5-YEAR REVIEW

Short Form Summary

Species Reviewed: *Corvus kubaryi* (Mariana crow; åga)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 83(88):20088-20092.

Lead Region/Field Office:

Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii

Name of Reviewers:

Tyler Willsey, Fish and Wildlife Biologist, PIFWO
Jacqueline Flores, Mariana Islands Team Manager, PIFWO
John Vetter, Animal Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

Methodology used to complete this 5-year review:

This review was conducted by staff of PIFWO, U.S. Fish and Wildlife Service (USFWS). The review was based on current, available information since the last 5-year review for the Mariana crow (USFWS 2014). The evaluation by Tyler Willsey, Fish and Wildlife Biologist, was reviewed by the Mariana Islands Team Manager, the Animal Recovery Coordinator, and the Conservation and Restoration Team Manager.

Background:

For information regarding the species listing history and other facts, please refer to the Fish and Wildlife Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (http://ecos.fws.gov/tess_public).

Review Analysis:

Please refer to the to the final listing rule for the Mariana crow published on August 27, 1984 (available at http://ecos.fws.gov/docs/federal_register/fr875.pdf), the previous 5-year review published on August 12, 2014 (available at https://ecos.fws.gov/docs/five_year_review/doc4421.pdf) and the draft revised recovery plan published in May 2005 (available at http://ecos.fws.gov/docs/recovery_plan/060111.pdf) for a complete discussion of the species' status (including biology and habitat), threats, and management efforts. No significant new information regarding the biological status has come to light since listing to warrant a change in the federal listing status of the Mariana crow.

New status information:
The Mariana crow population continued to decline on Guam from about 10 individuals in 2006, to three individuals in 2008, to one male in 2011 (SWCA 2012). The Mariana crow is now extirpated from Guam. The last known Mariana crow of Guam origin was observed in 2001, and the last known wild Mariana crow that was captive-reared from Rota and released on Guam was observed in 2012 (J. Quitugua, Guam Division of Aquatic and Wildlife Resources, pers. comm. 2014).

The Mariana crow population on Rota has stabilized or slightly increased since the last review, from 46 breeding pairs documented in 2013 to 50 breeding pairs in 2019. During the 2019 breeding season, 24 of the 48 pairs that nested (50%) successfully fledged young (R. Ha, unpublished data), which is similar to the 49% average pair success rate from 1996-2009 (Zarones et al. 2015).

Analyses of Mariana crow mark re-sight data from 1998-2018 show the best-fitting model for first-year survival across all years as an average of 59.4% with no significant change over time but with large year-to-year variations. Adult survival during 1998-2018 remained stable at 82.6% with less variation between years. Alternatively, an *a priori* model for first year survivorship, dividing data into two periods (1998-2011 and 2012-2018) based on a previously published model (Ha et al. 2013) found increased 1st year survival during the second period. However, low sample sizes during the first period mean that this data is less reliable than data than the following years, when larger teams were able to monitor survival on population-level.

Table 1. Summary of population estimates for the Mariana crow on Rota, adapted from Table 1 of the draft revised recovery plan (USFWS 2005).

Year	Population estimate	Unit	Survey Method	Source
1982	1,318	Individuals	Off-road VCP[1]	Engbring et al. 1986, as cited in USFWS 2005
1992	447-931	Individuals	Roadside VCP	M. Lusk, DFW, 1995 (unpubl. data), as cited in USFWS 2005
1993	336-454	Individuals	Roadside VCP	M. Lusk, DFW, 1995 (unpubl. data), as cited in USFWS 2005
1995	592	Individuals	Off-road VCP	Fancy et al. 1999, as cited in USFWS 2005
1995	365-607	Individuals	Off-road VCP	R. Camp, USGS, 2001 (unpubl. data), as cited in USFWS 2005
1998	138-504	Individuals	Off-road VCP	R. Camp, USGS, 2001 (unpubl. data), as cited in USFWS 2005

1999	234	Breeding adults	Extrapolated from known pairs and density estimates	Plentovich et al. 2005, as cited in USFWS 2005
2004	170[2]	Breeding adults	Off-road VCP	Amar et al. 2008, as cited in USFWS 2009
2008	50-60	Breeding pairs	Island-wide pair survey	Zarones et al. 2014
2013	46-54	Breeding pairs	Island-wide pair survey (direct count of 46 plus up to 8 additional pairs extrapolated from known density estimates to unsearched areas)	Kroner and Ha 2014
2015	50	Breeding pairs	Island-wide pair survey (direct count)	Faegre et al. 2015 (Annual Report).
2016	53	Breeding pairs	Island-wide pair survey (direct count)	Faegre et al. 2016 (Annual Report).
2017	52	Breeding pairs	Island-wide pair survey (direct count)	Faegre et al. 2017 (Annual Report).
2018	47	Breeding pairs	Island-wide pair survey (direct count)	Faegre et al. 2018 (Annual Report).
2019	50	Breeding Pairs	Island-wide pair survey (direct count)	Faegre et al. 2019 (Annual Report).

[1] Variable Circular Plot (VCP) survey methodology
[2] Magnitude of observed decline applied to most recent population estimate

New threats:

- Cat predation – While frequent evidence of cat predation and/or scavenging was found during telemetry studies from 2010-2011, little evidence has been found since that time. Changes that may account for this difference include cat control (during 2012-2016) and a change in the mortality monitoring protocol that now allows researchers to locate carcasses within 12 hours of death, rather than 24 hours, reducing the probability of scavenging and increasing our ability to determine cause of death.
- From 2012-2019, the primary cause of death in crows of all age classes has been an inflammatory syndrome of unknown origin. Among 25 crow carcasses that were submitted for necropsy, 20 had deaths attributed to this syndrome. This inflammatory disease has been called Aga Eucaryote X (AEX) by Dr. Thierry Work at the USGS Hawaii Field Station. Dr. Work suspects that AEX is an infectious disease; AEX causes illness and death through systemic inflammation,

anemia, and pneumonia. Efforts to identify the organism associated with this disease have not be successful and investigations are ongoing through both USGS and San Diego Zoo Global (Sarah Faegre, Rota Avian Behavior Ecology Project, pers. comm. 2020).

In addition to disease and cat predation, additional threats continue to be:

- Agricultural and urban development loss or degradation of habitat – Loss and/or degradation of habitat through military training activities and human development on Guam, and human development on Rota.
- Human disturbance – the actions of population managers directly impact local attitudes towards the Mariana crow, including the extent to which persecuting the crow is popular. Although there has not been any direct evidence of intentional killing of Mariana crow since 1995 (D. Grout testimony, as cited in NRC 1997), informal testimony from Rota community members suggests that opportunistic killing of crows still occurs.
- Nonnative snake predation – brown treesnake on Guam.
- Stochastic events - Typhoon mortality and reduced viability
- Stochastic events – Reduced viability due to low numbers.
- Low egg viability

New management actions:

- Population viability monitoring and analysis
    - Banding: The University of Washington's Rota Avian Behavioral Ecology Program (RABEP) has banded 306 Mariana crows since 2005 (Ha unpublished data). Mark re-sight data has been used to develop age-specific survivorship models (see "New status information" above) (Sarah Faegre, Rota Avian Behavior Ecology Project, pers. comm. 2020).
    - Nest monitoring: RABEP have conducted nest monitoring for the Mariana crow on Rota since 2005. Efforts provide data that is used for analyses of nesting success and demographics (see "New status information" above)(Sarah Faegre, Rota Avian Behavior Ecology Project, pers. comm. 2020).
    - Mariana crow mortality monitoring: From 2009 to 2019, transmitters were attached by RABEP to 115 Mariana crows that were tracked and monitored for the life of the battery. In all but one case the outcome was determined by either locating the carcass or re-sighting the live bird after battery failure (Sarah Faegre, Rota Avian Behavior Ecology Project, pers. comm. 2020).
- Disease Investigations: Dr. Thierry Work at the USGS-Hawaii Field Station is leading an investigation (2010 to present) into the inflammatory syndrome called AEX, with a focus on identifying infectious disease. Drs. Carmel Witte and Caroline Moore at the San Diego Zoo Global are leading an epidemiological investigation (2018 to present) into AEX with a focus on landscape-level patterns in AEX and potential infectious and non-infectious causes for the syndrome (Sarah Faegre, Rota Avian Behavior Ecology Project, pers. comm. 2020).
- Predator / herbivore monitoring and control – The UW Rota Island Feral Cat Removal Project began cat removal efforts on Rota in February 2012 (Ha et al.

2013). The UW removed 589 cats from areas in and around crow territories (Leo 2014). The Institute for Wildlife Studies took over cat control efforts on Rota from 2014-2016.

- Strategic planning / Threats management planning – USFWS in cooperation with the Mariana Crow Recovery Team conducted an exercise in structured decision making (SDM) to determine which actions should be taken now and over the next several years to maximize the probability of preventing extinction and set the foundation for at least one stable to increasing population in the wild. The two primary objectives driving the SDM were to prevent the extinction of the Mariana crow and to ensure a viable stable or increasing population in the wild. Priority actions identified in the SDM exercise included predator control on Rota, and a phased approach to captive propagation (see details below in "Recommendations for Future Actions).
- Captive propagation for genetic storage and reintroduction – Captive care of sick or injured crows was conducted on an as-needed basis by RABEP captive care specialists from 2010-2014. From 2015 to present, the San Diego Zoo Global (SDZG) has led a captive rear-and-release program; care of other captive aga have also been transferred to SDZG care. As of August 2020, SDZG has reared 37 Mariana crows to independence. Twenty-three crows have been released and 14 are currently in captivity with an expected release date of December 2020. Of 23 crows released by SDZG in 2018 and 2019, two died, two are currently in rehabilitation for injuries, and 19 remain in the wild and are fully independent from supplemental food (Sarah Faegre, Rota Avian Behavior Ecology Project, pers. comm. 2020).

Synthesis:

The Mariana crow population is now extirpated from Guam, and appears to have stabilized at a small population size on Rota (Table 1). Current models from mark-resight data suggest that juvenile and adult mortality rates have remained stable but are lower than expected for a healthy corvid population. None of the criteria for downlisting (USFWS 2005) have fully been met (Table 2).

While cat predation was a cause of mortality in 2010-2011, no recent evidence of cat predation on crows has been found, despite lack of cat control since 2016. Inflammatory disease was recently identified as a major mortality factor, but efforts to identify the cause of this disease and mitigate its impact are still underway. Other unknown factors are suspected to contribute to Mariana crow mortality, but intensive monitoring and management actions are required to identify and control those threats. Therefore, the Mariana crow still meets the definition of endangered as it remains in danger of extinction.

Recommendations for Future Actions:

Recovery implementation for the Mariana crow should include the following:

- Implement priority actions identified in the Mariana crow SDM exercise:
    - Captive propagation for genetic storage and reintroduction –Rear and release should continue, including the retrieval of eggs and/or chicks from

the wild population, hand-rearing until birds are passed the age of highest mortality risk, and releasing birds back to the wild on Rota. Future efforts may use founder birds from rear and release program for more intensive efforts in captive propagation or for translocation.

    - Disease investigation: The most critical step to moving forward with recovery of the species lies in the identification of the cause of the inflammatory syndrome, AEX, which has been the primary cause of death in crows of all ages since 2010. Despite investigation into the cause of this syndrome for the past 9 years, it remains a mystery. Support should be given to current, ongoing investigations within USGS and SDZG, and additional collaborations should be sought to increase the chances determining the cause of AEX (Sarah Faegre, Rota Avian Behavior Ecology Project, pers. Comm. 2020).

- Population viability monitoring and analysis
    - Continue field research to identify sources of adult and juvenile mortality and implement appropriate management measures to increase adult and juvenile survival.
    - Continue population and demographic monitoring on Rota.
    - Continue nest-monitoring to identify and mitigate causes of nest failure.
- Decrease the probability for human persecution by improving public perception of the crow—Involve Rotanese locals in the conservation effort, including hiring locals when possible, and increasing education and outreach.
- Habitat and natural process management and restoration – Set aside and protect recovery areas for Mariana crow on Guam.
- Predator / herbivore monitoring and control – Continue support of efforts to reduce brown treesnake populations over large areas of Guam, and interdiction efforts on Rota.

Table 2. Status and trends of the Mariana crow from listing through current 5-year review.

Date	Estimated Number (Guam/ Rota)	Downlisting Criteria Identified in Recovery Plan	Downlisting Criteria Completed?
1984 (listing)	150-200 individuals/ 1300 individuals	Populations of a minimum of 75 pairs occur on Rota and Guam	No
		Both populations are stable or increasing	No
		Sufficient habitat is protected and managed	No
		Brown treesnakes and other predators that threaten Mariana crow are controlled	No

		Brown treesnake interdiction effective on Rota	No
		Efforts to resolve landowner conflicts have been implemented	No
2004 (critical habitat); 2005 (draft revised recovery plan)	Insufficient data/ 170 breeding adults	Populations of a minimum of 75 pairs occur on Rota and Guam	No
		Both populations are stable or increasing	No
		Sufficient habitat is protected and managed	No
		Brown treesnakes and other predators that threaten Mariana crow are controlled	No
		Brown treesnake interdiction effective on Rota	No
		Efforts to resolve landowner conflicts have been implemented	No
2009 (5-year review)	2 individuals/ 120 breeding adults	Populations of a minimum of 75 pairs occur on Rota and Guam	No
		Both populations are stable or increasing	No
		Sufficient habitat is protected and managed	No
		Brown treesnakes and other predators that threaten Mariana crow are controlled	No
		Brown treesnake interdiction effective on Rota	No
		Efforts to resolve landowner conflicts have been implemented	No
2014 (5-year review)	Insufficient data/ 92 breeding adults	Populations of a minimum of 75 pairs occur on Rota and Guam	No
		Both populations are stable or increasing	No

		Sufficient habitat is protected and managed	Partially; 444 hectares of crow habitat set aside in conservation on Rota
		Brown treesnakes and other predators that threaten Mariana crow are controlled	Partially; some control efforts on Guam
		Brown treesnake interdiction effective on Rota	Partially; limited interdiction efforts now in place on Rota
		Efforts to resolve landowner conflicts have been implemented	Partially; Homestead MOA (USFWS 2011) resolved a longstanding landowner conflict; Incentive Plan implemented from 2012-2014 (USFWS 2012)
2020 (5-year review)	extirpated/ 102 breeding adults	Populations of a minimum of 75 pairs occur on Rota and Guam	No
		Both populations are stable or increasing	Partially; population on Rota is stable
		Sufficient habitat is protected and managed	Partially; 444 hectares of crow habitat set aside in conservation on Rota
		Brown treesnakes and other predators that threaten Mariana crow are controlled	Partially; some control efforts on Guam
		Brown treesnake interdiction effective on Rota	Partially; limited interdiction efforts now in place on Rota
		Efforts to resolve landowner conflicts have been implemented	Partially; Homestead MOA (USFWS 2011) resolved a longstanding landowner conflict; Incentive Plan implemented from 2012-2014 (USFWS 2012)

Table 3. Threats to the Mariana crow and ongoing conservation efforts

Threat	Listing Factor	Current Status	Conservation/ Management Efforts
Habitat loss or degradation	A	ongoing	Partially; 444 hectares of crow habitat set aside in conservation on Rota

Introduced predators	C	ongoing	Partially; cat control occurred from 2012-2016.
Human persecution	E	insufficient data	Partially; landowner conflicts have been addressed through Rota Homestead MOA, Rota Landowner Incentive Plan, and pursuit of the Rota Island-wide Conservation MOA. Education programs and public perception survey conducted by RABEP 2009-2013. Intensive landowner outreach by RABEP from 2018-present.
Typhoons	E	ongoing	No
Reproductive and small population problems	E	ongoing	No
Disease	C	onging	No
Nutritional deficiencies	E	insufficient data	No
Contaminants	E	insufficient data	No
Harassment by drongos	E	insufficient data	No
Competition with introduced species	E	insufficient data	No

References:

See previous 5-year review for a full list of references. References for new information are provided below.

Faegre, S., R.R. Ha, D. Hubl, L. Ware, and D. Wiitala. 2015. Annual Report for Mariana Crow Work 2015-16 - F14AF01145 (July 1 2015-June 30, 2016). University of Washington, Seattle, Washington. 38 pages.

Faegre, S., R.R. Ha, and D. Hubl. 2016. Annual Report for Mariana Crow Work 2016-17 - F15AF01118 (July 1 2016-June 30, 2017). University of Washington, Seattle, Washington. 35 pages.

Faegre, S., R.R. Ha, D. Hubl, and D. Wiitala. 2017. Annual Report for the Mariana Crow 2017-18 - F16AF01004 (July 1 2017-June 30, 2018). University of Washington, Seattle, Washington. 39 pages.

Faegre, S., R.R. Ha, H. Fandel, D. Hubl, and D. Wiitala. 2018. Annual Report for the Mariana Crow 2018-19 - F17AF01118 (July 1 2018-June 30, 2019). University of Washington, Seattle, Washington. 31 pages.

Faegre, S., R.R. Ha, H. Fandel, and D. Hubl. 2019. Annual Report for the Mariana Crow 2018-19 - in prep.

Ha, R. 2014. Annual Report For (July 1, 2014-June30, 2015). Report to CNMI DFW. University of Washington, Seattle, Washington. 6 pages.

[USFWS] U.S. Fish and Wildlife Service. 2014. Aga or Mariana crow (Corvus kubaryi) 5-year review summary and evaluation. Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 10 pages.

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 83(88):20088-20092.

Personal Communication:

Faegre, Sarah. 2020. Research Coordinator, Rota Avian Behavioral Ecology Program, University of Washington. Email to Tyler Willsey, U.S. Fish and Wildlife Service, dated August 8, 2020. Subject: Re *Aga 5 year review*.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW for
Mariana Crow (*Corvus kubaryi*)

Pre-1992 DPS listing still considered a listable entity? __N/A_____

Recommendation resulting from the 5-year review:

_____	Delisting
_____	Reclassify from Endangered to Threatened status
_____	Reclassify from Threatened to Endangered status
___X___	No Change in listing status

Name of Reviewers: Tyler Willsey, Fish and Wildlife Biologist, PIFWO
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For **Field Supervisor, Pacific Islands Fish and Wildlife Office**

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