Ecological Risk Assessment of Marine Fish Aquaculture in the Coastal Zone

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Outline

- Why Risk Assessment for Marine Aquaculture?
- What is Risk Assessment
- Application to Marine Fish Aquaculture

Why?

- Principle 15 of the 1992 Rio Declaration (United Nations Conference on Environment and Development) endorses the precautionary approach to development.
  - "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation"
- Recognize that decisions are not made by science but science can and should objectively inform decision making
- Science cannot prove a lack of an effect.

So, how can science help to apply the precautionary approach to marine aquaculture?

GESAMP Working Group 31

- The United Nations, Food and Agriculture Organization (FAO), Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) formed working group 31 (WG31) in 2002 on Environmental Impacts of Coastal Aquaculture to determine how science can be used in decision making based on the precautionary principle to marine aquaculture development.
- Led to the application of Risk Assessment Process developed by UN World Health Organization (WHO) used for assessing risk in other areas of our lives (for example, health risks from food, pollution and activities) being applied to environmental risk.

Workshop to develop Guidelines For The Ecological Risk Assessment Of Marine Fish Aquaculture as a test case.

- Member countries of the FAO-COFI sub-committee on aquaculture in a separate effort from GESAMP.
- Proposed by delegations of the United States and the European Union, and seconded by many others at Trondheim, Norway in October, 2003
- Utilizing the knowledge base developed for salmon farming.
- An International Workshop to develop guidelines was coordinated by NOAA Fisheries Service at Manchester, Washington, USA in April, 2005
- This was to be followed up by application of the guidelines by member countries to risks and for risk management from marine aquaculture industries in their countries (not yet done but see Rensel talk and Rust talk at this session).

WORKSHOP PARTICIPANTS

Participants

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- Why Risk Assessment for Aquaculture?
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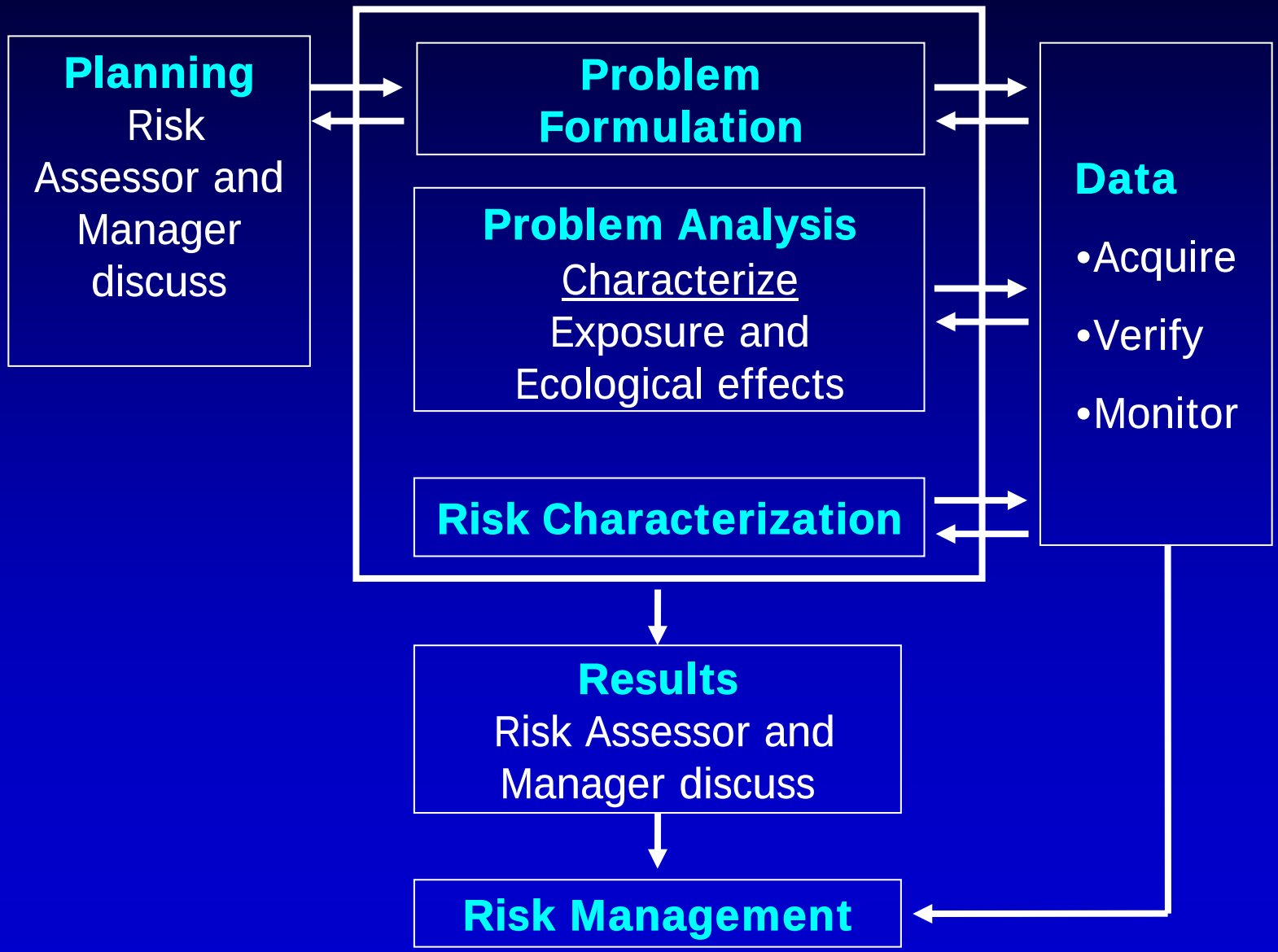
Terms and Definitions

- Hazard - Inherent property of an agent or situation capable of having adverse effects on something (substance, agent, energy source or situation)(Duffus 2001)
- Risk - The probability and severity of an adverse effect/event occurring to man or the environment from a risk source (hazard). (EU 2000)
- Risk Management or Risk Mitigation - Steps that can be taken to reduce or eliminate risks. Can be by reducing probability and/or severity; or totally eliminating the hazard.

FIVE OBJECTIVES OF RISK ASSESSMENT GUIDELINES

- Identify areas of substantive risk in the interaction between site operations and the environment
- Identify biological end points, both near and far field, that may be affected
- Identify methodologies for measuring and monitoring effects of exposure to each area of risk
- Provide a common framework to estimate level of potential adversity for each risk, and its mitigation
- Provide a concept of physical and environmental demands of the site, and a matrix to suggest orders of relevance for application of each area of risk in different ecosystems

WORLD HEALTH ORGANIZATION ECOLOGICAL RISK ASSESSMENT FRAMEWORK



PHASES OF THE RISK ASSESSMENT PROCESS

Phase I: Problem Formulation

Phase II: Problem Analysis

Phase III: Risk Characterization

PHASE I
PROBLEM FORMULATION

- Scope, focus, and sources to be considered
  - Aquaculture type and species
- Biological and ecological end-points
  - Attributes for protection
- Conceptual model
  - System organization
- Plan
  - Analysis of information
  - Conducting the assessment

PHASE II
PROBLEM ANALYSIS

Analysis of Exposure

- Predict or measure spatial and temporal distribution of a stressor or concern
  - Historic and current literature information
  - Complete baseline survey with field work
  - Dose response data?

PHASE II
PROBLEM ANALYSIS

- Exposure Response
  - Estimate possible impacts by considering
    - Near-field effects
    - Far-field effects

PHASE III
RISK CHARACTERIZATION

- Brings together
  - Analysis of the exposure
  - Analysis of effects (from hypothetical risks)
- Most effects of aquaculture are *interactive*
  - Complexity dealt with by ***Modeling*** *(see talks by Rensel on hazard of nutrient enrichment and Rust on hazards of feed and seed)*

ONGOING ACTIVITIES

- Risk Management
  - for example how do you change to eliminate or reduce risk
- Risk Communication
  - Maximize transparency and input
- Monitoring for subsequent risks and improved models

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- Why Risk Assessment for Marine Aquaculture?
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  - An example not a complete assessment

IDENTIFICATION OF BIOLOGICAL END POINTS FOR PROTECTION

- The choice of the target (end-point) species for protection depends on:
  - The need for the best indicator of system stress or system response
  - Protection of some desirable biological attribute

SOME END-POINTS TYPICALLY IDENTIFIED FOR PROTECTION (1-4)

- Species richness and abundance of seston, nekton, and infauna
- Abundance of a specific species in the seston, nekton, and infauna
- Species richness and abundance of the epifauna
- Abundance of a specific species in the epifauna

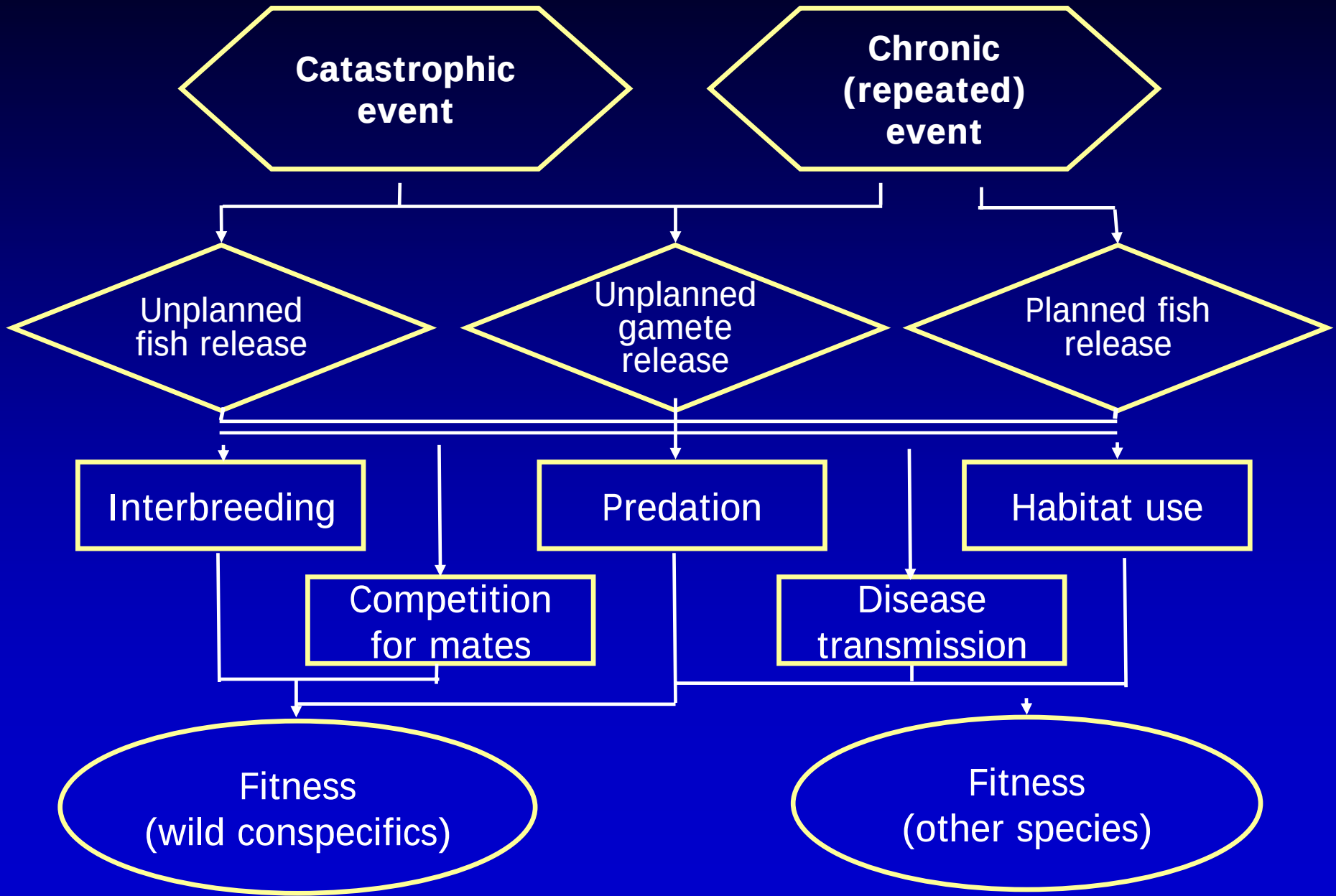
SOME END-POINTS TYPICALLY IDENTIFIED FOR PROTECTION (5-9)

- Abundance of a specific species of marine mammal, reptile, or bird
- Immune resistance of demersal and pelagic fishes
- Number and fitness on the natural (conspecific) population
- Fitness of another fish population
- Abundance of the industrial fisheries

CATEGORIES OF PERCEIVED OR OBSERVED RISK

- Increased organic loading
- Increased inorganic loading
- Residual heavy metals
- Transmission of disease organisms
- Residual therapeutants
- Biological interactions of escapees
- Physical interaction with marine wildlife
- Physical impact on marine habitat
- Using wild juveniles for grow-out
- Harvesting industrial fisheries for fish feed

TEMPLATE #6 - BIOLOGICAL INTERACTION OF ESCAPEES



APPLICATION OF THE FRAMEWORK

- Adopt a matrix approach to guide the application of Risk Assessments and choose the most important
- Three epipelagic systems
  - Offshore, coastal, and inshore
- First cut based on expert opinion, but further development based on models, experimental and historical data for risks with highest score.
- Uncertainty increases risk - assessment can highlight areas to reduce uncertainty.

CONTENTS OF A RISK ASSESSMENT REPORT

- Description of preliminary objectives and plans
- Description of environmental setting
- Proposed practice and species
- Review of conceptual model and assessment end-points
- Major data sources and analytical procedures used
- Review of stressor response and exposure profiles
- Description of risk to assessment end-points
- Review and summary of major areas of uncertainty, their direction, and approaches to address them

APPLICATION OF RISK ASSESSMENTS IN WATERS OF DIFFERENT BIO-GEO ZONES

CATEGORY OF OBSERVED OR PERCEIVED RISK	EPIPELAGIC ECOSYSTEM IN TEMPERATE WATERS (10 - 18˚C)			EPIPELAGIC ECOSYSTEM IN TROPICAL WATERS (>18˚C)		
	INSHORE	COASTAL	OFFSHORE	INSHORE	COASTAL	OFFSHORE
INCREASED ORGANIC LOADING	*****	**	*	*****	***	*
INCREASED INORGANIC LOADING	*****	**	*	*****	***	*
RESIDUAL HEAVY METALS	*	*	*	**	*	*
TRANSMISSION OF DISEASE ORGANISMS	***	**	**	***	**	**
RESIDUAL THERAPEUTANTS	**	*	*	**	*	*

KEY: POTENTIAL FOR ECOLOGICAL CHANGE WITHOUT MANAGEMENT ACTION

***** Significantly high **** High *** Medium **Low *Little/none

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	INSHORE	COASTAL	OFFSHORE	INSHORE	COASTAL	OFFSHORE
BIOLOGICAL INTERACTIONS OF ESCAPES WITH WILD POPULATION	**	**	*	**	**	*
PHYSICAL INTERACTIONS WITH MARINE WILDLIFE	**	**	*	**	**	*
PHYSICAL IMPACT ON MARINE HABITAT	**	*	*	**	*	*
USING WILD JUVENILES FOR GROW-OUT	**	**	*	***	***	**
HARVESTING INDUSTRIAL FISHERIES FOR FISH FEED	**	**	***	***	***	***

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Application of Risk Assessment in PICES region?

- Conduct Workshop to learn process
- Apply to one or more risks in each country
- Report on results of Risk Assessments and publish results
- Use to guide research priorities and decision making process.
- Next step is risk mitigation or reduction see talks by Rensel and Rust in this session for examples.

REFERENCE

- GUIDELINES FOR ECOLOGICAL RISK ASSESSMENT OF MARINE FISH AQUACULTURE
- Edited by C.E. Nash, P.R. Burbridge, & J.K. Volkman

- NOAA TECHNICAL MEMORANDUM NMFS-NWFSC-71

- DOWNLOAD FROM - http://www.nwfsc.noaa.gov/publications