly and more frequently as the season progressed.

Figure 32. Remains of pheasant killed by a mammal showing typical broken up appearance.

Figure 33. Another typical mammal kill. The egg was apparently within the bird ready to be layed when the bird was killed.

These kills have been tabulated by age, sex, and cause, and Table 4 presents the results as accurately as they could be determined. The listing of the marsh hawk as a predator only once does not mean that its work was restricted to that one kill. On the contrary, this hawk undoubtedly accounted for many kills, especially of juveniles. It is listed only once because that kill was witnessed by observers whereas the balance of its work was not distinctive enough to be definitely determined. The same thing holds true with the kills assigned to the Cooper's hawk. Several of these were either witnessed or the hawk flushed from the spot, and the characteristics of the remainder were so outstanding as to definitely label them Cooper's work. The rest of the avian kills may be the work of either of the above hawks, the red-tailed and sharp-shinned hawks, the great horned owl, or possibly some other avian predator such as the bald eagle. The most important avian predator, however, was undoubtedly the Cooper's hawk.

OTHER CAUSES. Aside from predation, there were two other main causes of mortality that took a great toll of the population. Both of these affected the younger chicks. One was a normal decimating factor, but the other was apparently a result of population density.

The first of these, has been termed "exposure" for want of a better designation. It refers to those common

TABLE 4

ANALYSIS OF KNOWN MORTALITY BY AGE, SEX, AND CAUSE

Cause	Adult M*	Adult F*	Juvenile M*	Juvenile U*	U*		Totals	%
Predation							61	55.0
Cooper's hawk		6	2	1		9		
Marsh hawk				1		1		
Avian		8	6	15	3	32		
Mammalian		5				5		
Unidentified	1		5	6	2	14		
Sub Totals	1	19	13	23	5		61	55.0
Cannibalism				13			13	11.7
Exposure				19			19	17.1
Accident							14	12.6
Smothered on roost				1		1		
Tar				5		5		
Caught in wire				1		1		
Mouse trap				1		1		
Drowning		5		1		6		
Human activities				1			1	0.9
Dog				3			3	2.7
Totals	1	24	13	68	5		111	
Percentages	0.9	21.6	11.7	61.3	4.5			
	22.5		73.0		4.5			100.0

*M, F, and U indicate male, female, and unidentified

instances of mortality in young chicks, apparently due to natural causes, that ordinarily ensue when chicks are separated from the hen before they are old enough to survive independently. Most of the juvenile mortality occurs during the earlier period of development, but even at a more advanced age a chick is apparently more vulnerable

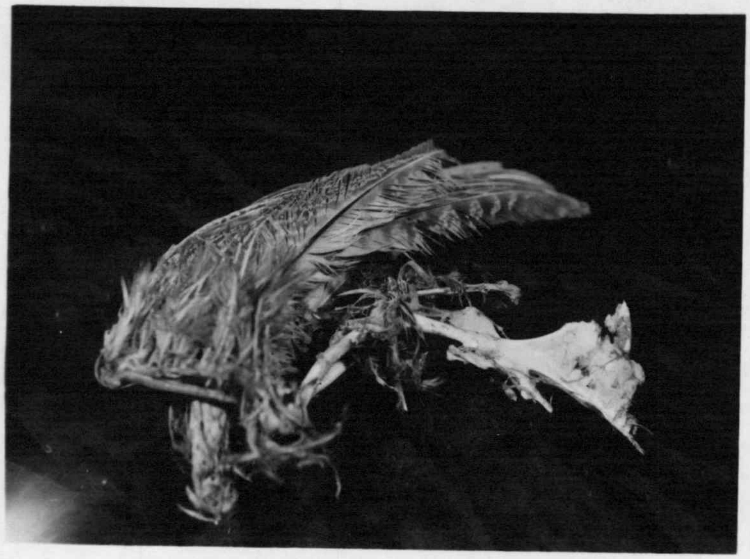


Figure 34. Typically macerated sternum bearing tooth punctures of a mammal.

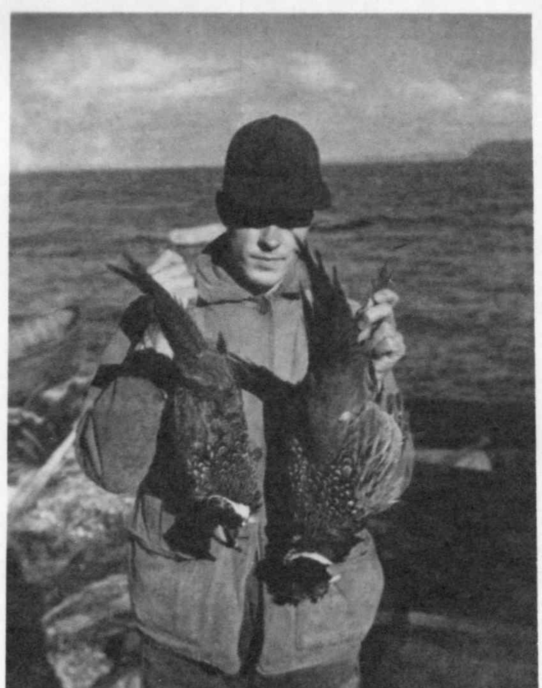


Figure 35. Juvenile and adult cocks killed on November 8. The juvenile (smaller one) is less than four months old.

than may be realized. On the evening of August 4th, such a chick was discovered by the dog, who pointed it out without molesting it. Examination showed that the chick, hiding in sparse cover, was rather logey and quite reluctant to move. As it was being observed, it huddled against the ground and its eyelids closed several times, giving the impression of a general lack of vitality. When the spot was revisited two hours later, the chick was found lying dead in a natural position a few feet away. Its crop contained one sow-bug, and its gizzard contained only a small amount of grit. No immediate cause of mortality could be discovered. Its age was estimated to be three weeks. The circumstances leading up to its death are unknown, but it was alone when found and apparently had been separated from brood and hen long enough to suffer from exposure aggravated by lack of food. Another similar instance occurred when inadvertant human interference caused a hen and young brood to be flushed after dark. It was feared that they would not reunite under these circumstances, and apparently this was the case, for within the next few days, three chicks of the same age were found dead of natural causes in the vicinity. In all, nineteen chicks were found dead of exposure or similar natural causes during the study.

The second main cause of mortality has been termed "cannibalism," also for want of a better word. These deaths were very similar to those often inflicted on chicks by hens or roosters in domestic poultry flocks. They were characterized by a peck at the base of the skull which peeled back the skin and laid bare the back of the head (Figure 36). This was the only visible injury and apparently the attacks were all deliberate but without intent to prey on the chicks. According to Mr. F. D. Kirkpatrick, Superintendent of the Corvallis State Game Farm, mortality of this sort is occasionally caused by the domestic hens brooding young pheasant chicks at the game farm, and also may be caused by wild pheasant hens that enter the brooding ranges. At Eliza Island, it is uncertain what caused this mortality, but the bulk of it occurred within the north oat patch and affected only chicks less than a week old. It is possible that cock pheasants frequenting the locality were the cause, or it may have been done by one or more hens in the vicinity. An instance was observed that points to the latter conclusion: For almost an hour one afternoon, observers watched several hens running about in the north oat patch, in a very unusual manner, appearing and disappearing with much perturbed chirping and clucking. Later inspection of the area showed three freshly-pecked chicks lying in the oats, in a typical example of cannibalism (Figure 39) which had perhaps been the cause or result of the

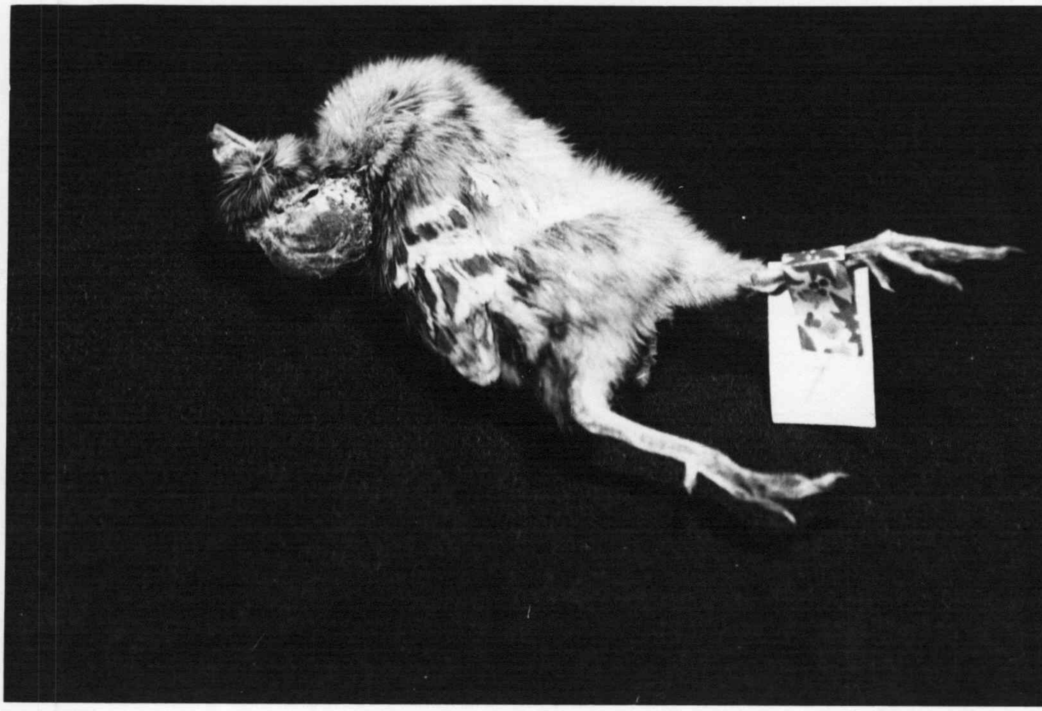


Figure 36. Typical example of cannibalism. Note skull laid bare.

Figure 37. Feather bearing obvious creases left by bill of avian predator.

strange activities witnessed earlier.

In addition to the causes of mortality discussed above, there were several incidental causes, as shown in Table 4. The greatest of these was drowning. One chick drowned in a sump hole on the island, and at least five hens drowned in the salt water bays. Three of these hens were recovered on the beach at Eliza. The other two were found on neighboring islands and the bands returned by cooperative residents. It is interesting to note the locations where these two were found. One drifted to Samish Island, about five miles southeast of Eliza Island, and the other drifted about the same distance to Guemes Island, southwest of Eliza Island. These islands are shown on the map, Figure 1. In view of the odds against finding a bird that has drowned off-shore, especially one that has drifted some distance, it seems very likely that the five birds recovered are only a part of those which met the same fate and were never recovered. Some of the 46 hens unaccounted for after balancing survival against mortality, may have been in this category. None of the birds were ever known to attempt a deliberate flight from the island, and it is thought that most of those that drowned had flown out over water inadvertantly, when disturbed by humans or other agencies.

Another interesting cause of incidental mortality was

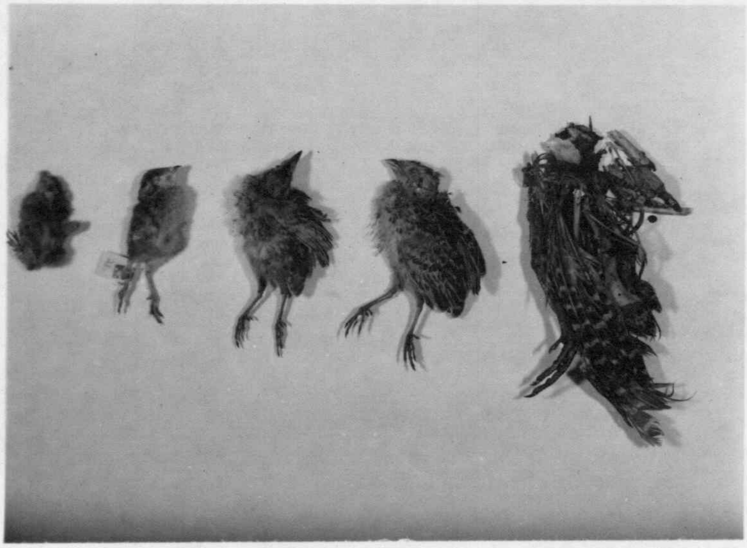


Figure 38. Typical examples of juvenile mortality at ages from one day to several weeks.

Figure 39. Young chick dead in a characteristic example of cannibalism.

a pool of tar, shown in Figure 13, that melted in the summer sun and, like the famous La Brea pits of old, trapped several songbirds as well as five pheasant chicks that wandered into it at various times. The tar was a remnant of the P.A.F. operation, but melting of a country road in summer is known to have had the same effect in the past.

The other incidental causes of mortality listed in Table 4 are comparable to the myriad of such decimating factors that effect any wild population. They are not of individual magnitude but are significant in that their sum will obviously have a limiting effect on the population as a whole.

Figure 40 shows graphically the occurrence of mortality from all causes in juvenile pheasants at various ages. The information was derived from examination of 75 dead juvenile pheasants collected in the field and later inspected by Mr. F. D. Kirkpatrick, Superintendent of the Corvallis State Game Farm, who through years of experience with young pheasants, was able to determine approximate ages of the birds. The average daily rate of mortality was then computed for each age group. The groups differed in size, as shown by the width of the bars, because of the varying difficulty in accurate determination at different ages. The group size depended on the number of

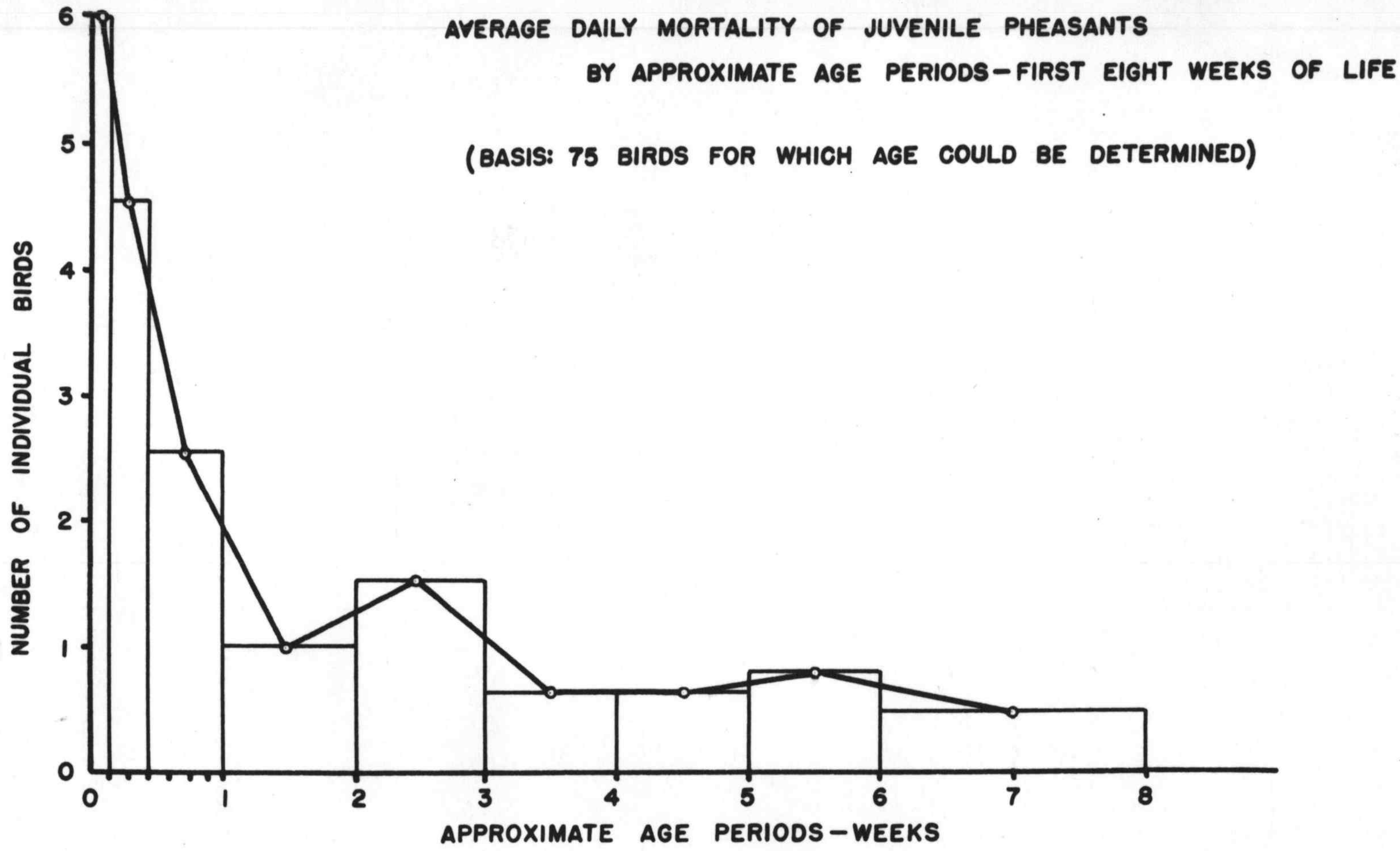


FIGURE 40

WIDTH OF BAR INDICATES LENGTH OF PERIOD FOR WHICH AVERAGE WAS COMPUTED days in an age period within which a bird could be safely placed with due regard to the accuracy of the estimate. For example, chicks that died when they were one day old were distinctive enough to be placed in a one-day age class, while birds that died between six and eight weeks of age were so similar in appearance that they could be accurately designated only as falling within a two-week period. A common denominator for the data was secured by computing mortality on a daily average basis for each age group.

Analysis of the data presented in the graph reveals that 8 per cent of the mortality occurred during the first day of life, and that exactly one-third of the total mortality was met with during the first week of life. These figures, and the graph in general, confirm the universal principal, as stated by McAtee (1937), that mortality varies directly with the immaturity of the forms involved. An interesting deviation may be noted in the two to three week age group where there is a definite increase in mortality. If this data is representative, the increase in mortality at that age may be the result of added hazards accompanying the period of first flight in growing chicks which often causes separation from the protective care of the hen.

SURVIVAL

Survival of the Eliza Island population was measured between October 23rd and December 5th by both live trapping and shooting. The results are given in Table 5. The ratio of surviving young per adult was approximately 0.72. Kimball (1948) speaking of a young adult ratio measured in the fall in South Dakota, says that 1.06, "was probably little more than one-third the reproduction necessary to maintain the population." He also quotes Buss as considering a composition of over 80 per cent young birds "good." In addition it was concluded from a five-year study in Wisconsin that in any large sample, 71 per cent of the winter population would be young birds (Buss, 1946). The composition in this study, of 41.9 per cent young birds must certainly be regarded as poor in comparison with these figures. It is evident then, that the age ratio in the surviving population was very unsatisfactory from the standpoint of increase or even maintenance of numbers. As a matter of fact the final numerical balance was a 39 per cent loss over the original population of 110 birds.

The sex ratio of the surviving adults emphasizes an important factor of differential sex mortality and survival. Out of the 10 cocks and 100 hens originally liberated, nine or 90 per cent of the cocks survived while only 30 or 30 per cent of the hens were still living after four to six

TABLE 5

SURVIVAL, MEASURED OCTOBER 23 TO DECEMBER 5

	Juvenile		Adult		
	Male	Female	Male	Female	Totals
Trapped	1	2	1	6	10
Shot	15	10	8	24	57
Totals	16	12	9	30	67
Percentage of surviving population	23.8	18.1	13.4	44.7	100
	41.9		58.1		
Percentage of original liberated population			90	30	100

months in the wild. This matches closely the more than three to one differential found on Protection Island (Einarsen, 1945). The surviving juveniles also exhibited a sex differential, but to a lesser degree. In a total of 28 survivors, 16, or 57 per cent were cocks, and 12 or 43 per cent were hens. The importance of this factor to management is obvious, especially when adult game-farm birds are to be released.

The actual survival rate of the juvenile pheasants produced on the island is an unknown quantity, but a very rough approximation of the maximum proportion can be arrived at. In the 37 nests discovered, a total of 127 eggs are considered to have successfully produced chicks. With a known survival of 28 juveniles three to four months later, the maximum ratio was approximately 22 per cent. The true percentage would of course be smaller in direct proportion to the number of additional chicks actually hatched, over and above the 127 that were recorded. This figure again suffers when compared to the 40 per cent survival after what is called the "tremendous juvenile mortality" in the first three months after hatching in Ohio (McAtee, 1946).

The individual birds, both young and adult, that survived until November were all in good health and their weights as shown in Table 6 compare favorably with those recorded for pheasant populations elsewhere (McAtee, 1946). Figure 35 shows a juvenile cock with an adult, both collected on November 8th.

TABLE 6

PHEASANT WEIGHTS IN POUNDS AND OUNCES, RECORDED BETWEEN NOVEMBER 8 AND DECEMBER 5, 1947

	Adult Cocks (8 birds)	Adult Hens (26 birds)	Juv. Cocks (15 birds)	Juv. Hens (10 birds)
Minimum	2- 8	1- 7	1- 14	1- 2
Maximum	2-14	2- 4	2- 10	1-15
Average	2-12	1-13.5	2- 4.5	1-10.5

ANALYSIS OF SURVIVAL

In analyzing the mechanism of survival the investigator departs from the field of quantitative results and enters the realm of theory. The numbers of birds found dead from various causes may be added up, totals obtained, and estimates made as to the accuracy of the results. But what do these figures signify? If the investigation was carried on as a controlled experiment, may the figures then be translated to fit any set of circumstances? Or are they merely the result of an isolated group of individual actions and reactions? The challenging inexactness of the science of wildlife management becomes obvious when questions such as these are raised. There is ample evidence, however, to indicate that the phenomena of mortality and survival in wild populations are composed of a strange blend of axiomatic principles and individual variations which, if measured accurately enough, are capable of producing standards by which population behavior may be measured and predicted.

The earlier-mentioned conclusions of Errington (1945) after a fifteen year study of a bobwhite quail population, emphasized what appears to be one of the most fundamental principles involved in the question of survival. This is the inverse relationship between the number of adults resident in an area and the numbers of young produced or tolerated. The studies on Protection Island (Einarsen, 1945) revealed a definite tendency toward unsuccessful reproduction when the pheasant population reached a high density and many other investigators have reported similar results which confirm this principal.

The factors involved in the operation of the principle are far from being understood, but it is apparent that they may be readily divided into two broad categories: those affecting the production of young, and those affecting the survival of young. Indications are that the first category may be of importance in dense populations and this has already been discussed in connection with abnormal nesting activities. The second category has been further explored by Errington (1946) who has suggested that the inverse relationship between population numbers and gain is closely associated with a "threshold of security" which marks a limit of density in any given population and habitat above which the operation of mortality factors will not permit the population to rise. In keeping with this theory is the principle of proportionate predation--varying with density--as suggested by McAtee (1932), and the knowledge that the affect of other mortality factors, such as highway kills, varies directly with the density of population (McAtee, 1946). In summing up the effect of all these factors, Errington (1946) has concluded that, in general, wild populations are subject to "compensatory predation," which operates in conjunction with other mortality factors to reduce or hold a given population to a certain density that is largely governed by available cover and other habitat characteristics. He cites the constant rate of summer brood shrinkage in pheasant populations without regard to degree of predation, as an example of this. Einarsen (1945) suggests that the principal of these habitat factors may be available food. In any event, this theory implies that in a wild population such as that at Eliza Island, a certain suitable density will be brought about by mortality of one kind or another, and in this process the activity of any particular agency of mortality is not, with certain exceptions, in itself significant.

The exceptions mentioned are the individual variations that are difficult to measure. According to Errington (1946) these may result in local pressure that is not compensatory in a particular area, while over a large range it would be. This local pressure often is the result of eliminative predation by "specializers"--individual predators that learn through experience and become habitual predators on a given population. The habits of the Cooper's and other hawks at Eliza Island hinted at this type of pressure. The lack of "buffers"--some alternate staple prey species such as rodents--would also increase the local pressure, and an insular condition such as that at Eliza would further distort the effect of predation by prohibiting intercompensation over a larger area.

Errington's study (1943) of mink predation on muskrats also resulted in conclusions that may have application to the Eliza Island problem. Hubbs (1944) summarized them as follows:

> "It was found that strangeness of environment, (and) intraspecific intolerance.....were especially important in predisposing muskrats .....to predation.....and that kinds and numbers of wild predators doing the preying, with a few apparent exceptions, had little bearing upon the net mortality."

It would not require a very great stretch of the imagination to conceive of a similar statement applying to the Eliza Island pheasant population. In addition still another variable was introduced at Eliza Island, with the apparently greater susceptibility of game farm birds to mortality in the wild (Buss, 1946).

In conclusion, it appears that the rather poor survival and reproductive success of the dense population at Eliza conforms to the principle of population gain in inverse ratio to population density, but that the increased effect of predation on the island, distorted by various local conditions, may have contributed to an abnormally low net survival. Subsequent experiments will reveal to what extent the mortality was influenced by population density, and analysis of the results of several such experiments should eventually yield data accurate enough for use as the sought-for standard of measurement.

TABLE 7

SCIENTIFIC AND COMMON NAMES OF PLANTS MENTIONED IN TEXT*

Common	Scientific Name
Alder, Red	Alnus rubra
Alfalfa	Medicago sativa
Aster	Aster Douglasii
Barley, Squirrel-tail	Hordeum jubatum
Barley, Wild	Hordeum sp.
Blackberry, Evergreen	Rubus laciniatus
Blackberry, Wild	Rubus ursinus
Bracken	Pteridium aquilinum
Cat-tail	Typha sp.
Cedar	Thuja plicata
Celery, water	Oenanthe sarmentosa
Currant, red-flowered	Ribes sanguineum
Dock	Rumex sp.
Fir, Douglas	Pseudotsuga taxifolia
Fire-weed	Epilobium angustifolium
Grape, Oregon	Berberis nervosa
Grass, Bent	Agrostis exarata
Grass, Goose	Galium aparine
Grass, Hair	Aira caryophyllea
Grass, Orchard	Dactylis glomerata
Grass, salt	Distichlis spicata
Hemlock	Tsuga heterophylla
Honeysuckle	Lonicera ciliosa
Horsetail	Equisetum sp.
Madrone	Arbutus menziesii
Maple, Big-leaf	Acer macrophyllum
Pea, Beach	Lathyrus littoralis
Pea, Marsh	Lathyrus palustris
Pigweed	Chenopodium sp.
Plantain	Plantago sp.
Rush	Juncus sp.

TABLE 7--Continued

Common Name	Scientific Name
Rush, Spike	Eleocharis sp.
Salal	Gaultheria shallon
Sedge	Carex sp.
Service-berry	Amelanchier florida
Silver-weed	Potentilla anserina
Snowberry	Symphoricarpos albus
Sow-thistle	Sonchus oleraceus
Thistle, Canada	Cirsium arvense
Vetch, giant	Vicia gigantea
Yarrow	Achillea lanulosa
Yew	Taxus brevifolia

*Nomenclature according to: Jepson, Willis Linn, A Manual of the Flowering Plants of California, University of California, 1925, 1238 pp.

CONCLUSIONS

The primary object of this study was to determine the feasibility of liberating game farm birds in late spring immediately following the egg producing period at the game farm. The practicability of this depends upon two factors: production and survival. These together determine the net population which results in the fall. The net fall population resulting from birds released in this study must be compared with that which would eventually result if the birds were not liberated until the following spring. If the latter procedure results in more birds, it must then be decided whether the cost of holding the birds over an additional nine months is warranted by a sufficient increase in the net fall population.

These decisions will be made on the basis of comparisons between this and subsequent controlled experiments with each class of birds. In doing this, the results of each experiment must be carefully analyzed to determine their validity for use in such a comparison from which general conclusions will be drawn. In making this analysis, however, it should be remembered that, while the majority of the results may be accepted as unusually accurate measurements of a wild population, they are not authoritative standards derived through exact statistical methods. As Buss (1946) points out, "the finest analysis is no better than the crudest measurement used in gathering the data."

The material presented indicates that the Eliza Island experiment resulted in abnormally low production and survival both. The decision must now be made as to whether this is a characteristic peculiar to the class of birds and their time of release, or of other factors, or of a combination of both. The results of the study suggest the following conclusions which should be considered in making this decision.

1. The female pheasant is apparently much more vulnerable than the male, and cannot be expected to survive more than about one-third as well.

2. The class of birds and their time of release had the following effects:

<u>Production</u> was adversely affected by:

A. A smaller average clutch size.

B. A possible lowered fertility rate, and a lessened vitality of chicks.

C. A deficiency in normal mating activities.

D. Lateness of the season which made renesting difficult after a nest failure.

<u>Survival</u> was adversely affected by:

A. The greater susceptibility of game farm birds to predation and other mortality.

3. The density of the population had the following effects:

<u>Production</u> was adversely affected by:

A. A greater tendency toward abnormal nesting and egg-laying activities.

<u>Survival</u> was adversely affected by:

A. Cannibalism.

B. A greater predisposition to predation.

C. Possible mortality derived from attempts to spread.

4. Local conditions had the following effects:

<u>Survival</u> was <u>favorably</u> affected by:

A. Absence of large-scale nest predation.

B. Absence of large numbers of mammalian predators.

C. Absence of other hazards connected with agriculture and civilization.

<u>Survival</u> was <u>adversely</u> affected by:

A. The insular condition which concentrated and encouraged avian predation, and provided additional hazards of mortality by drowning.

B. A lack of buffers which possibly distorted the affect of predation.

C. Possible presence of "specializing" predators which also distorted the affect of predation.

The above considerations may be reduced to these final conclusions:

1. The hen pheasant is significantly more vulnerable than the cock.

2. A liberation of game farm birds late in the season after a period of production in captivity may result in a sub-normal production of eggs and young.

3. The increase and survival on Eliza Island was probably smaller than could normally be expected because of the apparent effect of population density and various other local factors peculiar to the experimental area.

SUMMARY

This study was undertaken in an attempt to determine the feasibility of liberating pheasant hens in late spring at the close of their egg-producing activity at the game farm. Eliza Island, in an accessible location at the entrance to Bellingham Bay, Washington was chosen as the experimental area because its 158 acres provided habitat typical of the Northwest, and its physical isolation made possible a controlled study without the restrictions of captivity.

One hundred hens and ten cocks were liberated on the island June 4th, 1947. Survival and reproductive success were measured by trapping and shooting all the remaining birds five to six months later. In the interim, the entire population was subject to mortality by predation, accident, and other causes with the exception of agricultural practices and those peculiar to civilization.

Various general observations of pheasant activities were made, with particular attention to reproduction, mortality, and survival. It was found that the birds did nest, but that production of eggs and young was inhibited by two factors: population density and the combined effect of the condition of the birds and the lateness of the season. There was a large proportion of abnormal and unsuccessful nesting, and the average clutch in normal nests

was abnormally small.

Mortality paralleled that found in typical Northwest pheasant range with a few exceptions. Population density apparently caused a loss of young birds through cannibalism, and a loss of adults by predisposing them to predation and mortality incident to attempts to spread. Local conditions also probably caused a greater mortality by magnifying the effect of predation and other hazards peculiar to the insular situation.

Measurement of survival indicated that over the six-month period there was a 39 per cent loss in total population in spite of reproduction. The unsatisfactory nature of the reproduction is apparent in the 41.9 per cent proportion of juvenile birds in the surviving population. The greater vulnerability of the hen pheasant is also emphasized in the differential survival by sexes. Of the originally liberated birds, 90 per cent of the cocks, but only 30 per cent of the hens were alive after less than six months in the wild.

The results of this experiment have raised many interesting questions which will be answered only by comparison with the results of subsequent experiments. The controlled nature of this study however has made possible the gathering of accurate quantitative data which will be the basis for such comparisons.

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