Hawaii Division of Aquatic Resources

Alien Macroalgae Distribution and Management in Hawai'i

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Island Ecosystems: The Year of the Reef

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Hawai'i Convention Center, Honolulu

Introduction to the Enemy

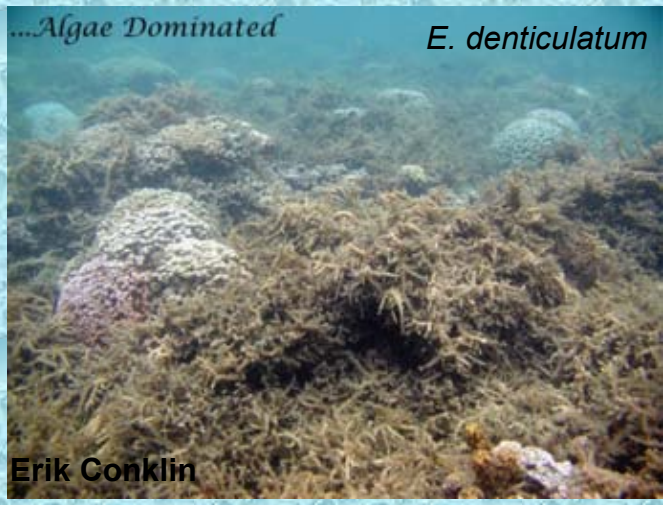
- Currently 5 marine alien algae species of high concern:
  - *Gracilaria salicornia*
  - *Kappaphycus/Euchuma* spp. Complex
  - *Acanthopora spicifera*
  - *Avrainvillea amadelpha*
  - *Hypnea musciformis*
- Invasive algae dominate regions of Oahu's South Shore and Kaneohe Bay
- They are abundant on parts of Molokai, Maui, and the Eastern side of the Big Island of Hawaii.
- Some species are throughout the MHI's; one in NWHI's
- Compete with native species
- Accumulates on beaches
- Smothers & kills corals

Gracilaria salicornia

- Introduced as aquaculture candidate in 1971 to Waikiki & Kaneohe Bay
- Competes with native sea grass *Halophila decipiens* (Peyton et. al 2006)
- Forms thick mats, which smother & kill coral
- Fills reef cracks & crevices; reducing habitat for fish & invertebrates
- Accumulates on beaches, depressions & shallow areas

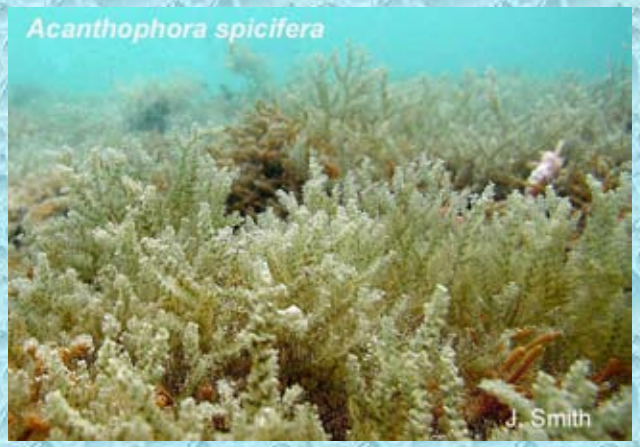
Kappaphycus/Euchuma spp. Complex

- Introduced as aquaculture candidates to Kaneohe Bay in 1974
- 3 species total *(K. alvarezzi, K. striatum, E. denticulatum)*
- Over grows and smothers Hawaiian corals
- Currently found in Kaneohe Bay and isolated areas to the North
- Found at Hawaii Kai boat ramp 2008



Acanthopora spicifera

- Most likely introduced to Pearl Harbor by hull fouling from Guam
- First seen in 1952
- Found in all major islands by 1961
- Grows on all types of surfaces and can also be free-floating
- Most abundant across the Hawaiian Island chain

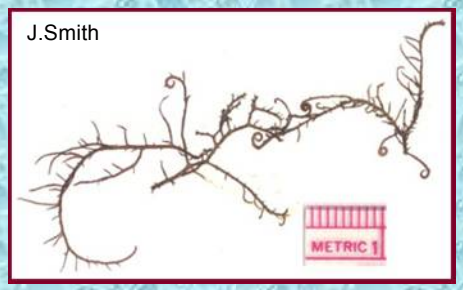


Avrainvillea amadelpha

- Introduction unknown; first seen in 1981 off Kahe Point, Oahu
- Grows on rock, rubble, or sandy reef flats from subtidal to 80 m
- Competes with the endemic seagrass *Halophila hawaiiana*

Hypnea musciformis

- Imported illegally from Florida for aquaculture 1974
- Has spread from Kaneohe Bay up to Necker Island of the NWHI
- Forms large accumulations on Maui's beaches which cost an estimated $20 million/year




Coral Dominated...
Erik Conklin


...Algae Dominated
Erik Conklin

Survey Methods

- Surveys conducted on snorkel using portable G.P.S. devices
- Spatial data and relative algal abundances are recorded
- Data used to generate accurate maps that project algal abundance and distribution
- Distribution maps are essential for determining further algal management strategies.

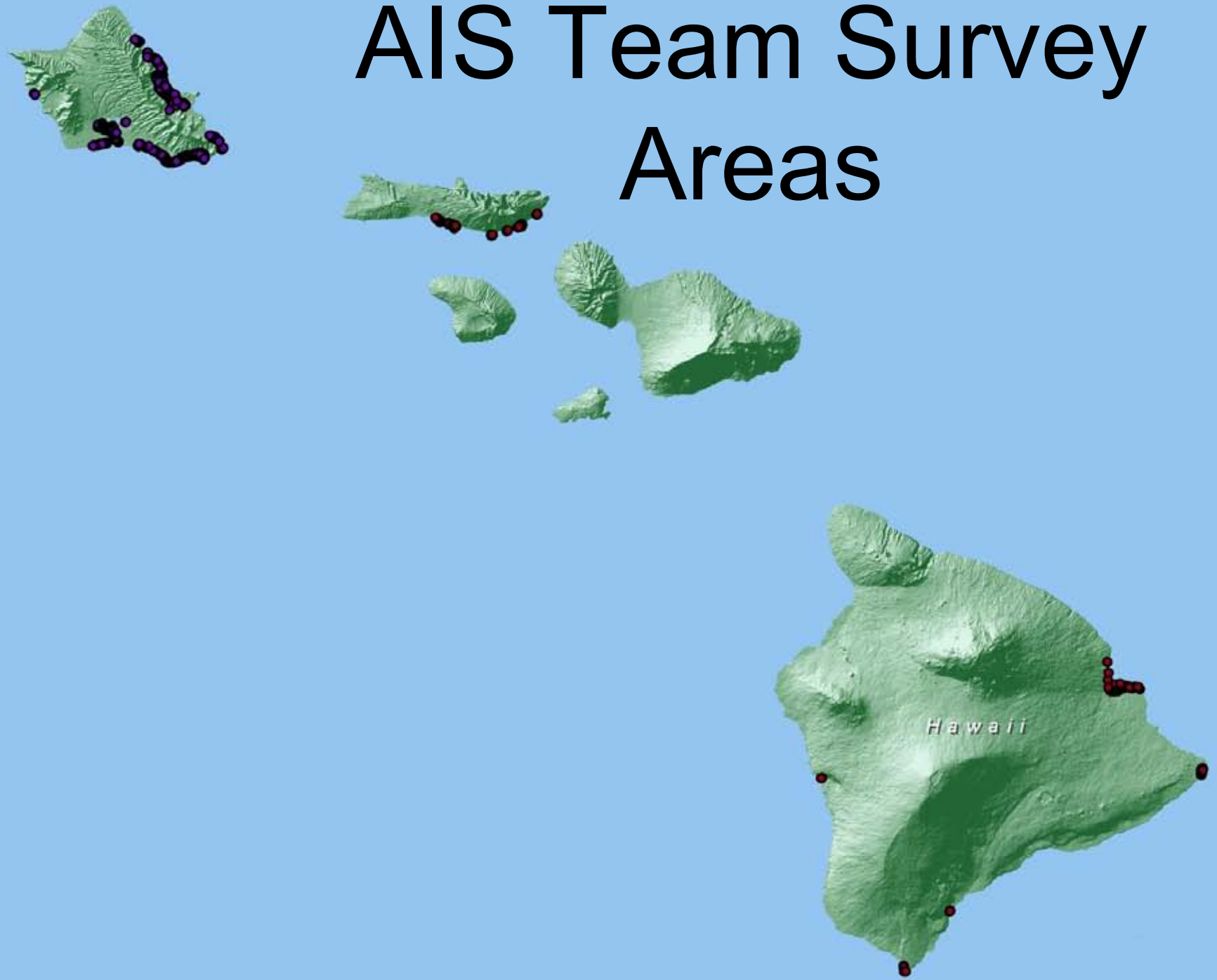
Survey Information

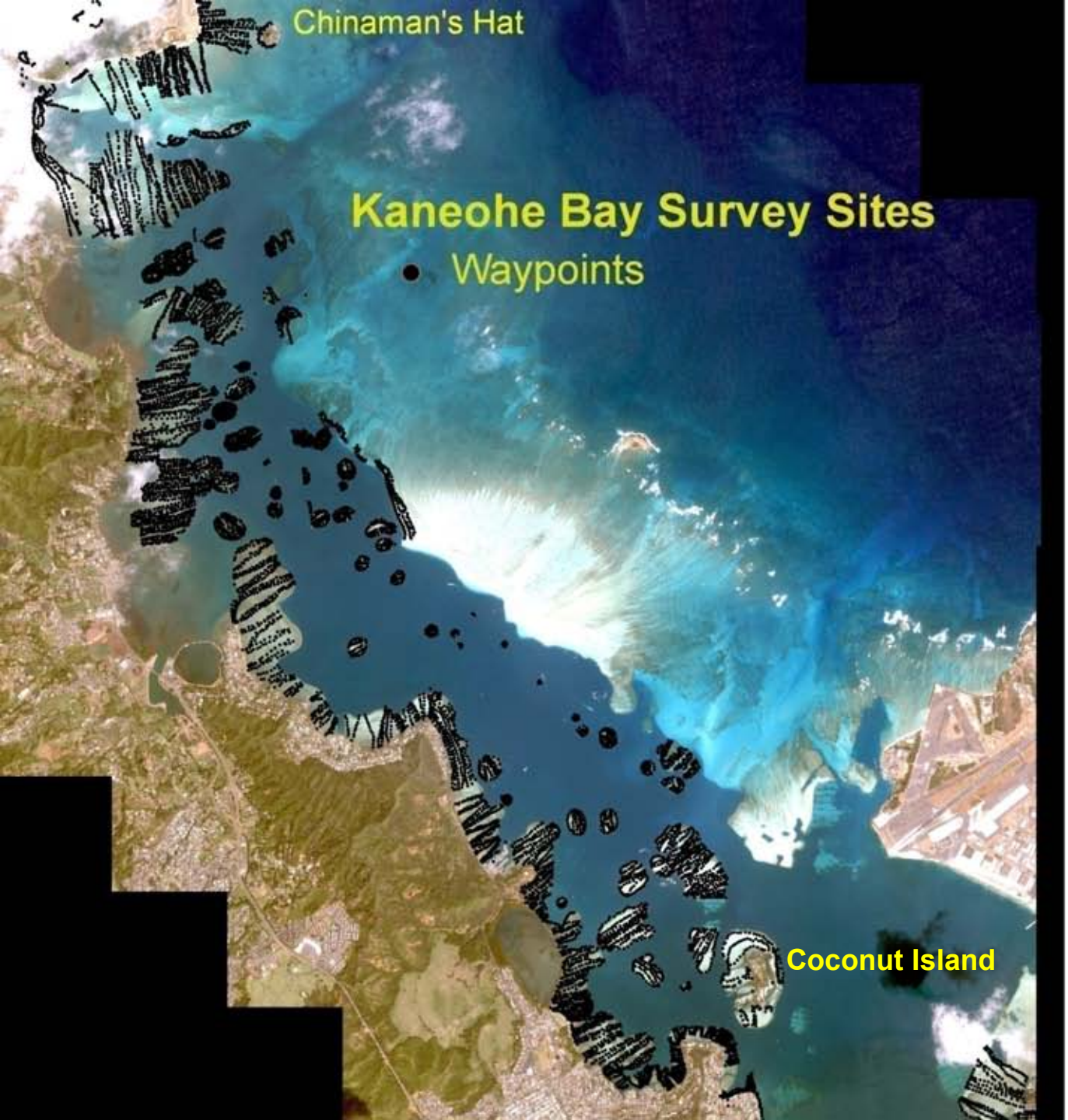
- 36,285 data points taken from 2005-2008
- Mapping done on Oahu, Molokai, Hawaii, and Kahoolawe

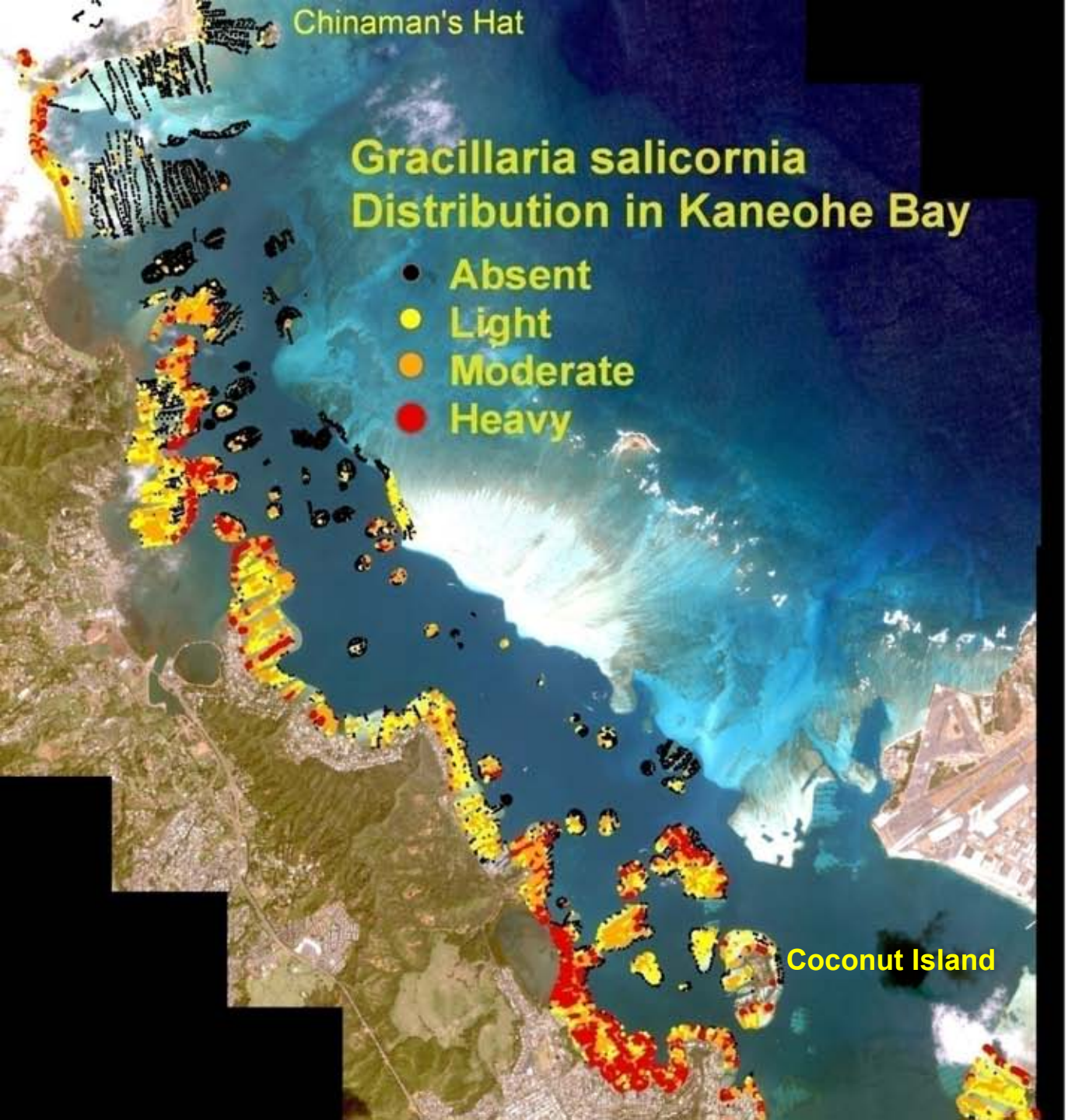
- Abundance rated on a 4 point scale
  - 0 Absent
  - 1 Present/Sparse
  - 2 Carpet/Light Matting
  - 3 Dense Mats

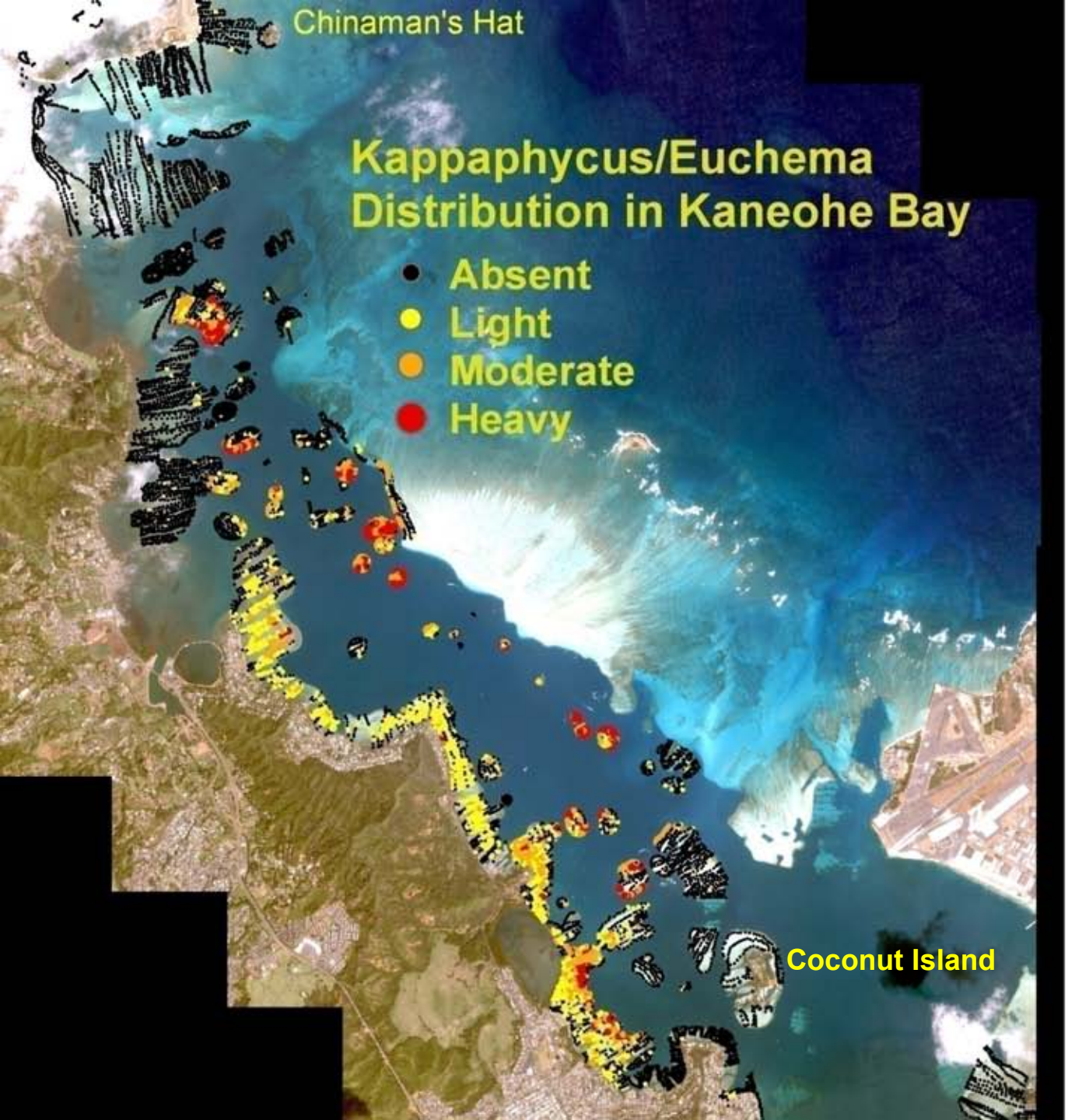
Species	Average weight per 1/4m2 (g)	Weight Range per 1/4m2 (g)
Kappaphycus/Euchema 1	40g (36)	12g – 110g
Kappaphycus/Euchema 2	654g (221)	427g – 979g
Kappaphycus/Euchema 3	6769g (3010)	**2540g – 10,436g +**
Gracillaria salicornia 1	29g (9)	18g – 39g
Gracillaria salicornia 2	643g (461)	253g – 1200g
Gracillaria salicornia 3	3008g (1136)	**1597g – 4789g +**

AIS Team Survey Areas

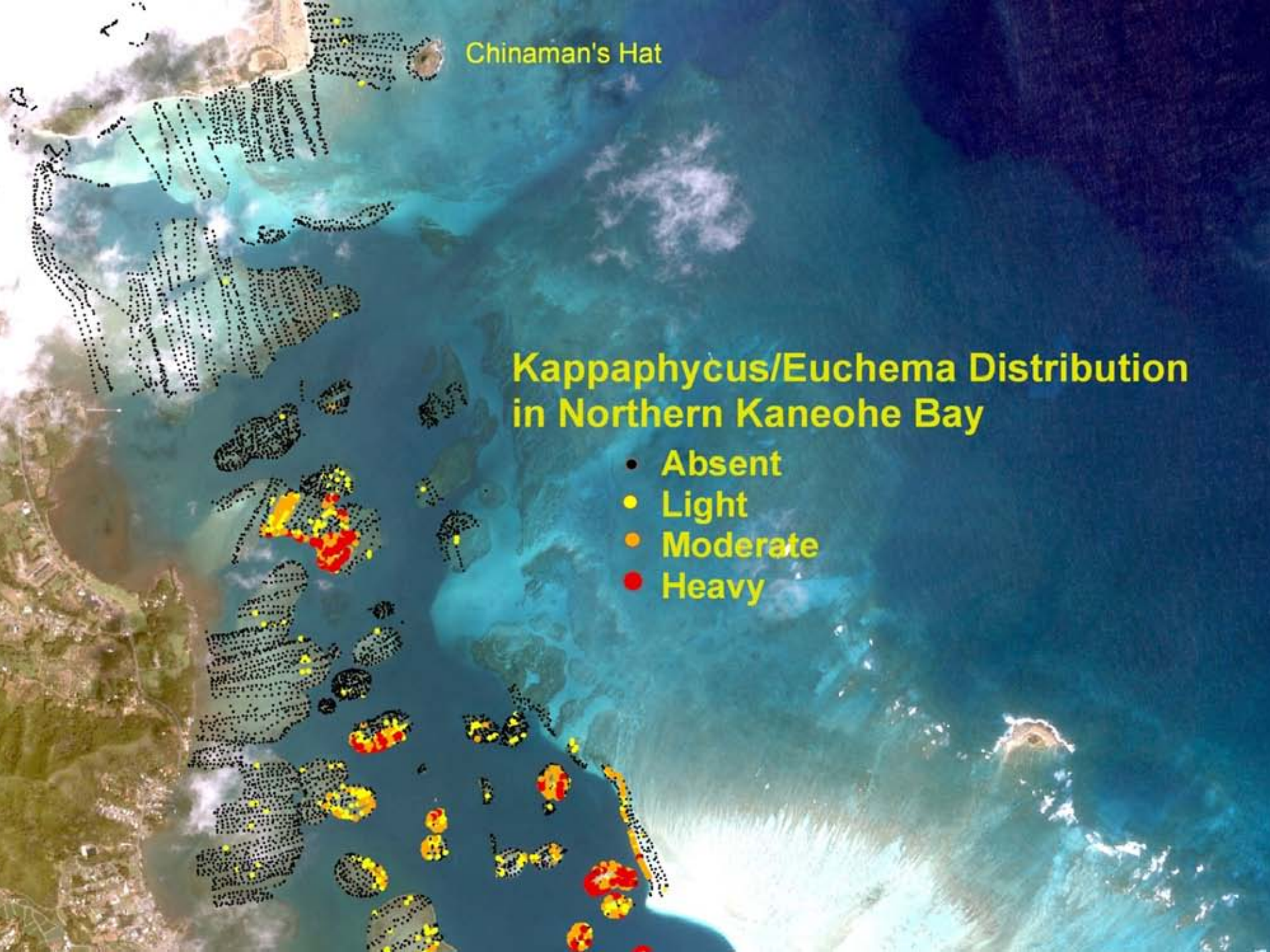


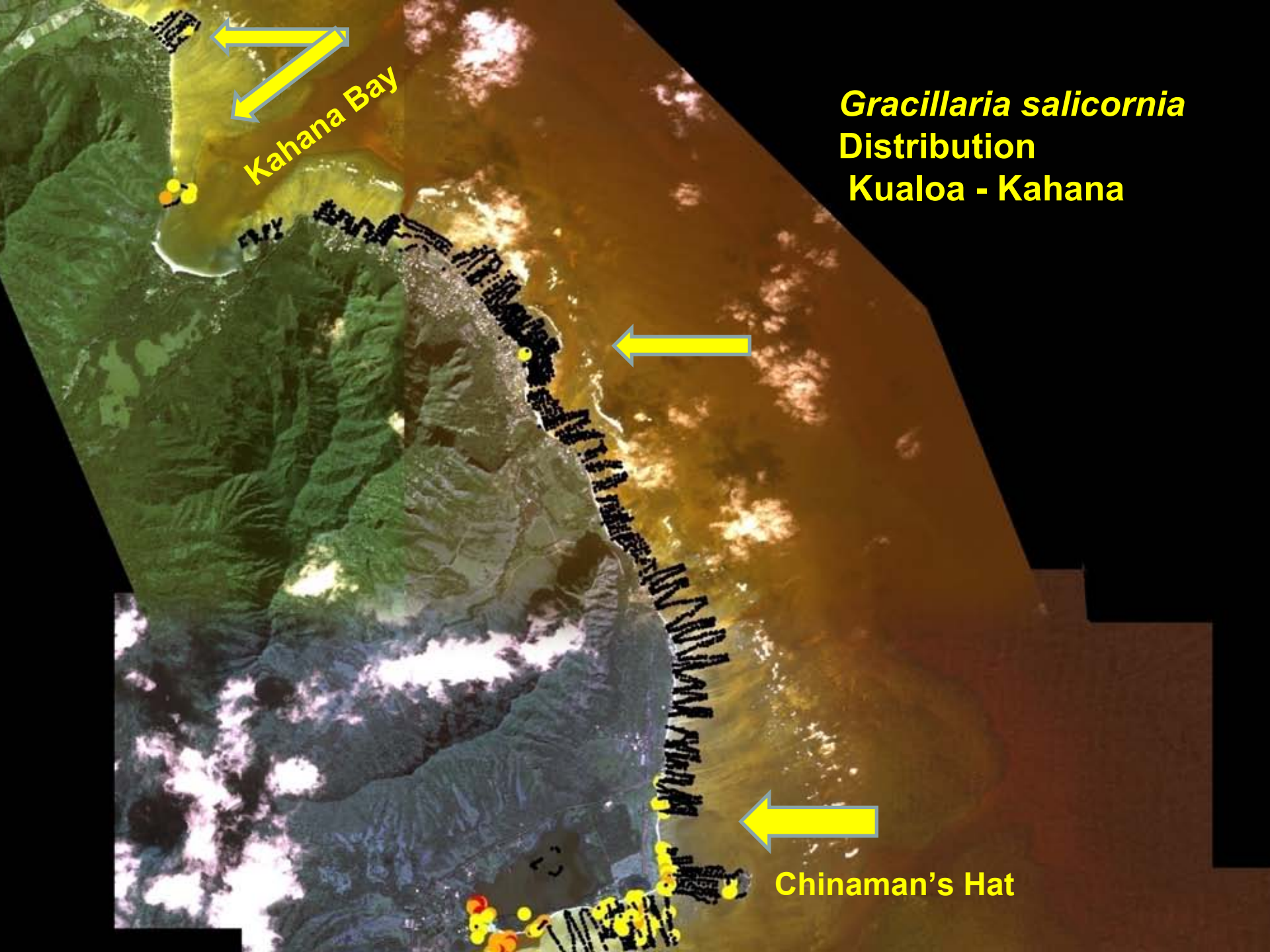

Chinaman's Hat
Kaneohe Bay Survey Sites
Waypoints
Coconut Island

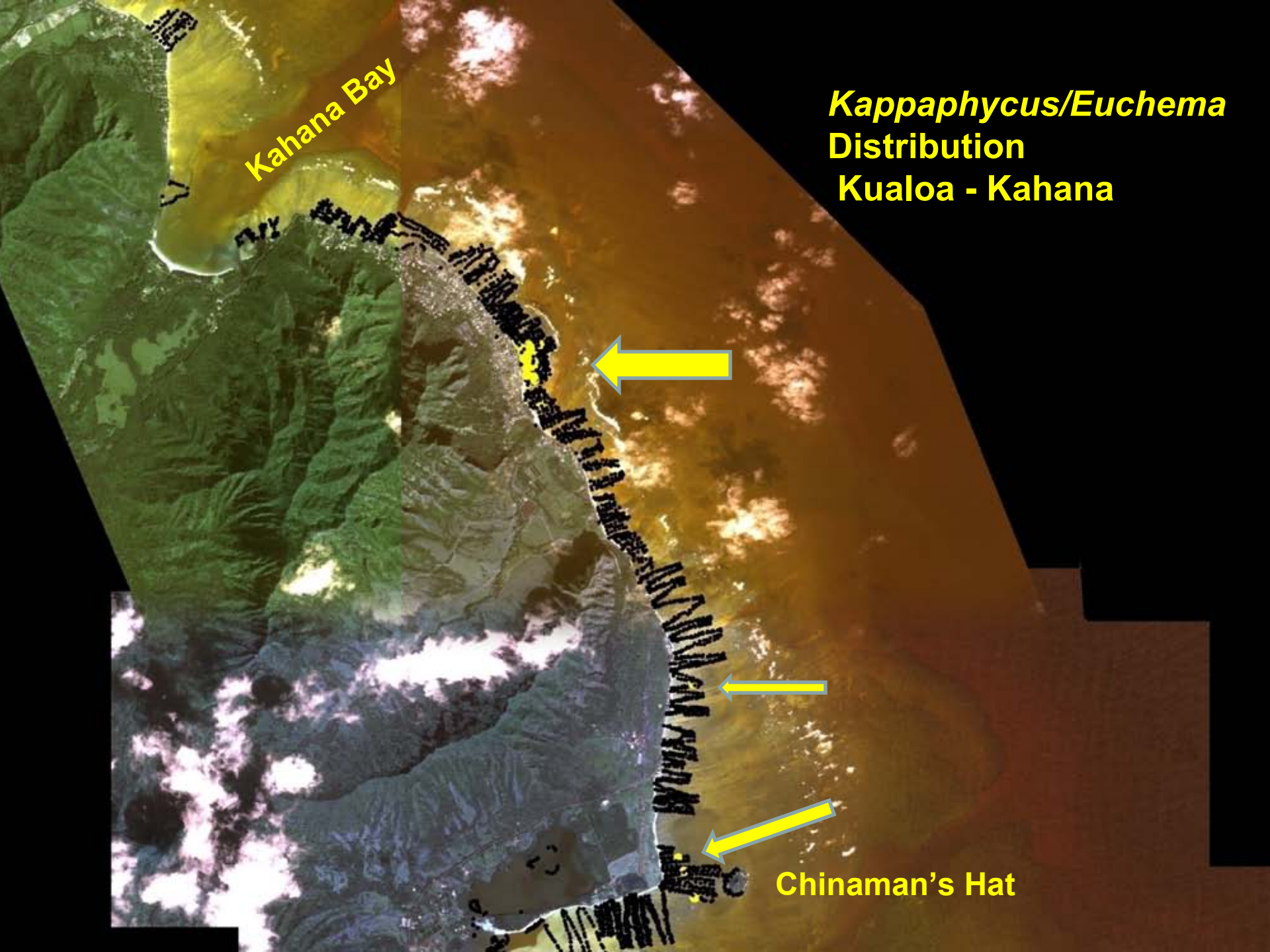

Chinaman's Hat
Gracillaria salicornia
Distribution in Kaneohe Bay
Absent
Light
Moderate
Heavy
Coconut Island

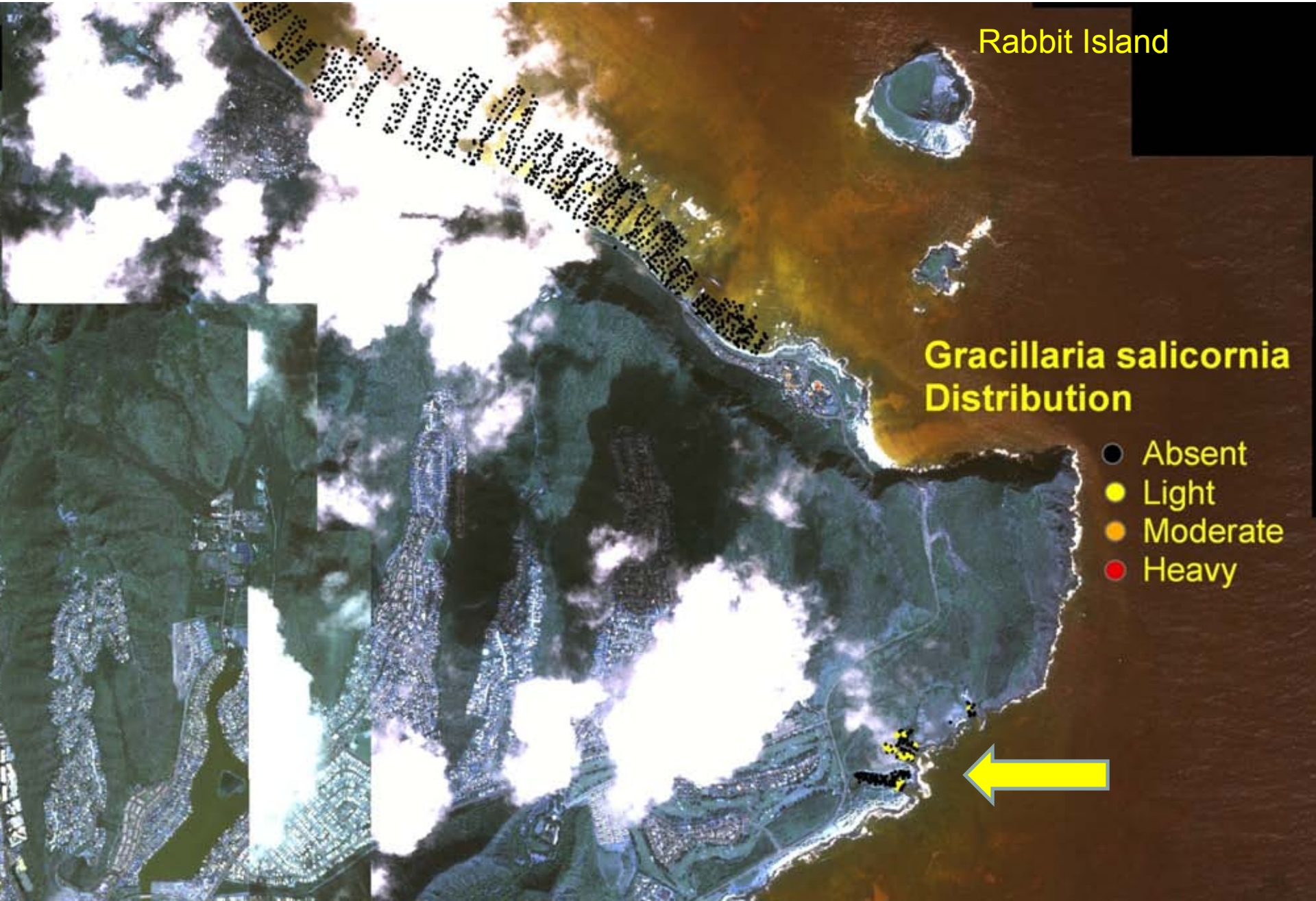

Chinaman's Hat
Kappaphycus/Euchema
Distribution in Kaneohe Bay
Absent
Light
Moderate
Heavy
Coconut Island


Chinaman's Hat
Gracillaria Distribution
in Northern Kaneohe Bay
Absent
Light
Moderate
Heavy

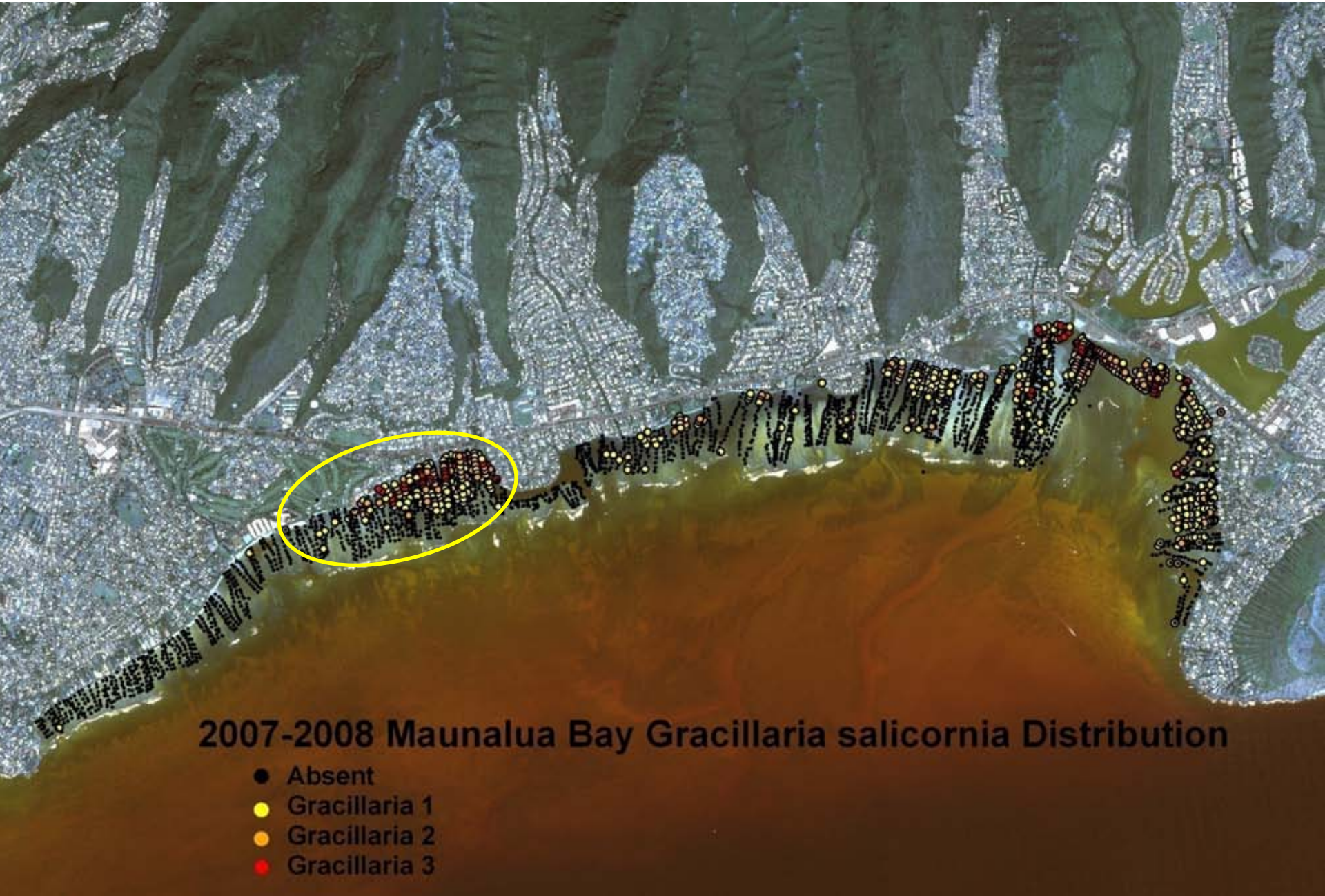

Chinaman's Hat
Kappaphycus/Euchema Distribution
in Northern Kaneohe Bay
Absent
Light
Moderate
Heavy


Kahana Bay
Gracillaria salicornia
Distribution
Kualoa - Kahana
Chinaman's Hat

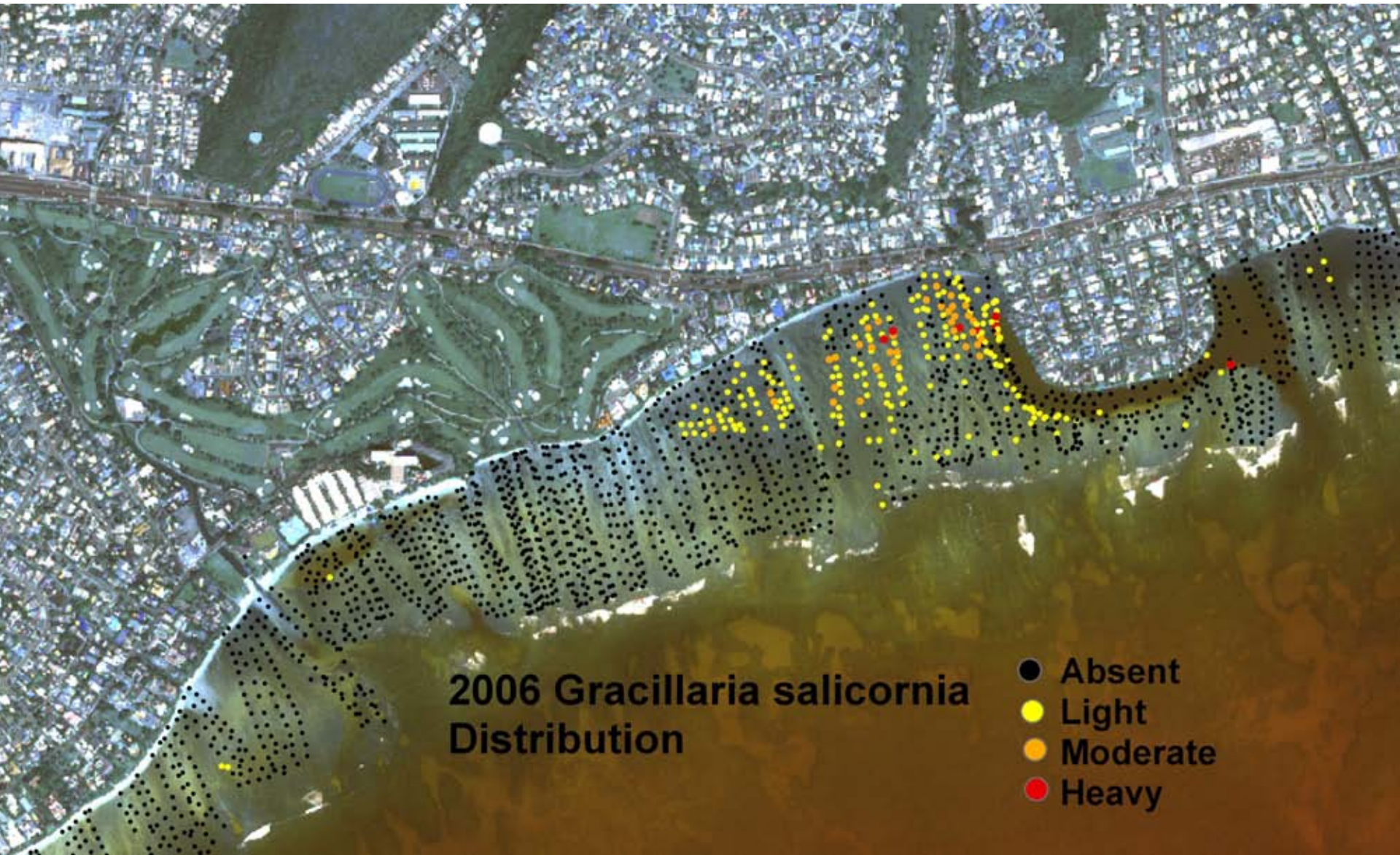

Kahana Bay
Kappaphycus/Euchema
Distribution
Kualoa - Kahana
Chinaman's Hat


Rabbit Island
Gracillaria salicornia
Distribution
Absent
Light
Moderate
Heavy

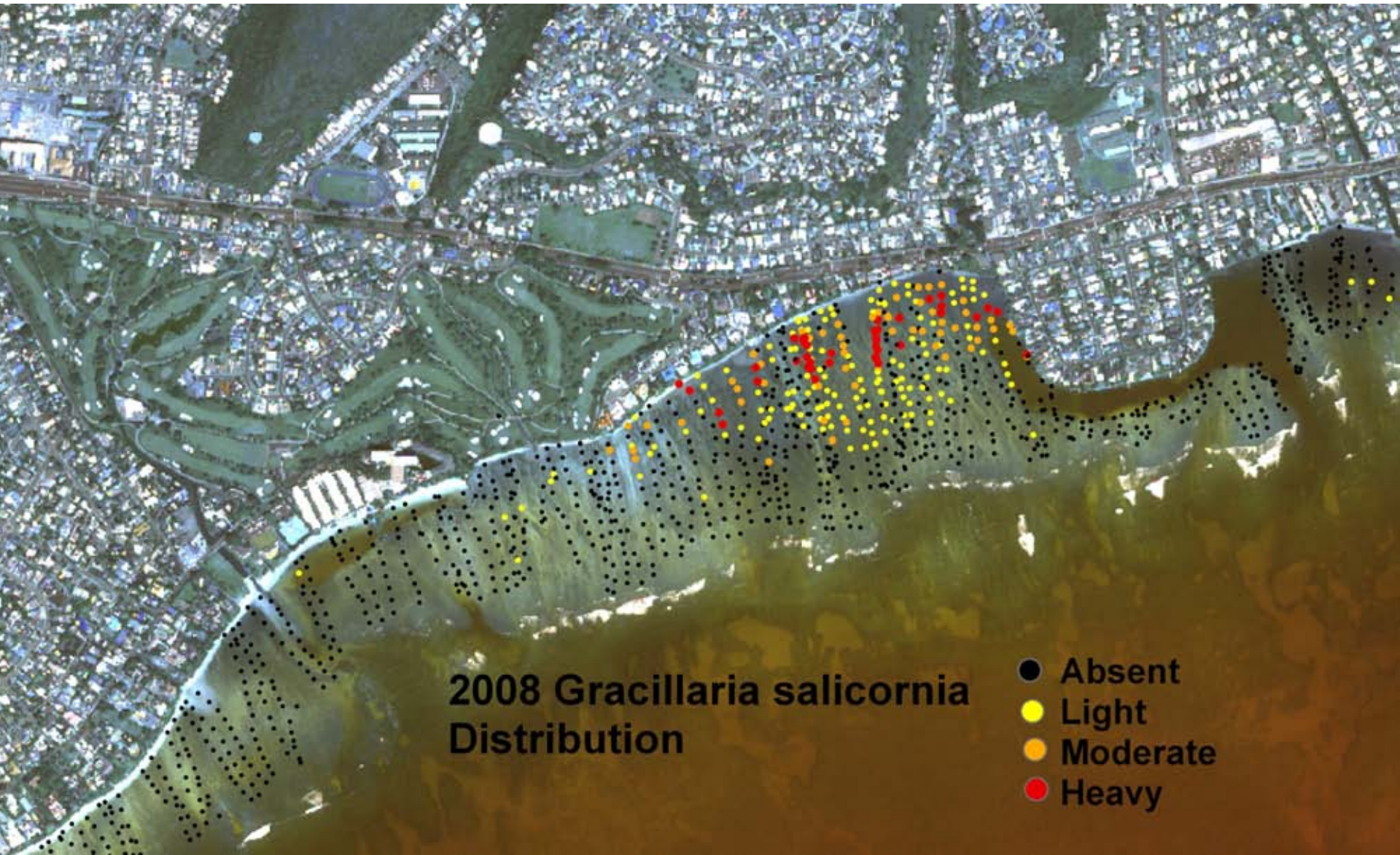

2006 Maunalua Bay Gracillaria salicornia Distribution
Absent
Gracillaria 1
Gracillaria 2
Gracillaria 3


2007-2008 Maunalua Bay Gracillaria salicornia Distribution
Absent
Gracillaria 1
Gracillaria 2
Gracillaria 3

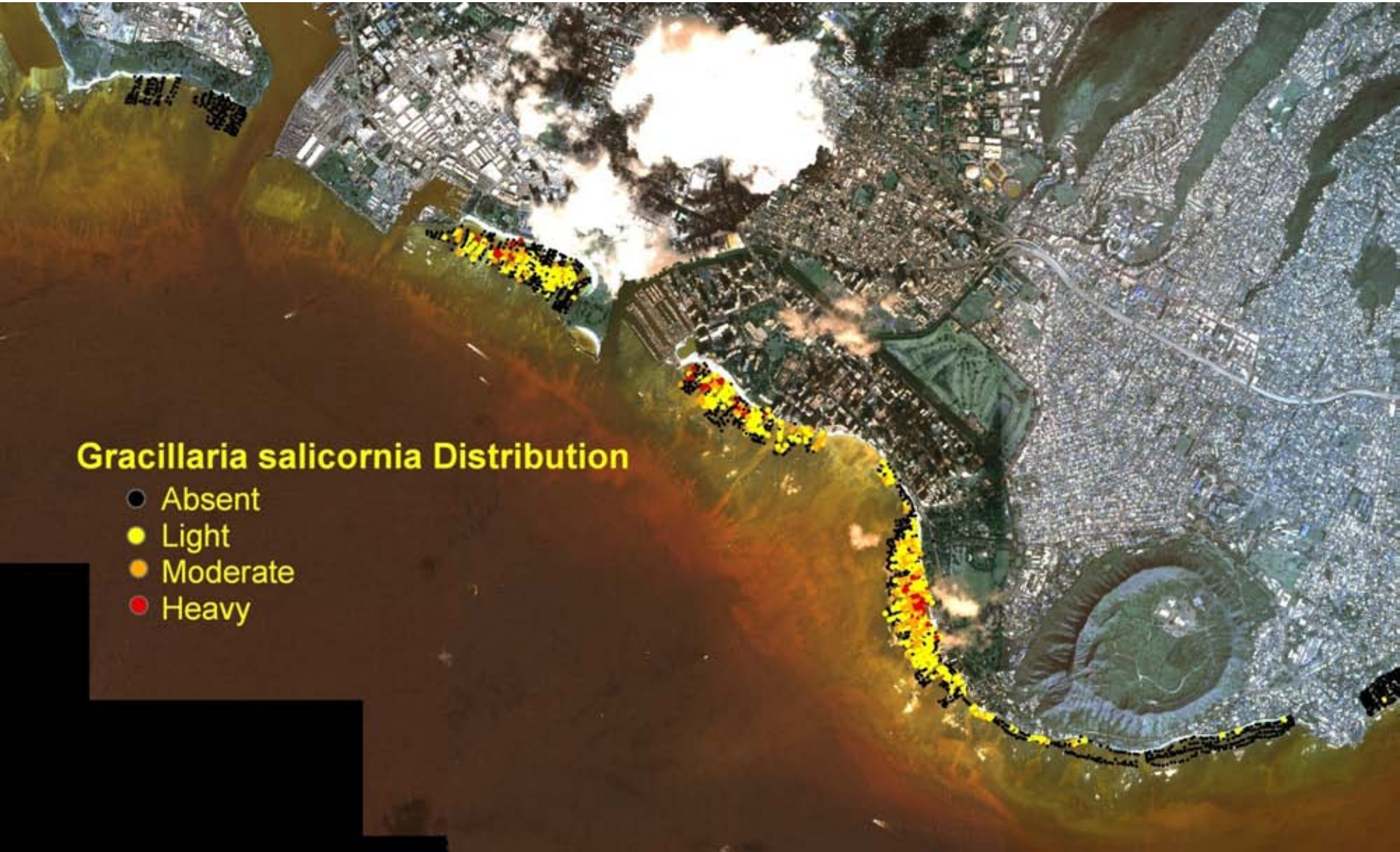
Kahala to Wailupe



Kahala to Wailupe

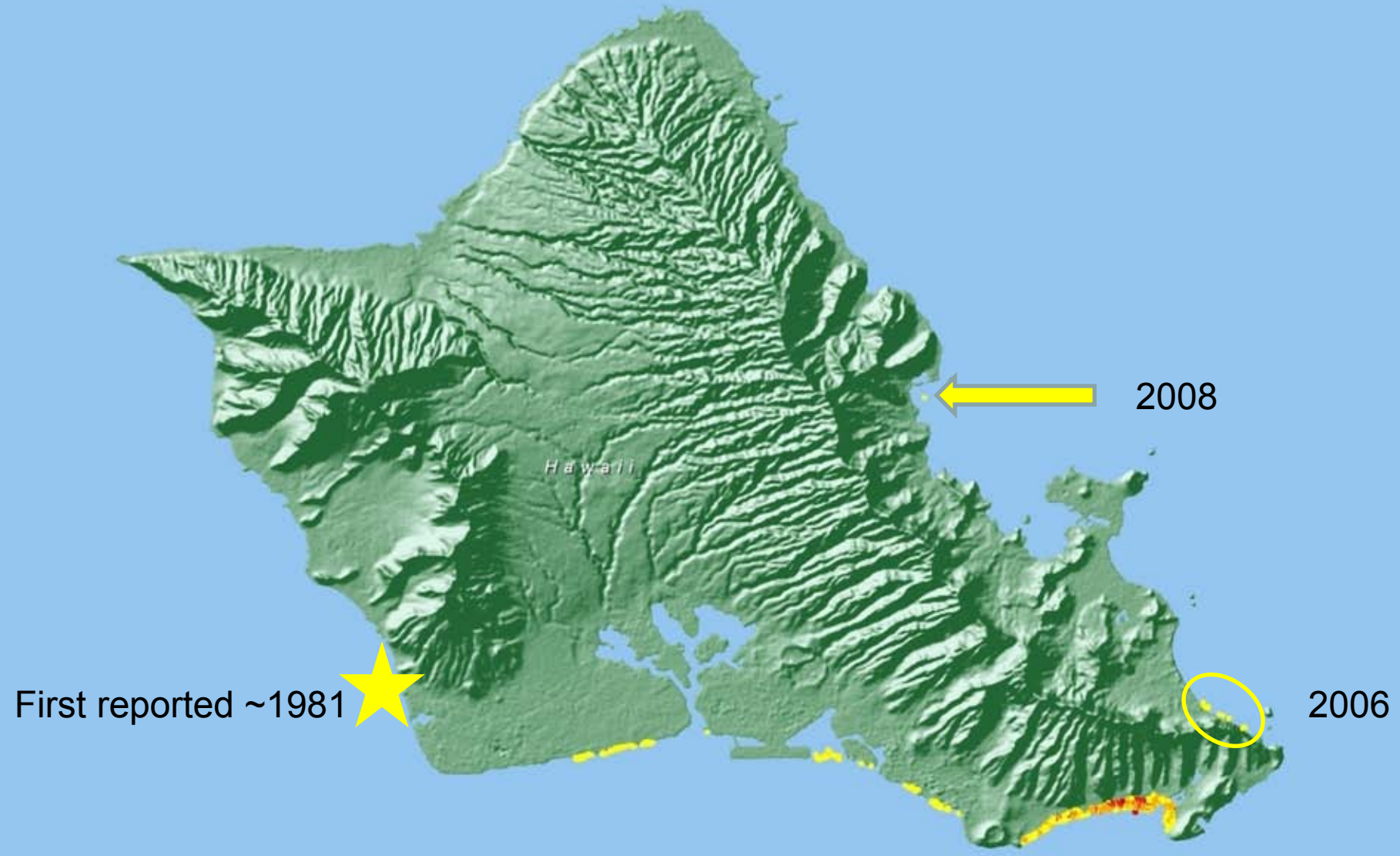


Sand Island to Black Point

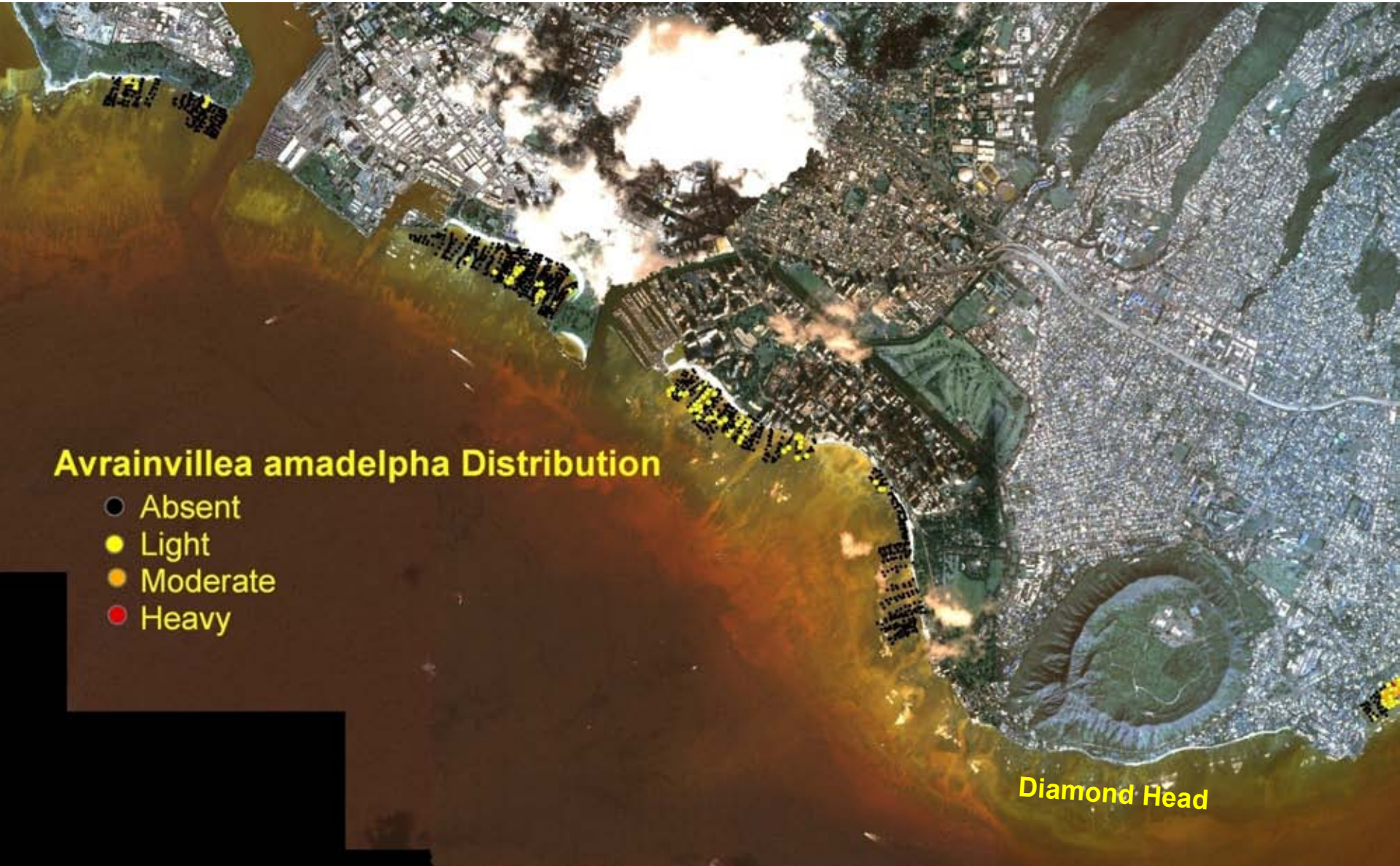


Gracillaria salicornia distribution in Pearl Harbor

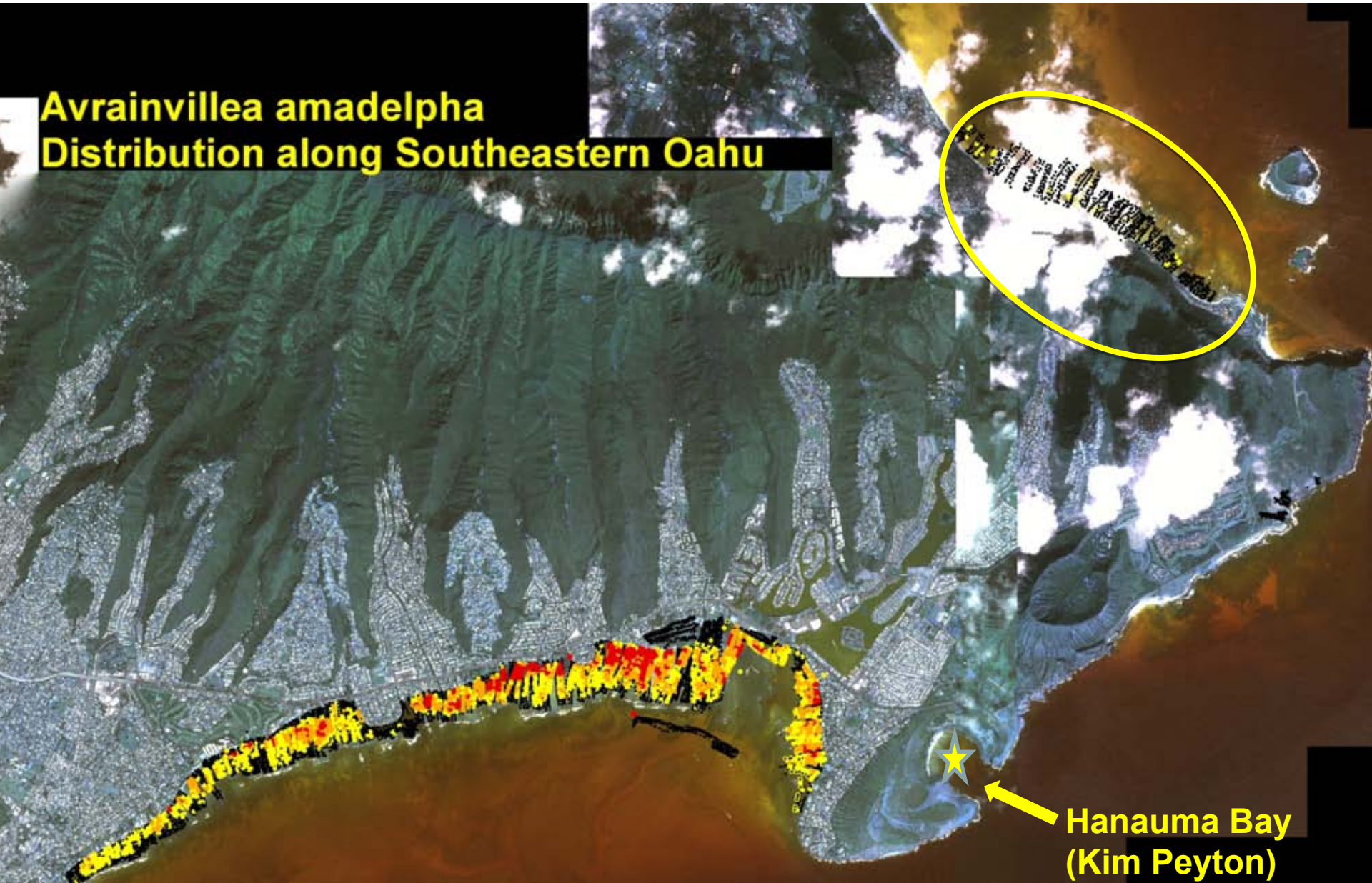
Avrainvillea amadelpha's expansion

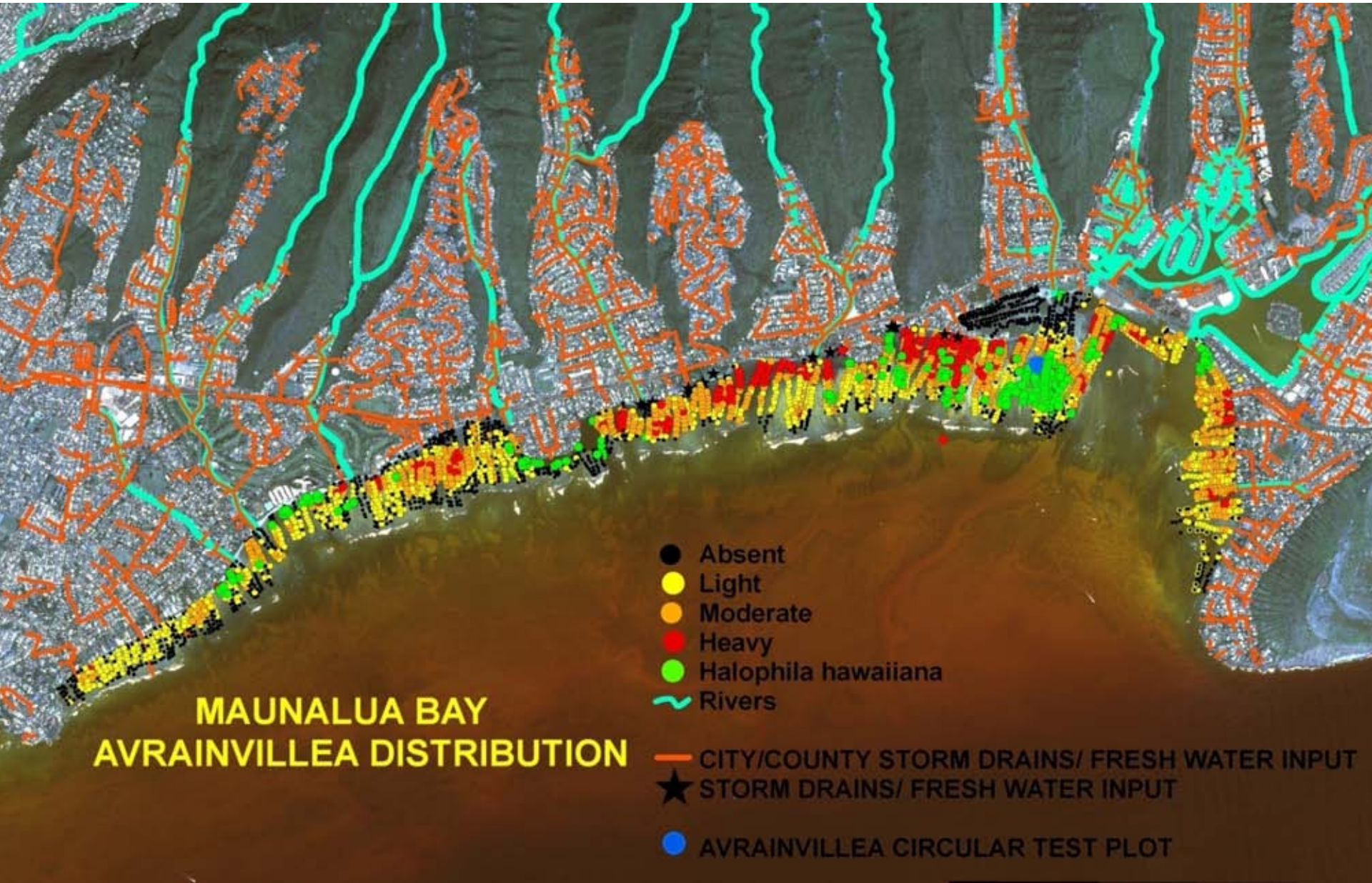


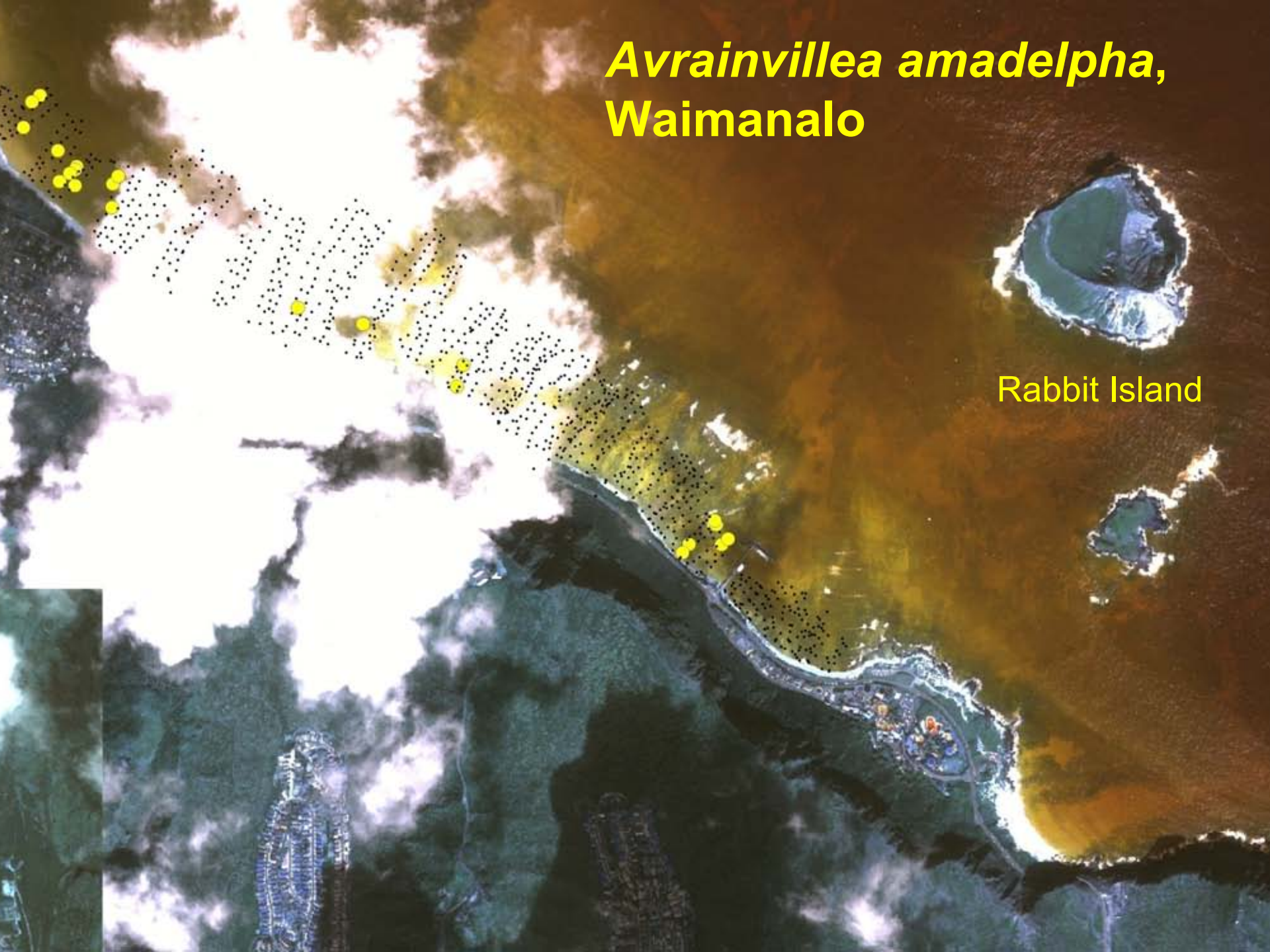
Sand Island to Black Point

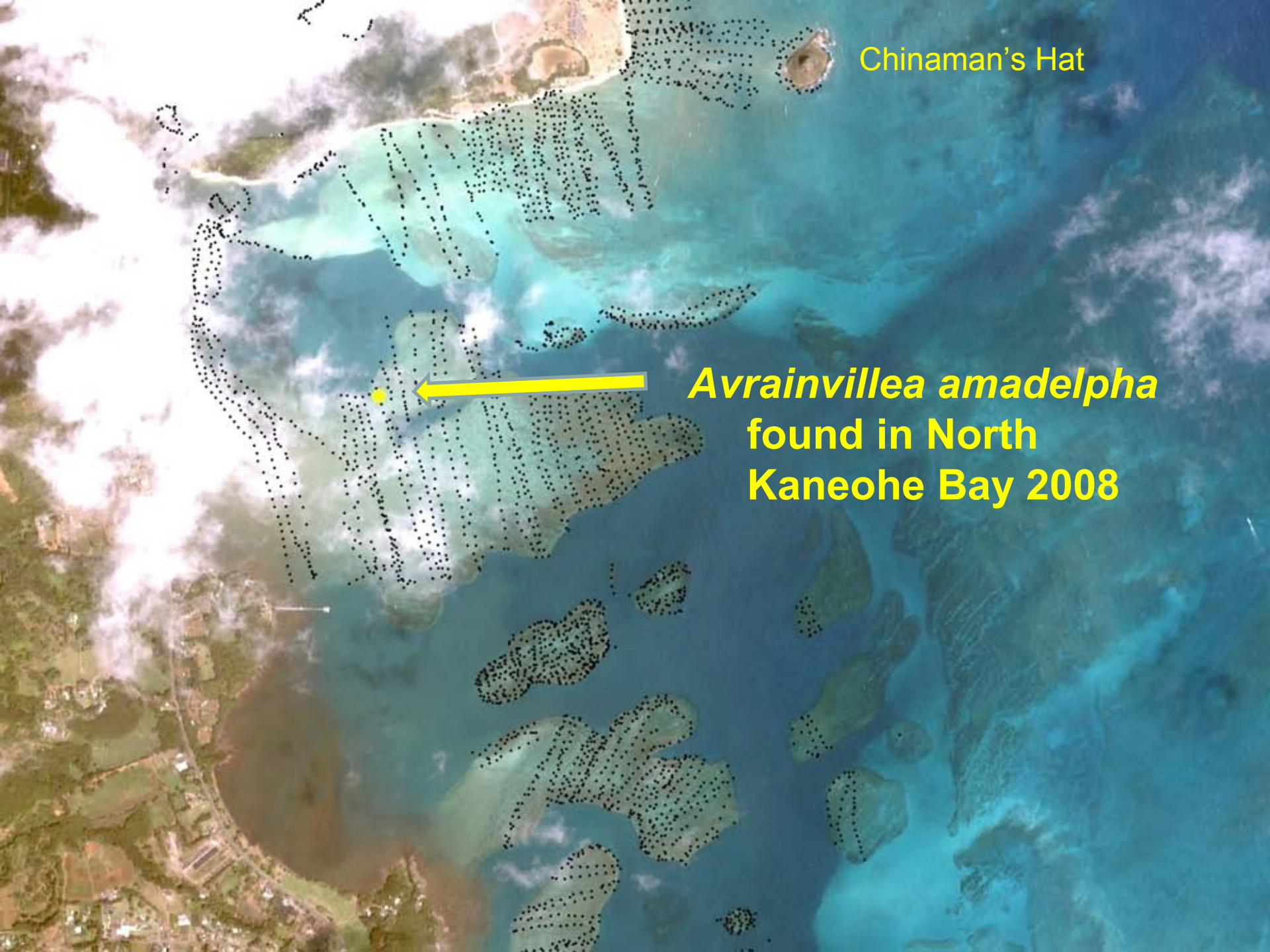


Black Point to Waimanalo

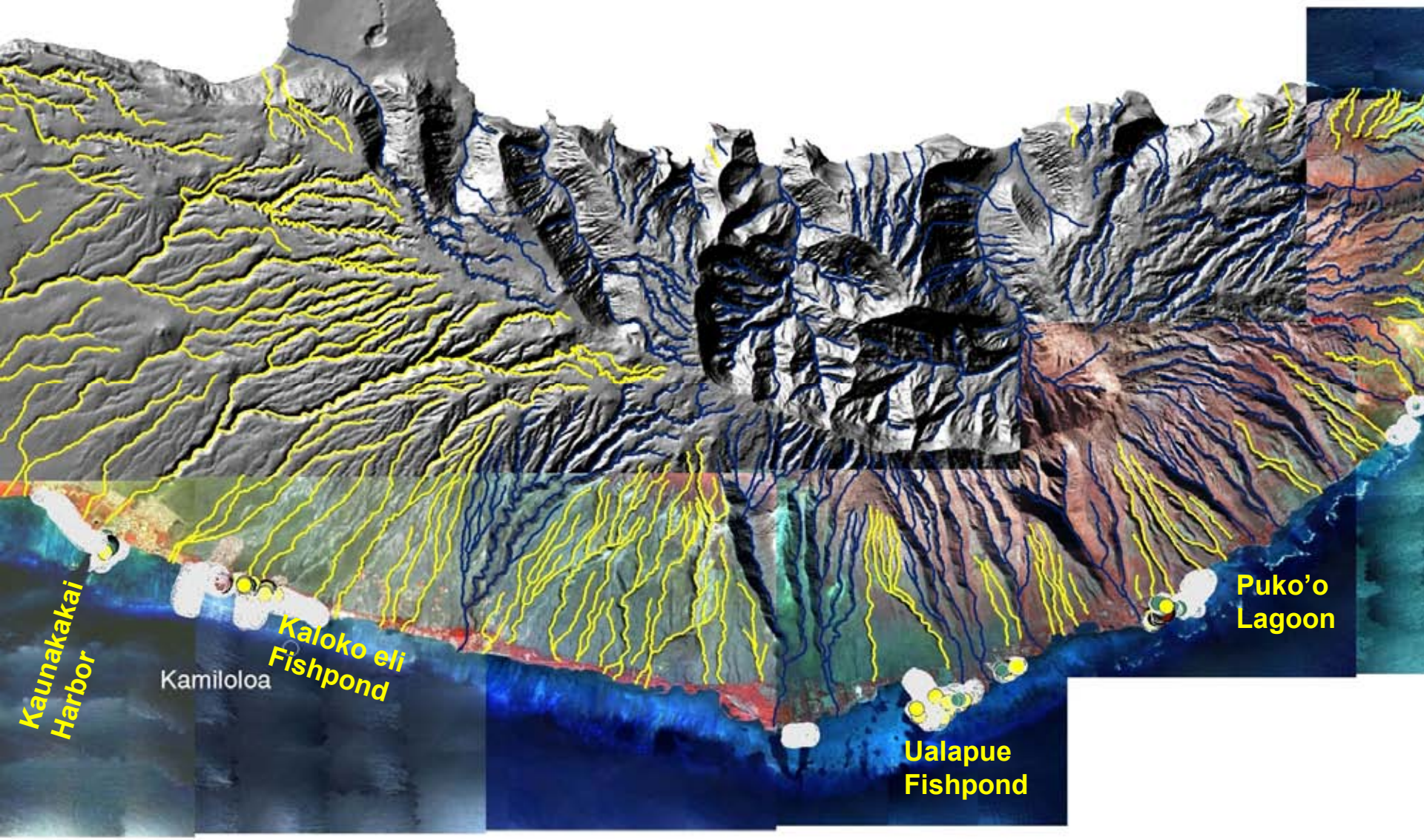



MAUNALUA BAY
AVRAINVILLEA DISTRIBUTION
Absent
Light
Moderate
Heavy
Halophila hawaiiana
Rivers
CITY/COUNTY STORM DRAINS/ FRESH WATER INPUT
STORM DRAINS/ FRESH WATER INPUT
AVRAINVILLEA CIRCULAR TEST PLOT


Avrainvillea amadelpha,
Waimanalo
Rabbit Island


Chinaman's Hat
Avrainvillea amadelpha
found in North
Kaneohe Bay 2008

Molokai's surveyed locations, and potential removal sites for *G. salicornia*



Cecile Walsh

Management

- DAR is currently collaborating with the University of Hawaii and The Nature Conservancy to develop strategies for problem areas in the State.
- Managers, using the distribution maps, have focused efforts in Kaneohe and Maunalua Bays, and are planning new efforts of control.
- New methods include:
  - Mechanical removal
  - Protection of key herbivous species
  - Out planting & restoration of native species
  - Nutrient/runoff improvement

Cleanup Evolution

Community-based volunteer clean ups

Super Sucker

Super Sucker Junior

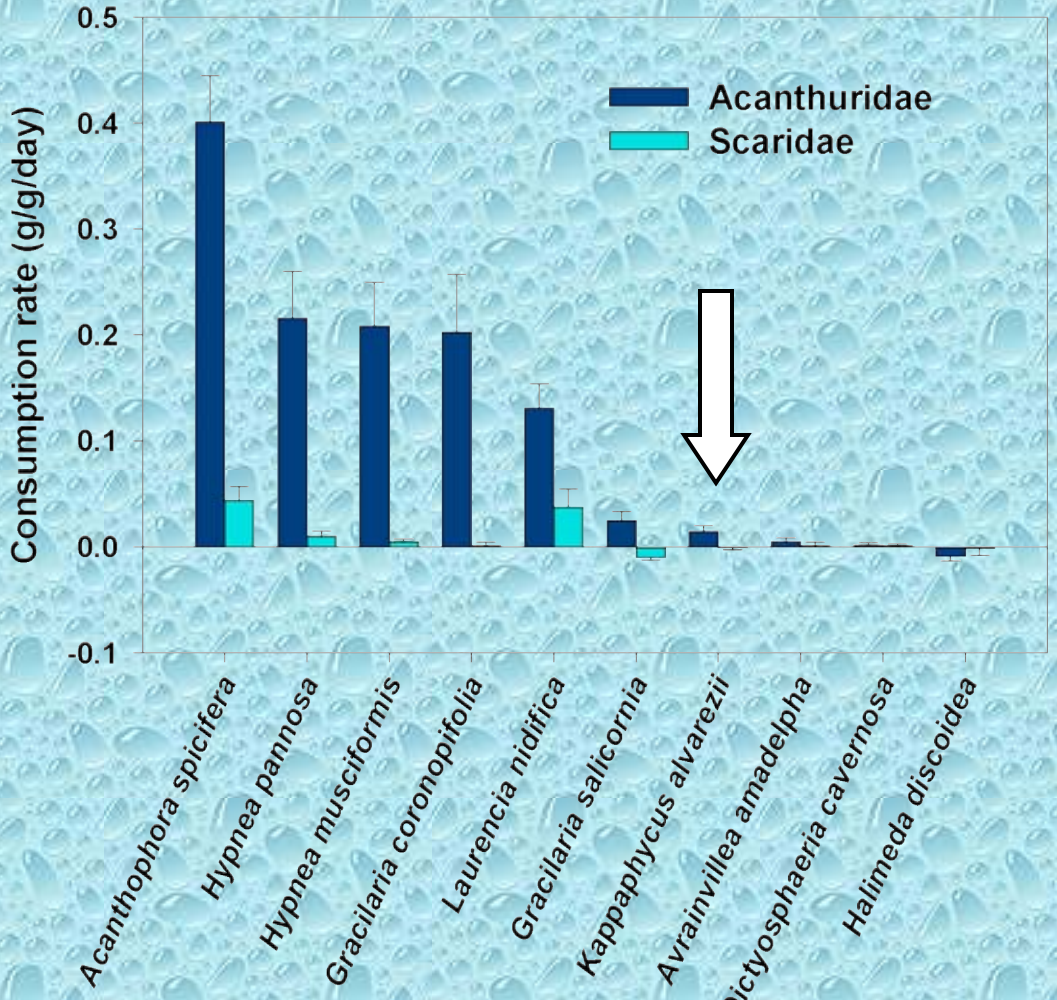

SST

Grazing Preferences

Jennifer Smith
Botany Dept.,
UH Manoa







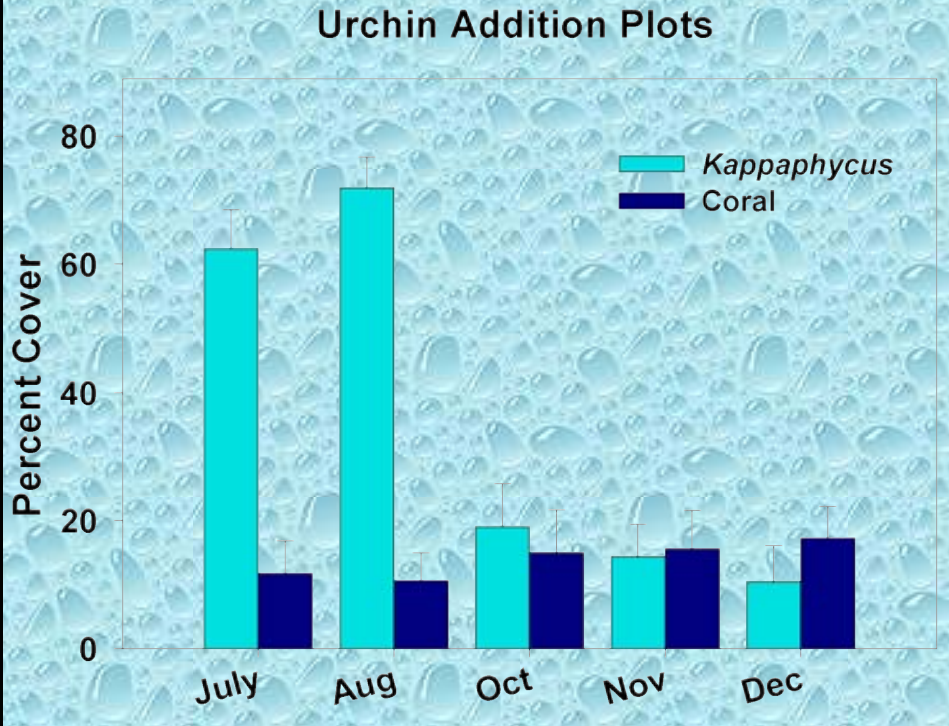
- Methods:
  - Preference tests conducted at HIMB
  - Outdoor flowing seawater
  - Two runs, n=20
  - Total of 8 species of common herbivorous fish tested
  - 24 hour trials
- Results:
  - *Kappaphycus* not preferred

Jennifer Smith
Botany Dept.,
UH Manoa

Management

Biocontrol: Tripneustes gratilla

- Methods:
  - Added *T. gratilla* to ¼ m^2 plots, n=3 per reef
  - Photoquadrats monitored monthly
- Results:
  - Significant reduction in *Eucheuma*



Conclusion

- **Alien species' distributions & borders are essential for determining further algal management strategies**
- Tools like the Super Sucker barges are part of a pilot project with a larger strategy to include:
  - Rearing and introduction of alien algae-eating native sea urchins
  - Enhancement of native herbivory
  - Out planting & restoration of native species to re-populate the reef
  - Decrease nutrient & sediment runoff
  - Community-based volunteer clean ups

Acknowledgements

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Research, Data & Photos courtesy of: Cecile Walsh, Cathy Gewecke, Celia Smith, Jennifer Smith, Kim Peyton, Erik Conklin, Anthony Montgomery, Larry Basch

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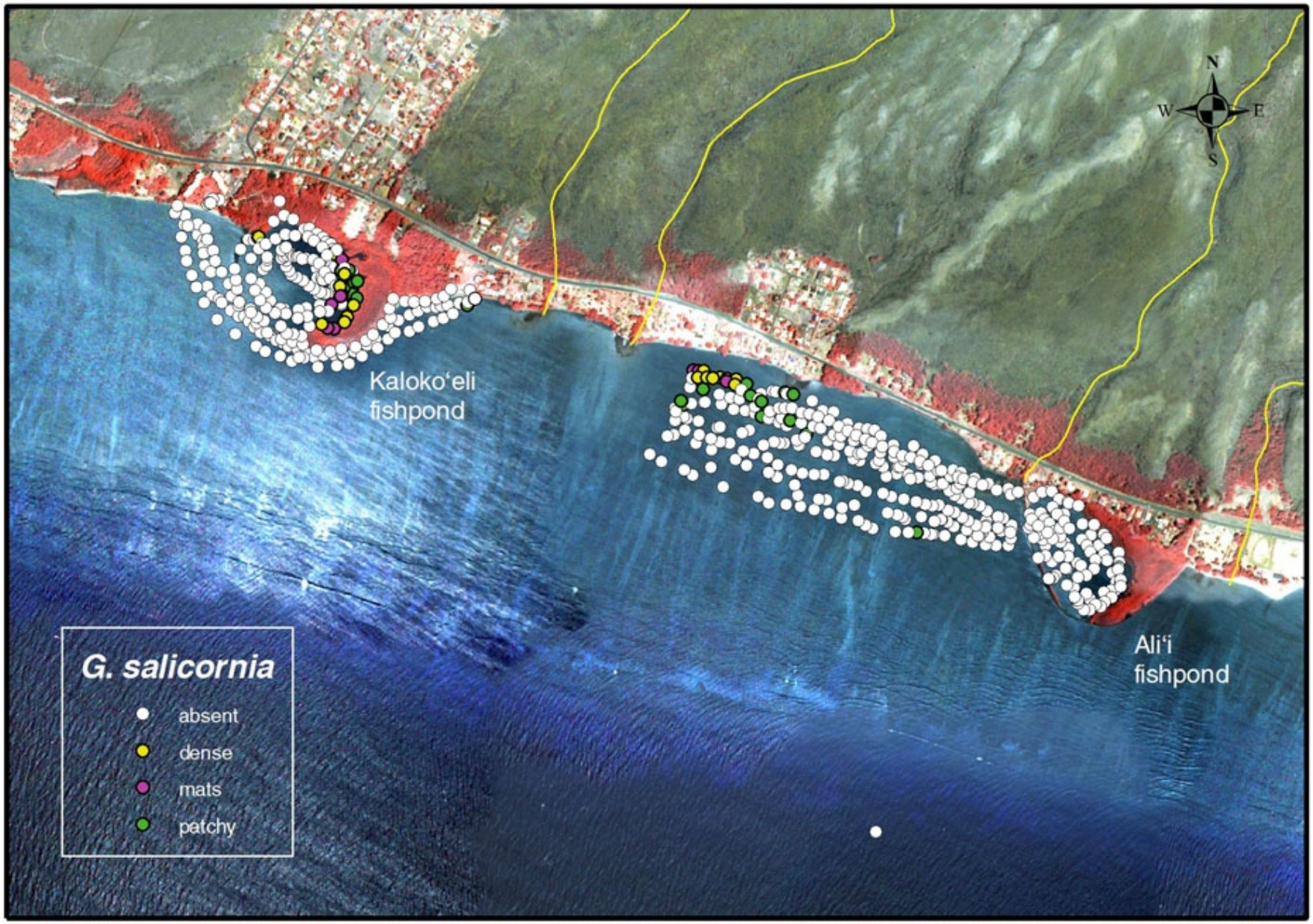

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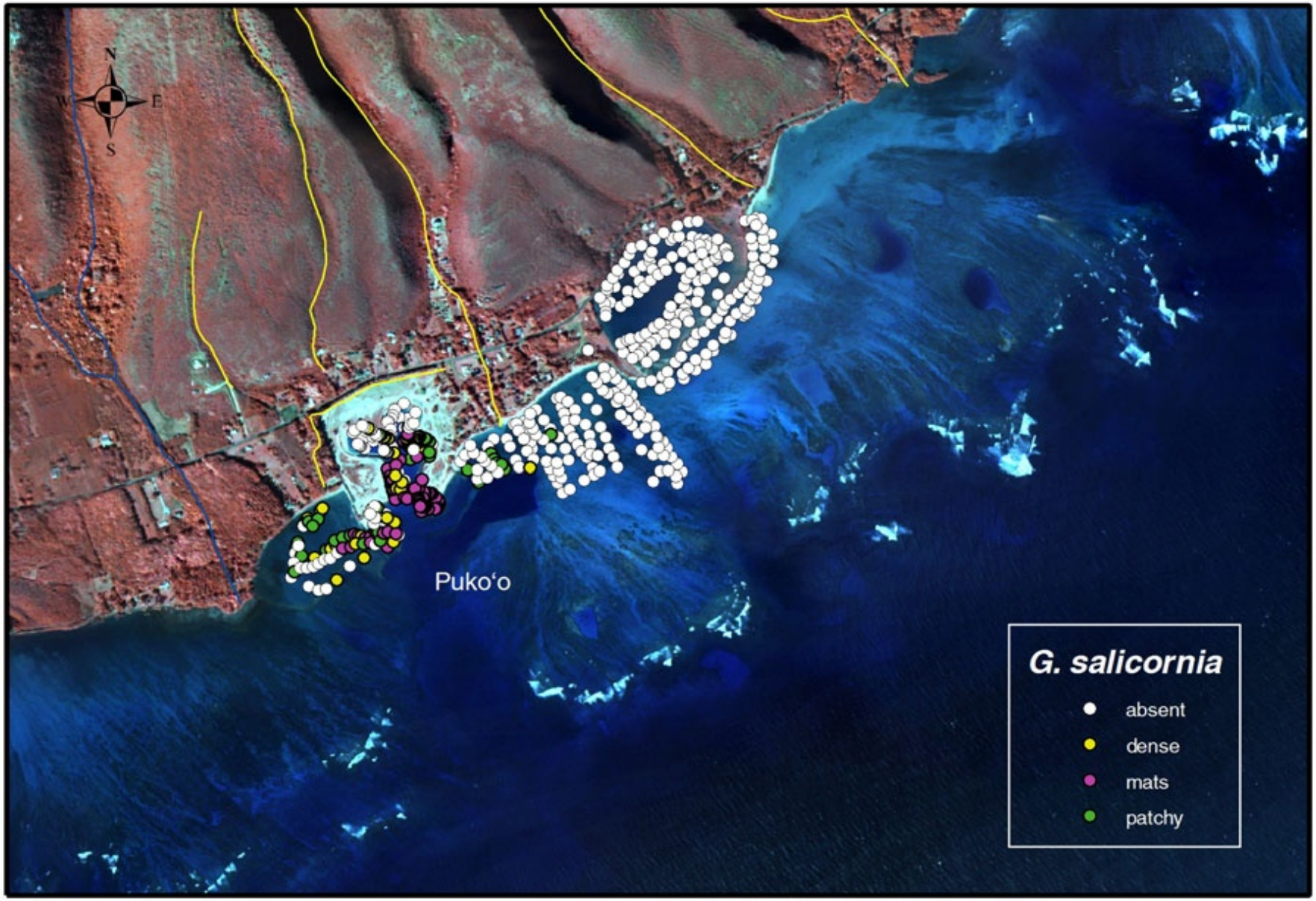

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Corridor