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BIOL 535 Term Paper

THE WETLANDS OF ASCENSION ISLAND, SOUTH ATLANTIC OCEAN

Anyone who has ever visited Ascension Island may find the concept of wetlands on that island rather odd. For good reason. Much of Ascension has the appearance and feel of a classic desert island—virtually all of the island had that appearance and feel prior to the permanent occupation of the island by the British Admiralty in the early 19th century. Even after an early morning arrival, passengers stepping out from a airplane on the tarmac of Wideawake Field, the Royal Air Force base on Ascension, are met with rippling waves of heat that distorts their view of expanses of grayish-white clinker—hardened lava flows—and rust-colored volcanic cones that surround the air field. Nevertheless, I suggest that the wetland concept is a useful one to apply to Ascension's spectacular and dynamic landscape.

Physical environment

Ascension Island (7°57'S, 14°23'W) is the tip of a large volcano about 100 km west of the Mid-Atlantic Ridge between the Ascension and Bode Verde fracture zones (Minshull, Bruguier, & Brozena, 1998; Nielson & Sibbett, 1996). The volcano rises from the ocean floor about 3,000 m deep to just shy of 860 m above sea level on the summit of Green Mountain (Daly, 1925). The tip of the volcano forms a roughly arrowhead-shaped island, roughly as broad as it is long, with the tip pointing to the east (Figure 1). Its area is about 93 km^2 (Brozena, 1986).

Evidence of Ascension's volcanic origins abound. It's surface features more than 60 vents ranging from small craters to the summit of Green Mountain (Daly, 1925). The nature of the igneous materials making up the surface of the island give it its striking colors. Rocks of basaltic (mafic) origin tend to be dark in color, while deposits derived from trachyte and rhyolite (felsic) origin tend to be much lighter (Ashmole & Ashmole, 2000). More than half the surface consists of lava flows, while most of the rest, with the exception of storm-deposited material along the island's beaches, consists of pyroclastic deposits (Daly, 1925). Basaltic flows and pyroclastic deposits dominate the northern and western portions of the island, while trachytic flows and rhyolitic deposits dominate the central and eastern portions of the island (Nielson & Sibbett, 1996). Basaltic materials give rise to the rust-colored cones around Georgetown (Figure 2) and the dark gray lava flows of Wideawake Fair (Figure 3), while trachytic and rhyolytic materials give rise to the spectacular white formations of the Letterbox (Figure 4) which forms the tip of the arrowhead, and thinly layered ash deposits in ridges in the center of the island (Figure 5).

Geologically, Ascension is quite young. The bedrock from which it rises is about 7 million years old (Evangelidis, Minshull, & Henstock, 2004; Klingelhöfer, Minshull, Blackman, Harben, & Childers, 2001), but the oldest surface rocks range between 0.6 and 1.5 million years old (Bell, Atkins, Baker, & Smith, 1972; Harris, Bell, & Atkins, 1982; Nielson & Sibbett, 1996). The most recent eruption may have taken place about a few hundred years ago (Atkins, Baker, Bell, & Smith, 1964; Baker, 1973). While no eruptions have been observed on the island since its discovery in 1501, it may rank as the most volcanically active South Atlantic island in the past 10,000 years (Brozena, 1986). The frequent (geologically speaking) disturbance has left little time and unfavorable conditions for wetland development.

Likewise, the island's climate is unfavorable for wetland development. The majority of the island is classified as a hot desert (BWh) climate according to both the original Köppen classification system (Köppen, 1936) and a modified classification (Guetter & Kutzbach, 1990), with a mean annual temperature of 28.8 °C and annual precipitation of 131.6 mm (Duffey, 1964) in Georgetown, the island's administrative center and primary port. Green Mountain, however, is high enough to intercept the moisture-laden trade winds, thus receiving water from precipitation and fog. According to data published in Duffey (1964), the summit receives 665.8 mm of precipitation annually, with a mean annual temperature of 19 °C. According to the original Köppen climate classification, Green Mountain has a mild humid climate with no dry season (Cfb), but the modified classification is hot steppe climate (BSh). As can be expected in tropical environments, there is little seasonality in either temperature or precipitation (Figure 6).

History

Portuguese admiral João da Nova first discovered the island on March 25, 1501. He named it Ihla da Concepção (Conception), but did not stop to plant a flag (Ashmole & Ashmole, 2000; Hart-Davis, 1973). Another Portuguese admiral, Affonso d'Albuquerque, rediscovered it on Ascension Day in 1503 and gave the island its current name (Ashmole & Ashmole, 2000). For centuries the island remained uninhabited—save for the occasional sailors, such as pirate-explorer William Dampier, marooned there—but the British Royal Navy occupied the island in 1815 to prevent the island being used as a base from which the French could mount an attempt to rescue Napoleon, who was imprisoned on nearby (given the neighborhood) St. Helena (Hart-Davis, 1973). The British found other uses for the island after Napoleon's death in 1821, using as a base from which to interdict the trans-Atlantic slave trade, a victualling station, and a telegraph relay station, among other things (Hart-Davis, 1973).

Prior to the British occupation, Ascension's flora was dominated by ferns, with mosses and lichen at higher elevations on Green Mountain. It had only one shrub, *Oldenlandia adscenionis*, scattered around on some slopes along with *Portulaca oleracea* and some grasses, including *Aristida adscensionis*; on lava flows and other barren areas, *Euphorbia origanoides* and some tussock grasses could be found. Along the coast, *P. oleracea* and *Ipomoea pes-caprae* could be found (Duffey, 1964). Of these, *O. adscensionis* was endemic to the island, but is now believed to be extinct (Cronk, 1980). Other endemic species include the grasses *Sporobolus caespitosus* and *S. durus* and the ferns *Anogramma ascensionis*, *Asplenium ascensionis*, *Dryopteris ascensionis*, *Marratia purpurascens*, *Pteris adscensionis*, and *Xiphopteris ascensionse* .(Cronk, 1980).

Once they decided to stay, the British were determined to make the island more livable. They began implementing a plan proposed by Sir Joseph Hooker to terraform the island by importing a wide variety of plants to the island (Duffey, 1964; Hart-Davis, 1973; Lawrence, 2008; Wilkinson, 2004). Among his proposal were: 1) plant trees at higher elevations to increase rainfall; 2) plant valley slopes with plants that will promote soil formation; 3) plant dry areas with species tolerant of xeric conditions; and 4) add European and tropical plants to the gardens the Royal Marine garrison maintained on Green Mountain (Duffey, 1964).

Wetlands

Obviously, the xeric conditions that prevail over most of Ascension Island makes any sizeable wetland sites unlikely. Nevertheless, there are areas where some of the conditions proposed by Cowardin et al.'s (1979) may be met:

> WETLANDS are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

In the past, one of these places would be the Devil's Riding School, an unusual formation between Green Mountain and Wideawake Field. Now dry, several lines of evidence suggest it is the bed of what was once a crater-like lake (Ashmole & Ashmole, 2000; Darwin, 1890; Packer, 1983). Packer analyzed some soil samples obtained from the Devil's Riding School and found a layer with significant amount of accumulated organic matter—mostly skeletons of diatoms

(Ashmole & Ashmole, 2000). The lake was long dry, however, by the time Darwin arrived on the island in 1836. Ashmole & Ashmole (2000) suggest the lake existed during glacial periods when rainfall may have been more abundant than at present.

Ascension had a number of drips, essential seeps or springs, some of which have been used to keep the human occupants of the island alive. One is named for one of the island's most illustrious visitors: Dampier. Dampier was on a voyage to New Holland (the Dutch East Indies, now Indonesia) when his ship sprung a leak. They made their way to the anchorage in what is now Georgetown, when the ship's carpenter unfixed the leak and sank the ship. Dampier and his men salvaged what they could and made it to Ascension's inhospitable shores. One of their first goals was to find water and they did:

> … to our great comfort, found a spring of fresh water about 8 miles from our tents, beyond a very high mountain which we must pass over: so that now we were, by God's Providence, in a condition of subsisting some time; having plenty of very good turtle by our tents, and water for the fetching. The next day I went up to see the watering-place, accompanied with most of my officers. We lay by the way all night and next morning early got thither; where we found a very fine spring on the south-east side of the high mountain, about half a mile from its top: but the continual fogs make it so cold here that it is very unwholesome living by the water. (Dampier, 1729)

The site now called Dampier's Drip does not match the description. Nevertheless, the British took advantage of a drip at that site to provision themselves with water (Figure 7). The site Dampier describes is most likely in Breakneck Valley, which the British likewise used to provision themselves with water. Much of the head of Breakneck Valley is paved to facilitate collection of water that is either intercepted or precipitates near the summit of Green Mountain (Figure 8). Some of these seeps have dried since the establishment of the artificial forest on Green Mountain, possibly because of increased evapotranspiration returning moisture to the atmosphere faster than it can infiltrate and percolate through the soil (Lawrence, 2008).

In 1875, the British created an artificial pond near the summit of Green Mountain, arguably in order to establish a last-ditch water supply should other water collection efforts fail (Hart-Davis, 1973; Packer, 1983). Aquatic plants, fish, and frogs were brought in to add to help maintain the pond ecosystem (Figure 9). Some time later, a thick bamboo (*Bambusa* spp.) forest was established in the portion of the summit surrounding the pond. Between the pond itself and the efficient moisture-trapping effects of the bamboo, that portion of the Green Mountain summit is perpetually damp. The immediate vicinity of the pond would definitely count as a wetland. How far out into the bamboo forest wetland conditions extend, however, is undetermined.

Wetland conditions may exist along the shores of the island—if there are areas where presettlement or introduced plants grow along the shore. (I did not see enough of Ascension's coastline to hazard a prediction on this.)

Questions and conclusions

Dr. Alan Gray of the University of Edinburgh questioned whether there is any legitimacy to the topic of this paper (Gray, *pers. comm.*) Among his questions were whether or not any areas fit definitions of wetlands in vogue among European scientists, or—assuming some areas do fit the definition—whether their origins (manmade vs. natural) or size (generally small) disqualify them from consideration. Personally, I am not disturbed by these challenges. Given the uniqueness of the Ascension environment, I feel the scientific community can afford to be flexible on these issues.

The more important question—another one that Gray raised—was whether climate change will derail development of wetlands on Ascension. Given that a warmer temperature may increase the elevation of the cloud base over Ascension, it is likely that progress toward a more hospital climate as envisioned by Hooker nearly 200 years ago will end.

REFERENCES

Ashmole, P., & Ashmole, M. (2000). *St. Helena and Ascension Island: A natural history*. Oswestry, Shropshire, United Kingdom: Anthony Nelson.

Atkins, F. B., Baker, P. E., Bell, J. D., & Smith, D. G. W. (1964). Oxford Expedition to Ascension Island, 1964. *Nature, 204*(4960), 722-724. doi: 10.1038/204722a0

Baker, F. E. (1973). Islands of the South Atlantic. In A. E. M. Nairn & F. G. Stehli (Eds.), *The ocean basins and margins* (pp. 493-553). New York: Plenum Press.

Bell, J. D., Atkins, F. B., Baker, P. E., & Smith, D. G. W. (1972). Notes on the petrology and age of Ascension Island, South Atlantic. *Transactions, American Geophysical Union 53*, 168.

Brozena, J. M. (1986). Temporal and Spatial Variability of Seafloor Spreading Processes in the Northern South Atlantic. *Journal of Geophysical Research, 91*(B1), 497-510. doi: 10.1029/JB091iB01p00497

Cowardin, L. M., Carter, V., Golet, F. C., & LaRoe, E. T. (1979). *Classification of Wetlands and Deepwater Habitats of the United States*. (FWS/OBS-79/31). Washington, D.C.: Fish and Wildlife Service, U.S. Dept. of the Interior.

Cronk, Q. C. B. (1980). Extinction and survival in the endemic vascular flora of Ascension island. *Biological Conservation, 17*, 207-219.

Daly, R. A. (1925). The Geology of Ascension Island. *Proceedings of the American Academy of Arts and Sciences, 60*(1), 3-80.

Dampier, W. (1729). *A continuation of a voyage to New Holland, &c. in the year 1699*. London: James and John Knapton.

Darwin, C. (1890). *A Naturalist's Voyage round the World: Journal of Researches into the Geology and Natural History of the Various Countries Visited by H.M.S. 'Beagle'* (Illustrated ed.). London: John Murray.

Duffey, E. (1964). The terrestrial ecology of Ascension Island. *The Journal of Applied Ecology, 1*(2), 219-251.

Evangelidis, C. P., Minshull, T. A., & Henstock, T. J. (2004). Three-dimensional crustal structure of Ascension Island from active source seismic tomography. *Geophysical Journal International, 159*(1), 311-325.

Guetter, P. J., & Kutzbach, J. E. (1990). A modified Koppen classification applied to model simulations of glacial and interglacial climates. *Climatic Change, 16*, 193-215.

Harris, C., Bell, J. D., & Atkins, F. B. (1982). Isotopic composition of lead and strontium in lavas and coarse-grained blocks from Ascension Island, South Atlantic. *Earth and Planetary Science Letters, 60*(1), 79-85. doi: 10.1016/0012-821X(82)90022-X

Hart-Davis, D. (1973). *Ascension: The story of a South Atlantic island*. Garden City, N.Y.: Doubleday.

Klingelhöfer, F., Minshull, T. A., Blackman, D. K., Harben, P., & Childers, V. (2001). Crustal structure of Ascension Island from wide-angle seismic data: Implications for the formation of near-ridge volcanic islands. *Earth and Planetary Science Letters, 190*(1-2), 41-56.

Köppen, W. (1936). Das geographische system der klimate. In W. Köppen & R. Geiger (Eds.), *Handbuch der Klimatologie* (Vol. Volume I, Part C). Berlin: Köppen, W.

Lawrence, D. M. (2008). The shade of Uliet: Musings on the ecology of *Dune*. In K. R. Grazier (Ed.), *The Science of Dune: An unauthorized exploration into the real science behind Frank Herbert's fictional universe* (pp. 217-232). Dallas: BenBella Books.

Minshull, T. A., Bruguier, N. J., & Brozena, J. M. (1998). Ridge-plume interactions or mantle heterogeneity near Ascension Island? *Geology, 26*(2), 115-118. doi: 10.1130/0091-7613(1998)026<0115:rpiomh>2.3.co;2

Nielson, D. L., & Sibbett, B. S. (1996). Geology of Ascension Island, South Atlantic Ocean. *Geothermics, 24*(4-5), 427-430.

Packer, J. E. (1983). *The Ascension Handbook: A Concise Guide to Ascension Island, South Atlantic* (3rd ed.). Georgetown, Ascension Island: J.E. Packer.

Wilkinson, D. M. (2004). The parable of Green Mountain: Ascension Island, ecosystem construction and ecological fitting. *Journal of Biogeography, 31*(1), 1-4.

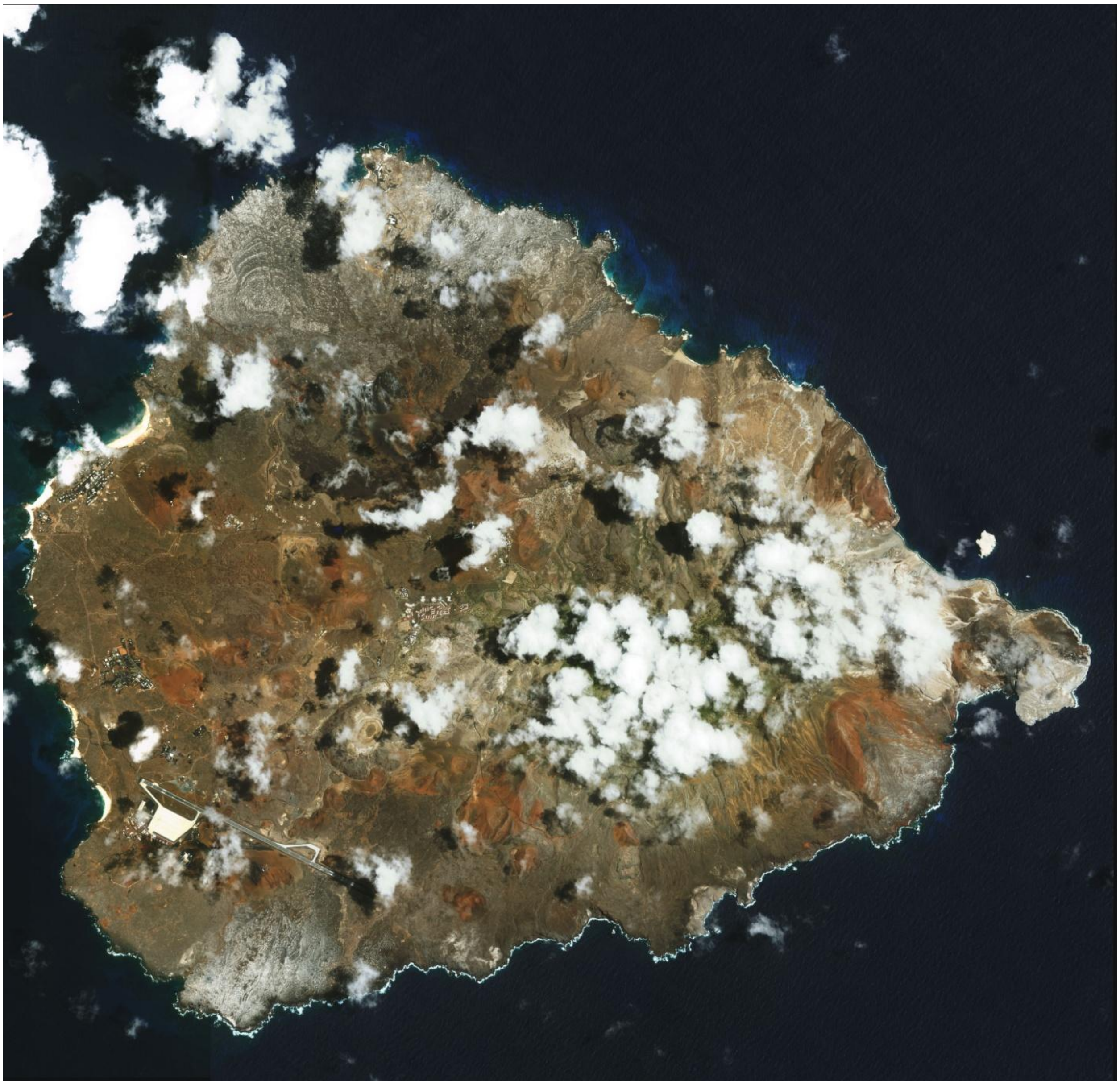

Figure 1. Satellite image of Ascension Island. The island's highest point, Green Mountain, is obscured by clouds in the lower center of the image.

Figure 2. Rust-colored volcanic cone near Georgetown, Ascension Island.


Figure 3. Basalt flow on Wideawake Fair near the southwest corner of Ascension Island.

Figure 4. Trachytic deposits give rise to the spectacular white features of the Letterbox, which forms the tip of the arrowhead at the far eastern end of Ascension.

Figure 5. Rhyolite forms the bulk of the easily eroded material in this road cut east of Two Boats Village, a settlement in the center of Ascension.

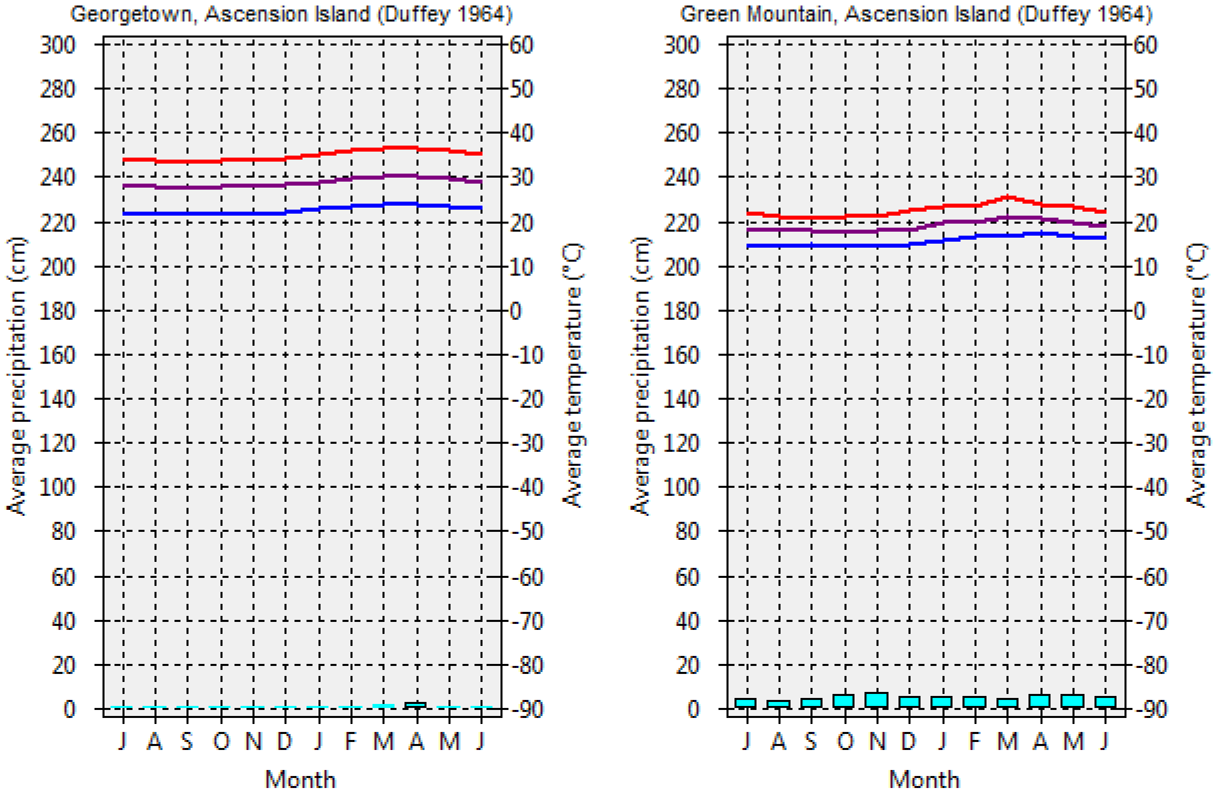

Figure 6. Climate diagrams for Georgetown (left) and Green Mountain (right), Ascension Island, South Atlantic Ocean.


Figure 7. A cave likely used as a shelter on the site of what is now called Dampier's Drip.

Figure 8. The head of Breakneck Valley on the southeast face of Green Mountain. The concrete was poured to facilitate capture of moisture from the southeast trade winds.

Figure 9. The Dewpond. Some of the bamboo forest can be seen in the background.