

# Risk and Decision-Making in Homeland Security

*A Presentation to the Department of Industrial and Systems Engineering*

*Rutgers, The State University of New Jersey*

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**Science and Technology Directorate**

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*“We need to adopt a risk-based approach in both our operations and our philosophy. Risk management is fundamental to managing the threat, while retaining our quality of life and living in freedom. Risk management must guide our decision making as we examine how we can best organize to prevent, respond and recover from an attack.”*

Secretary Michael Chertoff  
Department of Homeland Security  
16 March 2005



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*“...the "state of the art" of risk analysis is inadequate in the sphere of homeland security, and...to redress that problem, risk analysts must involve the legal profession and others in developing new risk analysis techniques.”*

Dr. John Graham

Former Administrator, Office of Information  
and Regulatory Affairs, OMB

23 May, 2006



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*“When there is confusion in the center, there is chaos at the periphery.”*

attributed to GEN Alexander Haig



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# First Principles

## 1. Managing Risk is Everyone's Responsibility

every decision-maker in the Department of Homeland Security should be taking risk into account as he or she is making decisions

## 2. "Risk-informed," not "Risk-based"

there is too much that will not be known and there are too many other factors that will have to be taken into account for homeland security decisions to ever be "risk-based."



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# What is “Risk” Anyway?

- Numerous definitions over the years
  - Developed for specific purposes
  - Useful in context for which developed
  - None inherently wrong
- A Subjective and Perceptual Construct
- Common theme - a possible future that would be different than we would like or expect



# Responding to Risk

- 4 Classic Responses
  - Avoid it
  - Mitigate it
  - Transfer it (e.g., insurance, NIMBY)
  - Accept it
- Others?
  - Substitute one risk for another (i.e., avoid + accept)



# The Strategic “Why?” in Risk Management

**Risk Management is a Strategy and a Means to an End  
– not an End in Itself**

$$\sum_1^n H = \sum_1^n TC_{RR} + \sum_1^n IC_{All} + \sum_1^n \$_{P,P,RP}$$

H – Harm

$TC_{RR}$  – Tangible Consequences of Risks Realized

$IC_{All}$  – Intangible Consequences of All Risks, Real and Perceived

$\$_{P,P,RP}$  – Costs of Prevention, Protection, Response Preparedness



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# The Strategic “Why?” in Risk Management

**Risk Management is a Strategy and a Means to an End  
– not an End in Itself**

**The End/Objective – Minimize Aggregate Harm**

$$\downarrow \sum_1^n H = \sum_1^n TC_{RR} + \sum_1^n IC_{All} + \sum_1^n \$_{P,P,RP}$$

H – Harm

$TC_{RR}$  – Tangible Consequences of Risks Realized

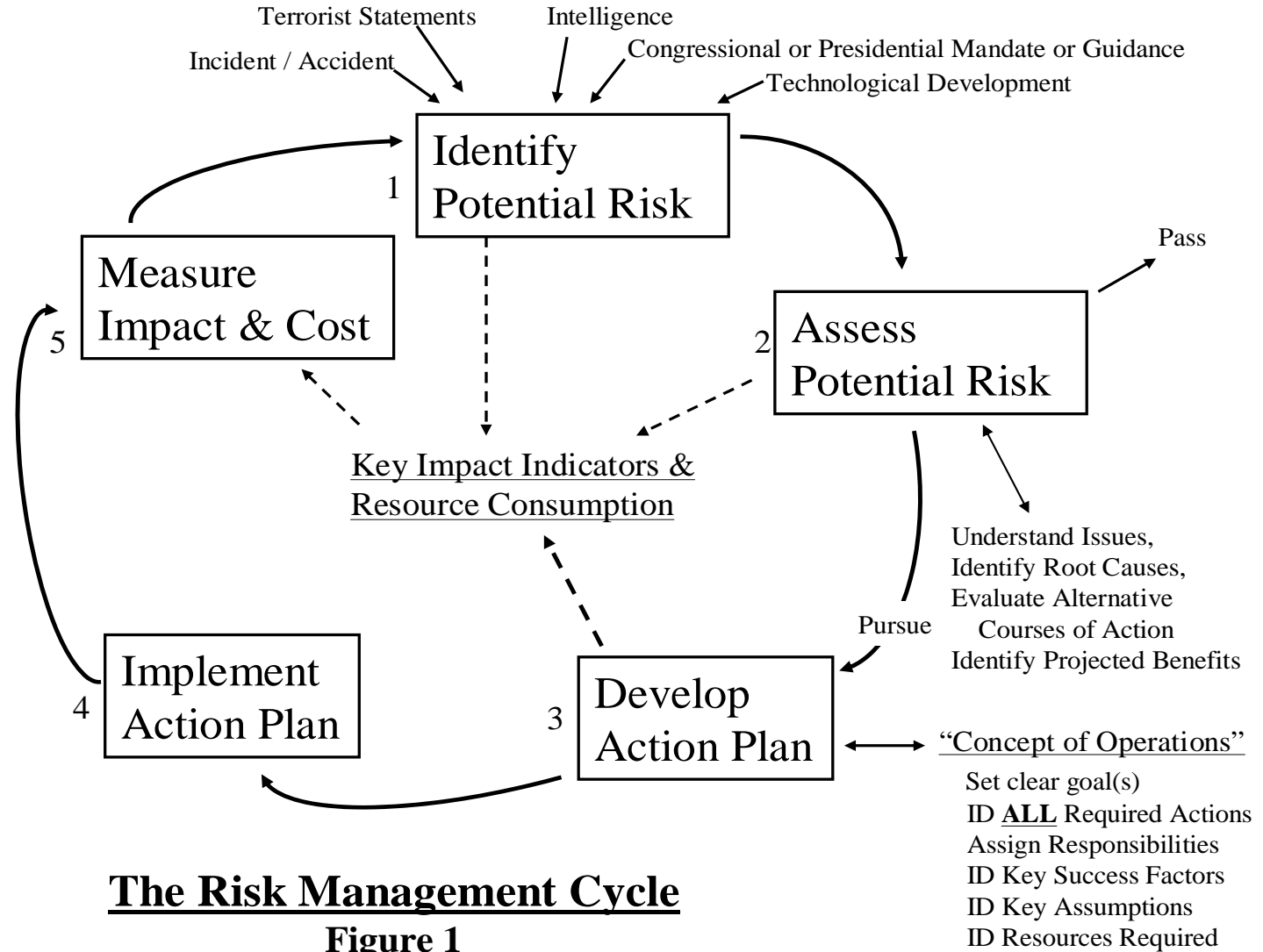
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# A Process View of Risk-Informed Decision-Making



## The Risk Management Cycle

Figure 1



# Homeland Security and Terrorism – A Complex Adaptive System

- “a dynamic network of many agents...acting in parallel, constantly acting and reacting to what the other agents are doing.”
- systems are not “indivisible elements, but [wholes] that can be divided into parts. However, the whole cannot be decomposed into independent subsets.”|
- *“Viewed structurally, a system is a divisible whole, but viewed functionally, it is an indivisible whole”*
- Interactions between the individual components produce patterns and “collective properties that are simply not present when the components are considered individually.”
- an “important feature of complex systems is their sensitivity to even small perturbations.”



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# Wicked Problems

## Characteristics

1. You don't understand the problem until you have developed a solution.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not right-or-wrong, but good-or-bad, better-or-worse.
4. Every wicked problem is essentially unique and novel.
5. Every solution to a wicked problem is a "one-shot" operation.
6. Wicked problems have no given alternative solution
7. Every wicked problem can be considered to be a symptom of another problem.

Rittel and Webber

8. Every solution to a wicked problem will generate more problems.

Ross



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# Puzzles, Problems and Messes

- **Puzzle** – a defined issue with a single discoverable solution
  - the task – finding the solution
- **Problem** – a relatively well understood issue with numerous viable solutions
  - the task – identifying possible solutions and then choosing one
- **Mess** – a complex and poorly understood issue, possibly with no true solution
  - the task – developing understanding sufficient to begin searching for potential, probably partial, solutions

Russell Ackoff, 'grandfather' of OR



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# Social Complexity

- **Numerous legitimate stakeholders**
- **Multiple Public and Private Goods**
  - Legitimate
  - In Competition
  - Irreconcilable
- **Choices**
  - Create Winners & Losers
  - Must be Made
- **Decision-Making Processes**
  - Political
  - Best Done in the Open
- **Decisions – Necessary, but not necessarily ‘Rational’**

Dr. Jeff Conklin – CogNexus Institute



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# Characterizing Risk

- **Simple**
- **Complexity** in assessing causal and temporal relationships
- **Uncertainty**
  - variation among individual targets
  - measurement and inferential errors
  - genuine stochastic relationships
  - system boundaries and ignorance
- **Ambiguity** in interpreting results
  - Interpretative ambiguity (What does it mean?)
  - Normative ambiguity (Is it tolerable?)

Professor Ortwin Renn – University of Stuttgart



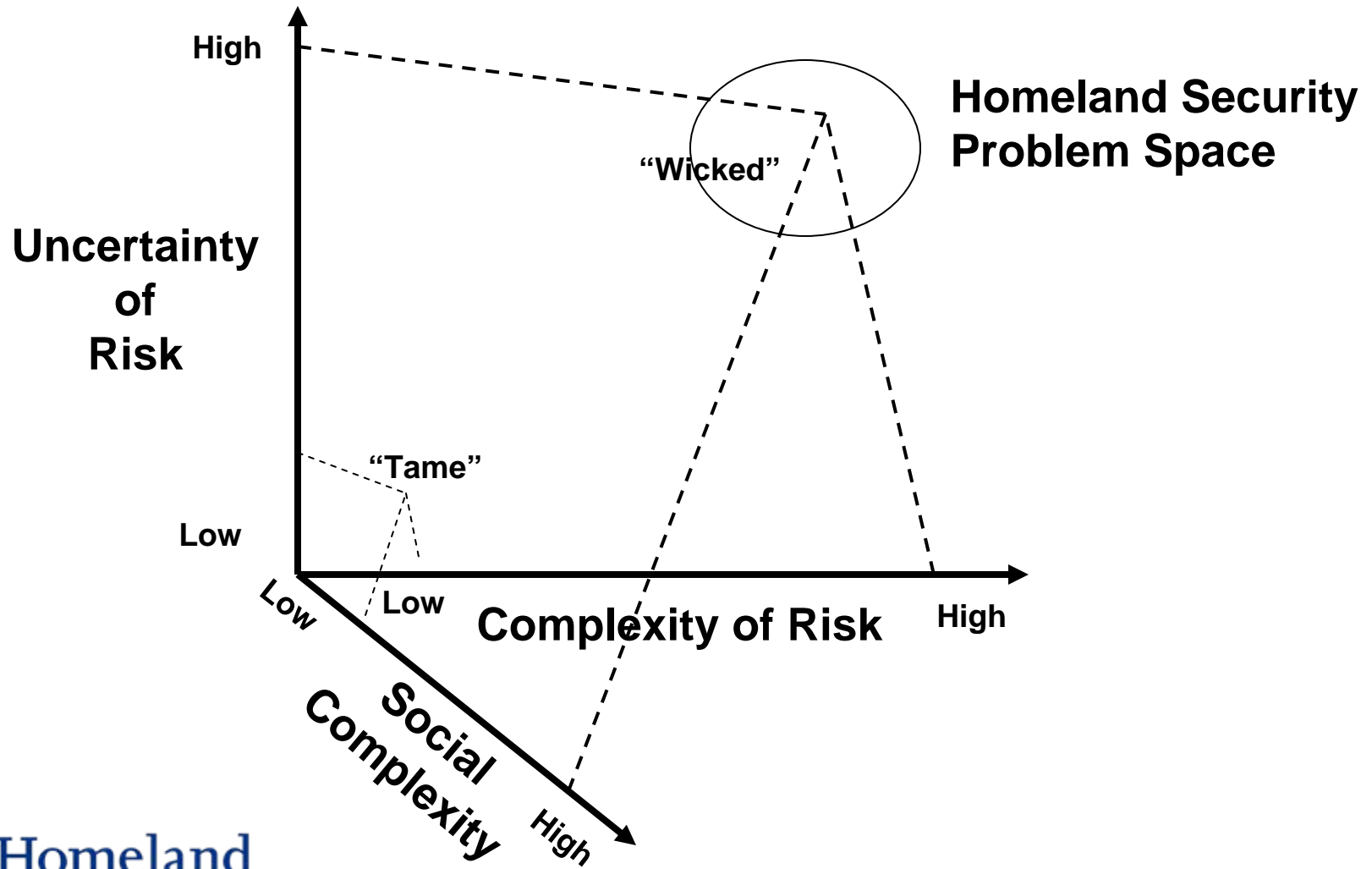
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# A Spectrum of Indeterminacy

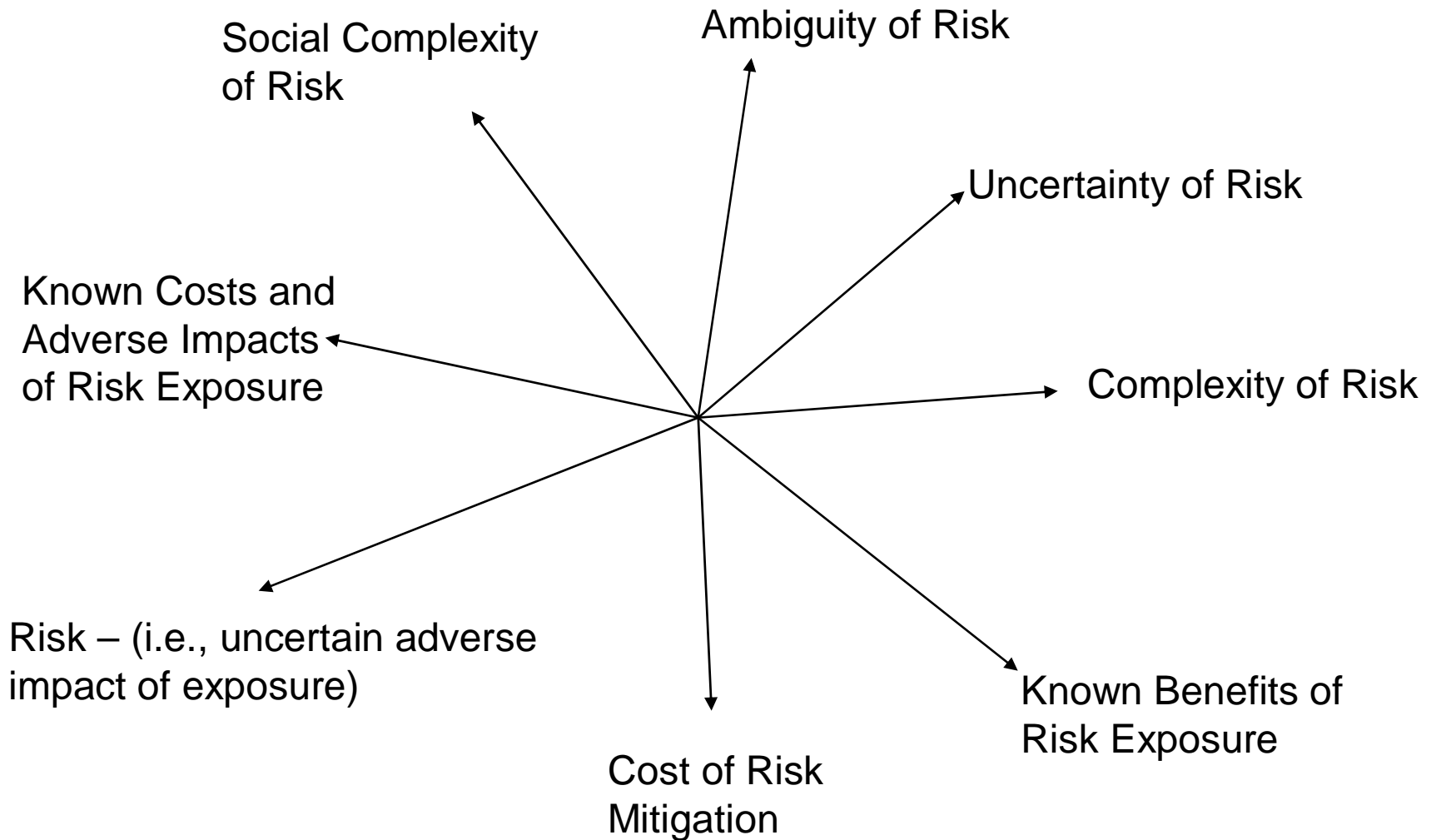
- **No Indeterminacy** – elements known, ‘engineering’ solutions
- **Statistical Indeterminacy** – randomly variable initial conditions with known statistics, effects of actions known
- **Stochastic Indeterminacy** – initial conditions may be known, statistically variable outcomes (e.g., roll of the dice)
- **Strategic Indeterminacy** – initial conditions known, actions of competing but independent players determine outcome
- **Structural Indeterminacy** – significant elements unknown or so little understood that problem can’t be defined in terms of other indeterminacies



# The Homeland Security Decision-Making Environment



# Eight Dimensions of Risk





# Two Case Studies

- The Ports and Waterways Safety Assessment Process (PAWSA)
- Offshore Vessel Routing Schemes along the California Coast and Monterey Bay National Marine Sanctuary

# The Ports and Waterways Safety Assessment Process (PAWSA)

# PAWSA Background

- EXXON VALDEZ oil spill
- Oil Pollution Act of 1990 (OPA '90)
- Assess need for Vessel Traffic Service (VTS) in “high volume oil ports”
- Port Needs Studies already in process
- Classical probabilistic/OR approach
- Results widely rejected
  - Congress
  - Stakeholders
  - Internal Coast Guard



# Criticisms of Port Needs Studies

- “Little stakeholder involvement”
- “Input data questionable and/or incomplete”
- “Focus on single solution to varied problems”
- “Not reflective of new technologies”
- “Inadequate attention to mariner needs”
- “Wrong answers”
- “Answers pre-determined”
- “Bloated federal program”

# “The Rest of the Story”

- All Politics is Local
  - Every port in the nation is the **MOST UNIQUE** port in the nation
  - Every port in the nation is the **MOST IMPORTANT** port in the nation
- Clinton Administration User Fee Proposal
  - Broad industry opposition to any fee
  - Concerns over User Fee impact on port competitiveness
- VTS as port “status symbol”
  - “so important it had to have a VTS”
  - “not important enough to rate a VTS”
  - “not safe because it has no VTS”
  - “so safe it doesn’t need a VTS”



# National Dialogue Group Guidance

- **Not every port needs a VTS**
- **VTS is only one of many available Vessel Traffic Management tools**
- **Solution may not be a VTS**
- **Appropriate tools to be used in coordination**
- **Local users can provide best insight on risk drivers in a given port**
- **Issue isn't "Where do we build the next VTS?"**
- **Issue is "What is needed where, to mitigate identified risks?"**



# Finding a Balance

- Stakeholder Needs
- Risk Drivers
  - Probability
  - Consequences
- Effectiveness
- Budget

# Ports and Waterways Safety Assessments

- Address vessel traffic risks
- National approach / broadly applicable
- Locally focused
- Low cost / widely deployed
- Expert & stakeholder involvement
- Structured analytical process
  - Rigorous
  - Documented
  - Replicable
- Select locally appropriate risk mitigation



## Key Features

- Systematic Evaluation
- Broad Risk Driver Coverage
- Flexible and Easy to Use
- 2-Day Process Involving 10-30 Participants
- Executed at individual Port level
- Local Expert Opinion

# PAWSA Methods & Techniques

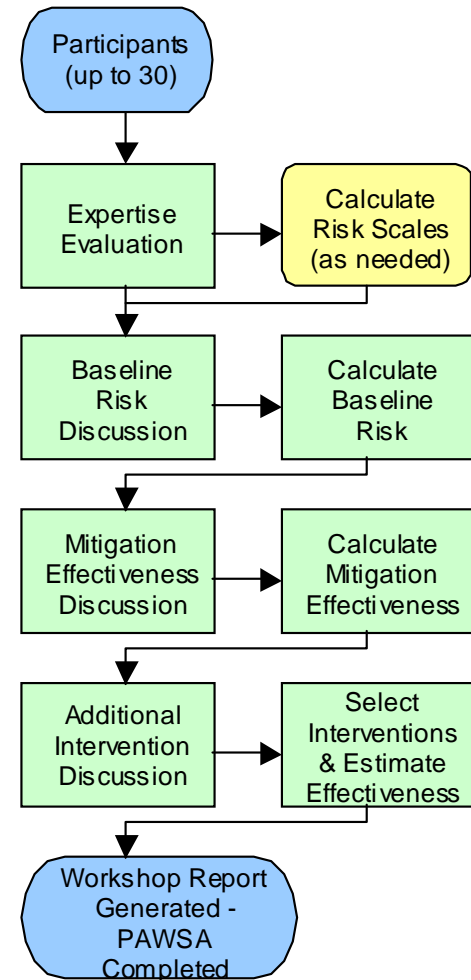
- Morphological Analysis of Risk Factors
- Anchored Rating Scales
- Expert Opinion Solicitation
- Analytic Hierarchy Process
- Neutral Facilitators
- Structured Process and Product

# Using Experts

- Requires Cross Section of Users, Planners, and Stakeholders
- Promotes Participant Buy-In of Results
- Answers Correlate with Known Quantitative Values
- Not Reliant on Available Data (i.e., user knowledge of “near misses” vs. CG data limited to actual accidents)

# Systematic Process

- Steps Build on Each Other
  - Expertise Evaluation
  - Baseline Risk
  - Mitigation Effectiveness
  - Additional Interventions
- Transparent Calculations
- Results Traceable to Participant Input



Process Flowchart



# Risk Categories and Factors

Vessel Conditions	Traffic Conditions	Navigational Conditions	Waterway Conditions	Immediate Consequences	Subsequent Consequences
Vessel Quality	Volume of Commercial Traffic	Winds	Visibility Impediments	Personal Injuries	Health and Safety
Deep Draft Mariner Proficiency	Volume of Small Craft Traffic	Currents	Dimensions	Petroleum Discharge	Environmental
Shallow Draft Mariner Proficiency	Traffic Mix	Visibility Restrictions	Bottom Type	Hazardous Materials Release	Aquatic Resources
Small Craft Operator Proficiency	Congestion	Obstructions	Configuration	Mobility	Economic



# Anchored Risk Driver Scale

## WIND

Port  
Heaven

Port  
Hell

1

3

5

7

9

Usually Calm  
(< 5 kts)

Typically Mild  
(< 10 kts)

Moderate  
(< 15 kts)

Typically Strong  
(> 15 kts)

Frequently Severe  
(> 30 kts)

Change Slow &  
Predictable Well  
in Advance

Change More  
Rapid but  
Predictable Well  
in Advance

Changes  
Frequently  
With Some  
Advance  
Warning

Changes  
Frequently With  
Little Advance  
Warning

Change Rapid &  
Unpredictable



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# Output – Baseline Risk



<b>Vessel Conditions</b>	<b>Traffic Conditions</b>	<b>Navigational Conditions</b>	<b>Waterway Conditions</b>	<b>Immediate Consequences</b>	<b>Subsequent Consequences</b>
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<b>Vessel Quality</b>	<b>Volume of Commercial Traffic</b>	<b>Winds</b>	<b>Visibility Impediments</b>	<b>Personal Injuries</b>	<b>Health and Safety</b>
4.5	1.9	4.5	1.0	5.7	3.0
<b>Deep Draft Mariner Proficiency</b>	<b>Volume of Traditional Fishery Traffic</b>	<b>Currents</b>	<b>Dimensions</b>	<b>Petroleum Discharge</b>	<b>Environmental</b>
5.5	3.4	7.9	5.3 *	9.0	9.0
<b>Shallow Draft Mariner Proficiency</b>	<b>Traffic Mix</b>	<b>Visibility Restrictions</b>	<b>Bottom Type</b>	<b>Hazardous Material Release</b>	<b>Aquatic Resources</b>
7.0	3.3	3.2	8.5	6.5	7.2
<b>Traditional Fisher Proficiency</b>	<b>Congestion</b>	<b>Obstructions</b>	<b>Configuration</b>	<b>Mobility</b>	<b>Economic</b>
5.6	2.6	2.6	5.1	4.3	7.6



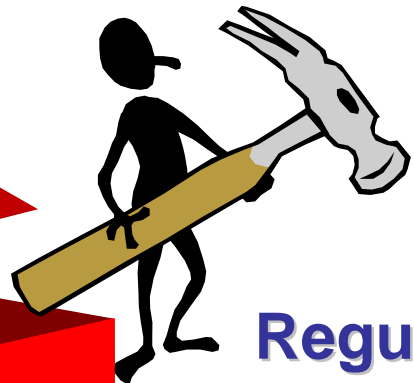
# Vessel Traffic Management - Tool Kit -



**Rules of the Road**



**Vessel Traffic Service**



**Regulated Navigation Area**



**Aids to Navigation**



**Pilotage**

**Traffic Separation Scheme**



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# Output – Mitigation Effectiveness

Vessel Conditions	Traffic Conditions	Navigational Conditions	Waterway Conditions	Immediate Consequences	Subsequent Consequences
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Vessel Quality		Volume of Commercial Traffic		Winds		Visibility Impediments		Personal Injuries		Health and Safety	
4.5	3.9	1.9	2.2	4.5	3.6	1.0	1.0	5.7	5.3	3.0	3.1
<b>NO</b>		<b>RISING</b>		<b>Balanced</b>		<b>Balanced</b>		<b>Maybe</b>		<b>RISING</b>	
Deep Draft Mariner Proficiency		Volume of Traditional Fishery Traffic		Currents		Dimensions		Petroleum Discharge		Environmental	
5.5	4.5	3.4	3.4	7.9	6.2	5.3	5.5	9.0	7.3	9.0	7.9
<b>NO</b>		<b>Balanced</b>		<b>Maybe</b>		<b>RISING</b>		<b>Maybe</b>		<b>Maybe</b>	

KEY	
Risk Factor	
Book 3	Book 4
Consensus	

Book 3	Absolute level of risk
Book 4	Level of risk taking into account existing mitigations
Balanced	Consensus that risks are well balanced by existing mitigations
Maybe	No consensus that risks are adequately balanced by existing mitigations
NO	Consensus that existing mitigations do NOT adequately balance risk
RISING	Existing mitigations or future projections are causing /will cause risk to rise



# Output – Interventions



Vessel Conditions	Traffic Conditions	Navigational Conditions	Waterway Conditions	Immediate Consequences	Subsequent Consequences
Vessel Quality	Volume of Commercial Traffic	Winds	Visibility Impediments	Personal Injuries	Health and Safety
Enforcement	Rules & Procedures	Balanced	Balanced	Coordination / Planning	Coordination / Planning
1.9 <b>Caution</b>	1.0			3.3	0.9 <b>Caution</b>
Deep Draft Mariner Proficiency	Volume of Traditional Fishery Traffic	Currents	Dimensions	Petroleum Discharge	Environmental
Rules & Procedures	Balanced	Nav / Hydro Info	Rules & Procedures	Coordination / Planning	Coordination / Planning
2.7		2.5	2.9	3.3	2.8

# PAWSA Results

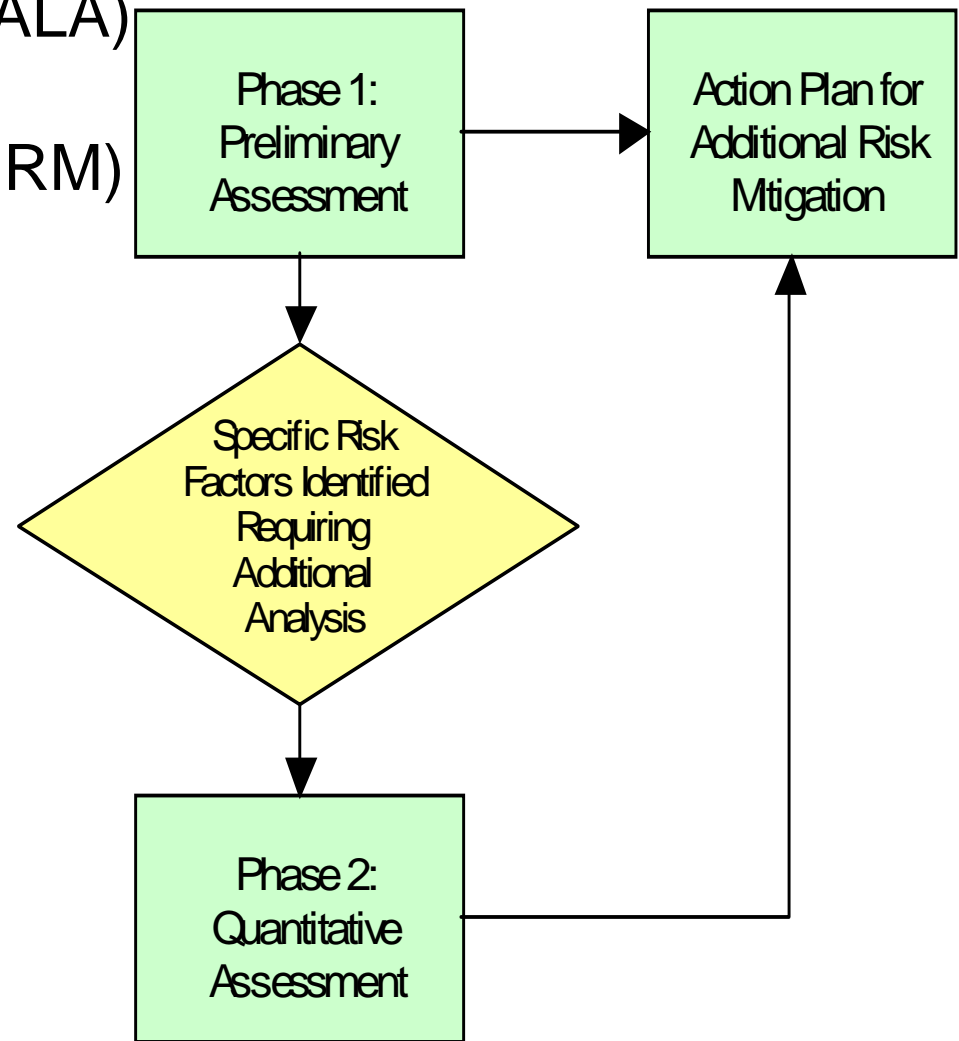
- Assessment of current measures vs identified & prioritized risks/risk drivers
- Projected effectiveness of alternatives
- Strategic Plan  
Identifies risk / Mitigation measure / Process owner
- Stakeholder buy-in
- Focuses future Harbor Safety Committee discussions / efforts
- Support for investment decisions



# Moving Forward

International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA)

- IALA\* Generic Risk Model (GRM)
  - PAWSA (Phase 1)
  - IALA Waterway Risk Assessment Program (IWRAP) (Optional Phase 2)
- Continued Refinement of PAWSA



Generic Port Risk Model Structure

# California Coast & Monterey Bay National Marine Sanctuary

## Offshore Vessel Routing Schemes

# Background

- Extreme Environmental Sensitivities
- Grounding & Oil Spill Risk Perceived as High
- Previous Effort followed traditional Port Access Route Study & Public Rule-making Processes
- Traditional Processes Proved Inadequate
- Highly Polarized Positions
  - Industry Viewed as Irresponsible & Greedy
  - Environmental Advocates Viewed as Unreasonable & Irrational

# Finding a Balance

- Stakeholder Needs
- Risk Drivers
  - Probability
  - Consequences
- Effectiveness
- Budget

# Developing a Win-Win Solution

- Facilitated sessions in neutral setting
- Ground Rules
  - All legitimate stakeholders represented
  - Respect for others' concerns
  - Objective Evaluation of Concerns (i.e., based on science & engineering)
  - Decisions based on fact, not emotion
- Start with Outcome/End-State **ALL** Agreed On
  - **NO** Oil Spills
  - **NO** Unnecessary Costs Incurred by Industry
- Reverse Engineer from desired end-state via scenarios incompatible with desired end-state



# Example Scenario

- Loss of Power
  - Ship drifting aground
  - Winds and Currents
- Feasibility
  - Historical Weather and Current Data
  - Drift characteristics of ships
- Interventions
  - Available Response Resources
  - Response Times vs. drift predictions
- Analysis – minor change to offshore routing schemes provides sufficient response time under worst case conditions



# Outcome

- Changes recommended
  - Coastal “Recommended Routes” moved slightly further offshore
  - Traffic Separation Schemes in Santa Barbara Channel and San Francisco entrance adjusted
- Transit Time and Fuel Cost increases
  - Minimal
  - Readily Accepted by Industry
- US and International Regulatory Changes Easily Approved due to Stakeholder Support

# Lessons Learned

- **Include stakeholders**
  - Legitimate stakeholders will fight if excluded
- **Respect** legitimacy of stakeholder concerns
  - Stakeholders will support decisions if meaningfully involved/heard in decision-making process
- Provide a **structured & transparent process**
- **Neutral** facilitation and venue help
- Work backwards from an **outcome** all parties agree to
- Identify **risk drivers** and appropriate **interventions**
- Work from **facts**, not emotion
- **Experts** add immeasurably (but get the *right* experts)
- ***“All of us*** is smarter than ***one of us.*”**



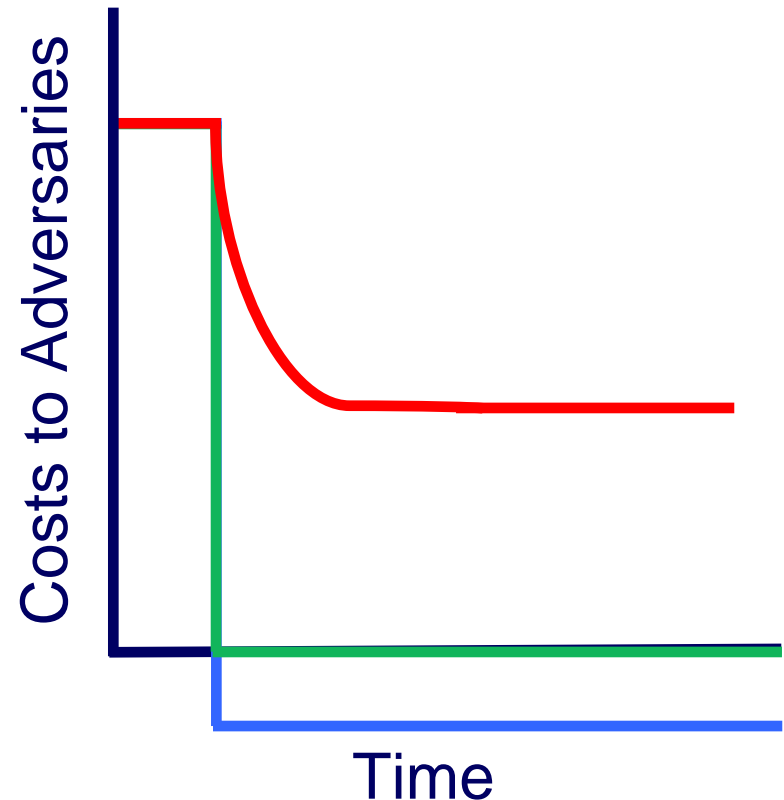
# A Note of Caution

- Fundamental Differences - Security vs. Safety Risks
- Levels of Uncertainty
  - Vessel Traffic Safety
    - where? when? how? which vessel or vessels? how bad?
    - the *sine qua non* for vessel traffic safety is the vessel but vessels don't hide – if there is a vessel, there is a risk
  - Terrorism
    - where? when? how? which target or targets? how bad?
    - the *sine qua non* for terrorism is the terrorist and terrorists DO hide – if there is no terrorist visible is a terrorist even there?
- Nature of Risk Drivers
  - Safety Risks arise from normal daily life
  - Security Risks driven by actions of an adaptive, reactive and strategically-driven adversary



# Terrorist Adaptive Behavior Can Significantly Reduce the Value of Security Measures

- Adaptation degrades the function of defense                     
  - Example: Group must take ongoing action to neutralize (effort cost) or defense pushes group to less effective tactics (effectiveness cost)
  - Benefit drops but remains positive
- Adaptation “breaks the code” of the defensive measure                     
  - Example: Identifying content of a profile-based security system
  - Benefit drops to zero
- Adaptation “turns the technology against us”                     
  - Example: Not just avoiding a detection system, but using it to trigger numerous false alarms
  - Benefit becomes a detriment



***Lesson: Assess counter-technology risk and include it as part of management above and beyond other risks program risks.***



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Source: based on forthcoming RAND report “Breaching the Fortress Wall”

# Closing Thoughts

- Under the best of circumstances Risk is complex – it requires understanding and careful thought
- Homeland Security risk considerations are not taking place under the best of circumstances
  - High Complexity, Rampant Uncertainty, Significant Ambiguity
  - Numerous legitimate but competing public & private goods at stake
  - Social Complexity is High
- Everyone wants Risk-Informed decisions, at least until...
- Current decision-support tools and decision-making processes are inadequate to the task
  - Analytic Methods – Discursive Approaches (epistemological – reflective – participative) – Consistent Lexicon – Comparable Results – Perishability of Benefits – Etc.
  - Analyst Humility and More Open Processes Are Called For
- If it were easy we would have already solved the problem



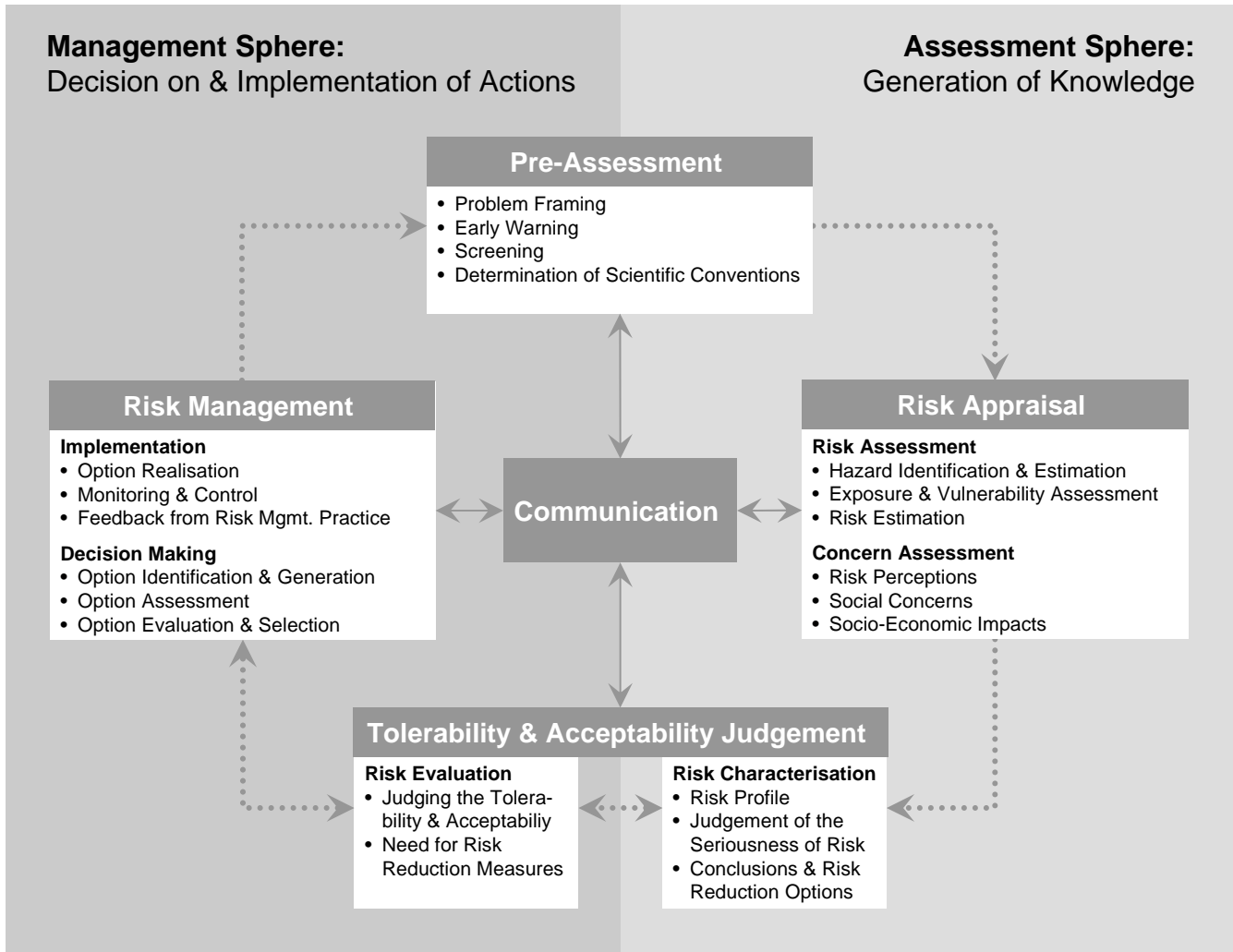
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# Questions?

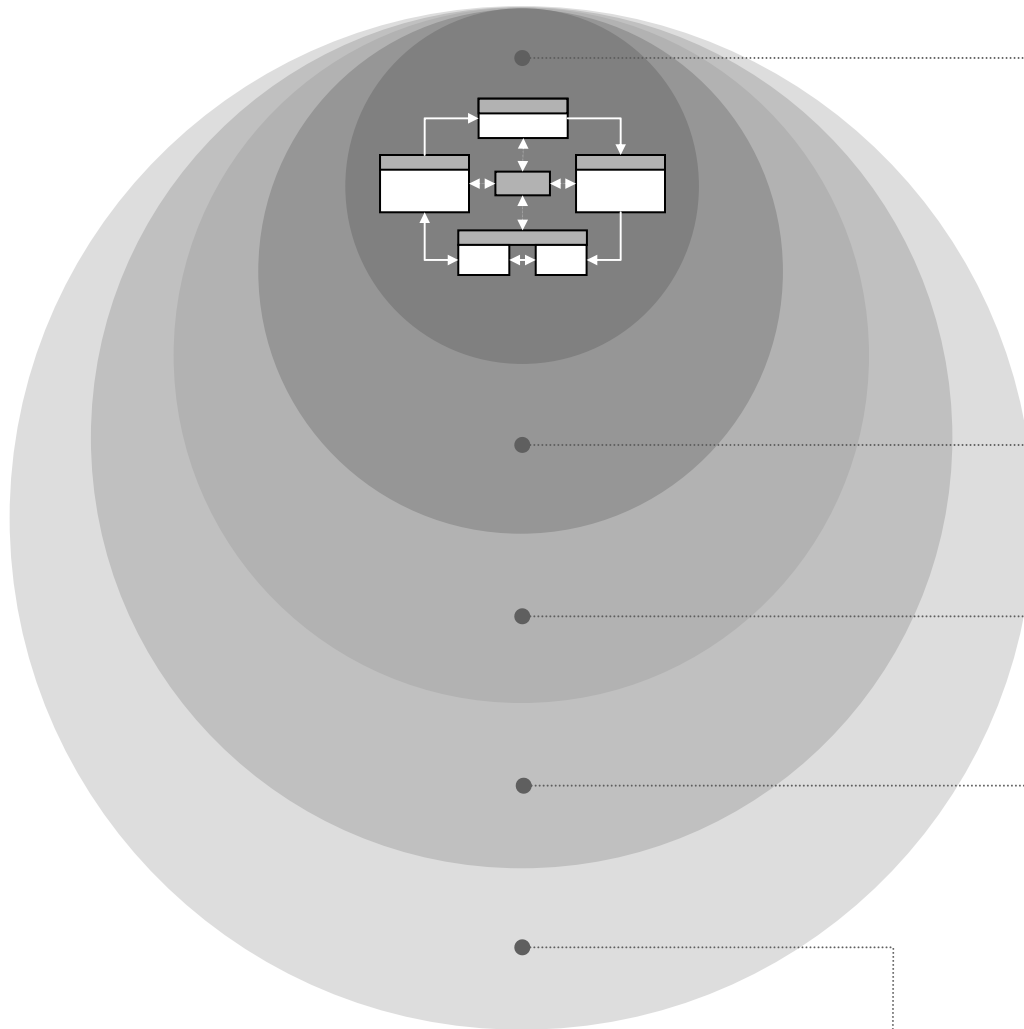
[http://www.navcen.uscg.gov/mwv/projects/pawsa/PAWSA\\_Back.htm](http://www.navcen.uscg.gov/mwv/projects/pawsa/PAWSA_Back.htm)

bob.ross@dhs.gov

# IRGC RISK GOVERNANCE FRAMEWORK CORE PROCESS



# IRGC RISK GOVERNANCE FRAMEWORK



## **Core Risk Governance Process**

- pre-assessment
- risk appraisal
  - risk assessment
  - concern assessment
- tolerability/acceptability judgement
- risk management
- communication

## **Organisational Capacity**

- assets
- skills
- capabilities

## **Actor Network**

- politicians
- regulators
- industry/business
- NGOs
- media
- public at large

## **Social Climate**

trust in regulatory institutions  
perceived authority of science  
degree of civil society involvement

## **Political & Regulatory Culture**

→ different regulatory styles



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