# BREAKOUT 3 - Ecosystem/Human interactions group

We cannot separate out basin-scale processes from processes on the coast.

The Galway declaration is not an Arctic-sub-polar initiative- The Scope should be North-Atlantic, not just Arctic.  Cannot see this process without seeing it from a basin-scale.

Scale - times are something that needs to be brought up in the top-level preamble.

Look at humans as drivers for pressures.

1) DRIVERS Natural and anthropogenic drivers as ecosystem change

2) RESPONSES Ecosystem response to human change

3) FEEDBACKS Feedback from ecosystems to humans

Need coupling of systems/models so that we work in an INTEGRATED manner joining physical oceanographers, geochemists, ecologists, managers.

What issues need a basin-scale analysis, and what issues would benefit from a combined /complimentary approach (building on national or regional projects/analyses).

**Discuss/show how this links back to the physical / biogeochemical / ecosystem health side.**

# Overarching interdisciplinary science questions:

1) How will marine ecosystem structure and function including feedbacks respond to environmental change in climate, ocean physics, biogeochemistry and human pressures?

2) What are the interactions between humans and changing arctic and Atlantic marine systems considering perspectives of health, wellbeing and impacts, and how should these inform sustainable management practices.

# Knowledge gaps:

First consider what the issues are from a DPSIR approach

**DRIVERS:**

* Climate change
* Ocean Acidification
* Hypoxia
* Reduced sea ice
* Increased demand for resources and space
* Changed demography on the coast
* Growing human population

**PRESSURES/STATE:**

(*We need to look to the rest of the program to understand what the State-changes are likely to be)*

* Warming oceans
* Reduces ice cover makes arctic accessible to shipping, oil, gas etc
* Increased storm risks
* Arctic more accessible - more tourists - more ships
* Increased shipping
* ballast-water discharge
* Increased petroleum extraction
* Increased renewable energy development/production
* Increased sub-sea mining
* Increased aquaculture
* human infrastructure (installations creating connectivity, from petroleum, renewables, aquaculture installations and similar)
* Increased extraction in frontier areas (previously ice-covered)
* Going deeper: oil/gas, mineral extraction, fisheries, aquaculture
* Increasing and redistribution coastal developments
* Invasive humans (eg. Tourism or other new access into new areas

**IMPACTS:**

Ecosystem:

* Changing food webs,
* shifting biogeographic boundaries
* invasive species
* Cumulative/synergistic impacts.

Humans:

* Health/safe food /safe recreation
  + pathogens
  + HAB (poisonous shellfish),
  + stinging jellyfish,
  + stinking beaches,
* Economic/social impacts
  + CC as a food-security issue
  + changing fishing patterns/opportunities,
  + changes in coastal community structure,
  + coastal infrastructure,
  + Security of coastal settlements
    - Acute (storms, tsunamis etc)
    - Chronic (coastal erosion, flooding, sea-level rise, waves)

**RESPONSES:**

* Better ballast-water regulation,
* Marine Spatial Planning (eg. offshore installations, pipelines, shipping, aquaculture sites, conservation zones, fishing zones)
* Changes in community structure and culture of indigenous people – responses to changes in ice cover, permafrost, changes in biogeography

## 1) Shifting biogeographic boundaries:

*Research questions:*

* What are the implications of climate change on food-webs especially in relation to shelf - open ocean connection?
* How is the coastal fish production impacted by changes in the oceanic areas?
* What is the impact of heat distribution on a basin-scale on the distribution of zooplankton/fish/whales?
* What are the implications for whale-watching/fisheries
* How is energy routed through the food-web? What are the changes to this routing likely to be?
* How are changes in nutrients changing the O2 levels on the shelf, and in turn affecting the productivity and distribution of fish stocks and other ecosystem components?
* What are the implications for genetic diversity and evolutionary adaption?
* What are the health, social, cultural and economic, impacts on coastal communities from biogeographic shifts?
  + Eg. how will fishermen who are used to fishing certain species respond to a new target species?
  + How communities avoid, mitigate or adapt to change?

## 2) Environmental and human effects of resource / space use / extractions

*Research questions:*

* What are the ecological implications of increased space demands/use from shipping, renewable energy, fisheries, aquaculture etc?
* Ecological implications of increased harvest at lower trophic levels and at mesopelagic communities?
* Ecological implications of deep-water mineral extractions
* How are new off-shore deep-water human activities affected by climate change?
* How can we develop tools, methods etc to understand the trade-offs? (eg. Social, economic, cultural, health and ecological trade-offs)

## 3) Extreme - risk events

*Research questions:*

* How do we identify vulnerable ecosystem / vulnerable human communities? (in relation to extreme events as well as in relation to longer-term impacts from climate change)
* How to assess, quantify and predict the risks / consequences of accidents (e.g. spill, shipwrecks, nuclear events)
* How to assess, quantify and predict the risks of extreme weather/environmental events and their resultant effects on coastal communities/ ecosystems?
* Research – what observation systems would we need to monitor extreme events (e.g. spills) in real-time?
* How can we communicate risk and uncertainty to the community?

## 4) Carbon Quotas /Carbon Balance

*Research questions:*

* How is the carbon pump changing including the links between the shelf and open-ocean, and how does this impact on the contribution to the climate regulation service?
* What is the role of higher trophic levels in the carbon cycle? *[Biogeochemical models need to be linked to fish/fisheries models.]*
* What impacts would human activities (extractions) have on the carbon pump service? (eg. Fishing at lower trophic levels or in new places, on mesopelagics)
* What are the trade-offs in ecosystem functions and services under varying exploitation/use patterns (eg. Harvest or not to harvest mesopelagics, changes in physical circulation/carbon cycling)?
* What are the trade-offs between exploitation food/feed resources and maintaining charismatic species?

## 5) Metrics of ecosystem health

*Research questions:*

* At a Basin-scale:
  + What monitoring do we need to develop to assess the health of the open ocean and what can rely on the monitoring along the shelves?
  + How can a suite or a single metric / indicator of ecosystem health be developed?
  + How to set targets, boundaries and reference points? What are the uncertainties of the assessments?
  + How to extrapolate / scale up from small spatial and temporal scale, few samples?
  + What observations, how many observations do we need to evaluated ecosystem health?
  + System integrity, resiliency to change?