

**JOB PROGRESS REPORT  
RESEARCH PROJECT SEGMENT**

**STATE:** Territory of Guam

**PROJECT NO.:** E-1-12

**STUDY NO.:** 4

**JOB NO.:** 3

**JOB TITLE:** Development and Testing of Control Methods for Enhancing Reproduction Affected Endangered Native Forest Birds and Fruit Bats (1470)

**PERIOD COVERED:** October 1, 1996 to September 30, 1997

**SUMMARY**

Field tests of electrical barriers designed to prevent predation at Mariana crow, *Corvus kubaryi*, nests by brown tree snakes, *Boiga irregularis*, were conducted at one nest site. Eggs were not laid, but normal nest attendance was observed when a dummy egg was placed in the nest before it was abandoned by the pair. No other nests were found, although one other pair did try to start a nest several times but failed. Eight captive crows, six Rota zoo crows and two hand-reared Guam crows, were released into the wild in northern Guam. Four Rota birds (one male, three females) are known alive, the status of a female hand-reared Guam bird is unknown, and three are confirmed dead. Of the three that died, two were victims of predation, probably monitor lizards or cats, and the third apparently died of natural causes, i.e., infection or sickness. Based on telemetry, released birds ranged from a few hundred to as much as 3 km from the release site. The released crows have adjusted well to their new surroundings and all have interacted with wild Guam crows. Although no breeding activity was observed, one Rota female did pair up with a male Guam crow.

**BACKGROUND**

Roadside counts by the Guam Division of Aquatic and Wildlife Resources (DAWR) have documented the decline of the native forest birds of Guam (DAWR 1974-1988). Studies by Conry (1988) and Savidge (1987) have indicated that predation by brown tree snake is the main cause of this decline.

Since these studies, attempts to develop effective means of protecting active nests of Mariana crows have been made. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of the adhesive resin Tanglefoot® have all been used as snake barriers around nest trees. The use of sheet metal girdles and Tanglefoot was partially successful but resulted in the mortality of nest trees and was discontinued. One fledgling was fledged from a nest in 1989 as a result of Tanglefoot protection.

Since 1990, active nests have been protected successfully with the use of a combination of electrical barriers placed on the trunks of active nest trees and clearing of vegetation around the tree (Aguon et al. 1992). Successful protection of active nests resulted in the fledging of three crows from two nests in 1992 (DAWR 1992) and two from two nests in 1994 (DAWR 1994). These were the first fledglings in the wild since 1985 (Michael 1987), with the exception of the one produced as a result of Tangle-Foot protection in 1989.

## **OBJECTIVES**

To develop methods for controlling brown tree snake predation on active nests of native birds and apply these methods to protect active crow nests.

## **PROCEDURES**

1. Develop methods for snake-proofing active native forest bird nest sites.
2. Implement snake-proofing methods at Mariana crow nest sites.
3. As a result of the National Research Council's (1997) recommendation, 2 hand-reared Guam Mariana crows and 6 Rota Mariana crows, transferred from the National and Houston Zoos on February 22-23, 1997, were soft-released into the wild in northern Guam.
4. The crows were instrumented with a 7 or 10 g radio transmitter (see Figure 4 for harness design) after they were weighed, measured for wing, tail, tarsus, bill length, and banded with a numbered band (size 4) and a unique combination of color bands.
5. After an acclimation period of 4-7 days to the radio transmitters, the birds were weighed again (to confirm no significant weight loss) and the harness/transmitter inspected for any fraying or defect.
6. Captive birds were transferred to a snake-proofed hacking box, measuring 1.8 m wide, 1.8 m high, and 3.0 m long (Figure 5). Seven of the eight crows were held in the box for at least seven days prior to being released, which allowed acclimation to the surrounding area. The eighth crow was released two hours after being placed in the hack box. Fresh food was provided daily and the birds were allowed to feed *ad libitum*. Food consisted of moistened dry dog food, mice pinkies, lizards, and live mice. In addition, wild caught grasshoppers, caterpillars, and other potential food items were provided.
7. After the crows were released from the hack box, movements of released crows were monitored daily during the first 90 days of their release and every third day after that via telemetry. For each day, 1-3 locations of each crow were obtained. Multiple locations obtained on a single day were at least one hour apart. Visual observations were made of the released crows daily for at least the first month of their release. For each observation, the date, time, weather conditions (percent cloud cover, wind speed, and presence or

absence of rain), habitat type, activity of the bird, species of tree used, location in tree, and height above ground were recorded.

8. After being released (site locations, see Figure 1), supplemental feeding was provided via an elevated food platform at the hack site until the birds became successful foragers on natural food items and ceased consumption of supplemented food.
9. Efforts to trap unbanded wild birds around the hack site were made. Noose traps and mist nets were used to trap crows and were not left unattended (Figure 6).
10. Recovered remains of any released birds that died were necropsied to determine possible cause of death. When possible, specimens will be kept for museum purposes as partial skeletons or skins.

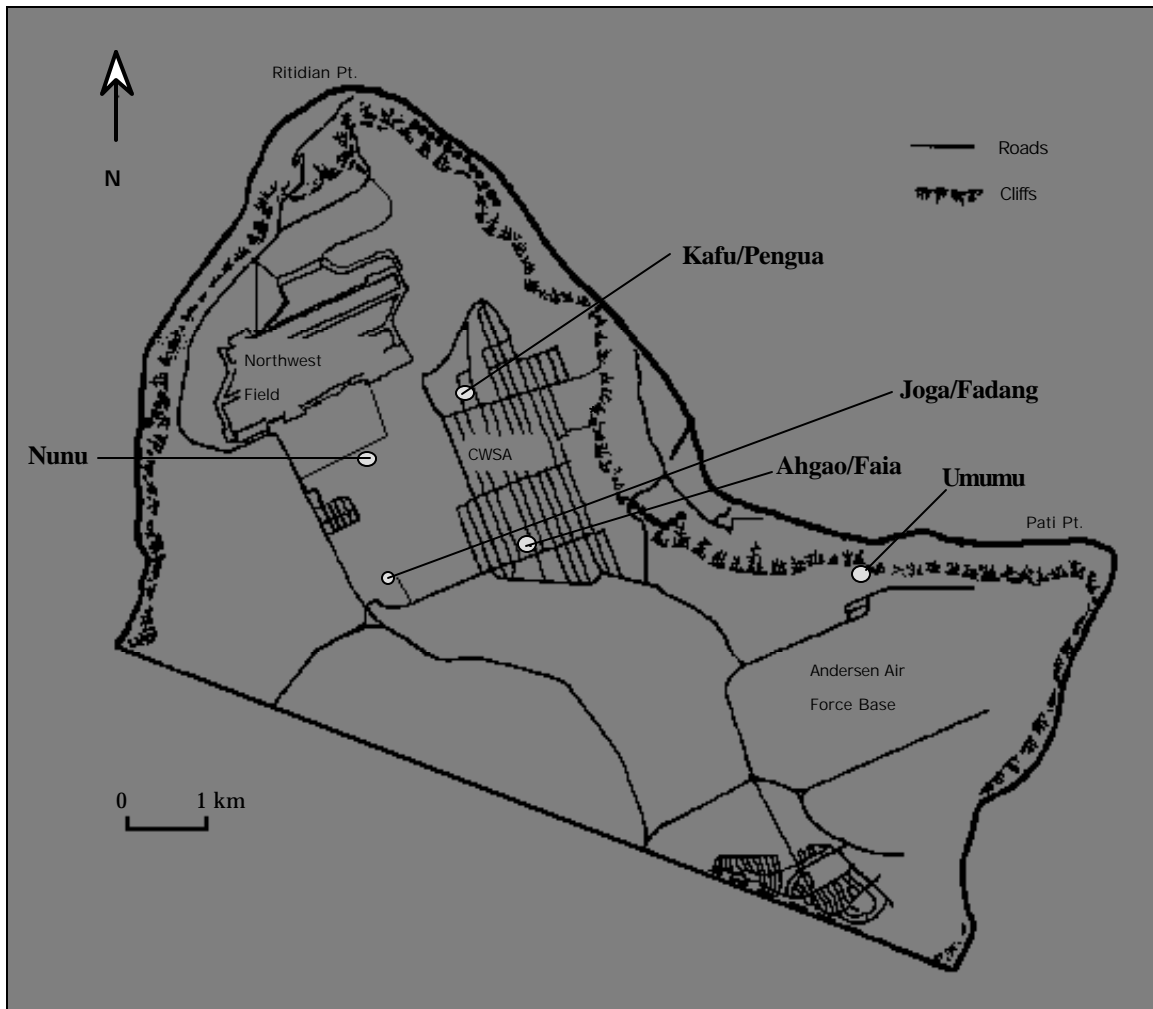


Figure 1. The location of release sites of captive Mariana crows in Northwest Field, Conventional Weapons Storage Area (CWSA), and near the cliffs of Andersen Air Force Base.

## RESULTS

### Nest Protection

Field use of electrical barriers to protect nests of the Mariana crow from predation by brown tree snakes and monitor lizards, *Varanus indicus*, continued this fiscal year. The design of this barrier is illustrated in Figure 2. This design proved highly effective in control field experiments in 1995 (DAWR 1995). The electrical barriers were powered by 12-volt lead acid batteries and were also equipped with solar panels, which lessened the frequency of battery replacement.

Intensive searches were carried out in northern Guam to locate crow territories and nests during the breeding season (approximately November to May). When an active nest was discovered, an electrical barrier was installed on the trunk of the nest tree at night prior to completion of the nest. Night installation was done to avoid undue disturbance to the nesting birds. Installation before completion of the nest allows for the removal of snakes by trapping prior to egg laying. Trapping for snakes usually involved 4 traps around the nest tree and 1 in the nest tree. Care and feeding of the mice used as bait in the traps and maintenance of the barrier occurred on a regular basis under the cover of darkness, usually during the early morning hours before sunrise.

Breeding activity this year was very poor. On January 21, the only active Mariana crow nest tree was found and snake-proofed six days later when the nest was nearly completed. Installation of this barrier took 9 man-hours (no. of hours x number people). Barrier voltage ranged from 5,100-5,200 volts.

This nest was built by the "Tarague Jeep Road" pair, which had a history of building nests and abandoning them without laying eggs. Egg production was not expected with this latest attempt. The pair abandoned the nest the day after the barrier was installed and was observed starting a new nest about 30 m away. A dummy egg was placed in the first nest on February 3 and on that same day, the second was destroyed. This forced the birds back to their first nest and on February 9, they were observed incubating the dummy egg. Nest attendance was very high (80-99%) during next 21 days before the birds abandoned the nest (Figure 3). No other nests were known to be constructed by this pair.

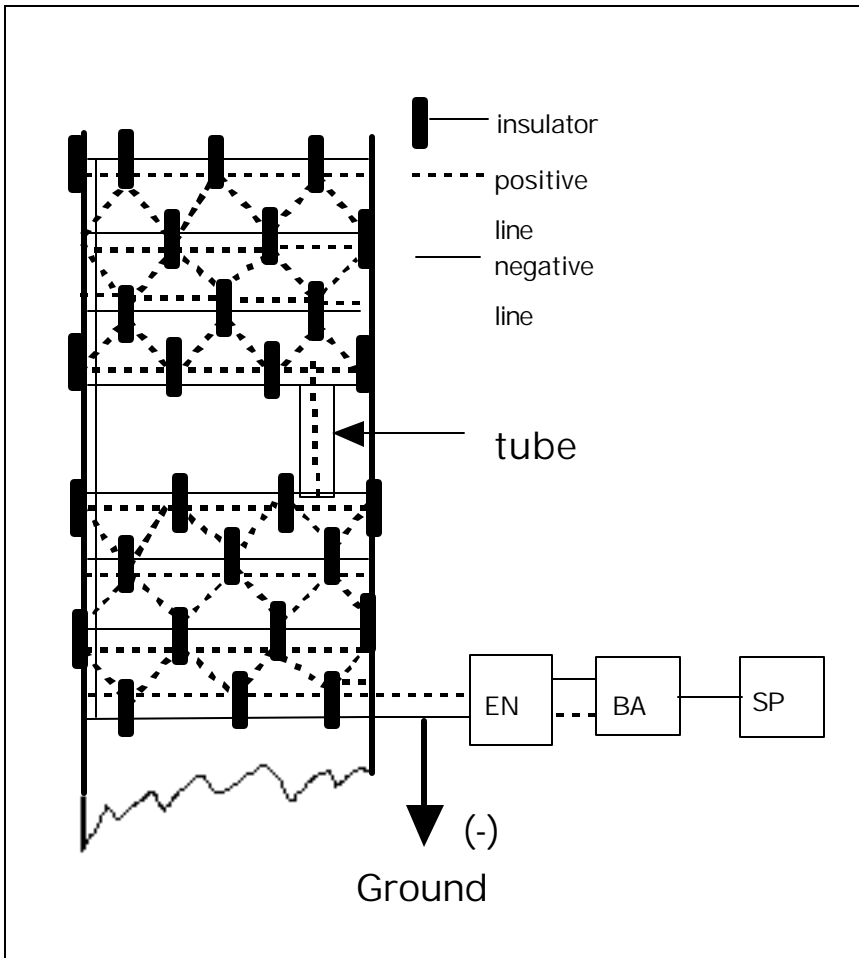


Figure 2. The electrical/hardware cloth barrier is assembled by first wrapping galvanized cable around the trunk of the tree and attaching one end to a steel rod inserted into the ground to form the negative line. Insulators are nailed to the trunk in a staggered pattern and a separate length of cable is placed onto them to form the positive line. The end of the positive and negative lines are then connected to an electrical fence energizer (EN) powered by a 12-volt DC lead acid battery (BA). A 300-watt solar panel (SP) is used to maintain the battery charge and reduces battery changes. The metal shelf is attached flush to the tree between the upper and lower electrical sections. A hollow plastic tube is used as an insulator to prevent grounding between the metal shelf and the positive line.

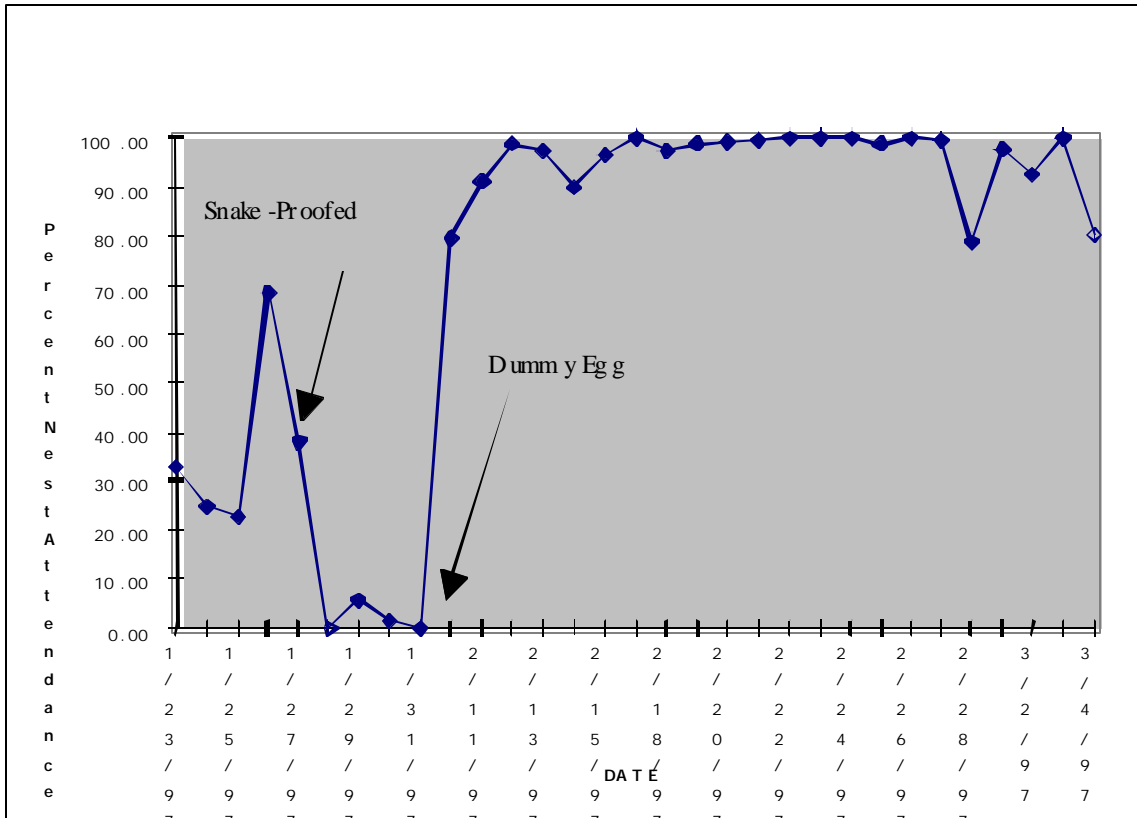


Figure 3. Nest attendance at the only nest found during the 96-97 crow breeding season. The nest was constructed by the “Tarague Jeep Road” pair, who began incubating after a dummy egg was placed in the nest. They abandoned the nest after March 4, 1997, even though the dummy egg was still present in the nest. The nest was snake-proofed.

While snake-proofing is important in improving the nesting success of crows by preventing snake predation, other additional factors are limiting reproductive success. The lack of breeding activity this season is more evidence of an aging population of crows on Guam. It is recommended that other management techniques be implemented (e.g., translocation of fertile eggs or nestlings from Rota) to improve the reproductive success of these birds.

Hacking Mariana Crows into the Wild

A review of the Mariana crow recovery program was recently completed by the NRC (1997). Their recommendations included releasing on Guam all Mariana crows being held in captivity at mainland zoos to help recovery efforts. Of the 12 birds eligible to be released during this breeding season, two were from the DAWR breeding facility (a male and female), 3 pairs and a female were from the National Zoological Park Conservation Research Center, and a pair and female were from the Houston Zoo. Eight Mariana crows were eventually released into the wild on Guam during January, March, April, and June 1997, including 5 from the National Zoo, one from the Houston Zoo, and the 2 hand-reared Guam crows. Two crows remain in captivity at the Houston Zoo, while 2 others died after the report was published.

Prior to their release, the birds were measured and weighed. The weights of the zoo birds were compared to their arrival weights to determine changes. All the crows transferred from the zoos showed excellent adjustment to their new surroundings and gained an average of 25 g (SD = 8.9 g, Table 1). A male crow, named “Kafu”, was showing some signs of stress as his crown and nape were defeathered. Despite this, he appeared to be adjusting to his new outdoor aviary, as did the other crows.

Table 1. Measurements of captive crows from Guam (hand-reared) and Rota (i.e., National Zoo [NZ] and the Houston Zoo [HZ]) prior to their release. Two body mass measurements are given for the zoo birds; arrival weight on Guam (ArWt), and weight before being instrumented (TxWt). Before being fitted with transmitters, birds were measured for bill, tarsus wing chord, and tail lengths. The mean and standard deviation (SD) for these measurements are given.

Band No.	Source	Name	Sex	Bill	Tarsus (mm)	Wing Chord	Tail (mm)	ArWt (g)	TxWt (g)	Wt Diff.
76469-301	Guam	Joga	M	45.0	53	220	140.3		260	
671	Guam	Nunu	F	40.6	49.1	200	125.0		190	
76469-302	HZ	Fadang	F	43.1	51.6	278	148	220	255	35
76469-303	NZ	Kafu	M	55.9	51.2	238	160	250	280	30
76469-304	NZ	Pengua	F	44.9	49.15	230	155	230	255	25
76469-305	NZ	Umumu	F	44.3	50.7	238	155	220	250	30
76469-307	NZ	Faia	F	47.7	51.6	230	146	210	230	20
76469-306	NZ	Ahgao	M	47.6	50.4	234	161	285	295	10
Mean				46.1	50.8	234	149	236		25
SD				4.6	1.3	22	12	28		8.9

After the determining the crows were ready for release, the birds were fitted with radio transmitters weighing 7-10 g and a harness made of teflon tubing (Figure 4).

Instrumentation of the birds took about 45 minutes. Birds were kept fairly calm by placing a cotton sock hood over their heads. They were transferred to release sites in Northwest Field, CWSA, and Pati areas (Figure 1) and placed in a hack box (Figure 5).

The crows spent an average of 18.8 days (SD = 14.2 days, range = 1-41 days; Table 2) before being released. However, one female, named “Umumu”, was released two hours after she was placed in the hack box. Time in the hack box also gave additional time for the birds to adjust to the transmitter. The harness did not appear to cause abrasions or discomfort to the birds.

After a short adjustment period of two weeks or less, the birds were transferred to the hackbox. Prior to their release, the crows spent an average of 10 days (SD = 8.8 days, range = 0-29 days; Table 2). A male hand-reared Guam crow, named “Joga”, spent the longest time in the hackbox (29 days), as he was allowed more time to adjust to the environment and feed on wild-caught insects and skinks. Of all the released birds, Joga exhibited the greatest affinity for humans. Umumu spent only a few hours in the hackbox and was quickly released to encourage a wild male in the territory to pair with her.

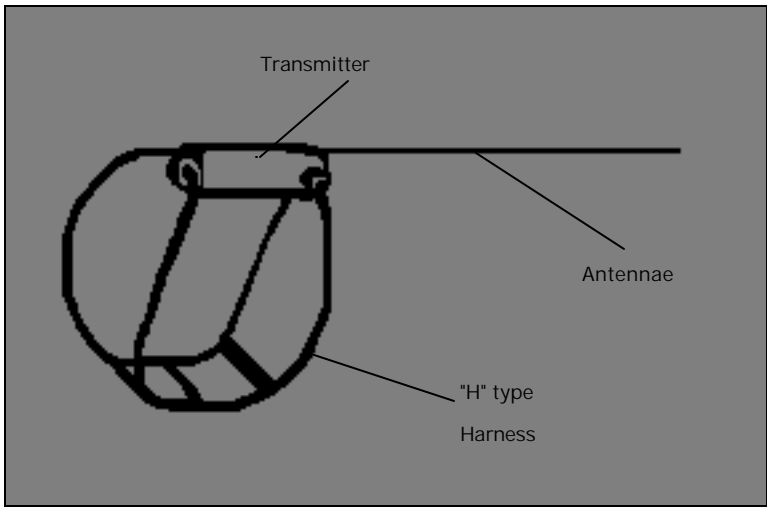


Figure 4. Hacked crows will be instrumented with transmitters using "H" type harnesses made of 1/4 inch Teflon ribbon (J. Marzluff, pers. com). The transmitters are rated for 500 days and are configured to be on 16 hours and off 8 hours during the first 90 days, after which they will switch to a 16-hr on and 56-hr off cycle.

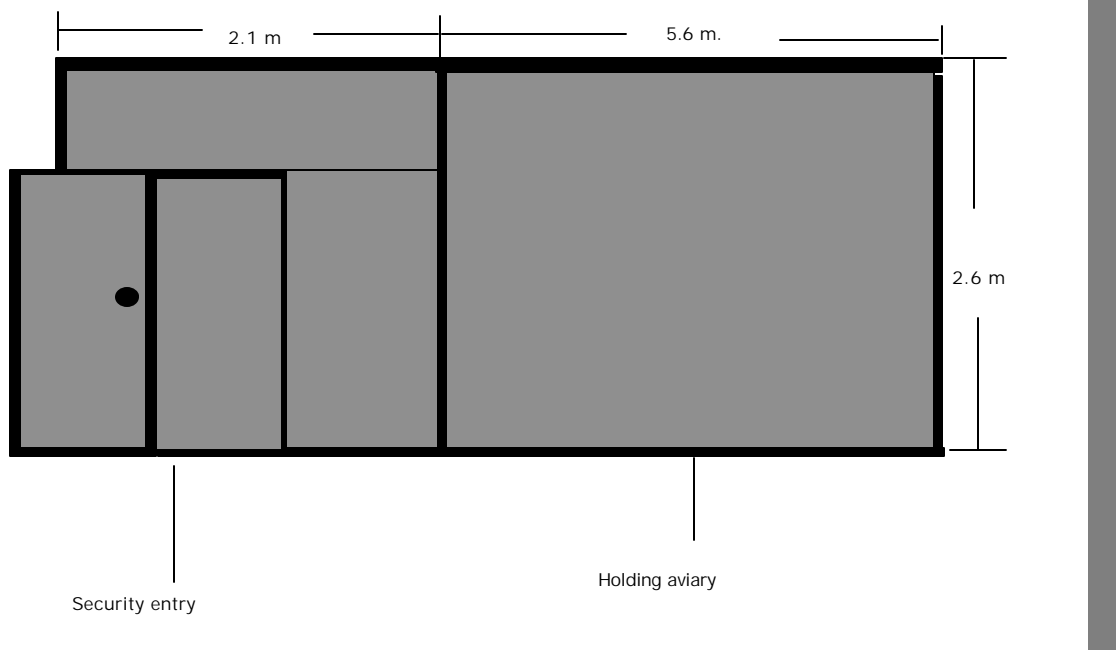


Figure 5. Overview of the outdoor aviary used to hold crows transferred from mainland zoos. The security entry prevented accidental escapes.

Table 2. The number of days each crow had its radio transmitter on before being released (Tx) and the date of its release. The number of days survived is given only up through September 30, 1997.

	Name	Sex	Date Released	Tx	Days Hackbox	Survived
1	Joga	M	1/15/97	36	29	219
2	Nunu	F	2/15/97	27	16	63 <sup>1</sup>
3	Fadang	F	3/19/97	8	5	195 <sup>2</sup>
4	Kafu	M	4/1/97	12	7	34
5	Pengua	F	4/1/97	12	7	182 <sup>2</sup>
6	Umumu	F	4/2/97	1	0	13
7	Faia	F	6/11/97	13	8	111 <sup>2</sup>
8	Ahgao	M	6/11/97	41	8	111 <sup>2</sup>
			Mean	18.8	10.0	116.0
			SD	14.2	8.8	76.9

<sup>1</sup>Nunu's radio failed after 63 days and her status is unknown.

<sup>2</sup>These birds were alive through September 30, 1997.

Efforts to trap unbanded wild birds around the hack site were made. Noose traps and mist nets were used to trap crows and were not left unattended (Figure 6).

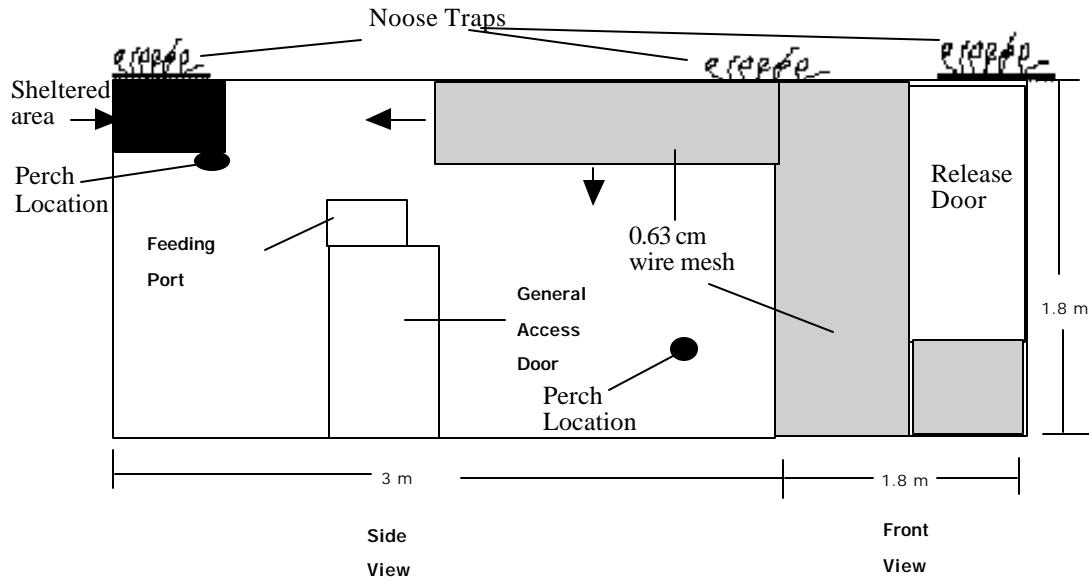


Figure 6. Hacking box with noose traps attached to the exterior upper corners of the box to catch unbanded wild crows.

### Survival of Released Crows

Survival of released crows averaged 116 days (SD = 76.9, range = 13-219; Table 2). Joga, a male crow named “Kafu,” and Umumu survived 219, 34, and 13 days in the wild, respectively. Joga and Kafu were possibly preyed on by monitor lizards or cats, since the deaths were believed to have occurred during the daytime. Kafu was blind on the right eye, probably making him vulnerable to predation. Umumu’s carcass was found intact beneath a rock in the Tagua Point area. On May 17, a captive-born zoo female crow, named “Fadang”, was found being held on the ground by a monitor lizard. The deaths of two crows and almost a third by monitor lizards or cats indicates that ground predators should be controlled for in future releases.

### Movements of Released Birds

Captive crows were fitted with transmitters manufactured by Advanced Telemetry Systems weighing 7-10 g. Locations of birds were determined by triangulations based on three bearings. Accuracy of these bearings were determined by using a “dummy” transmitter placed on the ground or above the ground (in a tree) at distances less than 100 m, greater than 100 m, and greater than 200 m from the person triangulating. The differences in distances between true and triangulated locations ranged from 50-105 m (Table 3). Ground measurements were most accurate when between 100-200 m from the observer. Above ground measurements were most accurate at distances less than 100 m (mean = 49.6 m, SD = 31.9 m; Table 3).

Table 3. The difference between the actual location of a “dummy” transmitter and the location based on bearings. Two different heights (ground and tree height) and three distance categories were used to determine accuracy based on telemetry. A U.S. Geological Survey map of the Conventional Weapons Storage Area (scale: 1:24,000) was used in the test.

Distance (m)	Height =	Ground	Tree
<100	MEAN	58.3	49.6
>100	STD	23.2	31.9
>200	N	10.0	10.0
<100	MEAN	27.7	105.4
>100	STD	12.6	70.1
>200	N	10.0	10.0
<100	MEAN	79.0	67.2
>100	STD	33.6	43.7
>200	N	10.0	10.0

On January 15, Joga was released in the CWSA (Figure 1), an area occupied by an unmated female, named “C1”. Though the birds were seen together many times, they did not pair. Joga’s average distance from the release site during his first week after release averaged 574 m (SD = 558.0 m; Table 4). During the following weeks, he made many visits to the supplemental feeding platform, which was stocked with food, but he was eventually weaned from it.

Following Joga’s release, Fadang was released in the same area on March 19 after it appeared the C1 female was not pairing up with Joga. After Fadang was transferred to the hackbox, Joga was recaptured and placed in the hackbox with her. This pair had exhibited pair bonding behavior as they were observed allopreening and perching side by side. After their release, they were observed constantly foraging, perching, and flying together. The C1 female was seen on many occasions following the pair. Average weekly distance traveled by Joga and Fadang ranged from 0-792 m from hacksite (Table 4). Soon after Joga’s death on August 22, Fadang’s radio had failed.

Table 4. Average weekly distance traveled by Joga and Fadang from the hacksite after their release. Joga was released on January 15 and Fadang on March 19.

Week	Mean	STD	N	Notes
1	574.13	558.04	8	Joga alone
2	93.62	103.08	7	Joga alone
3	345.99	299.13	8	Joga alone
4	96.61	171.28	8	Joga alone
5	62.94	76.03	8	Joga alone
6	36.06	0.00	8	Joga/Fadang
7	36.06	0.00	8	Joga/Fadang
8	21.63	19.75	5	Joga/Fadang
9	0.00	0.00	6	Joga/Fadang
10	178.60	125.84	5	Joga/Fadang
11	269.15	328.54	11	Joga/Fadang

12	731.27	199.55	9	Joga/Fadang
13	317.57	199.51	22	Joga/Fadang
14	287.30	186.47	29	Joga/Fadang
15	252.76	102.24	27	Joga/Fadang
16	250.60	151.23	22	Joga/Fadang
17	112.18	55.60	32	Joga/Fadang
18	190.23	113.06	30	Joga/Fadang
19	172.93	145.30	29	Joga/Fadang
20	230.67	197.88	32	Joga/Fadang
21	257.03	184.45	31	Joga/Fadang
22	135.18	145.21	30	Joga/Fadang
23	792.16	156.05	31	Joga/Fadang
24	772.60	373.40	31	Joga/Fadang
25	525.30	365.24	11	Fadang's radio failed
26	418.43	412.52	9	
27	132.26	44.91	2	Joga dead - 8/22/97

A hand-reared female Guam crow named “Nunu” was released in Northwest Field on February 15 (Figure 1). Very little site fidelity was observed as Nunu’s average weekly distance traveled ranged from 751-2,500 m (Table 5). Aside from feeding on food placed on the supplemental feeding platform during the first couple of days, Nunu spent most of her time away from the hacksite. She was observed spending several days at a time in the old housing area in Northwest Field, located about 500-600 m from the hacksite. The area is composed of a mixture of open fields and forest. Insect densities were abundant in this area. No observations of Nunu were made after her radio failed on April 23.

Table 5. Average weekly distance traveled by Nunu from the hacksite. This hand-reared female Guam crow was released on April 23.

<b>Week</b>	<b>Mean</b>	<b>STD</b>
1	750.56	795.71
2	575.06	646.69
3	1280.83	157.04
4	1123.46	111.23
5	2342.76	383.19
6	2996.98	210.10
7	1555.61	632.84
8	2073.38	327.00
9	2506.15	103.78

Kafu and a female zoo crow named “Pengua” were released as a pair in the CWSA area on April 1 (Figure 1). Their average weekly distance traveled during the first 5 weeks ranged from 314-945 m from the hacksite (Table 6). This pair did not use the supplemental feeding platform and was seen foraging in native trees (e.g., *Pandanus* and *Elaeocarpus*) immediately after their release. They seemed to be well suited for each other, and were observed foraging together and staying in close proximity of each other. However, on April 19, Pengua was not with Kafu and was later seen with two other unbanded crows on the north side of CWSA. She was reunited with Kafu on April 21 and the two remained together until Kafu’s death on May 5.

Table 6. Average weekly distance traveled by Kafu and Pengua from their hacksite after their release. Released on April 1, they remained together for most of the time until Kafu’s death. Pengua has since interacted with other crows, but has not paired up with any of them.

WEEK	MEAN	STD	N
1	313.95	262.33	19
2	858.35	331.99	19
3	809.46	502.15	13
4	231.98	204.90	18
5	944.49	640.88	5

A female zoo crow named “Faia” and a male zoo crow named “Ahgao” were released together in the CWSA area on June 11 (Figure 1). After their release, the pair separated; Faia had followed a male crow named the “11B6 male”, whose territory was nearby. This male had visited the hacksite many times while the birds were still in the hackbox. Though both males were seen aggressively vocalizing to each other, activity settled down in the following days. Ahgao spent several weeks in this male’s territory before venturing into adjacent areas in CWSA.

Because Faia and Ahgao separated after their release, data on average weekly distance traveled for each bird is reported separately. Ahgao’s average weekly distance traveled during the first 13 weeks of his release ranged from 584-2,420 m from the hacksite (Table 7). Besides his interaction with the 11B6 male in CWSA, he also encountered Joga and Fadang in the “Handicap” hunting area, 2,700 m from his hacksite. There were aggressive vocalizations (high pitched calling) between Joga and Ahgao, but no physical contact was observed. In subsequent days, Ahgao returned to the CWSA area near the 11B6 male.

Table 7. Average weekly distance traveled by Ahgao after his release on June 11. He was released with Faia, but the two had separated immediately after.

WEEK	MEAN	STD	N
1	583.85	333.73	34
2	508.18	70.50	31
3	428.46	111.93	32
4	464.99	236.82	29
5	761.33	206.75	28
6	935.36	248.45	27
7	1816.05	737.36	18

8	2373.61	153.56	22
9	1723.36	603.80	26
10	1898.34	150.08	17
11	2419.71	225.06	9
12	2275.77	40.28	5
13	1874.69	748.82	11

Faia's average weekly distance traveled during the first 13 weeks of her release ranged from 534 - 779 m from the hacksite (Table 8). After separating from Ahgao upon release, she spent most of her time with the 11B6 male in CWSA. The birds were constantly seen together and it appeared that they had paired up.

Table 8. Average weekly distance traveled by Faia from the hacksite since her release on June 11. She was released with Ahgao, but the two separated since their release. Faia paired up with a male located in the 11B6 CWSA area, but did not breed.

WEEK	MEAN	STD	N
1	603.36	432.56	31
2	622.60	228.17	27
3	601.09	248.69	32
4	562.16	227.66	31
5	741.34	323.00	28
6	779.19	152.65	28
7	724.08	289.37	24
8	583.35	120.43	25
9	669.59	182.60	27
10	534.83	154.23	19
11	633.85	150.54	9
12	699.07	236.20	11
13	578.05	210.68	13
14	534.21	28.99	4

In summary, observations of the eight released captive crows indicated that they adapted well to their new environment. Two of the three crows that died were probably killed by monitor lizards or cats, while the third most likely died from natural causes, e.g. sickness. None died from snake predation. The status of a fourth crow is unknown. The remaining four released crows settled in their new surroundings, all far from their release sites, and are interacting with other Guam crows. One female had paired up with a Guam crow.

## RECOMMENDATIONS

1. Operational implementation of proven methods to protect nesting Mariana crows.
2. Conduct *in situ* tests of methods which prove effective in laboratory experiments on actual active nest trees.

3. Explore the feasibility of area-wide snake control and exclusion of snake from larger areas encompassing nesting territories of crows with the use of barriers.
4. Explore and implement other methods or techniques to improve reproductive success of nesting birds to be used in conjunction with nest protection, i.e., translocation of crows from Rota.
5. Implement recommendations by the NRC for the recovery of the Mariana crow on Guam and Rota.

## **PROGRAM COSTS**

The estimated cost for this project under E-1-12 is \$200,000.

## **LITERATURE CITED**

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