From Controversy to Consensus:

A multi-attribute decision analysis for decommissioning California's offshore oil platforms

Max Henrion, Phd
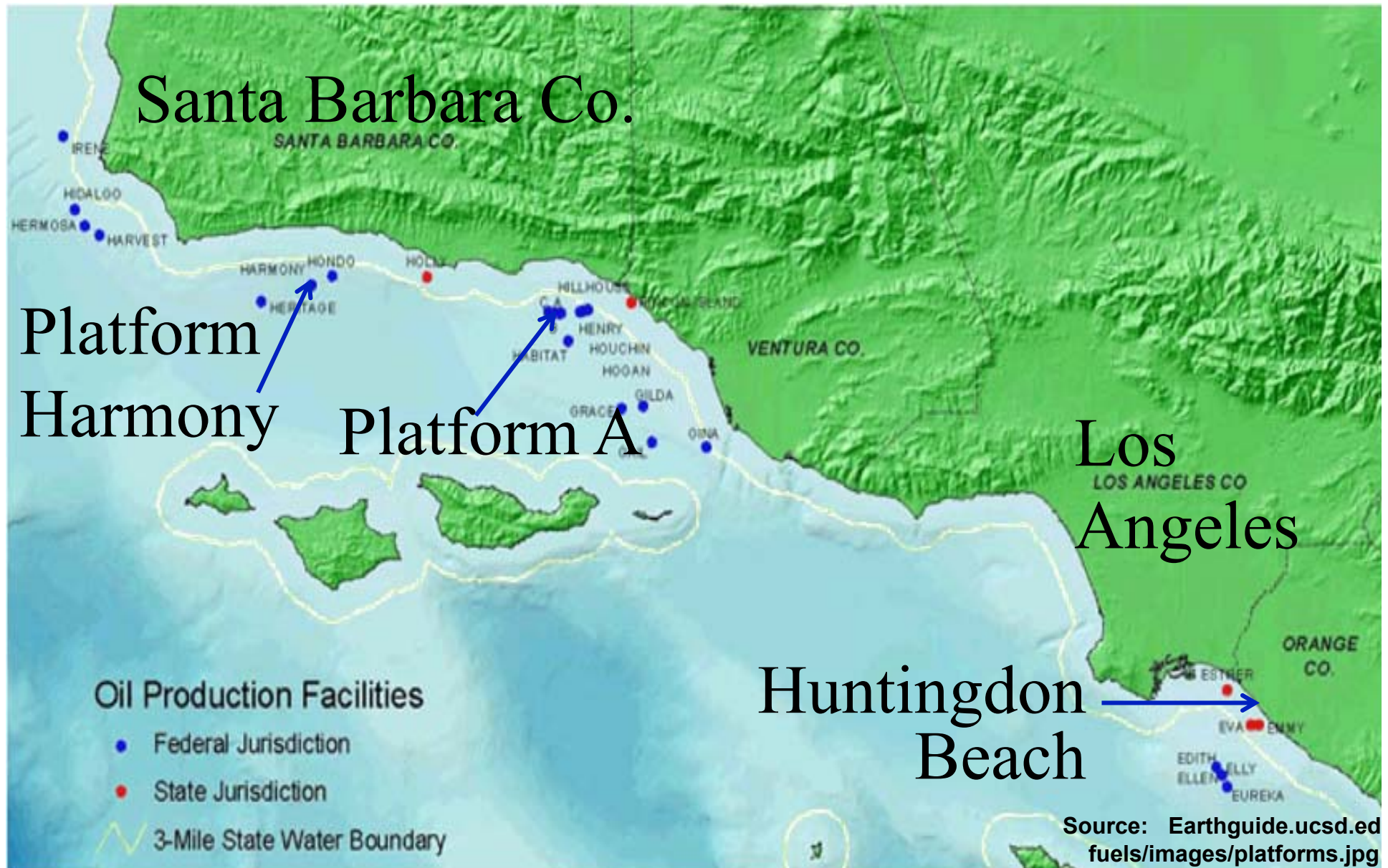CEO, Lumina Decision Systems
Los Gatos, California

Decision Analysis Affinity Group
Meeting, Huntingdon Beach
April 9-10th, 2015

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DECISION SYSTEMS®

Bringing clarity to difficult decisions

Oil and gas platforms in the Federal and State Waters of Southern California

Santa Barbara Co.

SANTA BARBARA CO.

IRENE

HIDALGO

HERMOSA

HARVEST

HARMONY HONDO

HOLLY

HERITAGE

Platform Harmony

HILLHOUSE

C A

B

HENRY

HABITAT HOUCHIN

HOGAN

Platform A

GILDA

GRACE

GINA

Los Angeles

LOS ANGELES CO

VENTURA CO.

ORANGE CO.

ESTHER

Huntingdon Beach

EVA EMMY

EDITH
ELLEN ELLY

EUREKA

Oil Production Facilities
- Federal Jurisdiction
- State Jurisdiction
- 3-Mile State Water Boundary
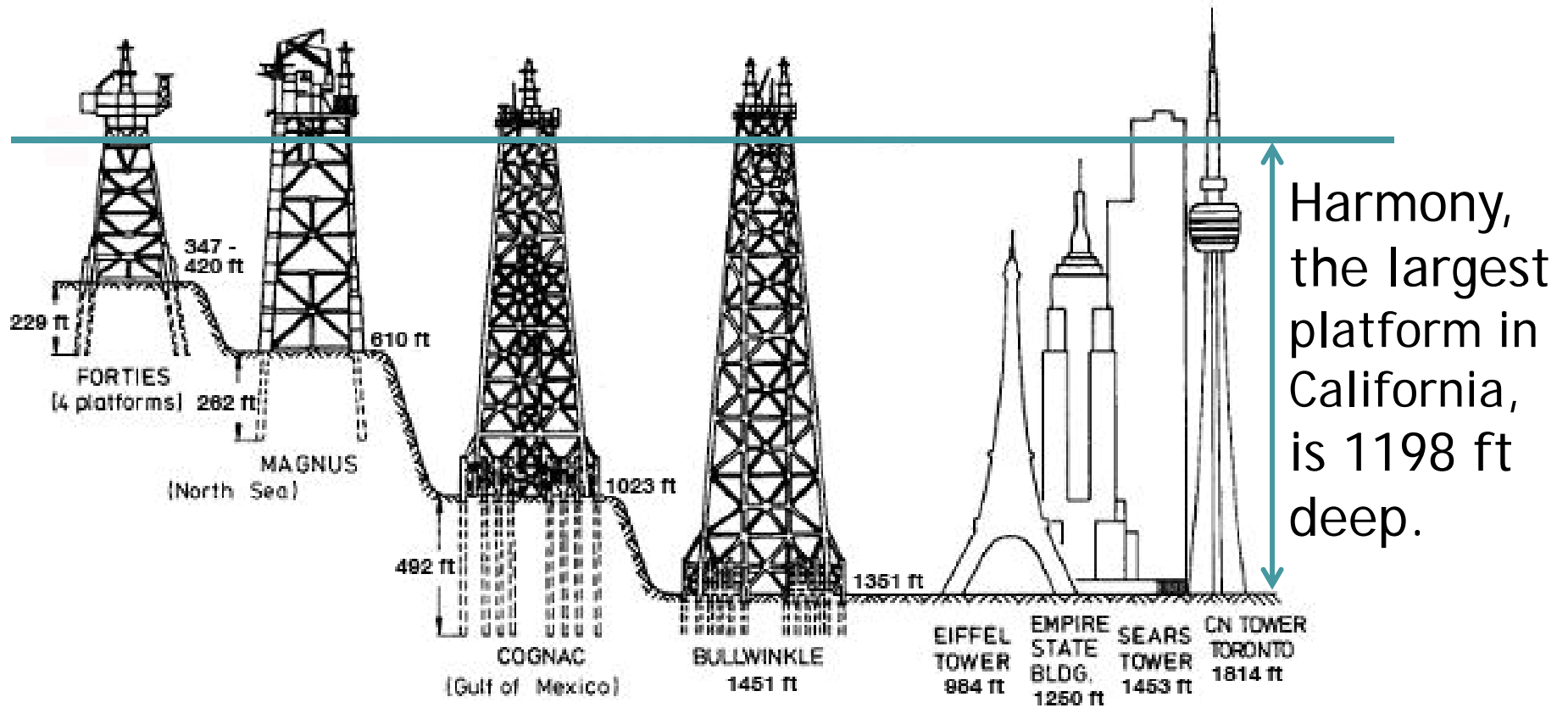
The Santa Barbara Oil Spill in 1969
from Platform A

How big are offshore oil platforms?

A segment of Platform Harmony before installation

375,000 tons steel for all 27 California platforms

Cars

Truck

Large crane

How big are offshore oil platforms?

Harmony, the largest platform in California, is 1198 ft deep.

modified from http://synclaire.net/blog/2008/02/oil-platform-comparison

Life under the platforms

- Platform jackets provide habitat for a substantial marine ecosystem
- Common biota include a thick encrustation of mollusks, rockfish breeding, seals, sea lions, and other visiting marine mammals.
- Rigs are popular for recreational diving and fishing

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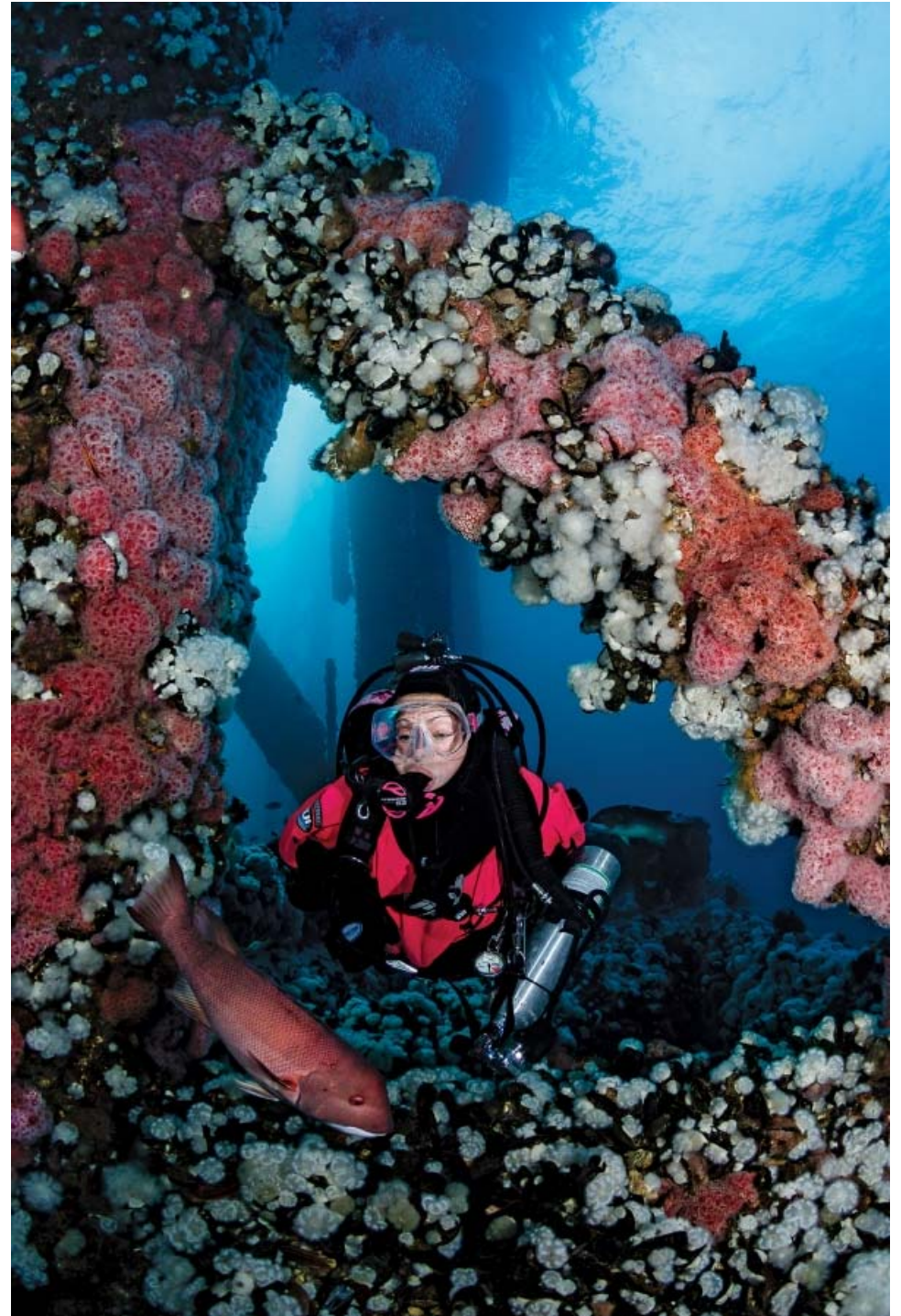
Selected stakeholder organizations

Federal and California gov.

Environmental groups

Owner operators of oil platforms

Commercial and sport fishing

Recreational divers
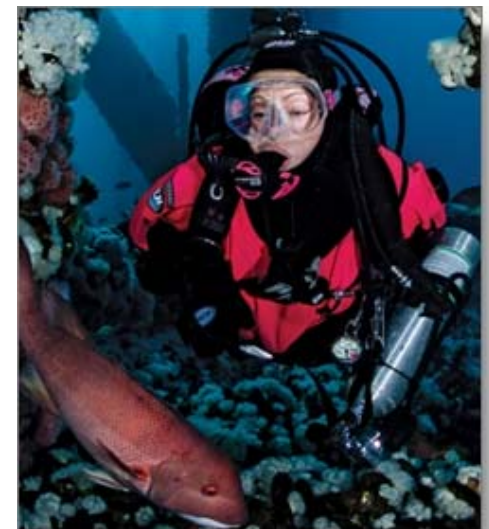
Project client: OST CALIFORNIA Ocean Science Trust

Skyli McAfee, Executive Director

Multidisciplinary Team

Brock Bernstein, PhD		Team lead, Project manager
Max Henrion, PhD	Lumina	Decision analyst
Surya Swamy	Lumina	Model developer
Daniel Pondella, PhD	Occidental College	Marine ecology, fisheries
Sarah Kruse, PhD	Ecotrust	Economist
John de Witt	Bowdoin College	Policy analysis
Astrid Scholz, PhD	Ecotrust	Economist
Andy Bressler	Texaco (ret.)	Offshore engineering
Peter Cantle	Bioresources	Air quality and emissions
Tim Setnicka	Superintendent Channel Islands National Park (ret.)	Federal policy, coastal management
Laurel Fink	Researcher	Marine ecology
Bridget McCann	Researcher	Legal and management

Advisory Committee

|		
Todd Anderson	San Diego State University	Fisheries
Doug Anthony	Santa Barbara County	Coastal management, air emissions
Ann Bull	Federal Minerals Management Service	Regulation, compliance
Robert Byrd	Proserv Offshore	Decomm. engineering
Alison Dettmer	California Coastal Commission	Coastal management
Dominic Gregorio	Calif. State Water Resources Control Board	Water quality
Linda Fernandez	University of California Riverside	Environmental policy
Grigg Gitschlag	National Ocean and Atmospheric Admin	Resource management
Alan Hager	California Dept. of Fish and Wildlife	Legal & regulatory
Sean Hecht	UCLA	Environmental law
Sonke Mastrup	California Dept. of Fish and Wildlife	Resource management
Michael McGinnis	University of California Santa Barbara	Decommissioning history, sociology
Mark Meier	State Lands Commission	Regulation, compliance
Mark Page	University of California Santa Barbara	Fisheries
Alan Winer	University of Southern California	Air emissions

PLATFORM: Decision Support Tool in
**analytica®**

- The team worked with OST, the advisory committee, and other stakeholders to structure the model and evaluate the decision tree options against multiple attributes, and to analyze sensitivities and uncertainties.
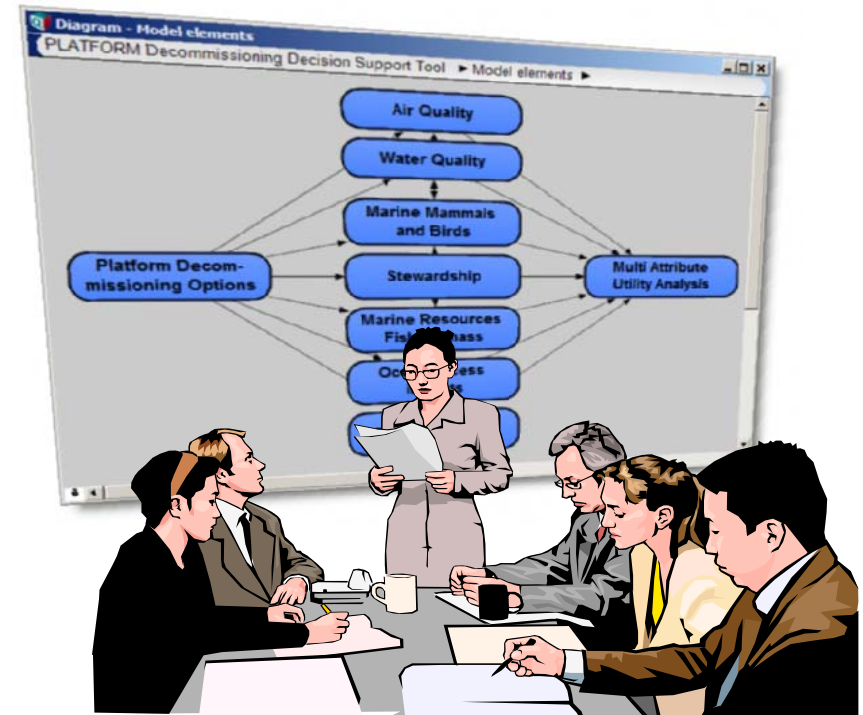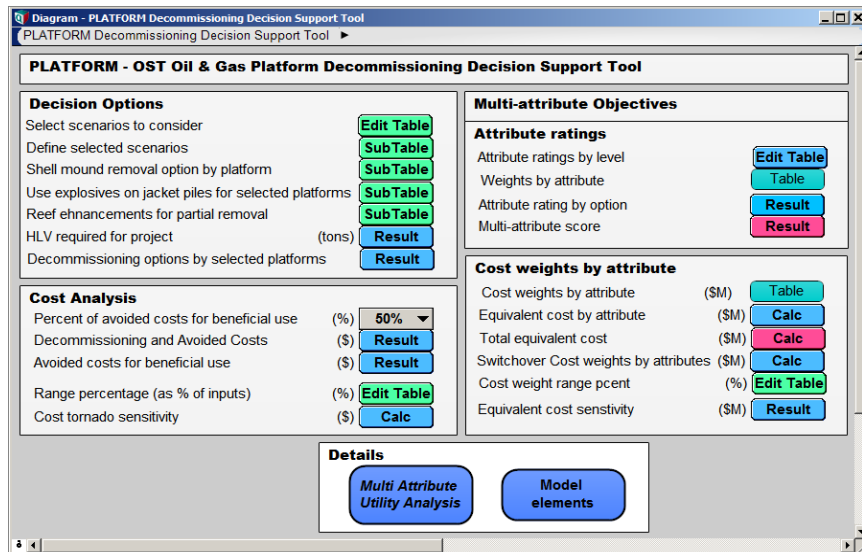
- PLATFORM is an interactive tool to empower stakeholders to explore alternative scenarios and preference models.
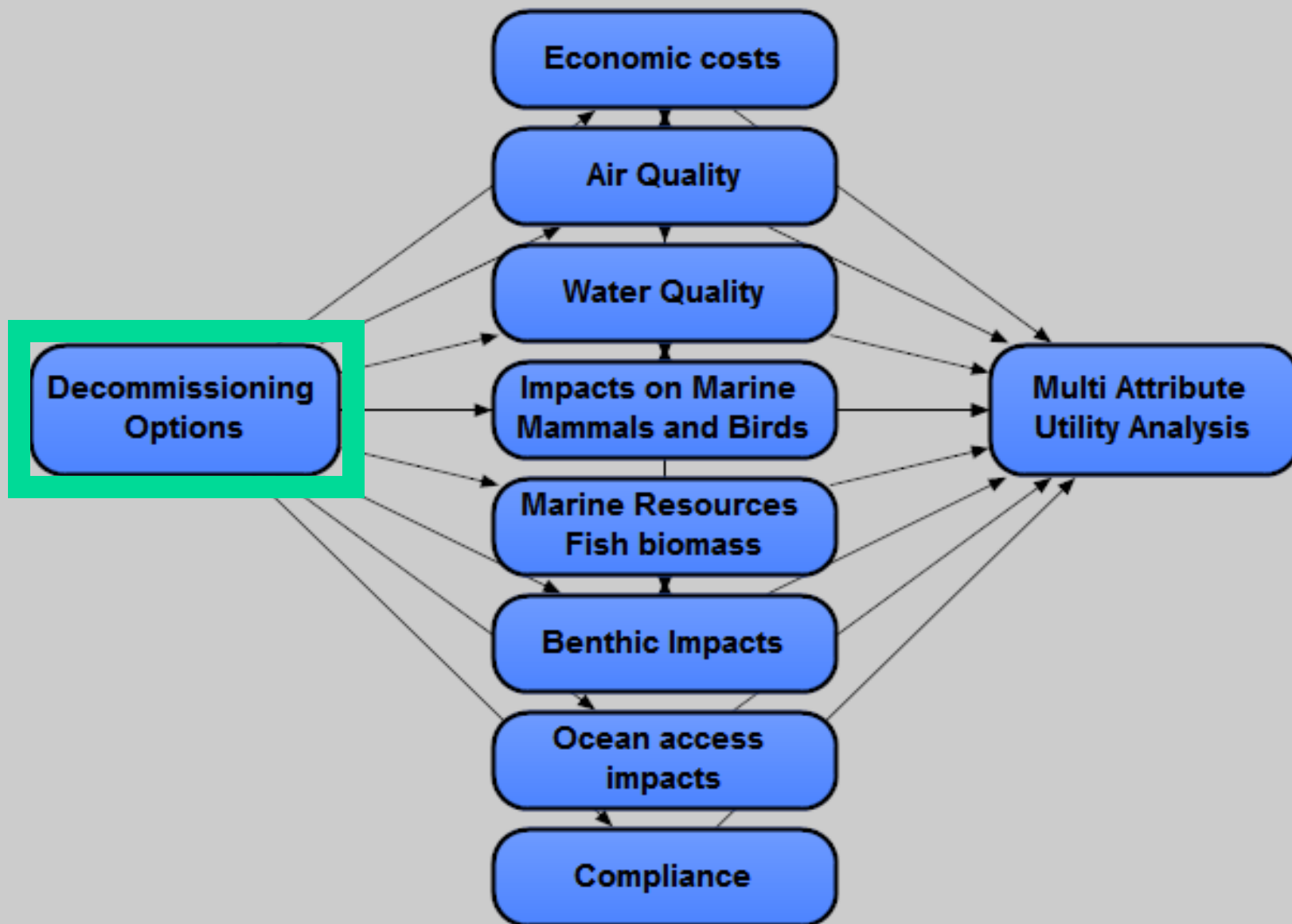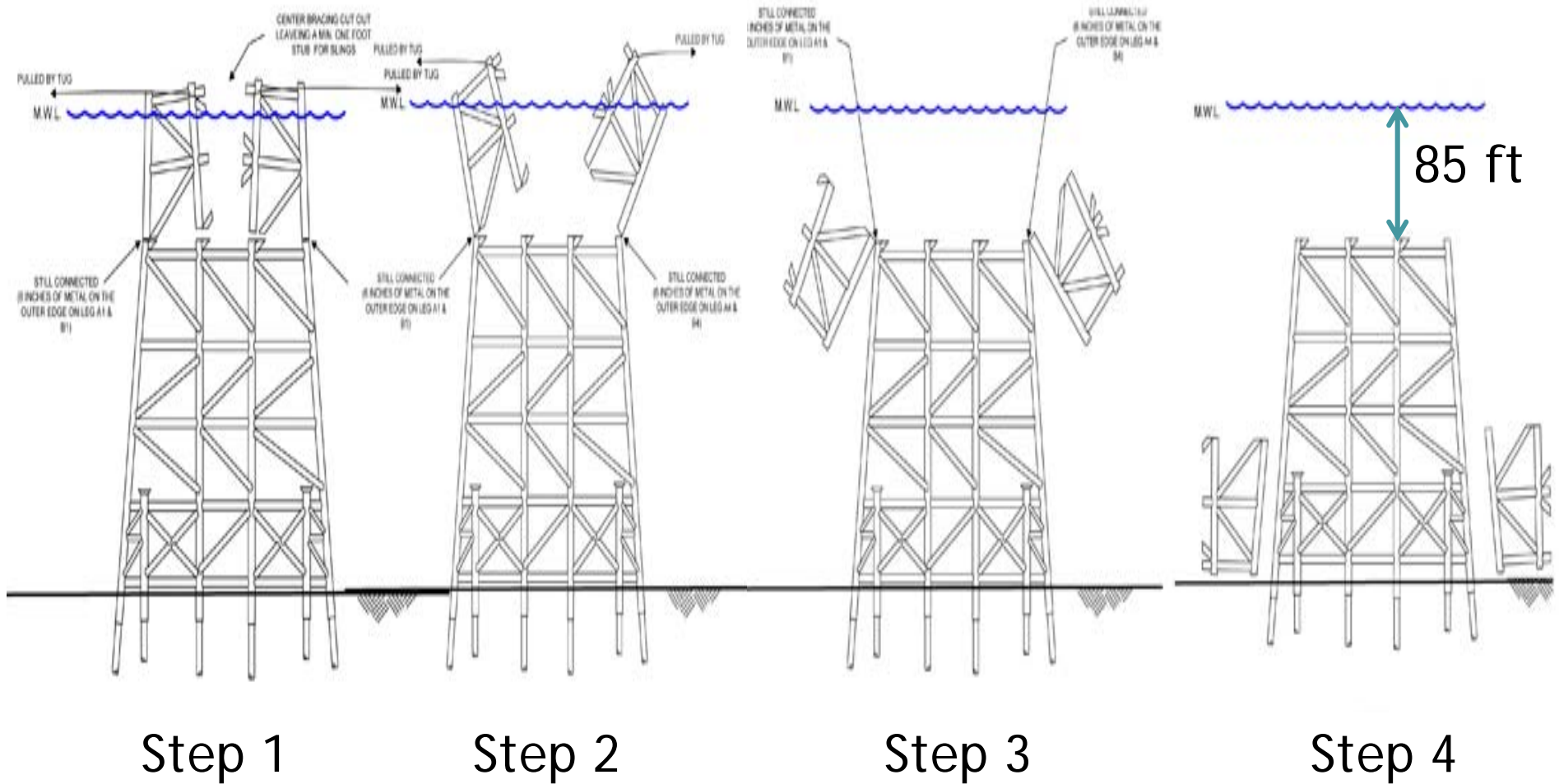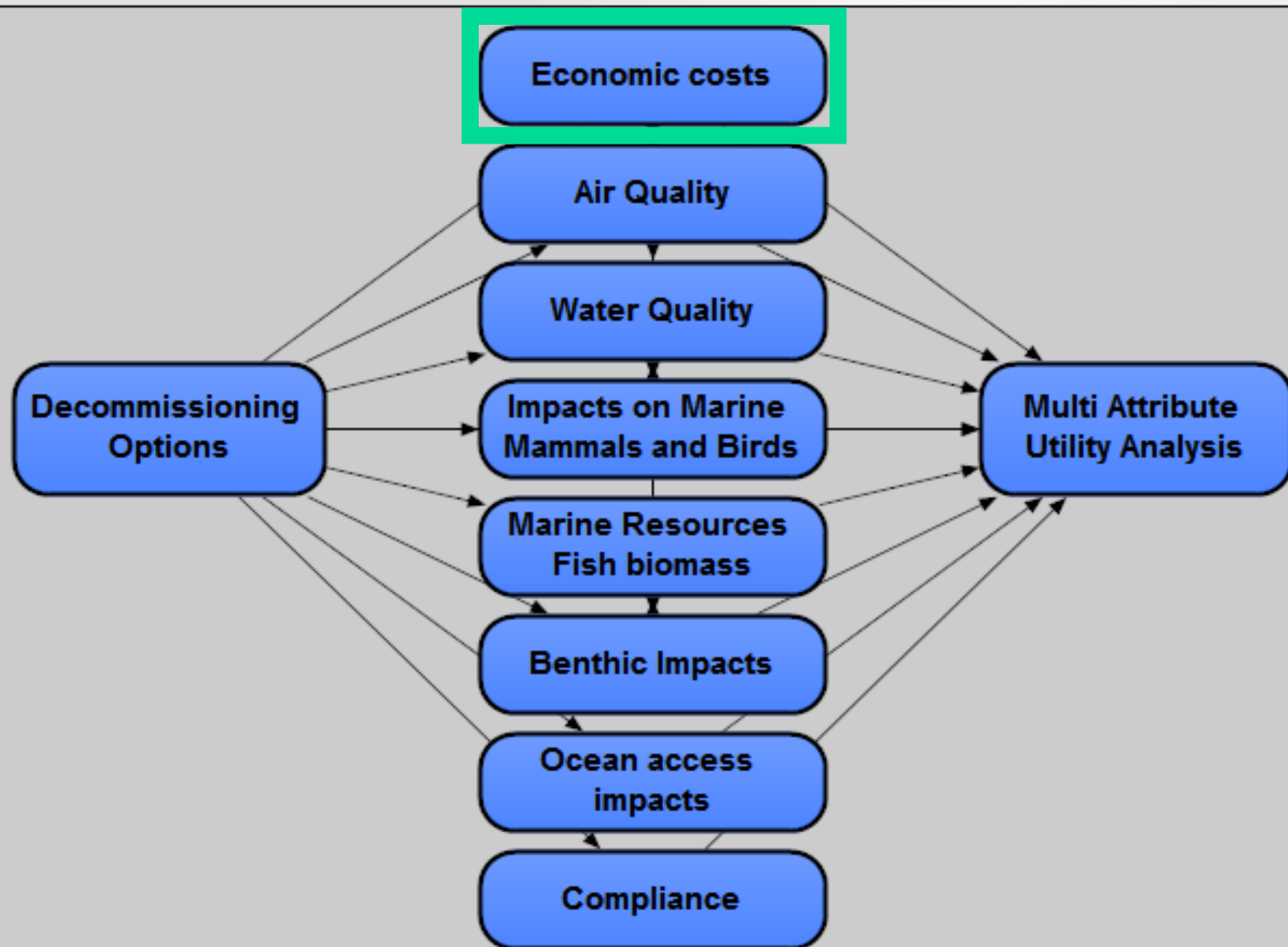
Decommissioning Options: Pruning the decision tree
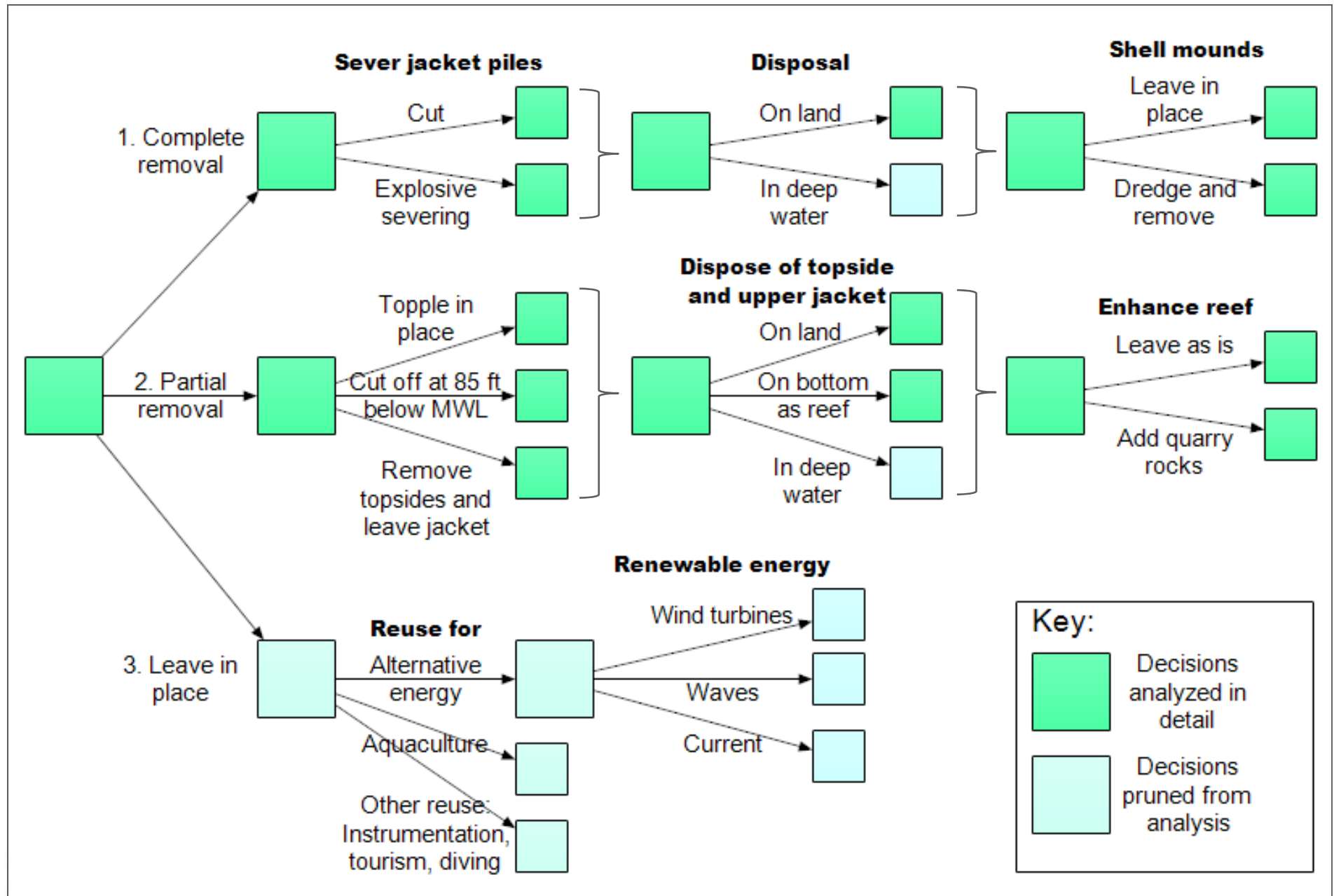
Partial removal ("rigs to reefs"):
Cut off at 85 ft below mean sea level

Step 1   Step 2   Step 3   Step 4

Economic costs of decommissioning

Tornado diagram: Range sensitivities
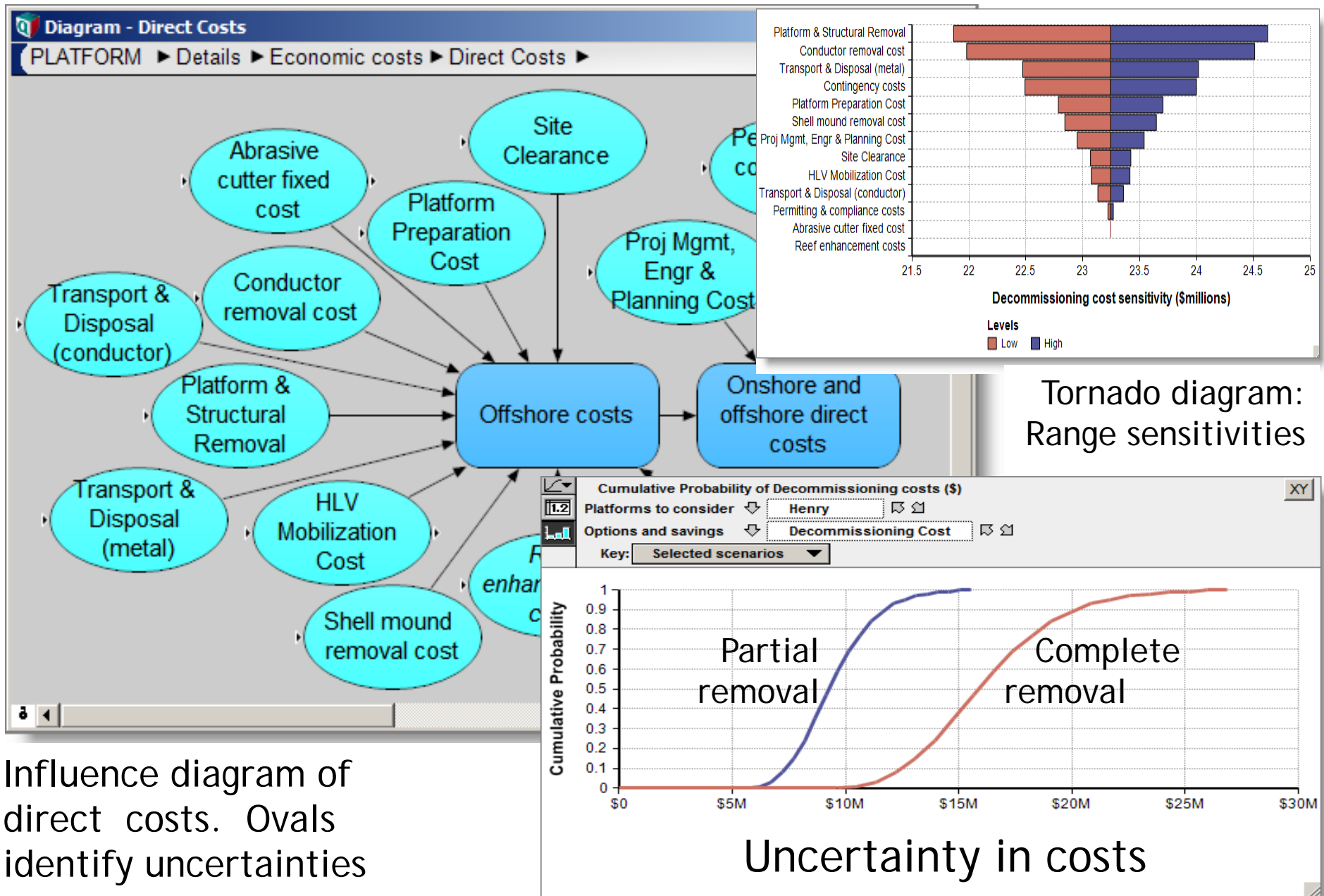
Influence diagram of direct costs. Ovals identify uncertainties

Uncertainty in costs
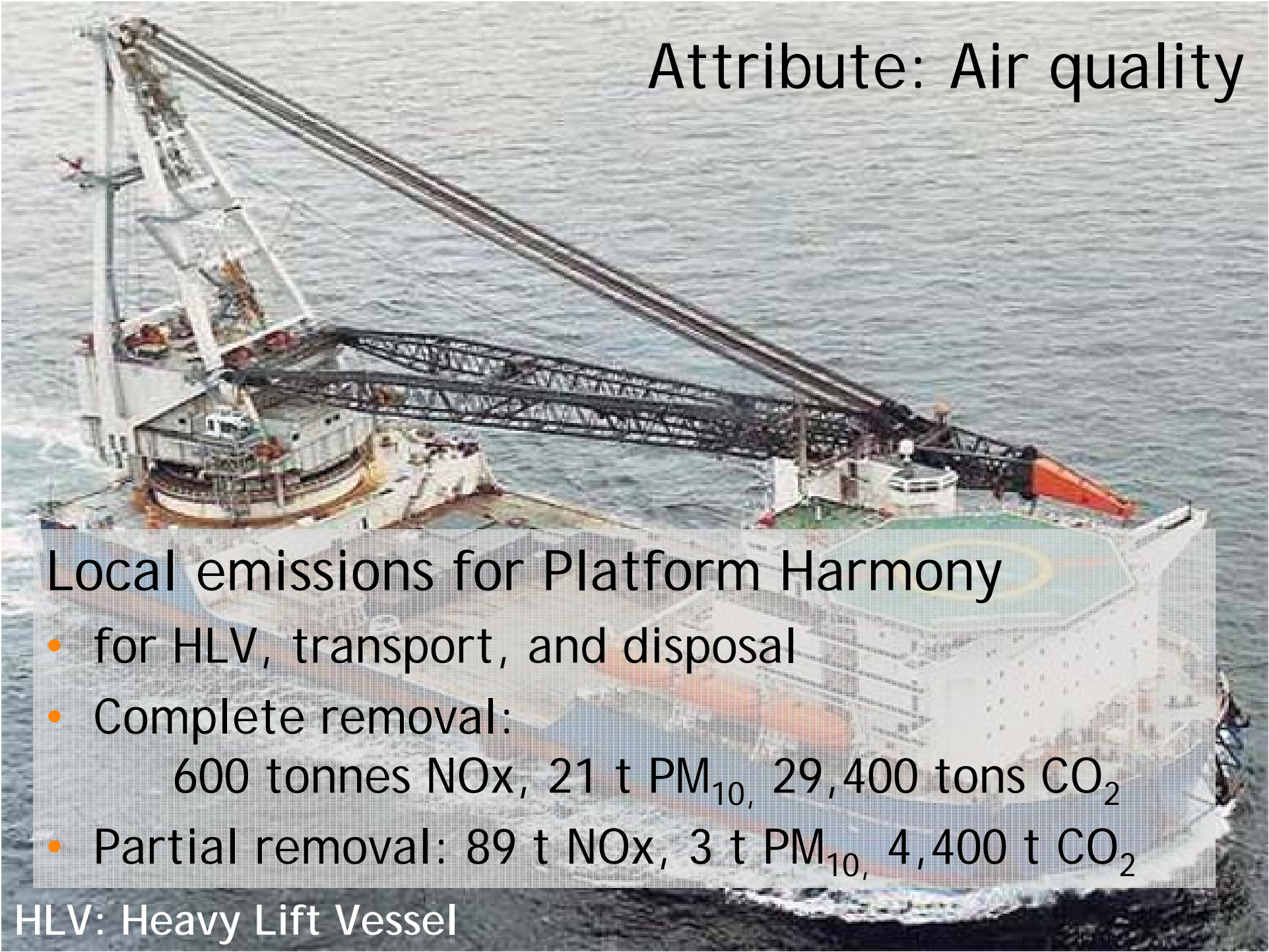
Probability distributions over decommissioning costs
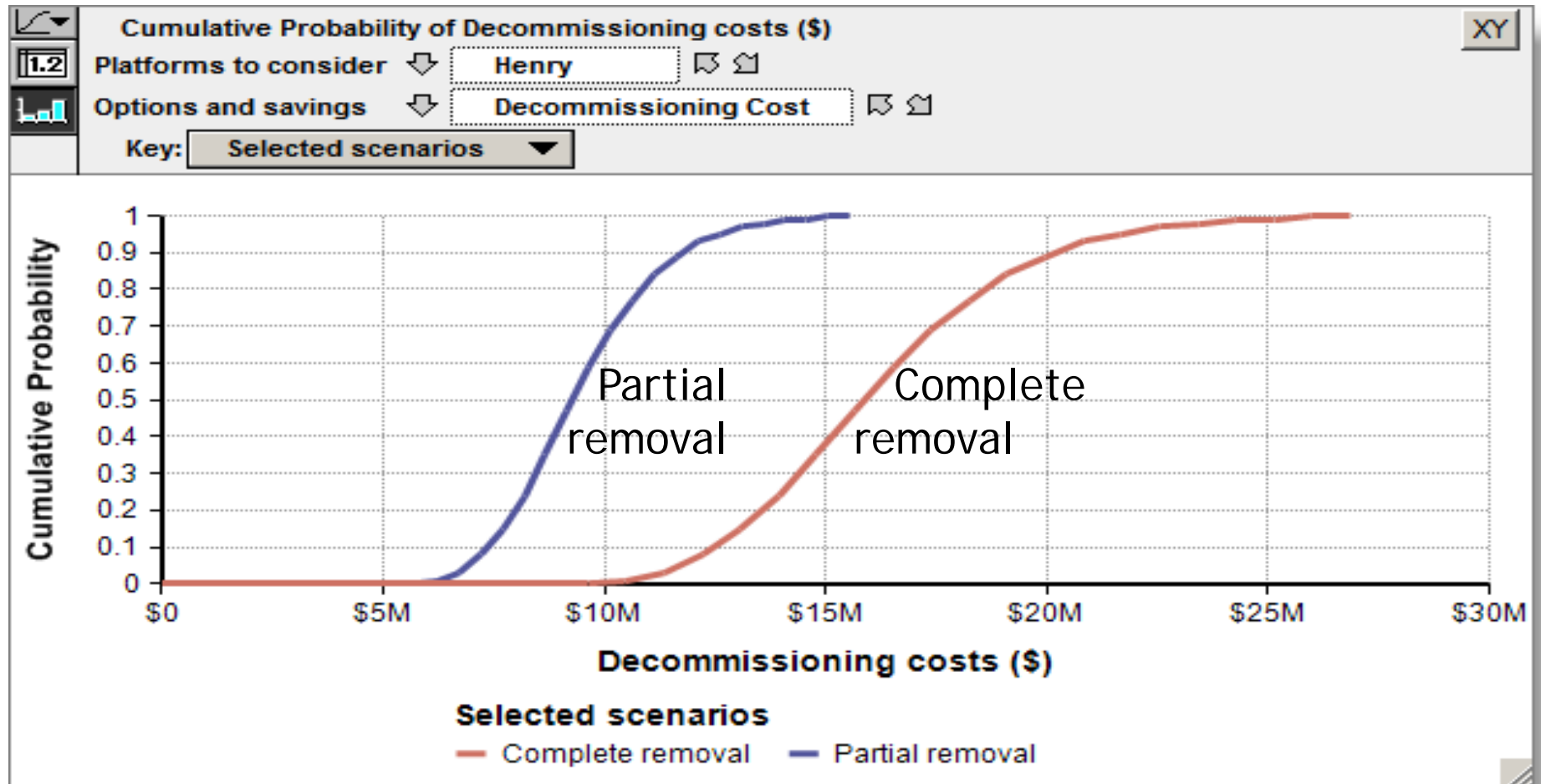
Uncertainty about cost of complete and partial removal: Distributions calibrated to estimation errors in 120 past estimates from 40 decommissioning projects (Byrd, et al).
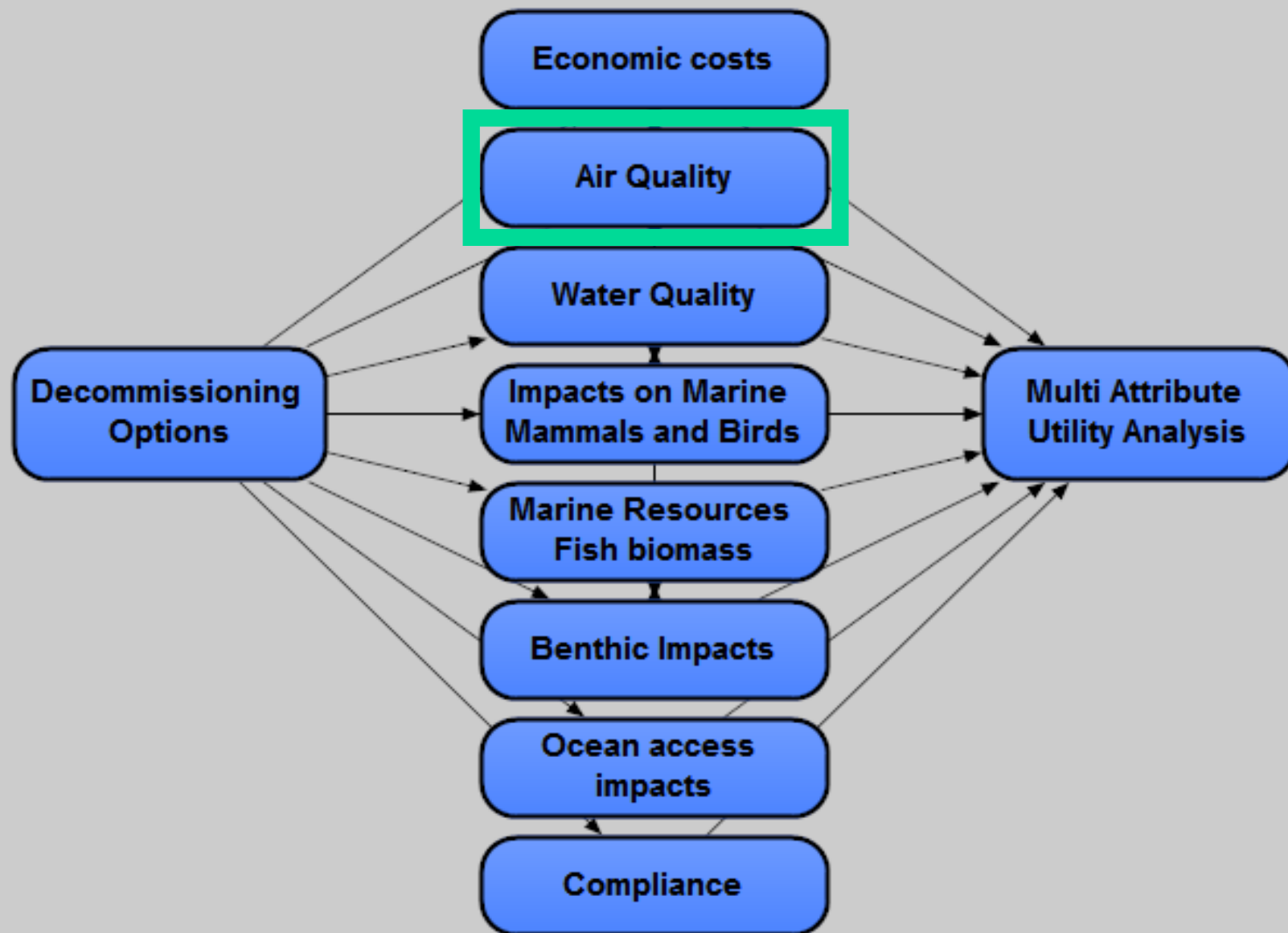
Attribute: Air quality

Local emissions for Platform Harmony
- for HLV, transport, and disposal
- Complete removal:
  600 tonnes NOx, 21 t PM_{10}, 29,400 tons CO_2
- Partial removal: 89 t NOx, 3 t PM_{10}, 4,400 t CO_2

HLV: Heavy Lift Vessel

Diagram - Model elements

PLATFORM Decommissioning Decision Support Tool ▶ Model elements ▶

- Economic costs
- Air Quality
- Water Quality
- **Impacts on Marine Mammals and Birds**
- Marine Resources Fish biomass
- Benthic Impacts
- Ocean access impacts
- Compliance
- Decommissioning Options
- Multi Attribute Utility Analysis
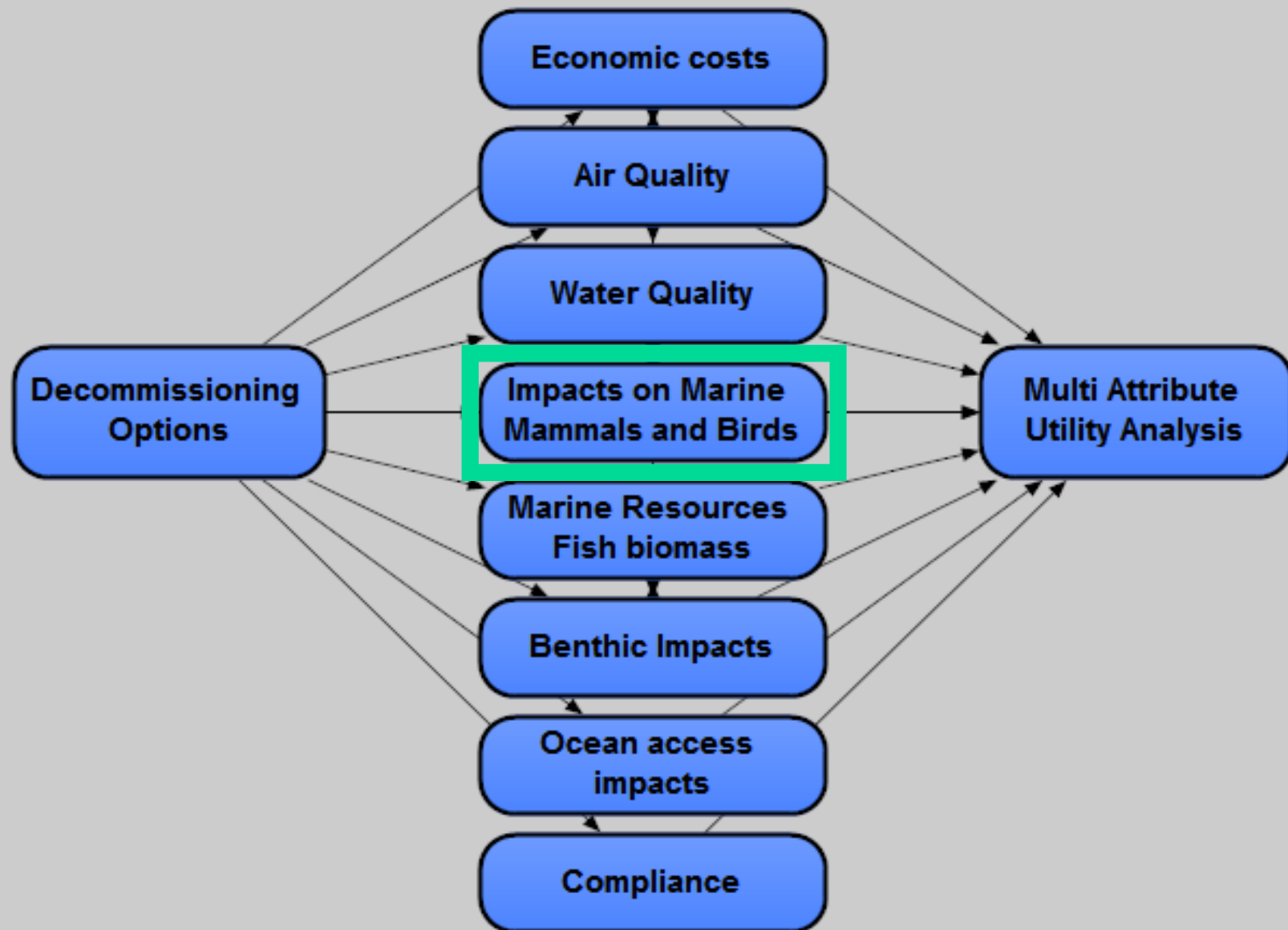
Defining and scoring an attribute: Impacts on Marine Mammals

Attribute: Impacts on Marine Mammals			
Level	**Description**	**Decisions**	**Score**
Best	Status quo, no effect	No action	100
Good			
Medium	Slight effect son movement or migration of marine mammals	Partial removal	70% ▼
Poor	Some disturbance or disorientation	Complete removal without explosive severing	50% ▼
Worst	Disturbance, disorientation, and possible mortality	Complete removal with explosive severing	0

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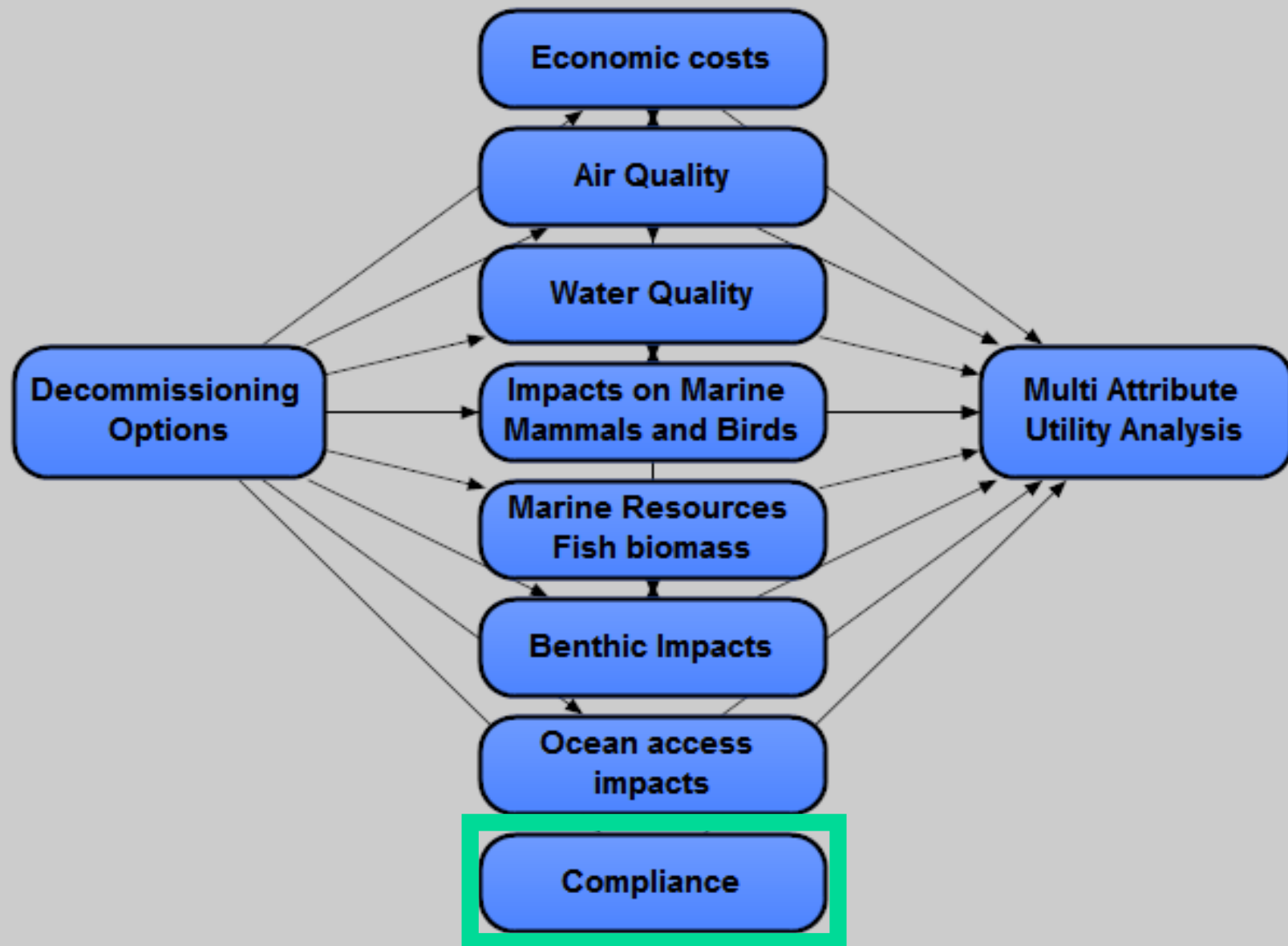
Attribute: Strict compliance
with platform leases requiring complete removal

Attribute: Strict compliance			
Level	**Description**	**Decision options**	**Score**
Best	Platform is completely removed and sea bed restored, compliant with lease	Complete removal including shell mounds	100
Medium	Jacket up to 85 feet below MWL and shell mounds left in place, non-compliant with lease.	Partial removal of platform	0% ▼
Worst	Entire platform left in place, non-compliant with lease.	Reuse of platform in place	0

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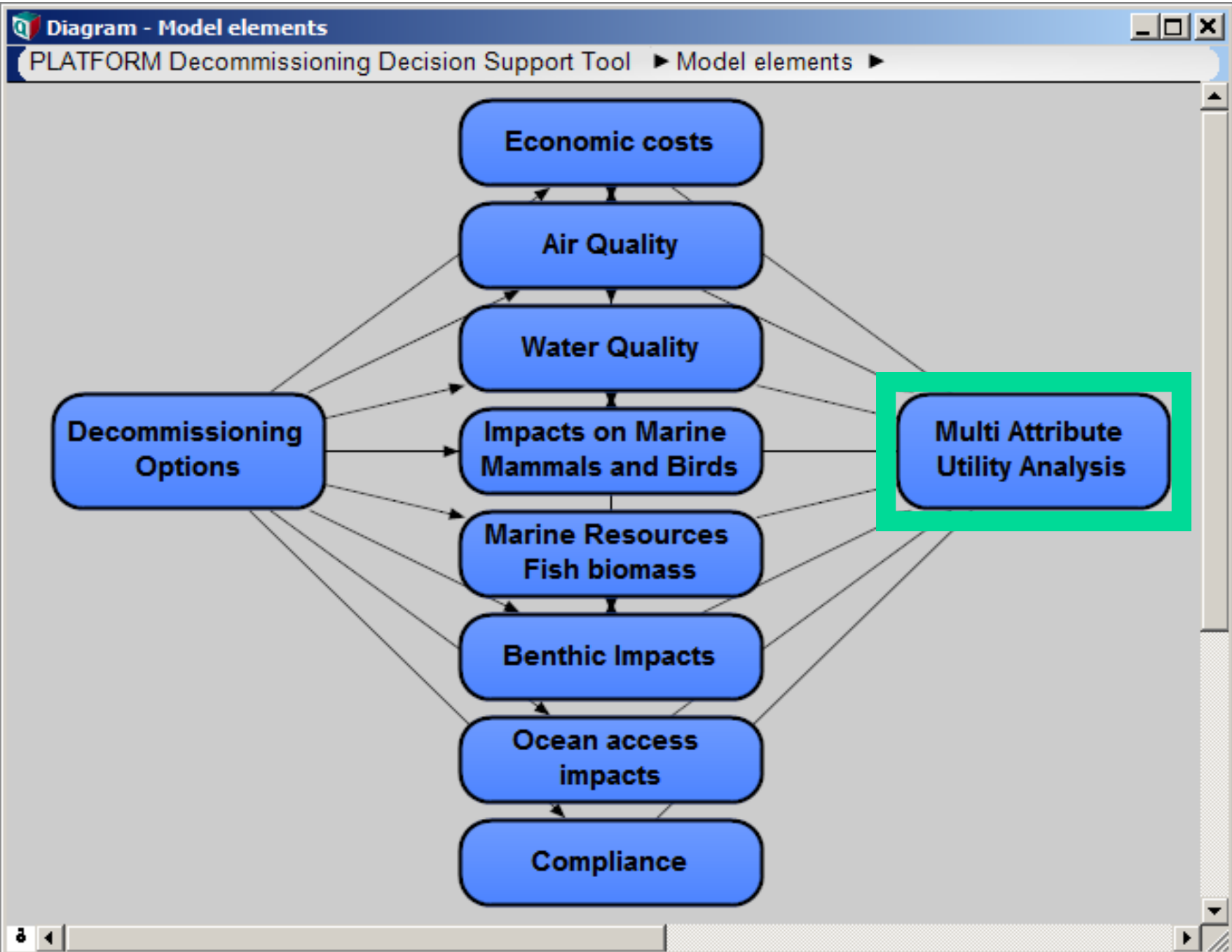
Assessing Swing Weights by Attribute

| Assessing swing weights by attribute				
Attributes	**Type**	**Best outcome**	**Worst outcome**	**Swing weight**
Costs	Quantitative	Status quo: $0	Complete removal: $250 million	100 ▼
Air quality	Qualitative	Status quo: Zero emissions.	Complete removal: Emissions from 4400 ton HLV onsite for 113 service days for complete removal.	40 ▼
Water quality	Qualitative	Status quo: No impact	Complete removal: Accidental discharge of contaminated material at surface, or shell mound removal with toxic sediment contaminates water column.	15 ▼
Marine mammals	Qualitative	Status quo: No impact	Complete removal: Explosive severing for complete removal causes disturbance, disorientation, and some mortality to marine mammals.	20 ▼
Birds	Qualitative	Deck removal: Reduced mortality from flight collisions. Loss of offshore roosting replaced by new	Deck removal: Loss of offshore roosting reduces fitness and survival, which outweighs reduced flight collisions.	10 ▼
Benthic impacts	Qualitative	Status quo: No impact	Complete removal: Anchoring or shell mound removal leads to widespread impact and spreading contaminants.	10 ▼
Fish production	Quantitative	Status quo: 10,000 Kg/y	Complete removal: Zero fish production	25 ▼
Ocean access	Quantitative	Removal: Adds 2 Sq N Mi	Status quo: Limits access	20 ▼
Strict compliance	Qualitative	Complete removal complies with lease	Partial or no removal violates lease.	50 ▼

SMARTS: Simple Multi-Attribute Rating Tool with Swing weights (Edwards & Barron,1994)

- Rate by swing – i.e. importance of change from worst to best outcome
- Select attribute with largest swing weight (100)
- Order from largest to smallest
- Select weight for each attribute

Tornado chart: sensitivity to swing weights and uncertainties

Each bar shows the effect on a variable of changing swing weight from 0 to 100

Higher level favors complete removal only for Compliance and Ocean access weight
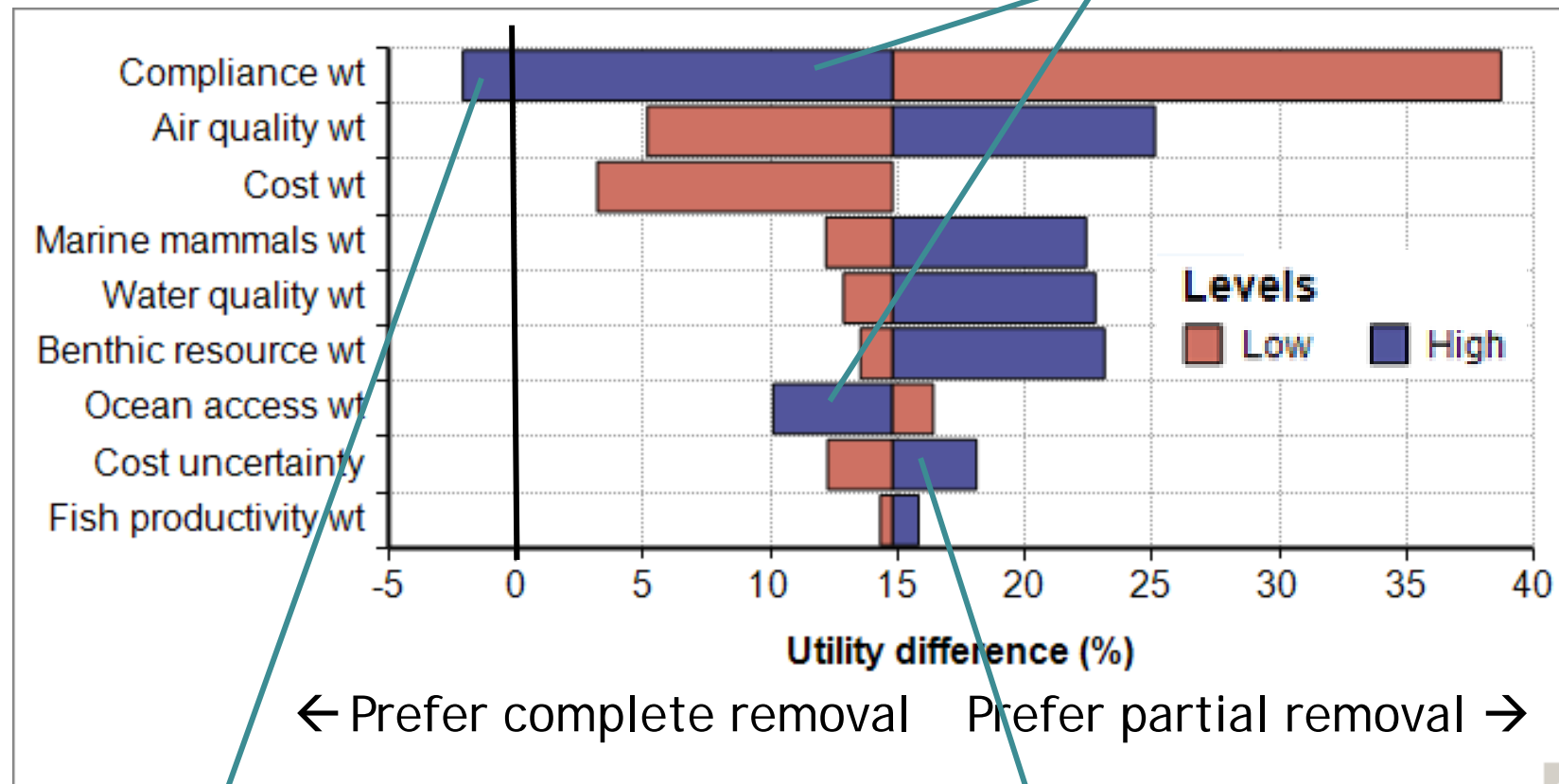
Compliance weight is the only variable that could change preference from partial to complete removal

Sensitivity to Cost uncertainty (change from 10th to 90th percentile) is smaller than 7 preferences (swing weights)

Exploring scenarios:
Selecting an option for each Platform

Platform	Scenario 1	Scenario 2
Platform A	1 Complete platform removal ▼	2 Partial platform removal ▼
Platform B	1 Complete platform removal ▼	
Platform C	1 Complete platform removal ▼	
Edith	1 Complete platform removal ▼	
Ellen	No action ▼	1 Complete platform removal ▼
Elly	2 Partial platform removal ▼	No action ▼

Dropdown options:
1 Complete platform removal
✓ 2 Partial platform removal
No action

Oil Production Facilities

- Federal Jurisdiction
- State Jurisdiction
- 3-Mile State Water Boundary

How weight on Strict Compliance changes the preferred decision

Changing swing weight on compliance

Platforms ordered by depth: Cost and environmental impact of complete removal increases with depth, so partial removal is preferred.

Number of platforms for which complete removal is preferred increases with the weight on strict compliance.

	Swing weight for Strict Compliance				
Platform	0	25	50	75	100
Esther					
Eva					
Emmy w/ sat					
Gina					
Hogan					
Edith					
Houchin					
Henry					
Platform A					
Hillhouse					
Platform B					
Platform C					
Gilda					
Holly					
Irene					
Elly					
Ellen					
Habitat					
Grace					
Hidalgo					
Hermosa					
Harvest					
Eureka					
Gail					
Hondo					
Heritage					
Harmony					
Num. platforms for Complete removal	0	4	20	24	27

Prefer partial removal

Prefer complete removal

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The essence of decision in one page

Full removal

Strict compliance with leases

Restore ecosystem integrity

Clear ocean access

Significant environmental impacts on air, water, and ecosystems

Expected cost $1.09 billion

Partial removal: Rigs to Reefs

Requires waiver of leases

Retain most biological production

Retain recreational fishing

Much reduced environmental impacts on air, water, ecosystems

Expected saving over $500 million

Operators save over $500 million

Split savings between operators and 55%+ to Ocean Conservation Fund

Driving the Public Policy Decision Process

"By clearly identifying the issues, synthesizing the best multi-disciplinary science, **daylighting the uncertainty**, and providing for unbiased review, **the tool .. was successful in distilling the rhetoric to meaningful discussion of trade offs and values**.

Further, the tool was made available to the public, its **assumptions and approach were transparen**t. Constituents had the opportunity to import various scenarios and learn the best approach.
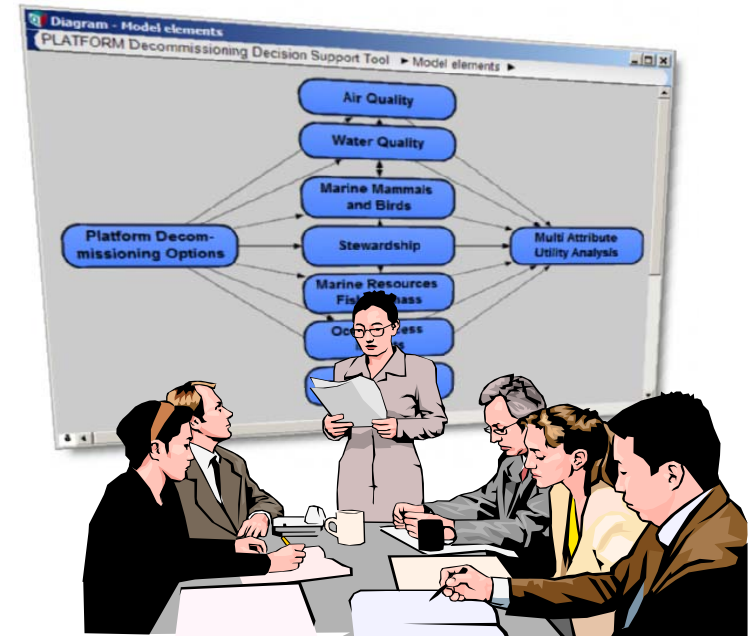
With this tool, sound legislation was passed that will serve California and our marine resources well."

Skyli McAfee, Executive Director

Emphasis added

Outcomes

- Legal options to waive "strict compliance" and change ownership of reefs to CA state

- Proposed split savings between operators and Ocean Conservation Fund

- Opinion shifted towards partial removal ("rigs to reefs") supported by (almost) all stakeholders:

- "Rigs-to-Reefs" bill AB 2503 passed almost unanimously by California State house

- Signed by Governor Schwarzenegger, Sep. 2010

Lessons learned

Sometimes

- An interactive decision tool can help stakeholders get deeper confidence and insights
- Sensitivity analysis can absolve us from requiring precise numbers
- Ingenuity can generate a dominating decision
- The interests of the energy industry and environmentalists don't *necessarily* conflict
- DA can help stakeholders realize that

For more...

- *ORMS Today*: "Rigs to Reefs: From Controversy to Consensus, A Decision Analysis for Decommissioning California's Offshore oil platforms", Max Henrion, Feb 2015

- *J. Int. Environmental Assessment and Management*: "A Multi-attribute Decision Analysis for Decommissioning Offshore Oil and Gas Platforms", Max Henrion, Brock Bernstein, Surya Swamy, (in press).

- Download the model with **analytica**® Free 101 from www.Lumina.com/case-studies

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Max Henrion, Brock Bernstein & Surya Swamy