Spatial Planning and Bio-economic Analysis for Offshore Shrimp Aquaculture in Northwest Mexico

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Program Coordination Office, Office of the Under Secretary

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MONTEREY BAY AQUARIUM

Seafood WATCH

YELLOWFIN TUNA

National Sustainable Seafood Guide
January 2011

BEST CHOICES

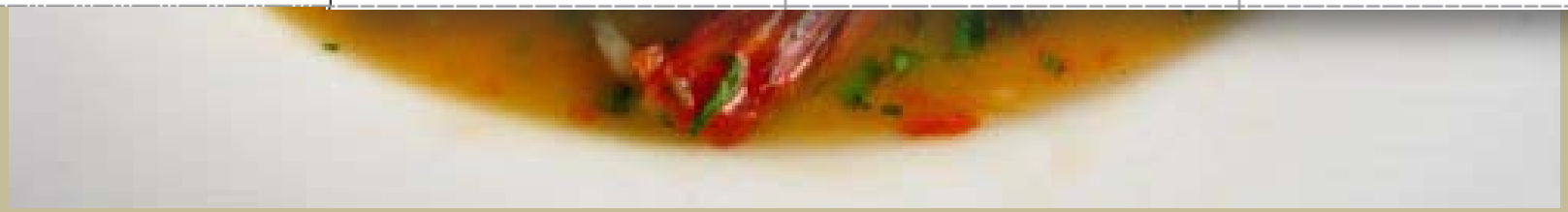
Abalone (US farmed)
Arctic Char (farmed)
Barramundi (US farmed)
Catfish (US farmed)
Clams, Mussels, Oysters (farmed)
Cod: Pacific (US bottom longline)
Crab: Dungeness
Halibut: Pacific (US)
Lobster: Spiny (US)
Rockfish: Black (CA, OR, WA, hook & line)
Sablefish/Black Cod (Alaska, BC)
Salmon (Alaska wild)
Sardines: Pacific (US)
Scallops (farmed off-bottom)
Shrimp: Pink (OR)
Striped Bass (farmed or wild*)
Tilapia (US farmed)
Trout: Rainbow (US farmed)
Tuna: Albacore including canned white tuna (troll/pole, US and BC)
Tuna: Skipjack including canned light tuna (troll/pole)
White Seabass

GOOD ALTERNATIVES

Basa/Pangasius/Swai (farmed)
Caviar, Sturgeon (US farmed)
Clams, Oysters (wild)
Cod: Pacific (US trawled)
Crab: King (US), Snow
Flounders, Sanddabs, Soles (Pacific)
Halibut: California*
Lobster: American/Maine
Mahi Mahi/Dolphinfish (US)
Pollock: Alaska
Rockfish (Alaska or BC, hook & line)
Sablefish/Black Cod (CA, OR, WA)
Salmon (wild, WA* and north of Cape Falcon, OR)
Scallops: Sea
Shrimp (US, Canada)
Spot Prawn (US)
Squid
Swordfish (US)*
Tilapia (Central & South America farmed)
Tuna: Bigeye, Yellowfin (troll/pole)
Tuna: Canned white/Albacore (troll/pole except US and BC)

AVOID

Caviar, Sturgeon* (imported wild)
Chilean Seabass/Toothfish*
Cod: Atlantic and imported Pacific
Cobia (imported farmed)
Crab: King (imported)
Dogfish (US)*
Lobster: Spiny (Brazil)
Mahi Mahi/Dolphinfish (imported)
Marlin: Blue*, Striped*
Monkfish
Orange Roughy*
Rockfish (trawled)
Salmon (farmed, including Atlantic)*
Sharks*
Shrimp (imported)
Swordfish (imported)*
Tilapia (Asia farmed)
Tuna: Albacore, Bigeye, Yellowfin (longline)*
Tuna: Bluefin* and Tongol
Tuna: Canned (except troll/pole)*



Shrimp Trawling

Land-Based Aquaculture

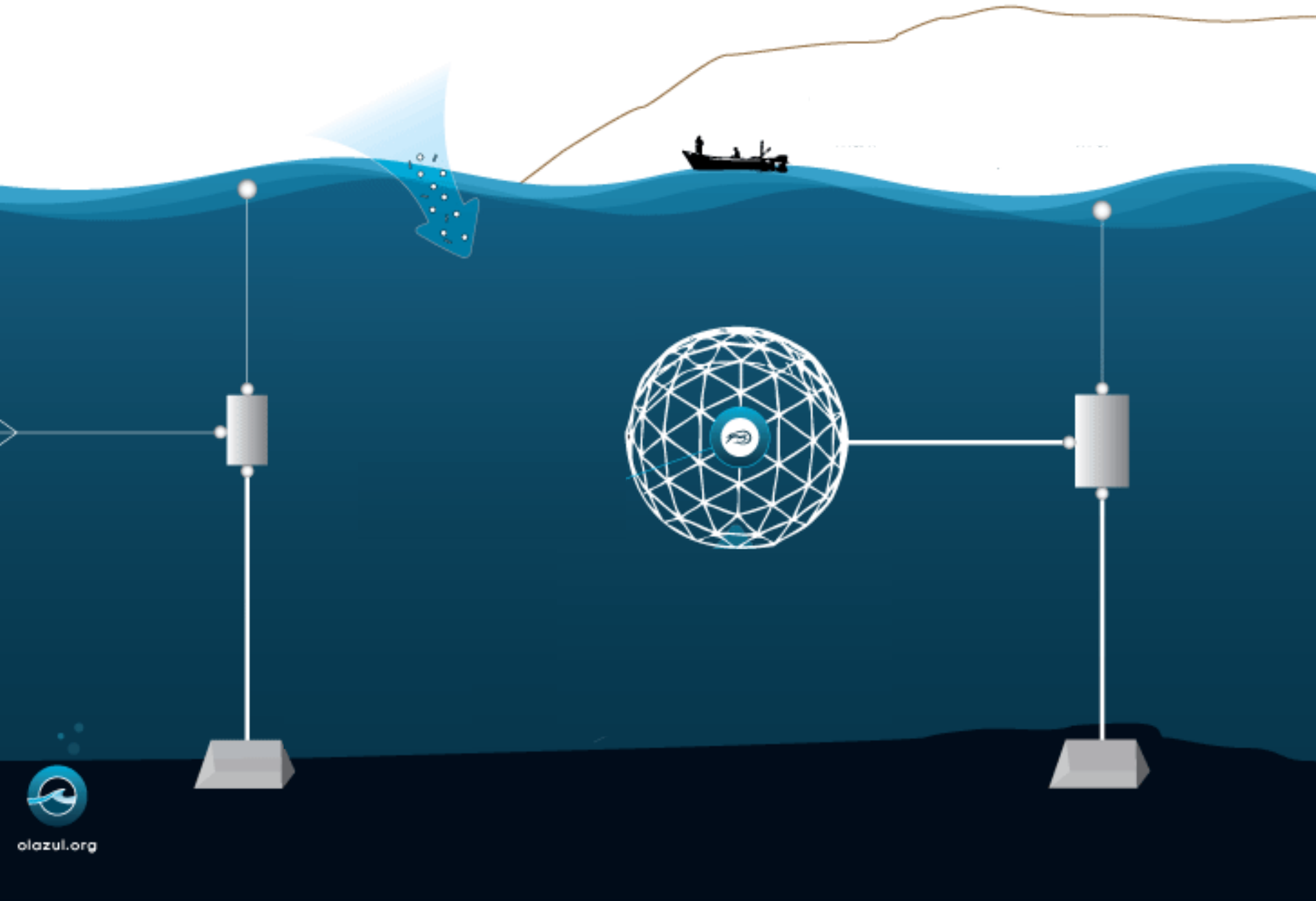
Environmental and social problems are closely linked

OLAZUL

A WAVE OF POSITIVE CHANGE

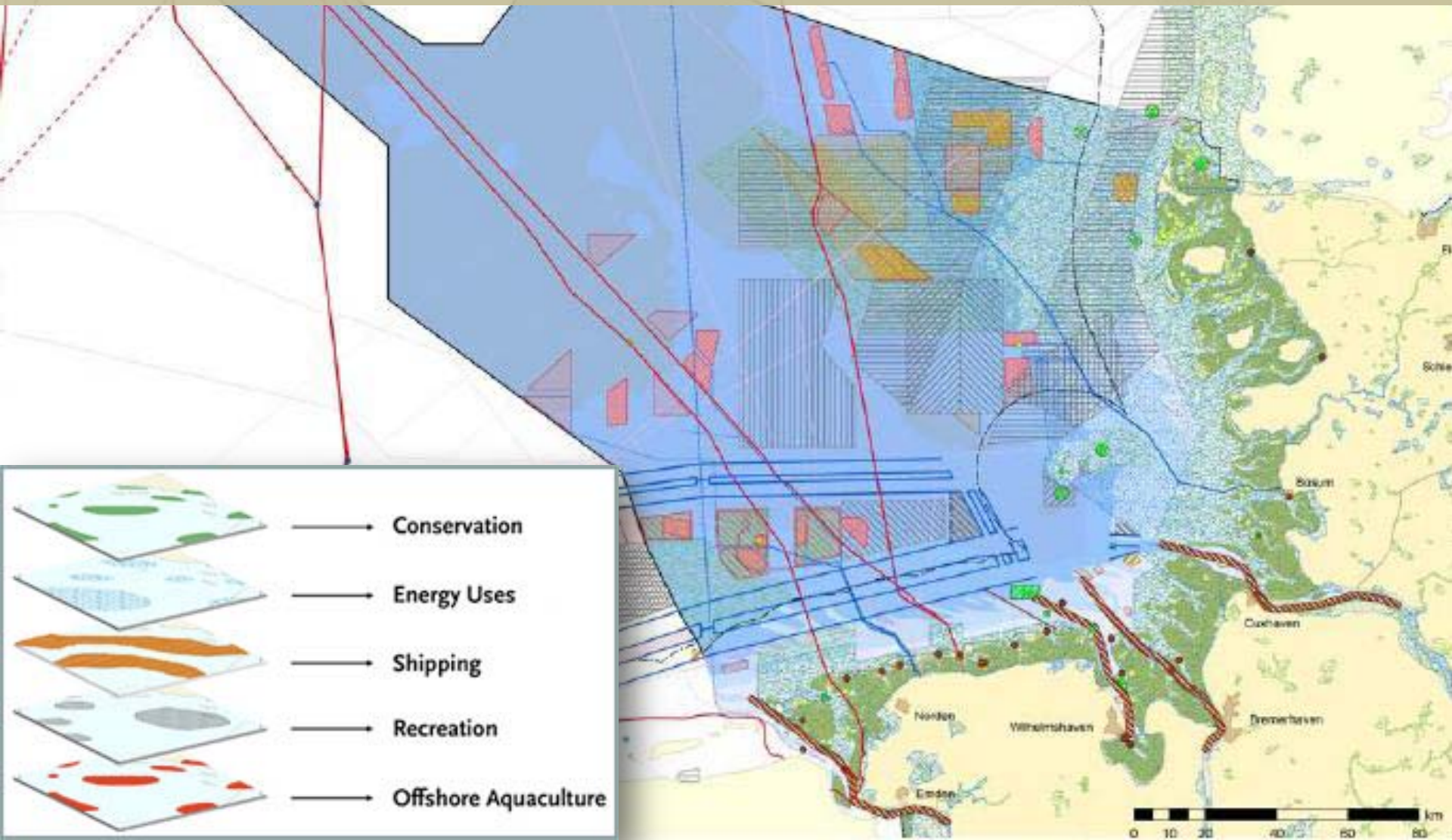
www.olazul.org

olazul: 21st century ecological aquaculture

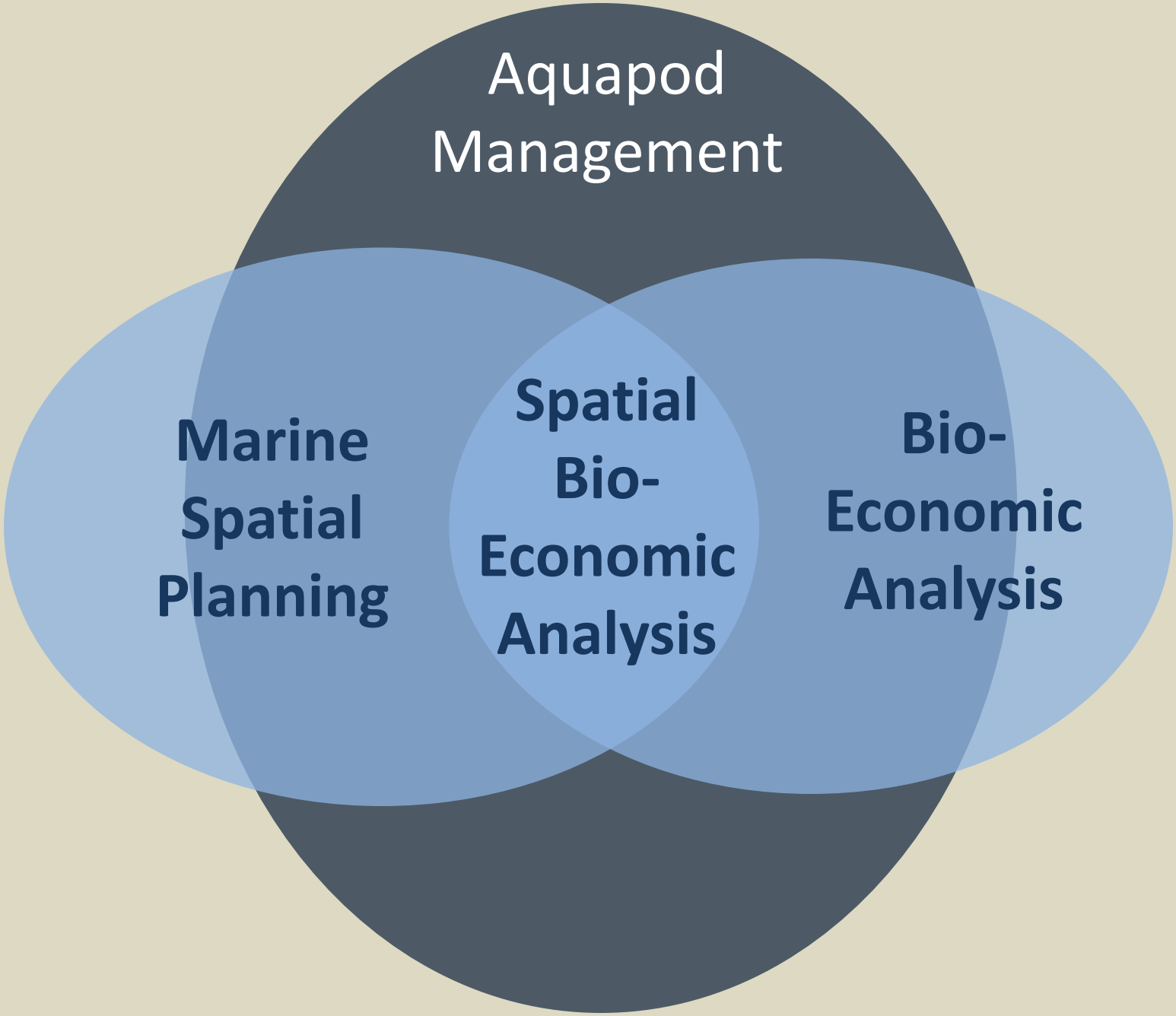


olazul.org

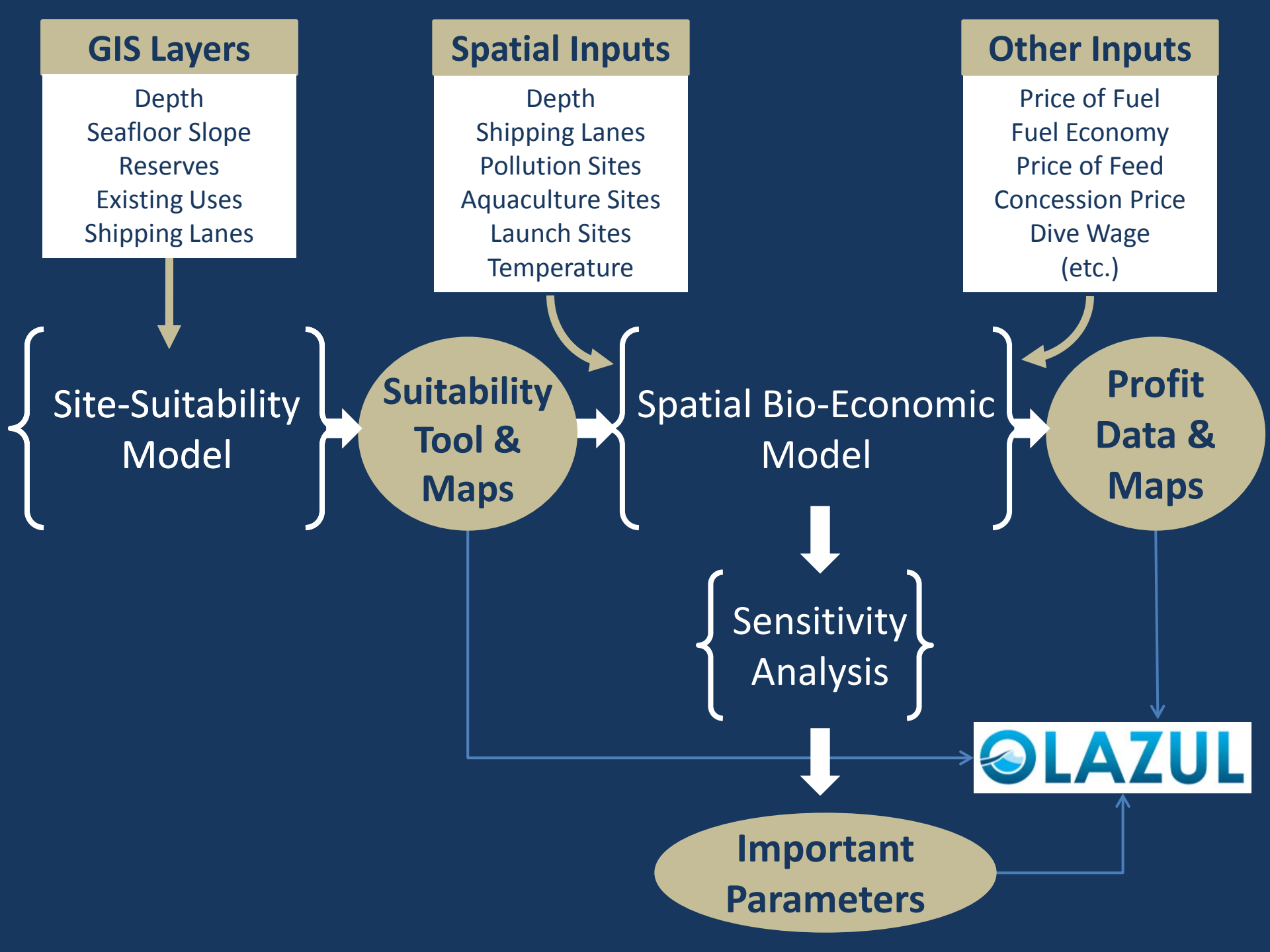
Using marine spatial planning to reduce conflict and establish community buy-in



Can Aquapods support local communities?


Aquapod
Management
Marine
Spatial
Planning
Spatial
Bio-
Economic
Analysis
Bio-
Economic
Analysis

Study Sites in Northwestern Mexico


GIS Layers
Depth
Seafloor Slope
Reserves
Existing Uses
Shipping Lanes
Spatial Inputs
Depth
Shipping Lanes
Pollution Sites
Aquaculture Sites
Launch Sites
Temperature
Other Inputs
Price of Fuel
Fuel Economy
Price of Feed
Concession Price
Dive Wage
(etc.)
Site-Suitability Model
Suitability Tool & Maps
Spatial Bio-Economic Model
Profit Data & Maps
Sensitivity Analysis
LAZUL
Important Parameters

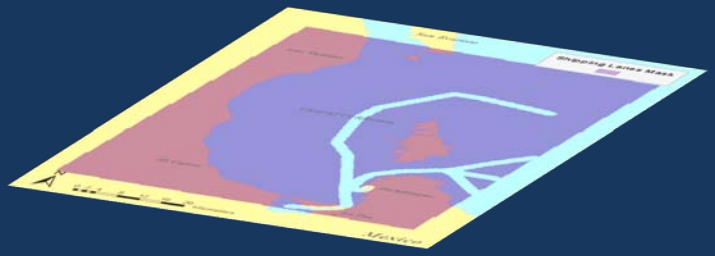
Where can we place Aquapods?

Depths of 15 – 45m

Seafloor Slope of ≤ 10%

Incompatible:

- Shipping Lanes
- Marine Reserves
- Existing Uses (i.e., offshore net pens)



San Evaristo

Las Tunitas

Gulf of California

El Cajete

Pichilingue

La Paz

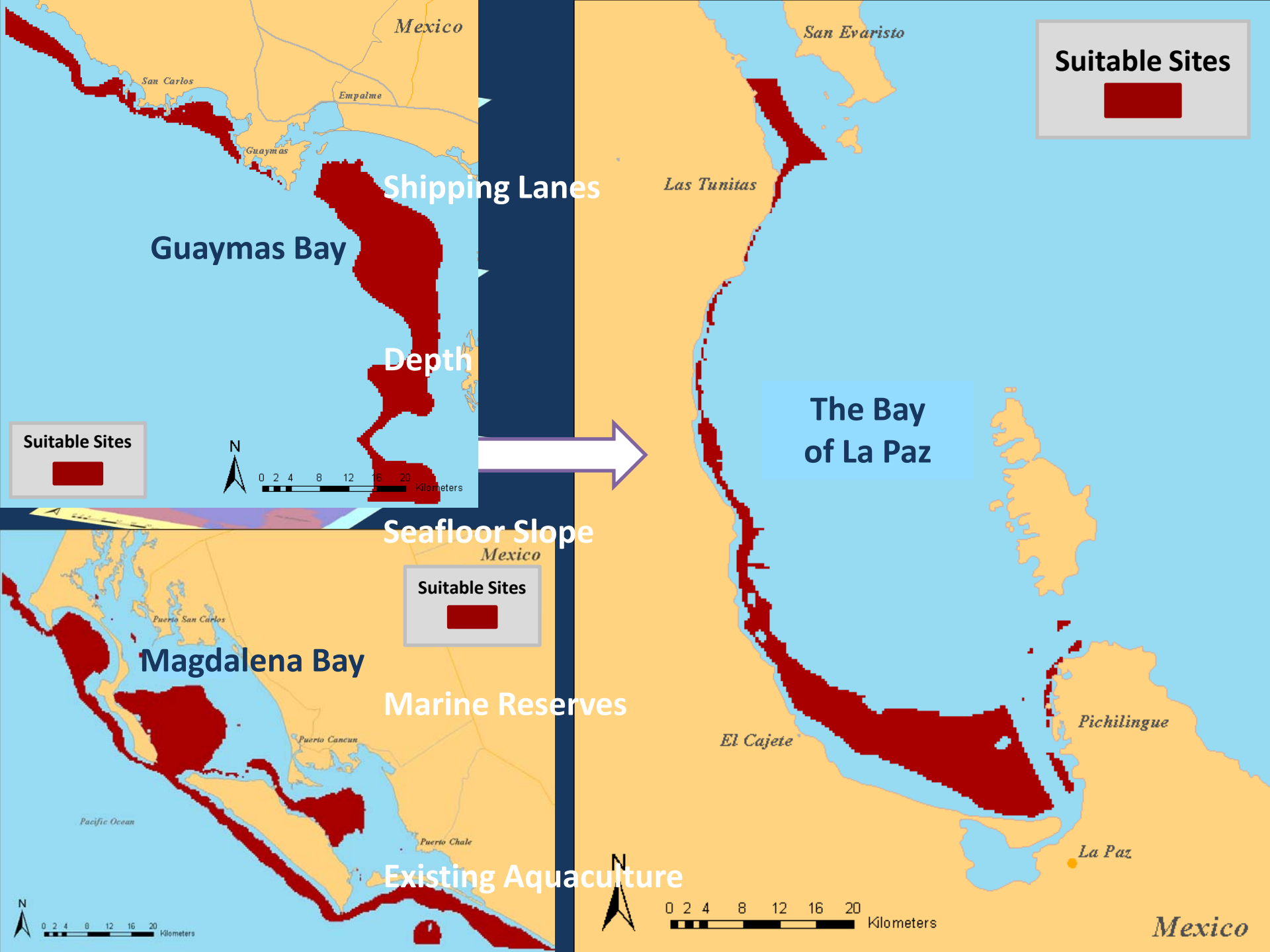
Mexico

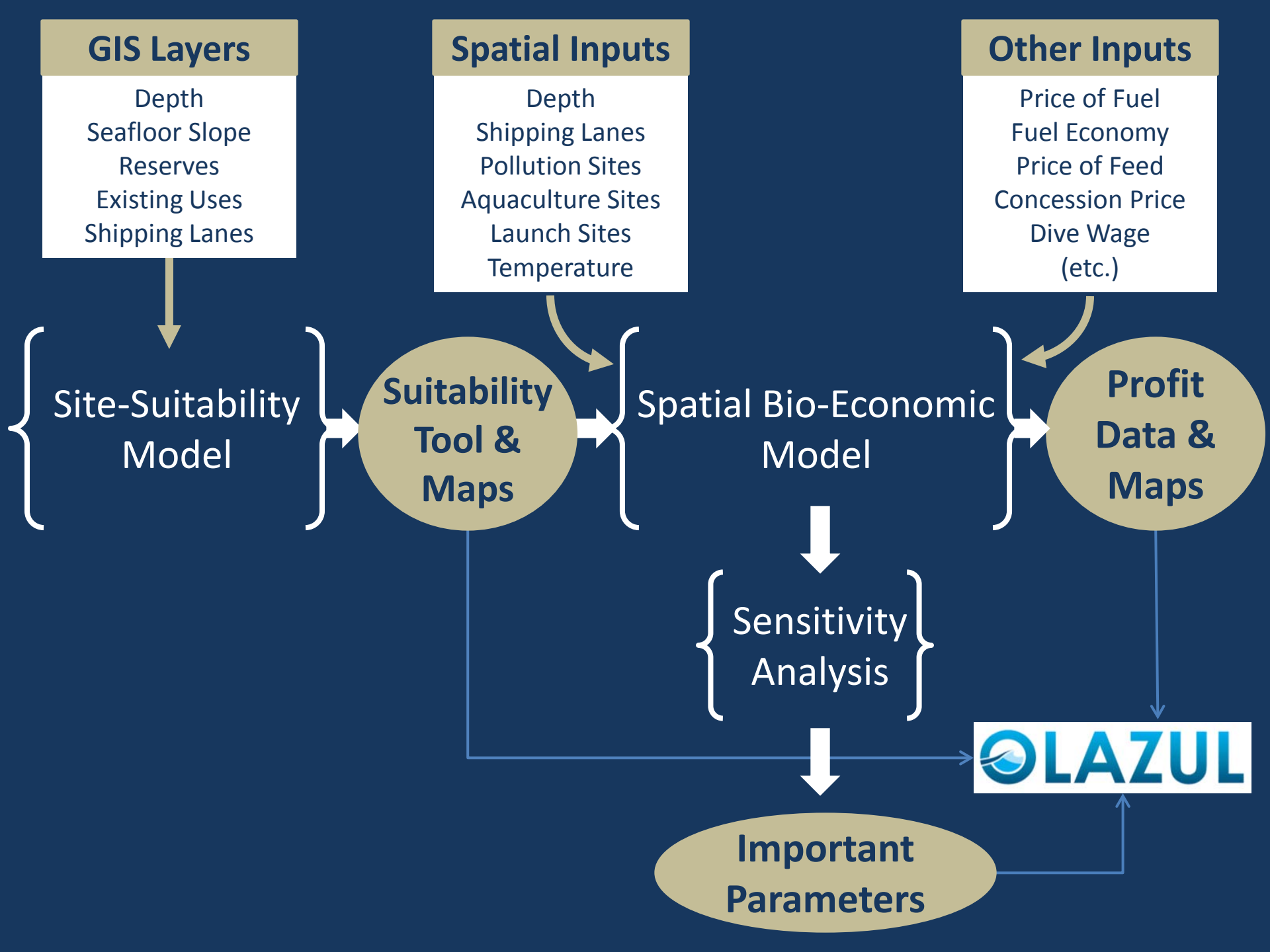
Shipping Routes

N

0 2 4 8 12 16 20

Kilometers


Mexico
San Carlos
Empalme
Guaymas
Guaymas Bay
Shipping Lanes
Depth
Suitable Sites
N
0 2 4 8 12 16 20
Kilometers
Seafloor Slope
Mexico
Suitable Sites
Puerto San Carlos
Magdalena Bay
Marine Reserves
Puerto Cancun
Pacific Ocean
Puerto Chale
Existing Aquaculture
N
0 2 4 8 12 16 20
Kilometers
San Evaristo
Suitable Sites
Las Tunitas
The Bay
of La Paz
El Cajete
Pichilingue
La Paz
N
0 2 4 8 12 16 20
Kilometers
Mexico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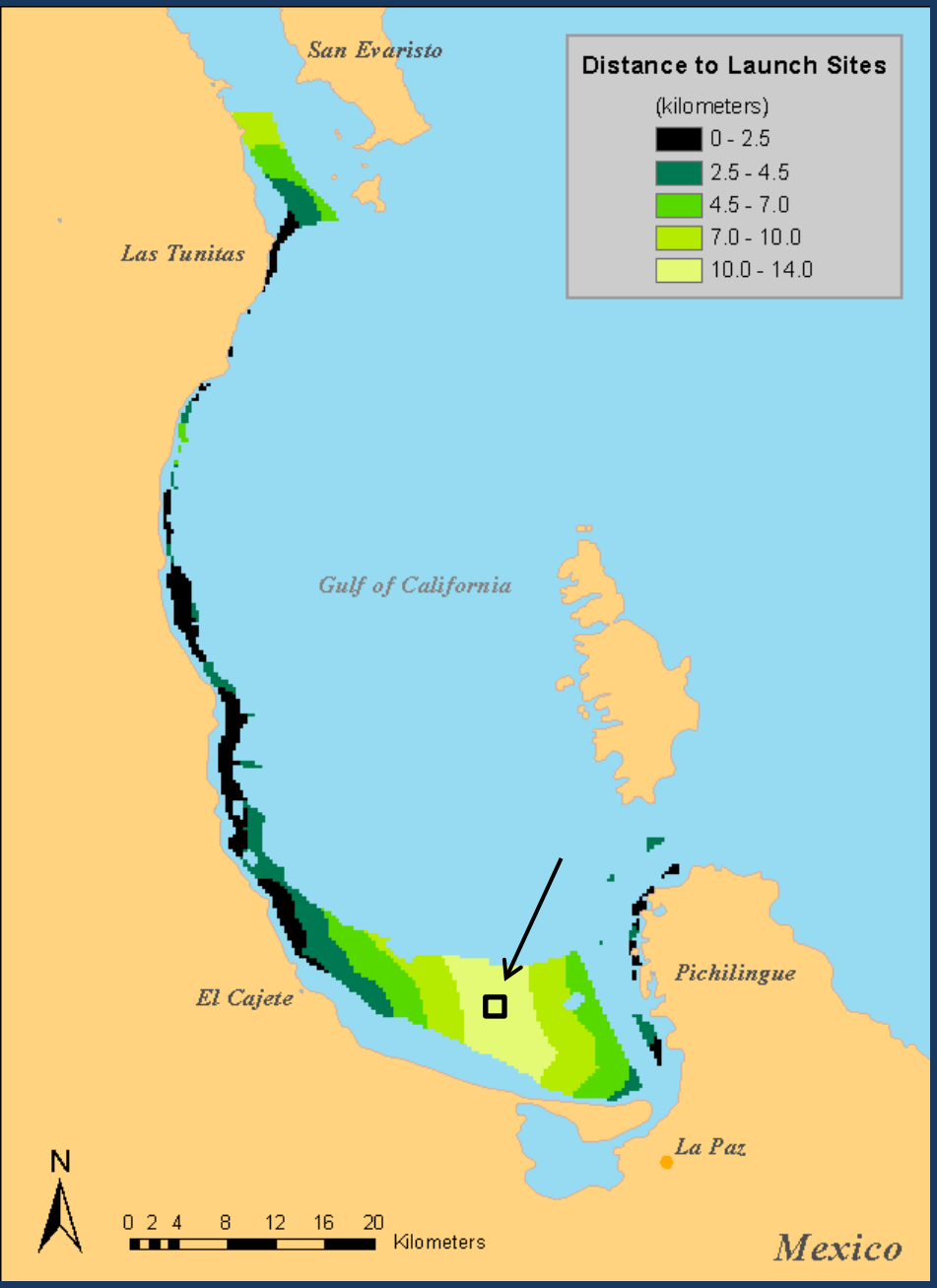
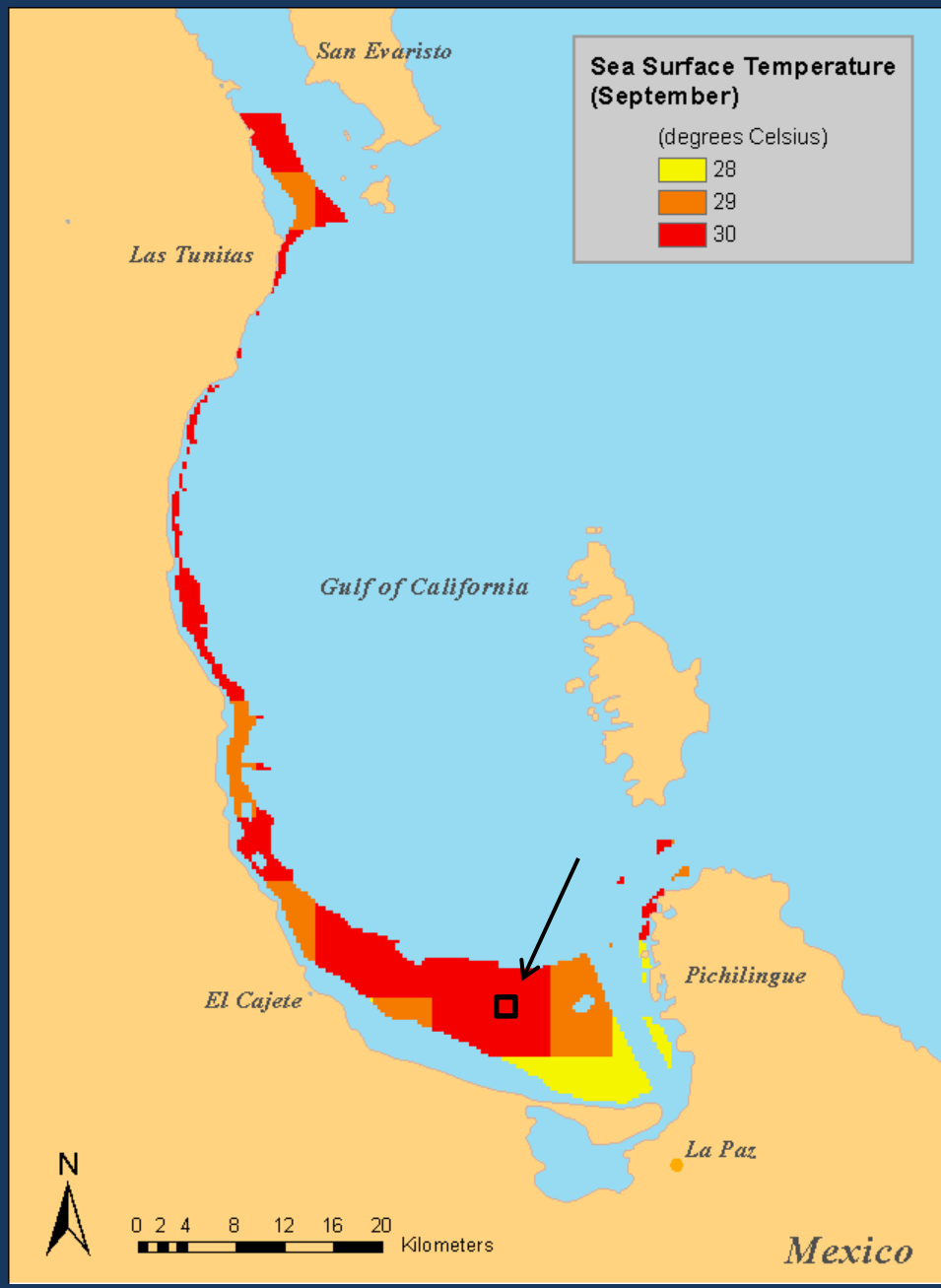
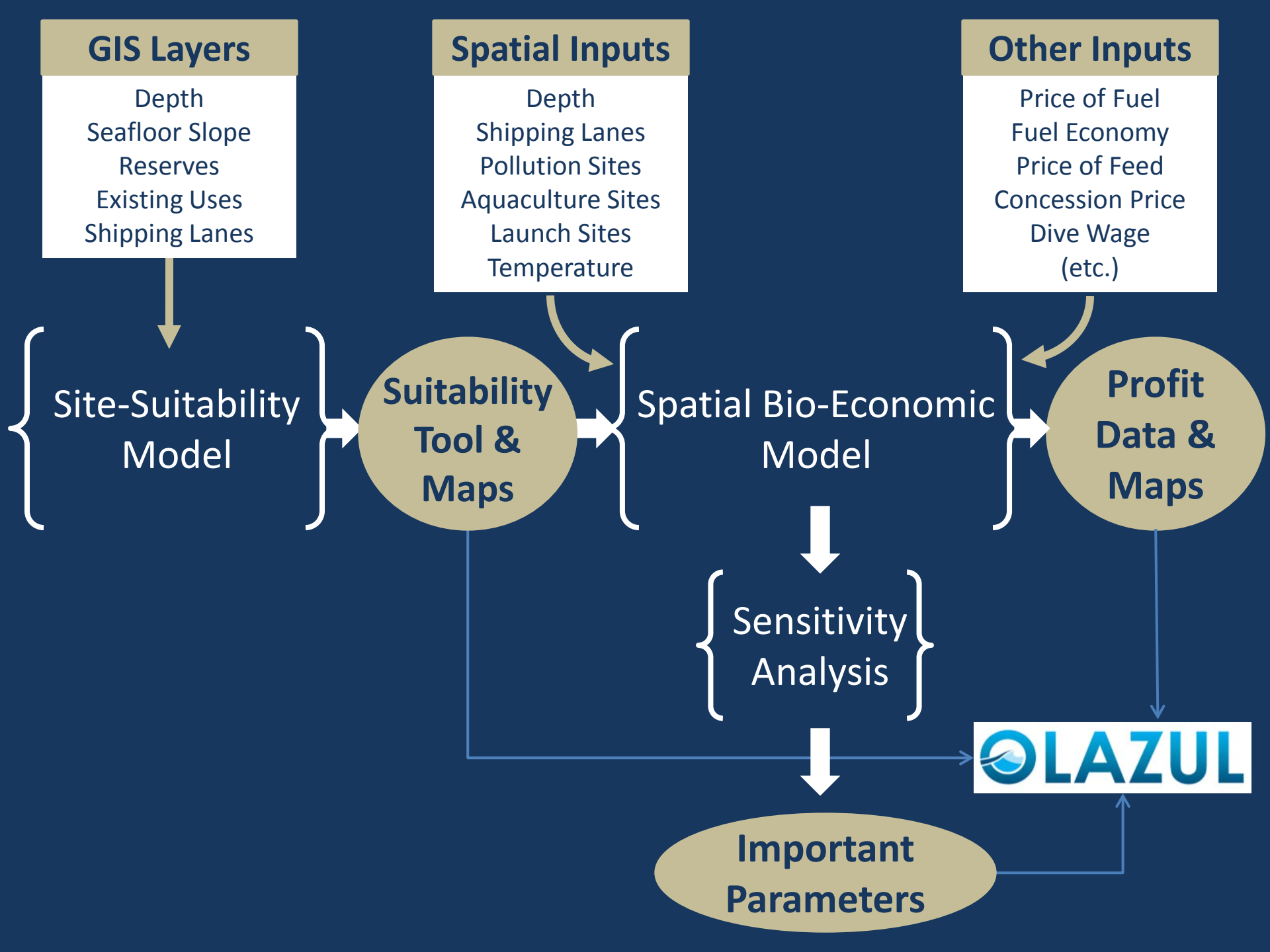
Important Parameters

Which spatial parameters affect profitability?


Distance to Launch Sites
(kilometers)
0 - 2.5
2.5 - 4.5
4.5 - 7.0
7.0 - 10.0
10.0 - 14.0
San Evaristo
Las Tunitas
Gulf of California
El Cajete
Pichilingue
La Paz
N
0 2 4 8 12 16 20
Kilometers
Mexico


Sea Surface Temperature
(September)
(degrees Celsius)
28
29
30
San Evaristo
Las Tunitas
Gulf of California
El Cajete
Pichilingue
La Paz
N
0 2 4 8 12 16 20
Kilometers
Mexico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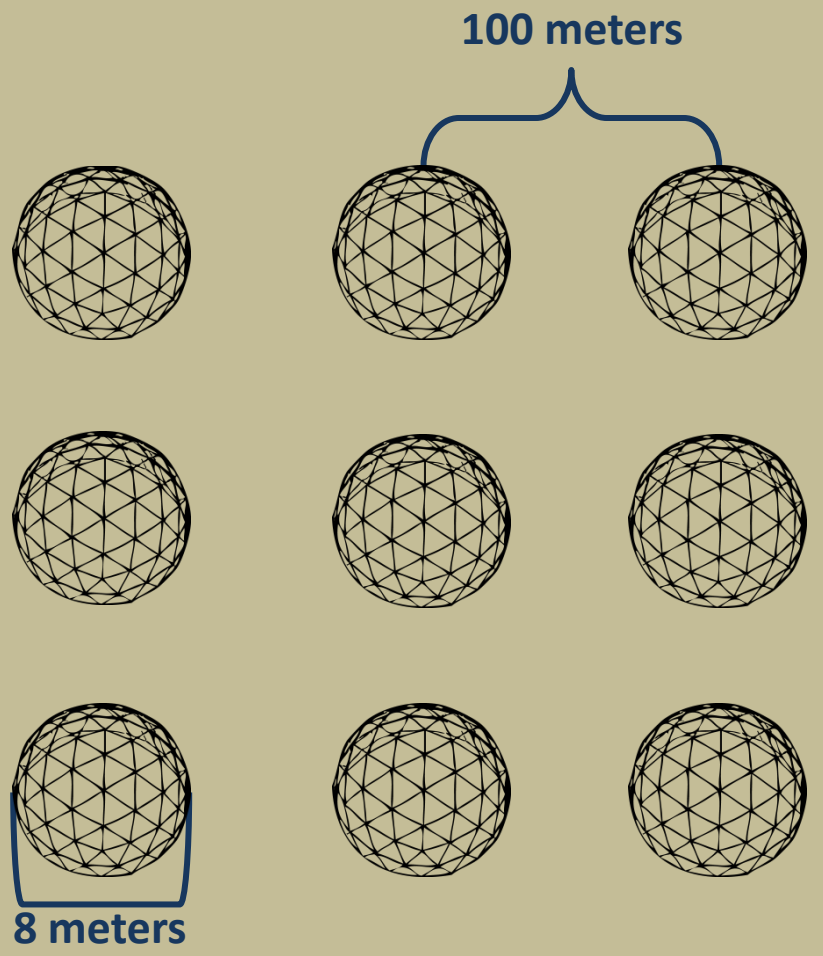
A business model that supports a community fishery



Ex-Vessel Price ...depends on shrimp size

Profit = (price x biom ... *isk)*

Shrimp Biomass

number of shrimp x average weight of shrimp

- Initial number of shrimp larvae
- shrimp rate of death

weekly growth rate . . .

- shrimp size
- water temperature

$$Profit = (price \times biomass - start\text{-}up - operation - risk)$$

Revenue — *Cost*

Start-up costs

- Aquapods
- installation
- boats
- dive gear

Revenue *Cost*

$$Profit = (price \times biomass - start\text{-}up - operation - risk)$$

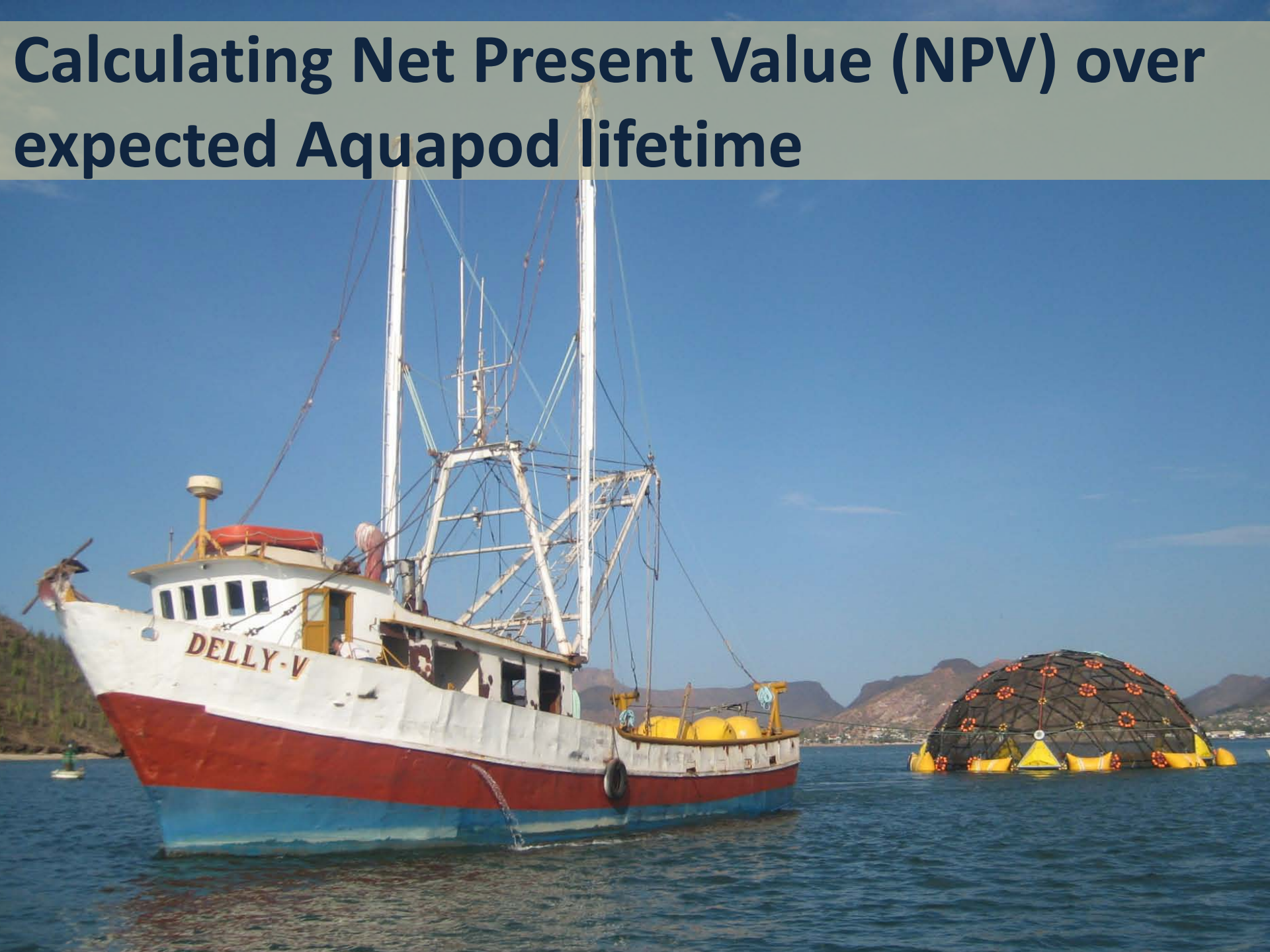
Operational Costs

Revenue *Cost*

$$Profit = (price \times biomass - start\text{-}up - operation - risk)$$

Risk Costs

Calculating Net Present Value (NPV) over expected Aquapod lifetime

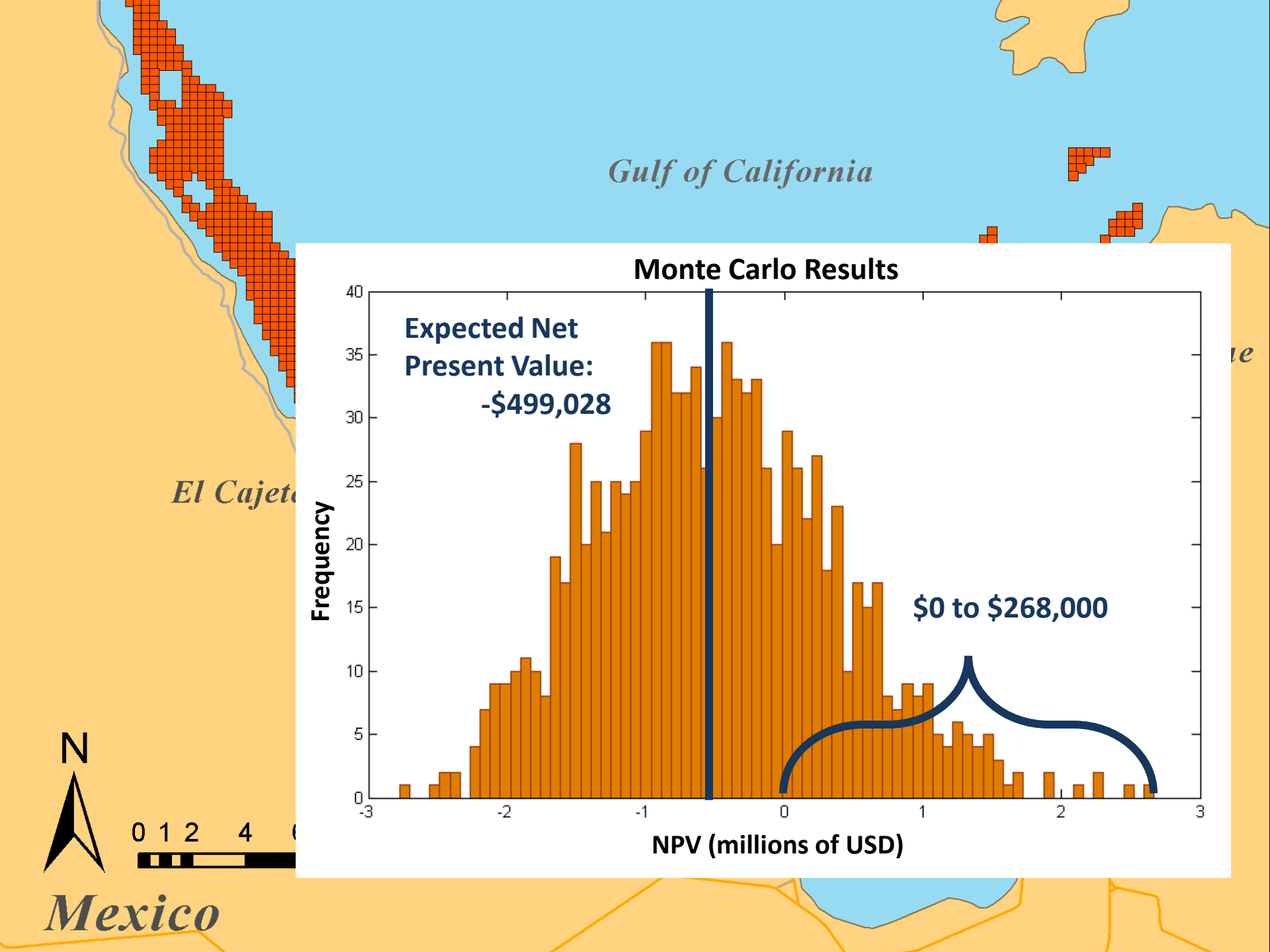


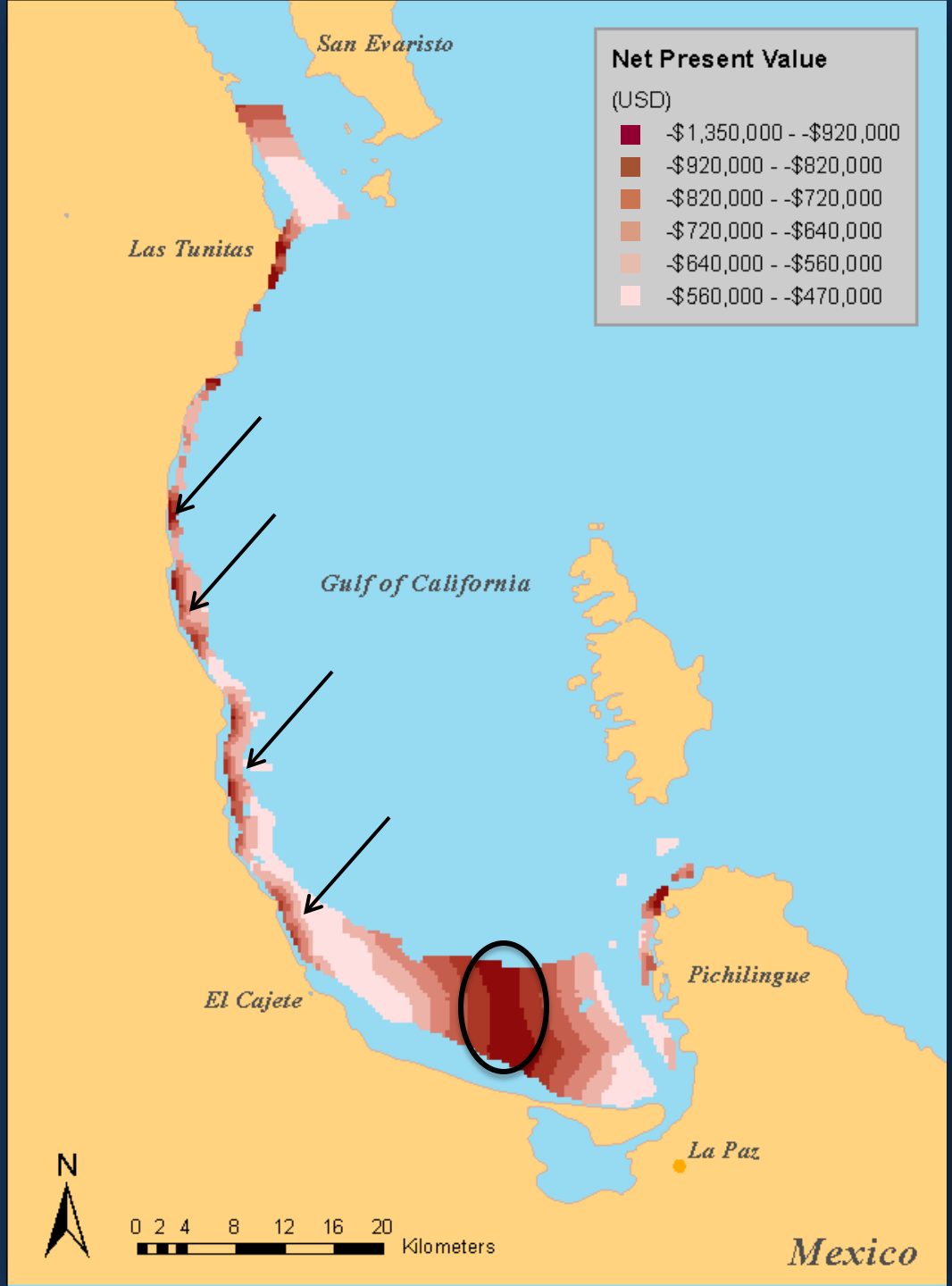

How do we account for uncertainty in our model?

Monte Carlo Analysis

Data Ranges

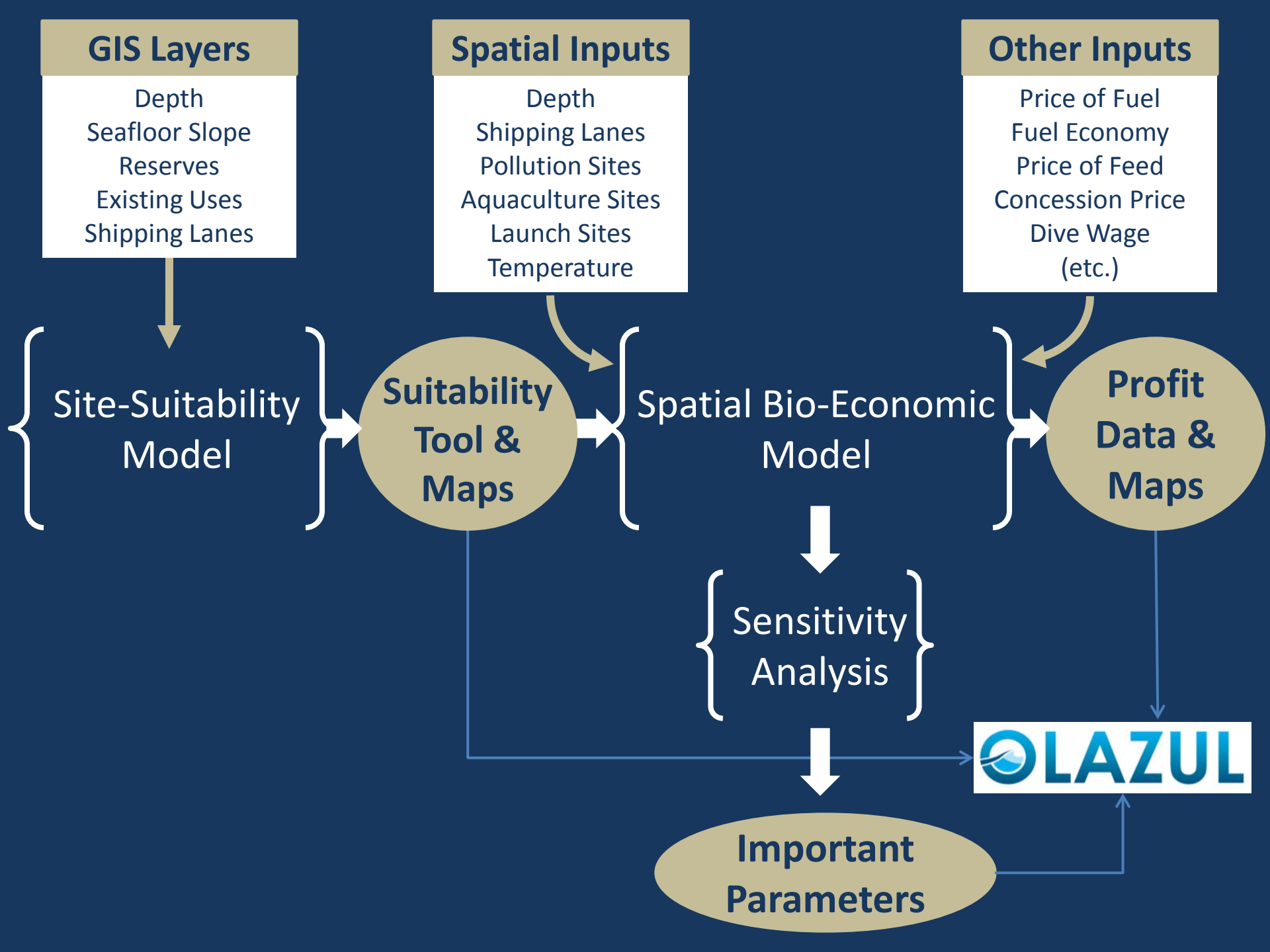
Parameter	Estimate	Min	Max
Price of fuel per liter	$0.68	$0.50	$1.00
Price of feed per kg	$1.20	$0.60	$1.80
Price of young shrimp	$0.01	$0.005	$0.02
Concession cost	$1000	$800	$2000
Diver wage per hour	$6.50	$5.00	$12.00


Gulf of California
El Cajete
Mexico
N
0 1 2 4
Monte Carlo Results
Expected Net Present Value: -$499,028
$0 to $268,000
Frequency
NPV (millions of USD)
0
5
10
15
20
25
30
35
40
-3
-2
-1
0
1
2
3



Unprofitable

Profitable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LAZUL
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Sensitivity Analysis

Parameter	Elasticity
Number of Divers	-16.7
Diver Wages	-15.8
Feed Cost	-9.4
Boat Fuel Economy	-5.3
Rate of Shrimp Death	-2.5

Sensitivity Analysis

Parameter	Elasticity
Number of Divers	**-16.7**
Diver Wages	**-15.8**
Feed Cost	**-9.4**
Boat Fuel Economy	-5.3
Rate of Shrimp Death	-2.5

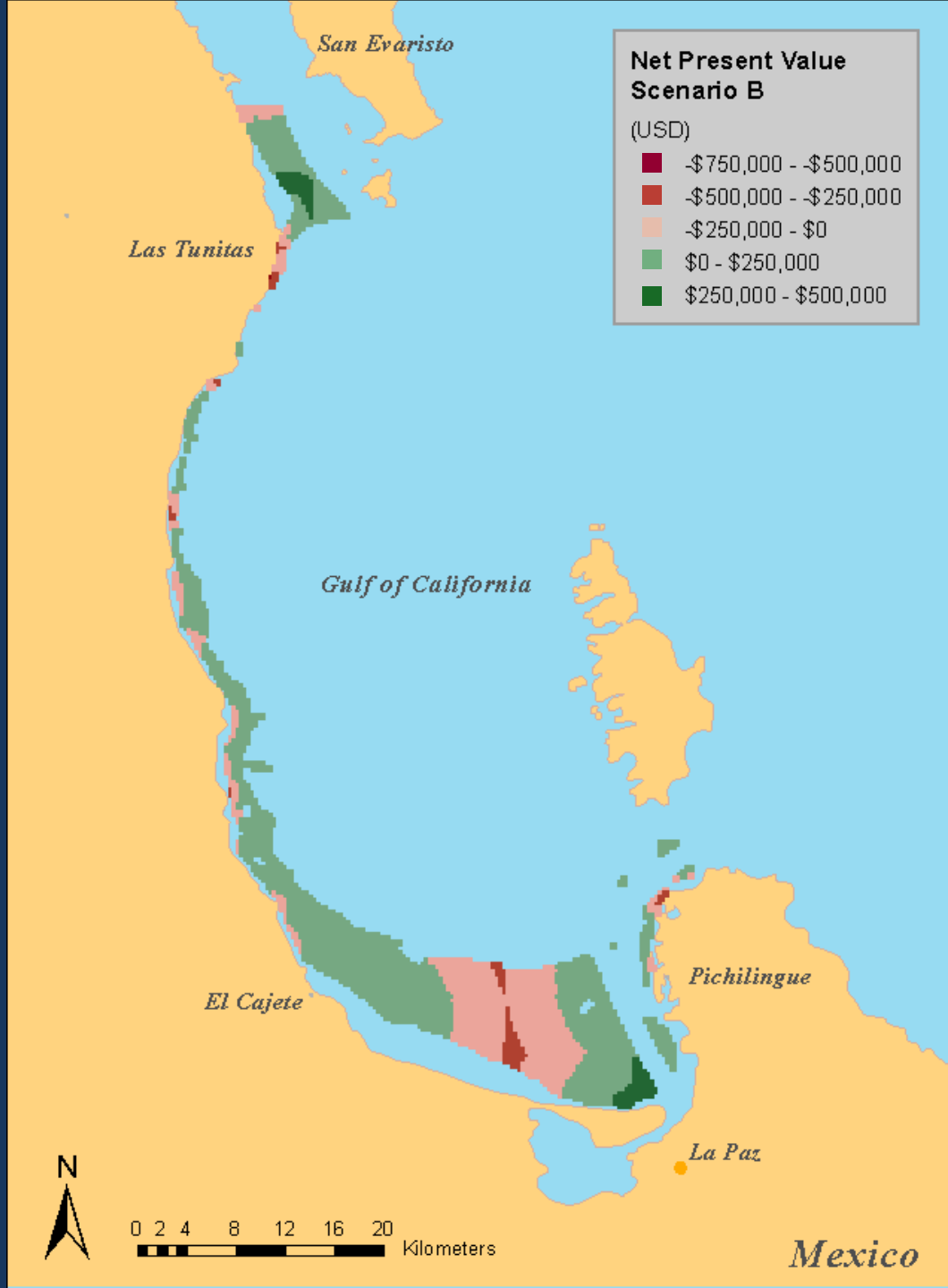
Alternative Management Scenarios:

reducing labor and feed costs

Reduced Feed Cost:

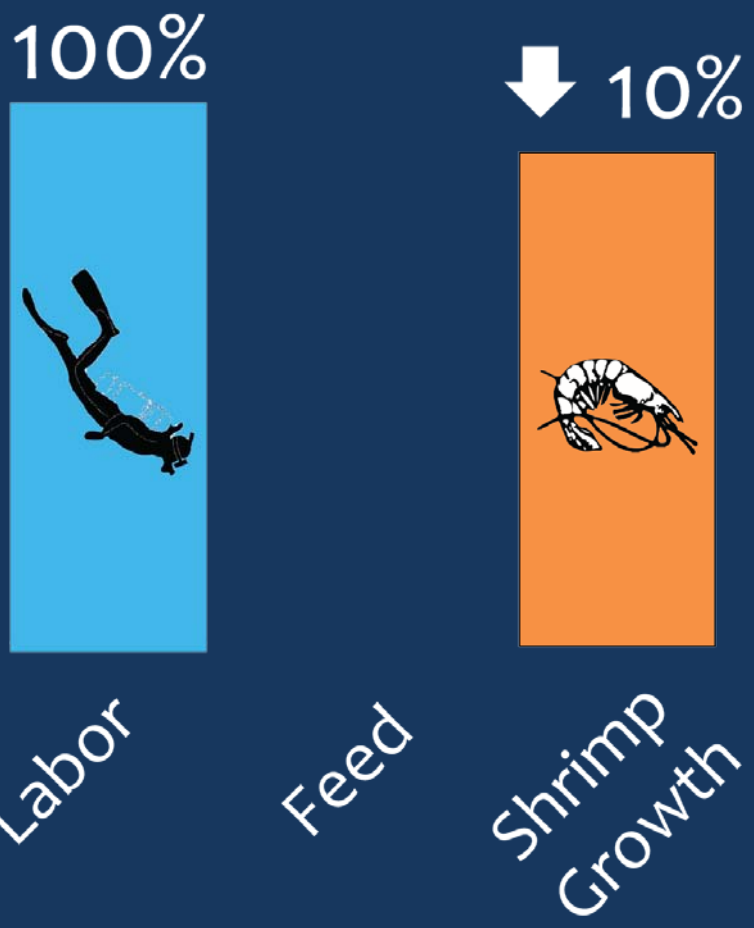
66% of suitable sites are profitable

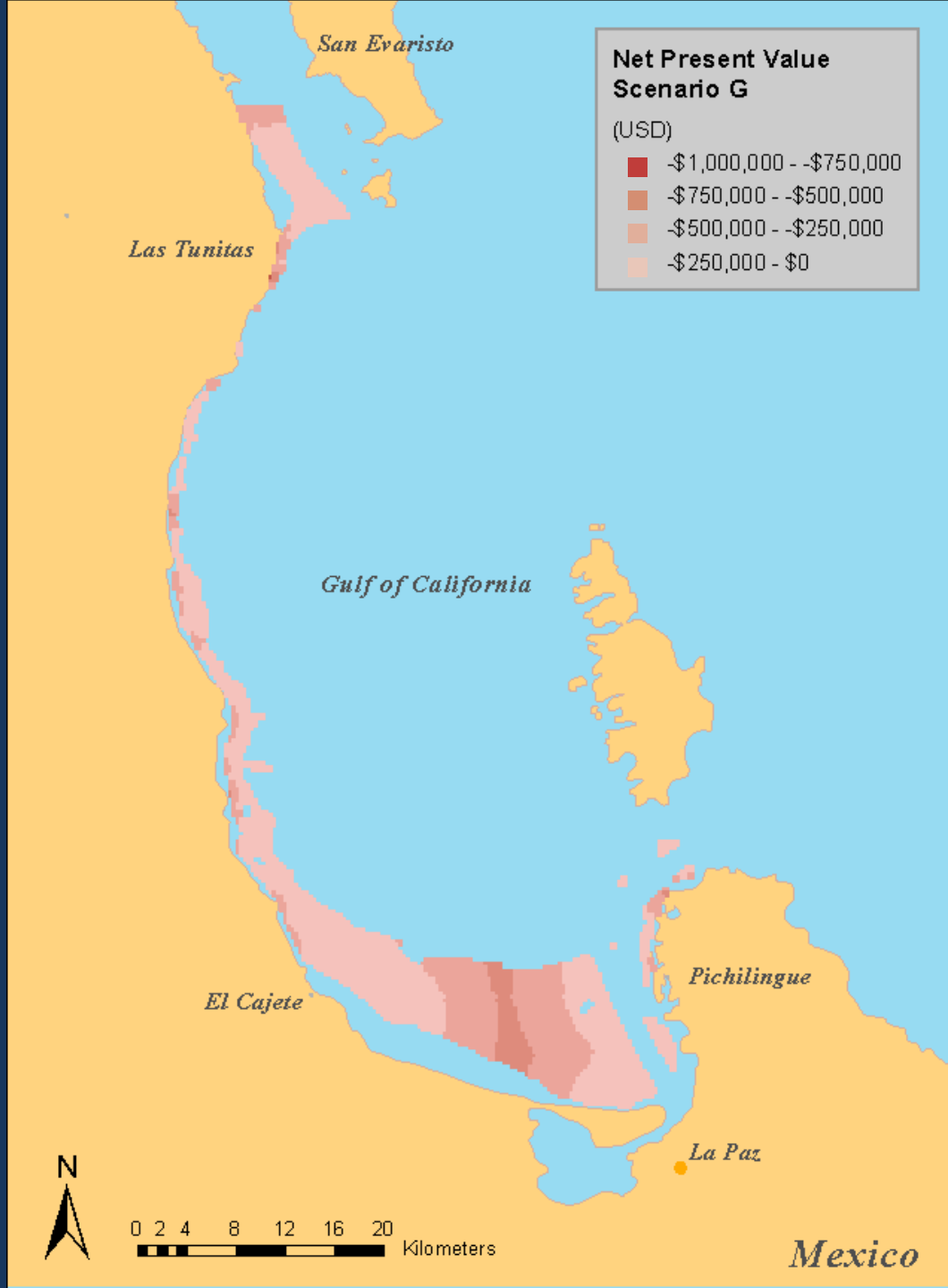
100%



Reduced Feed Quantity:

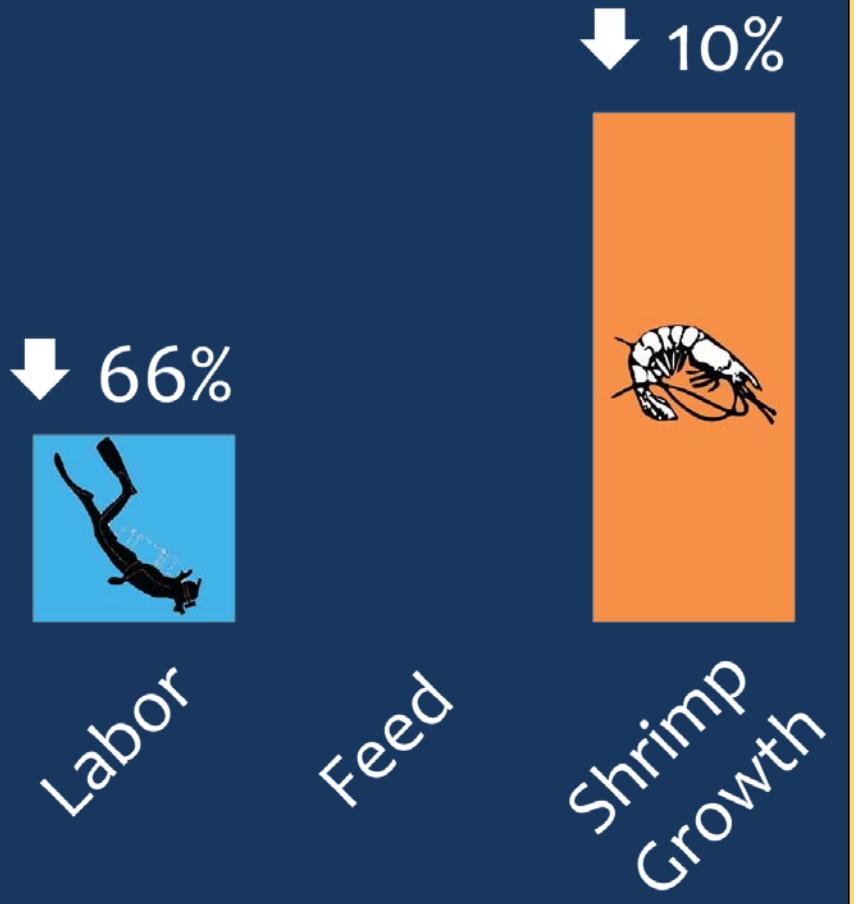
0% of suitable sites are profitable

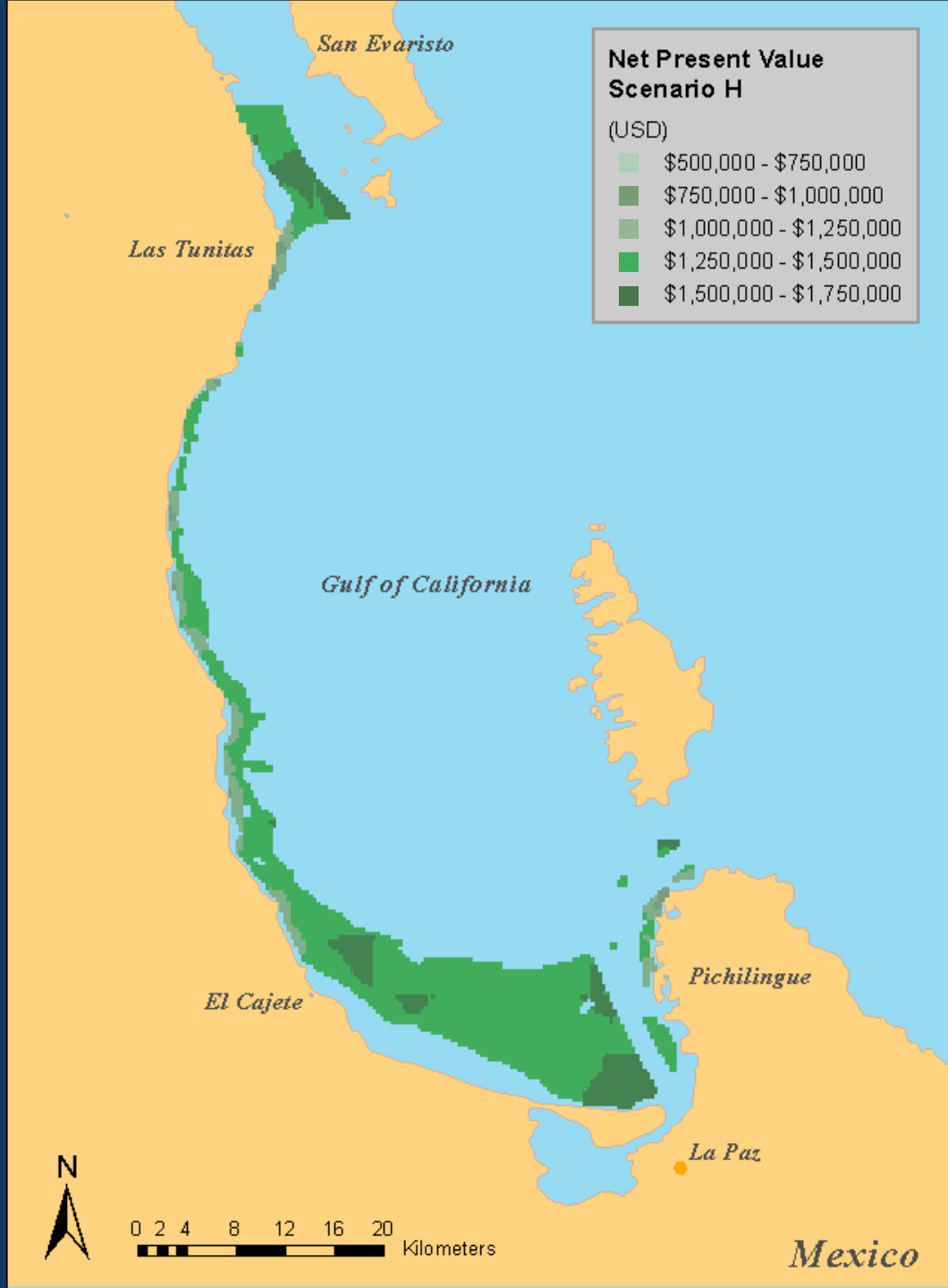




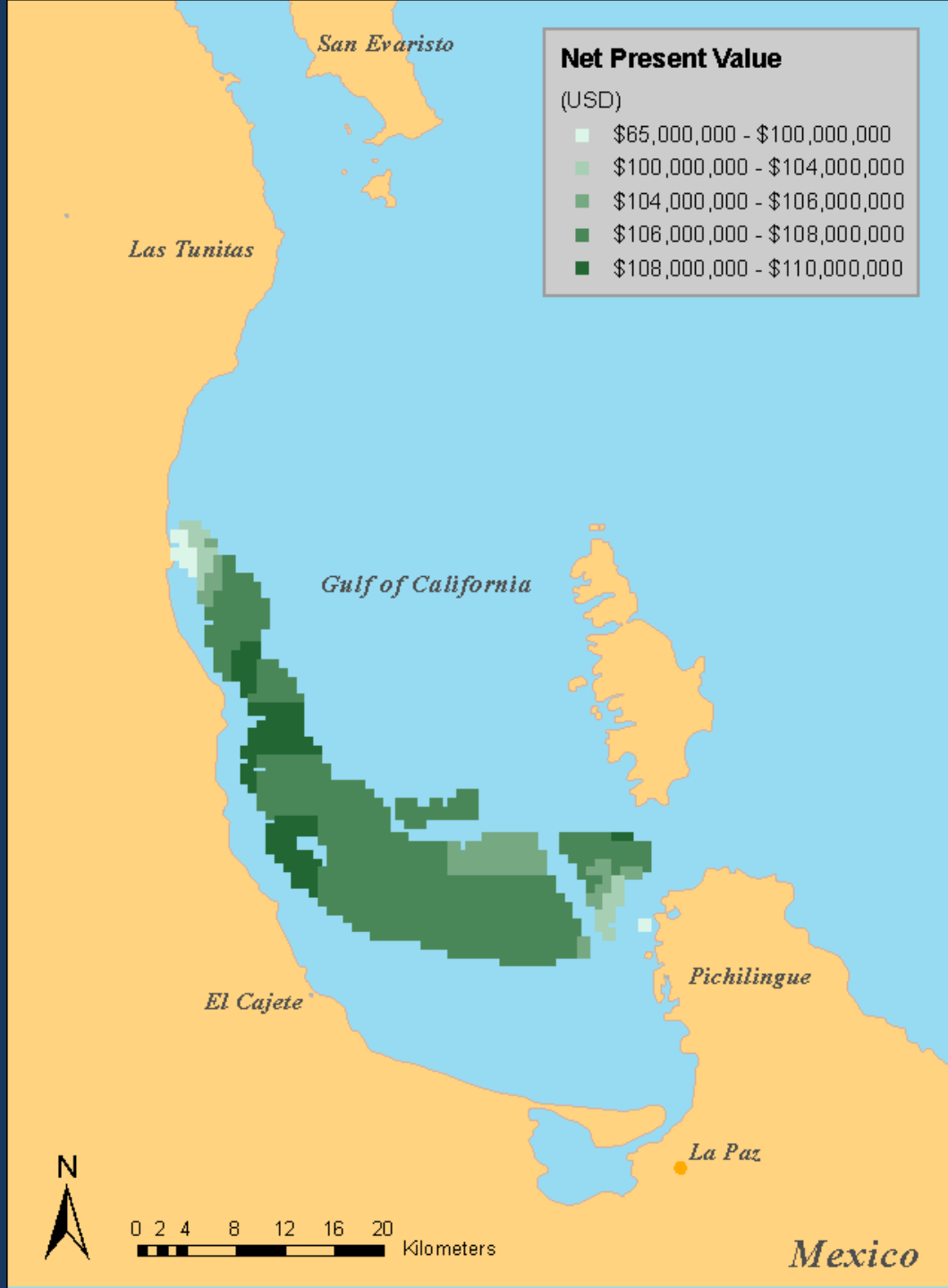
Reduced Labor and Feed Quantities:

100% of suitable sites are profitable





Industrial Model:
100% of suitable sites are profitable



Recommendations to Olazul

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1. **Study the feasibility of alternative business scenarios.**

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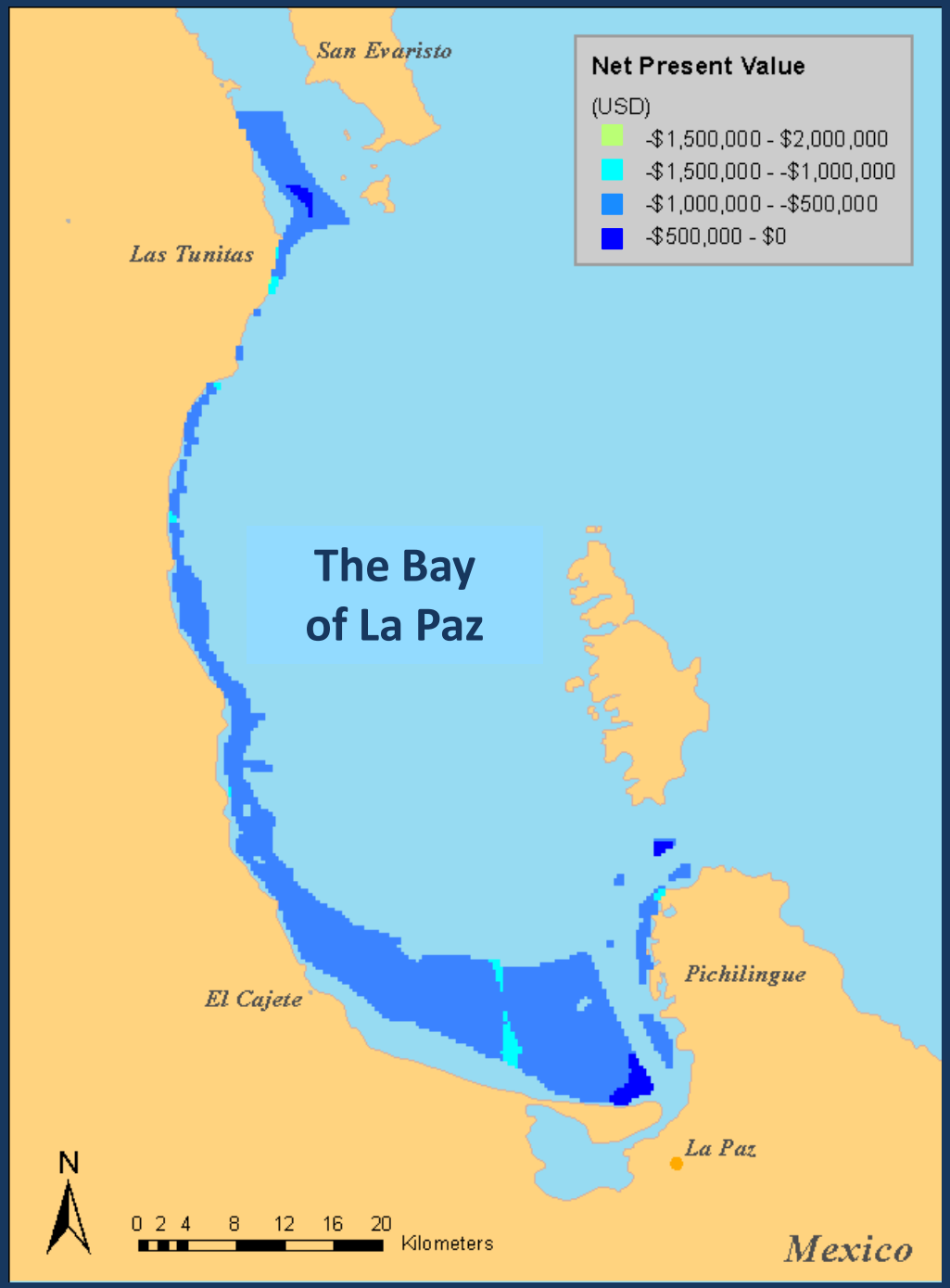
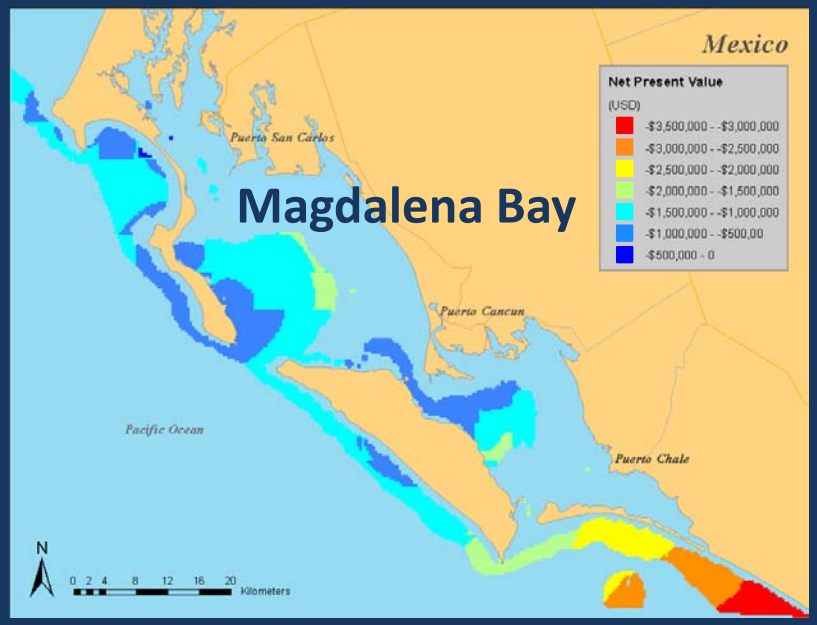
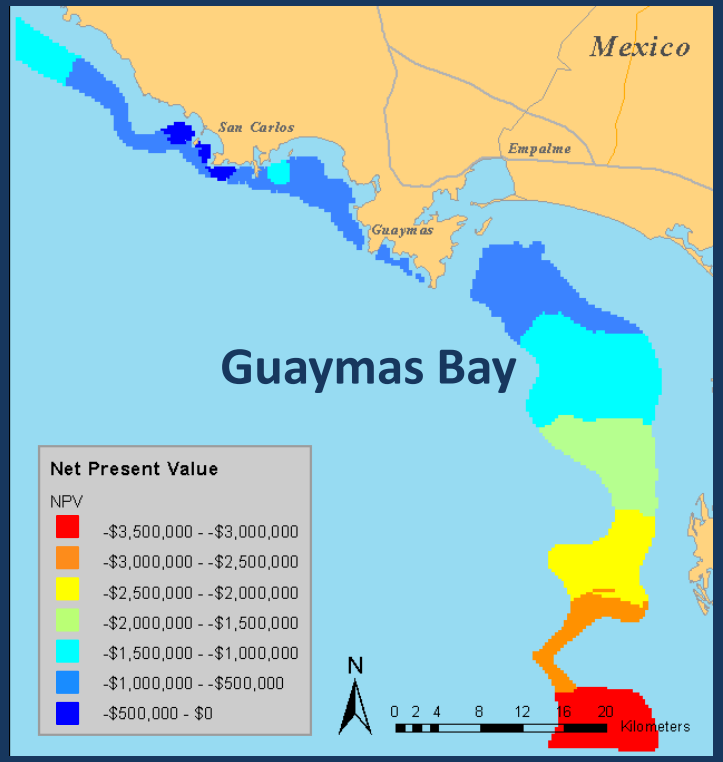
1. Study the feasibility of alternative business scenarios.
2. **Focus future research and pilot trials in La Paz.**


San Evaristo
Las Tunitas
Net Present Value
(USD)
-$1,500,000 - $2,000,000
-$1,500,000 - -$1,000,000
-$1,000,000 - -$500,000
-$500,000 - $0
The Bay of La Paz
El Cajete
Pichilingue
La Paz
N
0 2 4 8 12 16 20
Kilometers
Mexico


Mexico
Net Present Value
(USD)
-$3,500,000 - -$3,000,000
-$3,000,000 - -$2,500,000
-$2,500,000 - -$2,000,000
-$2,000,000 - -$1,500,000
-$1,500,000 - -$1,000,000
-$1,000,000 - -$500,00
-$500,000 - 0
Puerto San Carlos
Magdalena Bay
Puerto Cancun
Pacific Ocean
Puerto Chale
N
0 2 4 8 12 16 20
Kilometers


Mexico
San Carlos
Empalme
Guaymas
Guaymas Bay
Net Present Value
NPV
-$3,500,000 - -$3,000,000
-$3,000,000 - -$2,500,000
-$2,500,000 - -$2,000,000
-$2,000,000 - -$1,500,000
-$1,500,000 - -$1,000,000
-$1,000,000 - -$500,000
-$500,000 - $0
N
0 2 4 8 12 16 20
Kilometers

Recommendations to Olazul

1. Study the feasibility of alternative business scenarios.
2. Focus future research and pilot trials in La Paz.
3. **Update model with more accurate field data and measure environmental impacts of Aquapods.**

Recommendations to Olazul

1. Study the feasibility of alternative business scenarios.
2. Focus future research and pilot trials in La Paz.
3. Update model with more accurate field data and measure environmental impacts of Aquapods.
4. **Use maps to engage local stakeholders in a broader dialogue of ocean uses.**

Happening Now…

1. Deployed platform for artisanal shrimp farm pilot in Bay of La Paz (within high NPV zone)
2. Successful hatchery production of native brown shrimp
3. Testing “extensive” grow out- no formulated feed

Our Thanks to

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Kristin Reed
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Emmanuel Guevara

BREN SCHOOL OF
ENVIRONMENTAL SCIENCE & MANAGEMENT
UNIVERSITY OF CALIFORNIA SANTA BARBARA

OLAZUL

Our Thanks to

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Alejandro Flores – Marquez

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Bruce Kendall
James Frew
Arturo Keller

Ocean Farm Technologies
Barry Trexler
Cliff Goudey
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The Nature Conservancy
Anne Gondor

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Chad Burt
Jared Kibele

UCSB Department of Geography
David Siegel

UCSB Marine Science Institute
Andrew Rassweiler
Libe Washburn

UCSB Map & Imagery Lab

The Nature Conservancy
Protecting nature. Preserving life.™

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Questions?