A SITE SUITABILITY FRAMEWORK FOR AQUACULTURE IN OFFSHORE ZONES; THE CASE OF *MOI* (*POLYDACTYLUS SEXFILIS*) ON O'AHU

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Topics

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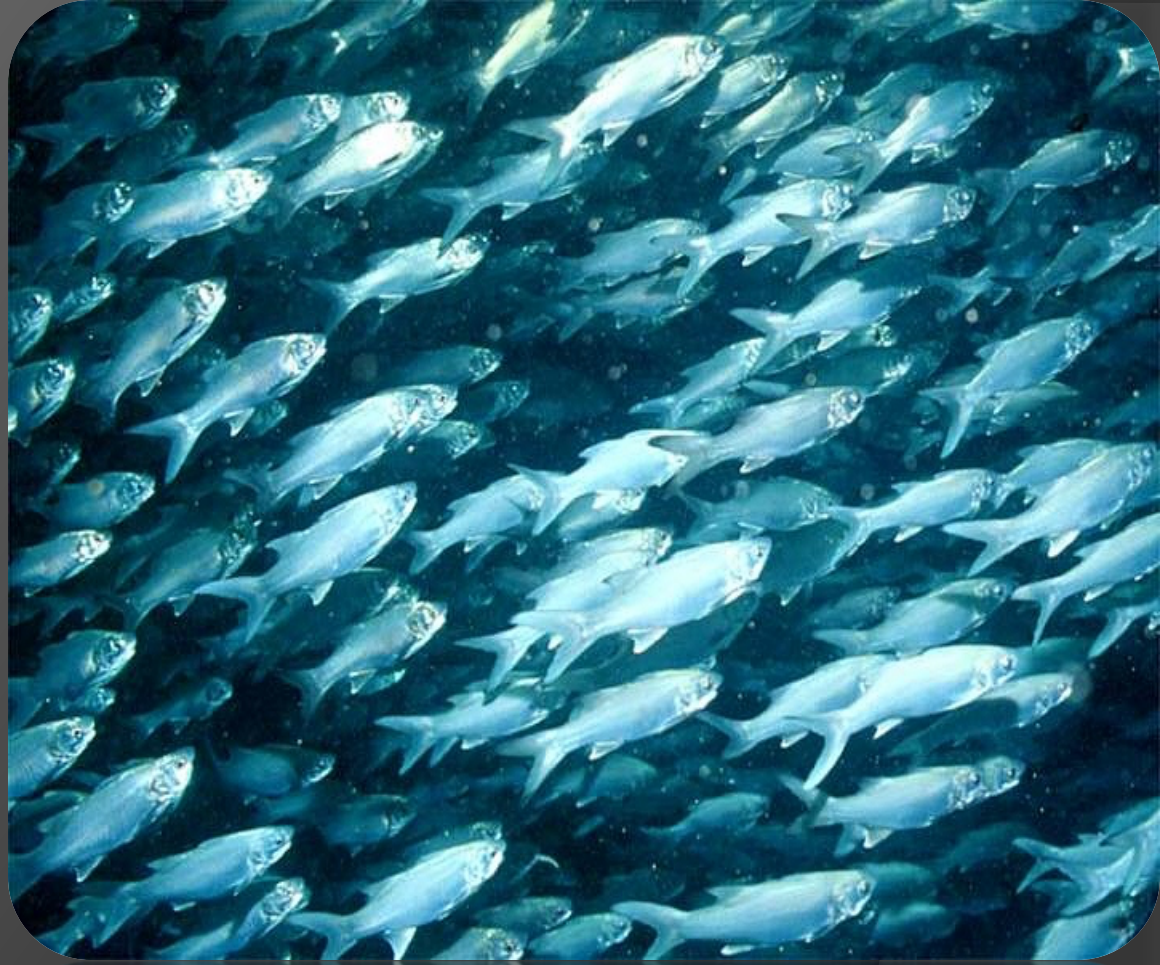
  - Problem
  - *Moi*
  - *History*
  - Offshore
  - Selection v Suitability
  - Objective
- Models
  - Basic
  - Environmental
  - Economic
  - Social
  - Combined
- Conclusions
- Questions?

Introduction



Statement of Problem

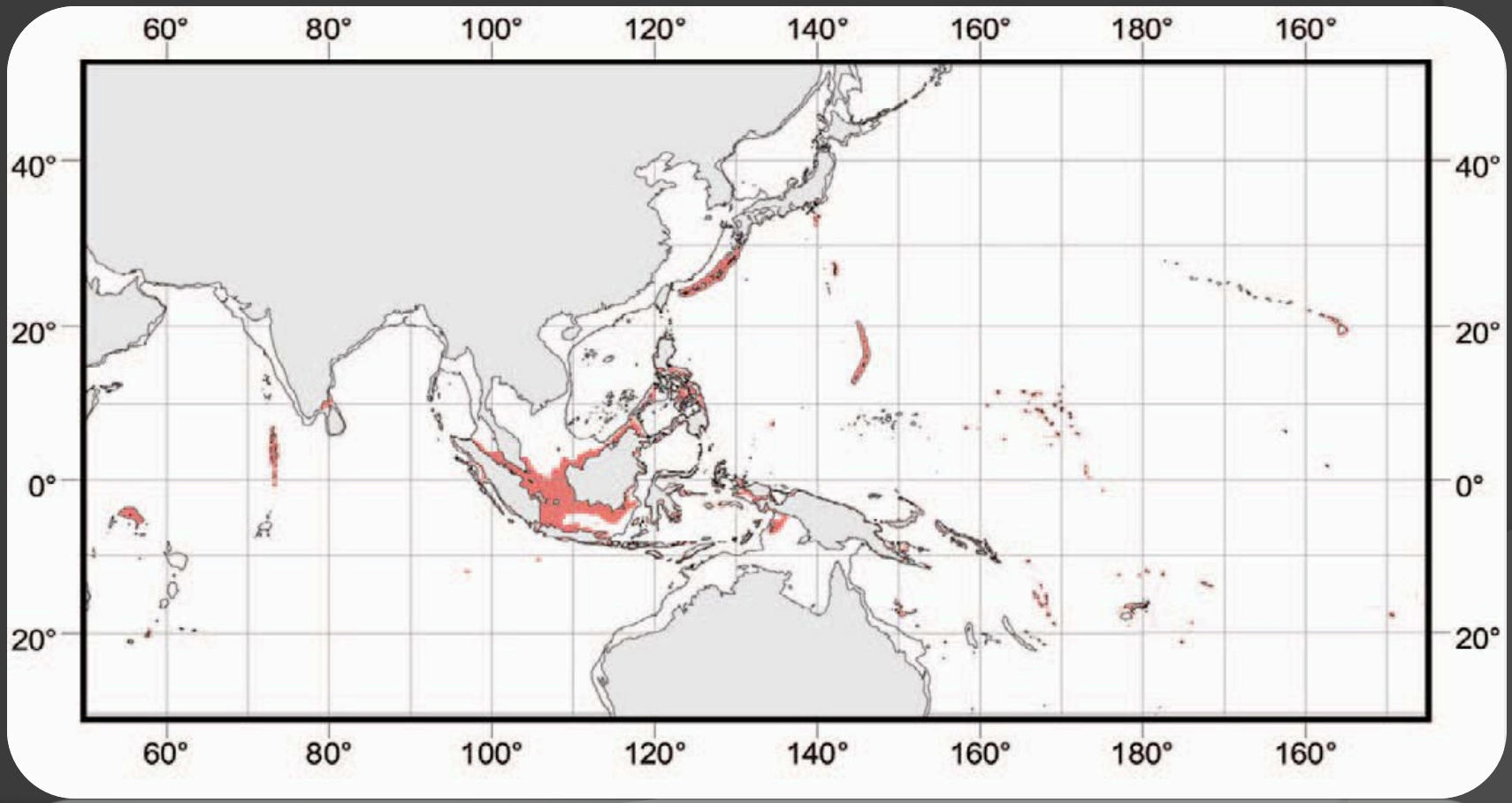
- Siting issues worldwide & Hawai‘i
  - Environmental, cultural issues, economics
- Goal:
  - Bridge environmental, social, and economic
  - Increase aquaculture production
    - Lessen demand on wild stocks
- How?
  - Simple Multi-Criteria Decision Making Model

Why *Moi*?

- Long history
- Markets
  - Local
  - Export
  - Stock enhancement
- Native species

Species Limitations

- *Moi* schooling species turbulent coastal waters, prefer sandy or rocky bottoms, up to 50 meters



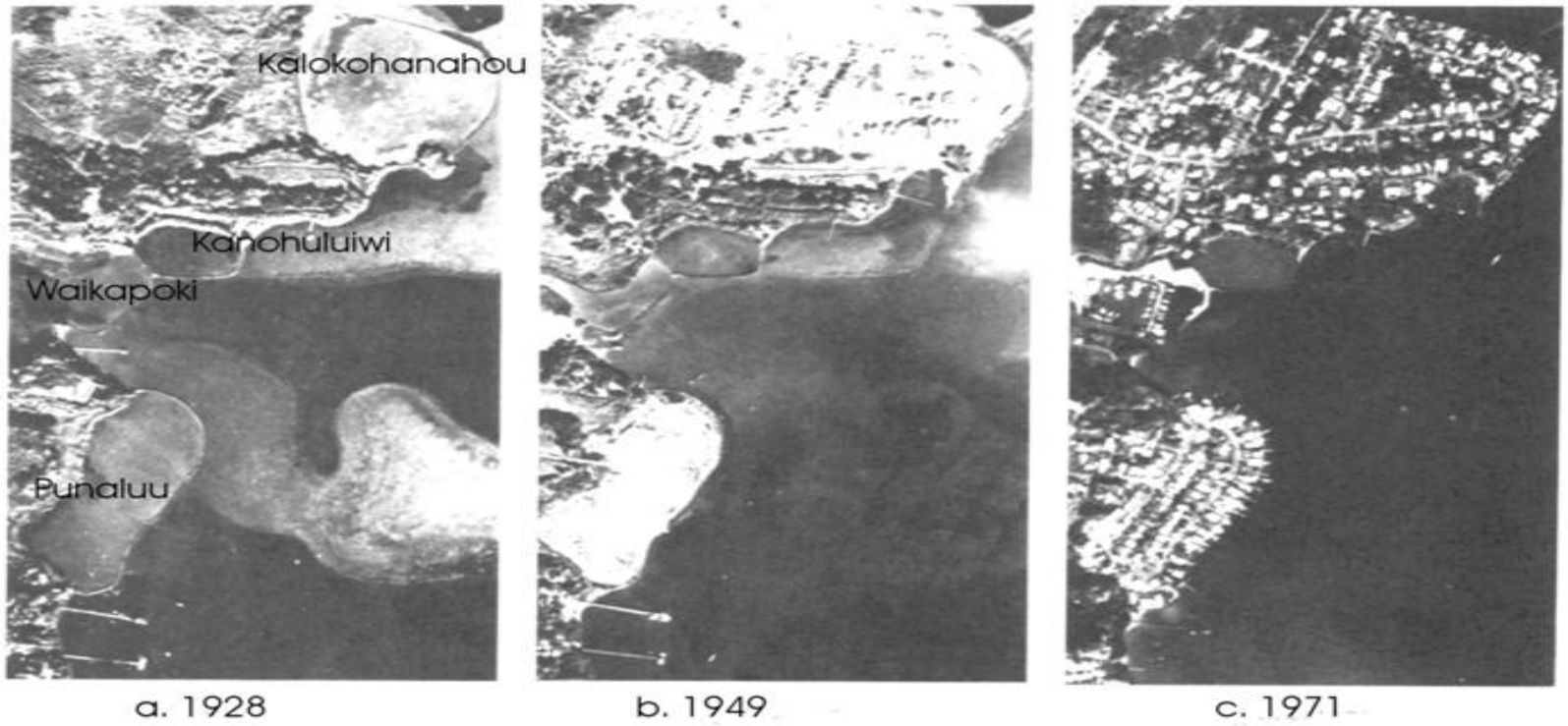
A Bit of History

Hawaiian Aquaculture

- Practiced extensive & semi-intensive aquaculture
- 488 total ponds ID on 6 main Hawaiian Islands
  - O‘ahu and Hawai‘i had most (178 and 138 ponds)
- Historical estimates in 1800
  - 350 ponds operating
    - >1.5 millions #s

Why Offshore?

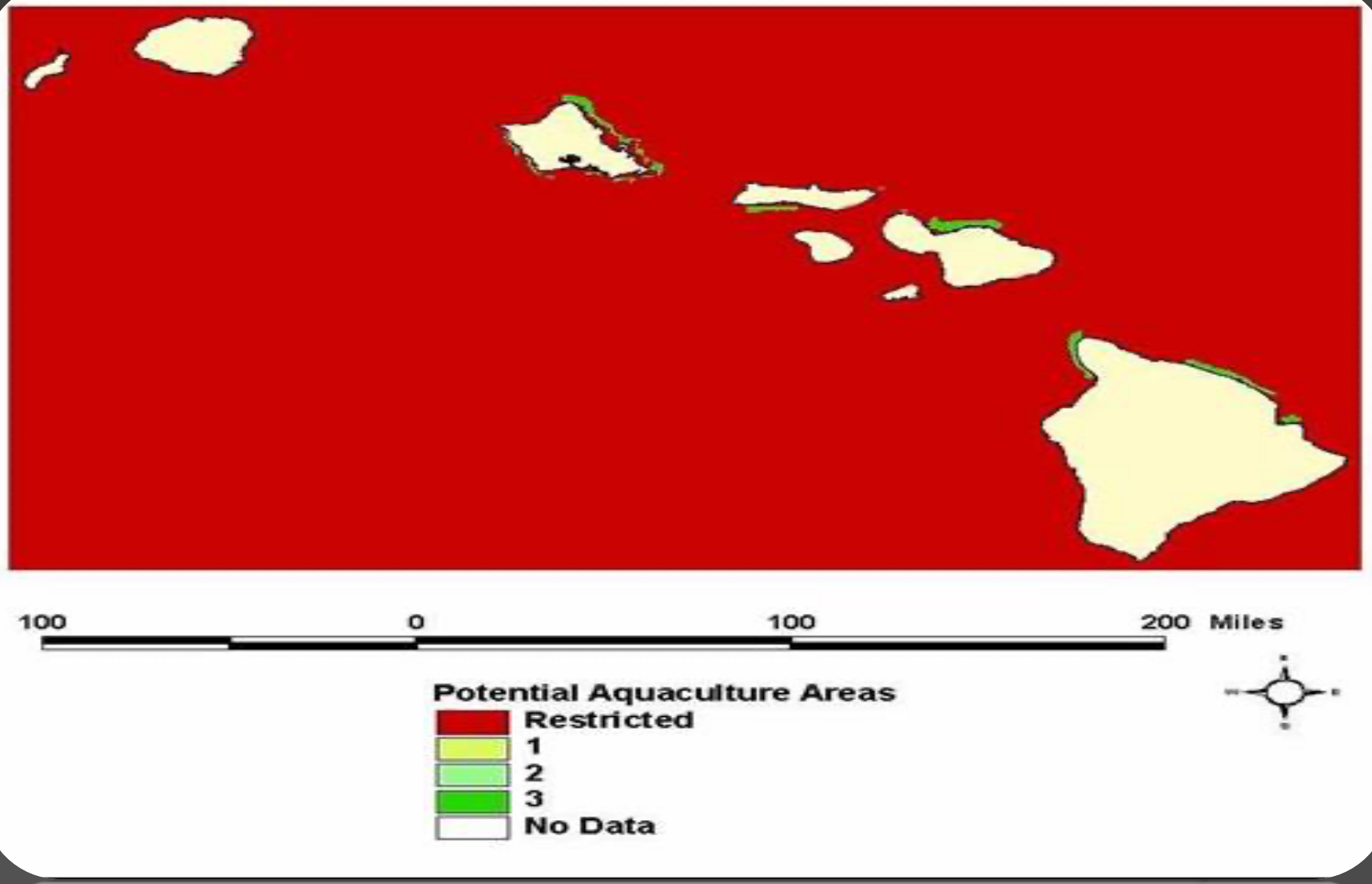
- 1990, 6 ponds: 31,639 pounds/year



GIS in Aquaculture

- 2003, Young et al in Hawai‘i
  - Examined: bathymetry, restricted, water classifications, 3-mile boundary
  - ID minimal conflicting sites
    - High
    - Marginal
    - No potential for aquaculture

GIS in Aquaculture



Selection VS Suitability

- Matter of scale
  - Selection:
    - ID specific spot where to place farm
    - Local
    - Well studied, data rich environments
  - Suitability
    - ID general areas that may be possible (planning, environmental management)
    - Regional
    - National level models (LENKA), rely on statutes and laws as well as science

Objectives

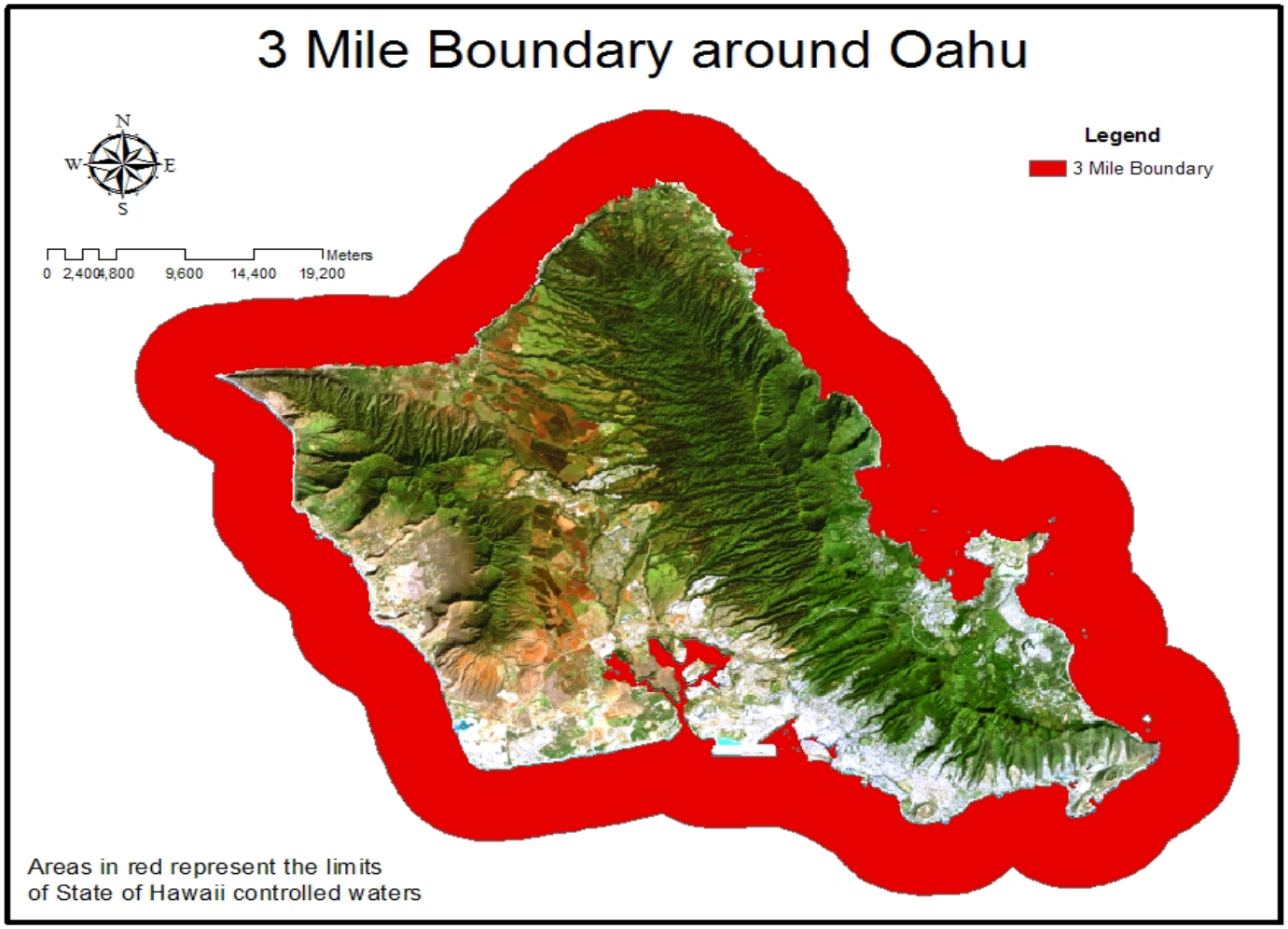
- Create a minimal data-set framework based on publically available data
  - Identifying suitable areas for further detailed research (adapted from FAO)
    - Most Suitable
    - Moderately Suitable
    - Least Suitable
- Transferable with low overhead cost
  - Home computer with moderate specs and ArcGIS software
  - Free /low-cost information

The Model Components

Model Components

- Basic & Military Constraints:
  - Areas incompatible with offshore cages
- 3 broad criteria
  - Environment
  - Economics
  - Social -scenarios
- WLC
  - Environment + Economic

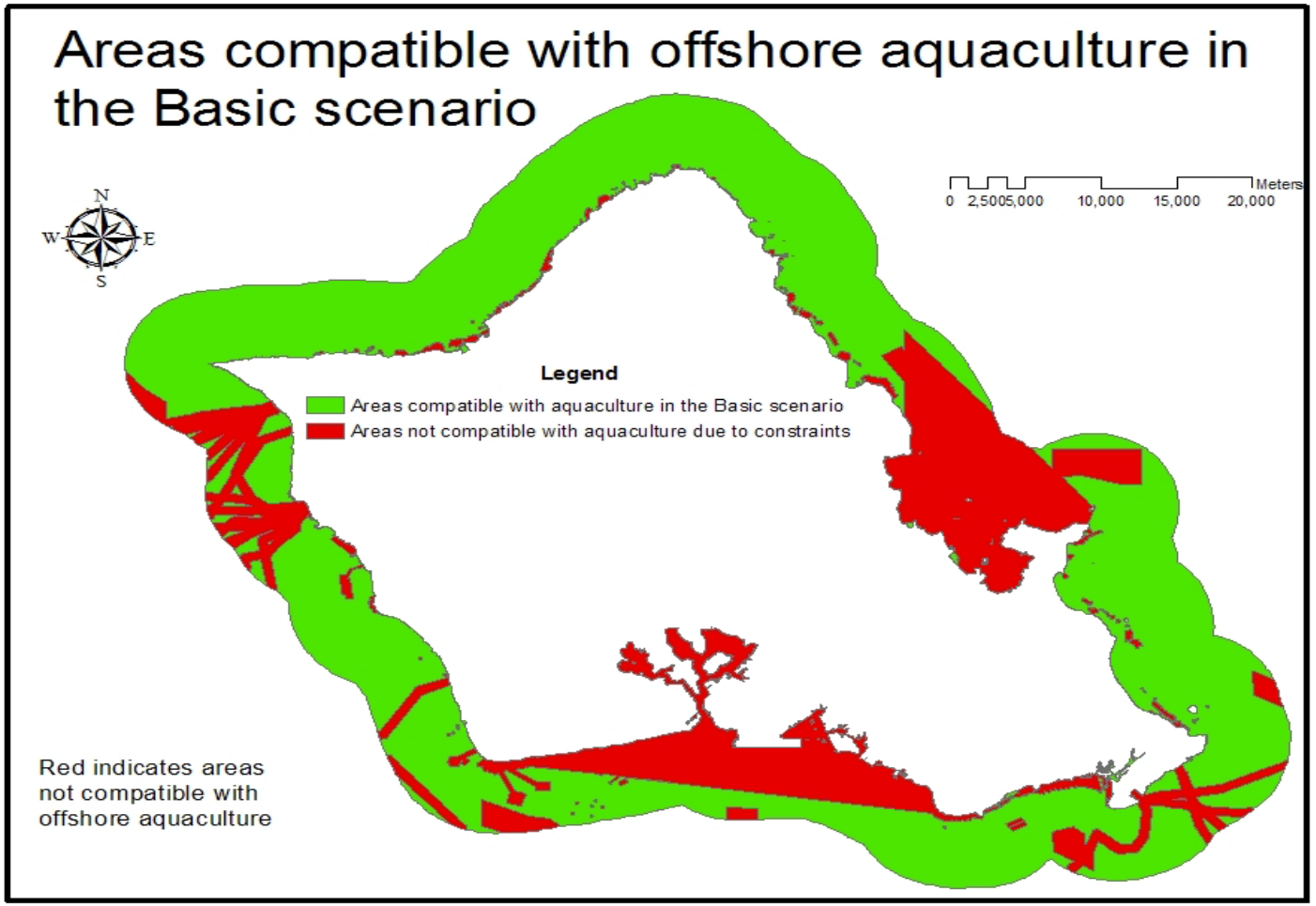
Limitations



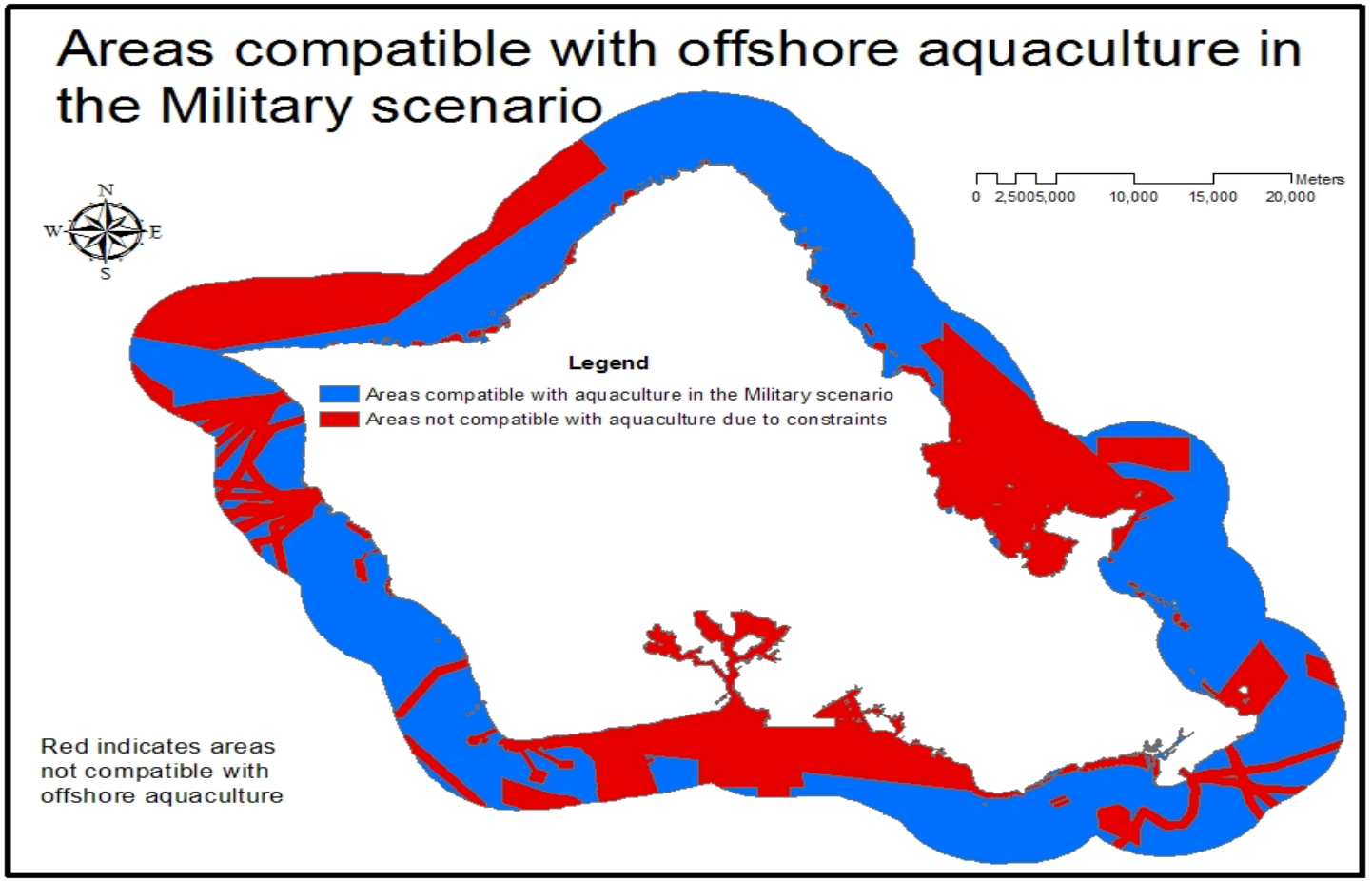
Basic Map Contents

- Anything that can conflict (the kitchen sink approach)
  - If point data, created buffer
  - Buffers based on published data (some layers no buffer)
    - Wrecks assumed average was 30m
- Has to be detailed as possible
  - Offshore farms have exclusive use zones

Basic


Areas compatible with offshore aquaculture in the Basic scenario
N
W
E
S
0 2,5005,000 10,000 15,000 20,000
Meters
Legend
Areas compatible with aquaculture in the Basic scenario
Areas not compatible with aquaculture due to constraints
Red indicates areas not compatible with offshore aquaculture

Military


Areas compatible with offshore aquaculture in the Military scenario
N
W
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0 2,5005,000 10,000 15,000 20,000
Meters
Legend
Areas compatible with aquaculture in the Military scenario
Areas not compatible with aquaculture due to constraints
Red indicates areas not compatible with offshore aquaculture

Area

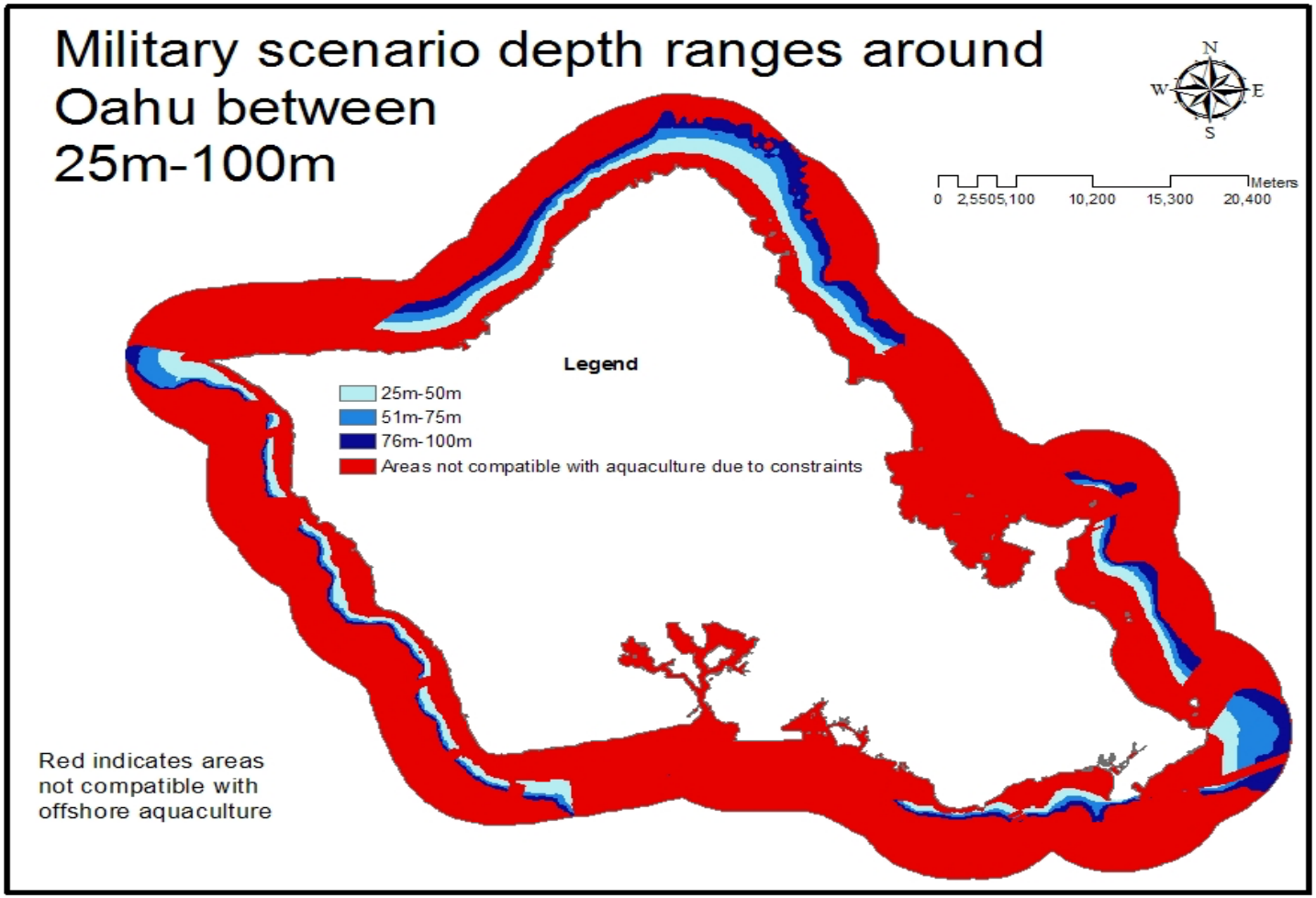
Layer	Size (m^2)	%
O‘ahu Full Extent	1,310,550,784	100
Basic	924,000,191	70.5
Military	769,486,606	58.7

Environmental

Environmental

- Based on publications and existing site suitability models
  - Basic and near-ubiquitous trait: Bathymetry
    - Missing data interpolate using Natural Neighbor
- 3 classifications
  - 25m-50m
  - 51m-75m
  - 76m-100m

Bathymetry Military

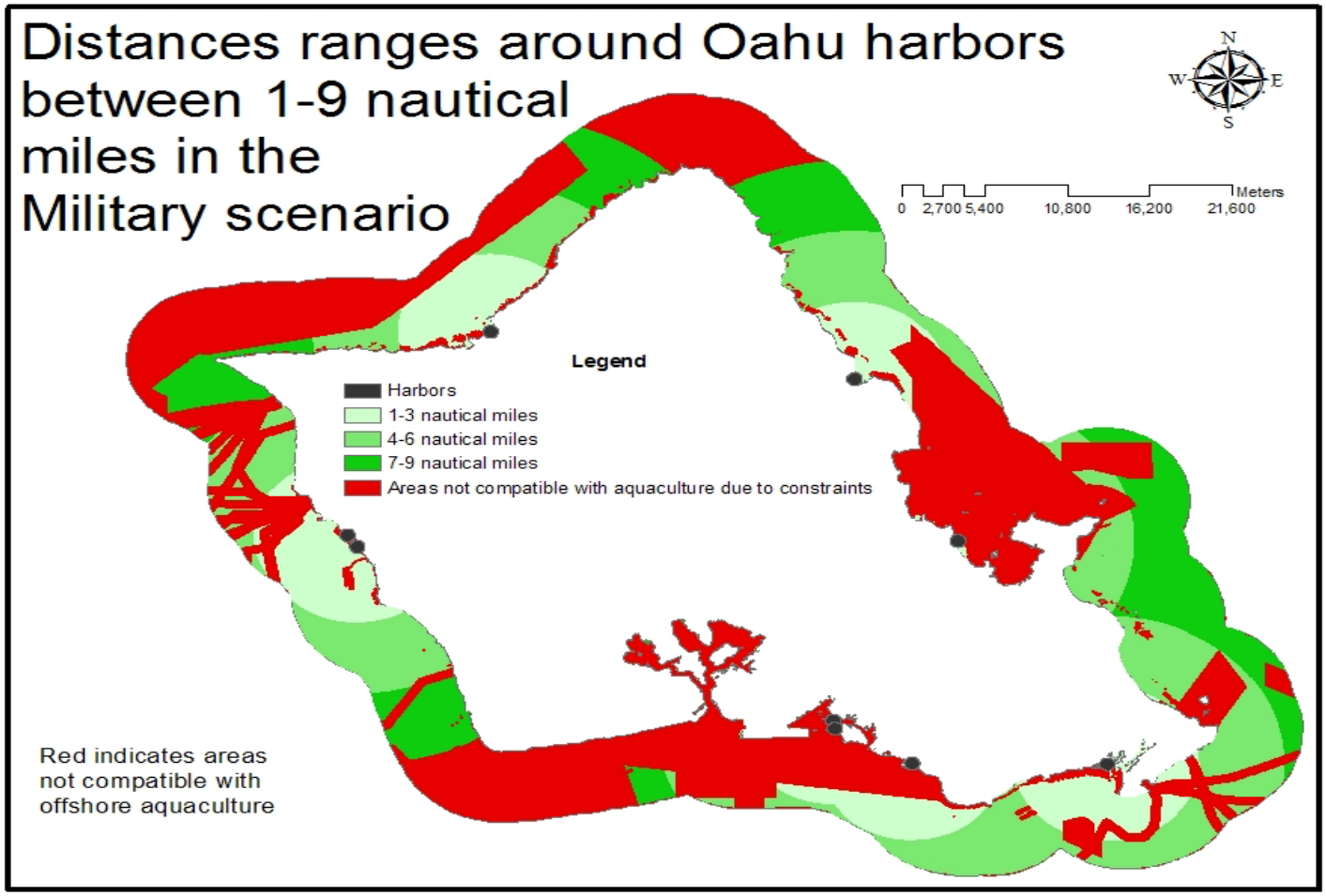


Economics

Economics

- Any harbor with reasonable area around it can be used
  - Storage space for feed maintenance equipment
- Why only distance from harbor?
- 3 classifications
  - 9 knots typical ship
  - 1-3 nautical miles
  - 4-6 nautical miles
  - 7-9 nautical miles

Economics Military



Social

Ocean Recreation

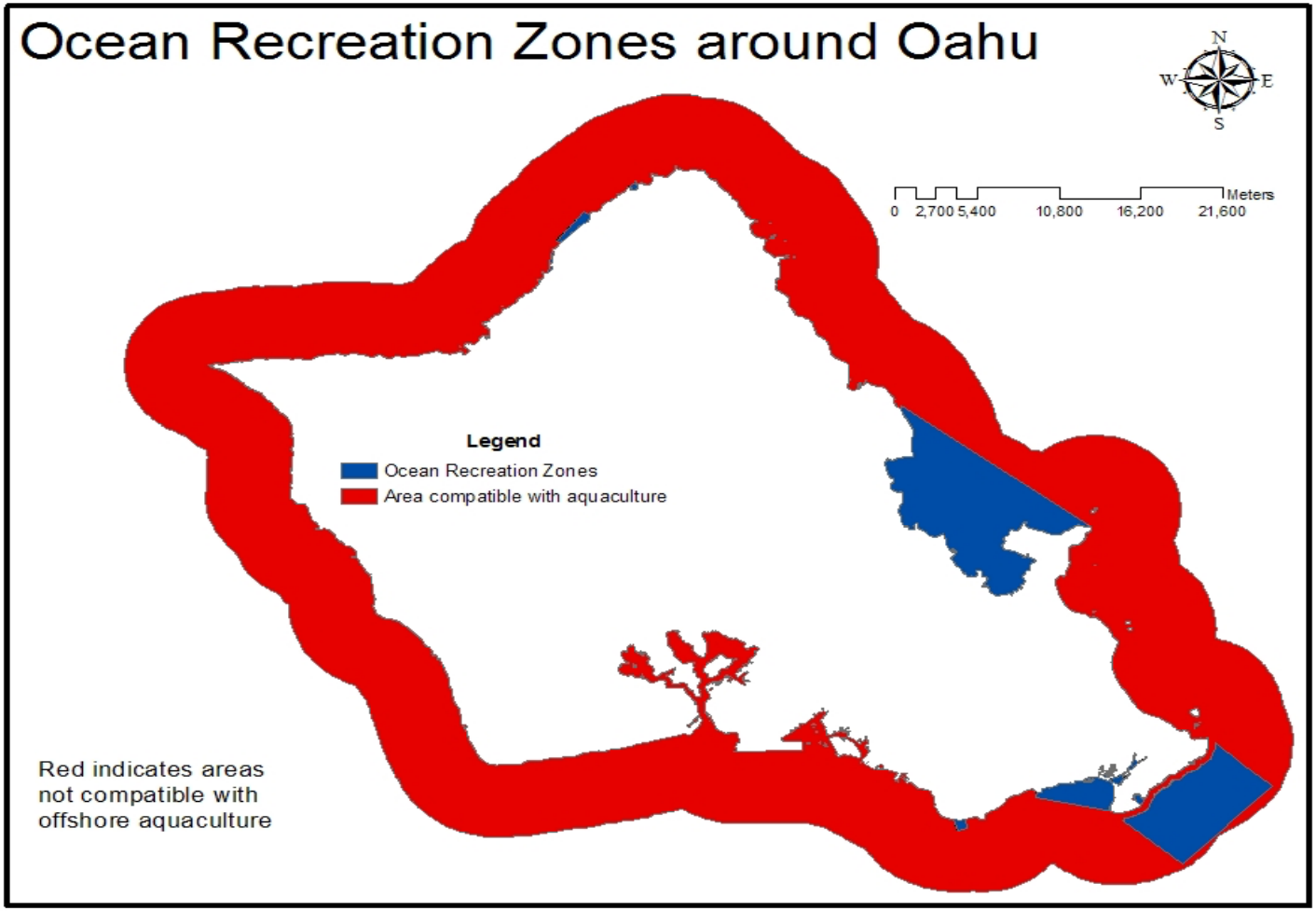
&

Konohiki

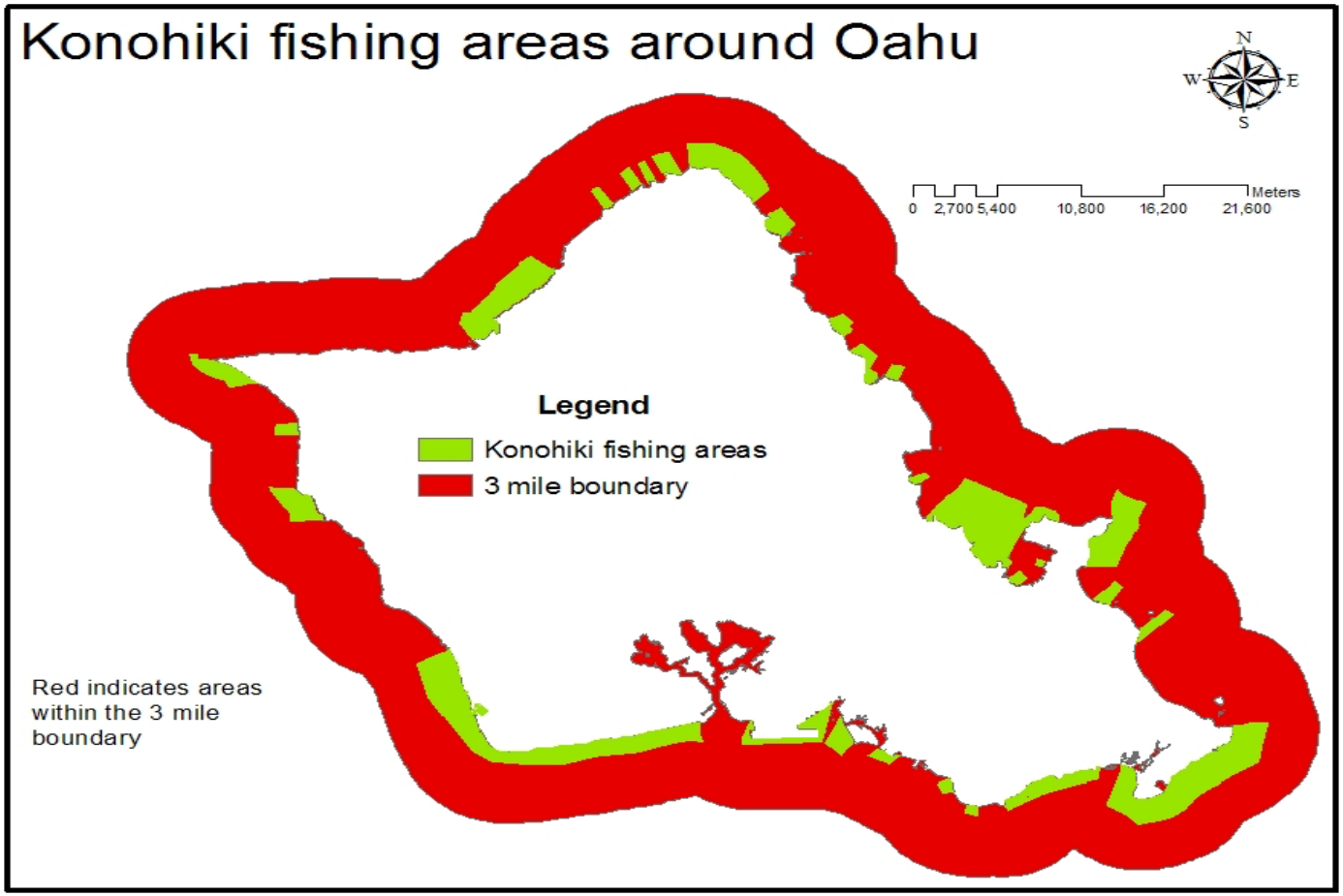
Social

- Modern use
  - Ocean Recreation Zone
    - Based on DLNR regulations
- Traditional use
  - Konohiki fishing area associated with Ahupua‘a
    - Historically important
    - Proxy for cultural uses

Ocean Recreation



Konohiki

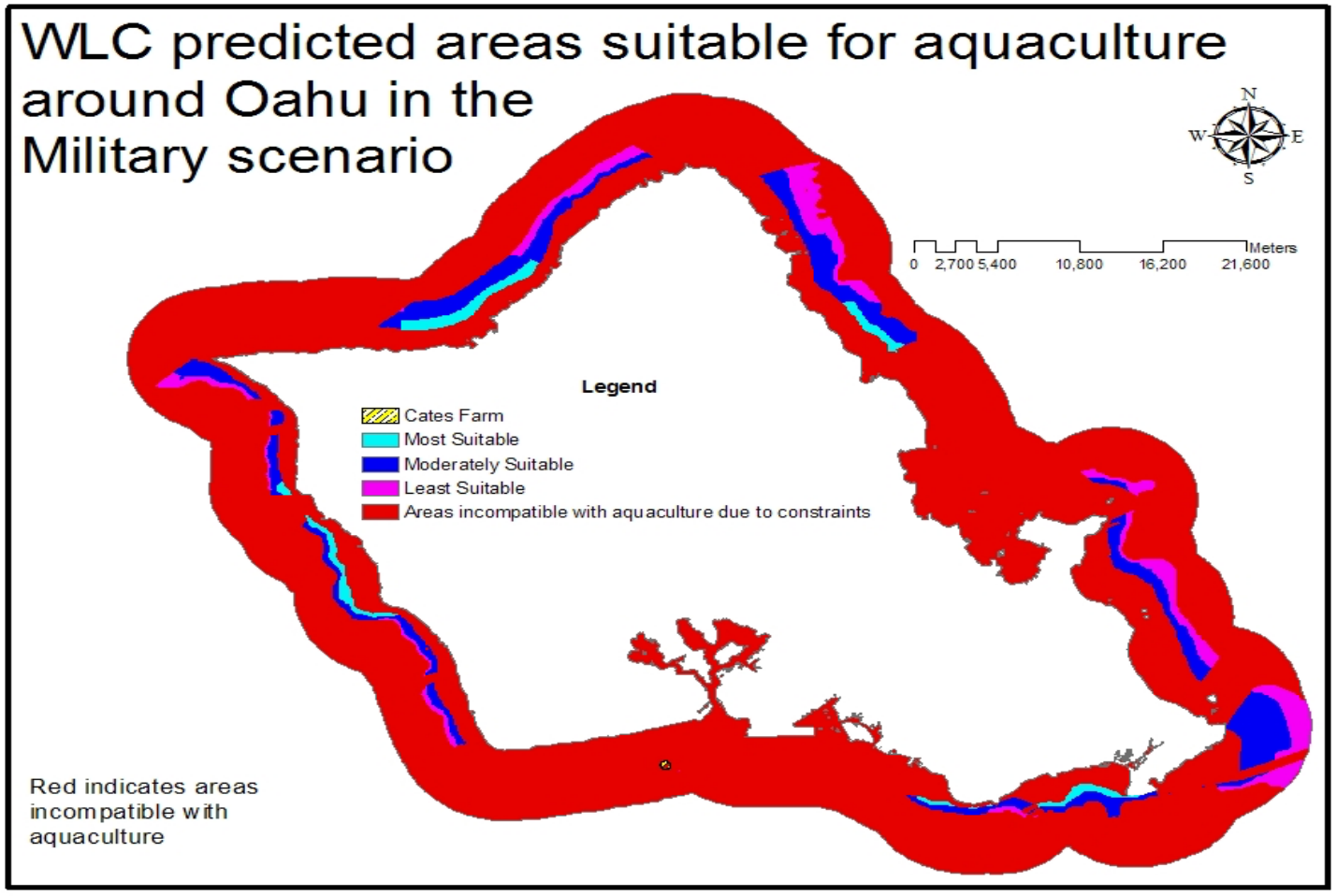

Konohiki fishing areas around Oahu
N
W
E
S
0 2,700 5,400 10,800 16,200 21,600
Meters
Legend
Konohiki fishing areas
3 mile boundary
Red indicates areas within the 3 mile boundary

COMBINED

Combined

- Run WLC of Environment & Economics, equal weight, within the Social dataset
- Combination of Ocean Recreation and Konohiki Fishing areas:
  - All Ocean recreation and k*onohiki* Fishing areas are available
  - No Ocean Recreation or k*onohiki* fishing areas are available for exclusive lease,
  - Only Ocean recreation zones but no k*onohiki* fishing areas are available for exclusive use
  - Only k*onohiki* fishing areas but no Ocean Recreation Zones

WLC Military

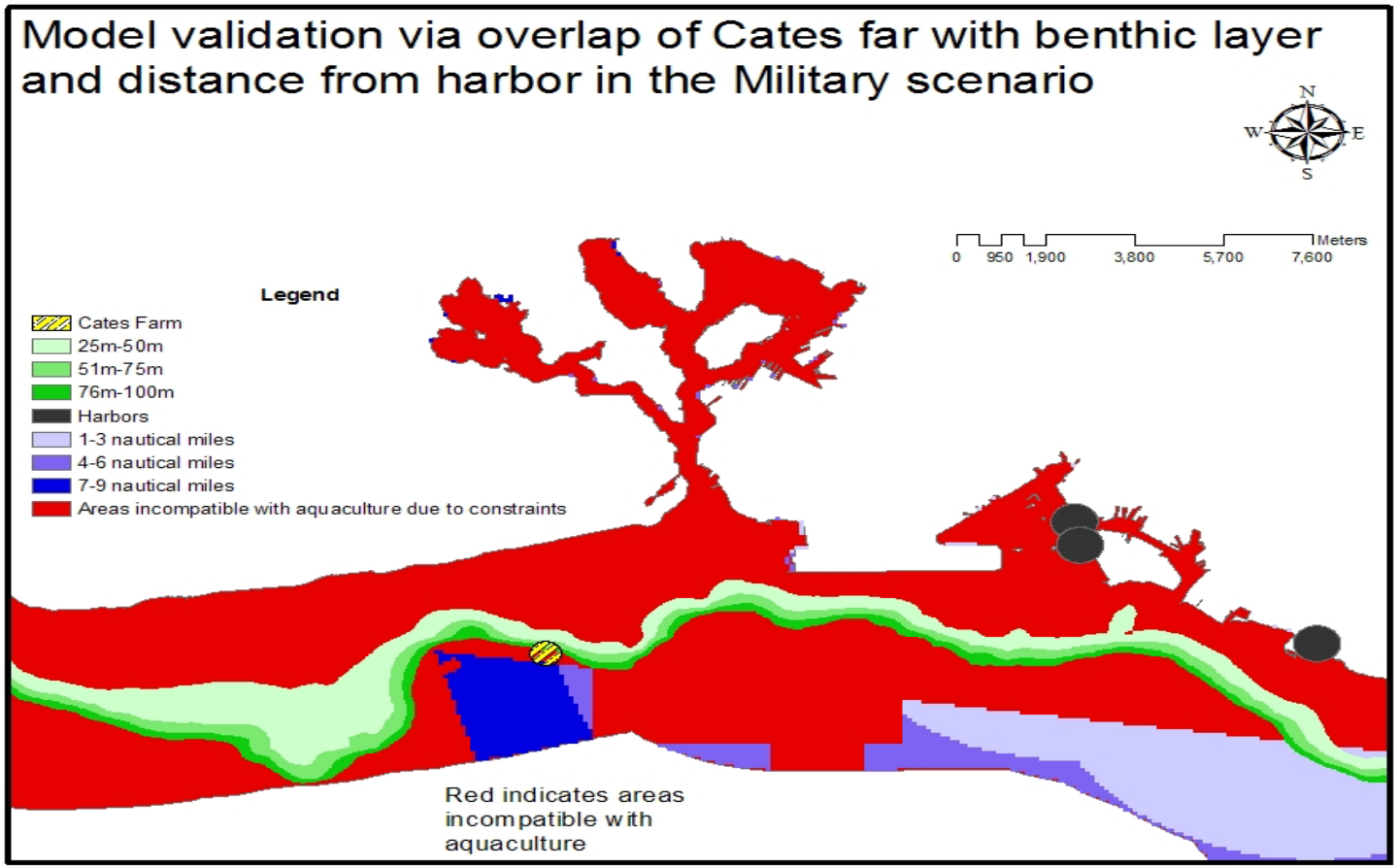


WLC Sizes

WLC Prediction	Full Extent Size (ha)	Basic Size (ha)	Military Size (ha)
Most Suitable	3,304	2,020	2,020
Moderately Suitable	15,430	11,547	9,532
Least Suitable	8,159	6,643	5,231
Total	26,893	20,210	16,783

Discussions & Conclusions

Validation


Model validation via overlap of Cates far with benthic layer and distance from harbor in the Military scenario
N
W
E
S
0 950 1,900 3,800 5,700 7,600
Meters
Legend
Cates Farm
25m-50m
51m-75m
76m-100m
Harbors
1-3 nautical miles
4-6 nautical miles
7-9 nautical miles
Areas incompatible with aquaculture due to constraints
Red indicates areas incompatible with aquaculture

Discussion

- Results comparison to ADP Phase 1
  - Problematic at best
  - Low resolution state-wide map, no details or quantifiable numbers (Phase 2 never completed)
- Results comparison to other regional scaled models
  - Incorporates similar information
    - New to the Pacific Islands

Conclusions

- Importance of suitability
- Proper siting
  - Saves:
    - Time
    - $ (governments, and businesses)
  - Eases growing pains in new markets
    - Local community support
- Few places around O‘ahu possible for expansion
  - State focus on Maui which is equally problematic
- Structure of model functions:
  - Cates operation within acceptable area

Conclusions

- Needed for next phase (Site Selection)
  - AHP based WLC with more detailed information
    - Information allows for alteration of weights
  - More accurate bathymetry
  - Currents
  - Waves
  - Temperature
  - Turbidity
  - Tides
  - More detailed infrastructure

Conclusions

- Transferability
  - Framework applicable for majority of Pacific Islands / Tropical Coastal regions
    - Open source data (nautical charts)
      - Minimal financial commitment
    - Can be adapted to most coastal regions by expanding limitations in Basic layer
  - Identifies suitable areas for further in-depth research to determine specific sites

Questions?

Job Offers?