



Shell Shocked! Temperature induced sea level rise threatening sea turtle nesting habitat

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Introduction

Sea level rise is a growing threat to coastal nesting habitats of sea turtles in the Hawaiian Islands. I will also examining co-management strategies of traditional Native Hawaiians and Western policy regarding the aid in the adaption to global climate change induced sea level. The north west Hawaiian islands have high conservation value due in part to their large populations of endangered and threatened species but are highly vulnerable to rising sea level because majority of the islands are low lying. Conservation actions typically involve implementing nest protection programs, or formally proclaiming coastal or marine protected areas, which may include both inter-nesting and nesting habitat. These types of strategies have been implemented throughout communities in the world.

Background

Climate models predict that global average sea level can rise significantly this century, affecting marine turtle stock and other species that rely on coastal habitats. It is important to note that are highly migratory and once sea turtle hatchlings reach the ocean they green sea turtles do not return to the nesting beaches for twenty years. This phenomena occurs due in part to the amount of years it takes a sea turtle to reach reproductive maturity for twenty to thirty years. These biological processes are essential in understanding why long term studies are the most effective in assessing sea turtle populations

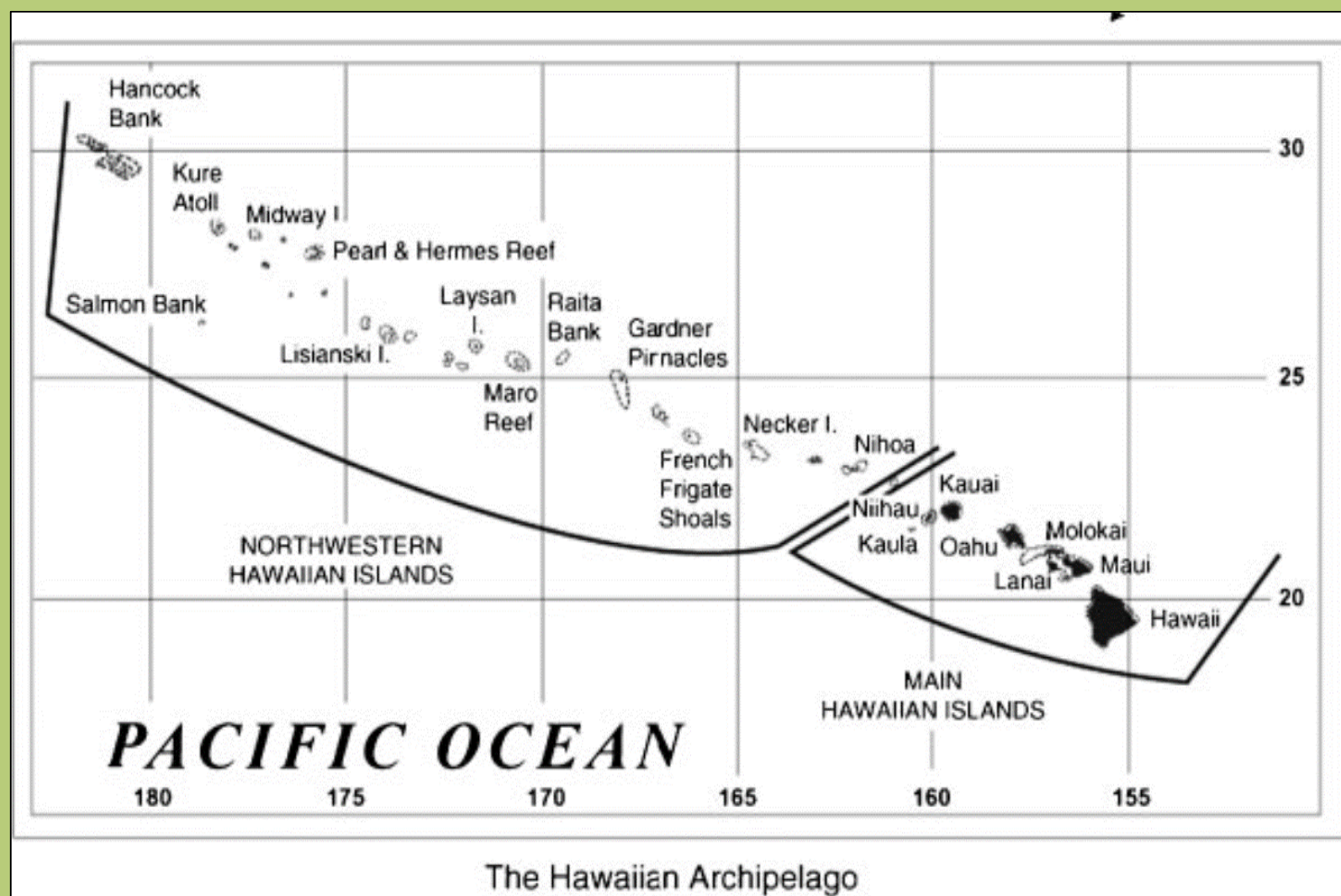


Figure-1 Map of the Hawaiian Archipelago, courtesy of NOAA. The Papahānaumokuākea Marine National Monument surrounds the emergent land of the NWHI out to 50 nm.

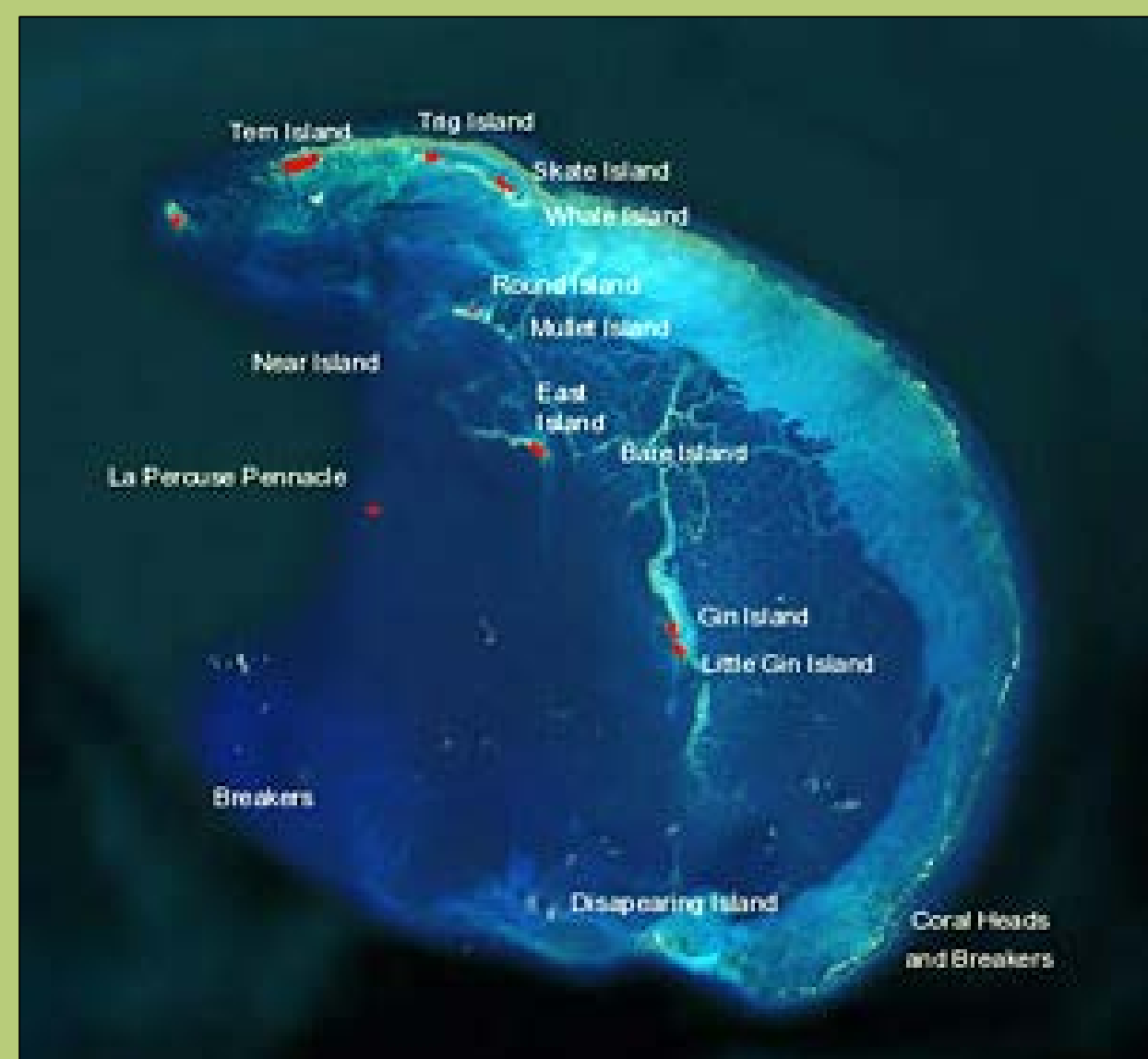


Figure 2- Map of the French Frigate Shoals, courtesy of the EPA

The NWHI sea turtle stock is essential because it is one of few sea turtle populations that has been monitored continuously over several decades. (Balazs and Chaloupka 2004, 492) The North Western Hawaiian Islands are home to one of the largest stock of green sea turtles (*Chelonia mydas*) in the Pacific. (Baker, Littnan, and Johnston 2006, 22)

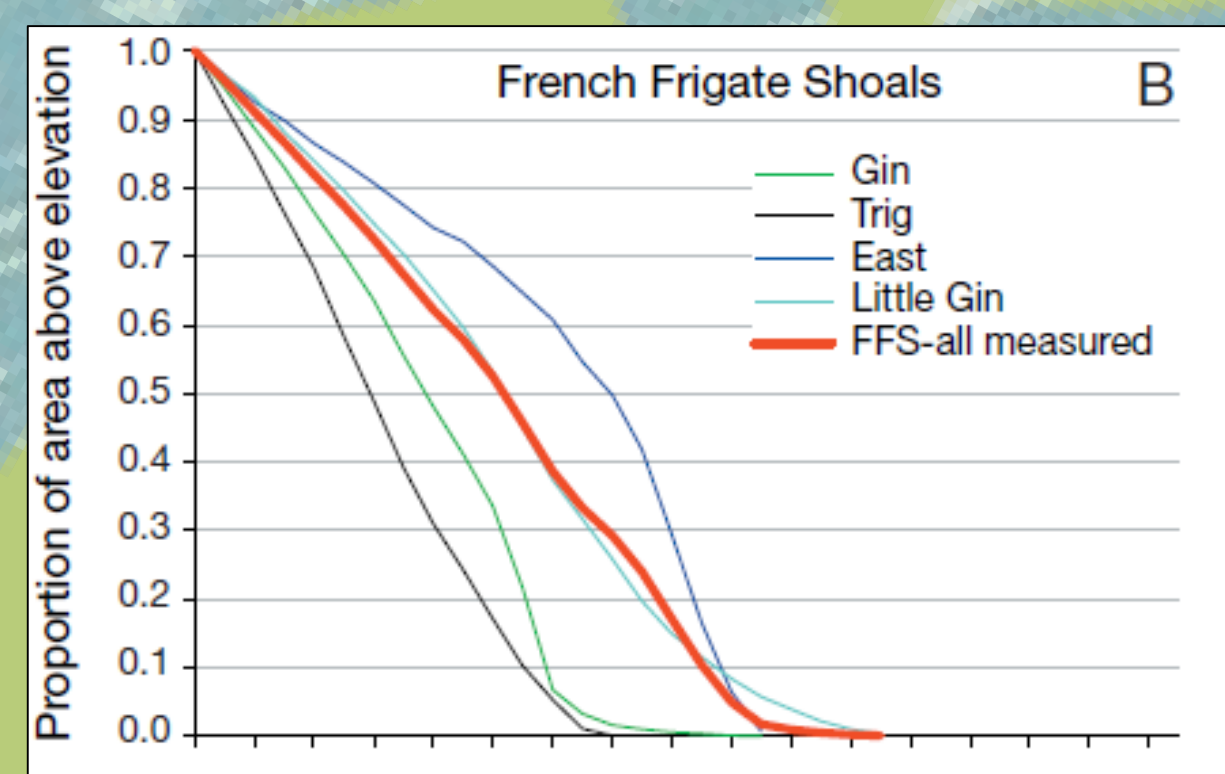
Projections of sea level rise show an average loss of 15% to 65% of area lost at the French Frigate shoals were Green marine turtle population has been increasing for the past 30 years (Balazs and Chaloupka 2004, 492). Many factors are of increasing concern regarding sea level rise including thermal expansion of the warming oceans along with melting of glaciers and ice caps and an increase in the proportion of extreme weather events in the most severe categories, such as hurricanes or typhoons, could also occur with changes in the global climate, which may cause significant loss/erosion of or damage to shorelines. In all species of marine turtles, successful reproduction depends largely on available terrestrial habitat. (Hawkes et al. 2009, 138–39))

Western Management VS Traditional Hawaiian Management

Western management system	Management Component	Traditional Hawaiian management system
Federal, State, and local laws and regulations implemented by various agencies	Authority	Ali'i (Chiefs)
Reef open to all with equal access	Access Rights	Inhabitants of the ahupua'a (a district) with consultation from the Ali'i. Access was limited only by permission from the chiefs and local villagers.
Trained Professionals in multiple government Agencies with responsibilities defined by law	Managers/ Stewardship	The Konohiki (a district manager appointed by Ali'i)
Generally weak and inconsistent due to concern for "due process" and rules of evidence	Enforcement	Authority is in the hands of Ali'i. Punishment is immediate and can be severe. Conservation ethics are reinforced by traditional ecological knowledge, social behavior, and spiritual principles.
Commercial as well as recreational fishery, economic development, conservation, endangered species, environmental protection	Management Focus	Limited to only what is needed by inhabitants to ensure a sustainable yield Focus primarily on plants and animal used for food , medicine and trade
Proven western science and subject to revision with new information	Management Theory	Traditional management practices that were developed and applied locally over many generations of trial, experimentation, study, application, and observation.
Published reports, records, data bases, documents, objective measurements and observations, and quantitative analyses of data	Knowledge base	Oral transmission with restricted access to information most knowledge is kept within family lineage.
"Regulated inefficiency" to reduce harvest. Restrictions on fishing gear and number of fishing days.	Primary fishery management tools	Intermittent Complete reef closures and kapu (forbidden take) of certain species at certain times
Generally one species with a focus on the whole ecosystem	Fishery Management target	Generally entire reef ecosystem with species specific kapu at certain times.
Infrequent quantitative surveys following environmental parameters and stocks, underwater observations. Sufficient data required for decisive management actions	Resource monitoring	Continuous daily interactions with reef resources, traditional knowledge of resources is held by the local master fisherman (po'o lawai'a), elders (kupuna), and the ho'a'aina (care taker of the land).

Figure-3 adapted from (Jokiel et al. 2011, 8) This chart provides a visual comparison of the Traditional Hawaiian Management System and the Western Management System.

Climate Change Induced Sea Level Rise



Analysis: Findings show that the French Frigate Shoals will lose 40% to 57% of its total nesting area at mean low water during the spring tide not taking into account storm surge and other factors. (Baker, Littnan, and Johnston 2006, 25) An overall 2m rise would quickly flood the entire island and this is projected under current conditions by 2100. Marine turtles face a variety of potential effects from climate change, one of which is their ability to produce male and female off spring. All marine turtles exhibit temperature dependent sex determination in the nest environment, as well marine turtles successful reproduction depends primarily on available habitat (Hawkes et al. 2009, p138). Increased beach fortification and costal engineering is a human response to climate change and the odds of an increase in fortification to protect human settlements is high because shoreline protection is already used. This overall reduces total habitat availability and in some cases entire beaches.

French Frigate Shoals Largest Islands East Island and Trig Island

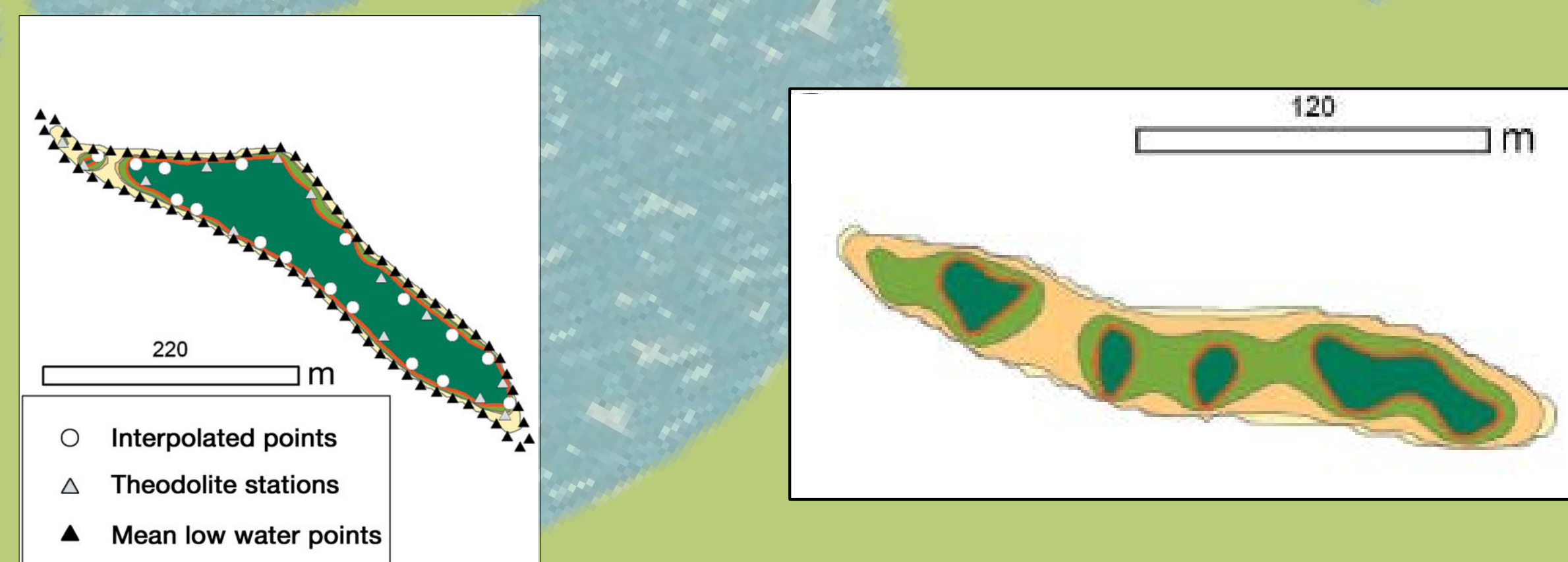


Figure 4-Current and projected maps of French Frigate Shoals at mean low water (MLW) with minimum (9 cm), median (48 cm) and maximum (88 cm) predicted sea level rise adapted from (Baker, Littnan, and Johnston 2006, 24)

Conclusion

As coastal regions experience erosion, various strategies have been used to control the impact of beach loss or storm damage. Soft stabilization measures include beach and dune renourishment and tend to be temporary, yet considerably expensive. Hard stabilization measures such as groins, jetties, and seawalls effectively protect property, but tend to result in beach narrowing or loss and can worsen erosion. Beach nourishment could be a solution to rising sea levels but, previous research suggests that nesting behavior can be influenced by characteristics of the sediment, including compaction and moisture content. The female turtles are powerful diggers, but coming ashore to nest requires a large energy expenditure. The process of digging a nesting chamber in the nourished areas can be difficult or unsuitable due to such changes in the substrate. (Leonard Ozan 2011, 50) In a study done by ANOVA on the selection, emergence success and hatching success of loggerheads on nourished beaches versus natural beaches in Florida, higher occurrences of false crawls or when a female determines the beach is unsuitable occurred more on nourished beaches versus natural beaches. Although increased availability of nesting habitat lead to an increase in population density. Seawalls can directly affect marine turtles by increasing the intensity of longshore currents; they prevent the exchange of sand between dune and beach such that the beach cannot flatten as it tends to do during storms to dissipate wave energy; and walls steepen the offshore profile, which in turn increases erosion. (Rizkalla and Savage 2011, 166) Research on New Jersey sea wall impacts shows how seawalls impact loggerhead sea turtle nesting by reducing nesting success and increasing the likelihood of nests being washed away during storm events. Fewer animals emerged in front of the seaward wall and there were fewer nests, but it remains unclear by what mechanism turtles detect appropriate nesting habitat. So although renourishment is expensive it may be the only viable option to managing the impacts of sea level rise on the green sea turtle populations in the north western Hawaiian Islands.

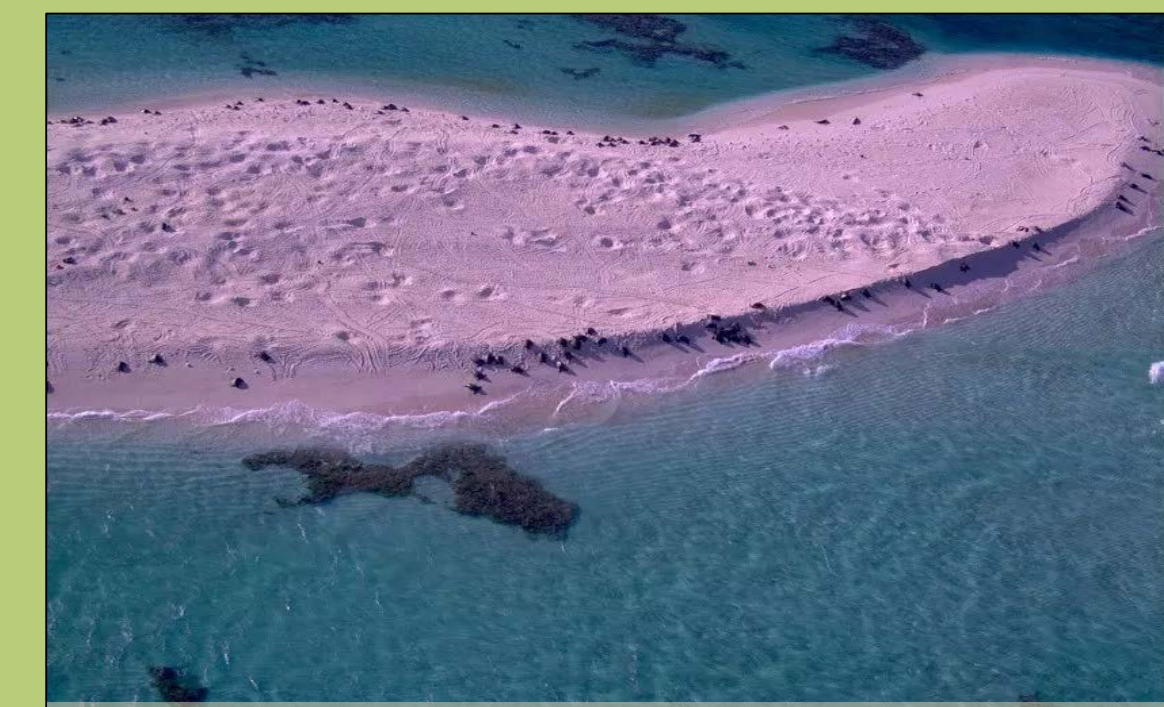


Figure-5 and aerial view of Trig Island provided by www.forkauaionline.com

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