Resilience Through Ecosystem Connectivity: the Role of Manu-o-Kū Poop

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Introduction

Nutrient cycling is an important ecosystem service that connects ecosystems together and allows and encourages them to be resilient. Seabirds play a role in this ecosystem connectivity and nutrient cycling by altering the conditions of their environment soil, sediment, and water at nesting locations (Otero et. al. 2018). Humans have interrupted this cycle with urbanization and made it difficult for seabirds to travel inland. The Manu-o-Kū (*Gygis alba)* have reestablished much of the the connection that was lost between the ocean and land ecosystems and increased their resilience by residing in Honolulu and transporting nutrients between the two ecosystems. For this project, I investigated resilience through ecosystem connectivity by focusing on the role of Manu-o-Kū poop. This was approached in different ways, first by quantifying poop, then by determining the amount of nutrients, specifically nitrogen and phosphorus, they were transporting from the ocean to the island.

Methods

Part 1: A drop cloth was left for a twenty-four-hours at a Manu-o-Kū nest located behind Lama building. It was measured and taped down to the concrete using duct tape. Soccer cones, blue tape from the Manu-o-Kū project, and a sign was also left so it is visible to passerby (figure 1). After the 24 hour, I took and downloaded pictures of the dropcloth to SketchandCalc and outlined each dropping to obtain the area and perimeter for each poop and for the total amount of poop during the twenty-four-hour period.

Part 2: Collected estimates of total amount of nitrogen and phosphorus excreted by a population (Otero et. al. 2018) to backtrack and find the amount excreted by an individual in a year. These estimates were multiplied by the estimated total of breeding adults and chicks on campus this semester and in Honolulu (VanderWerf and Downs 2018) to determine how much nutrients they are bringing to the island.

Part 3: The estimated amount of nitrogen in a fish was collected (Szoak et. al. 2012) to determine how much nitrogen they are taking from the ocean. These numbers were multiplied by the average number of fishes an individual eats and frequency, using numbers from Hawaii Wildlife Center (HWC) and Honolulu Zoo's soft release program.

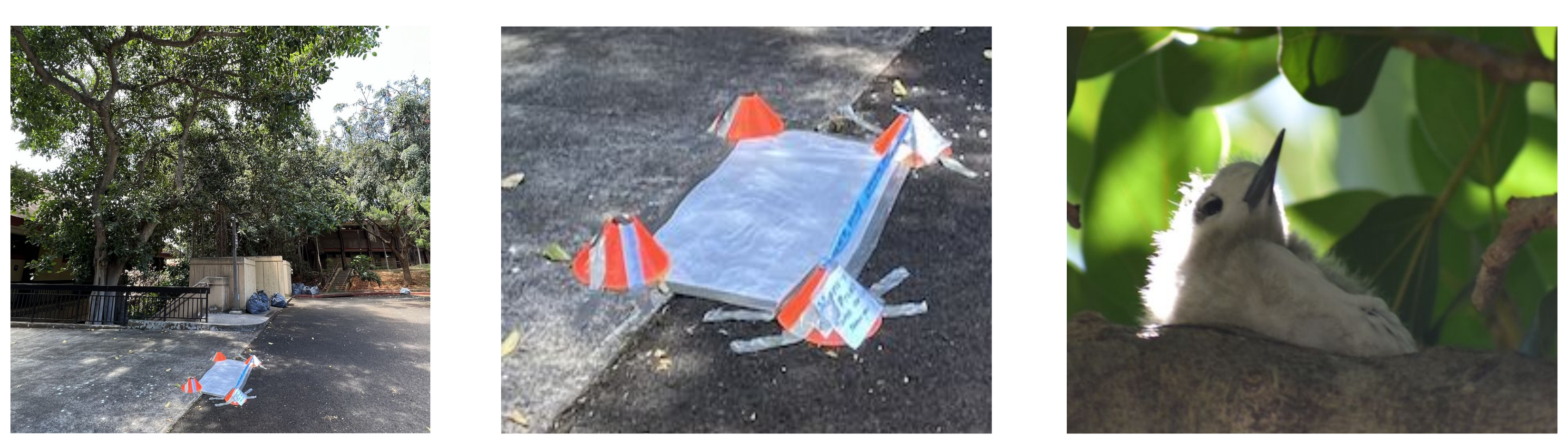

Figure 1: Drop cloth set up and chick behind Lama building for part 1

Results

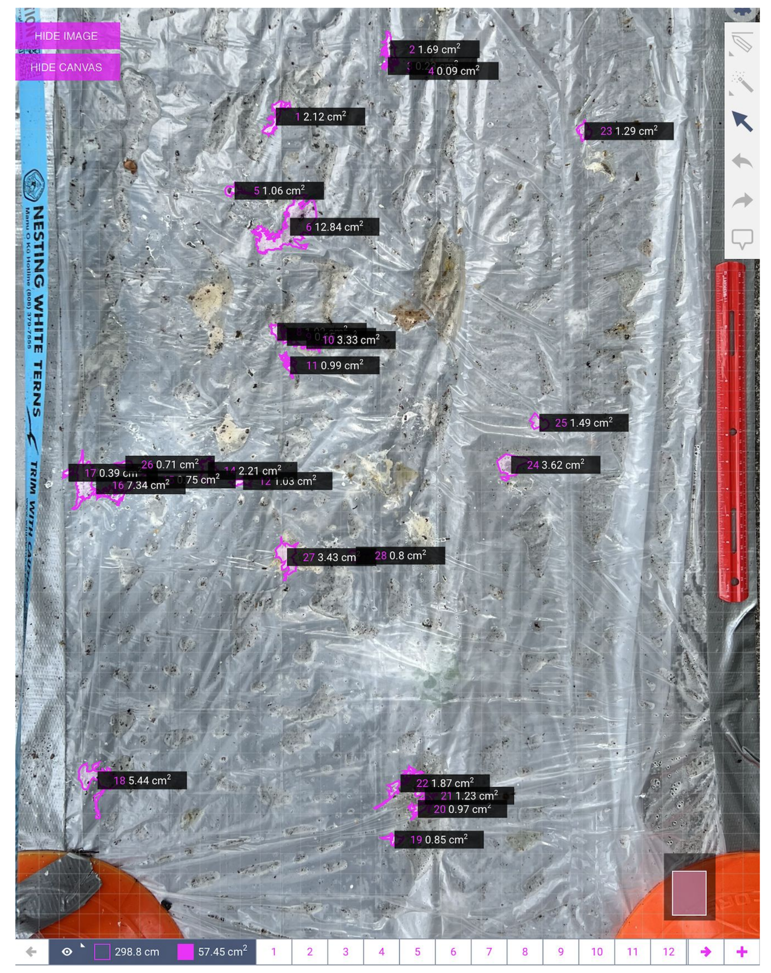

Table 1: Calculation of N and P excreted per *G. alba* (data sourced from Otero et. al. 2018)

Total number of *G. alba*	Total excreted N (grams N)	Excreted N per *G. alba* (grams)	Total excreted P (grams N)	Excreted P per *G. alba* (grams)
1,407,900	118,000,000	118,000,000/1,407,900 = 84	20,000,000	20,000,000/1,407,900 = 14

Table 2: Calculation of total N and P excreted at KCC and Honolulu by *G. alba* population

	Estimated number of *G. alba*	Total excreted N (grams)	Total excreted P (grams)
KCC	60	60(84) = 5040	60(14) = 840
Honolulu	2308	2308(84) = 193,872	2308(14)= 32,312

Figure 2: Drop cloth after 24 hours had 28 droppings with a total perimeter of 298.8 cm and a area of 57.45 cm^2

Table 3: Range of ‰ of N obtained from fish per day (data sourced from Szoak et. al. 2012 and HWC pers. comm)

	‰ of N obtained	Mass of fish (grams)	Feeding Frequency	Total N obtained (grams)
Minimum	3	1	2	0.003(1)(2) = 0.006
Maximum	4	4	5	0.004(4)(5) = 0.08

Discussion

These three approaches confirm that there is a non-trivial contribution of nitrogen and phosphorus by the Manu-o-Kū through poop. The results show that an individual gets 0.006 to 0.08 g N from fish and excrete 28 times (with perimeter of 298.8 cm and area of 57.45 cm^2) per day. This consumption leads the population to excrete 5040 N g at KCC, 193,872 N g in Honolulu, and 840 P g at KCC and 32,312 P g in Honolulu in a year. Therefore, there is also a non-trivial contribution by this seabird in increasing the connection between ocean and land ecosystems and increasing the resilience of these ecosystems through poop. Future research could include obtaining more accurate estimates of nitrogen and phosphorus by collecting and analyzing a sample of poop. It could also include calculations of other nutrients or determining their current population.

Figure 3: An adult G. *alba* eating and holding a fish

Literature Cited

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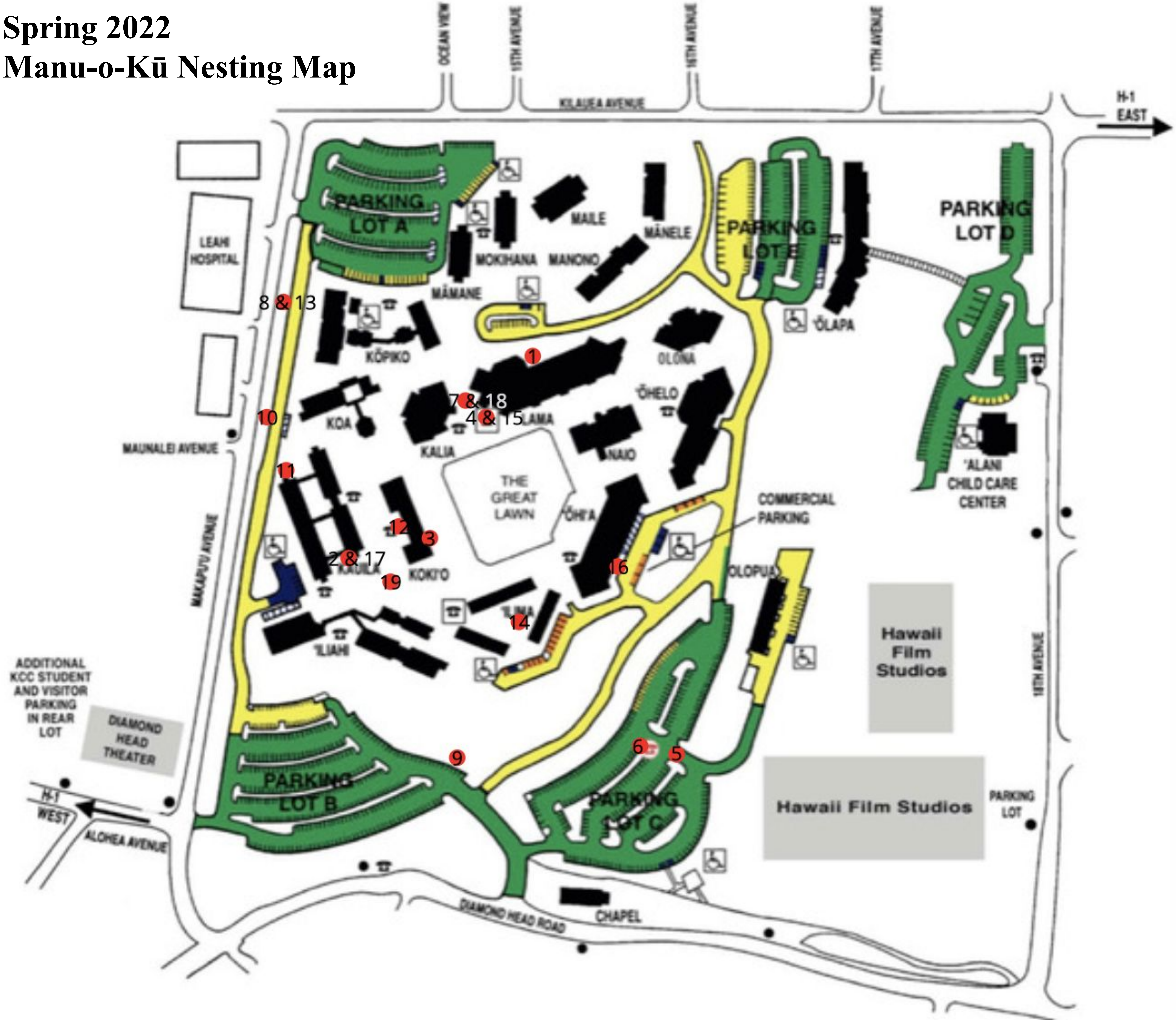
Spring 2022
Manu-o-Kū Nesting Map



1. Lama.A.1.A
2. Kauila.A.1.A
3. Kokio.A.1.A
4. Lama.B.1.A
5. LotC.N.A.1.A
6. LotC.N.B.1.A
7. Lama.C.1.A
8. LotA.SW.A.1.A
9. LotB.NE.A.1.A
10. Koa.A.1.A
11. Kauila.B.1.A
12. Kokio.B.1.A
13. LotA.SW.A.2.A
14. Ilima.A.1.A
15. Lama.B.2.B
16. Ohia.A.1.A
17. Kauila.A.1.C
18. Lama.C.2.A
19. Kokio.C.1.A