Navigation/Coastal Structure Asset Management

Status of Activities

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US Army Corps of Engineers
BUILDING STRONG®

CORNERSTONE OF THE SOUTHWEST!

What is USACE AM Vision

"A ***persistent catalyst*** for holistically integrating and enhancing the sustainment, restoration, modernization, and disposition of USACE water resources to continually serve the Nation."

USACE Asset Management

Inventory (what you own)

Indentify Condition (what kind of shape is it in, is it functioning)

Asset Management Strategy (min risk, max return)

Navigation/Coastal Structures Asset Management

The Problem:

- Numbers of Navigation/Coastal structures in our portfolio estimated to be 1000+ including breakwaters, jetties, piers, revetments, groins, dikes, bulkheads, seawalls, etc.
- Most structures are over 50 years old (some <100 yrs!)
- Various methodologies among District's to prioritize and fund assessments and repairs
- Tens of Millions $ spent each year repairing structures
- Not enough funding to cover the necessary repairs
- Competition for federal funds getting tighter each year

Navigation/Coastal Structures Asset Management

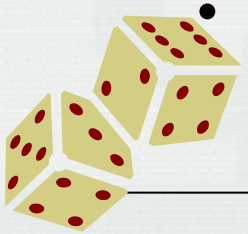
The Need:

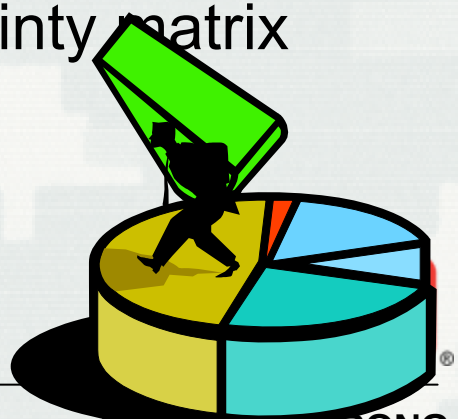
- Inventory - what do we own portfolio-wide.
- Condition Assessment - structural and functional - what kind of shape is it in and is it working.
- Risk and Consequences – how long will it continue to work and what are the results of in-action.
- Prioritization for Repair - rational method for assessing and prioritizing maintenance and repair of structures. Quantifiable metrics needed when determining coastal structure significance (economic, environmental, safety, recreation, etc.).

- Methodology that is objective, balanced, and fair
- Useful at District, Division, and Headquarters levels

Risk-Informed and Performance-Based Budget

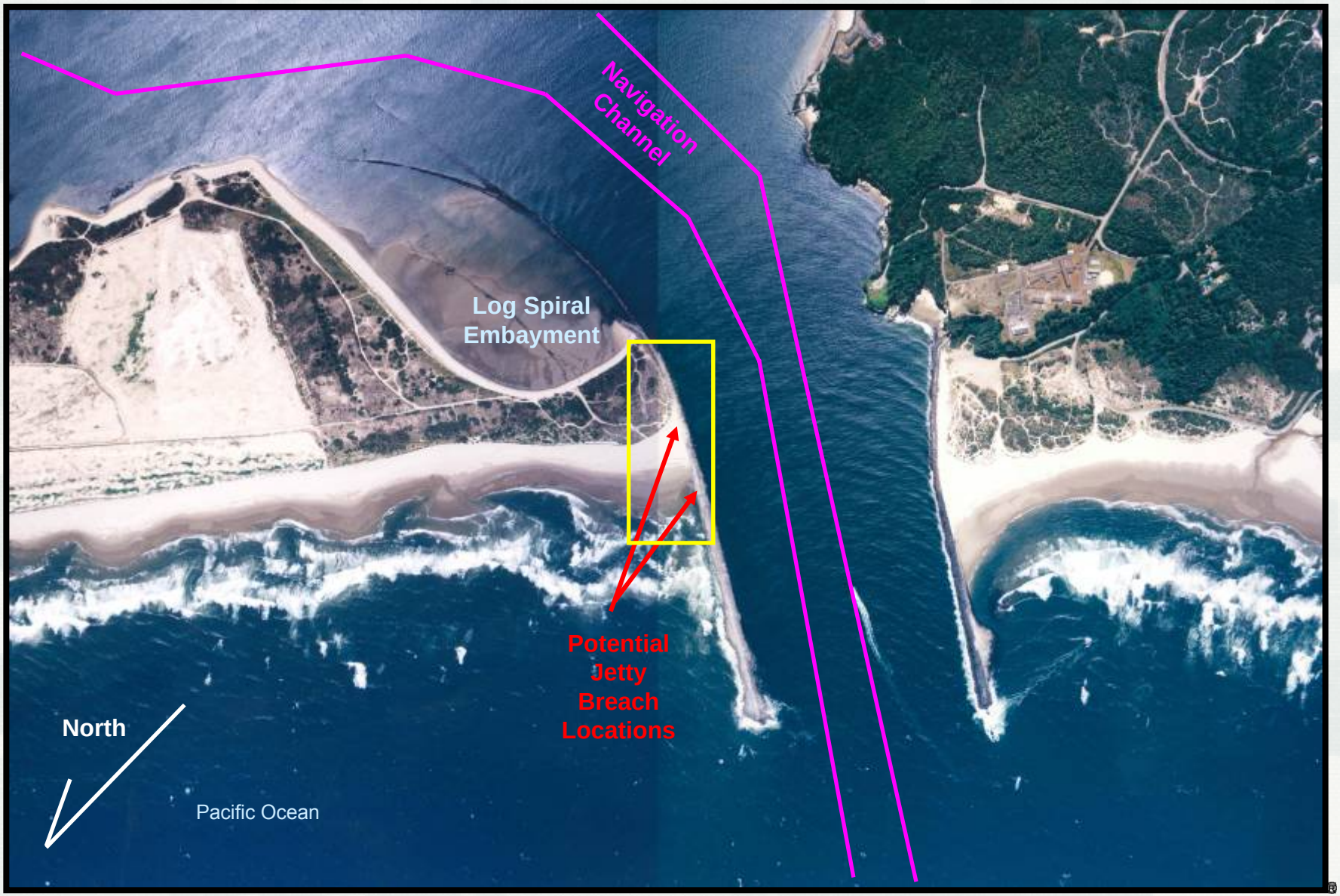
- Competition for federal funds getting tighter each year
- Goal to consistently prioritize nation's critical coastal infrastructure
- Risk-based matrices being developed in all major areas of Navigation business line
- Inland Navigation has jump on the process
- Final goal – to produce risk & uncertainty matrix to replace old condition index system
- Being used for FY10 budget process





Critical Columns in Navigation Budget Sheet

- Probability/Condition Rating
- Consequence/Economic Impact Rating
- Relative Risk Ranking
- Secondary Qualifiers:
  - Caretaker Activities
  - Critical Harbors of Refuge
  - Subsistence Harbor
- Consequence
- Remarks

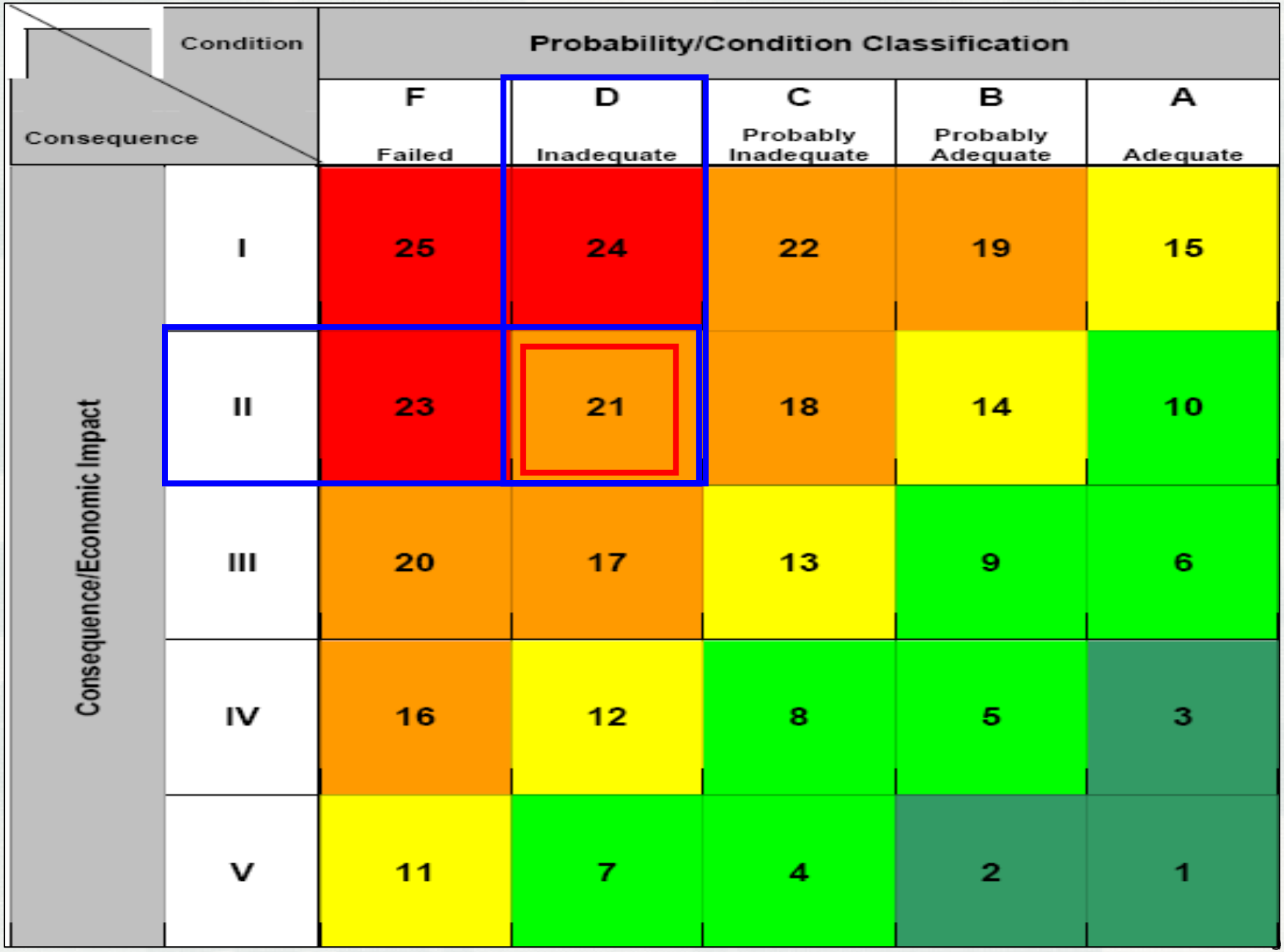

Navigation Channel
Log Spiral Embayment
Potential Jetty Breach Locations
North
Pacific Ocean


2008 1 7

Table V-9
Navigation Structures
Probability/Condition

Condition Level		Probability / Condition
GOOD	A	Failure to the point navigation will be measurably impacted is unlikely within budget cycle Project fully accomplishing its intended purpose
MODERATE	B	Low risk of failure to the point navigation will be measurably impacted within budget cycle
POOR	C	Medium risk of failure to the point navigation will be measurably impacted within budget cycle
FAILING	D	High risk of failure to the point navigation will be measurably impacted within budget cycle
FAILED	F	Condition severely restricts or halts navigation within budget cycle

Table V-10 Navigation Structures Consequence/Economic Impact	
Consequence Level	**Consequence Description**
1	Demonstrated highest economic impact[1] **Imminent** life safety impact Critical to safe navigation by commercial vessels at High Use Navigation Project (>10M tons) Critical to safe navigation at DoD Strategic Ports
2	Demonstrated High economic impact[1] **Probable life safety impact.** **Probable impacts to subsistence harbors/harbors of refuge.** High economic loss (5 - 10 M Tons) Probable life safety impact Alternate modes of transportation exist for Energy Distribution Facilities, but at a higher cost than water borne transportation
3	Demonstrated Moderate economic impact[1] **Possible life safety impact.** **Possible impacts to subsistence harbors/harbors of refuge.** Moderate economic loss (1 - 5 M Tons) Possible life safety impact
4	**Low economic impact[1] and no life safety impact. Little impacts to subsistence harbors/harbors of refuge.** Low economic impact (<1M Tons) No life safety impact
5	**Negligible economic and no life safety impact. No impacts to subsistence harbors/harbors of refuge.** Negligible economics (Recreation Harbors, No commercial Activity) No life safety impact.


Condition
Consequence
Probability/Condition Classification
F
Failed
D
Inadequate
C
Probably Inadequate
B
Probably Adequate
A
Adequate
Consequence/Economic Impact
I
25
24
22
19
15
II
23
21
18
14
10
III
20
17
13
9
6
IV
16
12
8
5
3
V
11
7
4
2
1

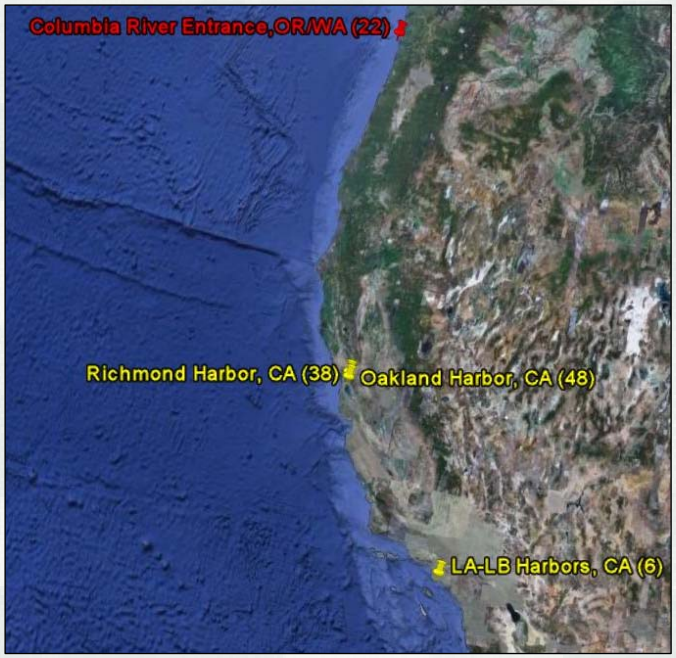
- Last year the Board requested the field to complete a self-assessment survey on the condition of their structures
- We currently have about a 90% return and from this selected the top 67 Ports based on tonnage. Out of these 26 have structures.
- Based on a RYG scale we found –

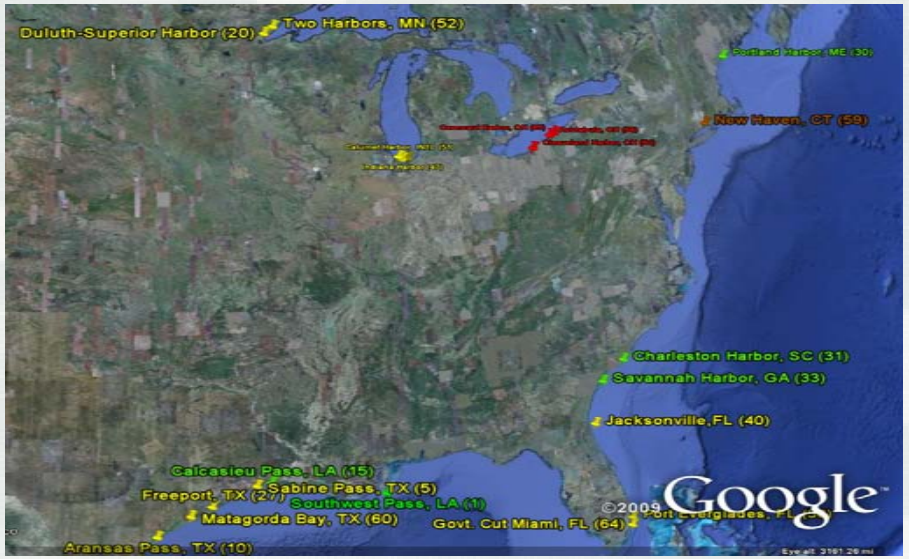
  4 RED 16 YELLOW 5 GREEN

B	C	D	E	F
Navigation Project or Coastal Structure	Probability of Failure Condition	Consequences of Failure	Caretaker Critical Harbor	Relative Risk Table V-3
	High Damage Level/Not Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	
	Medium Damage Level / Functioning	Moderate Navigation and Economic Impact	No	
	Low or No Damage	Low Navigation and Economic Impact		
Crescent City - Outer Breakwater	Low or No Damage	High Navigation Impact, High Economic Loss, Safety	Yes	Minimal
Crescent City - Inner Breakwater	Low or No Damage	High Navigation Impact, High Economic Loss, Safety	Yes	Low
Crescent City - Sand Barrier	Low or No Damage	High Navigation Impact, High Economic Loss, Safety	Yes	Minimal
Humboldt Bay North Jetty	High Damage Level/Not Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	Med-High
Humboldt Bay South Jetty	High Damage Level/Not Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	Med-High
Noyo Harbor - North Jetty	Medium Damage Level / Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	Med
Noyo Harbor - South Jetty	Medium Damage Level / Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	Med
Bodega Bay - North Jetty	High Damage Level/Not Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	Med-High
Bodega Bay - South Jetty	High Damage Level/Not Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	Med-High
Bodega Bay - Spud Pt Breakwater	Low or No Damage	Moderate Navigation and Economic Impact	Yes	Minimal
Richmond Outer Harbor - Training W	Medium Damage Level / Functioning	High Navigation Impact, High Economic Loss, Safety	Yes	Med
Berkeley Marina - Rubblemound Bre	Low or No Damage	Moderate Navigation and Economic Impact	No	Minimal
Berkeley Marina - Sheetpile Breakwa	Low or No Damage	Moderate Navigation and Economic Impact	No	Minimal
Oakland Harbor - South Jetty	Medium Damage Level / Functioning	Moderate Navigation and Economic Impact	No	Low
San Leandro Marina - Breakwater	Low or No Damage	Moderate Navigation and Economic Impact	No	Minimal
Fisherman's Wharf Outer Breakwate	Low or No Damage	High Navigation Impact, High Economic Loss, Safety	No	Minimal
Fisherman's Wharf West Breakwater	Low or No Damage	Moderate Navigation and Economic Impact	No	Minimal
Fisherman's Wharf East Breakwater	Low or No Damage	Moderate Navigation and Economic Impact	No	Minimal
Gas House Cove Breakwater	Low or No Damage	Moderate Navigation and Economic Impact	No	Minimal
Pillar Point Harbor - West Breakwate	Medium Damage Level / Functioning	High Navigation Impact, High Economic Loss, Safety	No	Low
Pillar Point Harbor - East Breakwate	Low or No Damage	High Navigation Impact, High Economic Loss, Safety	No	Minimal
Santa Cruz Harbor - West Jetty	Low or No Damage	High Navigation Impact, High Economic Loss, Safety	No	Minimal

West Coast | Gulf Coast | Southeast Coast | Northeast Coast | Great Lakes

Structure Rating for Top Commercial Ports



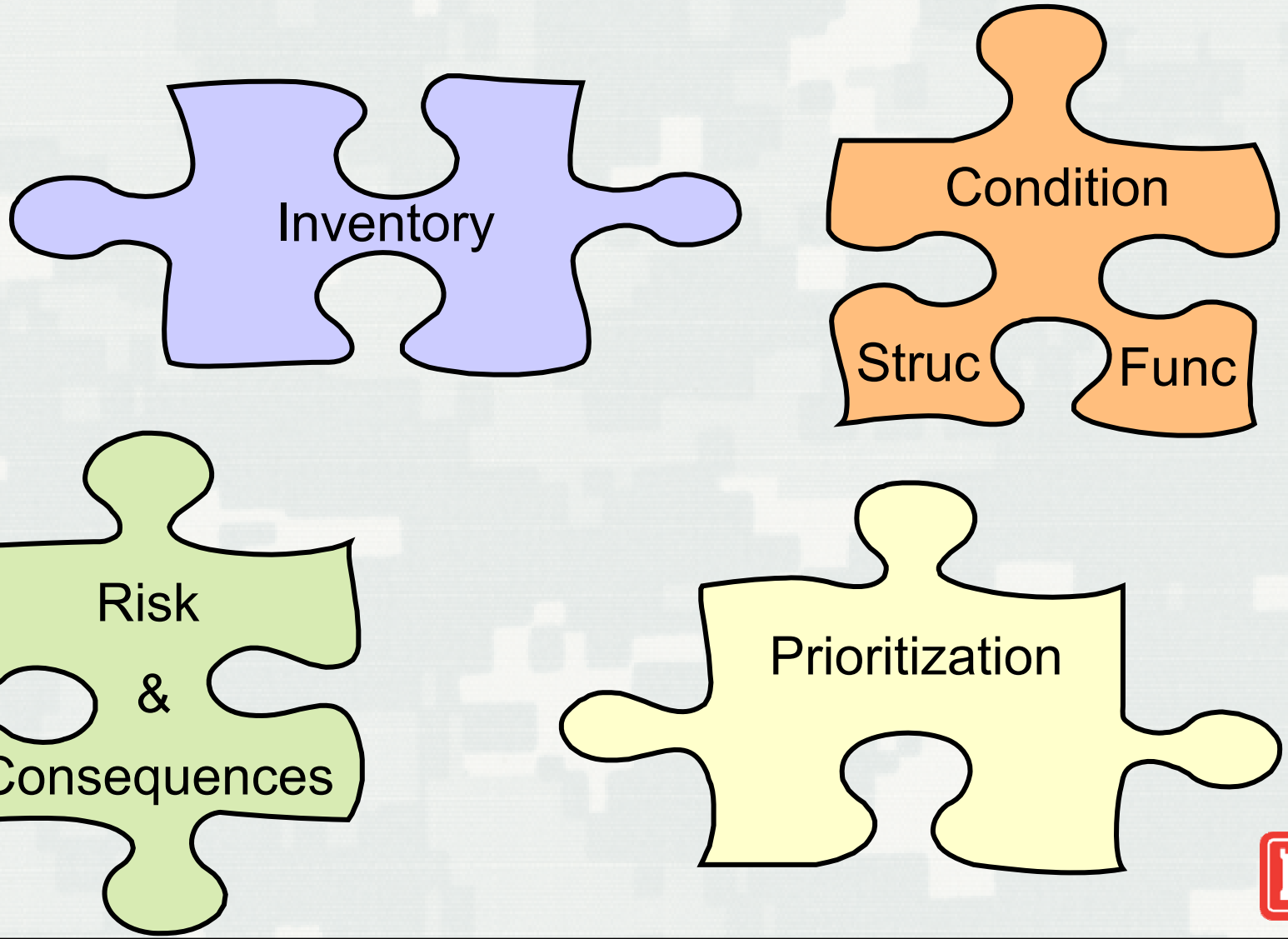


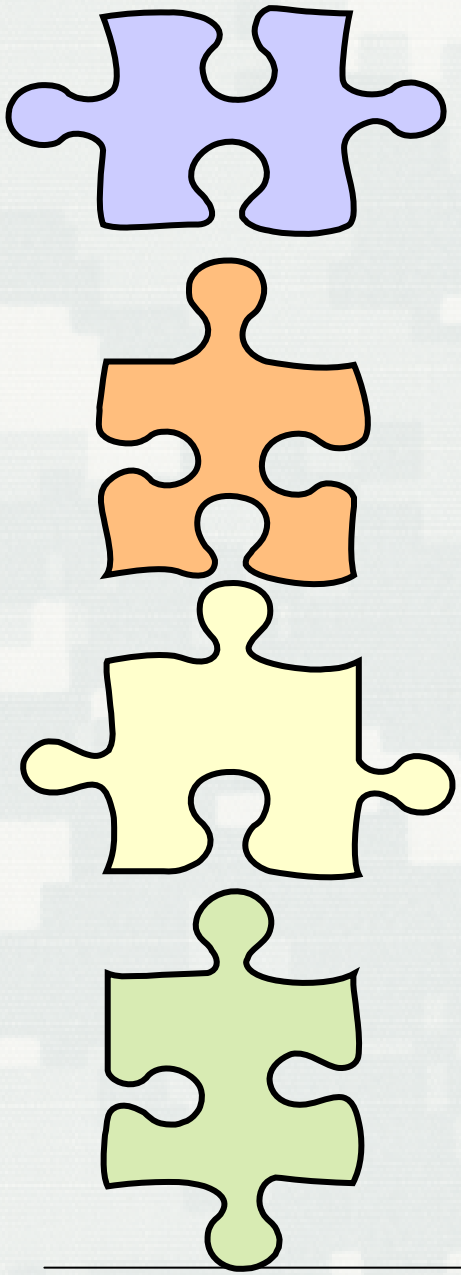
Navigation/Coastal Structures Asset Management

What do we need to do -

Develop a rational, ***consistent*** *and* ***transparent*** *method for managing* ***O&M expenditures*** *on critical navigation and coastal infrastructure.*

Where are we now ???





Inventory

Condition
Structural
&
Functional

Risk
&
Consequences

Prioritization

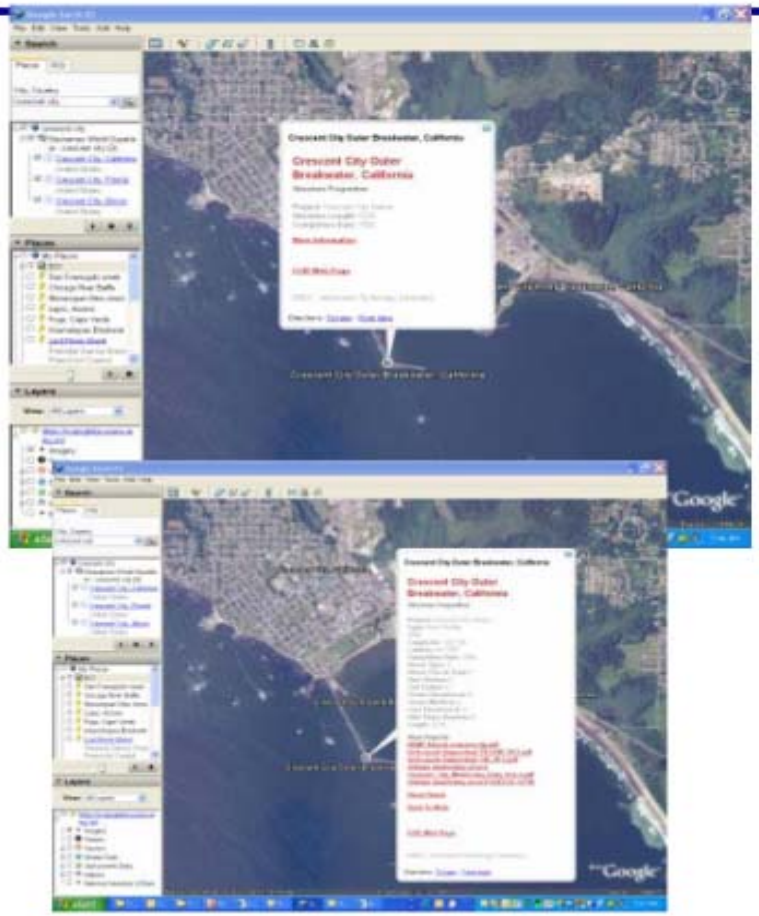
ECID
FEMS

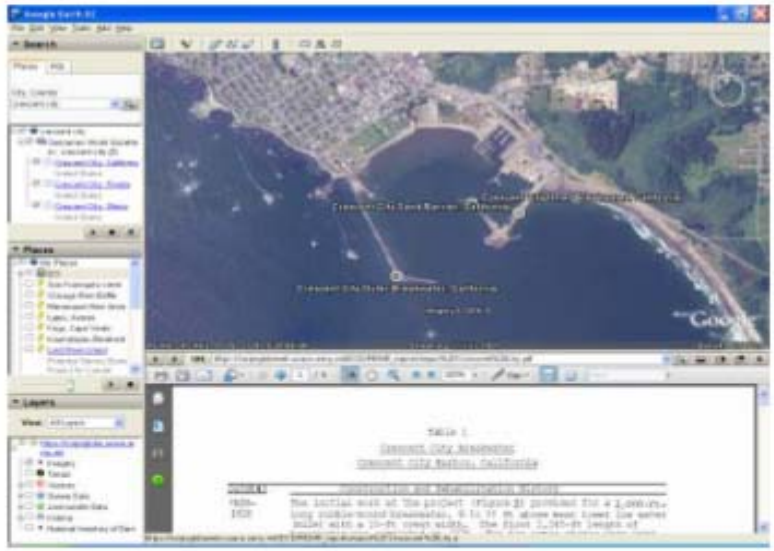
COSCA

CSMART

CAMS

Enterprise Coastal Inventory





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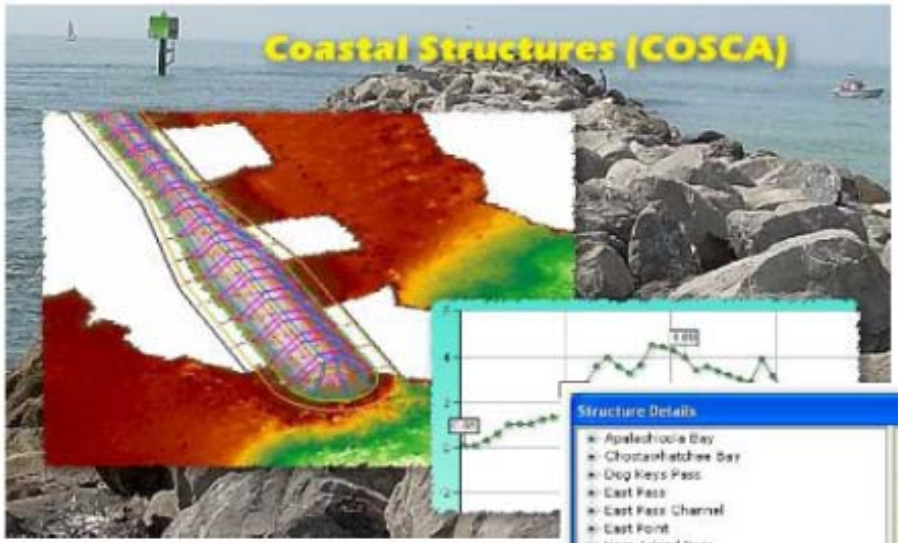
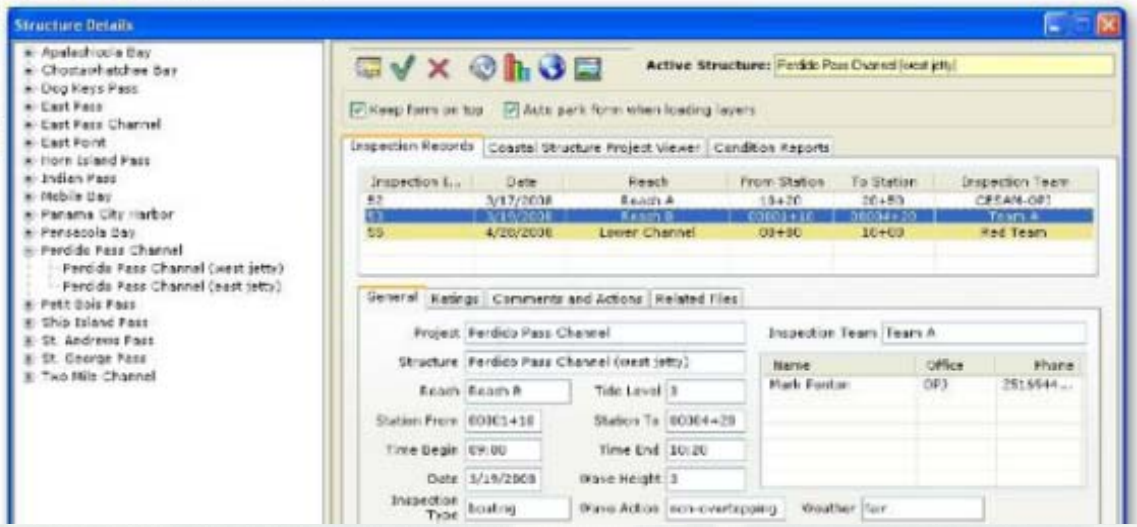
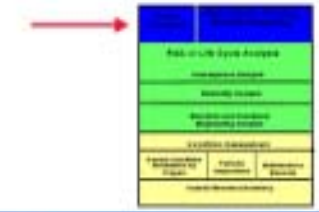
Condition Assessment



Coastal Structure Condition Assessment System COSCA

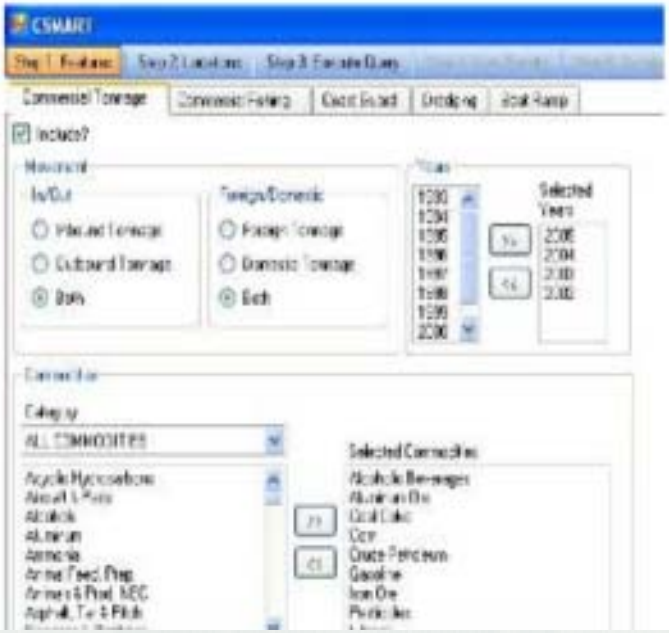


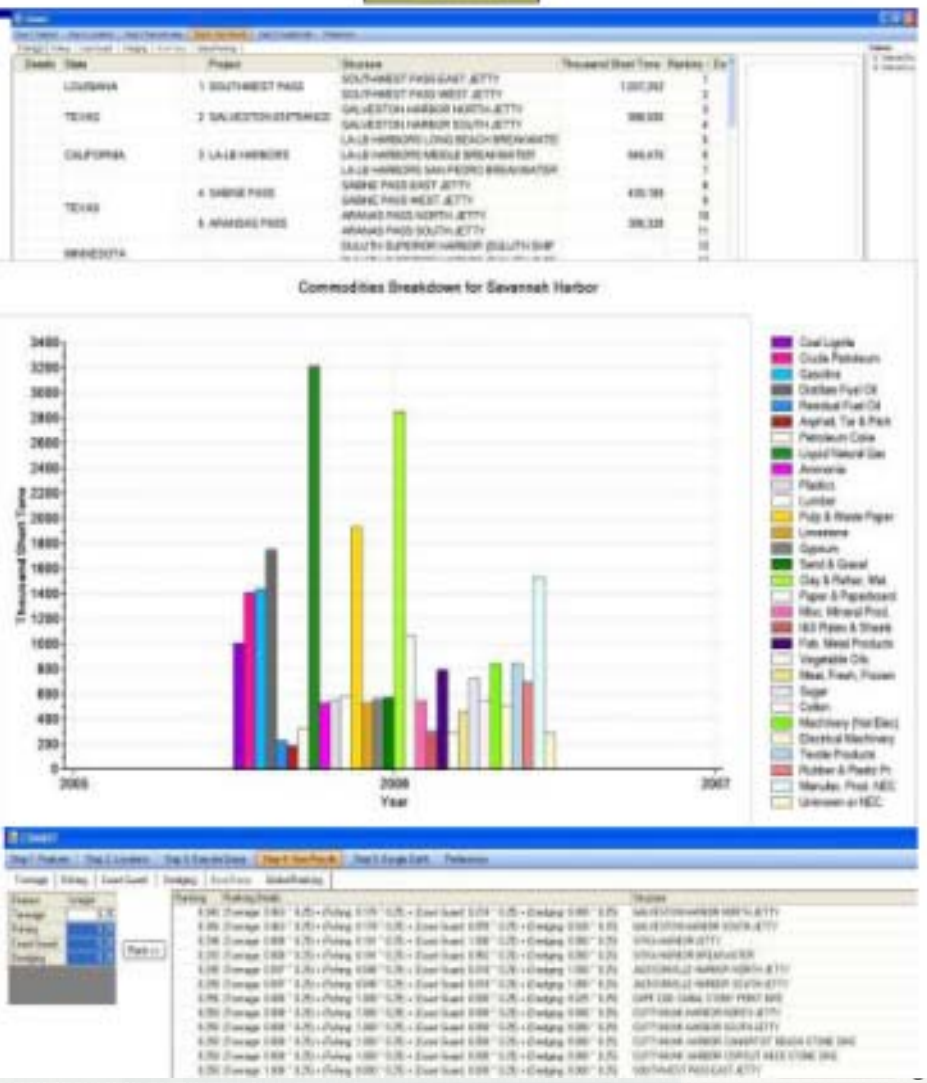
Asset Ranking



ERDC
Engineer Research and Development Center

Coastal Structures Management, Analysis, and Ranking Tool CSMART

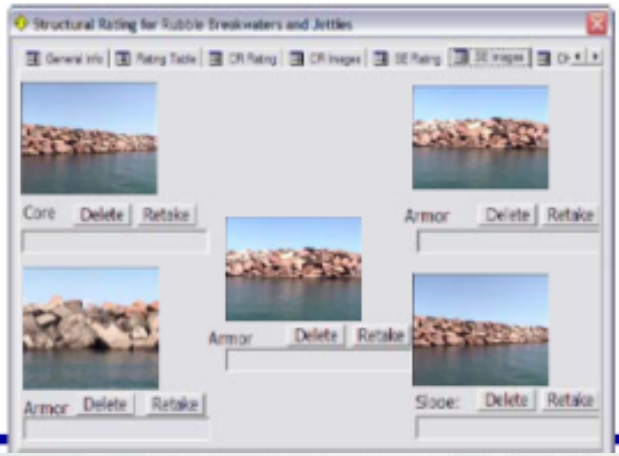


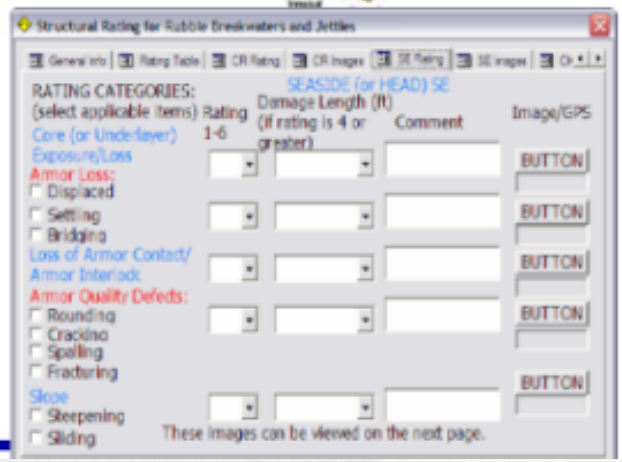


New Technologies

- Inspection methods and tools
  - Hammer with forms, camera, laser
  - Terrestrial Lidar and Geo-Swath multi-beam sonar
- National Coastal Mapping Program
- Condition index forms
- GIS and COSCA software

HAMMER





Greatest Challenge is coupling Structural Integrity with Functionality for Complete Condition Assessment

Establish Simple Relationships Between Structure Condition, Function, and Economic Consequences

- Established transportation cost savings as a function of water depth at all GL commercial harbors/channels, also know cost to shippers associated with delays
- Relationship between crest height/structure cross section & structure function (wave attenuation)
- Relationship between wave climate and vessel loading (?), delays to vessel movements in a harbor, damages to moored vessels
- Relationship between structure condition and harbor shoaling(?)

➢ Can function and consequences be modeled, applied consistently, and generalized in meaningful ways to allow application on the scale required for asset management?

Mission Economics Impacts

- Separate by port type
  - Small port, large commercial port
- Valuation or tonnage or number of vessels moved through channel - OMB wants monetized metrics: cargo value, damages reduced. Data available from AIS/LOMA (tracking all ship movement).
- Valuation of property - damages reduced, benefit categories, project formulation
- Other usage generating economic benefit
- Separate by structure type - breakwater, jetty, hybrid
- Importance of economic metric
- Subsistence harbor and supplying harbor

Consequences – Mission Economics Impact Rating

Rating Definitions

1 **Extreme Economic Impact:**
- Quantity of goods transported > 10 Mt
- Total Cost
  - Value of goods transported > (?? Depends on range in database)
  - Value of property vulnerable > ? (damages reduced, benefit categories, project formulation, Other usage generating economic benefit)
  - Value of other usage and other benefits lost
- Estimated project cost (this goes somewhere else)
- Importance of goods transported and cost

2 **High Economic Impact**
- Quantity of goods transported > 5-10 Mt
- Total Cost
  - Value of goods transported > (?? Depends on range in database)
  - Value of property vulnerable > ? (damages reduced, benefit categories, project formulation, Other usage generating economic benefit)
  - Value of other usage and other benefits lost
- Importance of goods transported

3 **Medium Economic Impact**
- Quantity of goods transported > 1-5 Mt

4 Low Economic Impact
- Quantity of goods transported < 1 Mt

5 Negligible Economic Impact

Consequences - Life Safety Impact Rating

Ratings Definitions

- Extreme LS Impacts
  - Demonstrated life safety impact directly attributable to structure condition
  - Significant modification of use based on life safety risk
- High LS Impacts (>50% chance during 2 year budget cycle)
  - Probable life safety impact directly attributable to structure condition
  - Probable impact to subsistence harbors/harbors of refuge
  - Probable impact to Coast Guard search and rescue
- Possible LS impacts (<50% chance during 2 year budget cycle)
  - Possible life safety impact
  - Possible impact to subsistence harbors/harbors of refuge
  - Possible impact to Coast Guard search and rescue
- Low LS impacts
  - subsistence harbors/harbors of refuge
  - Coast Guard search and rescue present
- No LS impacts
  - Not a subsistence harbors/harbors of refuge
  - No Coast Guard search and rescue

Consequences – Security Impact Rating
Ratings Definitions

- Critical to navigation or project operation at DoD Strategic Ports
- Coast Guard national security mission
- Other national security - border patrol, CG boats at non-CG facilities

Consequences – Regulatory Impact Rating
Ratings Definitions

Mandated action by resource agency due to structure

Enhanced environmental sustainability due to structure

Examples of regulatory laws

Non-compliance due to structure

ESA - Endangered Species Act

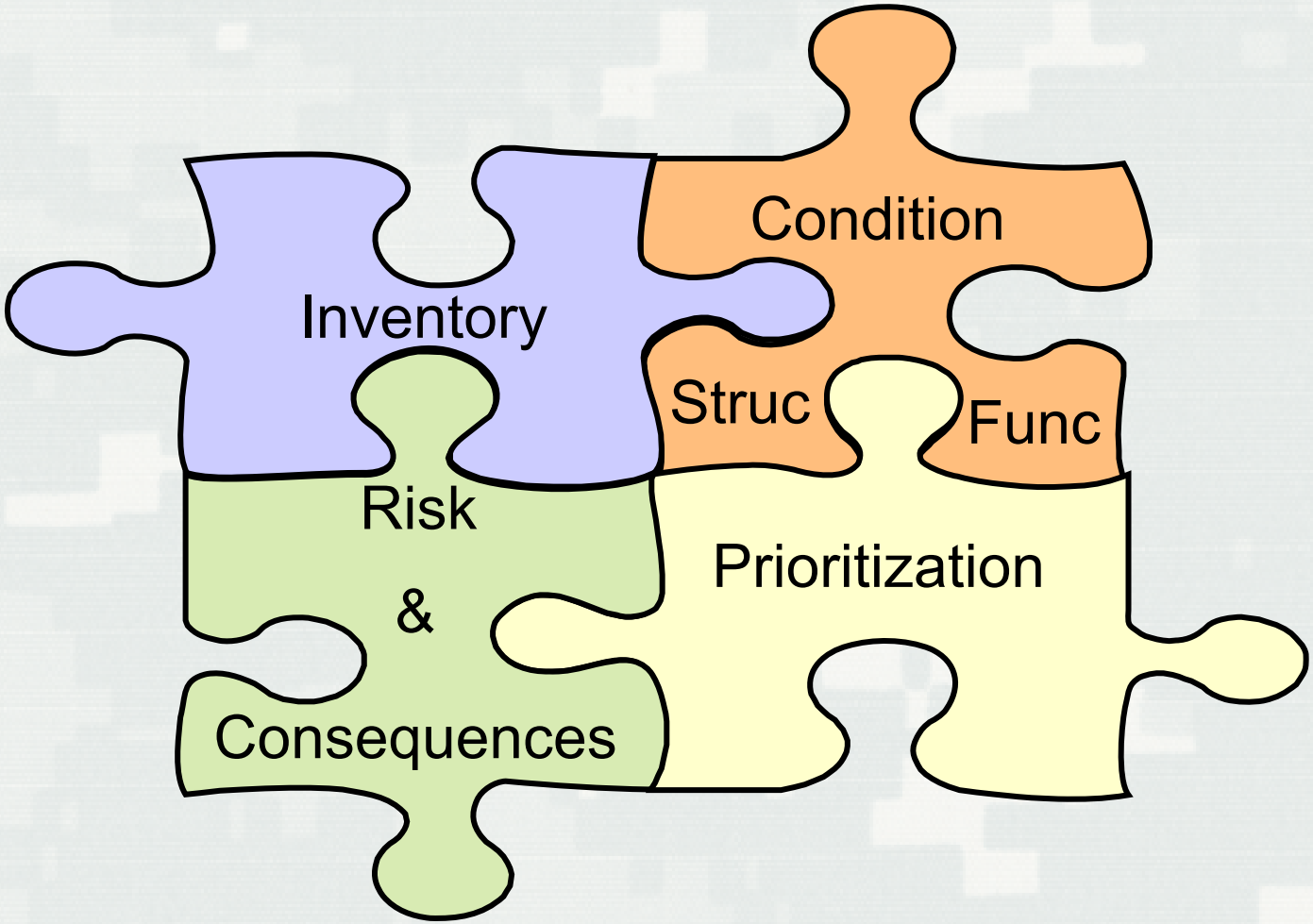
EFH - Essential Fish Habitat

EPA - Open Water Disposal

Monitoring and Mitigation

CDF - Confined Disposal Facility, Clean Water Act non-compliance

Asset Management System for Navigation and Coastal Structures



So What's Next ?

- Continue to work on the puzzle pieces
- Provide products to the fields as soon as developed
- Make improvements to the current process as defined in the Budget EC
- Link the puzzle pieces as soon as possible
- Establish an Portfolio Assessment type process for Coastal Navigation Structures

How to do this ?

Follow a Portfolio Assessment Process to find the top 10 or 20 worst Structures in the Country

OCA Teams

- Establish **Teams** which are **Regionally (MSC) Staffed, Experienced, and Multi-Disciplinary**. Number of teams and staff consistent with number of projects within the MSC.

- Teams are lead by One Participating Member (Preferably District neutral). Lead can also be an assessor.

- Team Members rate assets within their area of expertise.

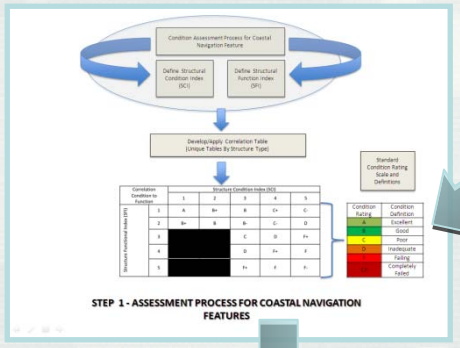
- Teams will use existing data provided by the Districts

- All members and lead maintain continual oversight during assessment to assure that ratings are assigned in accordance with standardized processes. Adherence to consistency. ***Engaged Discussion !***

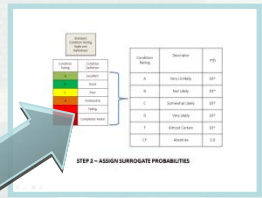
OCA PROCESS

Using all of our puzzle pieces -

Condition ***(Performance and/or Standards Deficiency)***	***Performance Impact***	***Response***
Minor/Moderate	***Marginal***	***Not Required***
Moderate/Significant	***Moderate***	***Investigate/Plan Prepare***
Major	***Significant***	***Urgent Attention***
Severe	***Critical***	***Immediate Action***



STEP 1 - ASSESSMENT PROCESS FOR COASTAL NAVIGATION FEATURES



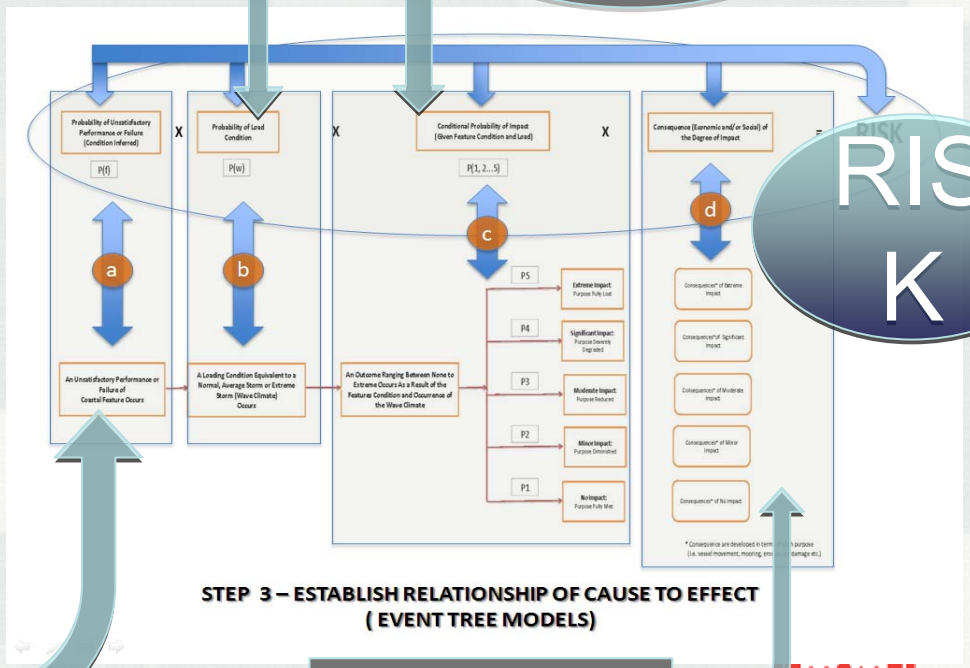
STEP 2 – ASSIGN SURROGATE PROBABILITIES

Developed Tables For Each Structure Type through Formal Expert Opinion Elicitation (EOE)

P(w)

Load Condition P(w)

a. Normal Storm Event 0.50
b. Average Storm Event 0.10
c. Severe Storm Event 0.01



STEP 3 – ESTABLISH RELATIONSHIP OF CAUSE TO EFFECT (EVENT TREE MODELS)

RISK

Quantified Economic and Social Consequences For Each Degree of Impact

Standard Condition Rating Scale and Definitions

Condition Rating	Condition Definition
A	Excellent
B	Good
C	Poor
D	Inadequate
F	Failing
CF	Completely Failed

Condition Rating	Descriptor	P(f)
A	Very Unlikely	10^{-5}
B	Not Likely	10^{-4}
C	Somewhat Likely	10^{-3}
D	Very Likely	10^{-2}
F	Almost Certain	10^{-1}
CF	Absolute	1.0

STEP 2 – ASSIGN SURROGATE PROBABILITIES

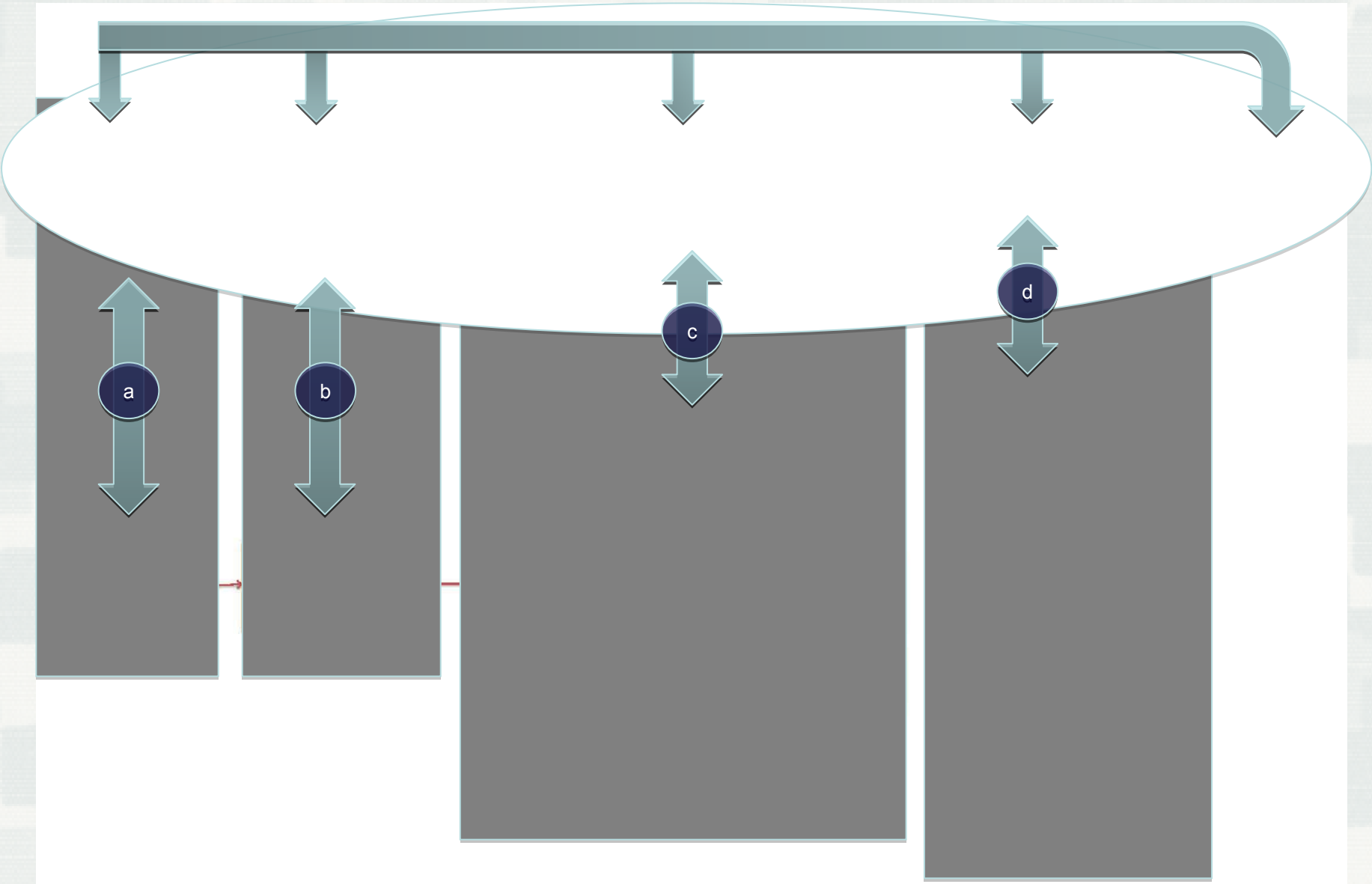
▸Risk analysis involves breaking a complex system down into its fundamental components, then determining potential failure mechanisms and the physical processes that could cause each mechanism.

► Risk analysis methodologies commonly applied to embankment dams and levees include use of event trees and fault trees.

► An event tree is a visual representation of all the events that can occur in a system

► A fault tree is a graphical tool that shows the relations between the various elements of a system to compute the reliability of that system.

► Use of either method allows the detailed analysis of potential failure mechanisms and provides qualitative insight as to how a series of events leading from an unsatisfactory performance or failure might unfold. These methods also can be used quantitatively, with the help of probabilities, to assess the reliability of the system.

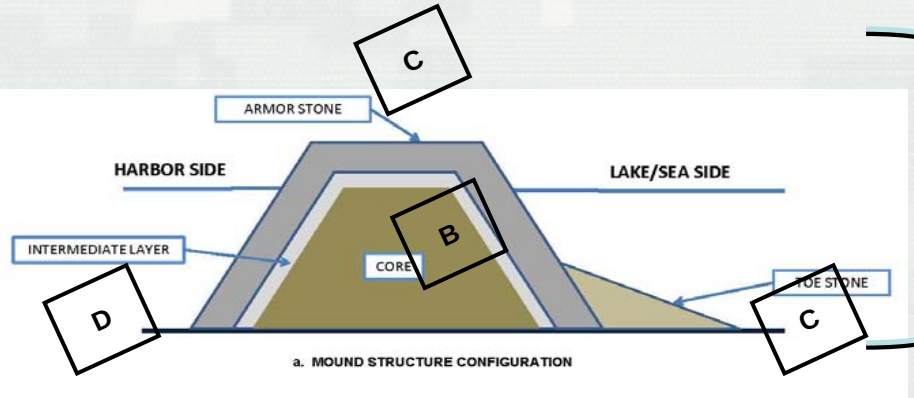


STEP 3 – ESTABLISH RELATIONSHIP OF CAUSE TO EFFECT
(EVENT TREE MODELS)

►The probability of unsatisfactory performance may be *inferred from the assessed condition* of the coastal feature.

► Two ways may be used to establish P(f):

a. Roll Up All Assessed Individual Ratings into an Overall Rating for the feature and then Directly Apply Surrogate P(f),



D

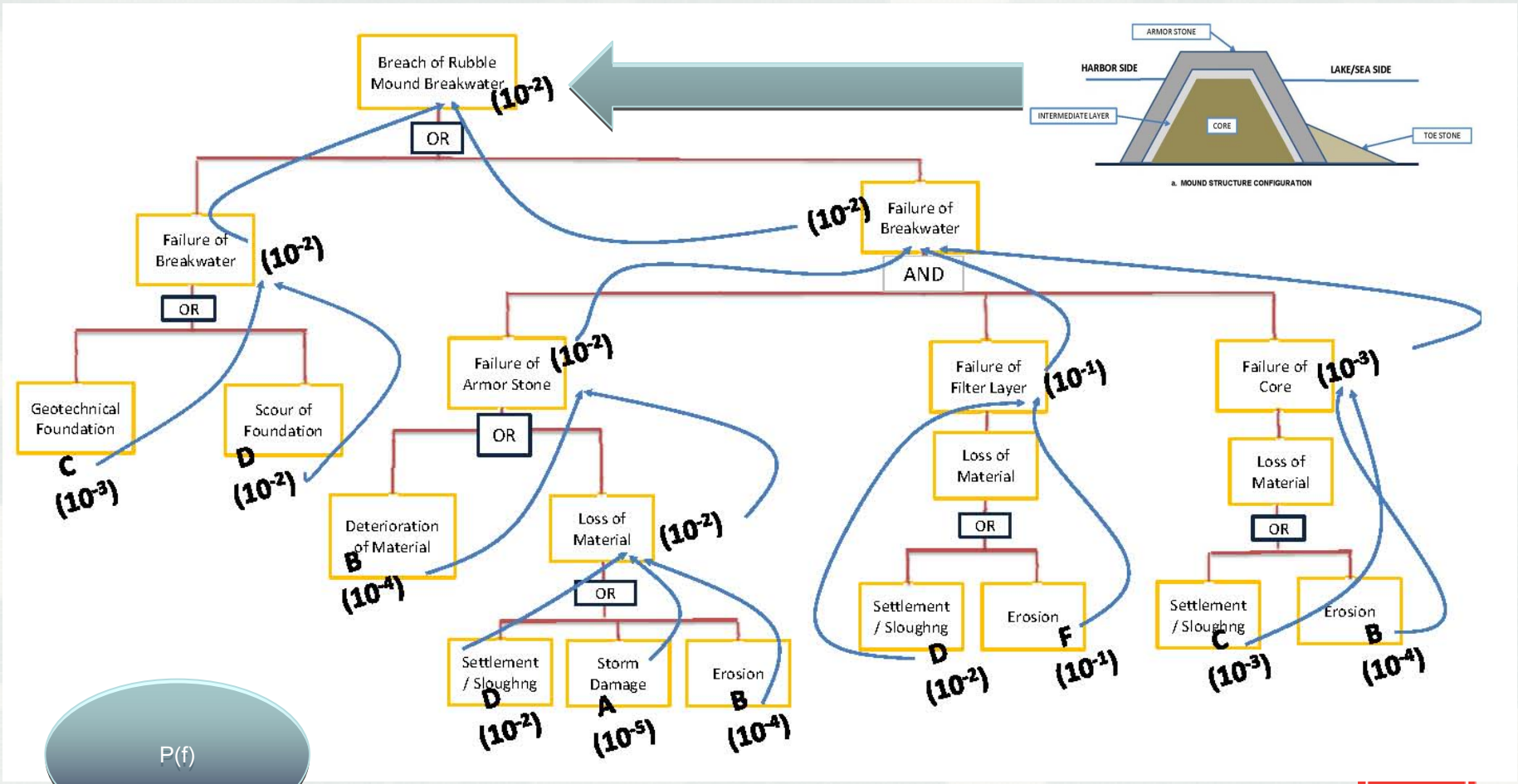
Condition Rating	Descriptor	P(f)
A	Very Unlikely	10^{-5}
B	Not Likely	10^{-4}
C	Somewhat Likely	10^{-3}
D	Very Likely	10^{-2}
F	Almost Certain	10^{-1}
CF	Absolute	1.0

P(f)

STEP 3a – ESTABLISH PROBABILITY OF UNSATISFACTORY PERFORMANCE

►OR,

b. Use a fault tree model that shows the logical relationships between the various assessed elements of the coastal feature to compute its unreliability, P(f)



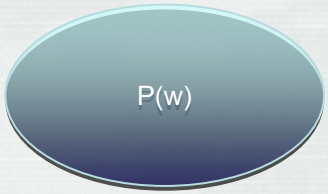
STEP 3a – ESTABLISH PROBABILITY OF UNSATISFACTORY PERFORMANCE

► Load condition is directly related to the wave climate.

► The following load conditions (wave climates) will be considered for the Great Lakes Risk model:

Load Condition	Recurrence Interval (Yrs), P(w)
a. Normal Storm Event	2, 0.50
b. Average Storm Event	10, 0.10
c. Severe Storm Event	100, 0.01

► The load conditions (wave climates) for other regions (i.e. Atlantic, Pacific, Gulf) may vary from those used for the Great Lakes.



►Establish condition probabilities that the affect to the wave climate in the harbor/channel area, or whatever condition is considered. These conditional probabilities are the likelihood that the affect is any of the follow:

P1 – None
P2 – Minor
P3 – Moderate
P4 – Significant
P5 - Extreme

Given the particular condition (A-F) of the feature and the occurrence of the particular storm event (normal, average, severe).

►Define thresholds of what these degrees of affect represent quantitatively.

►A set of tables must be developed for each type of structure and each condition being evaluated.

►Use formal Expert Opinion Elicitation to complete these values.

Conditional Probability Table
For
Severe Storm (1%) Event

When Condition (P(f)) Is;	Probability that Impact to Purpose Will Be/Given P(f):				
	(P1)	(P2)	(P3)	(P4)	(P5)
	No Impact	Minor	Moderate	Significant	Extreme
A (10^{-5})					10^{-5}
B (10^{-4})					10^{-4}
C (10^{-3})					10^{-3}
D (10^{-2})					10^{-2}
F (10^{-1})					10^{-1}

Conditional Probability Table
For
Average Storm (10%) Event

When Condition (P(f)) Is;	Probability that Impact to Purpose Will Be/Given P(f):				
	(P1)	(P2)	(P3)	(P4)	(P5)
	No Impact	Minor	Moderate	Significant	Extreme
A (10^{-5})					
B (10^{-4})					
C (10^{-3})					
D (10^{-2})					
F (10^{-1})					

Conditional Probability Table
For
Normal Storm (50%) Event

When Condition (P(f)) Is;	Probability that Impact to Purpose Will Be/Given P(f):				
	(P1)	(P2)	(P3)	(P4)	(P5)
	No Impact	Minor	Moderate	Significant	Extreme
A (10^{-5})	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}
B (10^{-4})	10^{-2}	10^{-1}	10^{-2}	10^{-3}	10^{-4}
C (10^{-3})	10^{-3}	10^{-2}	10^{-1}	10^{-2}	10^{-3}
D (10^{-2})	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^{-2}
F (10^{-1})	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}

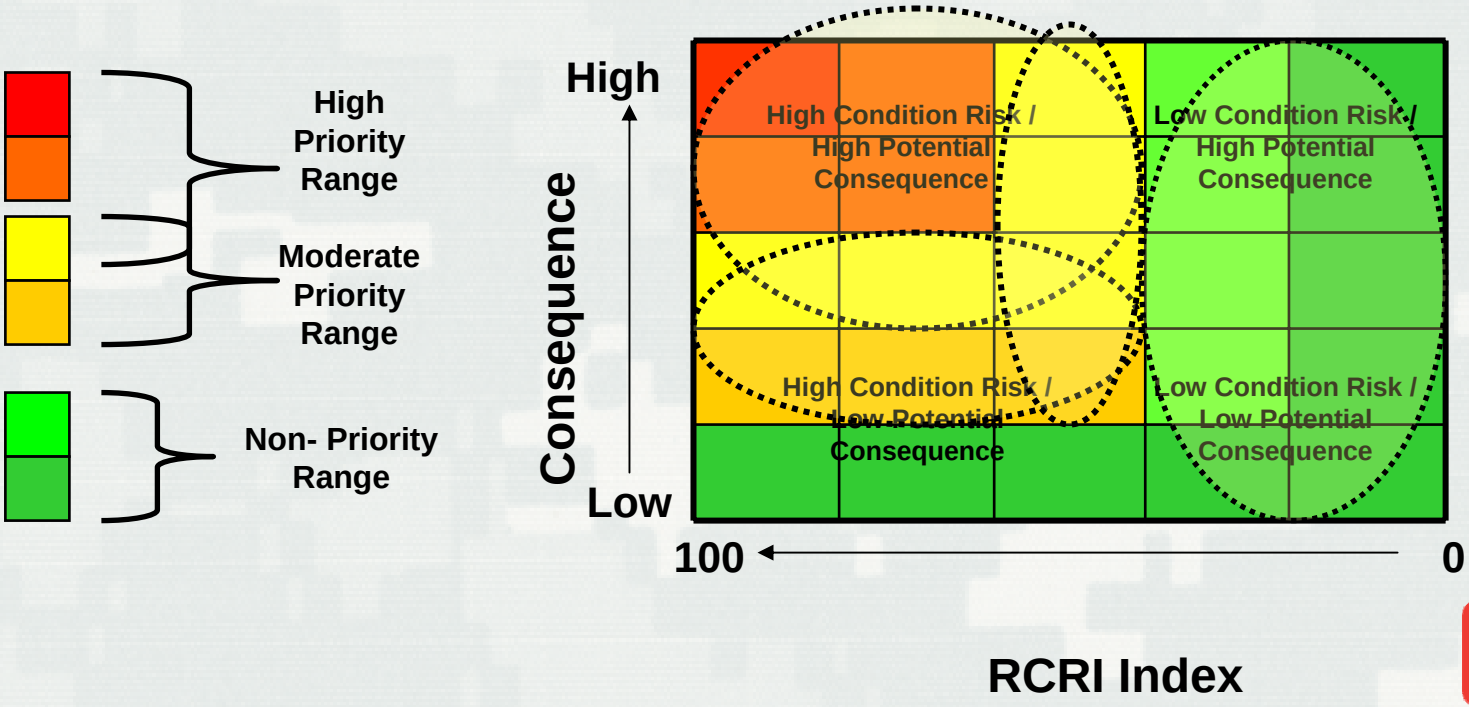
3 TABLES X EACH STRUCTURE/FEATURE TYPE X EACH CONDITION

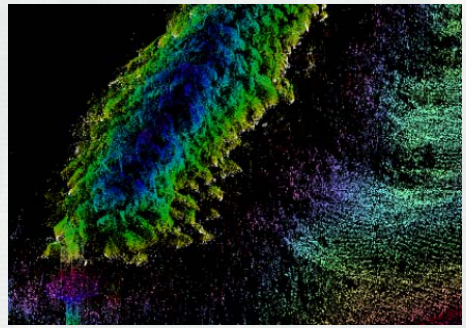
STEP 3c – ESTABLISH CONDITIONAL PROBABILITIES OF IMPACT

Identifying and Managing Risk

OCA Data with Consequences, Independently

OCA data and Consequences can be analyzed in concert, but as separate and unique measures of risk. This can be done by using the current budget EC 5x5 matrix format. RCRI values for each asset may be plotted against the subsequent Consequences to relate condition risk to the resulting consequences.





QUESTIONS ?


Thank You