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Photo: Steve Schnoll

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Brown Boobies (*Sula leucogaster*) roosting at Washington-Slagbaai National Park, Bonaire, Caribbean Netherlands

Fernando Simal*[1,2], Adriana Vallarino[3], Elsmarie Beukenboom[4], Rutsel Paula[4], Henry Beaumont[4], George Zaragoza[4], Esther Wolfs[5], Patrick Holian[6], and Elisabeth Albers[7]

Abstract Brown Boobies (*Sula leucogaster*) are known to roost on the northwestern coast of Bonaire, Caribbean Netherlands. A published account from the 1950s reported ~200 Brown Boobies roosting in this area, along with smaller numbers of two other seabird species, and described regular hunting raids by fishermen in which up to 100 birds were harvested. In 1969, this roosting area and its surroundings were designated as a 30-km² nature reserve, and hunting became illegal. Although seabird assemblages were not monitored subsequently, anecdotal reports suggest that the number of roosting seabirds had decreased dramatically to < 60 individuals. In 2008–2010, we conducted roost counts at seven sites in Washington-Slagbaai National Park in northwestern Bonaire. Most counts were substantially higher than the anecdotal reports, with a maximum of 240 Brown Boobies in July 2009. We saw no evidence of breeding and did not observe any banded birds. Other roosting birds—Masked Boobies (*Sula dactylatra*) and Brown Noddies (*Anous stolidus*)—were also present in very small numbers.

Keywords Bonaire, Brown Booby, Caribbean Netherlands, citizen science, roost, *Sula leucogaster*, Washington-Slagbaai National Park

Resumen Individuos de *Sula leucogaster* descansando en el Parque Nacional Washington-Slagbaai, Bonaire, Caribe Neerlandés • Se conoce que *Sula leucogaster* tiene dormideros en la costa noroeste de Bonaire, en el Caribe neerlandés. En un informe publicado de la década de 1950 se registró que aproximadamente 200 individuos de esta especie dormitaban en esta área, junto con un menor número de individuos de otras dos aves marinas. También se describieron incursiones regulares de caza por parte de pescadores en las que se capturaron hasta 100 individuos. En 1969, este dormidero y sus alrededores fueron designados como una reserva natural de 30 km² y la caza se convirtió en ilegal. Aunque los grupos de aves marinas no se monitorearon posteriormente, los informes anecdóticos sugieren que el número de estas especies que pasaban la noche en esa zona dismnuyó drásticamente a < 60 individuos. En 2008–2010, realizamos recuentos de dormideros en siete sitios del Parque Nacional Washington-Slagbaai en el noroeste de Bonaire. La mayoría de los conteos fueron sustancialmente más altos que los informes anecdóticos, con un máximo de 240 individuos de *Sula leucogaste*r en julio de 2009. No observamos evidencia alguna de reproducción y no observamos aves anilladas. Otras especies que se encontraban descansando fueron *Sula dactylatra* y *Anous stolidus*, aunque en cantidades muy pequeñas.

Palabras clave Bonaire, Caribe neerlandés, ciencia ciudadana, dormidero, Parque Nacional Washington-Slagbaai, *Sula leucogaster*

Résumé Reposoir de Fous bruns (*Sula leucogaster*) dans le Parc national de Washington-Slagbaai à Bonaire (Pays-Bas caribéens) • Les Fous bruns (*Sula leucogaster*) sont connus pour fréquenter des reposoirs sur la côte nord-ouest de Bonaire (Pays-Bas caribéens). Une publication des années 1950 faisait état d'environ 200 Fous bruns et de plus faibles effectifs de deux autres espèces d'oiseaux marins sur les reposoirs de cette zone. Elle décrivait également des expéditions de chasse régulières au cours desquelles les pêcheurs prélevaient jusqu'à 100 oiseaux. En 1969, cette zone de reposoir et ses environs ont été classés en une réserve naturelle de 30 km², et la chasse y est devenue interdite. Bien que par la suite les communautés d'oiseaux marins n'aient pas fait l'objet de suivi, des rapports ponctuels indiquent que le nombre d'oiseaux marins présents sur les reposoirs avait très fortement diminué pour atteindre moins de 60 individus. En 2008–2010, nous avons réalisé des dénombrements sur les reposoirs de sept sites du Parc national de Washington-Slagbaai, dans le nord-ouest de Bonaire. La plupart des résultats des comptages étaient sensiblement plus élevés que ceux des rapports ponctuels, avec un maximum de 240 Fous bruns en juillet 2009. Nous n'avons vu aucune preuve de reproduction et n'avons observé aucun oiseau bagué. D'autres espèces — des Fous masqués (*Sula dactylatra*) et des Noddis bruns (*Anous stolidus*) — étaient également présentes sur les reposoirs, mais en très petit nombre.

*Corresponding Author: [1]WILDCONSCIENCE BV, Kaya Platina 42, Bonaire, Caribbean Netherlands; e-mail: fernando.simal@wildconscience.com. Full list of author information is available at the end of the article.

Mots-clés Bonaire, Fou brun, Parc national de Washington-Slagbaai, Pays-Bas caribéens, reposoir, science citoyenne, *Sula leucogaster*

The Brown Booby (*Sula leucogaster*) is a common breeding resident on many islands of the Caribbean (Schreiber 2000, Bradley and Norton 2009), but it is not known to breed on Aruba, Bonaire, or Curaçao, the "ABC islands" of the Dutch Caribbean (Voous 1955, Prins *et al.* 2009). In summarizing the Brown Booby's status on these islands in the 1950s, K.H. Voous wrote:

> Communal sleeping roosts are located on the North capes of all three ABC islands. The most frequented one is that of Malmok, Bonaire, where up to 200 may assemble at dusk, together with an occasional Red-footed Booby [*Sula sula*] and larger numbers of Brown Noddies [*Anous stolidus*]. However, numbers and proportions of adults and immature vary considerably, apparently according to the progress of breeding activity in nearby colonies (e.g., Las Aves). Periodically these and other sleeping places (e.g., Boca Bartol, Bonaire) are raided at night by local fishermen, who may snare considerable numbers (sometimes over one hundred) for food and for liver to be used in "bruha" (black magic). (Voous 1983:37)

Based on these numbers, one single raid could have decreased the number of Brown Boobies roosting at Malmok by approximately 50%.

In 1969, the government of Bonaire established Washington National Park, a nature reserve of approximately 30 km² that included the roosting sites near Malmok. In 1979, the reserve was expanded to include an additional 26 km² and renamed Washington-Slagbaai National Park. Hunting subsequently became illegal in the reserve, likely decreasing and perhaps ceasing entirely, but records of hunting were not kept. Nonetheless, several local fishermen report that the number of roosting boobies decreased dramatically to < 60 individuals after the original establishment of the reserve (FS pers. obs.). Between 2008 and 2010, we used citizen science to conduct roosting surveys in Washington-Slagbaai National Park for Stichting Nationale Parken Bonaire (STINAPA Bonaire), the non-governmental organization (NGO) that manages the reserve. Our objectives were to (1) assess the roosting assemblage status, more than 50 yr after the last assessment, by estimating the minimum number of Brown Boobies roosting on northwestern Bonaire on a quarterly basis over a 3-yr period, (2) assess seasonal variability in abundance, (3) determine the

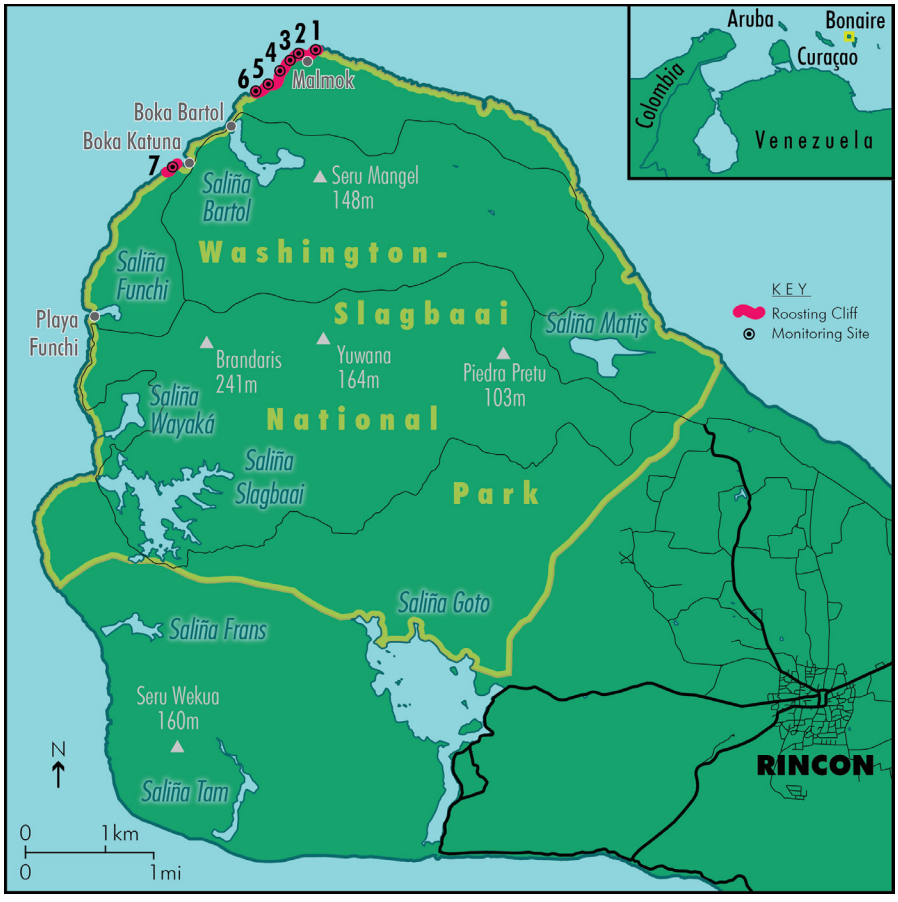

Fig. 1. Brown Booby roosting sites in Washington-Slagbaai National Park, northwestern Bonaire. Map credit to Alison Ollivierre.

proportions of immature and adult individuals, (4) confirm breeding or lack thereof, (5) monitor other species of roosting seabirds, (6) document banded birds of all the species assessed, and (7) increase awareness of seabirds among reserve staff, residents, and visitors by involving them in this monitoring program.

Methods

After conducting preliminary observations of a 4.5-km length of coastline between Malmok (12°18′43.1″N, 68°23′16.1″W) and Playa Funchi (12°16′55.4″N, 68°24′50.2″W), from both land and sea, we identified seven cliffside sites that were regularly occupied by roosting seabirds (i.e., birds and guano present; Fig. 1). We did not detect any other roosting sites on Bonaire. Moreover, we visited other former roosting sites known to locals and confirmed they were unoccupied. We established a survey location on land for each site, and marked these to ensure that each count at a given site would be made from the same position. We trained STINAPA staff, island residents, and visitors in the use of telescopes, binoculars, and counters to identify and count roosting seabirds, including how to differentiate between immature and mature Brown Boobies. Seventeen different volunteers participated over the course of the study. At least one observer visited each of the seven sites simultaneously on one day during the first two weeks of January, April, July, and October of 2008, 2009, and 2010. During these visits, observers used binoculars (8×40) and telescopes (20–60×) to monitor Brown Boobies and other roosting seabirds, including looking for banded birds and evidence of breeding (i.e., mating behavior or nests), and to conduct counts of Brown Boobies, including identifying adults and juveniles. Additionally, one observer (FS) visited all seven sites at least once per month throughout the entirety of 2009, to confirm the presence of birds and document possible nesting; no official counts were made during these additional visits.

Each count started 1 hr before sunset and concluded at sunset. All sites were located on a vertical limestone cliff with a height of ~7 m, and their lengths ranged from 20 m to 100 m. Because each roosting site had a "blind spot" resulting from the irregular shape of the limestone and the overhangs created by wave erosion, we could not make direct counts of the birds roosting there. Birds arrived at the roosting sites by flying in from the sea and departed by flying out to sea again. Once present at a site, birds did not move between the visible section and the blind spot. Therefore, we made an initial count of the visible section at each roosting site, then kept a running tally by adding or subtracting birds as they arrived from or departed toward the sea, regardless of whether they were in the visible section or in the blind spot during their time at the site. The tally at the end of the 1-hr period became the final count for that site. To give an example: if 50 birds were visible initially, and over the course of an hour 10 birds arrived and landed in the visible section, 5 birds arrived and landed in the blind spot, 7 birds flew out to sea from the visible section, and 3 birds flew out to sea from the blind spot, the final count for that site would be 50 + 10 + 5 − 7 − 3 = 55. Though this method avoided double-counting birds that entered and exited a roosting site multiple times, it did not account for individuals that remained in the blind spot for the duration of the 1-hr count, nor for individuals that were in the blind spot for the initial count and later flew out to sea. Finally, we pooled the simultaneous counts made at the seven sites to generate comprehensive counts for the whole study area, which we present below.

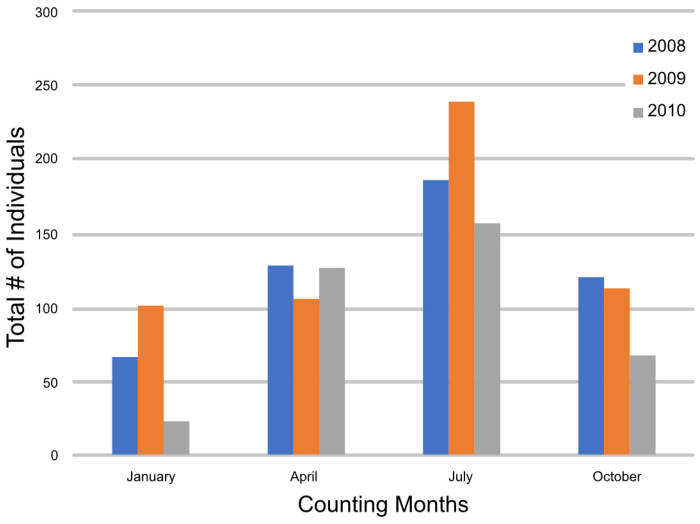

Fig. 2. Total numbers of Brown Boobies recorded across seven roosting sites on northwestern Bonaire during counts in 2008, 2009, and 2010.

Results and Discussion

Counts were highest in July each year (Fig. 2) with a maximum count of 240 individuals in July of 2009. In contrast, counts were lowest in January of each year, ranging from approximately 20–100 birds among years (Fig. 2). Monthly patterns of abundance were similar among the three years (Fig. 2). In 2008 and 2010, we could not collect enough data to calculate the percentages of adult and immature birds, due to the lack of experience of some volunteers. Consequently, we do not present results on age for those years. In 2009, the proportion of immature birds across the seven roosting sites varied among counts from 14.7% to 26.4%, with an average of 20.1%. We did not detect any evidence of breeding during the 3-yr study period, nor did we observe any banded birds. We observed 13 Brown Noddies and 1 Masked Booby (*Sula dactylatra*) in 2008, and 1 Brown Noddy and 4 Masked Boobies in 2009.

The hunting raids reported by Voous may have led to a dramatic decrease in the numbers of roosting birds. Although the lack of monitoring means we cannot be certain that such a decrease occurred, the notion is supported by the anecdotal reports of < 60 birds during the subsequent period. Even considering the relatively low counts in 2010, our data therefore suggest that the number of Brown Boobies on northwestern Bonaire may have increased again. It is possible that establishing the area as protected and managing it to conserve biodiversity helped bring about such an increase.

The seven sites we surveyed have not been further monitored since 2010. We believe it would be valuable to determine the breeding grounds of the boobies that roost on Bonaire, and identify whether and to what degree individuals from different breeding populations use this roosting area. This knowledge would enable better-informed conservation and management decisions. It may also allow us to put the proportion of immature birds observed into context; we do not currently know where the

immature birds are born or where they might go on to breed. To accomplish these objectives, it is necessary to start a region-wide mark-resight program, with resource managers in the nature reserve and across the region collaborating to band and monitor Brown Boobies. We suggest using plastic color bands to avoid having to recapture birds in order to read their metal band. This initiative could also be supplemented by tracking individuals that roost on Bonaire; for this, we recommend using real-time devices that upload their data remotely rather than deploying archival GPS loggers that need to be recaptured.

Regarding the use of citizen science in our study, we found that despite our limited ability to collect data on the ratio of immature to adult individuals during 2008 and 2010, all objectives of the project were successfully achieved with trained volunteers.

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Author Information

[1]WILDCONSCIENCE BV, Kaya Platina 42, Bonaire, Caribbean Netherlands; e-mail: fernando.simal@wildconscience.com; [2]CARMABI, PO Box 2090, Willemstad, Curaçao, Dutch Caribbean; e-mail: info@carmabi.org; [3]CINVESTAV Unidad Mérida, Mérida, Yucatán 97310, Mexico; e-mail: avallarinom@gmail.com; [4]STINAPA Bonaire, Barcadera 10, Bonaire, Caribbean Netherlands; e-mail: info@stinapa.org; [5]Wolfs Company, Bulevar Gobernador Nicolaas Debrot 31, Kralendijk, Bonaire, Caribbean Netherlands; e-mail: info@wolfscompany.com; [6]Project Stormvogel, Bonaire Maritime Heritage Foundation, PO Box 782, Bonaire, Caribbean Netherlands; e-mail: info@oldboatsbonaire.org; [7]Bonaire Wild Bird Rehab, Mangrove Info Center, Kaminda Lac 140, Bonaire, Caribbean Netherlands; e-mail: info@mangrovecenter.com

Title Page Illustration

Brown Boobies (*Sula leucogaster*) roosting on a cliff at Malmok, Washington-Slagbaai National Park, in northwestern Bonaire. Photograph taken on 6 October 2019 by Steve Schnoll.

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