Lack, D. and E. Lack. 1951. The breeding biology of the Swift (*Apus apus*). *Ibis* 93:501-546.
Newton, I. 1978. Feeding and Development of Sparrowhawk (*Accipiter nisus*) nestlings. *J. Zool.* (Long.) 184:465-487.
_____. 1979. The population ecology of raptors. Buteo Books, Vermillion S.D. 399 pp.
Olendorff, R.R. 1972. On weighing and measuring raptors. *Raptor Res.* 6:53-56.
_____. 1974. Some quantitative aspects of growth in three species of buteos. *Condor* 76:466-468.
Perrins, C.M. 1965. Population fluctuations and clutch-size in the Great Tit, *Parus major*. *Anim. Ecol.* 34:601-647.
Ricklefs, R.E. 1967. A graphical method of fitting equations to growth curves. *Ecology* 48:978-983.
_____. 1968. Patterns of growth in birds. *Ibis* 110:419-451.
_____. 1973. Patterns of growth in birds. II. Growth rate and mode of development. *Ibis*. 115:177-201.
_____. 1982. Some considerations on sibling competition and avian growth rates. *Auk* 99:141-147.
Roest, A.I. 1957. Notes on the American Sparrow Hawk. *Auk* 74:1-19.
Schmutz, S.M. and J.K. Schmutz. 1975. Rearing and release of two young American Kestrels (*Falco sparverius*). *Raptor Res.* 9:58-59.
Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Co., Inc., New York.
Steel, R.G.D. and J.H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc., New York. 481 pp.
Sumner, E.L., Jr. 1929. Comparative studies on the growth of young raptors. *Condor* 31:85-111.
Thomsen, L. 1971. Behavior and ecology of Burrowing Owls on the Oakland Municipal Airport. *Condor* 73:117-192.
Welty, J.C. 1979. The life of birds. 2nd Edition. Saunders College Publ., Philadelphia, Pa. 623 pp.
Werschkul, D.F. and J.A. Jackson. 1979. Sibling competition and avian growth rates. *Ibis* 121:98-102.

THE PRICE OF SUCCESS IN GOSHAWK TRAPPING

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Abstract

Four Swedish traps for goshawks are described. Falling-end traps were most successful of 3 live-bait trap types, but were more expensive to build and less easily moved than sprung-roof

and falling-lid traps. The latter 2 types were equally successful, but the falling-lid trap cost least time and money to build. An automatic spring-net baited with a hawk's kill was successful, and more selective of resident hawks, than the live-bait traps.

Introduction

In field studies of raptors, effective and inexpensive live-capture techniques are needed. A variety of trap designs have been published in falconry books and wildlife journals (e.g. Mavrogordto 1960, Beebe & Webster 1964, Meng 1971, Berger & Hamerstrom 1962). Some types, using mist-nets or nooses, require more or less constant attendance; whereas other 'containment' traps are less labour intensive because they secure the raptor inside and can therefore be checked much less frequently. Fuller & Christenson (1976) compared the capture rats of mist-nets and bal-chatri with 2 'containment' types (the 'Swedish' goshawk trap (Meng 1971) and an automatic bow-net) in different habitats, for catching mainly buteos and owls. We compare capture rates, building time, and cost of 4 Swedish 'containment' goshawk traps, 3 of which appear not to have been described in English.

Materials and methods

Sprung-roof trap

This design, originally attributed to Knöppel (Hamilton et al. 1947), was used as described by Meng (1971), except that the sides were extended upwards to form a frame round the top (Fig. 1). Without the extra support this modification provides, the spring-loaded roof sections are liable to operate prematurely in windy weather or when a hawk alights on them prior to entering the body of the trap. One or 2 domestic pigeons (*Columba livia*) were used as bait, dark plumage during snowcover and light colours at other times.

Falling-lid trap

These were modified from a design by Hamilton (Lundberg 1933), having a box frame with 70 cm edges, in which a single horizontal sheet of wire netting separated pigeons in the lower third from the upper capture compartment. A vertical pole projected 60 cm up from the center of one side, to which a heavy lid was hinged, and near the pole's top a metal strip was center-pivoted so that a hook on one end held the lid about 80° open (Fig. 2). A wire from the opposite end of the pivoted strip ran down through the top of that side of the trap to the center of the somewhat flexible partition above the pigeons, so a hawk entering the upper compartment pulled the wire to pivot the metal strip and let the lid fall under gravity.

Falling-end trap

This design was 80-110 cm wide, 190-220 cm long and 80-90 cm high, the ends being closed by heavy doors which dropped vertically in side runners (Fig. 3). A narrow central compartment containing pigeons was separated by vertical partitions from a capture compartment at each end. Two break-back rat traps were mounted on top so that a wire cable from each breaker could jerk out a hook holding one door up. A hawk entering encountered fine wires fixed across the capture compartment near the inner partition like an inverted 'T', of which the 'arms' were fastened to the sides ca 5 cm above the bottom and the 'stem' attached through the roof to the break-back trigger plate. For catching raptors the minimum dimensions were used and the sides could be covered with chicken netting, in which case the traps had to be sited so that foxes (*Vulpes* sp.) or other large mammal predators could not enter. Otherwise it was

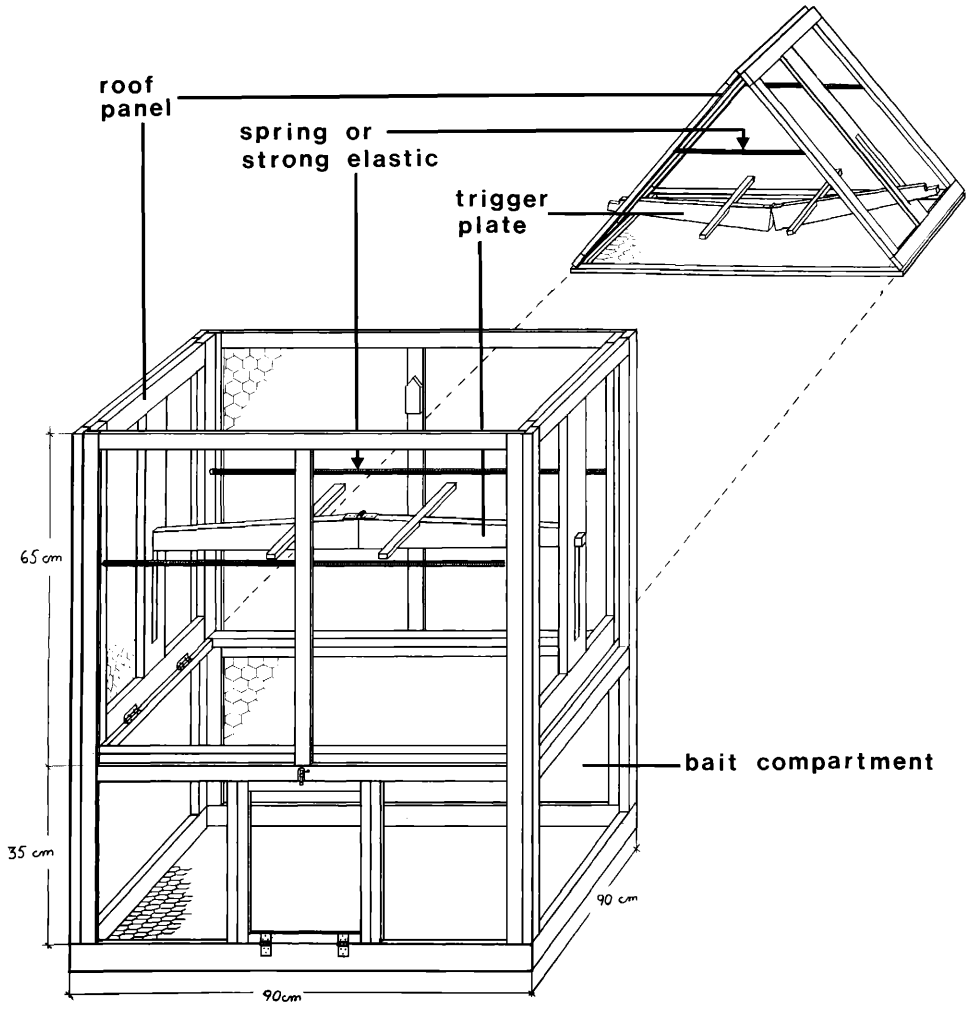

Figure 1. Sprung-roof trap, shown in set position. Inset shows the trap in sprung position.

necessary to use heavy duty chain-link netting, fitted inside the wood frame of capture compartments, because trapped mammals damaged the frame by trying to gnaw out. In this case the bait compartment had an inner lining of fine mesh chicken netting to protect the pigeons. Herman Karlsson developed this trap, which is frequently called the 'Nyborg trap' after the estate where he worked (Högfeldt 1954).

Automatic spring-net

These were baited with the part-eaten carcass of a hawk's kill, which was attached to the trigger plate of a mechanism for releasing a square, spring-loaded frame spanned by a net (Fig. 4). The frame and folded net would normally be covered with leaves and feathers from the kill, and arranged so a hawk would tend to approach from end A. This trap can be used with a stuffed bird as bait. The bait's head should be pointing towards end B so that the hawk is heading into the net as it strikes the 'prey' from behind.

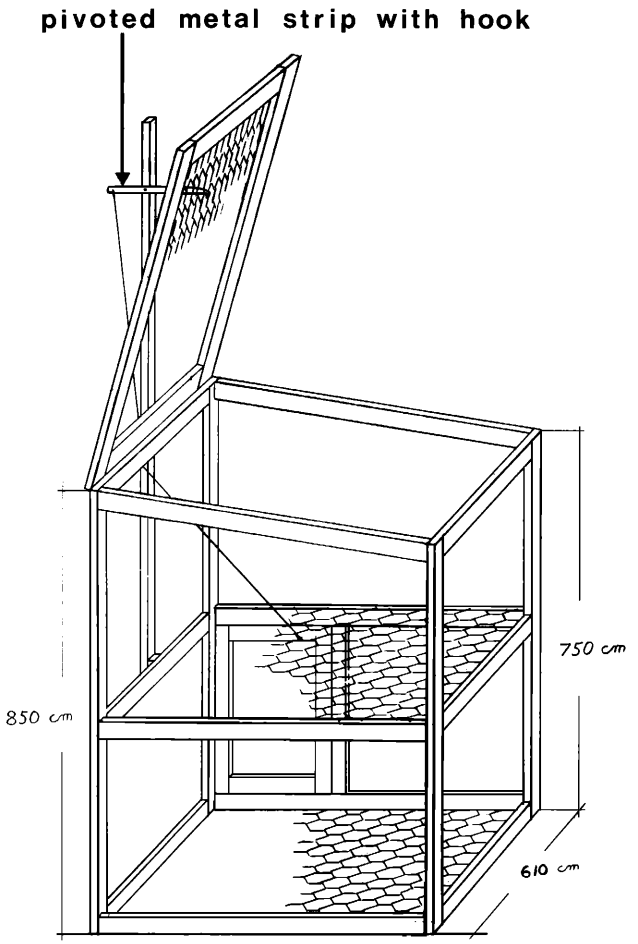

Figure 2. Falling-lid trap, in set position.

Trapping

The first 3 trap types were set either near pheasant feeding areas or in other sites with good visibility through at least 180°, and if possible with a nearby tree in which approaching hawks could perch. Traps were sited where they were unlikely to attract human interference, but most could be seen by looking carefully from roads, which facilitated checks within 2 hr of dawn, at midday and at dusk. Pigeons were fed and watered once a day. There was transparent plastic sheeting in one corner of the bait compartment as shelter against wind or rain, and pigeons were removed in very poor weather. Spring-nets were set when kills were found, and checked at the same times as the other types until a hawk was caught or for 2 days.

The traps were used in 2 areas, described elsewhere (Kenward 1977, Kenward et al. 1981). At Frötuna estate there were 6-8 falling-lid traps, 1 falling-end trap, and up to 3 spring-nets in use at a time. At Segersjö there were 2 falling-lid traps, with 1 falling-end trap, 2 sprung-roof traps and occasional use of 2 spring-nets.

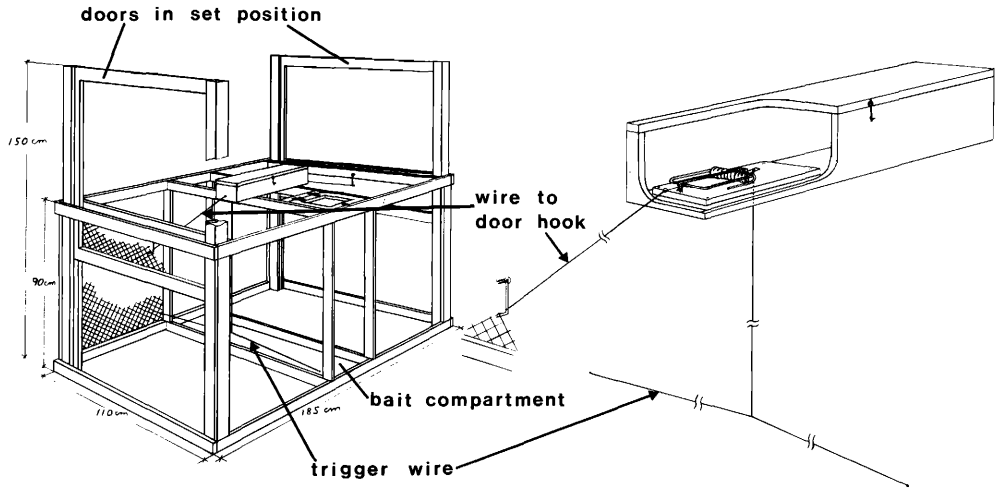

Figure 3. Falling-end trap. Inset shows detail of break-back trap trigger mechanism.

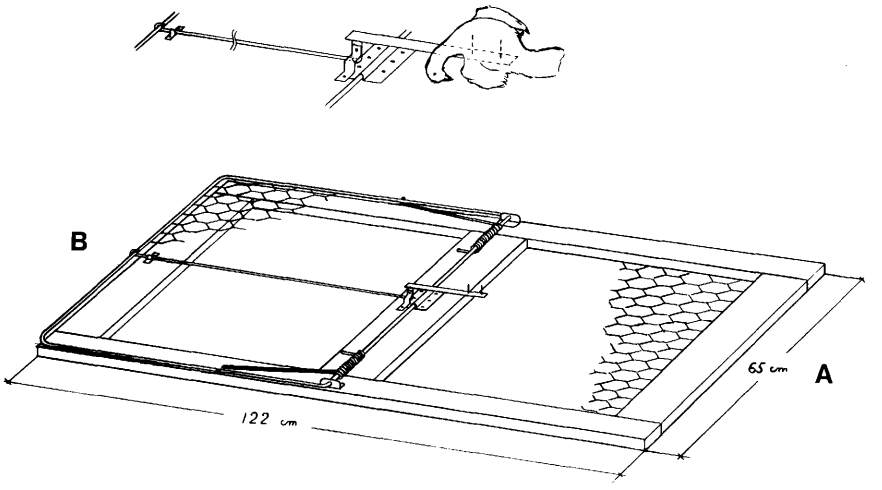

Figure 4. Automatic spring-net in set position; inset with bait.

Results & Discussion

Falling-end traps had higher capture rates than falling-lid or sprung-roof traps (Table 1), the difference being significant in comparison with the falling-lid type at Frötuna ($Chi^2(1) = 21.17$, $P < 0.001$). It is unlikely that the hawks could see the bait most easily in the falling-end traps, because the wire sides tend to conceal pigeons more than in the falling-lid and sprung-roof types, and the falling-end trap at Frötuna was in one of the least conspicuous positions. Falling-end traps were most successful, probably because hawks often run round traps on the ground, trying to get at the bait from the side, and do not always discover the top opening of other trap types (Högfeldt 1954). Falling-end traps can catch two hawks at the same time: before the study, this trap at Frötuna caught a goshawk in one end and a Golden Eagle (*Aquila chrysaetos*) in the other (L. Lans, pers. comm.).

Capture rates at Segersjö were lower than at Frötuna (Table 1), the difference being significant for the falling-end traps ($X^2(1) = 4.62, P < 0.05$), probably because hawk densities were 4 times higher at the former site (Kenward et al, 1981), where about 4,000 pheasants were released annually; no pheasants were released at Segersjö.

The automatic spring-nets were the most successful traps, and caught hawks almost every time they were set with a fresh kill unless they were sprung by corvids (*Garrulus glandarius, Pica pica*) or locked by moisture freezing on the mechanism. Hawks at Frötuna returned to eat again from 71% of their pheasant kills (Kenward 1977), and 3 hawks were caught in spring-nets baited with pheasants killed by other (radio-tagged) hawks.

Table 1. Capture success and cost of Swedish goshawk trap types in 2 study areas.

	Sprung-roof	Falling-lid	Falling-end	Spring-net
Trap-days/capture (N of captures) at Frötuna		24 (34)	7 (18)	2[a] (31)
Trap-days/capture (N of captures at Segersjö	23 (14)	31 (13)	16 (11)	2 (3)
Cost of trap material ($)	35-50	25-30	70-85	50-55
Building time (hrs)	10-15	4-6	10-15	b

a Approximate figure, in absence of precise records of trap days.
b Cost of trap from AB Vapen-Depôten, FALUN, Sweden.

No hawk deaths occurred in the 123 trap events. One hawk lost the end of its tongue, which tangled in spring-netting, and 1 received a deep cut when the trigger wire of a falling-lid trap came loose and twisted round the bird's leg. Both birds, which were radio-tagged, survived for at least 3 months afterwards. Some hawks scraped skin from the top of their heads, but this healed quickly in retrapped or captive birds. Minor injuries and occasional broken feathers probably had little adverse effect on survival, and all these traps could routinely be used to trap hawks at game farms for release elsewhere (Marcström & Kenward 1981).

There was no marked tendency for any of the 3 pigeon-baited trap types to catch more male, female, adult or juvenile hawks than the others, but sample sizes were small (Table 2). However, the proportion of males was higher among hawks caught in spring-nets than in traps baited with live pigeons, inter-trap differences being significant among first captures at Frötuna ($X^2(2) = 5.68$, $P < 0.05$). One reason for spring-nets selecting males was that a higher proportion of males than females took pheasants, both at Frötuna (6 of 6 males, 4 of 7 females) and at Sergersjö (3 of 8 males, 1 of 6 females), although these differences were not significant.

Table 2. Age and sex classes of hawks taken in four different trap types.

	At Frötuna				At Segersjö			
	Male		Female		Male		Female	
Trap type	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult
Sprung-roof					5	3	1	5
Falling-lid	16	3	11	4	7	1	4	1
Falling-end	7	2	7	2	6	2	2	1
Spring-net	18	8	2	3	1	1	0	0

All nine hawks which were radio-monitored for more than a week at Frötuna were caught in spring-nets at least once, compared with only 1 of 4 hawks which left within a week (Fisher exact test, P = 0.014). All 9 hawks that stayed took pheasants, whereas the other may have been spring-netted on another hawk's kill. Two of the 4 hawks that killed pheasants at Sergersjö were spring-netted, compared with none of 9 others, and all the spring-netted hawks remained in the area for several weeks. Thus, spring-nets caught almost exclusively hawks which killed pheasants, and not hawks passing through the study areas.

One further type of live-baited containment trap is used in Germany. This "butterfly" clap-net is less bulky and hence more portable than the Swedish live-baited types, but pigeons are less easy to see from a distance. Hawks do not have to enter a capture compartment, and capture rats for this trap may therefore be at least as high as for the Swedish types provided that pigeons can be detected easily by hawks.

Conclusions

Where kills could be found easily, as at sites visited regularly to feed pheasants, spring-nets required the least effort to operate per captured hawk. They were also the most portable, and therefore very suitable for recapturing radio-tagged hawks when these could be located with relatively large prey. For routine capture of hawks where kills were scarce or too small to use as spring-net bait, falling-end traps gave best success rates, but falling-lid types might be preferred to reduce construction costs and facilitate movement of traps. Spring-traps were more selective than live-baited traps for hawks which stayed in areas and killed pheasants.

Literature Cited

Beebe, F., and H. Webster. 1964. North American falconry and hunting hawks. World Press, Denver.

Berger, D.D., and F. Hamerstrom. 1962. Protecting a trapping station from raptor predation. *J. Wildl. Manage.* 26:203-206.

Fuller, M.R., and G.S. Christenson. 1976. An evaluation of techniques for capturing raptors in east-central Minnesota. *Raptor Res.* 10:9-19.

Hamilton, H., B. Haglund, and O. Knöppel, 1947. Fällor, fångstmetoder, hjälpfodring m.m. *In* Svenska Jägareförbundet: Viltvård, pp. 223-225. Lantbruksförbundets tidskriftsaktiebolag, Stockholm.

Högfeldt, N. 1954. Nyborgsfällan för rovdjursfångst. *Svensk Jakt.* 92:238.
Kenward, R. 1077. Predation on released Pheasants (*Phasianus colchicus*) by Goshawks (*Accipiter gentilis*) in central Sweden. *Viltrevy* 10:79-112.
Kenward, R.E., V. Marcström, and M. Karlbom. 1981. Goshawk winter ecology in Swedish Pheasant habitats. *J. Wildl. Manage.* 45:397-408.
Lundberg, A. 1933. Hanbok för jaktvårdare. Fahlcranz & Co., Stockholm.
Marcström, V., and R. Kenward. 1981. Movements of wintering goshawks in Sweden. *Swed. Wildl. Res.* 12:1-35.
Mavrogordato, J.G. 1960. A hawk for the bush. Witherby, London. 1973 2nd ed. Neville *Spearman*, London.
Meng. H. 1971. The Swedish Goshawk trap. *J. Wildl. Manage.* 55:832-835.

OBSERVATIONS ON NESTING WHITE-TAILED HAWKS

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During the period 16 July to 20 August 1977, I observed and photographed adult and young of the White-tailed Hawk (*Buteo albicaudatus*), at a nest on Laguna Atascosa National Wildlife Refuge, Texas. Observation began when 2 young were approximately 2 days old, and continued at 7 day intervals. A 500 mm telephoto lens and 35 mm camera were used to photograph and observe the birds.

The nest was a platform of woody stems placed between two branches of a Spanish dagger or Spanish bayonet (*Yucca treculeans*), 2.7 m above the ground. The nest was about 1 km west of Laguna Madre Bay on an open ridge among scattered mesquite (*Prosopis* spp.) and Spanish dagger. Observations were made from a blind 2.7 m above the ground, approximately 18 m from the nest.

During my first visit (16 July) I saw only one nestling. By 23 July both young were active and one was visibly larger than the other. When they were being fed, the larger one became dominant and maneuvered into a position to receive most of the food when it was in limited quantity. When feeding was first observed (23 July), the smaller nestling was too weak to sit erect for more than a few seconds, while the larger sibling was erect and prepared to take most of the food brought to the nest. By 30 July there were still signs of dominance, although the size difference was no longer recognizable. On 13 August and 20 August the young fed themselves from prey left at the nest.

The adults were seen during each of my visits, which extended from before sunrise (time unknown) until 1200-1400 hours. From daylight until approximately 0930 hours both perched on Spanish dagger plants 20-50 m from the nest. I assumed these sites were used as night roosts. The adult hawks left their perches, presumably to hunt, during mid-morning (0930 - 1030 hours). One adult invariably returned with food between 1030 and 1100 hours. After feeding the young or depositing its catch in the nest, the adult again perched and preened at or near the nest for varying periods.

I was not able to identify all of the prey, but at least 7 different species were eaten by the young including: eastern yellow-bellied racer (*Coluber constrictor flaviventris*), western ribbon snake (*Thamnophis proximus*), Texas horned lizard (*Phyrnasoma cornutum*), Mexican ground squirrel (*Citellus mexicanus*), cottontail rabbit (*Sylvilagus floridanus*), blue crab (*Callinectes sapidus*), and an unidentified small, long-tailed rodent.

During my last two visits, when the young were estimated at between 30 and 37 days of age, they frequently alternated between stretching and flapping their wings. The young used the nest edge and its supporting branches as exercising perches. Exercising included extending the wings to catch the wind and then springing into the air, hovering momentarily over the perch, alighting, and hovering again.

The 2 young were still in the nest at my final visit on 20 August.