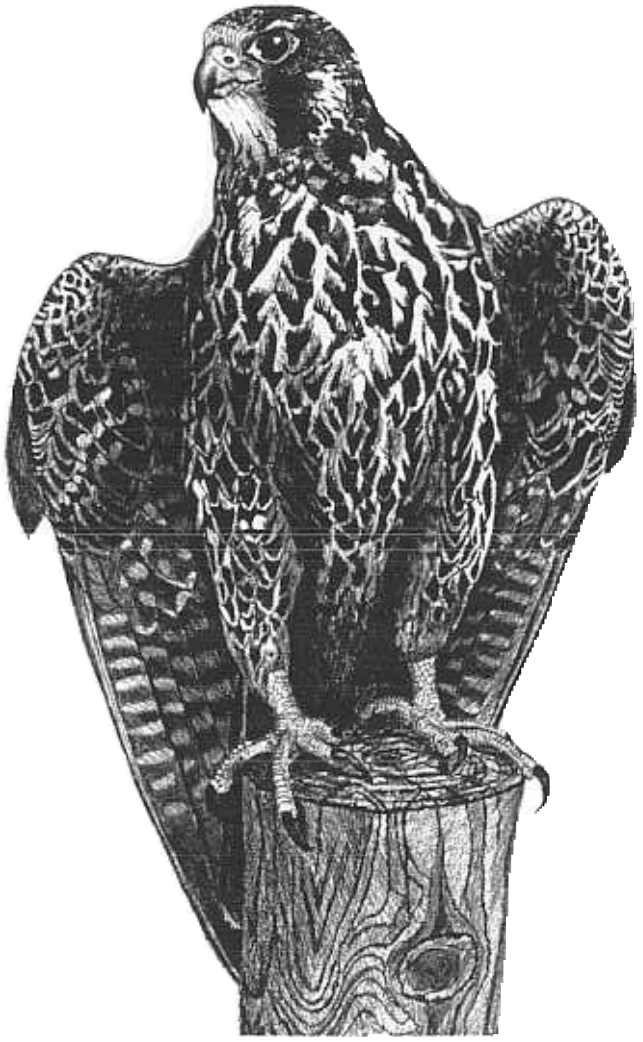
HACKING: A METHOD FOR RELEASING PEREGRINE FALCONS AND OTHER BIRDS OF PREY



by
Steve K. Sherrod, William R. Heinrich, William A. Burnham,
John H. Barclay, and Tom J. Cade

THE PEREGRINE FUND

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It is not advisable to try extending the length of time for incubation of dummy eggs much beyond 35 days. If young peregrines are not available to replace the dummy eggs by this time, prairie falcon nestlings can be substituted into the nest and later replaced by peregrines. This second switch should take place before the prairies are old enough to tear their own food (about three-and-one-half weeks of age).

If peregrine chicks are available to substitute directly for the real or dummy eggs, they should be placed in the nest at about three weeks of age. At this age, the young are old enough to be accurately sexed and banded. They can also tolerate the cold if not brooded immediately. If the chicks have been fed by adults in captivity, they will show little resistance to initial approaches by foster parents, but instead usually beg at the sight of the wild adults. This food solicitation seems to deter aggression by adults which have just found large young instead of eggs in their nest. The adults may try to brood these older downies though the youngsters will probably resist such attempts. Even though young falcons may not have been raised by captive adults, they can still be placed into wild nests. The young provide visual and vocal stimuli to the adults which promote parental behavior, and any resistance on the part of the young is soon overcome by hunger. If the young are much older than four weeks when placed in the nest, the risk of their falling from the nest ledge within the first few days is increased. The young are walking by this age, but are not familiar with the new ledge especially if sudden danger startles them. After the switch, the falcons are left alone except for observing them from a distance to insure that the young are being fed by the adults.

Direct-fostering is probably the most desirable technique of releasing peregrines and of augmenting production in the wild. A remnant population of peregrines, however, must first be present to use this technique, and intensive observations must be made so that the manipulations occur at the proper time in the reproductive cycle. This method usually involves a great deal of physical work as well as advanced climbing skills.

Cross-fostering consists of essentially the same process as direct-fostering, but peregrine chicks are substituted for the young in the nests of other raptors, preferably congenerics such as prairie falcons (*Falco mexicanus*). It is desirable to conduct this switch when the peregrines are about three weeks old since more pronounced differences between the young of the two species may occur after that time. A maximum of four young should be placed in the nest.

We have encountered several problems during cross-fostering experiments with prairie falcons. The lizards, snakes, insects, and small mammals that some adult prairie falcons fed to young peregrines appeared to account for the improper weight gain in the substituted nestlings. Several prairie falcon nests have suffered massive infestations of Mexican bedbugs (*Ociacus* spp.) and other invertebrates (e.g. black flies, *Simulium* spp.). These parasites either forced the young from the nest prematurely or resulted in direct mortality. Prairie falcons often choose nest sites that are more vulnerable to predators than most peregrine eyries in the Rockies. We have lost young peregrines in prairie falcon nests to great horned owls (*Bubo virginianus*), golden eagles (*Aquila chrysaetos*), and coyotes (*Canis latrans*). It is possible, however, to locate prairie falcons that are nesting on high, protected cliffs, some of which are even historic peregrine eyries. Nevertheless, before cross-fostering is encouraged or used further by The Peregrine Fund, we feel that additional investigation is necessary. It is important to know if peregrines released by this method will reproduce with conspecifics or will attempt to breed with the species of the foster parent.

Hacking is a process that has been used by falconers since ages past to allow natural, physical conditioning of eyasses or young birds of prey taken from the nest before they can fly. The falconer places the young raptors on a building such as a shed, barn, or other conspicuous structure and provides them with food which is usually tied down to a board. The birds develop naturally and begin flying, but they return daily to the site for food which the falconer supplies. The birds eventually begin making their own kills and spend more and more time away from the hack site. At this point the falconer retraps the raptors and tames them to be trained for sport.

We have adapted this technique for use in the release of peregrines into the wild state, and we have enjoyed considerable success. Several pairs of wild, adult peregrines are now nesting in areas from which they had been completely extirpated. Other hacked falcons have paired with wild birds and are breeding independently. We feel that this is the next best method of releasing peregrines after direct-fostering, and the details of hacking comprise the main subject matter of this booklet.

The Release of Adults is still in an experimental phase. We are testing both the release of pairs of adults at potential eyrie sites and the release of single adults as mates for lone, wild peregrines that are occupying traditional eyries. The latter process has already proved successful and involves caging a single bird at a site for later release. The barred cage is an approximate one and one-half meter (about five feet) or larger cube with an enclosed area for protection from the wind.

We play courtship vocalizations toward the wild adult over a loud speaker and place food for the bird on the outside of the cage in order to simulate food transfers. After about ten days or depending on the behavior of the birds, the caged falcon is released or tethered to an outside perch, especially if it is a female. The release of females is probably a simpler task than vice versa since males will court them and bring food to them thus enhancing the probability of survival for the female. The release of males on the other hand is more complicated since a wild female will "expect" her prospective mate to feed her, and she may be very aggressive in her "demands." In both situations it may be necessary to supplement the food supply of the birds for a few weeks after release.

SELECTION AND DISTRIBUTION OF RELEASE SITES WITH EMPHASIS ON HACKING

General Plan

The general pattern of distribution for release sites should be of prime consideration in any release program well before the first birds are liberated. In the overall scheme political boundaries must be considered,

but if the project is destined for success, the influence of these boundaries should be minimized in favor of cooperation and sound biological planning. The release of peregrines at a given location is a large investment in falcons, time, and money. An initial release at a given site commits the program to continue hacking birds at that location for several years. This is necessary in order to maximize the likelihood per number of birds released that pairs will eventually become established. In other words, serious thought should be given when choosing the location for every hack site. Because of the need for long term stability of nest sites, National Parks, National Forests, Bureau of Land Management property, and National Wildlife Refuges with the necessary ecological requirements are highly desirable among potential locations for the release of peregrines.

Originally we thought that our release sites would be located at old, historic eyries. Accordingly, we set up one or two sites in each of several states in cooperation with the state and federal wildlife departments and land managing agencies. Our idea was that by limiting releases to these six or seven states the peregrines would wander enough to eventually encounter one another, pair, and breed. This wandering and pairing has occurred to a certain extent. At the same time, however, many peregrines have returned to breed at release sites or as lone individuals which stayed throughout the breeding season waiting for a mate.

Whether trying to establish a new population of falcons or attempting to augment the production of young in an ailing population, we now feel that breeding pairs can be obtained much sooner, especially in a localized area, by release efforts that saturate small regions with as many immature birds as possible. Because the mortality rate of peregrines during the first year of life ranges between 55 percent (Shor, 1970) and 80 percent (Mebs, 1960) and because they must be at least two years old to breed, several seasons of releases are usually required for success. Barclay (1980) has shown that during releases in the eastern United States, between two and eight peregrines must be hacked for every subadult or adult falcon that returns. It is an uphill battle, but the saturation process must be continued until pairs are eventually formed.

Critical Requirements for Hack Sites and for Nesting Peregrines

Releasing young peregrines from a given location is undertaken with the intention that falcons will return to breed at the site of release or somewhere nearby. The hack site, then, is really a potential nest site or eyrie.

When envisioning a classic peregrine eyrie, one usually conjures up the image of a falcon screaming in defiance from a ledge somewhere on the face of a remote cliff. Ironically, a quick review of nesting records indicates that this cosmopolitan falcon is actually quite adaptable in its choice of nest sites. Aside from breeding on cliffs, the peregrine has been observed to nest directly on the ground, especially in some of the areas of flat terrain found in Europe and Asia. Old stick nests of other birds (Dall and Bannister, 1869; Thomasson, 1947; White and Roseneau, 1970; Campbell et al., 1977; White, Jones, and Devine, 1978) or cavities in trees (Goss, 1878; Ridgeway, 1895; Ganier, 1931; White, Jones, and Devine, 1978) have also served as nest sites for this species. Even man-made structures such as an abandoned oil derrick, bridges, castles, churches, and skyscrapers in the middle of some of the world's largest cities including New York, Montreal, and Philadelphia have served as nest sites for the peregrine falcon (Craighead and Craighead, 1939; Bond, 1946; Groskin, 1952; Hall, 1955; Hickey and Anderson, 1969; Mebs, 1969; see also Barclay, 1980, for further discussion).

The flexibility with which the peregrine adjusts to different nesting situations has allowed us to successfully hack falcons at three types of sites: natural cliffs, towers, and urban locations. Whether for the successful release of young peregrines or for nesting by returning adults, there seem to be four critical requirements. These are isolation from too much disturbance, security from other predators, protection from the elements, and an adequate food supply. There are no hard and fast rules that satisfy these requirements, however, and each category should be examined independently.

Isolation. Isolation from too much disturbance is important, but it does not necessarily indicate that no human activity should take place within 100 kilometers (about 60 miles) of a peregrine eyrie or hack site. For example, a peregrine nesting on the thirty-third floor of a skyscraper in Baltimore is effectively isolated from the human activity below her as is the falcon nesting on the ground in Finland surrounded by marshy bog, or a falcon nesting on a cliff 200 meters (about 650 feet) above a river used by kayakers. Conversely, a cliff that is only 20 meters high (about 65 feet) and which stands in a picnic ground is not isolated enough for either a nest site or release site. The frequency of disturbance plays an important role in the degree of isolation required by peregrines. A cliff face which is scaled in the spring and summer by rock climbers on almost a daily basis or even on weekends is not suitable for peregrine management. The occasional passing of a car on a nearby dirt road or a hiker on a trail, however, is not enough to cause any problem for either breeding falcons or hacked falcons. Another prime consideration is the seasonality of disturbances. No major operations such as logging or seismic testing, for example, should take place in the immediate vicinity of the peregrines during the spring and summer months (March to August). Conversely, during the fall and winter there should be no problem with this type of work. In fact, assuming that there is enough other suitable habitat in the area to support prey species, logging in particular can be beneficial since it produces open habitat over which the falcons can effectively hunt. One final point to consider with regard to critical disturbance is the time in the breeding cycle or hacking operation at which the disturbance is initiated. If something that is deemed a major, continuing disturbance within a kilometer (about one-half mile) of the eyrie or hack station cannot be avoided during the spring and summer, it is preferable that the disturbance begin before the breeding season or before the young are released. In this manner returning adults or hacked young can become habituated to the problem from the onset of their presence at the site. If the disturbance is initiated during a critical period in the nesting cycle (egg laying, incubation, or the first week after hatching) or the hacking operation (the first week after release), it can produce disastrous results.

Predators. Breeding adults usually pick nest sites that are not accessible to mammalian predators, and the parents are extremely aggressive toward any avian predators in the area. Falcons that are hacked and there-

fore without defense by natural parents, however, are very susceptible to predation. We have found that small cliffs at lower altitudes surrounded by mixed deciduous-coniferous forests and pasturelands are likely to be visited by great horned owls and that young peregrines may be killed in the night even two weeks after they have been flying. On the contrary, falcons fledging from cliffs at higher elevations and surrounded almost completely by coniferous forests have suffered no predation from owls. These nocturnal predators are nearly always present in woods that are adjacent to marshes and wetlands, and hack towers should always be placed at least one and one-half kilometers (about a mile) away from forests.

Golden eagles are a constant threat at many of the hack sites which are located on cliffs; ideally, a hack site should not be located within 16 kilometers (10 miles) of a nesting pair of eagles, but, again, this depends on the local topography. Goshawks (*Accipiter gentilis*) and red-tailed hawks (*Buteo jamaicensis*) will also attack and kill young peregrines. Although all of the avian predators mentioned may make an easy meal of a young falcon, this is especially true of the hawks that are nesting near the hack site. Ospreys (*Pandion haliaetus*) are normally rather unaggressive, but if they are raising young in the vicinity of a hack tower, certain individuals will pursue nearby peregrines with deadly determination. Hack towers should be placed no closer than 500 meters (about 550 yards) to an active osprey nest. In many of the instances where our hacked falcons were killed by owls, the falcon was not eaten. It appeared that the falcons may have been killed on a competitive basis since anything that is prey for the falcon in the daylight hours is prey for the owl at night.

Mammalian predators can also be a threat to young falcons. Raccoons (*Procyon lotor*) are especially troublesome, and at higher elevations, martens (*Martes americana*) are potential problems. Both of these mammals will not hesitate to attack and kill a peregrine if they can catch it. They are probably attracted to the hack box by the odor of decaying food remains. We have found that porcupines (*Erethizon dorsutum*) will chew on hack boxes, presumably attracted to the glue in the wood. Not only can porcupines destroy a box over the winter, but in a single night they can chew a large enough hole to allow other mammalian predators an entrance to the hack box.

Foxes (*Vulpes* and *Uroncyon* spp.) and coyotes will also kill fledglings, and they are especially dangerous during the first two to three days of flight when the falcons may end up on the ground.

The best strategy to use against other predators is simply to avoid them. Sometimes, however, this is impossible at cliff sites. Before any measures are taken to control predators, it is necessary to have the proper permits from both state and federal authorities. We have already mentioned that the more heavily wooded, higher elevations are usually free of owls. J. Barclay has worked out an effective method of trapping great horned owls at night with a mist net, a tame owl tethered below the net, and a loud speaker which plays the recorded hooting of a courting owl. The problem with this method of management is that there seems to be such a dense "floating population" in many areas that any owls which are removed by trapping are almost immediately replaced. We have removed as many as five great horned owls from one location, and left another three untrapped when we finally quit trying. Even if it were possible to remove the owls prior to or during a hacking season, in suitable habitats new owls will be present again in following years when the falcons return to breed.

There are some measures that can be used against eagles, redtails, goshawks and other raptors if they cannot be avoided. We have found that if the young of large raptors are removed from their nests (and transplanted to other nests) about ten days prior to the release of the falcons, the aggression of the parent hawks toward the falcon is reduced. They may still be dangerous, however, and should be avoided if at all possible. If the young falcons have not been attacked within a week of first flight, they usually become agile enough to avoid most other raptors in the air. Even so, eagles and owls are a threat to immature falcons during the entire hacking period.

In an area where there are potential problems with eagles, the site attendants must be on guard during every minute of daylight for the first week after release. By placing himself/herself in a position on a dominant part of the cliff that would be visible to an incoming eagle, the attendant should make every effort to frighten off this avian predator upon sighting it in the area. Shotguns loaded with cracker shells are sometimes effective, but discretion should be used because the explosion may also frighten away the peregrines. Permits are required for the harassment of eagles when using cracker shells.

Raccoons can be trapped, but, again, most efforts seem futile. We have trapped over 20 raccoons from a single ledge used for hacking. We use Havahart traps baited with a punctured, but unopened can of sardines or tuna. If jaw traps are used, they must be set only during hours of darkness. Flashing must be used on all tower poles to prevent raccoons from climbing up to the platform (see Contruction of Tower Sites).

Protection from the Elements. Breeding peregrines are usually quite adept at choosing an overhung ledge, cave, or other protected structure for a nest site. The hack box which is described elsewhere in this paper seems to serve well to protect young falcons during the hacking process and to protect breeding adults which use them as nest sites. Further discussion is presented in the section concerned with The Hack Box.

Adequate Food Supply. An adequate food supply is determined by two necessities. The first is a prey population sufficient to support a family of falcons, and the second is habitat which permits the falcons to catch the prey in flight. In both fresh and salt water marshes, the abundance of avian life is obvious to an observer. While the water associated with such habitat provides refuge for some of the aquatic species from the attacks of falcons, the peregrines can at the same time use the water to isolate and catch other species away from cover. The openness of a marsh makes it prime hunting habitat. This is one reason why hack sites placed on towers in marshes have proved so successful in producing breeding pairs of peregrines.

At cliff sites that are surrounded by intermittent grasslands and forests, the prey populations are usually more difficult to evaluate than in marshes. The habitat may support as much or more bird life as the wetland, but the prey is often hidden beneath the forest canopy. In this

situation, peregrines use surprise and speed to capture birds that are crossing the open areas between one side of a canyon and the other, or they isolate their prey above bodies of water such as the rivers that originally formed the canyons.

In urban areas, the abundance of feral pigeons (*Columba livia*) and starlings (*Sturnus vulgaris*) provides a source of prey that is readily accessible to the falcons. As at cliff sites, the falcons must use high speed dives from a soaring position or from atop tall buildings in order to surprise their prey away from the cover of the architectural maze below.

Other Considerations for Hacking

There are a few other general precautions necessary in the selection of a hack site. It is well to be aware of the attitude that residents in the area of the hack site have toward raptors because even in this day of "ecological awareness," some peregrines still suffer gunshot wounds. The presence of a pigeon loft within several kilometers (miles) of a release site is a certain attraction to young falcons. Some pigeon fanciers may destroy the falcons even though they are protected by state and federal laws. Power poles in the vicinity of the hack site should be examined for safety. The future of the release area should be checked out thoroughly as housing or recreational developments may be planned.

Ironically success itself can cause a major problem. Returning adults and subadults are often aggressive toward young birds that are being hacked. In general, subadults and adults are more aggressive toward immatures of their own sex, but some adults or subadults may attack any immatures regardless of sex. The attacks by the older birds can range in intensity from vocal protests and shallow stoops that never actually make contact, to blows that literally knock the young right out of the air. The latter type of attacks can be lethal.

If adults or subadults are present at a former hack site, we avoid using that site. This means that release sites which have been used for one or more seasons should be scouted each spring for returning birds before hacking can take place there. In such a situation we usually hack the birds at a newly-constructed, adjacent site up to about 25 kilometers (about 15 miles) away, depending on the local topography. We have tried using sites where adults or subadults were present, and in only a few cases were the adults (males) tolerant of the young. In other instances we have lost as many as four young to the attacks of a single adult. The problem is that the adults usually pay no attention to the young before they are released. Once flying, however, the young may even attract adults that had not been present before. If the adults or subadults attack the young during the first week of flight, the young may be driven to the ground or other locations where they are vulnerable to mammalian predators. Often adults attack the young on their maiden flights driving the fledglings away from the hack site and causing them to become disoriented. Frequently in such circumstances the young birds then become lost never to find their way back to the hack box for food. Sometimes an adult will only defend the area around the hack box against the young, but this prevents the young from returning to get something to eat.

We did curtail the aggression that one resident pair of peregrines showed toward young which we attempted to hack at "their" site. We trapped the female (a subadult) and held her in a breeding chamber for three weeks, but left the adult male at the site. The male then reduced his aggressive attitude and instead, adopted the young and fed them. We have since found that the best practice is to simply avoid sites where adults or subadults have returned. In one instance, we built a new tower in a salt marsh, and the day after completion, a subadult female set up residence there. We hacked young falcons at the site, and she literally knocked them out of the air as if they had been hit by a shotgun. Fortunately, they all made it through the first week and finally to independence. We have found that if the attacks of the adults can be avoided during the first week of flight, the young usually become adept enough at flying to defend themselves in the air after that time.

Choosing Individual Release Sites

We have already suggested under General Plan that the location of all release sites should be part of a concentrated pattern. We have also presented the general prerequisites for the survival and management of the peregrine under Critical Requirements for Hack Sites and for Nesting Peregrines. Additional considerations are presented below concerning the choice of a location for any one of the three types of hack sites.

Cliff Sites. Unless plant succession, farming practices, or certain types of development have radically changed the habitat, most cliffs that were formerly used as nest sites by peregrines are suitable locations for hacking. It is not necessary, however, that the cliff be an historic peregrine eyrie. Large cliffs at least 70 to 100 meters high (about 300 feet) that overlook extensive areas where the falcons can hunt are the most desirable for hacking. Few North American peregrines nest above 3,000 meters (about 9,000 feet), and the nesting altitudes generally decrease with northerly latitudes.

Before the decision is made to use a particular cliff, at least two to three trips should be made to the site in search of other raptors that may be nesting on the face or somewhere nearby. The easiest way to do this is by carefully searching the area from a helicopter before the leaves are on the trees. It is a good idea to examine the area on foot and look for scat and other signs of mammals which could threaten the birds. See the section on Predators with regard to the necessary precautions.

At the same time, the cliff should be studied for ledges on which to place the hack box (Fig. 1). Some cliffs have no suitable ledges and others have several. The best type of ledge is one that sits in a dominant position on the cliff face where the fledglings can see it from all directions once they have started flying. Overhangs make it difficult to feed and work the site. Long ledges measuring three meters or more are preferable because they allow room for attendants to work and a place for the birds to land. The ledges should not extend more than about three meters from the cliff. The birds usually land on the edge of a ledge and may not find the food on their initial returns if the box is set too far back from their landing spot.

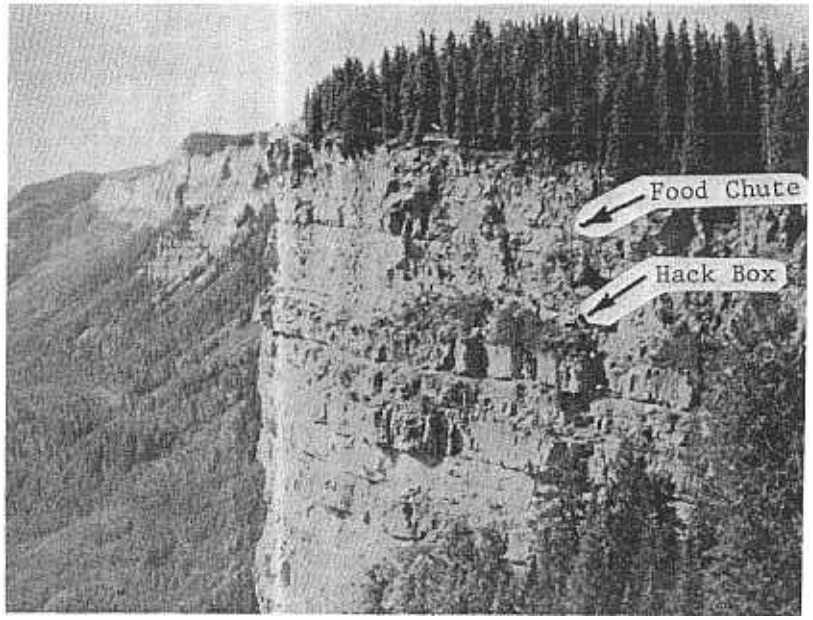


Fig. 1 Hack box placed on natural cliff. Note food chute which appears as vertical line above box.

The ledge must be accessible to the site attendants either by climbing down to it or by a short rappel. If bears (*Ursus* spp.) or possibly mountain lions (*Felis concolor*) are in the area, the ledge must be inaccessible to them as both of these animals can easily rip open a hack box. Smaller mammals such as raccoons and martens can reach many places on a cliff that one would not expect. Some ledges are located so that they are more effective than others at preventing small animals from reaching the box. The choice of a ledge with regard to protection from predators is largely a matter of personal judgment.

While on the ledge, one should pick out prospective anchor points for the hack box. No matter how stable the box appears to sit on a ledge, steel cables should be run through the corners of the box and anchored to trees or pitons. Cliffs can funnel extremely high winds that will lift even the heaviest box up and over a ledge.

A good campsite should be picked either below the cliff where the attendants can observe the birds or in some situations, on top of the cliff. If the camp is on top of the cliff, it should be back several hundred meters from the edge where the birds will not see the attendants. The attendants should also choose additional observation points that allow a good view of the cliff and surrounding area.

Fig. 2 Tower type hack site.

Tower Sites. There are several advantages to using artificial towers for hacking peregrines. They introduce more flexibility into the location of hack sites making it easier to saturate an area with young peregrines. Towers can be erected in a concentrated pattern by themselves, or as part of a pattern in combination with wild eyries and cliff-type hack sites (see General Plan).

In situations where all other requirements seem ideal but there is no cliff, a tower is used (Fig. 2). We build tower-type hack sites primarily in salt water and fresh water marshes. When choosing the exact location for the erection of a hacking tower, it is best to place the structure on at least semi-solid marsh, 300 to 500 meters from the edge of the water. This is desirable because when the falcons are about ready to take their first flights, they sometimes slip and flutter to the ground below the tower. Placement of the towers away from the water also allows the birds a margin of isolation from people passing by in boats. In many areas, especially on offshore islands, there are high winds which predominate from one direction. In these situations it is a good idea to place the tower so that there is plenty of land downwind. During initial flights, the falcons will launch off into the wind, but will probably be swept downwind. It is obviously dangerous if they should become exhausted over water. For this reason, plans should be made to have a boat available at all times if working in a marsh. It is best to place the tower in the most open area available. It should be at least one and one-half to two kilometers (one to two miles) away from trees in order to avoid owls (see Predators). Osprey nests should be avoided also (see Predators). The falcons will spend some time on the ground, and when placing the tower one should avoid cattails (*Typha* spp.) and bushes because the falcons may fall into them and the vegetation will mask the approach of ground dwelling predators.

Before construction, it is essential to visit the prospective locations for towers at least a couple of times during the spring and summer when hacking or nesting will normally occur. Sites that look ideal three months before the hacking period are sometimes swarming with people when warm weather arrives.

Although our tower sites have been primarily at structures which we have built and which we prefer, there is no reason why existing platforms cannot be used. Water towers and high tension towers could be modified in the same way that towers in Idaho have been modified as structures for nesting eagles. Feeding the fledglings could be complicated for the attendants, however, and it would be imperative to insure that electrical hazards did not exist. It would also be necessary to delay maintenance on these structures, for example painting, until the fall or winter months.

Urban Sites. In choosing a structure for an urban hack site, one should pick a tall building that overlooks an open area such as a park, an undeveloped area, or a bay (Fig. 3). The building should have ledges or other areas on which the falcons can perch.

Once a suitable building has been located, it is advisable to contact the president or a vice president of the company and the building superintendent. Since the heart of a big city is not always directed toward conservation, a brief slide presentation can be useful when explaining the purpose of the project.

Access to the area of the building where hacking will occur should be blocked off from curious onlookers. There are always many interested parties at urban release sites. It is advisable to determine what kind of seasonal maintenance (window washing, machinery inspections, etc.) is scheduled during the hacking period and during the future nesting seasons.

Chimneys and air ducts in the building and in the surrounding area should be covered with wire grates to prevent the falcons from falling down them (see Behavior). Frequently, the air conditioning systems of large buildings involve water coolers placed atop the roofs. Chemicals are placed in the water as algacides, and it must be determined as to how these will affect the falcons. Similarly, any potential programs in which pigeons, sparrows, and starlings are poisoned in the city should be thoroughly investigated with regard to the welfare of the falcons. In particular, it is important to determine which poisons are used and the susceptibility of the falcons to secondary poisoning.

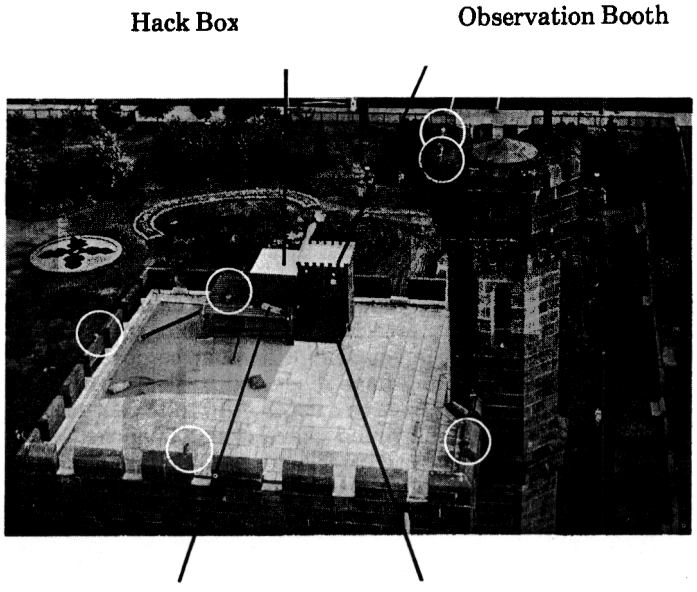


Fig. 3 Urban hack site. Note small tower, observation booth, door from roof leading into booth, and circled falcons.

CONSTRUCTION OF THE HACK SITE

Hack Box

Description. Whether the release site is on a natural cliff, tower, or a building, it will be necessary to construct some type of sturdy hack box. Diagrams for the prefabricated type of box that we use is provided on the following pages (Fig. 4) along with a short set of instructions for assembly.

The box provides protection for the young peregrines from predators, high winds, sun, and rain and restrains the falcons until it is time for release. The bars prevent the falcons from braking their feathers during the period of restlessness just prior to release. The wire on the outside, and the gap between it and the bars prevent predators from grabbing the fledglings from the outside. In some situations we advise that house screen be put on the front of the boxes. This prevents black flies, wasps, and mosquitos from seriously biting or stinging the young falcons during the prerelease period. Wasps attracted to uneaten meat and black flies and mosquitos can be a serious threat to the youngsters and their growing feathers. Attention should be paid to the reduction of airflow caused by the screening, however, to insure that the birds do not become overheated.

We paint the top of our boxes white or silver to reflect heat, and we paint the rest of the box with wood preservative that approximates the color of the rock or building. This protects the wood and decreases the chance of discovery by people. Boxes on towers are painted in the same manner.

A door is cut in the end of the box for easy access to the falcons, although contact should be kept to a minimum. Small peep holes (one centimeter or one-half inch) are cut in the top and sides. We have placed peep hole magnifiers of the type used in the front doors of houses in some boxes for a better view.

In the back corner opposite the end door we place a hide or a vertical piece of plywood positioned diagonally. This is one of the most important parts of the box. Whenever threatened, the falcons predictably run behind this hide, and it is frequently occupied by sleeping birds. It offers protection in the open-fronted box from wind and rain, but it is most importantly used during the actual release process (see discussion under Release.) The hide panel should be solidly attached inside the box so that there is no chance it will collapse on the young, but it must be possible to remove this structure once the young have dispersed.

The bottom of the box is filled to a depth of 10 to 15 centimeters (about four to six inches) with small round gravel which is about three to five millimeters (about one-eighth to three-sixteenth inch) in diameter. Sand retains too much moisture when it gets wet, and large gravel can break the eggs when a returning adult sits on them. Proper-sized gravel allows the wastes to drain but does not stick to the food of the young birds. The same material is used on the ledges in which our captive falcons scrape and lay eggs and has also worked well for the birds which have returned to breed in these boxes. Three or four large rocks or sections of log are placed on the gravel, since young falcons at this age prefer to sit on a perch rather than a flat surface. A number of holes are drilled in the floor of the box prior to the addition of the gravel. These holes are important as they prevent a buildup of water in the gravel which increases the chance of disease and makes it too wet for proper incubating conditions by returning adults.

A hack board should also be prepared. This is simply a rectangular piece of plywood which measures roughly one-half meter (about two feet) by one-third meter (about 10 to 12 inches). We paint our boards white, but any pattern or color that will be obvious to the birds can be used. Several pairs of small holes should be drilled in the board so that food can be tied to it after the young are released. The use of the hack board is discussed under the section on Feeding.

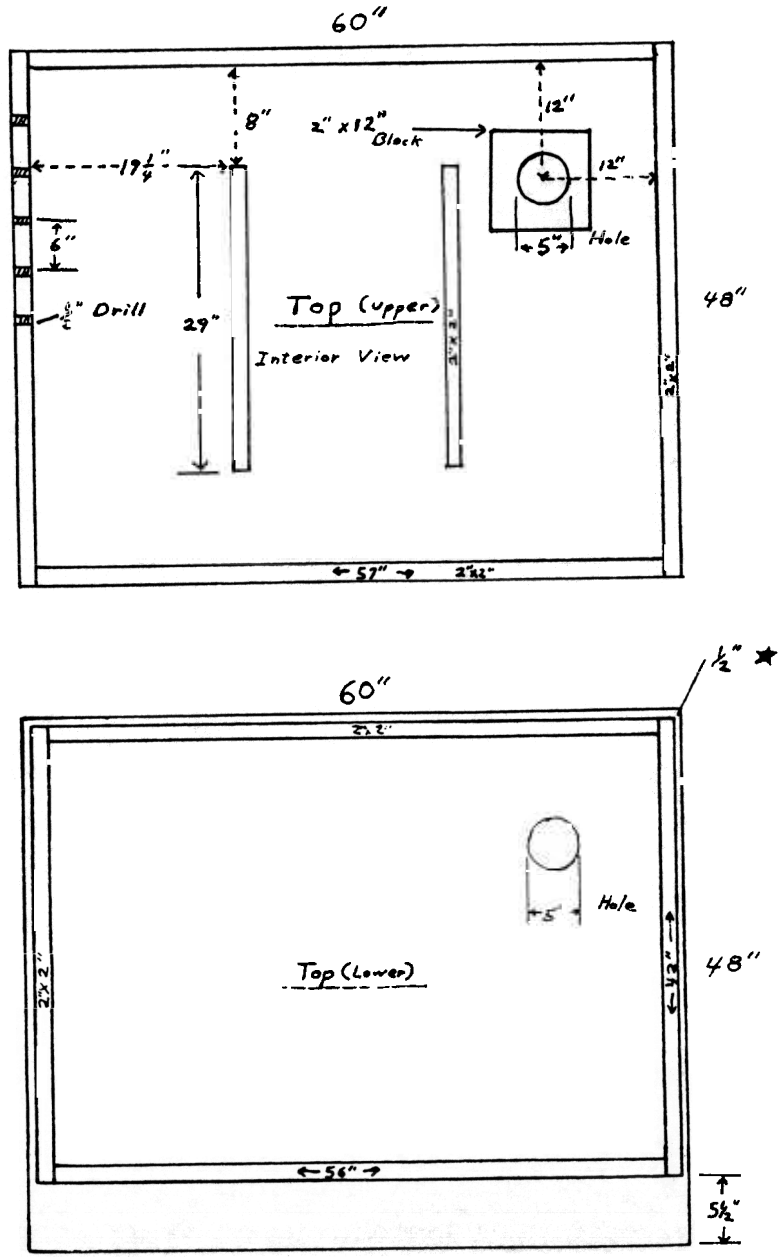
Details of the food chute are explained in the section on the Construction of Cliff Sites. Depending on the type of site, it may be desirable to construct a delayed feeder which mounts on top of the box. This type of feeding mechanism is especially useful at towers. It is also helpful at cliff sites where the box is placed on top of the cliff or in a situation where a food chute cannot be used. A description of the delayed feeder follows the List of Hack Box Materials.

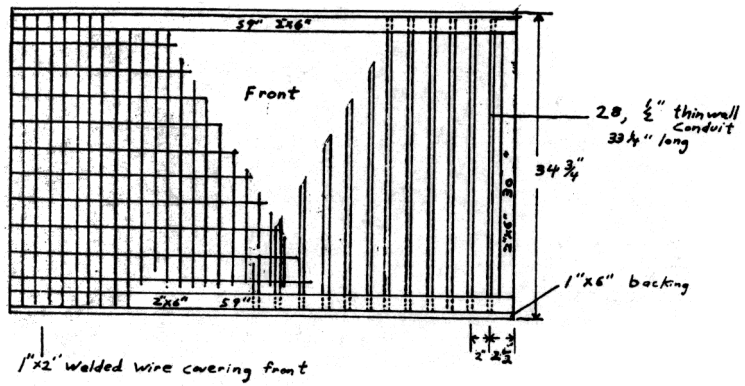
Instructions for Construction of Hack Box

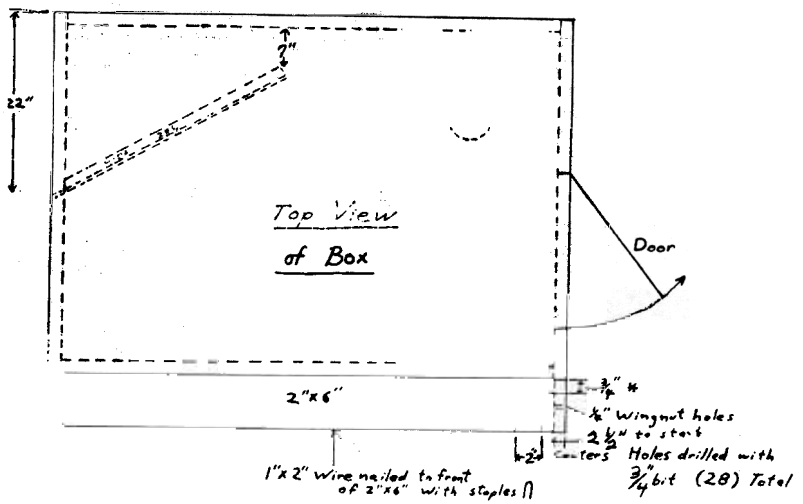
NOTE: Measurements are provided in feet and inches (U.S. Customary System).

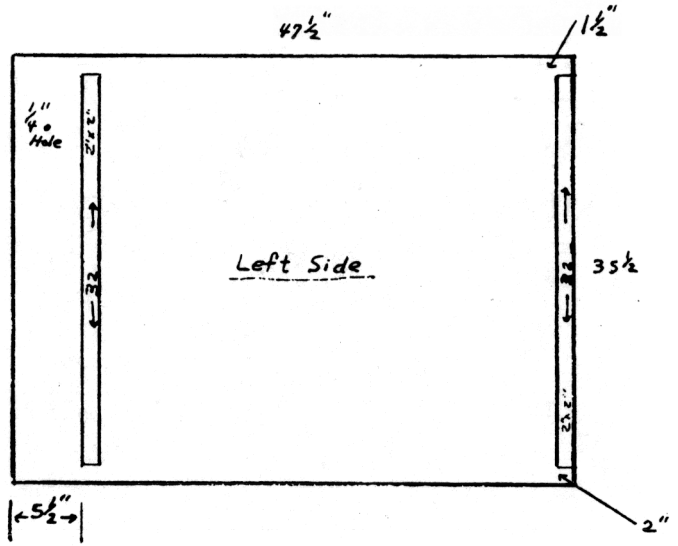
In areas where heat may be a problem the top of the box has a double thickness of plywood with a 2" x 2" frame separating the plywood sections. There are also two 29", 2" x 2" supports toward the center, between the sections. A 6" long 2" x 6" block with a 4" diameter hole cut in it is placed between the two sections of the roof at the junction of the box and

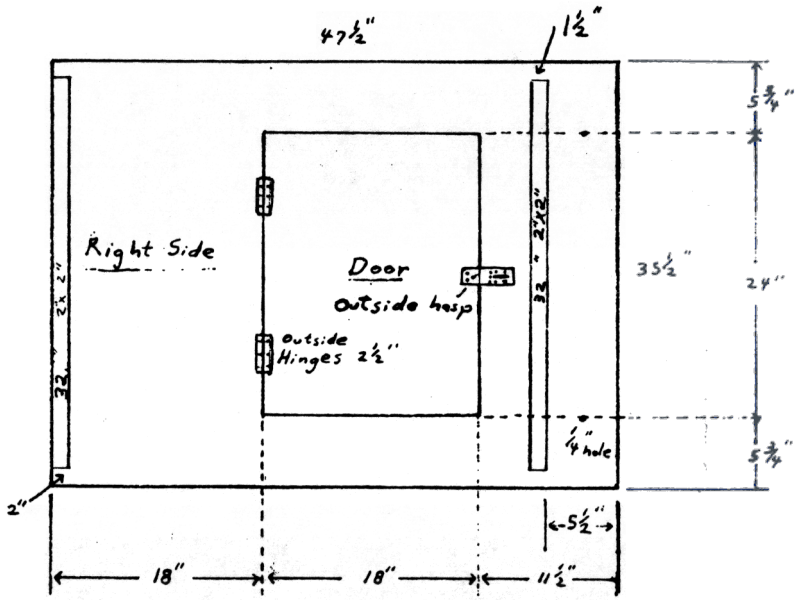
Fig. 4 Diagrams for construction of hack box.

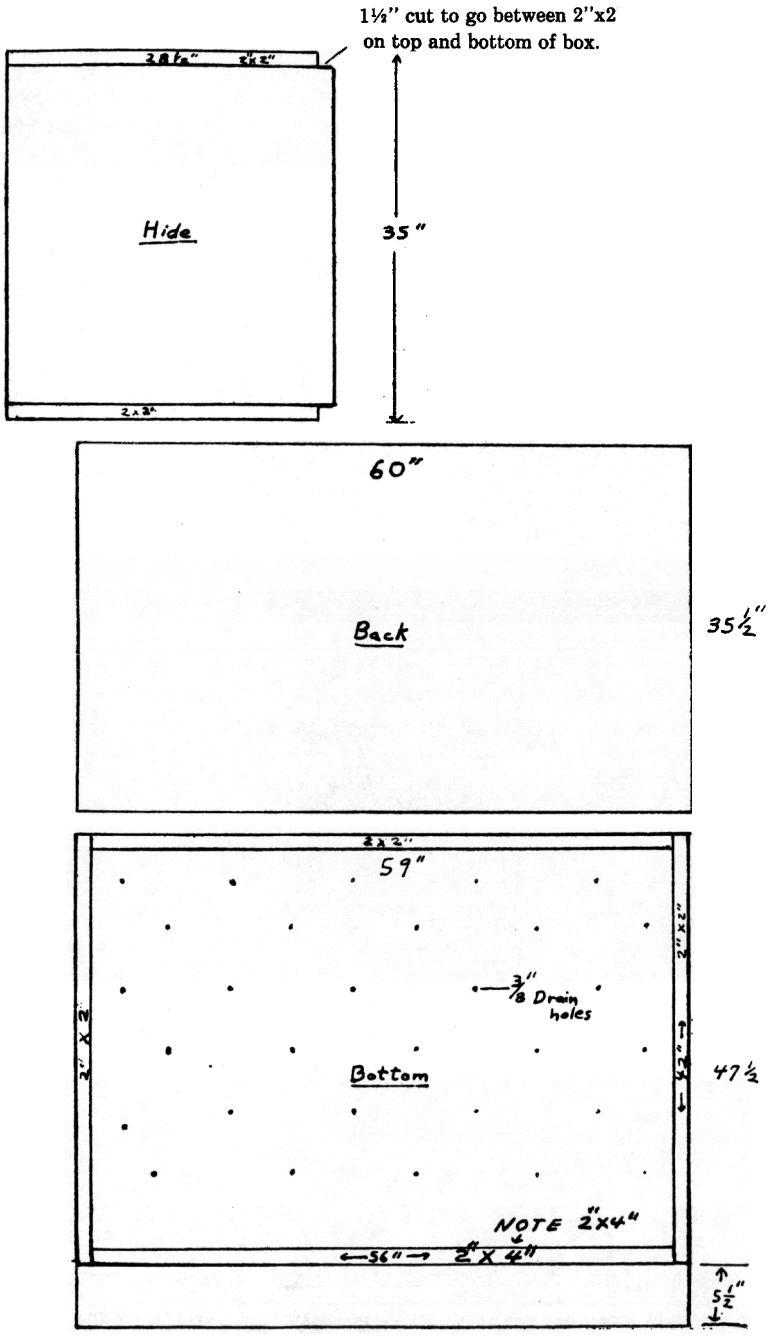


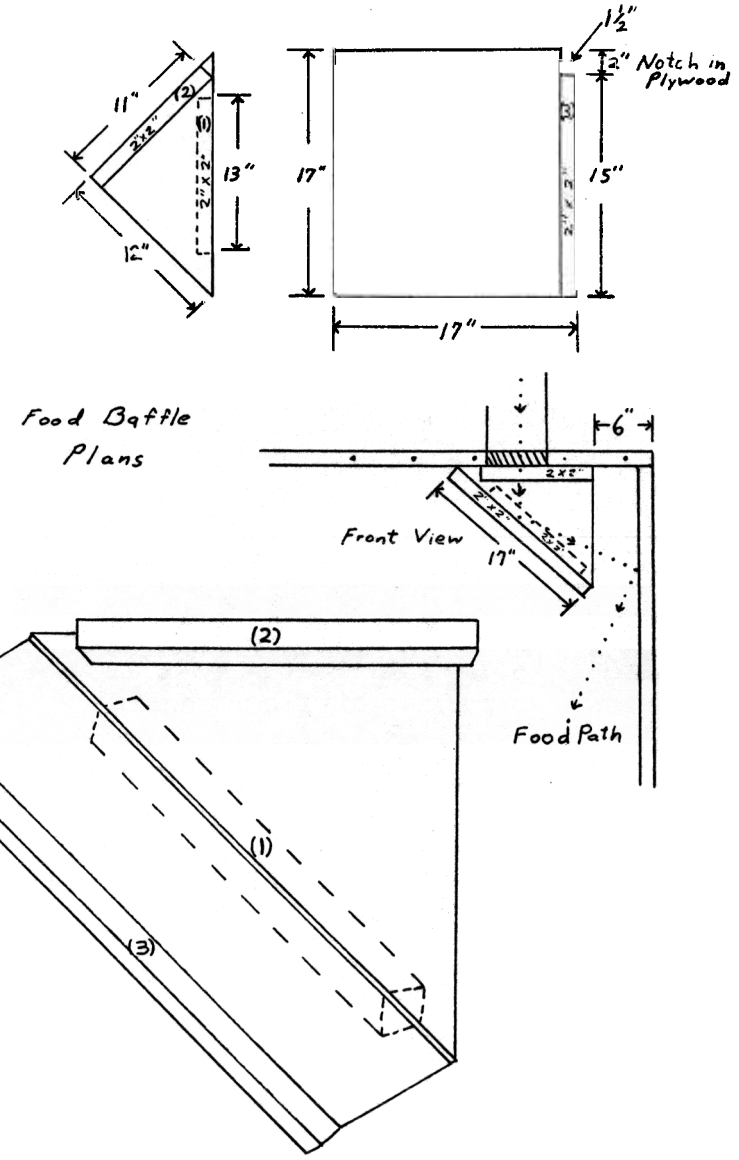

59" 2x6"
Front
28, ½" thinwall Conduit 33¼" long
34¾"
30"
2x6"
1"x6" backing
2x6"
59"
1"x2" welded wire covering front


22"
7"
Top View of Box
Door
2"x6"
¾" ⌀
⅛" Wingnut holes
2½" to start
ters Holes drilled with ¾" bit (28) Total
1"x2" Wire nailed to front of 2"x6" with staples


47½"
1½"
¼" ⌀ Hole
2"x2"
Left Side
35½
32"
2"
5½"


47½"
1½"
Right Side
2"x2"
32"
Door
outside hasp
outside Hinges 2½"
2"x12"
35½"
24"
5¾"
¼" hole
2"
5½"
18"
18"
11½"


1½" cut to go between 2"x2 on top and bottom of box.
28½"
2"x2"
Hide
35"
2x3"
60"
Back
35½"
2x2"
59"
3/8" Drain holes
Bottom
2" X 2"
2"X2"
47½
NOTE 2"x4"
56"
2" X 4"
5½"


1½"
2" Notch in Plywood
11"
2"x2"
(2)
(1)
2"x2"
13"
12"
17"
15"
17"
Food Baffle Plans
6"
2x2"
Front View
17"
(2)
(1)
(3)
Food Path

food chute. This support keeps food from catching between the sections of the roof and lends extra bracing to the chute. Holes, 1/2" in diameter, should be drilled into the sides of the 2" x 2" frame which is between sections of the double roof. Placement of these holes at 6" intervals provides air flow. At locations where only a single roof is necessary the top (upper) piece can be omitted from the plans.

If quail is the only food used at a site, a 4" hole in the roof and a food chute of 4" PVC pipe are adequate for the food to pass through. When five week old chickens or pigeons are used, PVC pipe of 5" to 6" in diameter may be required to prevent the food from getting stuck in the pipe.

The front of the box is framed with 2" x 6"s. Twenty-eight holes, 3/4" in diameter, are drilled on 2" centers in the top and bottom 2" x 6". The only exception is that the distance from the end of the board to the first hole should be 2-1/2". The center of the holes is spaced 3/4" to 1" from the inside edge of the 2" x 6", note * in plans. A piece of 1" x 6" backing is placed on the outside surface of the 2" x 6"s to hold the conduit in place. Holes should be drilled for the bolts that hold the front of the box in place (see diagram). Wing nuts are used for the attachment and removal of the front. Lastly, the 1" x 2" welded wire is attached to the front with wood staples or U nails. *Note that there is an approximate 4" distance between the conduit and wire.*

At sites where the box is left in place permanently, i.e. tower, urban, and some cliff sites, it is best to paint the top with aluminum roof coating or white oil paint. The rest of the box, inside and out, should be painted with a good wood preservative, "Cabots" or "Cuprinol". Do not use creosote preservative. Another option is to use pressure-treated plywood, in which case the box need not be painted with preservative.

All 2" x 2" framework is attached to the plywood with glue and 1-1/2" sheet rock screws as indicated. Note the 56", 2" x 4" which goes on the bottom or floor of the box. This board prevents the four inch depth of pea gravel from falling out the front of the box.

At sites where food is dropped down a food chute of PVC pipe, it is necessary to install a baffle in order to soften the impact of the falling food. Without a baffle, food which falls several meters, can injure young falcons. A baffle is not desirable at sites without a food chute. In the diagram of the wooden baffle, note that the 2" x 2" piece represented by a broken line (1) goes on the inside of the triangular piece and holds the two sections of plywood together. The two other 2" x 2" pieces are placed on the outside of the baffle. The 2" x 2" attached to the exterior of the triangular piece (2) is also attached to the roof. The 2" x 2" on the outside of the square piece (3) is connected to the back wall as well. When installed the baffle should be 6" from the end of the box. This allows the food to hit the baffle and bounce off the wall before dropping to the hack board on the bottom of the box. A 45° elbow to fit on the end of the PVC food chute inside the box can be used instead of the wooden food baffle to direct the food off the wall, but the elbow should only extend a minimum distance inside the box. If it extends too far young birds will attempt to jump up and perch on it, or they can damage their wings by flapping against it. Care should also be taken to test the elbow to insure that food dropped through it will not become clogged.

Hack Box Materials

3 sheets 1/2"CDX or treated plywood (4 sheets if double roof is employed)
1 - 75', 2" x 2" stock for framework
1 - 56", 2" x 4" stock for floor frame, front
2 - 8', 2" x 6" for front frame that holds conduit
1 - 6", 2" x 6" with a 4" or larger hole in the center to be inserted in the roof below the food chute
1 - 10', 1" x 6" backing for front frame that holds conduit
10 - 10' pieces of 1/2" thin wall electrical conduit to be cut into 28 bars 33-1/4" long
1 - 3' x 5' piece of 1" x 2" welded wire to cover the front of the hack box (staple to 2" x 6" frame)
2 - 2-1/2" hinges for door attachment
1 hasp to keep door secured
1 clip or padlock for hasp
1 box of 1-1/2" sheet rock screws for attaching 2" x 2"s to plywood
1 bottle of wood glue to be placed between 2" x 2"s and plywood before screwing
1 box of wood staples for attaching welded wire (staples from guns are not acceptable)
4 - 3" x 1/4" bolts and wing nuts for front attachment
white paint for roof and brown Cuprinol for the rest of the box
lengths of 4" to 6" diameter PVC pipe for food chute as required

Description of Delayed Feeder. The purpose of the delayed feeder is to prevent the falcons from associating the visit of the caretaker with the provision of food. It is a good idea to use the feeder unless a food chute has been constructed (cliff site) or the birds are fed from an observation booth (urban site) (see also Feeding).

The delayed feeder is simply an 8" x 10" wooden box that is 6" high. It is installed over a hole of identical size which is cut in the roof of the hack box. Both the top and bottom of the feeder are hinged, the top opening upward and the bottom down into the box. A hasp on the top keeps mammals from entering the feeder. A small eyescrew is set in the upper surface of the hinged bottom about 1/2" from the front, side corner. A small hole is drilled in the bottom of a side of the feeder so that it corresponds to the hole in the eyescrew. A 16d nail can be placed through the hole in the side of the feeder and into the eyescrew to hold the bottom up. Food is placed in the box, and later released by pulling a trigger line tied to the nail. When triggered the bottom drops down and releases the food onto the hack board below. The line should run freely through eyescrews set in one of the corner poles if used at a tower. It is convenient to attach an extension of about 2' of line from the nail to the box so that the nail will not come off of the tower every time the trigger line is pulled. Another short line should extend from the eyescrew in the bottom of the feeder (which is part of the trigger mechanism) and up and over the lip of the front of the feeder. By pulling this line before the box is opened, the bottom will raise and the trigger nail can be inserted. As a result, the young birds are prevented from seeing the attendant when he/she places food in the box. This line must be slacked when placing food in the box so that the bottom will be free to fall when the trigger is pulled.

The Construction of Cliff Sites

The construction of a hack site at a cliff is simple, but getting the materials up there is not always easy. After the sections of the box have been hauled to the cliff, they are lowered or raised to the ledge on a rope, and the structure is bolted together. It is sometimes necessary to build up a flat base for the box with rocks, logs, and dirt. Before the gravel is poured into the box, the steel cables which anchor the box should be attached. Saplings work well when extended over the edge of the cliff for perch poles.

The PVC pipe is used as a food chute from the top of the cliff to the hack box. Connecting pipe to the cliff is the most difficult part of rigging this type of site. The pipe is cemented together after a route up the rock wall has been chosen. If any slight bends in the pipe are necessary as a result of jutting rocks, allowance should be made before the PVC sections are cemented together. In some cases, especially where it may be necessary to dismantle the pipe, taping at the joints may be more desirable than cementing. The pipe can be secured to the wall by tying it in to pitons, rocks, or trees. Sections of rope can be used, but rubber shock cords work well because they provide constant tension. A tall coffee can or fruit juice can should be placed over the top of the pipe to prevent entry by small mammals. A dog leash clip that is tied and taped to the pipe and that clips into a hole on the downward rim of the can will keep the cover in place. After the pipe is secured, several test drops should be executed to insure that the food birds will fall all the way through the chute, hit the baffle, and drop to the area of the hack board inside the box.

The Construction of Tower Sites

NOTE: Measurements are provided in feet and inches (U.S. Customary System).

Towers can be constructed according to any number of designs. They should be built to last. The structure should allow the attendants to feed the falcons, should provide perches and shade for the birds once they begin flying, and should be a secure nesting place for adults that return to breed.

Our design is illustrated on the following pages. It consists of four, vertical, 30′ to 40′ telephone poles sunk 6′ into the ground and bolted together at the top by a 10′ square frame of 2″ x 12″ boards. The boards which form the actual platform are spaced 1″ apart to allow for drainage and to prevent antenna wires or tail markers from becoming tangled in small cracks. If the corner poles extend 2′ to 4′ above the platform, climbing over the edge is easier. Copper or coppercored lightning rods should be connected to two opposite corner poles. They should be high enough to provide a 60° cone of protection above the box and platform. Saplings, 2″ to 3″ in diameter and 8′ to 15′ long, serve well as perch poles when extended horizontally from the platforms. Vertical, crisscross bracing of 2″ x 6″ boards should be connected between all four poles. Depending on how solid the substrate is and on winds, it may be advisable to attach steel cables at each corner pole and secure them in the ground with sand anchors. Two 2″ x 6″ braces are placed about 3′ below the platform crisscrossing between opposite corner poles (Fig. 5). This provides perches for fledged falcons where they can sit protected from the sun under the shade of the platform. In areas of high wind, plywood may be framed between the poles on the windward side of the crisscross perches to provide a windbreak.

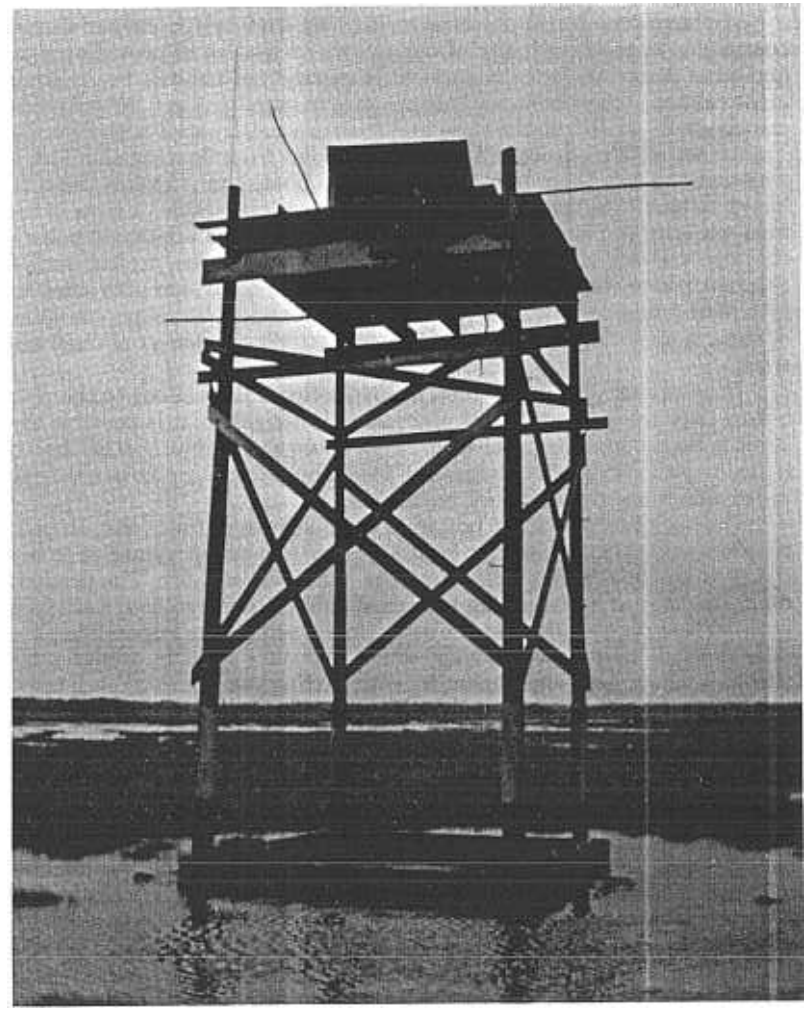


Fig. 5 Tower type hack site showing mudshoe, crossbracing, and perches below platform. Note also lightning rods.

Permanent spikes are driven into one of the corner piles starting about 12′ from the ground. A stepladder is used to reach the first spike. Sheets of 4′ wide aluminum or galvanized steel flashing should be wrapped around each pole starting about 6′ off the ground to prevent mammals from climbing the tower. It is very important that the metal be nailed only at the top and bottom and *not* nailed along the seam. Nails along the vertical overlapping seam can provide toe holds for raccoons and enable them to climb past the predator guard. Collars constructed of sheet metal that is at least 2′ in width should be placed at the top of the flashing.

We have been fortunate in receiving help from telephone and electric companies in erecting many of our towers as well as in providing poles and other materials for construction. In marsh-type habitat, heavy equipment cannot always be used. It is possible to erect by hand 30' poles that are about 9" to 10" at the base and that are not treated with creosote. Treatment with creosote will prevent the poles from floating should it be necessary to tow them to the site behind a boat, and it makes them too heavy to handle by hand. Wolmanized poles are preferable. A crew of four men working in pairs and using pike poles can raise telephone poles of this size without too much difficulty. For a conservation project such as this one, power companies can usually be convinced to loan pike poles and give instructions on their use. A climber that is adept at using pole spikes or some type of "cherry-picker" is necessary to rig up the rest of the framework.

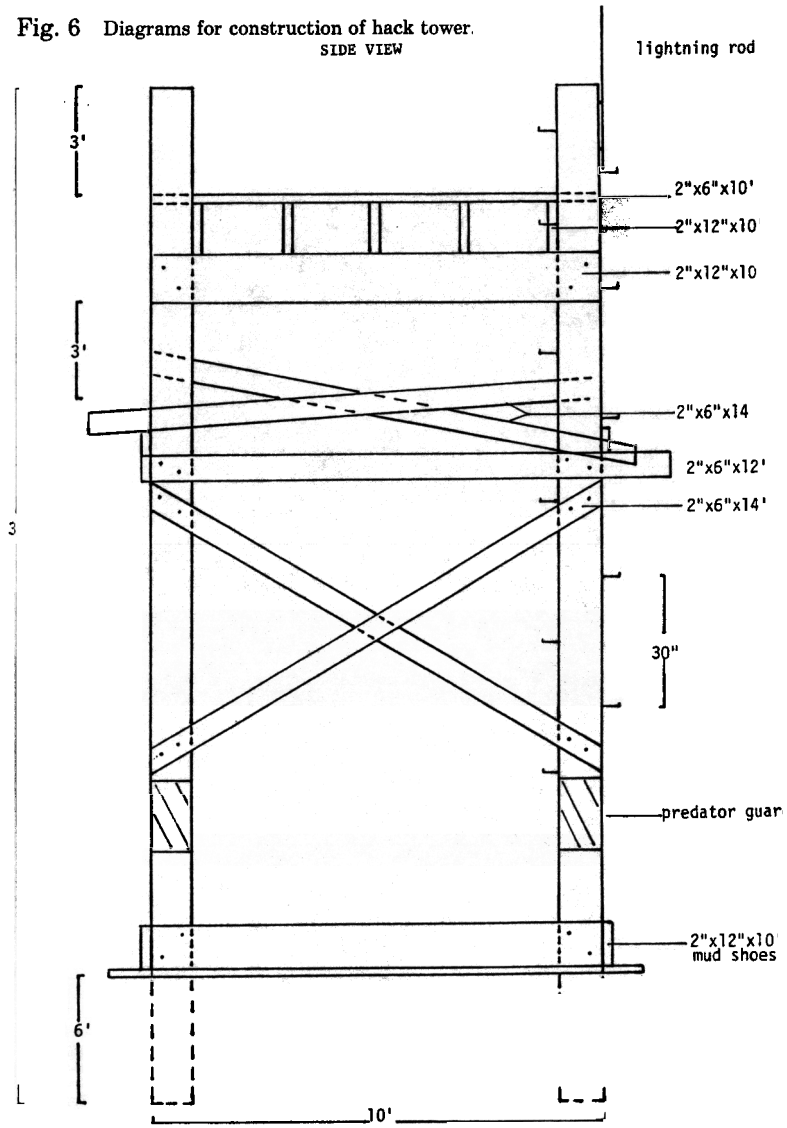
In most marshes it is a good idea to connect mud shoes to the poles before they are erected. If this precaution is not taken, it is possible that some poles might sink out of sight. Mud shoes are simply 2" x 12" boards nailed together in an "T" shape (Fig. 6) and bolted to the pole at the depth up to which the poles should be buried.

The hack box should be bolted to the platform of the tower. In order to offer protection to nesting adults as well as hacked young, it is best to orient the box facing away from the hot afternoon sun. The predominant direction of approaching storms should also be avoided. Satisfying both of these requirements at the same time is sometimes impossible. Since it is difficult to predict exactly which exposure nesting adults might choose, we have been experimenting with putting two boxes on each tower.

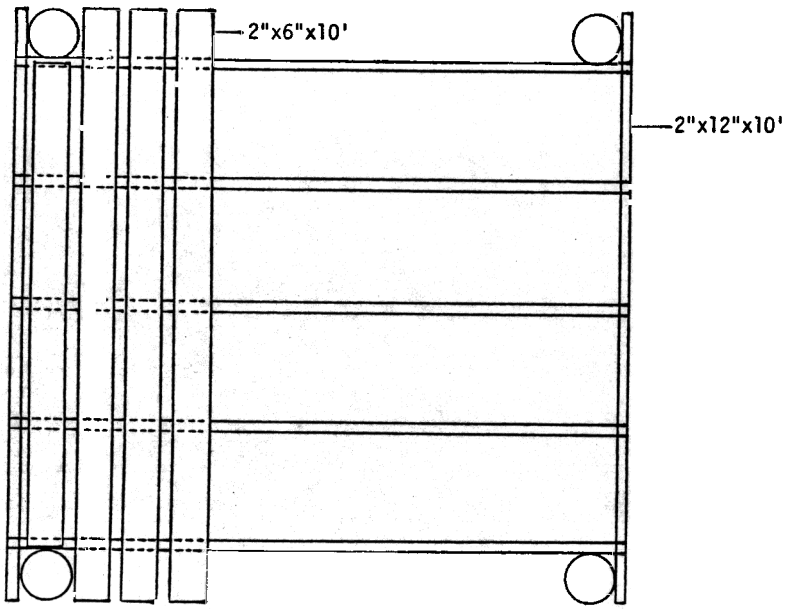
The boxes are arranged with the backs facing each other, and with a single back corner of one box touching the mirror-image corner of the other box. From above, the gap between the backs should form a 30° angle or V shape. A plywood floor is placed in the bottom of the V and a plywood roof on top. When both boxes and the floored V are filled with gravel, returning adults have a choice of three nest sites, each of which is exposed to a different direction. If falcons are placed in both boxes for hacking, it is necessary that the doors be placed on the ends of the boxes which are away from each other. Consequently, during construction the hide and door must be switched to the other end of one of the boxes.

If present, ospreys will use towers or the nest boxes on them as nesting structures. This is no problem if adult peregrines are nesting in the box as they will return to occupy the site before the ospreys. If no falcons have returned to the box, ospreys will probably begin nesting before the hacking season arrives. To prevent nest building by the ospreys, Dr. M. Byrd of Virginia has constructed wooden cones that fit on top of the box. They extend from front to back of the box top and angle upward at 30° or more.

Fig. 6 Diagrams for construction of hack tower.



TOP VIEW OF PLATFORM



TOWER MATERIALS

4 - 30' CCA treated poles (pilings), 9-10" bottom, 5-6" top
7 - 2"x12"x10', main beams (2), joists (5), 8 additional if mud shoes used
18 - 2"x6"x10' decking
4 - 2"x6"x12' square bracing
10 - 2"x6"x14', X bracing (8), diagonals (2)
2 lightning rods, grounding rods (6'), grounding wire (60') and proper connectors. Install lightning rods so they provide a 60 degree cone of protection for platform and box.
15 pole steps, start at 12' above ground, use detachable pole steps, if available, below 12'
4 - 4' x 3' sheet metal flashing for predator guards
32 -1/2" x6" galvanized lag bolts; 16 X bracing, 8 square bracing, 8 outside joists, add 16 if mud shoes used
8 - 1/2"x8-10" galvanized bolts for main beams
15 lbs. 16d galvanized nails for decking
10 lbs. 20d galvanized nails for framing

Suggestions for the Construction of Urban Sites

We have constructed most of our urban hack sites on the tops of buildings (Fig. 3). Although there are variations on every rooftop, the general structure which we use is a small tower similar to the one used in marshes. The platform is usually about 3' to 4' off the ground. This provides shade for the young birds, and shade is often lacking on rooftops. It is a good idea to place a large piece of indoor-outdoor carpeting under the tower. Two by twelve inch boards should be laid flat under the legs of the tower to spread the weight of the structure and to prevent breaking the seal of the roof. Building superintendents may not want the tower to be bolted into the rooftop because of potential leakage problems. In this case, sand bags can be used to secure the structure. The hack box should be bolted securely to the platform at the back edge of the tower. High winds are sometimes funneled up and over buildings, and every precaution should be taken to prevent harm to the falcons or to people below from blowing debris.

The main problem with a rooftop hack site is that once the birds have been released it is difficult to approach the box for feeding without being seen by the falcons. We circumvent this problem by building an "out house"-sized observation booth that connects the rooftop door to the back of the hack box. This requires placing the mini-tower close to the rooftop door. As a result the front of the observation booth functions as the back of the hack box. We place 6"x6" squares of one-way glass in the back of the hack box so that the attendants can observe the birds. A trap door in the back of the box serves as a feeding port. One-way glass windows look out on top of the hack box and below the tower platform as well as on other sides of the booth to allow viewing the birds after release. A few convex car mirrors placed in strategic locations provide a view of the booth top, etc. Windows in the booth should be covered with flaps of carpeting when not in use to prevent too much light from entering the booth.

Cities tend to be hotter than wilderness areas and a double rooftop on the hack box is imperative. It is also desirable to place a small bathpan in the hack box and to clean and refill it regularly when the food scraps are removed.

CARING FOR THE "FOOD BIRDS"

Coturnix quail (*Coturnix coturnix*), chickens (*Gallus gallus*), or pigeons (*Columba livia*), listed in order of preference as food for the falcons, are kept live at the site, or the "food birds" are killed and frozen. These "food birds" cost us $1 to $2 apiece to produce. In addition, the cost of transporting the birds to the hack site must be added. When one considers the total expenditure for food at all of the hack sites, it is easy to understand why we ask attendants to care for them properly so that we can keep down the waste.

If a food shortage develops, it is sometimes necessary to use quail, chickens, or pigeons from an extraneous source. Once past the nestling or "chick" stage, both quail and pigeons are suitable to feed to the falcons. Day-old chicks, however, have little calcium and are not suitable to feed growing falcons. Similarly, full grown hens are undesirable because they

are usually covered with fat, tumors, and other inclusions. They may be used as a last resort if they are cut up and cleaned of fat and other objectionable substances.

Live Food

In some of the areas where we are hacking falcons, we do not have access to electrical power. In such areas the food is kept live. Coturnix quail are the least hardy, and pigeons are the most hardy in outdoor conditions. Regardless of the type of bird, however, all should be kept strong and healthy because one cannot hack falcons without fresh meat to feed them. The cages should be set up on two parallel logs so that the droppings fall below the floor. The birds must be fed faithfully each day and watered several times a day. The food should be kept in a waterproof container because damp food will mold and possibly kill the birds. It is important to keep the "food birds" shaded from the direct sun except during the early morning hours. The birds must be covered with a tarp when it is raining or dewy. All the sides should not be covered, however, because the birds may suffocate or become overheated. Wet birds will probably die from hypothermia.

It is advisable to remove and bury all dead food animals. If quail or chickens have gotten wet or otherwise died of exposure, they are still usable for food as long as they are fresh. Birds which are suspect or diseased should not be fed to the falcons. Any diseased individuals should be buried away from camp, and the attendant should be sure to wash his/her hands after touching them. Pigeons are the greatest liability to disease. We medically treat any pigeons that are provided as food, or we direct the attendants to dose them.

Local predators are a major problem in keeping live food birds at the site. Raccoons, martens and even weasels (*Mustela* spp.) are particularly bad about eating birds through the cage wire. Feet, heads and wings are often chewed off the caged birds so the attendant should be on the lookout for these signs. It may be necessary to suspend the cages from trees to get away from these predators and especially from bears. In other areas, double-walled cages may be required to prevent depredation.

Frozen Food

In areas where electrical power is available at a nearby ranch house or other source we are now using small portable freezers and frozen quail or chickens. Every two or three days the hack site attendants transfer a small number of frozen birds from the freezer at the power source to a styrofoam ice box buried at their camp site. This method works well if no bears are in the area. It eliminates the necessity of feeding and watering the "food birds" as well as transporting feed and water to the site. It also eliminates the loss of food to predators and the elements.

A few comments concerning the freezing of "food birds" might be helpful. The birds can be killed in any number of ways including CO_2, suffocating by constriction of the thoracic area, or by propelling each bird against a large rock or concrete slab. The last method sounds inhumane, but actually the birds die instantly owing to an exploded heart. Once killed, the birds should be spaced apart in the shade and allowed to cool for a couple of hours. Then the birds can be frozen, but it is best to place them

apart until they are hard frozen, even in the freezer. If not, the birds in the center of a pile may spoil before they freeze. Regardless of the type of food that is used, hack site attendants must advise us by at least ten days in advance if supplies are running unexpectedly short. This is necessary to allow time for transporting more food to the site.

CARE OF THE FALCONS—PRE-FLIGHT

Hatching and Raising

In most cases our young peregrines are artificially hatched and brooded (Cade and Temple, 1977). Because we trust our researchers with newly hatched falcon chicks more than many of the adult peregrines, the young birds are usually fed by hand for 10 days to two weeks after hatching. They are then placed in a chamber with adults that are parentally motivated. The adults readily feed the youngsters, and usually within a day both the young and the adults respond well to each other. If there is any problem, it is most often because a youngster is unwilling to adopt a parent falcon after being hand-fed. Hunger overcomes this opposition shortly, and within two weeks when the young peregrines are removed from the chambers, they appear as opposed to human presence as do wild youngsters.

If there are no captive adults available to feed the young falcons or if the adults are "worn out" from feeding too many broods of young, we place the nestlings in a standard hack box at our facility. The box is faced away from all human activities, and the birds are fed through a chute. In this way the falcons become thoroughly accustomed to the interior of the hack box and feel "at home" when placed in the hack box at the actual release site.

Number and Sex of Young at a Hack Site

How many individual youngsters and how many of each sex should be released at a single hack site are points worthy of consideration. In the wild, the size of a brood is probably influenced by how many eggs an adult can cover during incubation, how many young an adult can successfully feed, and how plentiful the food supply may be.

Since the broods are usually composed of young from several parents and since we supply all the food that the growing youngsters need, it would seem that any number of young peregrines could be hacked at a single site. In theory, this is true except that the attendants must also guard the youngsters and keep them out of trouble especially during the first two weeks after release. A large number of young can be hacked at a site as long as no trouble arises. Of course, one never knows what might happen, and it is at times when trouble does occur that the error quickly becomes apparent. At one site we hacked nine young. About two days after release, an adult suddenly appeared and began knocking the youngsters out of the sky. Five were driven off to starve, and only four successfully survived to independence.

It is difficult for two attendants to keep track of more than six young at a site, and we place the limit on eight young. If more than six birds are to be released at once, the brood should be divided and placed into

two hack boxes. By adding additional site attendants or volunteers during the critical period after release, there are more caretakers per bird if something goes wrong. We feel safer, however, by not putting "all of our eggs in one basket" should tragedy occur.

We place the lower limit on three birds per site and preferably four. Owing to the high mortality rate of young peregrines during their first year of life, only one of three can be expected to survive once independent. Consequently, it is hardly worth the trouble and expense of the hacking procedure if less than three young are released per site even if other hacking stations are located nearby.

In one instance, we did experiment by hacking a single youngster at a site. The bird had difficulty in orienting back to the hack box and had to be returned several times. It appeared lethargic and did little flying. Clearly, a lone fledgling would miss the hundreds of hours of interactions that a falcon normally experiences once flying with its siblings.

The ideal, theoretical sex ratio for a hacked brood might be half males and half females; however, we must release whatever sex of bird hatches. It is necessary to group the young into broods of approximately the same age to avoid "bullying" and insure that all of the birds can get something to eat. If there is too much disparity in the ages, once flying the young falcons can be forced from the air into dangerous situations by older birds (see Consecutive Releases) that are further along in their behavioral development.

When all factors are considered, it is necessary to place the chicks into groups of six or less according to the order of hatching and development. This results in broods that are composed of various sex ratios. We sometimes alter the makeup of a brood by excluding or including slightly older or younger individuals in order to balance the sex ratio, but we try to avoid a spread of ages that is greater than one week. If the hack sites are in close proximity to each other and to wild eyries as we have already suggested, there should be no problem if one brood is comprised of all males and an adjacent brood of all females.

Transporting to the Hack Site

At four weeks of age the falcons can tear their own food, even though in many cases they are still fed mostly by their parents. If scheduling necessitates, the young may be transported to the hack boxes at this age. It is preferable, however, to wait until the young are about five weeks old before placing them in the hack box at the site. This extra week decreases considerably the number of "food birds"that must be moved to the field and insures that the young are eating on their own. At the same time, it makes the birds a little more difficult to transport since the feathers have grown out farther but are still susceptible to bruising or breaking. The ages given here are simply guidelines because there is considerable variation in the physical development between males and females of the same age and even between individuals of the same age and sex. Regardless of the age of transfer to the hack site, it is at this time that we place federal bands, color bands, and, if used, dummy transmitters on the birds (see Telemetry).

An ordinary cardboard box is best for carrying the young falcons while they are inside of a vehicle en route to the site. We use a cubic box that is two-thirds of a meter (about two feet) on each side. Up to three males or two females can be placed in each box. We cut three or four holes five centimeters (about two inches) in diameter at the top of each side of the box. This allows the rising body heat to escape, but prevents the growing tail feathers of the bird from being broken in the holes. We place about five centimeters (a couple of inches) of Sanicel (ground, sterilized corn cobs) or *clean* straw in the bottom of the box to soak up the excreta. If the trip to the site will take longer than a day necessitating that the birds be fed in the box, we prefer straw. Sanicel sticks to the meat and could cause an impacted crop or stomach. The straw must be clean, however, such as that used in the stables at horse tracks. Much of the straw that is commercially available is too dusty for our use and is liable to be a source of aspergillosis. The falcons should be checked periodically to make sure that they are not getting too hot in the box.

It is natural for the falcons to pant if they are too hot, but panting is not desirable since it indicates that the birds are under stress. If a falcon is so hot that its tongue is sticking straight out and the tip is bent downward at a right angle, the situation is serious. The bird should be placed in the shade immediately and given water.

Caution should be used when placing a second or third falcon in the cardboard box. Usually birds already in the box will grab anything that is placed in with them, including a hand or a sibling. If one falcon grabs another, continued efforts to separate them are usually futile, because in their fright they immediately begin clenching anything and everything once freed. This can result in more dangerous situations than originally existed. When one bird is gripping another it is best to close the box and leave them alone. They will gradually release their grip. If a talon is near an eye or into a wing, however, an effort should be made to free the birds.

When it is necessary to handle a falcon, it is best to hold the bird with two hands by placing an open palm over the back and dorsal surface of each wing (Fig. 7). The grip should be high across the back, just below the wrist of the wing. It is not acceptable to hold a falcon with one hand. A young falcon should never be held in this manner because the growing primaries can be easily damaged. In the same manner, a young falcon should not be held by the feet or legs alone for more than a few seconds. This is because the leg joints are still soft and easily damaged as are those of the wings which will be wildly flailing in the air if the bird is held in this manner. If a young peregrine grabs a human or another object with its feet, the person should try to bear the pain while gently prying the talons loose. If the individual flinches and immediately jerks away, the soft, growing talons can be easily torn loose from the toe of the bird.

Once the area of the release site is reached, it may be necessary to hike in the rest of the way on foot, go by helicopter, boat, or snowmobile. In all cases the box containing the young must be hand held as the birds can be seriously injured during the jolting and jarring that occurs on the seat of a boat or snowmobile. If the weather is too rough when crossing the water, the trip should be put off a day. It is possible to get into situations on the water where one cannot hold himself/herself in the boat, let alone hold the birds.

Fig. 7 Proper way to hold a young peregrine. Note also the woven backpack type basket used for carrying the nestlings to the hack box.

If a hike is necessary to reach the release site, it may be desirable to rig up one of the woven basket-type backpacks or picnic baskets for carrying the birds (Fig. 7). A two story container can be made by rigging up a divider in the woven backpack (Fig. 8). The inside should be lined halfway up with a smooth material to prevent the falcons from catching their talons or jamming their tails into the basket. Sanicel or straw should be placed in the bottom. It is best to hike to the site early in the morning when the weather is still cool. The cloth in the basket can be wetted to help keep the birds comfortable.

Fig. 8 Woven backpack type basket with two stories. Two, three week old peregrines rest on the floor of the second story.

Placement and Care of the Birds in the Hack Box

Before placing the birds in the hack box, we usually skin and quarter about two quail or one chicken/pigeon per falcon and place them on the hack board (see also Feeding). We then place the falcons behind the hide where most of them prefer to take refuge. A few, however, will come out grabbing with their feet. Care must be taken not to let them grab the other falcons as they are placed inside. It may take a few hours for the birds to settle down and begin eating, depending on how long it has been since their last meal.

Between the time that the birds are placed in the box and the time that they are released, the attendant should spend an hour or so each day watching the falcons through the peepholes in the box. The attendant should never go in front of the box! Observing may necessitate that the attendant sit absolutely motionless while watching because the young are keenly aware of any noise outside the box. It may also be possible for the attendant to see the young between the front bars by observing through the spotting scope from a distance. The caretaker should make certain that all the birds are eating and that each appears to be in good shape. If the attendant suspects that one of the birds has some sort of abnormality, he/she should call us immediately to discuss the problem.

Fig. 9 Technicians placing falcons in a hack box located at a cliff site. Note white PVC food chute at rear of box and wired/barred front of box.

FREE FLYING FALCONS

Release

At around 42 to 45 days of age the young peregrines are old enough to be released. During the days just before this time, the birds may try to climb the bars of the box. This is part of a pre-flight restlessness that the young normally exhibit. In the wild the young leave the nest ledge on foot at this time and scramble to different points along the cliff, but they may not fly for several days thereafter (Sherrod, 1982). The exact age of release can vary according to the individual rates of development, sex, and type of hack site. Some individuals seem to grow slightly faster than others; individuals of the smaller forms of peregrines nearly always develop to the stage of flight slightly before those of larger forms. Males are usually ready to fly a day or two before the larger females, but it is necessary to keep them inside the box until the rest of the young have developed to the stage for release.

The winds present at nearly all cliff sites produce updrafts that stimulate the young to fly, as well as keep them aloft on flight feathers which are only three-fourths grown out at this time. On the contrary, the physical structure of a tower does not result in updrafts, and once off the tower, the fledgling peregrine may have more trouble in getting airborn again should it land on a low perch or the ground. Since flying ability is largely a matter of maturation, releases at towers may be timed a day or two later than at cliffs. The falcons should be released, however, before they are too old. During some of our early hacking attempts two of four falcons released around 55 days of age flew off and never returned. The idea, then, is to release the falcons before they can fly too well but after they can fly well enough to take off from a ground dwelling predator should they end up in that situation.

The *actual release process* may be the *single most critical aspect of the hacking procedure*. Since these birds are wild, the presence of a human worker in front of the hack box while the barred front is being removed is usually enough to make the falcons bolt and perhaps fly straight out of sight. The same may happen if the falcons look out or up and see a human within 30 meters (100 feet). To prevent this problem from occurring, we clean out all scraps of food from the box and withhold food from the birds on the day prior to the release date.

On the day of release a worker carefully enters the box with a roll of duct tape and a pre-cut piece of cardboard (approximately 25 centimeters or 10 inches by 83 centimeters or 32 inches). An attendant stationed outside the box closes it once the worker has entered. It is imperative that utmost care be taken to insure that no falcons escape from the box at this time.

If transmitters are not placed on the birds the falcons can often be herded or placed behind the hide with a minimum of effort. The cardboard cover is then taped or braced over the opening for about ten minutes to contain the birds and to keep the compartment dark. In the darkened conditions the falcons usually calm down.

If transmitters are placed on the birds, the cardboard can be secured to the hide and folded in such a way that there is a small flap at the bottom about 20 centimeters or 8 inches from the floor. This is done before

the birds are caught. Then the first bird is carefully grabbed and restrained while a transmitter is placed on its leg (see discussion on telemetry). Afterwards the bird is placed in the hide through the cardboard flap. The same procedure is followed until all birds are behind the hide.

We place the white hack board, off which the falcons have fed while in the box, out front. We then secure a two to three day supply of food per falcon on and around the board (i.e. six quail or three chickens/pigeons per peregrine). A few of the quail are left in front of the hide so that the falcons can see them immediately after the hide has been removed. This is done to prevent flushing the young birds after they are released but before they have chosen to fly on their own (see below).

All workers except the one who removes the cardboard then clear way to a distant viewing area. That worker carefully removes the cover and retreats from the rear of the box in the most expeditious and inconspicuous manner. The young may come out from behind the hide within a few minutes or may wait until the next day. The falcons usually advance to the front, see the food and begin eating. Occasionally, however, a young bird will jump out and take off immediately. Such a bird should be watched, but it will probably return after a few circles or sometime later in the day (see below). The vast majority of the birds stay, eat, and spend a considerable amount of time observing their surroundings and flapping their wings rather than immediately bolting from the box.

Frequently photographers and public relations officials want to get good close-up photos of the birds coming out of the hack box. At the time of release this is just not possible because it is simply too risky. A picture of a young peregrine frightened off into flying away to starvation is not worth much. Photos which can be used for the same purpose may be obtained safely about a week after release or whenever the birds have been flying and returning repeatedly to the box.

The time for the first flight of an individual is completely unpredictable. If released at the suggested ages, most birds will be flying within three days. In a few cases, certain individuals have waited up to seven days before taking their first flight in spite of the fact that a brood mate of the same sex and age may have first flown on the initial day of release. If the birds have not flown by the time that the three day supply of food runs out, it can be tricky to provide food for the falcons without flushing them. The food chute can be used at most cliff sites, but it is more difficult at tower sites. A falcon forced to fly for the first time in this manner may become disoriented and try to land in the water or at another unsuitable location; therefore, this situation should be avoided. It is just for circumstances such as this that a boat must be handy if the site is near the water. Unfortunately, it is not always possible to avoid such an instance, and each case can be different. It is sometimes possible for the attendant to approach closely and lightly toss the food near the box while keeping the box between himself/herself and the birds. There will be some cases, however, in which the only alternative is to flush the birds off into their first flight in order to place out additional food. It is important to have food at the site when a fledgling first returns so that from the start it associates its return with obtaining something to eat.

The First Week After Release

How well the falcons can fly on their maiden attempt is often surprising, especially at cliff sites. They usually have little trouble in staying aloft, especially if there is some wind. Landing is another matter. The fledglings can be very clumsy at this, and they often have difficulty in negotiating smooth landings during the first two or three days of flight.

After the release, the major hurdle is the first return of all the young to the hack site for food. It actually appears to be a matter of training the birds to return. The homing instinct of the fledglings is well developed, but it appears in most cases to be directed only to a general location. That is, the falcons return and hang around the area, but may have trouble finding the exact spot to which they must return for food. This is especially true at the cliff sites, where the box is often camouflaged and not particularly obvious against the rock. In addition the falcons have never seen the box from the outside. This generalized type of homing behavior is not surprising considering the behavior of young falcons in the wild. After fledging, the young at a wild nest are scattered out on the cliff, and the presence of an adult returning with food elicits begging from the youngsters. The adult then goes to the young falcon. Later the young falcons chase the adult for food (Sherrod, 1982). In both cases they have a moving, living parent on which to fix their attention.

In open fields or marshes the artificial towers are obvious, and they are frequently the only perches nearby. On the cliffs, however, the young birds will often glide up and down the face in front of the box without apparently recognizing it. For this reason we place the white hack board covered with quail or chickens directly in front of the box in order to attract the attention of the peregrines. It is a good idea to break the wings of the dead quail/chickens/pigeons at the humeri so that the wind will cause a flapping motion that catches the eye of the falcon. The presence of unfledged siblings or other young eating at the site also facilitates the return of the birds which have already flown.

Often fledglings will not return to the box immediately after their first flight. The hack site attendant should try to keep track of the birds at all times with binoculars and telemetry. This person should be cautious when searching for the birds in order to prevent inadvertently flushing perched individuals. A young falcon may make its initial flight and then spend the rest of the day in a tree, on a tower, or on the cliff. It may not return for food during the first day of flight, nor for most of the next day. Since the falcons have had all that they want to eat up to this point, they are fat when they first fly and are not extremely hungry. It may take three days before they find the hack box and food supply, but a careful watch should be made of such birds during the entire period prior to their initial return. Should a peregrine fail to come back to the box by the end of the third day after departure, it may be necessary to place food at other perching locations or to make every effort to see that the bird gets something to eat. Finally, an effort should be made to retrieve the bird. The falcons usually begin showing signs of weakness after three days with no food. Placement of food at locations other than the hack box should be done only as a last resort, because it is desirable for all the birds to return to a common food supply at the box. Falcons that have returned to the site

once usually have no problem in finding the site again, and the hack site attendant can rest a little easier after this has occurred.

During the first few days of flight, falcons that land on the ground or that fall after failing to land in a tree or on a pole are vulnerable to predators. Mink (*Mustela vison*) and otters (*Lutra canadensis*) in marshes and foxes and coyotes in woods or fields are dangerous threats to grounded fledglings. Hack site attendants should mark down all birds when they first land. This may not be possible initially, especially at a cliff site, but efforts should continue until the birds are sighted or found with telemetry. Falcons that fly into a woods should be located to make sure that they are off the ground. It is not necessary that a bird be picked up immediately unless the situation is obviously dangerous. Instead, the bird should be guarded from a nearby observation point but not so closely that the falcon is overly nervous at the presence of the observer. A careful lookout for predators should be kept in the area around the bird. The falcon will probably make its way up to a higher perch within a couple of hours. As long as the bird gets to a safe perch off the ground, it can spend the night there. If the perch is in an area that looks like it is vulnerable to owl attacks, etc., it is advisable to flush the falcon well before dark. If the peregrine stays on the ground, the attendant should retrieve it a couple of hours before dark, and place it behind the hide in the box.

The easiest way to capture a newly flying falcon that has become grounded is for two people to work together. One individual slowly approaches from the front while making occasional movements to gain the attention of the bird. The other person approaches from behind, but remains motionless each time the falcon turns to watch in that direction. Finally, a light jacket may be thrown over the bird from the rear or it may be grabbed from the back over both wings. Once the person has approached close enough from behind and the decision is made to make the grab, he/she should not hesitate because the falcon may sense the danger and take off.

Behavior of Young Falcons on the Wing

Aerial Behavior, Pursuit of Prey, and First Kills. As we have already mentioned, once the birds have been flying for a week or so, the main period of danger is passed. After that time, the primary responsibility of the attendants is to place food at the hack site daily, but notes should still be kept on the daily activities of the birds.

Aerial behavior by the young birds varies according to the age of the birds at release, their sex, and the physical properties of the site. Males are nearly always more adept at aerial activities than females. Older birds seem to exhibit certain types of behavior sooner than younger birds that have been flying for the same amount of time.

The first type of flight behavior that usually occurs is simple flight from one perch to another (perch to perch flights) with little or no interaction among the young while in the air. These may occur for several days longer at a tower site than at a cliff site because of the lack of updrafts at the former on which the young can ride. Within a few days the birds may begin chasing each other in a type of sibling pursuit or mock combat. One bird will fly above, below, behind or alongside of the other. The siblings will repeatedly extend their legs and opened feet while grasping

toward each other, rolling over and diving together. Sometimes the birds will actually grab feet and tumble several meters through the air. Two or more siblings may participate in this activity at once, and it is usually accompanied by a screaming type of vocalization. A sample of 25 hacked males and 29 hacked females began participating in mock combat at an average of 46.7 days of age and 49.4 days of age respectively. A sample of 23 hacked males and 31 hacked females began mock combat at an average of 2.3 days and 2.8 days of flying (Sherrod, 1982).

Soon the falcons begin grasping at inanimate objects. The peregrines will fly by and grab leaves blowing in the wind, sticks floating in the water, small rocks, or clumps of grass. They often tag trees and bush tops. Sometimes young peregrines will even hang upside down from a branch until they break it off and carry it away while "plucking" the leaves from it in the air. The falcons catch all types of insects and other airborne invertebrates. Some of the insects are eaten and others are discarded. Many of the invertebrates escape, but it appears that the young falcons are often not very serious about catching these animals. The pursuit of insects seems to be determined mostly by weather conditions since invertebrates are usually most active during warm periods.

The young peregrines also pursue other birds and even a few mammals. Some of the species pursued are appropriate prey for falcons while others are completely inappropriate. In a study of seven broods of peregrine fledglings, Sherrod (1982) lists more than 75 avian species that were pursued by young peregrines ranging in size from seaside sparrows (*Ammospiza maritima*) to great blue herons (*Ardea herodias*). Mammals ranged in size from the little brown myotis (*Myotis lucifugus*) to white-tailed deer (*Odocoileus virginianus*). The young falcons are stimulated to pursue almost anything that moves. They seem to chase with greatest frequency those species that are most obvious in the area of the hack station. A sample of 43 hacked males and 41 hacked females first began pursuing other vertebrates at an average of 50.6 days of age and 55.7 days of age respectively. A similar sample of hacked males and females began first vertebrate pursuit at an average of 4.7 and 7.9 days on the wing respectively. The first pursuits of vertebrates by offspring from wild nests fell into this same range of time on the wing. The first 10 hacked males to make pursuits after vertebrates averaged 1.7 days on the wing before beginning this behavior and the first ten hacked females to pursue other vertebrates averaged 2.3 days on the wing before beginning such pursuits (Sherrod, 1982). There is a lot of individual variation among the falcons in this respect. Initially, small birds will quickly outfly the young peregrines as will larger species, although to a lesser extent. Often other birds will reciprocate and begin aggressively pursuing the peregrines during the initial chases by young falcons. Soon the peregrines will be able to keep up with larger birds such as gulls, herons, or ravens, and although the falcons can easily grab these species they do not. Most of these chases are not of a serious nature, and the falcon will simply follow along behind the prey without even dropping its feet. Sometimes the falcon will tap the other bird with its feet or hover above it once the bird has landed. Gradually the peregrines will be able to keep up with the more maneuverable, small birds that are flying in the area, and the pursuits become more serious. In most cases, it is these smaller species that comprise the first kills of young peregrines. Of 69 kills which young hacked peregrines made and which could be identified, only three consisted of medium to large species [green heron (*Butorides virescens*); white-faced ibis (*Plegadis chihi*); and laughing gull (*Larus atricilla*)] (Sherrod, 1982). As with the first pursuits, the age at which young peregrines make their first kills varies a great deal with individual falcons. A sample of 62 hacked males were known to have killed at between 55 and 102 days of age and between 9 and 55 days on the wing. The males in this sample were observed to make kills at an average of 73.3 days of age and 27.7 days on the wing. A sample of 33 hacked females were known to have killed between 59 and 91 days of age and 12 and 41 days on the wing. The females in this sample were observed to make kills at an average of 76.8 days of age and 30.9 days on the wing (Sherrod, 1982). Although an observer will probably see the young falcons chasing other birds at a hack site, it is rare to witness an actual kill. It is much easier to see this event in a marsh where the terrain is flat than at a mountainous hack site.

Wild peregrine parents transfer birds to their young in the air and even drop both dead and live prey to their offspring. This type of parental behavior, however, is not necessary to stimulate a young falcon to pursue or capture avian prey. Young peregrines are genetically programmed to exhibit both types of behavior even though parental influence does not exist. Similarly, it is not necessary to cut back on the food supply in order to stimulate young peregrines to pursue or to kill prey species. In fact, Sherrod (op. cit.) found that a cutback of food within about the first ten days to two weeks of flying caused a decrease in the pursuit of vertebrates by young falcons. Young peregrines treated in this way returned to the hack station where they sat and screamed waiting for food. Within a few days of resumed feeding, the falcons were eagerly chasing prey again. Frequently, a young peregrine can be seen flying in pursuit of potential prey even though the falcon has a full crop.

Sherrod (op. cit.) found that hacked peregrines which were intermittently deprived of food began killing on the average between two and four days on the wing sooner than peregrines which were fed all they could eat; however, 71 percent of all the observed kills by males and 55 percent of all the observed kills by females were made during the periods when the falcons were receiving all the food that they wanted. The birds which had not already made earlier kills began killing during the sixth week of hack when the food supply was provided on alternate days only. A six week long hack period is based on the minimum period of flying dependence that wild peregrine fledglings enjoy (Sherrod, op. cit.). We feel that a peregrine which builds up a natural supply of fat during the dependency period and which kills of its own natural instincts has a better chance of surviving after independence than one that is "starved" into killing. By the sixth week of hack the falcons have developed enough aerial skill so that they can easily catch prey and, in fact, readily do so almost immediately when the food supply is only slightly reduced. If the food supply is reduced when the falcons have been flying for only two to three weeks, some birds may be successful at killing, while others may starve to death (Sherrod, op. cit.).

Dispersal

Keeping track of the young falcons at a mountainous hack site is more difficult than at a marsh site. The birds can quickly disappear behind rocks and over hills at the former type of site. By the time the falcons have been flying for three weeks or more, they will probably be ranging some distance away. Sherrod (op. cit.) has tracked hacked falcons that were ranging as far as about 15 kilometers (about 10 miles) from the hack site by the time they had been flying about 18 to 21 days. Sometimes because of extreme heat, humidity, or lack of wind, the falcons may remain sluggish and will not range out for several weeks. This is especially true at tower type sites.

Even though the peregrines are ranging from the hack site and may only return to the box once a day for food, this does not mean that they are independent or are dispersing. This is part of the natural exploratory behavior which exposes them to the big wide world including new prey sources, other raptors, and sometimes even fatal experiences. It can be rather boring for the hack site attendant who only gets to see the falcons for a few minutes each day during this period, but the vigil must be maintained in order to successfully complete the project.

The young peregrines will nearly always return to the general hack area to roost. After a couple of weeks or more on the wing, it sometimes happens that a falcon does not return to the hacking area to roost for the night. The bird may return the next day or even the second day afterwards. This behavior usually indicates that the peregrine has made a kill, gorged, flown up to a perch and roosted elsewhere for the night. A close watch should be kept for that bird, however, because its absence at roosting time or during the morning afterwards may also mean that it was killed or frightened off in the night by a predator. As we have already mentioned, the fact that a young peregrine has made an initial kill does not mean it is independent and does not indicate that feeding should be discontinued by the site attendants.

Sherrod (1982) found that 77 percent of 52 hacked males and 63 percent of 46 hacked females dispersed voluntarily prior to the beginning of the sixth week of hacking when food was provided only on alternate days. In a sample of 29 males the average age of dispersal was 75.9 days and the average time on the wing at dispersal was 29.6 days. A sample of 17 females dispersed at an average age of 80.6 days and at an average time on the wing of 32.9 days. A few hacked birds in this sample dispersed voluntarily or involuntarily by three to three and one-half weeks on the wing and were known to have survived, but most did not. Sherrod found that in a migratory population of peregrines (Greenlandic), the wild family group remained together for about five and one-half to six and one-half weeks from the time that the young first took flight until the time that the falcons began to migrate. The parents were still feeding the young at least part of the time up until migration. He found that young peregrines in a resident population (Australian) were still being fed by their parents at least part of the time up to ten weeks after first flight. Some family groups in this same population were apparently still together up to three and one-half months after the young had begun flying, but there is no evidence as to whether or not the young were still receiving food from their parents at this time. To summarize, we have found that a hacking period of six weeks seems to be sufficient to allow the young falcons a maximum chance for survival.

Tameness

The hacking program is set up so that every effort is made to avoid exposing the falcons to an association between food and humans. Nevertheless, it is inherent in such a project that the human caretakers must be present, however inobtrusively, in order to guard the birds and to see that development is progressing normally. Concern has been expressed by some parties in the past that the young peregrines at hack sites are "too tame". It is very difficult to define what "too tame" really means. When one has visited many wild peregrine eyries with young that are newly flying and where there has been little if any human intrusion before the visit, it becomes clear that relative tameness is a characteristic of all immature peregrines. This is true whether they are hacked or raised in a wild nest. They will frequently allow humans to walk up within a few meters of their perch without showing alarm. This characteristic is one reason that this bird has been so desirable in the past for falconry; it easily adapts to life with man. Unfortunately, it is also the same reason that the bird is so vulnerable to shooting. With time immature peregrines, even if raised by hand, become wild and afraid of man. If the procedures outlined in this pamphlet are followed, we feel that an independent, hacked peregrine falcon will be comparable in every aspect including tolerance of man to a peregrine falcon that has been raised in a wild nest.

FEEDING THE FALCONS

Some information about feeding the falcons has been presented in several of the sections which deal directly with hacking. The following pages include a few additional comments on feeding the peregrines during the hacking operation as well as a brief summary of the feeding schedule.

The amount of food that the falcons eat will vary according to the ambient temperature, their age, sex, etc. It will range from one to two quail per day to one chicken/pigeon per day or even more per peregrine. The attendant should begin by feeding one and one-half to two quail per day or one chicken/pigeon per day per peregrine. It is better to overfeed than vice versa. The attendant should kill the birds and cut them in half before feeding them to the falcons. This will reduce fights among the young. Since it may be the first time the young have not been fed by adults, the sight of fresh, defeathered meat may be necessary to get them started eating from a carcass. If the falcons are particularly young, less than 32 days of age, it may be necessary to cut up the food into small pieces during the first few days after the falcons are placed in the box. This will be an added inducement to get them eating on their own. Later after the falcons are stronger and eating well, the food birds can be given whole. This will retard spoilage, moisture loss, and fly infestation. The falcons will usually discard most of the entrails, but it is best to leave these organs in the food birds. Studies conducted for us have shown that if the entrails are removed the nutritional value of the food is reduced and even deficient in some vitamins and minerals essential for proper growth and development.

The food should always be dropped in so that it lands on and around the white hack board. The falcons soon learn to associate the board with food. This is especially helpful when released birds are initially finding their way back to the box. As they glide by the ledge and recognize the hack board, the birds will land and eat.

After a few days the young will be feeding well on their own, and when the attendant feeds the birds, he/she can check through the peepholes for leftovers from the previous day. Food should be cut back if too much is left over. A little more should be fed if every bone is picked clean.

The leftovers can be cleaned out through the end door every two or three days or as necessary. This is also a good time to clean out and replace the small bath pan if one is being used. By sticking head, arms and shoulders through the door, one can block the birds from bolting out of the opening. THIS HAS NEVER HAPPENED AND NEVER SHOULD! The remains are placed in a bag and carried to the garbage at camp. The attendant should never throw them on the ground as food will attract raccoons, crows, and other animals that can be hazardous to the falcons or that will repeatedly return to steal food.

Feeding should take place at a standard time each day, for example 8 a.m. or 4 p.m., both before and after release. If the birds are young, it is best to feed them small portions on a twice a day schedule and then switch to larger portions on a once a day schedule within a few days. Getting the falcons on a regular feeding schedule will be useful later when the birds are wandering out of sight. During this later period an observer will be more likely to see the birds near the box at feeding time.

The falcons should never see the attendant with food. If this happens, the birds will soon learn that humans are a source of food, and the peregrines will direct food begging behavior toward people. This behavior will of course heighten their chances of harm by humans. Food should be carried to the hack box or food chute in a closed container such as a paper sack both before and after the birds are released. If the birds are being hacked from a tower, the attendant should approach during the period before release by walking about 130 to 180 meters (150-200 yards) out around the structure. It is best for the caretaker to come in from behind and drop the food into the feeder so that the birds do not see the person. After a few minutes the feeder can be tripped from below the tower (see Description of Delayed Feeder).

Once the birds have been released, if possible it is desirable to place the food at the hack box while the birds are away. There will probably be times, however, when it is necessary to flush the birds from the area of the box in order to place food out for them. These circumstances should be kept to a minimum and even at these times, the birds should not be allowed to see the attendant with food.

Daily feeding should continue for as long as the falcons return regularly (see Dispersal). A bird may be gone for two days but come back starved, so feeding should not be stopped just because a bird fails to show for a single day or two. Even though the falcons might be seen catching an occasional meal, they might still be unable to make a completely independent living at the time.

The same feeding schedule then should continue throughout the hack period with the following exceptions:

(1) The falcons are not fed on the day prior to release. At the time of release enough food for at least three days is placed on the hack board in front of the hack box (see Release for details).

(2) If trapping is necessary the falcons are not fed on the day prior to trapping or until they are trapped.

(3) Except for (1) and (2) above, food is placed out every day for the first five weeks after release. Unless all the falcons have completely dispersed, food is placed out only every other day during the sixth week of hacking and then discontinued after that time (see Dispersal for details).

Close attention should be given to the food that is left out for the falcons after they have been released. It may appear as if the falcons are cleaning up all the scraps when in reality raccoons, crows, vultures, martens, or even squirrels are carrying it off. The attendants must be absolutely certain that it is the falcons which are eating the food. Rivalries sometimes develop among sibling falcons, and certain individuals may be prone to flying off with their food. This is permissible, but if an individual begins caching large amounts of food, it may be necessary to discourage this behavior by tying the food down to the hack board or to rocks and logs immediately in front of the box. In the later stages of hack it may also be necessary to tie down the food in order to determine which individuals are still returning.

As simple as it seems, there is a right and wrong way to tie the food down as we have learned by experience. Whole quail/chickens/pigeons should be tied down directly to a flat rock or to the hack board. Of course the board should also be secured. The cord must be tied to a sturdy part of the food bird such as around the breast and under the wings. There should be *no slack between the food and the point at which it is secured* because the falcon may grab it and dive over the ledge where it will hang and possibly injure itself. If the food is tied to a perch pole, it should be tied securely to the top surface of the pole so that the food cannot slip to the bottom. If the food does slide below, the falcon will not be able to get it.

CLOSING THE HACK STATION

When the hacking period is completed and it is time to close down the hack station, there are a few minor chores that should be completed.

It is satisfying to know that a brood of peregrine falcons has successfully reached independence, but this is only a minor achievement toward the final goal, a nesting pair of peregrines. We want to leave the site in the proper condition for occupancy by a pair of falcons if they should set up territory around the box throughout the winter or return early in the spring before observers can watch for them. All food scraps should be cleaned out of the box and hauled away. *The hide should be removed* to prevent other animals from living behind it. Barn owls (*Tyto alba*) and ravens (*Corvus corax*) will nest behind the hide and prevent the returning peregrines from using the box, especially at marsh sites. Once the hide has been removed, the roof loses some of its support. It is a good idea to secure a vertical board (for example a 2" x 4") in the center of the box so that the roof can stand a snow load. The logs and rocks used for perches

inside the box should be securely pushed into the gravel and arranged so that the returning falcons will have plenty of room to scrape. They sometimes like to nest next to a log or rock for cover. The gravel should be smoothed out so that tracks, the remains from subsequent kills, and signs of other activity can be easily identified. It may be necessary to add more pea gravel to insure an overall depth of 10 centimeters (about four inches). It is a good idea to give the outside of the box a coat of wood preservative such as linseed oil or Cuprinol at this time. The lightning rods and their connections and the predator guards should be inspected. It is also a good idea to inspect the tower framing members to insure that the structure is still sound. If these measures are taken in the fall, the site should be ready for returning adults in the spring.

CLIMBING

Introduction

In many instances we situate our hack boxes on a ledge three to 30 meters from the top of the cliff. This makes the box relatively inaccessible to ground dwelling predators, especially bears.

In these instances it is necessary for the site attendants to use a rope in order to reach the hack box for the purposes of cleaning and observation. This requires a knowledge of various climbing techniques including rappelling, belaying and ascending. The Peregrine Fund provides the basic training and issues the following equipment unless the attendant prefers to use his/her own equipment: a rope, a locking carabiner and figure eight rappelling ring, a hard hat, a pair of ascenders with sling attachments, and a swami belt.

The life of the attendant is at stake every time rope work is involved. Safety and common sense are always of paramount importance and no aspect of climbing should be taken for granted. Climbers must always respect the weather conditions and should use extra caution when the climbing surfaces are the least bit wet. When the lichen growing on a rock gets wet, it can become as slick as glass. Periods of hard rain and lightning should be avoided. During any activities that are being conducted on the cliff or the actual ledge with the hack box, the persons involved should *always* be tied in and belayed by their partner (see below). DO NOT GAMBLE—take the few extra minutes required to be safe.

A hard hat should be worn by the climber at all times because falling rocks pose a constant threat. Even a walnut-sized rock can break an arm or, at worst, kill the climber if the rock has fallen very far before impact. It is essential for the climbers to check all surfaces directly above the work area on a daily basis in order to insure that no rocks have become loose and are about to fall. It is equally important that the partner who does the belaying uses extreme caution so that he/she does not knock any rocks down on the climber or hack box.

Care of Equipment

Good care must be taken of all climbing equipment. Careless use of ropes and other gear can lead to the death or injury of even the best climbers. Ascenders and other types of equipment are often made of cast

aluminum and should not be dropped on any hard surface. Hairline cracks can develop that greatly weaken such items eventually leading to the failure of the equipment. Special attention should be given to the rope, and the rules listed below must always be followed:

(1) One should never stand or step on a climbing rope, nor should the rope be dragged along the ground. This forces dirt and sand between the fibers and causes unnecessary and dangerous wear. It follows, then, that the rope should be kept as clean as possible.

(2) One should never leave the rope exposed to sunlight for extended periods because it can damage the nylon fibers.

(3) A wet rope should always be dried before it is stored.

(4) A rope should never be left hanging over the cliff when not in use. Small mammals often chew on unattended ropes. Each day when the work at the hack box has been completed, and the rope is no longer needed, the attendant should untie the rope, coil it, and place it in a weatherproof stuff sack. The attendant should carry the sack back to the camp or store it in a safe place on top of the cliff away from the reach of animals.

(5) As a means of protecting the rope against excessive abrasion, it is best to place a small piece of garden hose or some soft material such as an old shirt at the point where the rope comes in contact with the lip of the cliff.

(6) The climber must avoid dropping rocks on the rope because they can easily cut or weaken fibers. A rope which appears unsafe for any reason should be retired.

Rappelling to the Hack Box

The attendant should locate a secure rock or sturdy tree on top of the cliff above the hacking ledge to serve as an anchor for the rope. A bowline (Fig. 10a and b) should be used to fasten the rope to the strongest

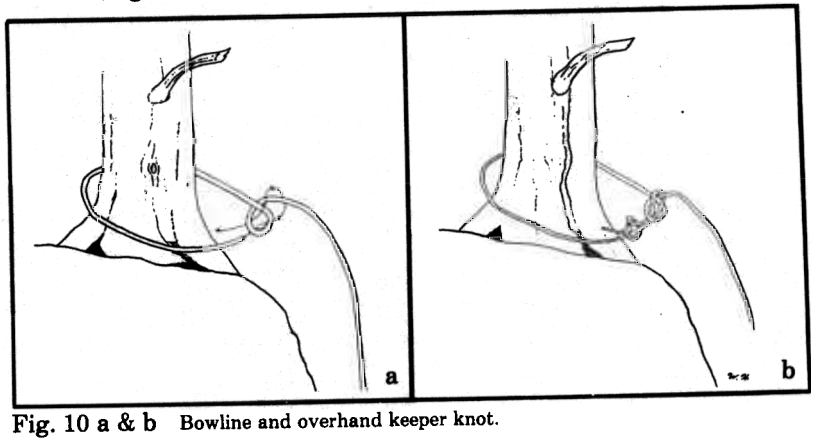


Fig. 10 a & b Bowline and overhand keeper knot.

point of the anchor which is usually at the base of the rock or the tree. If the anchor is located at least head high above the lip of the cliff, the act of going over the edge will be an easier task. When lowering the rope over the edge, the climber must take care not to hit the hack box or to throw the rope in front of it and frighten the peregrines.

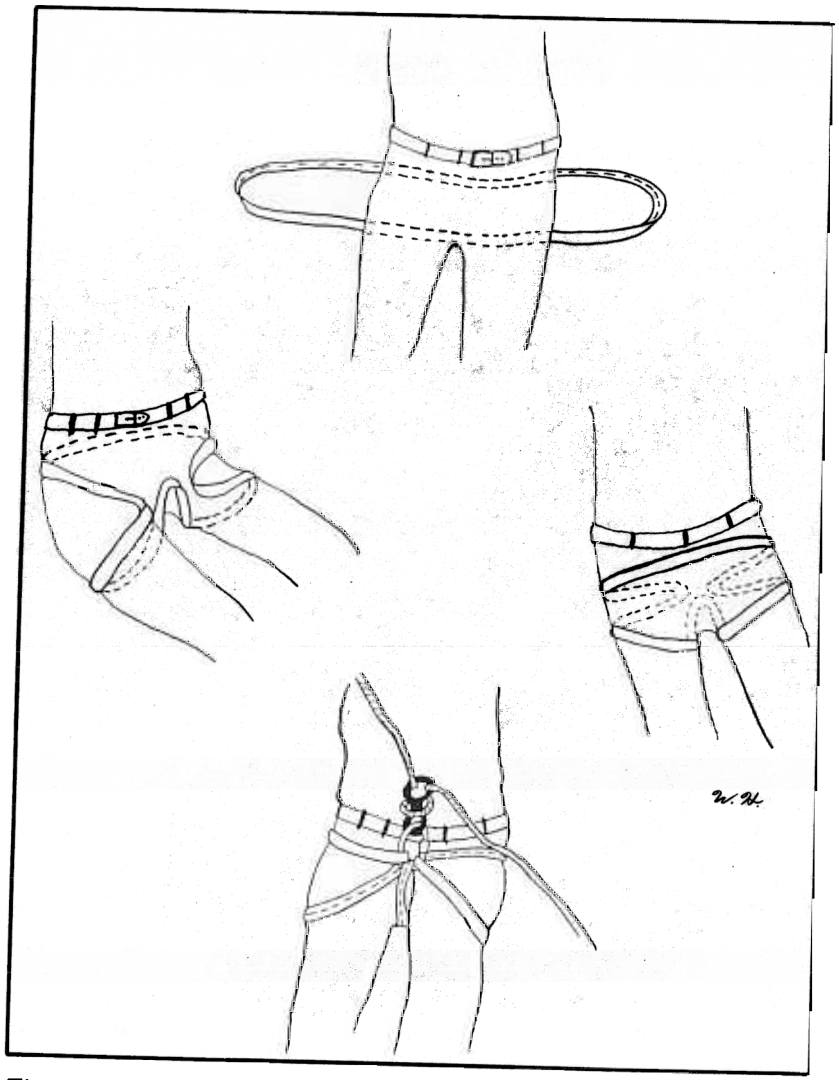


Fig. 11 Swami belt or diaper sling.

With the rope secured, one of the attendants prepares to descend. During the entire process of rigging up, the climber should always be in a safe and secure position on the cliff top. The swami belt or diaper sling is a piece of webbing in the shape of a large loop. The loop weaves behind the back, beside the hips, and up between the legs of the climber (Fig. 11). The three smaller loops which result after the belt is in place can be connected at the crotch with a locking carabiner. The belt should fit snugly but not tight enough to cut off circulation.

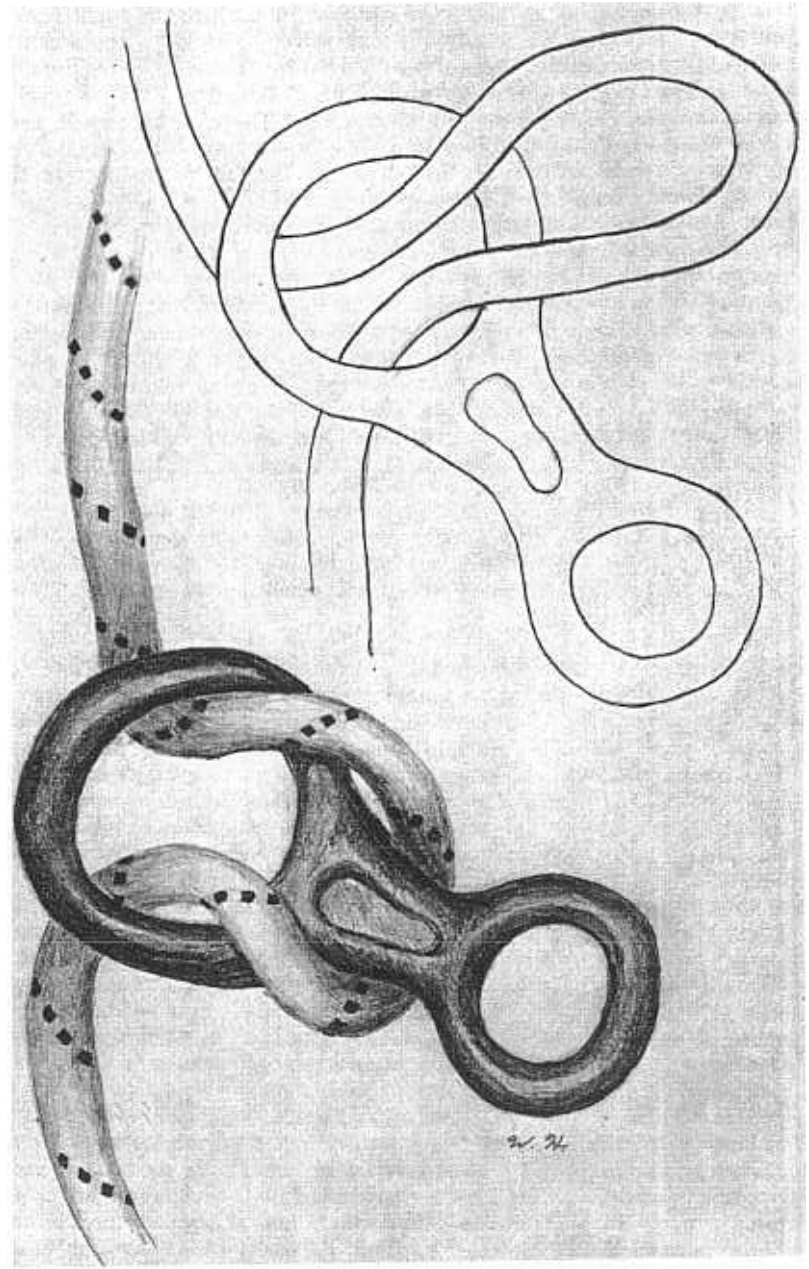


Fig. 12 Figure eight descending ring.

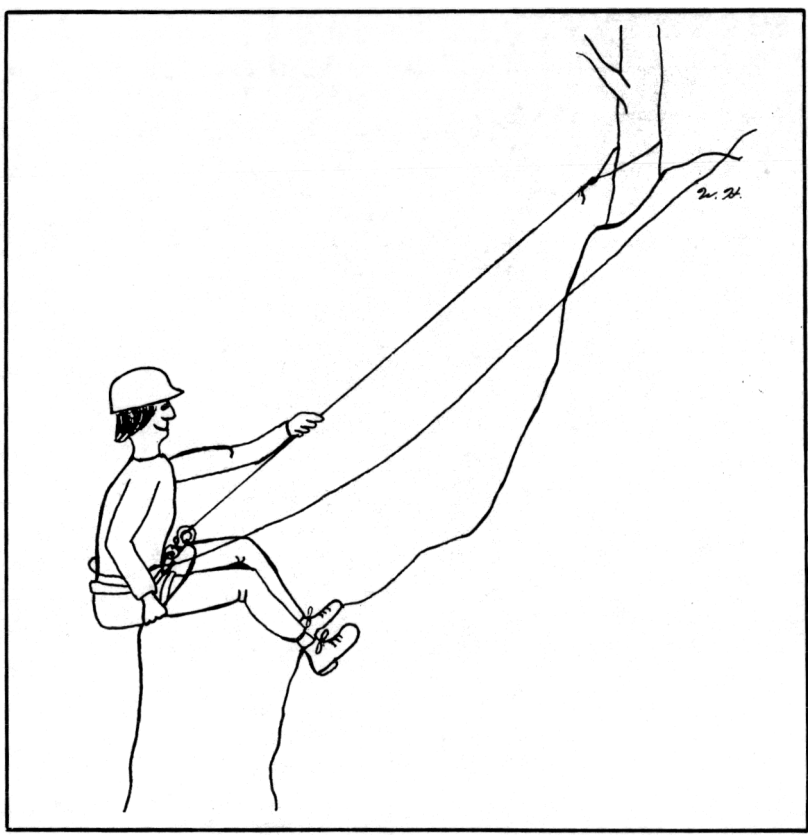


Fig. 13 Rappelling. Note slack, belay rope.

left hand. This hand will slide down the rope as a guide and for balance. The right hand grips the rope just beyond the figure eight ring at about the hips (Fig. 13). With this hand he/she brings the rope slightly toward the back so the rope presses against the side of the right hip. This hand acts as the brake and controls the speed of descent. The climber backs up as if going over the cliff so that all of the slack in the rope between the anchor and the climber disappears. He/she then leans back and pulls on the rope. The friction of the rope going through the figure eight, by the hip, and through the right hand will be so great that the climber will not be able to move until the grip is loosened and the pressure is released by moving the rope slightly from the hip. By simply tightening and loosening the grip and by altering the pressure of the rope against the hip, the climber maintains complete control of the descent. Holding the rope too tightly with the left hand will only cause unnecessary fatigue.

At this point the climber should feel secure. He/she should back up to the edge with the feet spread apart about shoulder width and the knees slightly bent. Most of the weight should be against the figure eight ring with only slight pressure against the legs and feet for balance. By slowly releasing pressure on the rope, the attendant can ease over the edge and proceed to walk down the face of the cliff to the hack box. The climber should avoid rapid descents, jumps, and quick stops so that loose rock on the cliff will not be dislodged. Once the attendant has reached the ledge, he/she should always remain tied to the belay rope for safety.

Belaying

During the period in which the climber has been descending to the hacking ledge, the partner has been acting as the belayer. This means that the partner is controlling the belay rope from atop the cliff so that should the climber fall, the partner can save him/her by pulling the rope taut. In most cases the partner will use a standard sitting, hip belay. The belayer takes a seat preferably behind a large, secure rock or tree. The legs should be spread, knees slightly bent, and heels dug in or secured in a comfortable position. If no rock or tree is present, the belayer should anchor his/her own body to the same point as is the rappelling rope. Thus, if the climber falls, the belayer is in a position to withstand the weight of the fall without being pulled over the cliff. To prevent tangles, the partner should neatly coil enough rope on his/her left to reach down to the ledge. The belaying rope should extend from the waist of the climber, up and over the cliff, and behind the hips of the seated partner. The belayer uses the left hand to take rope from the coil which goes behind the back and is fed to the climber with the extended right hand. In case of a fall, the left hand acts as a brake by quickly bringing the rope forward where it presses tightly against the left hip. This causes enough friction to stop the fall. The belayer must stay alert during every second of the climb. Both hands should remain on the rope at all times with the feeding arm extending and retracting as the rope slides through the braking hand. If it is necessary to remove a hand from the rope, it should be the feeding hand, not the braking hand. Belaying should take place on the ascent as well as the descent.

Ascending

When the climber is ready to return to the top, he/she should remove the rappelling rope from the figure eight ring. The ascenders are then attached by depressing the safety, opening the cam, and clipping one above the other onto the rope at about chest high (Fig. 14). Two pieces of webbing or nylon rope are attached to each ascender. The short piece from each ascender should be clipped into the locking carabiner on the swami belt. The longer pieces are stirrups, and each foot should be placed in the small loop at the bottom. After the ascenders are in place (Fig. 15), the climber simply slides each one up the rope alternately with the hands, while stairstepping in the respective stirrups with the feet. The arms and hands are only used to slide the ascender and the slack stirrups upwards; they are not used to pull the body upward as this causes unnecessary fatigue. The legs should do the work of lifting the body as if climbing a ladder. This process is continued until the climber has reached a secure position on top.

All of the climbing techniques which we have described can be accomplished with a little practice. At sites where climbing is required, it is mandatory for site attendants to spend enough time practicing the above techniques to become proficient and relaxed about the whole process. This should be done before the peregrines are placed in the hack box. Some attendants may be accomplished climbers and may prefer to use any of a number of other approved climbing techniques to reach the hacking ledge.

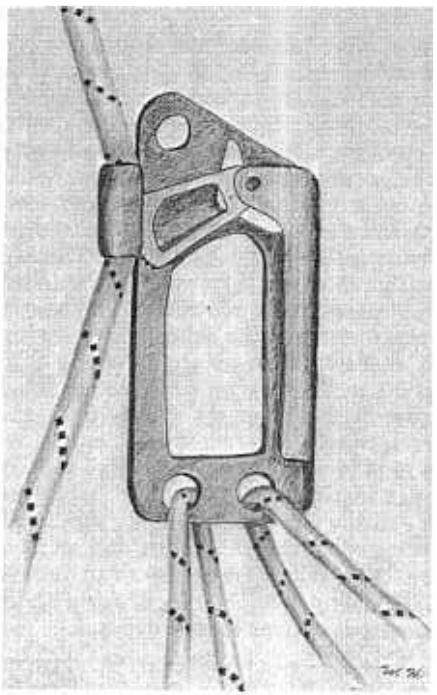


Fig. 14 Ascender in place on rope.

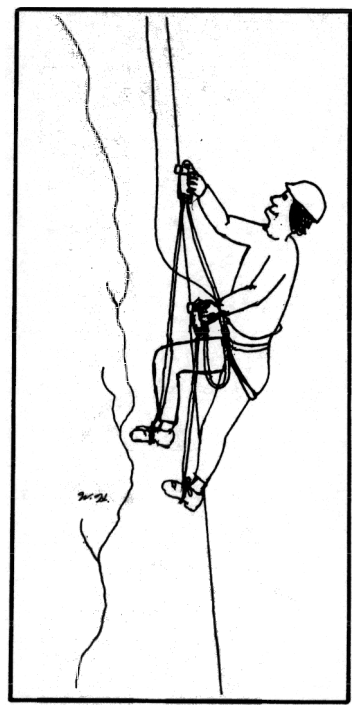


Fig. 15 Ascending. Note slack, belay rope.

SAFETY—PLEASE READ

We have found that most of our hack site attendants are more than willing to tackle almost anything that we ask of them. At the same time, the willing enthusiasm of the attendants is not always accompanied by the experience or caution that should be shown with regard to a certain task. The sage old men who are authoring this booklet have found that in most tasks, of which climbing is a good example, it is just when one feels one is getting good that overconfidence results in getting into trouble. Below are a few notes about safety hazards that we want you to read even though you are probably already familiar with the information.

Bears

If you are working in bear country, you probably already realize that they can be extremely dangerous. You should suspend your food, food birds, and even the bird food three to four meters (about 10 to 15 feet) above the ground and two meters (about six feet) from the nearest tree trunk. Do not leave food or contaminated clothing in your tent. Be sure to close the windows in your car, and do not leave food in the vehicle.

Research has shown that bears can be attracted to human females who are in their menstrual cycle, and caution should be used in disposing of sanitary napkins, etc. around the campsite.

In most areas, bears are afraid of people, but not always, especially in national parks. The information is conflicting on what to do if confronted by an aggressive bear. Some sources suggest yelling to frighten the bear. Others say that you should quietly move away ignoring the bear. Few suggest running as this may trigger the predatory instincts of the animal. For more information on bears see *Bears of Yellowstone* by Paul Schullery.

Fires

In most areas you will be cooking on small stoves. Do not light the stove with an open bottle of gasoline around, and be especially careful of stoves or candles inside tents. Most tents are highly combustible. If you do have a campfire, be sure to put it out with water, dirt, or both before you leave it even for a short period.

Snakes

Most snakes are harmless. The most common poisonous species in the areas of our hack sites are rattlesnakes. Avoiding them is the best precaution. If by some remote chance, one should bite you, do not run and thereby increase your circulatory movement. Again, there is contradictory information on the first aid for snake bite. One school suggests placing a constricting bandage on the affected limb between the bite and the heart. Another suggests making a very shallow incision at the point of puncture by the fangs. The poison should be sucked out and then spat from the mouth. A constricting bandage should also be applied in the latter case. It is best if the partner goes for help immediately after first aid has been applied. See also *Standard First Aid and Personal Safety* by the American Red Cross.

Lightning

Several of our hack towers have been struck by lightning, and it is advisable to stay off of them during thunderstorms or threatening weather. You are also susceptible to being struck by lightning if you are on top of cliffs or other high points in the terrain. As you probably know, it is not wise to stand under tall trees during thunderstorms.

Electricity

If you are working at an urban release site, please be aware that there are often high voltage wires on tops of many buildings. Crossing these wires with lumber or tools when building hack platforms can be fatal. Inquire to the building superintendent about these hazards and watch where you step!

If a falcon becomes hung on a power pole or line, get help from professionals to free the bird. Do not attempt to free the bird yourself as this situation can be fatal for both the bird and attendant.

MARKING TECHNIQUES

Telemetry

During our initial hacking experiments, we placed telemetry on every falcon that was released. Now that we are aware of most potential problems, we use telemetry less frequently. We still use telemetry at sites where there is a high potential for trouble such as owls, or adult peregrines, or where a good probability exists that the falcons may be lost.

At sites where telemetry is used, The Peregrine Fund issues to the attendants a Custom Electronics receiver (151 or 216 MHz) and a folding, three-element, Yagi antenna. Eight AA penlight cells supply the power for regular units and 10 NiCad batteries power receivers that are rechargeable. Batteries are replaced by removing the four screws at the outside corners of the control panel. After the screws have been removed, the panel is pulled off by lightly grasping the antenna socket at the lower left hand side of the panel. It is preferable to use alkaline or mercury batteries as unshielded penlight batteries sometimes leak and damage the unit.

The life of the young peregrines at the site may depend on the proper functioning of the receiver. Rough handling and exposure to extreme heat or to wet conditions can damage the finely-tuned radio unit. All telemetry equipment is extremely expensive (receivers about $600, antennas about $70, transmitters about $75). No equipment should ever be dropped or otherwise abused in any manner. Each transmitter weighs about six grams, is about 28 mm (1.2 inches) long, and about 10 mm (.4 inches wide). The units which are tuned to 151 MHz have a 46 cm (18 inch) whip antenna, and those tuned to 216 MHz have a 30 cm (12 inch) antenna. The shorter antenna length reduces the chance of hanging or electrocution. We have found that a light (22-23 ga.), stainless steel, teflon-coated wire works well for the antennas. The two types of transmitters which we most often use are powered by either one or two RS312-G, 1.5 volt silver-oxide, hearing aid batteries. The single battery model (single stage) is designed primarily for long life. We find that they last approximately 20 days in

the field. The double battery type (dual stage) has a longer range but the life span of the batteries is only about seven days. The transmitting range of the single stage transmitter is about five kilometers (approximately three miles), ground to air; the dual stage model transmits about 11 kilometers (approximately seven miles) ground to air. The use of transmitters is most important during the first week that the peregrines are flying. It is at this stage that the young falcons are most vulnerable to becoming lost or killed by predators. Consequently, we trade off longer transmitter life for a stronger signal by using the dual stage model.

When dual stage transmitters are used, the two batteries are stacked on top of each other and slipped into a short section of shrink tubing five mm (.2 inches) deep and eight mm (.3 inches) in diameter. This insulates them from the side of the battery clip.

The transmitters are activated when the stacked batteries are placed face (small disc) down in the battery clip. Backward placement of the battery inside the clip can result in ruining the transmitter. Just prior to mounting the transmitter on the tarsus of the falcon we put the batteries into the battery clip and seal them in place with five-minute epoxy or dental acrylic. This makes the batteries impossible for the falcon to remove and provides a waterproof barrier between the batteries and the elements.

When the falcons are first placed in the hack box, we attach dummy transmitters to their tarsi so that they will become accustomed to a strange object on their legs. Often they bite and tear at the antennas or dummy transmitters. On the release day, we substitute the real transmitters for the dummies. By this time there is little danger that the falcons will damage the real units by biting or pulling on them. We prefer to attach the transmitters as shown in Fig. 16. This requires a strip of pliable leather for the bracelet. It should be approximately one mm (.04 inch) thick. An application of mink oil will soften and preserve the leather. First, a small hole is punched in the center of the leather strip. One end of the strip is pulled through the slot in the top of the transmitter and then back through the hole in the leather. This prevents the metal from coming into contact with the leg of the falcon. Next, the transmitter is attached to the tarsus by placing a small dot snap into two prepunched holes at both ends of the leather strip (Fig. 16) or bracelet. The snaps and leather punches can be purchased at most handicraft shops which deal in leather. Figure 17 shows two patterns for the leather bracelets. The smaller pattern is for males, and the larger one is for females. Once on the bird, the bracelets should rotate easily around the leg but should not be so loose that they slip down over the top of the foot. Ideally, they should fit like the Fish and Wildlife Service band. If mounted on a leg that also carries a band, the transmitter should be placed below the band.

Dummy transmitters can be made by running a leather strip through a small, transmitter-sized, metal nut just as if it were a real transmitter. Next, a piece of insulated antenna wire which is the same size as that used on the real transmitter is wrapped twice around the center of the nut. Finally, a piece of heat shrink tubing is placed over the nut and heated. Any tubing that protrudes beyond the leather must be trimmed to prevent the rough edges from coming into contact with the tender skin of the leg.

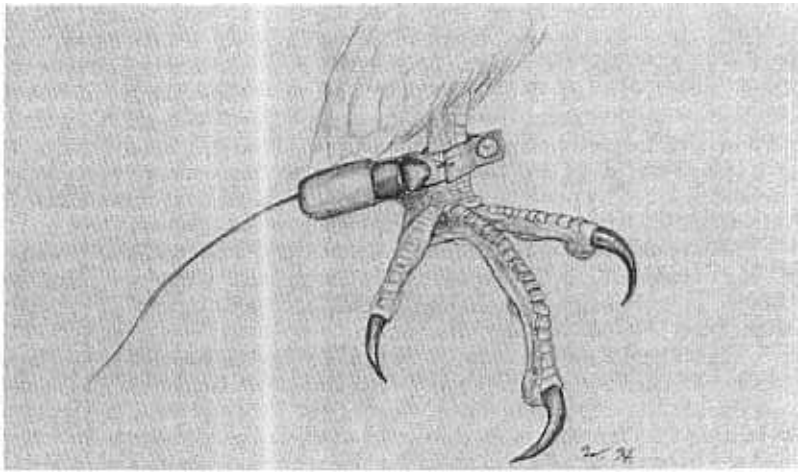


Fig. 16 Attachment of transmitter on tarsus.

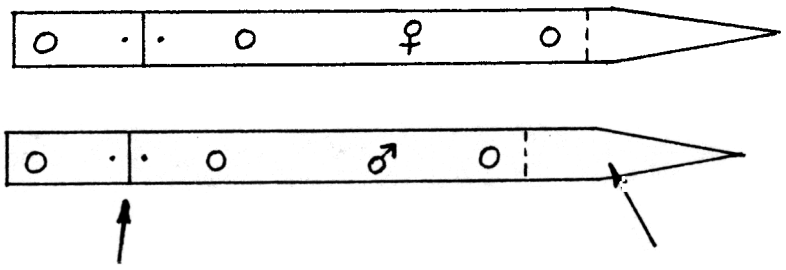


Fig. 17 Patterns for leather bracelets (life size).

In the past, we trapped the hacked falcons in order to remove their transmitters after the birds had been flying for about two weeks. If the birds had been on the wing any longer than this, it was sometimes difficult to trap the more independent individuals. Even the safest trapping techniques involve at least some risk to the bird. It is a necessity, therefore, that an experienced person travel to the site to supervise the work. Since the time of supervisory personnel is at a premium during the reintroduction season, and since the cost of travel to the release sites often exceeds the value of the transmitters, we no longer trap the falcons in order to recover the transmitters. Instead, we design the bracelets which carry the real transmitters so that they will fall off.

This is accomplished by cutting the leather bracelet in half between the transmitter and the dot snap. We sew the two edges together at the cut with a single strand of lightweight cotton thread (about 25 gauge) and securely knot the ends together. If the birds have been conditioned to wearing a dummy transmitter, they should not tear the threads apart. We have found that the thread will usually deteriorate enough so that the transmitter falls off in the course of several weeks. In addition, the thread will break and free the bird if the antenna should become hung up. If the stitch is sewn into the bracelet ahead of time, it is possible to quickly place the transmitter on the bird's leg by simply clamping the dot snap shut with pliers. The transmitters can often be retrieved after they fall off, as long as the batteries are still functioning. Many fall off in the immediate vicinity of the hack box.

Before sealing the batteries into place or placing the transmitter on the bird, it is a good idea to test and identify each transmitter. The Yagi antenna should be plugged into the antenna outlet on the receiver via the coaxial cable. Some models of receivers turn on with a switch marked "internal power" and others with a turn of the gain dial. The gain should be turned up to at least 4, and the Yagi antenna pointed in the direction of the transmitter. Each transmitter is tuned to be picked up at the high, medium or low setting on the receiver and somewhere between 0 and 5 on the frequency dial. The signal from some transmitters will be received at more than one setting. The frequency or frequencies of each transmitter must be determined and recorded before they are placed on the birds. For each site, it is best to choose transmitters that have maximum difference in frequencies in order to minimize confusion in identifying individual falcons in the field.

The high, medium and low settings always stay the same, but the zero to five reading may vary slightly with extreme changes in temperature. For example, a transmitter tuned to low 3 may be picked up best on the receiver at low 3.2 on a very cold morning, and by mid-afternoon go back to the usual low 3 reading. Once the Yagi antenna is pointing in the direction of the transmitter and the signal is picked up, the frequency dial on the receiver should be adjusted until the loudest and clearest signal is heard. At this point, the gain control should be adjusted to the volume which gives the most clarity in the signal but with the least amount of static. After these adjustments have been made, the signal will get louder as the distance between the transmitter and receiver decreases. The signal becomes fainter as the transmitter and receiver move farther apart. Both of these rules assume that the Yagi is pointed in the exact direction of the transmitter. The signal will fade as the antenna is moved laterally in either direction from the transmitter.

When trying to locate a falcon with telemetry, it is highly desirable to take the reading from a position where the tracker suspects he/she would have a direct line of sight to the bird. Signals are strongest when there are no obstructions between the transmitter and the receiver, and often, a transmitter cannot be picked up if it is on the other side of a hill or canyon rim. It is necessary to be much closer to a transmitter that is on the ground in order to pick up the signal than it is to a transmitter that is on a high point or in the air. It is a good idea for the tracker to climb to the top of a hill in order to pick up the initial signal. This is done by ad-

justing the gain to full volume and tuning the frequency to that of the lost transmitter. The tracker should hold the antenna out in front of him/her and turn slowly in a circle until the signal is picked up. It may be necessary to repeat this procedure several times. The orientation of the elements on the antenna should be in the same direction as the antenna on the transmitter for maximal reception of the signal. When the antenna on the bird is in a vertical position, the loudest signal can be heard when the elements on the Yagi antenna are in a vertical position. The same is true of the horizontal. If the loudest signal is heard when the hand held Yagi is horizontal, then it is probable that the bird is flying with the antenna trailing behind, or perhaps sitting on the ground. If the best signal is heard when the Yagi is held vertically, the bird is probably perched somewhere with the transmitter antenna hanging straight down.

Telemetry is actually quite simple to use. Only with practice, however, can one become proficient at determining exactly where the birds are located. When telemetry is used, we issue a spare transmitter to the site attendants so that they can practice before the birds are released. They alternately hide the transmitter for each other to find until both get a good feel for the technique. After a little experience, a tracker can even locate a grounded transmitter in the dark.

In some situations it is possible to pick up a signal when the Yagi is pointed directly away from the transmitter. Consequently, upon picking up the initial signal, it is always wise for the tracker to turn completely around, checking for a signal all the while. The transmitter will be located in the direction of the loudest signal. A phenomenon commonly encountered in mountainous areas is that the signal sometimes bounces off of rock faces and is picked up coming from a direction other than that of the transmitter. This can make for difficult tracking, but with practice, the tracker learns to allow for this problem. The closer the receiver gets to the transmitter the louder the signal becomes and the more the gain should be tuned to a lower position. As mentioned earlier the frequency and gain should be adjusted so that the clearest and loudest signal is heard.

Another problem that sometimes occurs is the reception of interference or radio communications (especially in the 151 MHz receivers) from other units operating in the area. Reception of the transmitter signal can be completely blocked out, but when this happens, all the tracker can do is to be patient and wait for the disturbance to stop. In some instances, telemetric studies on other species in the area of the hack site can account for the reception of signals from transmitters on animals other than the falcons. For this reason, the site attendants should be completely familiar with the pulse rate and frequency of each transmitter carried by the falcons.

When the signal from a certain bird is picked up during the day, but stays in the exact same location for over four or five hours, one should become suspicious. The birds usually move from place to place quite frequently, especially after they have been flying for three or four days. If the weather is extremely hot, however, the falcons are sometimes lethargic and may sit for extended periods. If a steady signal is heard from the same location, the attendant should follow that signal and try to locate the falcon to insure that it is not in trouble.

Color Marking

During several years of work, we have tried a number of marking techniques to identify our falcons although no permanent marker has really proved to be ideal. The problem arises from the fact that nearly all markers which are safe for the birds are hardly visible.

We have tried using wing markers constructed of yellow Herculite. These were very visible, but they caused considerable abrasion to the patagium resulting in open sores on several birds. In addition, a more subtle problem may arise from these markers when used on falcons. A frequently used hunting method of the birds is to fly hard and low to the ground thereby concealing their own silhouette and surprising prey which is feeding in the distance. Since highly contrasting colors are chosen for visibility, it seems probable that they may also present a flash pattern which will alert the prospective prey and result in failure to kill by the young falcon.

We have used the colored plastic bands with black engraved letters produced by Dr. F. Prescott Ward for his International Peregrine Falcon Color Banding Program. This program, however, has been discontinued.

Since most of the reports of our falcons were turned in by people spotting the antenna from tail mounted transmitters used in research, we devised a colored tail streamer. It consists of one or two 22 centimeter (nine inch) pieces of Teflon wire insulation (no wire inside) color coded according to the release site and attached to the base of the deck feather with a dental acrylić clip. If the falcon becomes caught it simply pulls the feather out releasing the bird unharmed. It is highly visible when the falcon is at rest or in flight. However, it is lost in the moult and to attach it necessitates retrapping the birds a couple of weeks after first flight when the feathers are hardpenned.

Currently we are using anodized FWS bands and plastic, numbered, wrap around bands of the type made for pigeons. A single color denotes that nesting falcons originated from captive-produced stock.

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APPENDIX I

Consecutive Releases

Hacking a second brood at the site after the first has dispersed is another method of placing more young out at a given location. This method is more complicated than it may appear initially. The young from the first brood do not necessarily leave when they become independent and begin relying solely on their own hunting skills for food. Usually they wander and may return to the area of the hack site periodically or even habitually for several months after independence. Although the members of the independent, first brood may not necessarily be aggressive to the second brood at release, the older birds will approach the younger birds and initiate sibling pursuit as described in the chapter on Behavior. If this occurs before the members of the second brood are accomplished fliers, or within about a week of first flight, there is a good chance that the young birds will be forced down in locations where they are vulnerable to other predators. The youngsters may also be driven away where they cannot find their way back to the hack box. At the same time, some members of the first brood will take advantage of the opportunity to freeload off of the food placed out for the second brood, and more food will be necessary as a result.

The period of vulnerability is only about a week long, and if the risk is considered worthwhile, it might be desirable to experiment further with consecutive releases.

APPENDIX II

Care of Injured Falcons

There is always the possibility that one of the birds at the hack site will be injured by a predator, electricity, an adult peregrine, or some other cause. If this happens, it may be necessary for the attendant to hold the bird for observation or for return to the breeding facility. It is best to place the bird in a large cardboard box like the one in which the birds arrived at the site. Long grass or other soft, absorbent material should cover the bottom, and a short log or rock should be place in the center as a perch. If the box is transported, the perch must be stabilized or removed to prevent injury to the bird. A few air holes must be cut in the bottoms of the sides, and the box kept in a *cool* quiet place. It should be fairly dark inside the box so that the bird remains calm. Hack site attendants should call the breeding facility at once after these initial measures have been taken.

APPENDIX III

Reminder Sheet

HACK SITE ATTENDANT DUTIES

BEFORE RELEASE

1. Read Hacking Manual.
2. Make sure all birds are eating daily. Observe through peep holes in box.
3. Feed thawed quail (1 to 2 quail/bird/day) between 7 a.m. and 9 a.m. every morning. EXCEPTION: Do not feed the day before release.
4. If birds are not leaving ½ to 1 quail uneaten each day, feed more until they do so, but do not let large numbers of uneaten quail build up in the box.
5. If necessary, clean out extra food in box the night before the day you do not feed. Small pieces such as wings, legs, and heads may be left.
6. *Have 6 quail per bird* (at least 15 thawed) ready to feed on the day of release.
7. Never let birds associate you with food. Do not let birds see or hear you near box. Travel to box out of view of birds, and never stand in front of the box.
8. Store a few days' supply of frozen quail in insulated cooler. Beginning on the first day, thaw each morning's ration the night before.
9. Hack boards and food shoots are no longer used at many locations. Do not worry if these are absent from your site.

AFTER RELEASE

1. Read Hacking Manual.
2. Be able to account for every bird, and be sure that each one has returned to the box to eat. Use telemetry and a close observation blind to know the location of every bird daily. Be certain that all birds are eating after the first four days.
3. If all birds have fledged and returned to box, begin daily feedings on 3rd day. Otherwise, feed on 4th day (count release day as Day 1). Remove any *old* quail from box and discard in camp trash daily.
4. So birds have plenty of food, be sure 1 or 2 quail are left over after each day's feeding. Discard these quail in camp trash the next day.
5. Feed when birds are away from box.
6. Be sure the peregrines, and not other animals, are eating the quail. If there are never any leftover quail, something is wrong.
7. At the end of Week 5, feed *one* daily ration every other day.
8. At end of hacking period, ask for advice and specifics about closing down site.