ECOSYSTEM RISK ASSESSMENT (ERA) – ECOPATH WITH ECOSIM (EWE)

1. Objective

This Ecosystem Risk Assessment (ERA) evaluates the potential impacts of the Karnataka purse seine fishery on marine ecosystem structure and food web stability.

The assessment integrates:

- Scientific literature on Arabian Sea ecosystems
- CMFRI monitoring programs and stock assessments
- Ecosystem trophic structure analysis using Ecopath-style modelling concepts
- Expert judgement from fisheries scientists and FIP stakeholders

The objective of the ERA is to:

- Identify trophic interactions within the ecosystem
- Evaluate potential ecological risks from fishing activities
- Assess impacts on predator–prey dynamics
- Rank ecosystem risks using a structured risk matrix

2. Ecosystem Functional Groups (Ecopath Conceptual Model)

The ecosystem structure was simplified into major **functional groups** consistent with Ecopath ecosystem modelling approaches.

Functional Group	Examples
Primary Producers	Phytoplankton
Primary Consumers	Zooplankton
Small Pelagic Fish	Oil sardine, Indian mackerel, scads
Mid-level Predators	Tuna, seerfish, barracuda
Apex Predators	Sharks and large pelagic predators
Marine Mammals	Dolphins
Seabirds	Terns, gulls
Fishery	Purse seine fleets

These functional groups represent the **main energy pathways** within the pelagic ecosystem of the Arabian Sea.

3. Simplified Trophic Level Structure

The trophic structure of the Karnataka pelagic ecosystem can be represented across five levels.

Trophic Level 5
Apex predators (large tuna, sharks)

Trophic Level 4
Large pelagic predators (seerfish, tuna, barracuda)

Trophic Level 3
Small pelagic fish (oil sardine, Indian mackerel, scads)
Primary target of purse seine fisheries

Trophic Level 2
Zooplankton

Trophic Level 1
Phytoplankton

This structure illustrates the **energy transfer pathway within the marine ecosystem**.

4. Predator–Prey Energy Pathway

The primary ecosystem energy pathway in the pelagic ecosystem is summarized below:

Phytoplankton
↓
Zooplankton
↓
Small Pelagic Fish
(Oil sardine, Indian mackerel, scads)
↓
Predatory Fish
(Tuna, seerfish)
↓

Top Predators
(Sharks, dolphins)

Small pelagic fish act as **key forage species**, transferring energy from planktonic productivity to higher trophic predators.

Because of this ecological role, fisheries targeting these species must be evaluated carefully for potential ecosystem impacts.

5. Trophic Role of Target Species

The purse seine fishery primarily targets **mid-trophic pelagic species**.

Species	Approximate Trophic Level	Ecological Role
Oil Sardine (Sardinella longiceps)	~2.7	Plankton feeder
Indian Mackerel (Rastrelliger kanagurta)	~3.1	Zooplankton and small fish predator
Scads (Decapterus spp.)	~3.3	Mid-level predator
Lesser Sardines (Sardinella spp.)	~2.8	Plankton feeder

These species are characterized by:

- High productivity
- Short life cycles
- Rapid population turnover
- Strong recruitment variability linked to monsoon productivity

These biological characteristics reduce the long-term ecosystem risks associated with fishing pressure.

6. Ecosystem Risk Heat Map Assessment

A qualitative risk assessment was conducted considering **likelihood and ecological consequence**.

Ecosystem Component	Likelihood	Consequence	Risk Level
Small pelagic prey availability	Medium	Medium	Medium
Predator population stability	Low	Medium	Low
Marine mammal interaction	Low	Low	Low
Seabird interaction	Low	Low	Low
Non-target fish species	Low	Low	Low
Benthic habitats	Very Low	Low	Low
Plankton productivity	Very Low	Low	Low

Most ecosystem components fall within the **low-risk category**, indicating limited ecosystem disruption from purse seine fishing activities.

7. Quantitative Risk Scoring Matrix

A simple scoring system was applied to rank ecosystem risks.

Ecosystem Component	Likelihood (1–3)	Consequence (1–3)	Risk Score	Risk Category
Small pelagic forage species	2	2	4	Medium
Predator fish	1	2	2	Low
Marine mammals	1	1	1	Low
Seabirds	1	1	1	Low
Non-target fish	1	1	1	Low
Plankton productivity	1	1	1	Low
Benthic habitats	1	1	1	Low

No ecosystem component was classified as **high risk**.

8. Ecosystem Safeguards and Management Measures

Several management measures are currently implemented to reduce ecosystem impacts.

Seasonal Fishing Ban: Annual monsoon fishing bans protect spawning and recruitment periods of key fish stocks.

Mesh Size Regulations: Minimum mesh sizes reduce juvenile fish capture and maintain stock productivity.

Spatial Restrictions: Purse seining is prohibited within **6 km from the coastline**, protecting sensitive coastal habitats.

Scientific Monitoring: Regular monitoring of fish stocks and ecosystem indicators is conducted by **ICAR-CMFRI** through national marine fisheries research programs.

These measures contribute to **maintaining ecosystem balance and reducing ecological risks**.

9. Interpretation of ERA Results

The ERA indicates that:

- The purse seine fishery primarily interacts with **mid-trophic pelagic species**.
- The fishery has **minimal interaction with seabed habitats**, as the gear operates in the water column.
- Predator populations are unlikely to be significantly affected under current fishing pressure.

The only moderate ecological consideration relates to **forage fish exploitation**, which should continue to be monitored through stock assessments.

10. Conclusion

The Ecosystem Risk Assessment concludes that:

- No **high ecosystem risks** were identified.
- Most ecosystem components fall within **low risk categories**.
- Existing management measures and monitoring programs help maintain ecosystem stability.

Therefore, based on the available scientific information and ERA analysis, the **Karnataka purse seine fishery is unlikely to cause significant negative impacts on marine ecosystems**.