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TROPICAL CANOPY NETTING AND SHOOTING LINES OVER TALL TREES

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Abstract.—Using improvements and extensions of the aerial mist netting method of Greenlaw and Swinebroad (1967) and a new, inexpensive method of line shooting, 150 canopy birds of 46 species were caught and macaw movements were observed from ropes in emergent trees in the Manu National Park of Amazonian Peru. Here the modified netting methods and the new line-shooting method, which allows easy access to the tops of the tallest trees in the Amazon, are described. Also included are suggestions for ascending and hanging from ropes in the rainforest canopy.

COLOCANDO REDES EN EL DOCEL DEL BOSQUE TROPICAL Y TIRANDO LÍNEAS SOBRE ÁRBOLES ALTOS

Sinopsis.—Se llevó a cabo un estudio de las aves del docel del bosque tropical en el Parque Nacional Manu, localizado en el área amazónica de Perú. Utilizando extensiones e introduciendo mejoras en el método aéreo de colocar redes de Greenlaw y Swinebroad (1967) y haciendo uso de un nuevo método de colocar líneas, se capturaron 150 aves del docel pertenecientes a 46 especies. Se pudieron observar además los movimientos de guacamayos en los árboles emergentes. En este trabajo se describen los métodos modificados de colocar redes aéreas y el nuevo método de colocar líneas que permiten acceso fácil al tope de los árboles más altos en el Amazonia. Se incluyen sugerencias para ascender y colgarse de sogas en el docel del bosque pluvial tropical.

Normally, mist nets are strung parallel to the ground at a height of 0.2–2 m, but at that level they catch only low-flying species. To catch species flying higher, one must resort to slipping nets up and down tall poles (Beehler 1983, McClure 1984) or hanging pulleys from tree limbs to support even higher nets (Greenlaw and Swinebroad 1967, Humphrey et al. 1968).

To catch and color-band birds of the complex mixed-species flocks of the Amazon (Munn 1984, 1985, 1986), I experimented with the Humphrey et al. (1968) method and modifications of that method (Webber 1975, Whitaker 1972) and found it too labor intensive, complicated and very destructive of vegetation. Accordingly, I successfully modified and extended the simpler Greenlaw and Swinebroad (1967) method and caught forest birds up to 45 m above the ground without having to climb and without hiring assistants. With this method I caught 150 birds of 46 species in 22 temporary net locations in approximately 700 net-h of operation.

To place climbing ropes in canopy emergent trees for observation of large macaws (*Ara* spp.) in Peru's Manu National Park (Munn 1988a,b) since 1983, assistants and I have shot lines over high branches in 80 canopy emergent trees that measure 40–60 m.

Here I detail the extensions of Greenlaw and Swinebroad's (1967)

netting method and describe a new method for shooting lines over tall trees. Like Greenlaw and Swinebroad (1967), my design criteria for the netting were easy operation by one person, easy temporary erection and subsequent removal and erection at other sites without climbing trees, and minimal disturbance to vegetation. Design criteria for shooting high lines were easy shooting by one shooter and one assistant, and minimal cost of line-shooting equipment.

MATERIALS AND METHODS

Net modification.—As in Greenlaw and Swinebroad (1967), net modification involves tying one pole to each end of a 12-m-long, 36-mm mesh, black nylon net, removing the three middle shelfstrings and restringing these shelfstrings through the mesh perpendicular to the long axis of the net. This restringing is tedious and time-consuming, so I shall describe shortcuts.

Net mesh catches on all rough objects, buttons, jewelry or debris. Woven plastic tarps available from outdoor stores are good for laying out nets for modification, but any smooth surface will do. Two smooth, 3-m-long poles (cane in my case) will function as the upper and lower yards of the long, vertical, sail-like net to keep the net open when erected. The top pole should be strong enough not to crack when hung horizontally from its two extremes, while the bottom pole should be heavy enough to keep the net hanging properly in winds and during raising and lowering. If the bottom pole is too heavy, it may snap the outer, remaining shelf strings. Prudence suggests following Greenlaw and Swinebroad's (1967) suggestion of adding lengths of 80-lb-test nylon fishing line to the outer shelfstrings to keep them from breaking. All watches, buttons, etc. should be avoided while operating nets. Use shirts and trousers with smooth snaps instead.

To modify a net, count the number of mesh squares between each original shelf string and then cut or untie the internal shelf strings at their extremities. Firmly tie the fully-open side loops to the poles with parachute cord or other cord of similar strength and resistance to abrasion. Lay out the net (now with poles tied at each end) on the tarp, which should be on soft earth to make the next step easier. Mount the open net at waist level over the tarp by tying the poles horizontally to vertical poles planted in the ground around the tarp, which should be folded to the size of the net. With the net (devoid of internal shelfstrings) suspended above the ground, tie the end of the one of the removed shelfstrings to a 10–15-cm-long, blunt-tipped needle, which in my case was a large palm spine with a hole whittled in its base. Tie the other end of the string to one of the long sides of the net (the original outer shelfstring) and guide the needle up and down through the meshwork on a straight line across the net until reaching the other side. Allow as many mesh squares between new shelf strings as on the original net. Provisionally tie off the shelfstring at the other long side of the modified net with an untieable knot and cut it, leaving an excess of 10 cm or more for later adjustments.

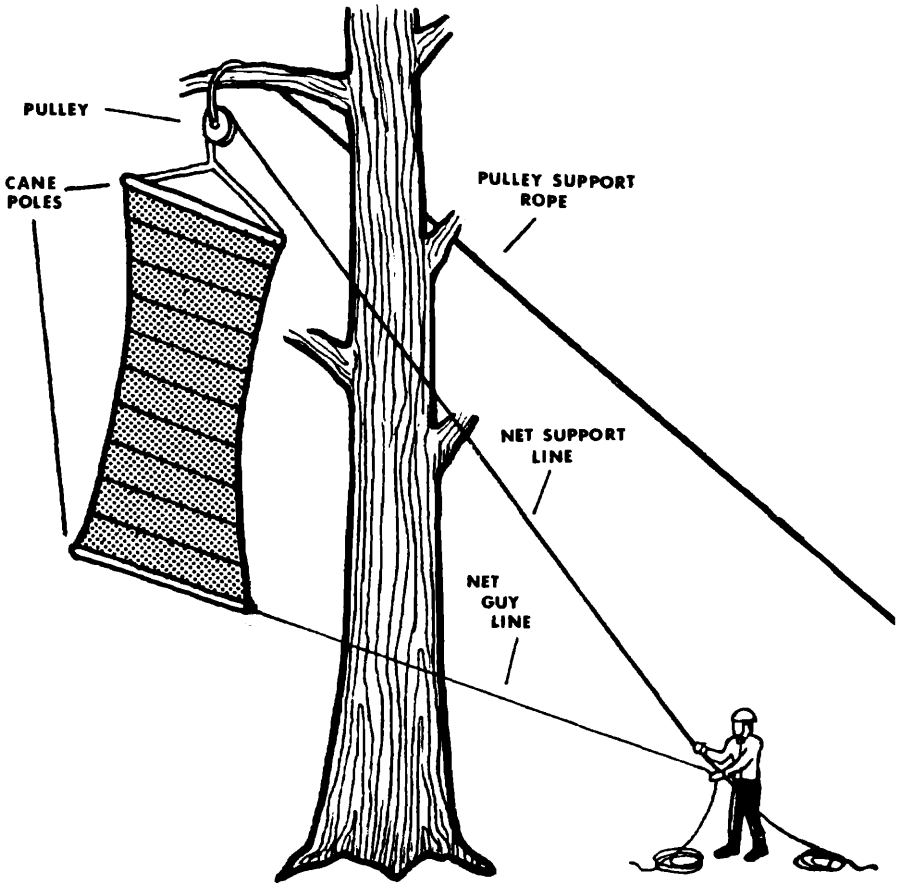

FIGURE 1. Vertical aerial mist net rig. See text for details.

It is hard to estimate how tight to tie each new shelf string without comparing all the finished strings and adjusting them all to produce a perfectly taught net face. The finished net likely will bow inward slightly in the middle shelves if all of the shelf strings are adjusted properly. Properly-adjusted shelfstrings are the key to producing optimal bird-catching "bags" between each shelf string (see Fig. 1). Eyeball the net while it is suspended on the poles above the tarp and make all shelfstring adjustments. At this point irreversibly tight knots should not be tied in the shelfstrings.

Untie the net poles from their four supports and lay the net on the tarp. To ensure appropriate slack in the mesh, between each pair of new shelfstrings, use an overhand knot to tie a side loop of approximately 8–15 cm of string taken from the original top and bottom shelfstring (now the side strings). To catch birds well, the modified net must have appropriately large "bags" between each new shelfstring. Thus, it is best to

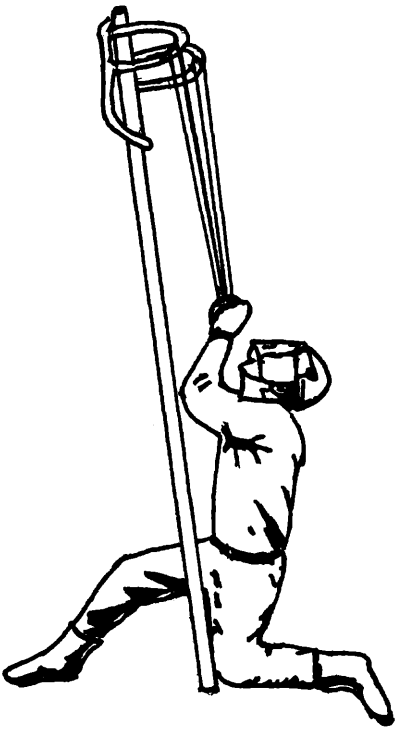

FIGURE 2. Giant slingshot for shooting lines over tall trees. See text for details.

measure the normal operating distance between shelfstrings on an erected, unmodified horizontal net before deciding how much side string to tie to make each new shelf sufficiently baggy.

Finally, remount the two endpoles on their four supports and recheck the net for proper taughtness and alignment. Then make the final, permanent knots in the shelf strings. As the shelfstrings are nylon, use appropriate non-slip knots.

Shooting lines over tall trees.—My method for shooting lines over tall trees, which uses latex tubing to project lead weights, is significantly different from published methods using bow-and-arrow (Greenlaw and Swinebroad 1967), cross-bow, line-shooting gun, and small slingshot (Nadkarni 1988). I tied lead fishing weights to monofilament nylon fishing line and shot these lines over trees using commercially available slingshots or with a home-made giant slingshot (Fig. 2). I then pulled two successively heavier lines over the limb, the latter of which supported a pulley. Through the pulley I threaded another heavy line with which I raised and lowered the canopy net (Fig. 1).

The materials used for placing these pulley and net support lines are less cumbersome, less expensive and easier to pass through Peruvian customs than the laminated bow, fiber-glass fishing arrows, and line-

shooting gun used by other investigators. These materials include the following.

1) An inexpensive commercial slingshot equipped with a brace on your forearm available in sporting goods stores in many but not all states. Buy extra sets of slingshot tubing, as the original often breaks.

2) Teardrop-shaped lead fishing weights of various masses. Twenty-eight-g and 57-g weights with small swivels worked well for heights below 30 m, while heavier weights of 85 and 113 g, with or without swivels, and shot with the giant slingshot described below, worked best for shooting over the tallest trees in the Amazon (60 m). I lost approximately one lead weight for every two lines that I placed higher than 30 m, so take extra weights.

3) Home-made giant slingshot. For shooting over branches higher than 30 m, an assistant and I made a giant slingshot out of about 2 m of thick, latex surgical tubing, an army surplus backpack frame, a 10 × 20-cm swatch of heavy canvas material, and a 3.5-m-long, 5-cm-thick hardwood pole (Fig. 2). With the frame lashed to the pole, the sides jutted out in "Y" fashion perpendicular to the pole and offered good points of attachment for two 1-m-long pieces of heavy latex surgical tubing (from a university stockroom or hospital supply store). Any strong "Y-shaped" branching structure tied perpendicularly onto the pole should serve as well as the backpack frame. The two pieces of tubing ran through the two sides of the rectangular piece of canvas, which had two side sleeves sewn with heavy thread by a cobbler. All edges of this rectangle should be sewn to avoid unravelling of threads. Loose threads hamper shooting by catching on the monofilament line.

4) An open-faced spinning reel capable of holding 150–200 m of 5-, 7-, or 10-lb-test nylon monofilament fishing line.

5) A 1.8-m-long, smooth pole that can be stuck into the ground and to which the spinning reel can be tied at thigh height.

6) Braided, not twisted, nylon line of at least 100 lb test to be pulled over high branches by the nylon fishing line. Twisted line rotates too much as it is pulled over branches and then forms huge tangles. There should be enough of this braided line to leave an unknotted length over each branch that could prove useful for future netting or climbing. Both ends of each line over a branch should be tied to a vine-free sapling in the understory and cleaned every few months of new vines. As sunlight damages nylon, replace lines frequently (at least once a year).

7) Safety equipment and procedures. When using small or giant slingshots, protect yourself and others from rebounding or falling lead weights or branches. The slingshot shooter should remove all watches, jewelry, and buttons from his/her arms to avoid snagging the fishing line. If the fishing line catches on something as the weight is shooting upwards, it can snap back at dangerous speeds. Therefore the shooter should wear a hard hat equipped with an impact-resistant face shield. The shooter also should wear safety glasses behind the shield. Others nearby also should wear hard hats and stand behind trees during shooting. When using a

hand-held slingshot, protect the hand that supports the slingshot, particularly the fingers on the front side of it, by wearing a chainsaw glove or other protection. To avoid accidents, first practice shooting weights over low branches before graduating to higher ones.

8) A tripod-mounted spotting scope to see where the weight and the fishing line went and if they are tangled in the canopy.

9) Two-hundred–four-hundred-lb-test nylon rope that is thick enough to hold up the net pulley without breaking. Extra rope can be useful to break or tie out of the way medium or large canopy or subcanopy branches that are blocking an otherwise perfect net location.

10) A pair of heavy gloves to protect the hand when pulling hard on the braided nylon line.

11) Fairly heavy pulleys and net support lines (0.64–0.95-cm diameter suggested, but experiment before committing to a pulley and line set). The line that is tied to the upper yard of the canopy net must run smoothly but snugly through the pulley and not slip off the wheel and jam in the gap between the wheel and the pulley sides.

To shoot lines over high limbs, find the best spot from which to shoot, clear all saplings, twigs, leaves, etc., from a 2–4-m-diameter circle, erect the pole with reel toward the back of the circle and the giant slingshot in the middle of the circle, take safety precautions, and shoot the weight over the limb. A tarp on the ground in front of the pole also helps keep the monofilament line from snagging on debris when reeling it in. As the weight ascends in the split second after shooting, grab the monofilament line with your hand as soon as the weight appears to have passed the desired branch. This procedure keeps the weight and line from going too high, through additional, undesired branches. Shooting as vertically as possible (Fig. 2) helps avoid passing undesired limbs behind the target limb. In practice, check the position of the weight and line with the scope. If the weight tangles in small branches, watch through the scope (I used a Questar telescope) and try to free the weight by tugging on the line. Pulling, jerking and releasing of the line often solves the problem and allows the weight to slide smoothly to the ground on the far side of the limb. When the line passes an undesired limb, locate the weight near the ground and cut it or untie from the line before reeling back the line with the fishing reel. On the very rare occasion when some monofilament line gets stuck in a tree, you should shoot other lines and try to climb (using the techniques described in Perry and Williams 1981 and Whitacre 1981) and remove it, as it is dangerous to birds, bats and other animals.

Once the monofilament line is over the desired limb, use a small, secure knot or series of knots to tie the braided nylon line to the monofilament and reel the braided line up and over the limb. Knot only the monofilament line, as knots on the braided line catch more readily on vegetation. If the braided line catches in branches, watch with the scope while repeatedly pulling and then rapidly releasing the monofilament or the braided line. Try backing off from a problem spot and then pulling the braided line over faster or slower in successive attempts. Wrapping the junction of the

monofilament and the braided line with something slippery like plastic or mounting a small funnel at the junction with the spout pointed upward might help the braided line pass a bad spot.

If the monofilament goes over limbs that are much too high, you still might be able to pull the braided line over the high route, tie a non-tightening loop or a ring onto the braided line and then use the braided line to pull the weight (resting in the loop or ring and with monofilament line tied to it) to a desired spot from which it can be lowered over the desired limb. This procedure sounds complicated but might be easier than again shooting the weight over a very difficult route. Then you must use the last monofilament line to pull the braided line over the desired branch as described above.

Once the braided line is over, use it to pull over a 200–500-lb-test nylon or dacron pulley support rope or a heavy caving rope (see Perry 1978, Perry and Williams 1981, and Whitacre 1981 for details of climbing tall trees). Knot only the braided line, not the thicker pulley support or caving rope. Use gloves when pulling the final, heavy line over with the braided line, as the braided line can cut your hand when under tension. Try sending large waves up the heavy line to help take some weight off the point of friction when passing high limbs. To pass a limb, you may have to approach repeatedly a sticking point faster or slower or with bigger waves. Use the telescope to diagnose problems. The braided line can snap and recoil at great speeds, so protect your face. Likewise, when removing the caving rope from a limb, it falls dangerously hard, so protect yourself and others. Dead branches or other debris can also fall from the canopy when passing lines, so wear hard hats and listen for falling objects. Neatly recovering the braided line is very time consuming, and a large reel for electrical cable or the like could be adapted to pay out and recover it efficiently.

When the pulley support rope or the caving rope is in place, tie one end to a strong tree and have several persons lean or hang on the other end to make sure the limb and rope can support much more than the weight of the net or the human climber (see procedures in Whitacre 1981).

Here I add five suggestions for tropical tree climbing to methods in Perry and Williams (1981) and Whitacre (1981). 1) A light bosun's chair (available from West Marine Products 1-800-538-0775, Box 6303, Santa Cruz, California 95063 USA) is a much more comfortable way to sit for hours on the rope in the canopy than is a climbing harness, a butt-bag, or a parachute harness. 2) A no-see-um head net (available from Campmor 1-800-526-4784, P.O. Box 997-C, Paramus, New Jersey 07653-0997 USA) is useful to protect eyes, nose, mouth and ears from droves of salt-hungry sweat bees that constantly pester a perspiring climber. 3) A pair of heavy-duty pruning shears or a Huntsman model Swiss Army knife with a small saw is very useful if tied with a string to your chest or pants pocket so that you can pull it out easily to cut or saw through branches as you climb up a rope through vegetation. 4) Button your top

shirt button so that large stinging ants, which you might shake off overhead vegetation, are less likely to fall inside your collar. 5) Consider leaving a long enough length of climbing rope at the anchored end of a rope that if you need help and cannot descend on your own, a team of persons could use friction techniques of rope braking (see Wheelock and Robbins 1988 and other mountain climbing and caving books), carefully untie the anchored end of the rope, and pay out the entire rope until the climber reaches the ground. Alternatively, you can tie the climber's end of the rope to the anchored end of the rope, use rope braking techniques, untie the anchored end, and carefully rotate the resultant loop of rope to bring a stuck climber down safely.

Also note that Guderian et al. (1986) claim that the effects of insect stings and venomous snake bites disappear if you immediately apply current from a modified electric shock "stun gun" (available from Nova Technologies, 1-800-777-7886, Austin, Texas, USA) or from a live spark-plug on an internal combustion engine.

Raising and operating the nets.—Tie a pulley onto the end of the pulley support rope, which should be longer than twice the pulley's working height. Then tie a 5–6-m-long piece of net support line onto the ends of the upper pole of the modified net. Finally, tie a net support line (once again, longer than twice the pulley height) to the middle of the 5–6-m-long upper pole line and pass the net support line through the pulley (Fig. 1). Raise the pulley with the net support line through it to the desired height. Tie a braided net guy line or some other lighter line to one end of the lower net pole. This guy line will help guide the net into position and keep it from rotating during and after raising. Pull the net support line with one hand to raise the net while simultaneously paying out the lighter guy line with the other hand. With practice, one person can raise and lower the net. By pulling moderately on the guy line from the right location on the ground, you can even send a net up through a diagonal gap in the canopy. The net guy line must then be tied with moderate tension on it to keep the net in a somewhat diagonal final position. When sending a net up diagonally or tying it off in a diagonal position, frequently examine the guy line and other net lines for wear, for if the guy line breaks, the net will swing into vegetation, endangering birds and destroying the net.

Use a scope or binoculars to check canopy nets every 15–20 min. Such frequent checks are necessitated in part because sections of canopy nets frequently are in patches of sun, which quickly can overheat and kill captured birds.

To remove a bird, the net is lowered with the net support line. It takes from 30 s to several minutes to lower a net to remove a bird. Use a scope or binoculars to check canopy nets for small birds. It is easiest to remove a bird from the net if one lowers the bird to chest level or below, tying the net support line to a nearby tree while you work. If the net support line jams in the pulley while raising or lowering the net, the long pulley support rope can be untied and the entire net and pulley system can be

lowered to the ground. When one is removing birds from the net or storing the net for the night, always have the net descend onto a ground tarp. Furthermore, as insects and small terrestrial animals sometimes crawl into the folded net while it is on the ground when not in use, wrap the net completely with the tarp, using clothes pins to close off all openings and folds at the ends of the tarp. To transport the net, carry it attached to its poles and wrapped inside a folded tarp.

To remove a high branch from a desirable net position, shoot a monofilament line over it, pull up a braided line, pull up a piece of pulley support rope or a caving rope, and pull hard on the rope until the branch can be tied out of the way or broken off. I also tied two ropes onto the ends of a small, flexible saw (available from forestry supply companies) and cut through high branches by pulling back and forth on the ropes. Shorter trees and lower limbs can be tied out of the way or cut with pole-mounted saws.

DISCUSSION

With practice you probably could modify two or three nets per day or mount five to ten canopy nets per day. It should be possible for one person to run 15–25 canopy nets all day long, day after day. Using these techniques, it should be possible to capture all species of canopy birds. If the birds use particular routes through the canopy, nets can be mounted to intercept them. On very overcast days, the canopy flock species in the Manu National Park in Amazonian Peru tended to move into better lit areas around the edge of canopy clearings. On such days I was successful at netting these birds in canopy nets near and in these clearings. If a fruiting tree is attracting birds, it should be possible to catch them there. Once I was able to mount a vertical net between the crowns of two trees by shooting pulley support lines over the crowns of the trees (resting on dozens of small branches for support) and hanging the pulley and net in a small gap between them.

The canopy netting and line shooting methods described here remove some economic and logistical barriers to netting and canopy observation in tall forests. Thus, all species of forest birds, no matter how high or how small, should be fair game for netting.

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