

Evaluating the Vulnerability of Sea Turtle Nesting Beaches to Sea Level Rise, Coastal Erosion, and Shoreline Armoring on O'ahu, Hawai'i

Robert Walker,¹ Sheldon Plentovich, Ph.D.,² Alexander Gaos, Ph.D.,³ Samantha Mislinski,¹ Marybeth Melcher.¹ ¹Integral Consulting Inc., ²Pacific Islands Coastal Programs, U.S. Fish & Wildlife Service, ³NOAA Pacific Islands Fisheries Science Center.

Over 90% of Hawaiian green turtles nest on a vulnerable atoll. Where will they go if the habitat disappears?



Image from NOAA Fisheries

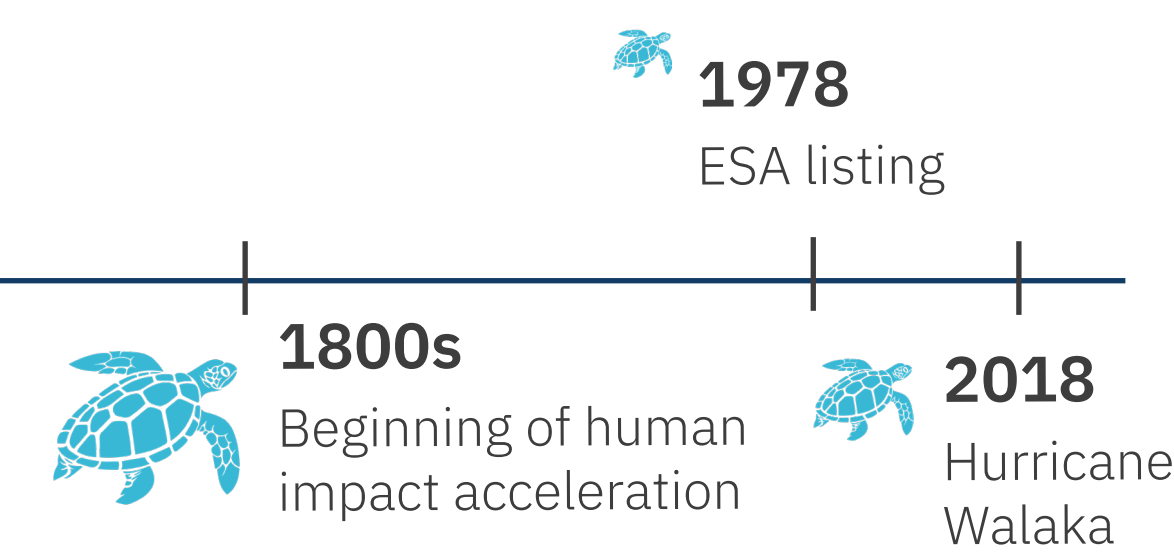
In 2018, Hurricane Walaka destroyed significant portions of Lalo's nesting beaches.¹ The low-lying Lalo atoll is located approximately 500 miles northwest of the Main Hawaiian Islands (MHI).²

The Green Turtle's Tale

120 million years of evolution vs. 200 years of human impact

The Green Sea Turtle (*Chelonia mydas*), decimated by human activities since the 1800s, has shown signs of recovery since its 1978 Endangered Species Act (ESA) listing. More than 90% of the Hawaiian population now nests on Lalo atoll. However, the 2018 hurricane and highly dynamic nature of the atoll threatens their current critical habitat.

120 million years ago
Sea turtle evolution



A Shifting Nesting Landscape

As Lalo atoll changes, O'ahu's beaches become crucial lifelines

Green turtles have seemingly returned to nesting on the MHI in recent years. Most recent nesting has been documented on O'ahu's beaches, making them the focus of our analysis.

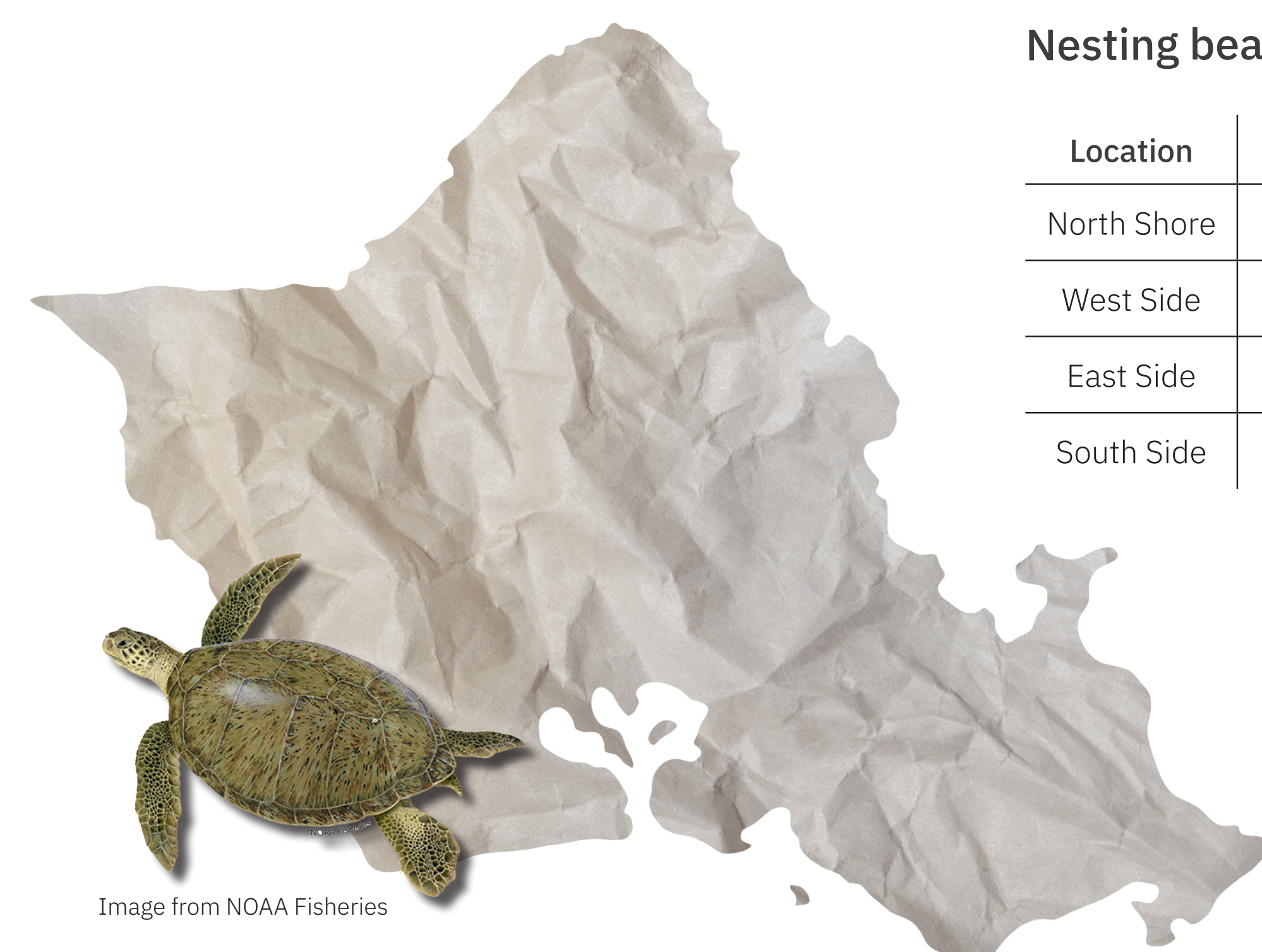


Image from NOAA Fisheries

Nesting beach area in our study

Location	Beaches	Area (m ²)
North Shore	5	142,431
West Side	2	108,879
East Side	3	249,417
South Side	2	34,387

Threats Old and New

From overharvesting to sea level rise: Evolving challenges for nesting turtles

Historical threats

- Overharvesting
- Habitat destruction

Current threats

- Sea level rise (SLR) and coastal erosion
- Artificial lighting along beaches
- Shoreline armoring structures
- Debris from failed infrastructure
- Nest compaction from foot traffic and vehicles
- Increased sand temperatures

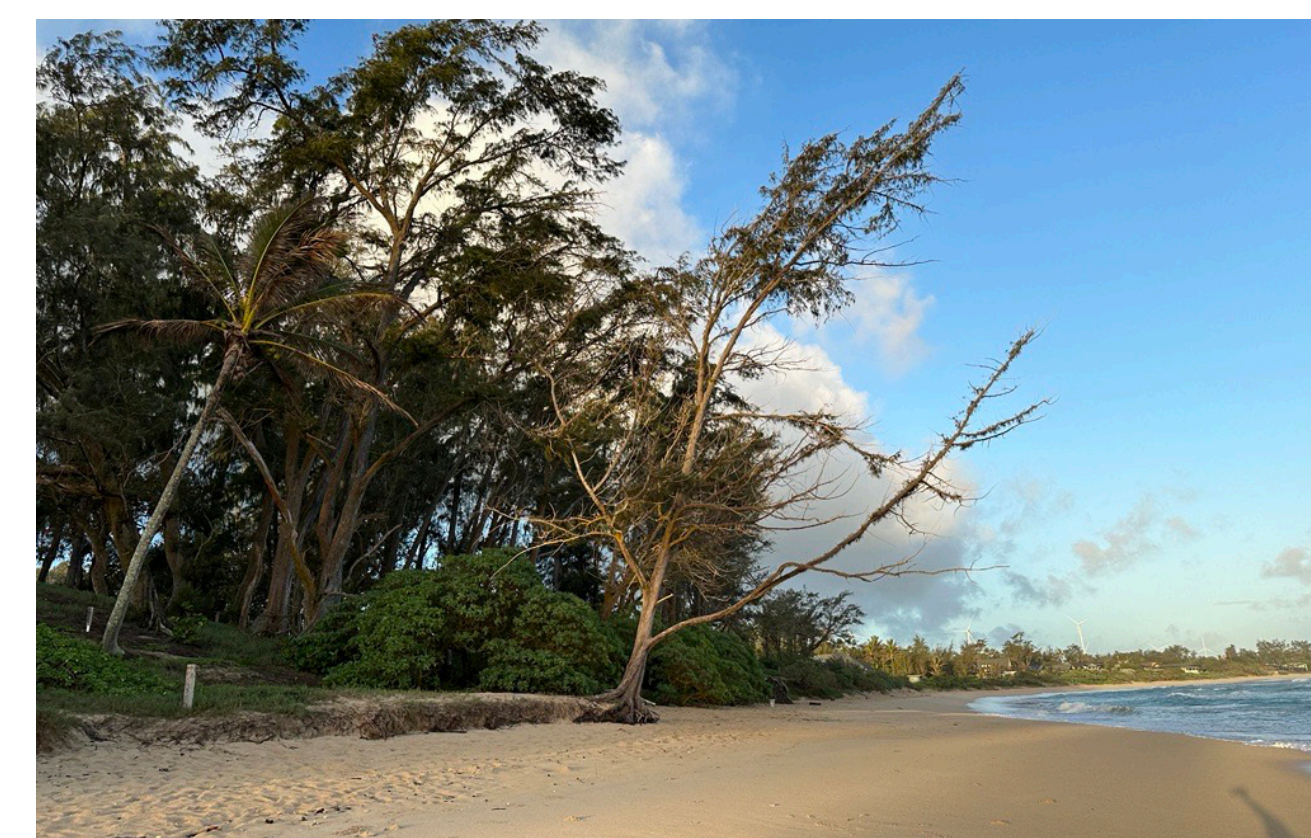
The Silent Danger: Shoreline Armoring

Beach "protection" that endangers sea turtles when sea levels rise

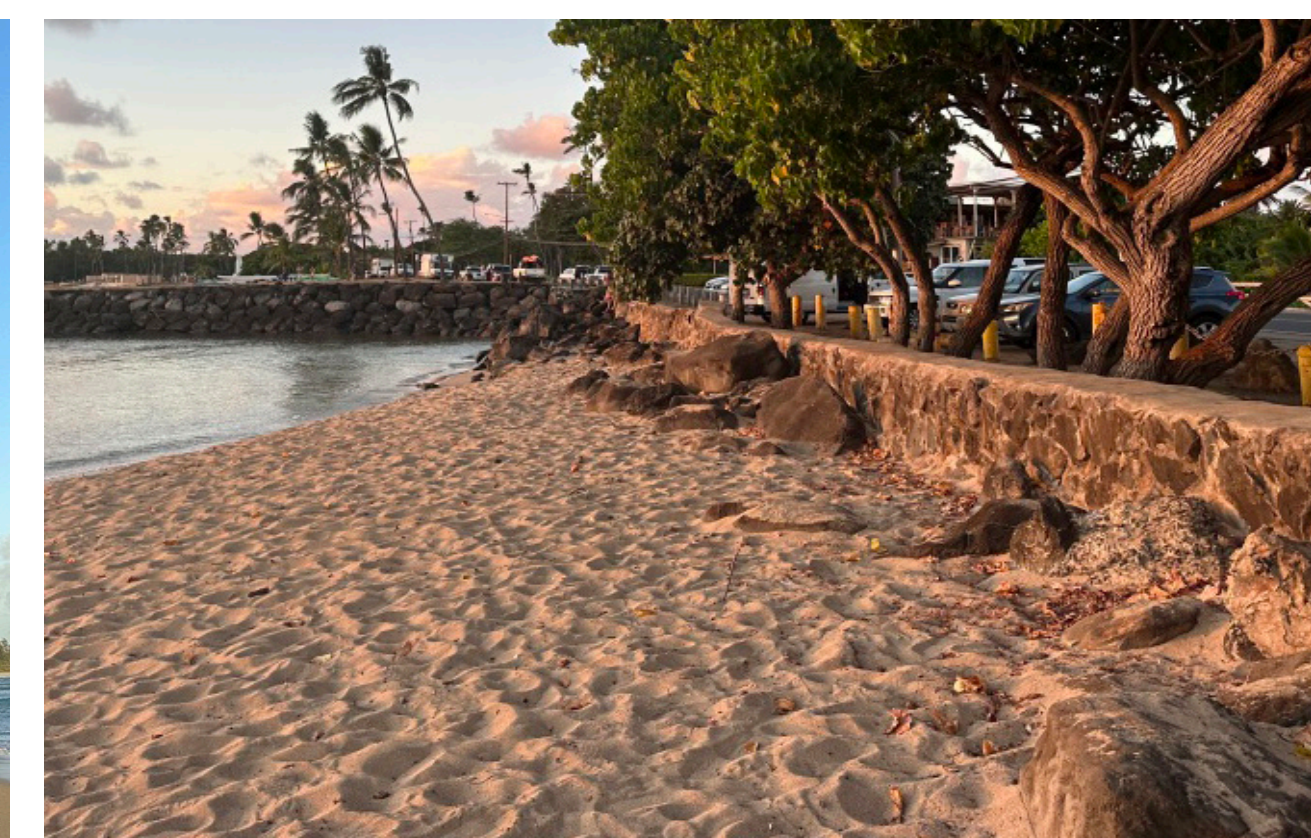


A geotextile sandbag structure has protected private property, but results in a total loss of nesting habitat.

Photos by Rob Walker, O'ahu, HI



Beaches backed by native vegetation (with no shoreline armoring) have the potential to naturally adapt with sea level rise while preserving nesting habitat.



Beaches backed by legacy seawalls prohibit natural adaptation under rising sea levels and limit viable nesting habitat.

On evolutionary timescales along undeveloped shorelines, beaches have been able to migrate landward during sea level rise, and nesting viability was maintained.

Shoreline armoring structures prohibit this natural shoreline retreat and recovery process, endangering sea turtle nesting and survival.³

Unpermitted installations are still on the rise.

For chronically eroding shorelines backed by shoreline armoring, sea level rise is expected to result in **total loss of beach**.

Integral's Methodology

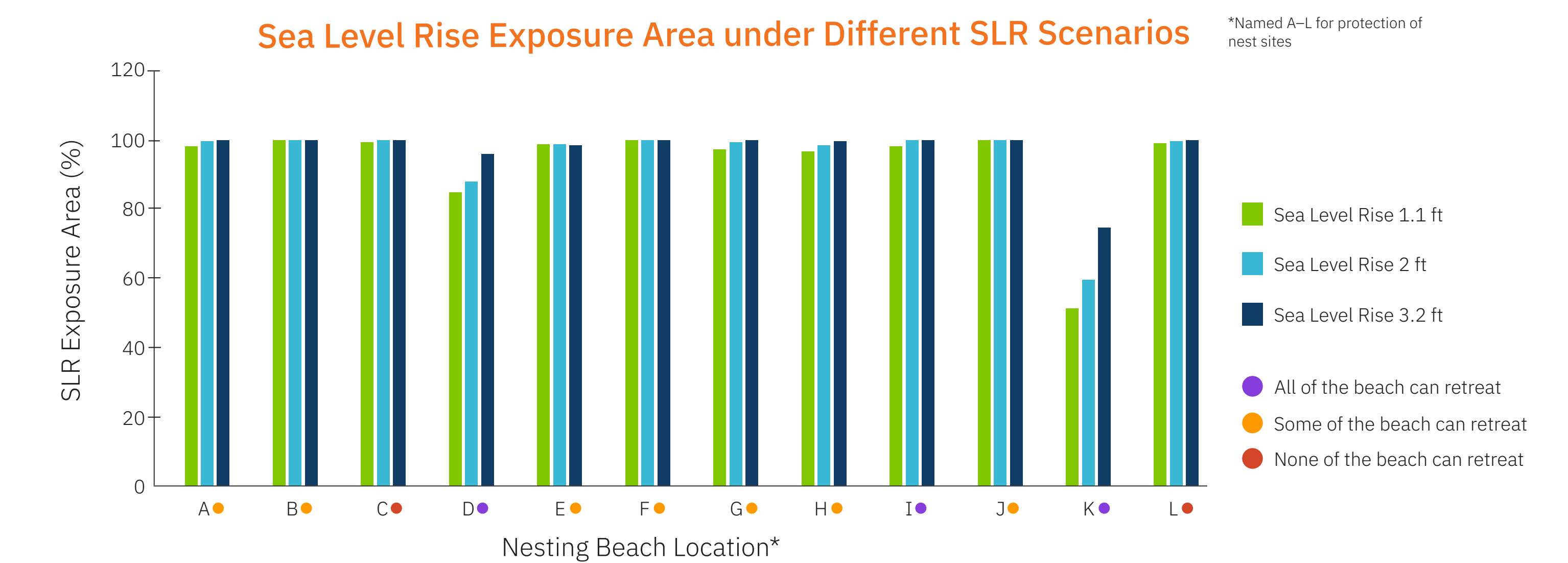
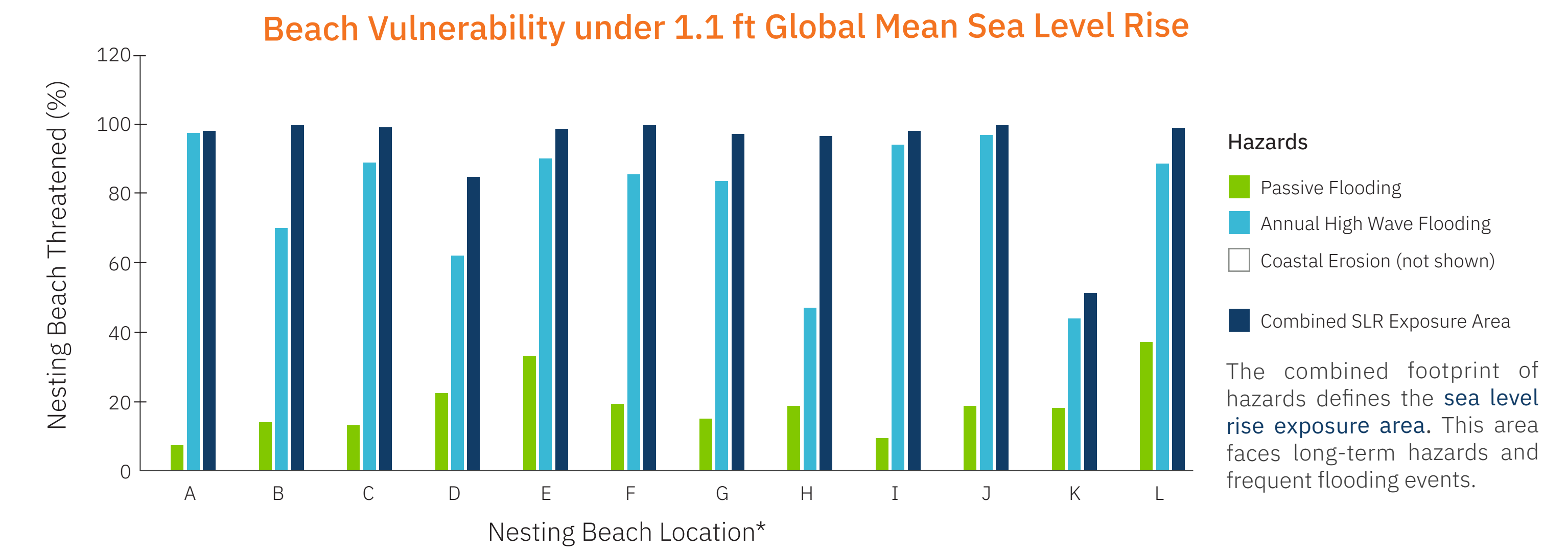
Integral scientists and engineers partner with USFWS and NOAA to identify and assess vulnerable nesting beaches on O'ahu

- Complete
- In Progress
- Identify key nesting beaches using USFWS and NOAA data
- Analyze sites for flooding and erosion impacts under various sea level rise scenarios
- Characterize each beach's geomorphology, seasonal changes, and physical traits
- Evaluate potential nature-based approaches to protect nesting habitats

Key Findings: A Future at Risk

A sobering forecast: Analysis reveals critical threats to nesting beaches

Analyses in ArcGIS utilized previous modeling efforts assessing the impacts of passive flooding, annual high-wave flooding, and chronic coastal erosion on O'ahu.⁴



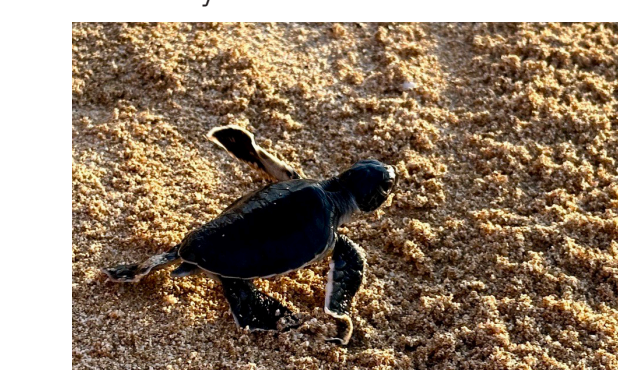
- **Severe impact across all beaches:** Even with 1.1-foot SLR, many beaches face significant impacts
- **Critical thresholds:** Several beaches approach or reach 100% exposure with higher SLR scenarios
- **Variability in vulnerability:** Some beaches are able to retreat and show more natural adaptive capacity while others face significant vulnerability in all SLR scenarios
- **Accelerating loss:** The rate of beach loss increases dramatically as SLR progresses

Implications: The Urgency of Now

As sea levels rise, what is critical for the long-term survival of green turtles nesting on Hawaiian beaches?

- ☀️ **Prioritizing protection** of turtle nesting beaches by prohibiting new shoreline armoring and encouraging nature-based shoreline protection measures
- 🛡️ **Informing policymakers** of the anthropogenic hazards to green turtles and the impacts of sea level rise
- 📊 **Long-term monitoring** of future nesting beaches
- 🎓 **Enhanced enforcement** of the Endangered Species Act and shoreline armoring structure restrictions
- 👥 **Educational outreach** to homeowners and other stakeholders on how they can personally reduce their impacts
- 🔍 **More research** on nesting populations of the MHI

Photo by Samantha Mislinski



Robert Walker
Integral Consulting Inc.
808.202.1920
rwalker@integral-corp.com

