MOANA
MINERALS

MOANA 1 PROJECT:

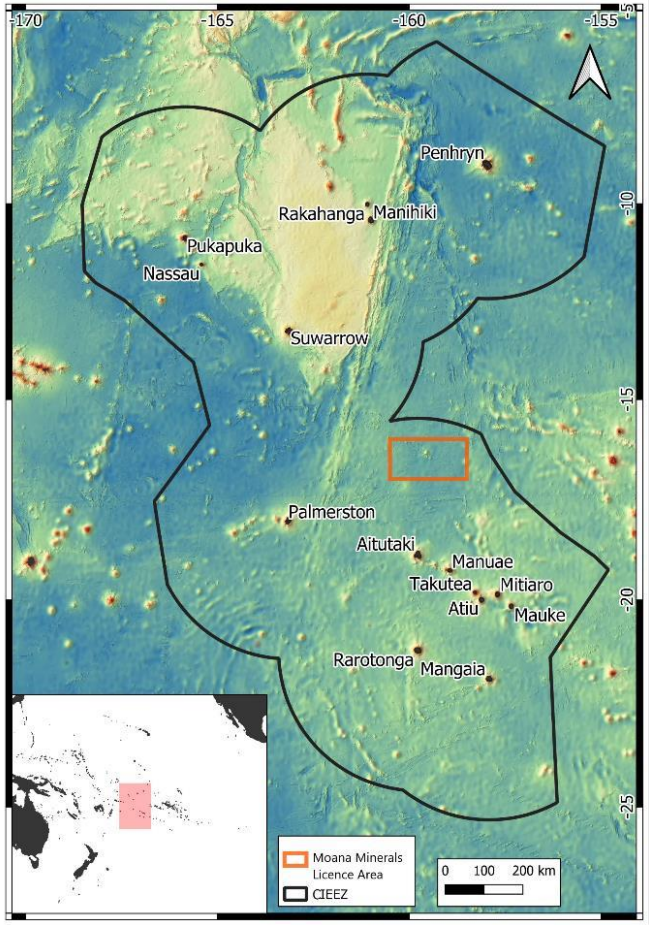
Key Elements of the Environmental Management Programme

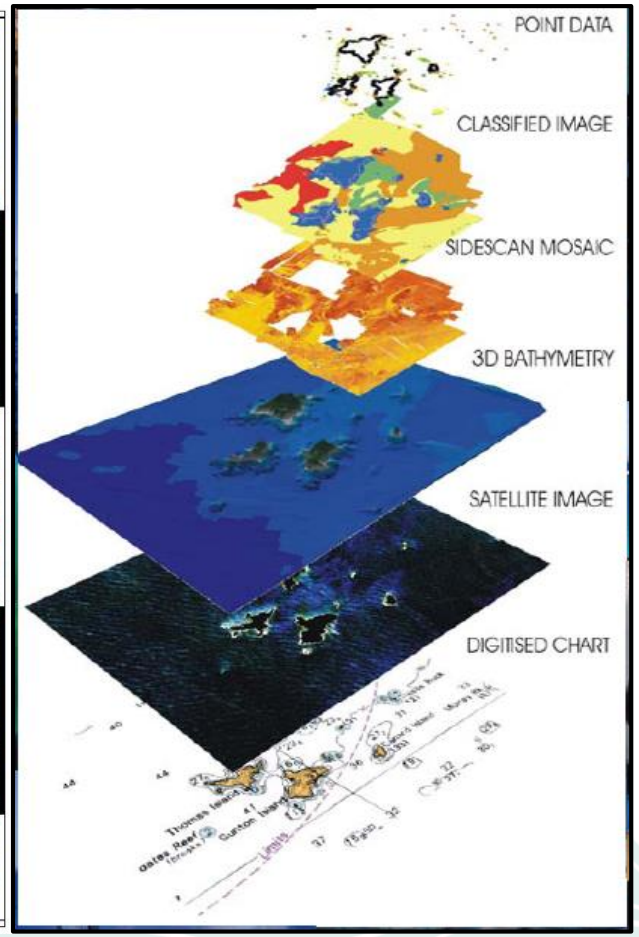
FATHOM PACIFIC

ERIAS

Key Principles of Exploration EMP

- Exploration Activities planned to date are Tier 1 Activities = no significant impact.
- Exploration license awarded on the basis of reflecting the 9 principles of the Marae Moana Act.
- Moana Minerals' Exploration Activities within framework of an ESIA.

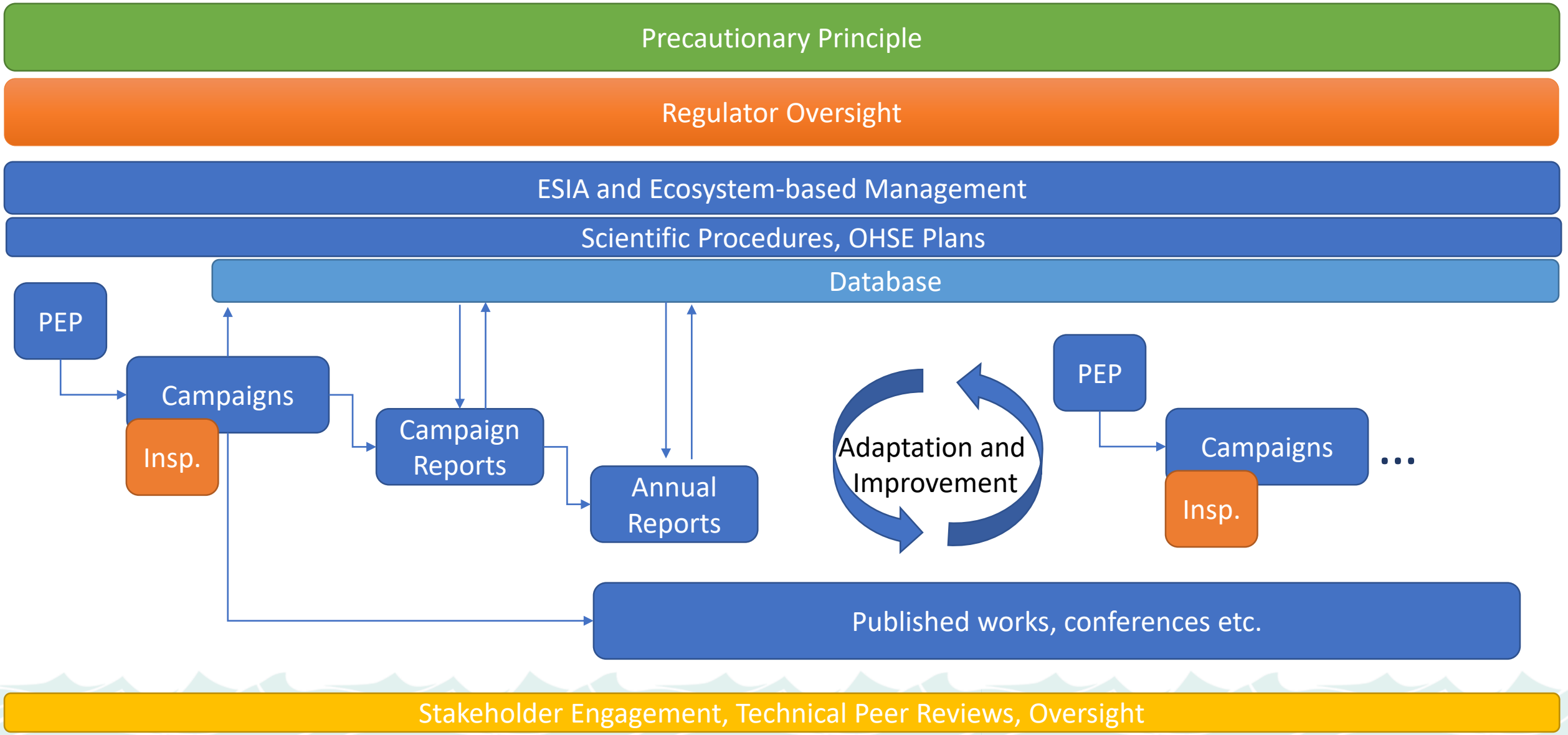




Design concepts:

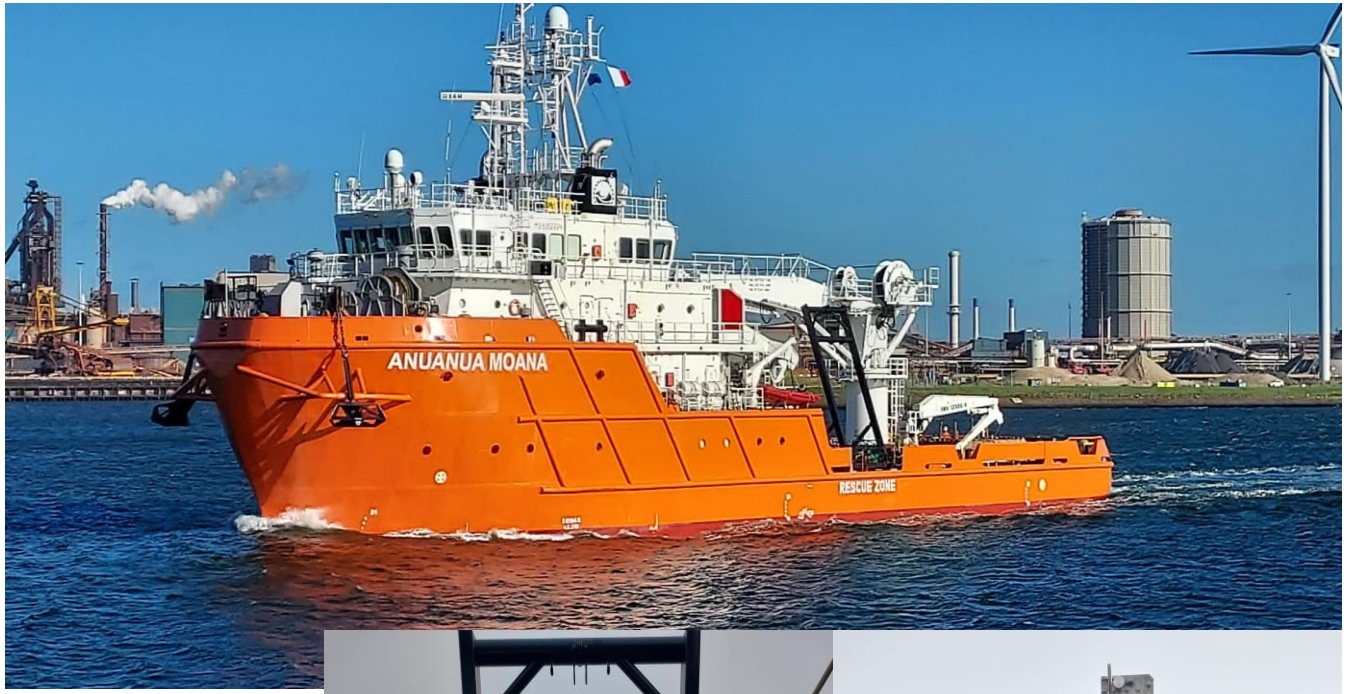
- Hierarchical
- Increasing resolution with habitats as the base
  - One of the most significant mitigation tools available in deep-sea mining is spatial planning.
- Sequencing
  - Sampling sequenced to major project design junctures.
- Monitoring
  - Maintain focus on transition of effective monitoring indicators and methods.

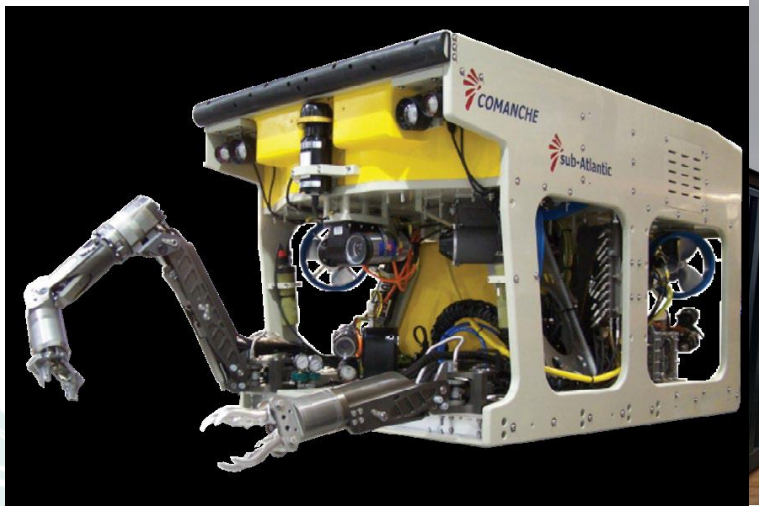
Process

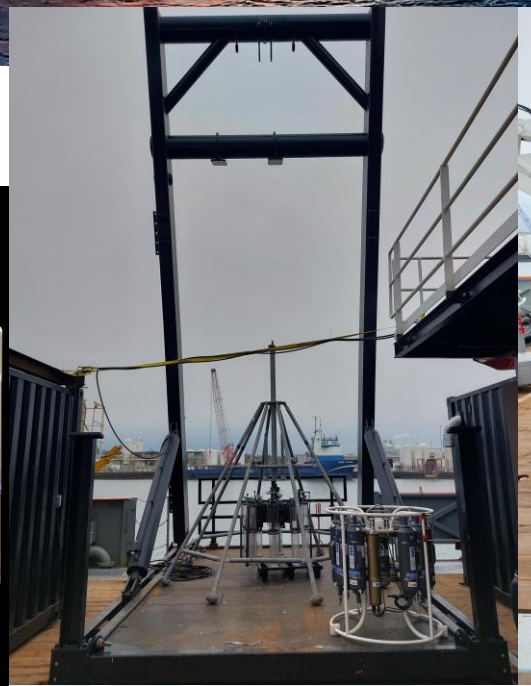

Precautionary Principle
Regulator Oversight
ESIA and Ecosystem-based Management
Scientific Procedures, OHSE Plans
Database
PEP
Campaigns
Insp.
Campaign Reports
Annual Reports
Adaptation and Improvement
PEP
Campaigns
Insp.
...
Published works, conferences etc.
Stakeholder Engagement, Technical Peer Reviews, Oversight

EMP Execution

- Executives and operational team based in Cook Islands.
- CI-based vessel –
  - '*smaller and more frequent*' approach
  - de-risks the '*mega-campaign*' model of environmental surveys
  - allows progressive integration and adaptation
- Program of work within an Environmental and Social Impact Assessment framework –
  - focuses studies to information need

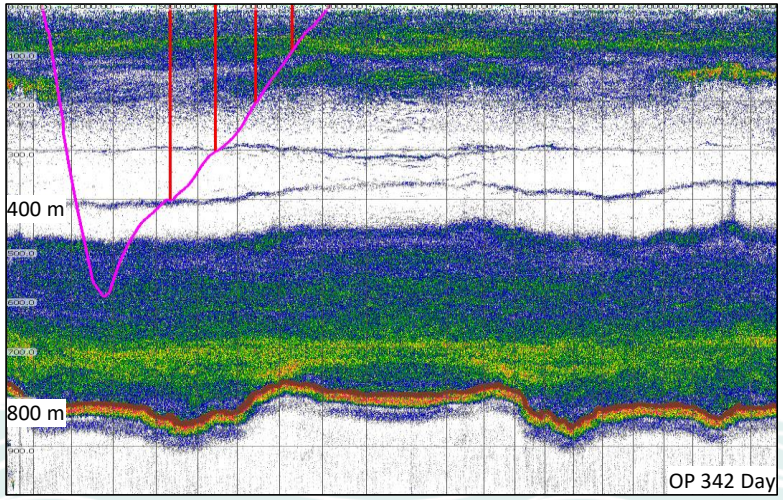


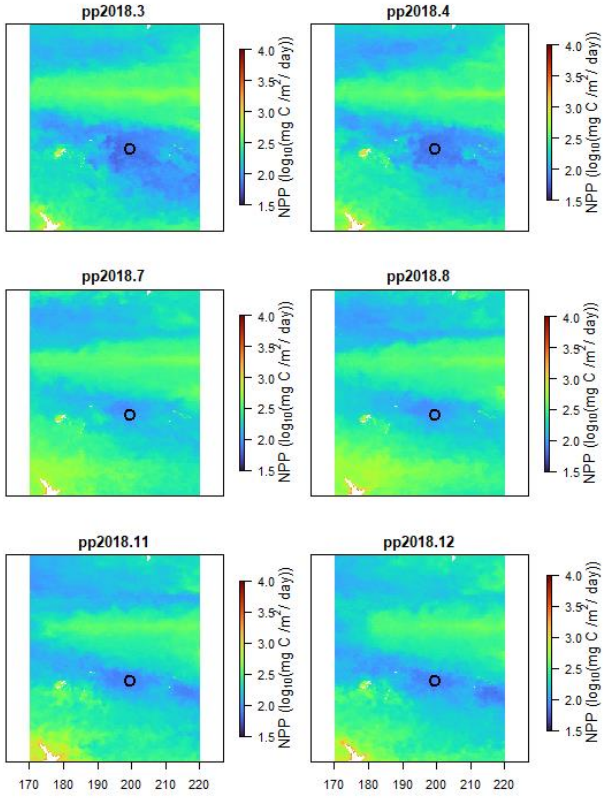


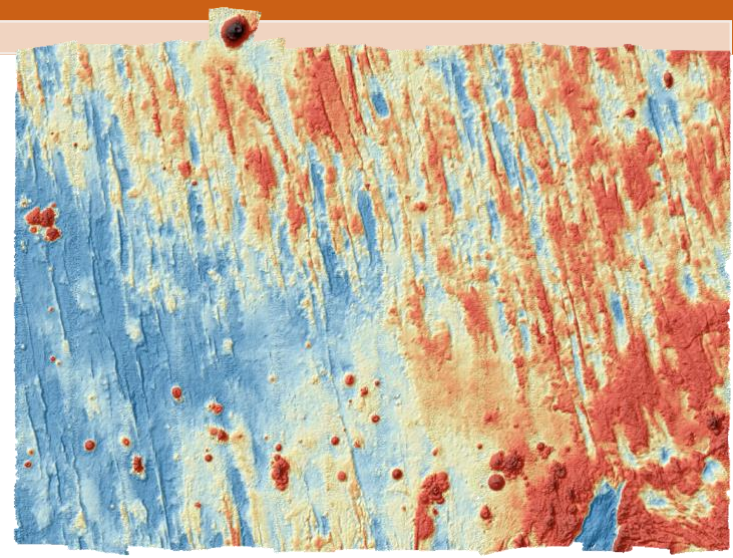


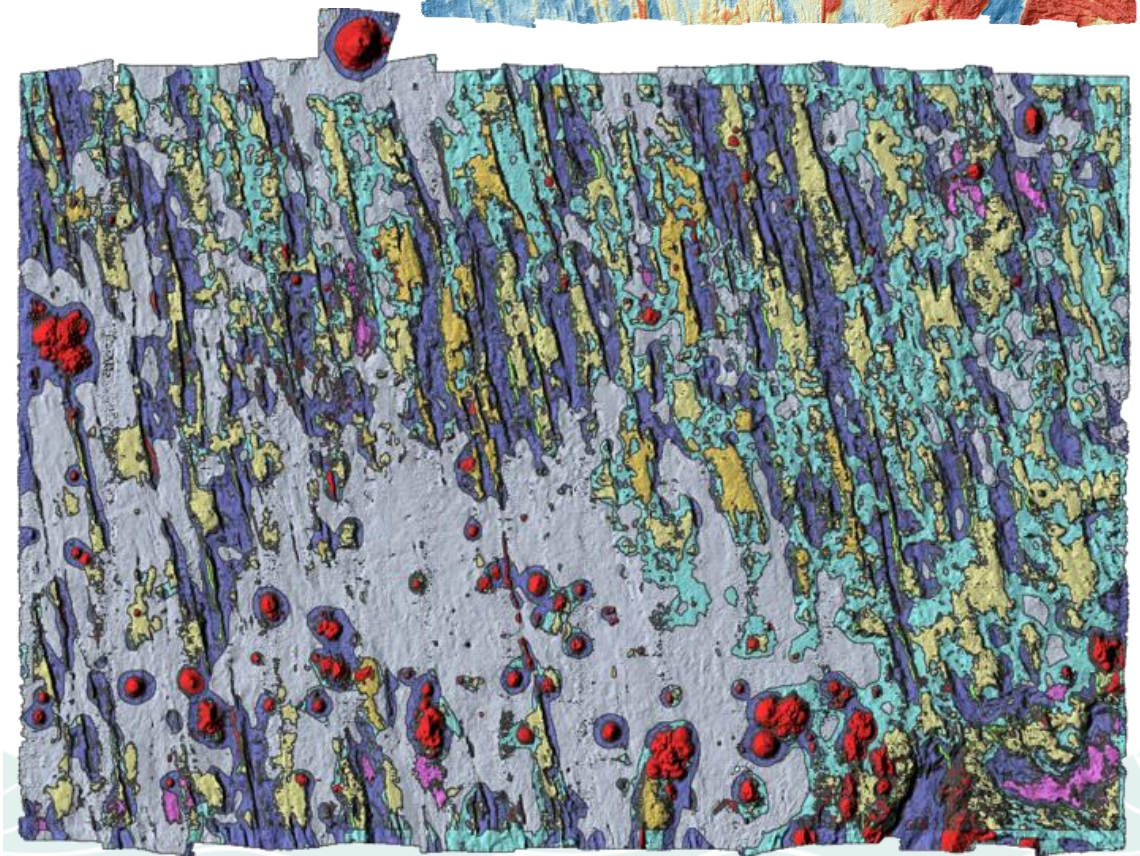
EMP Outputs – Remote sensing approaches

- Benthic and Pelagic
- Geostatistical analyses to identify Level 2+ habitats nested within HMZs
- Provides a spatial basis for all sampling and project design



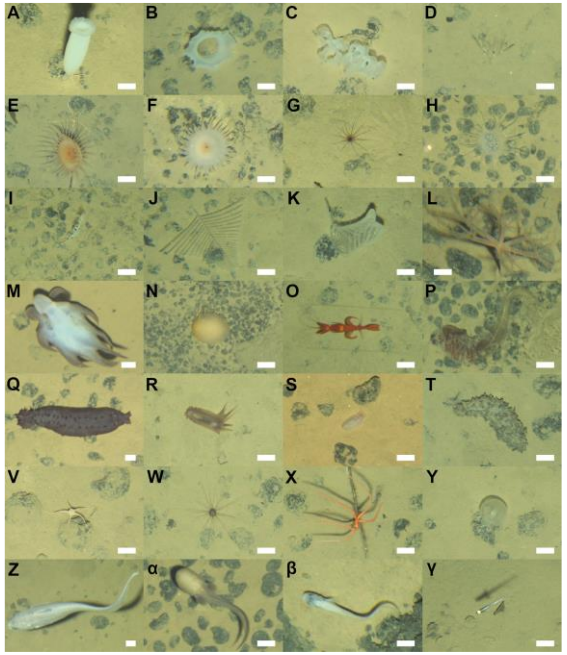


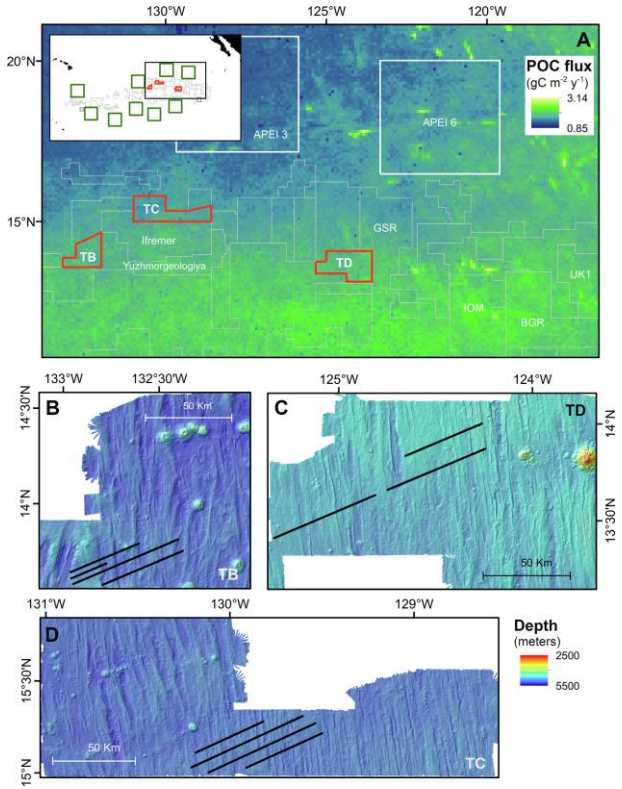




EMP Outputs – Biological community structure and function

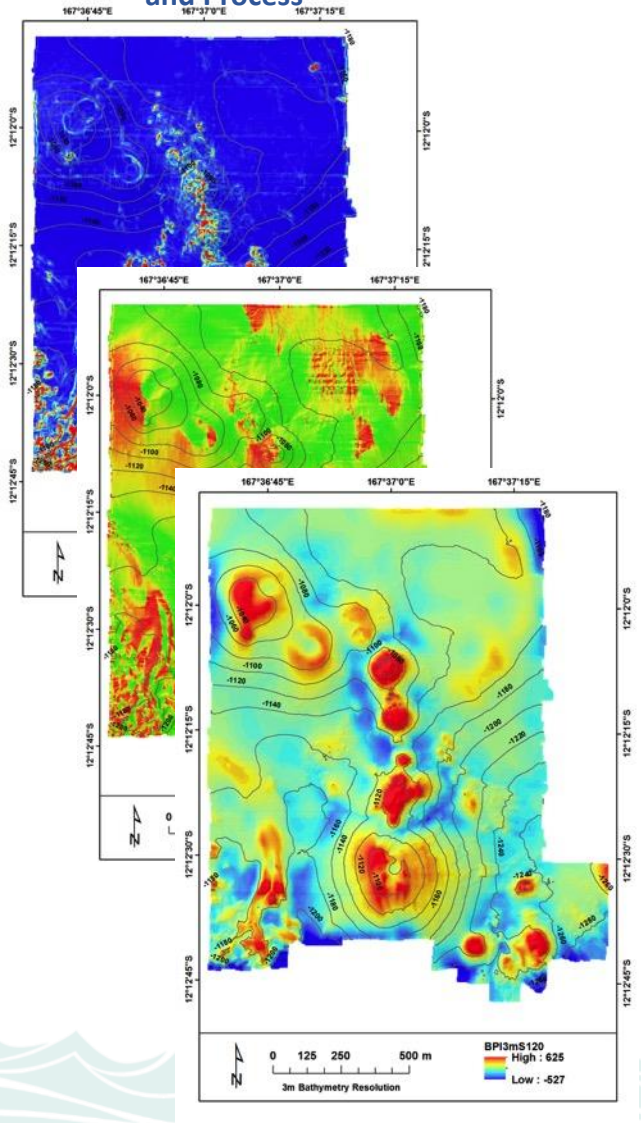
Observation data



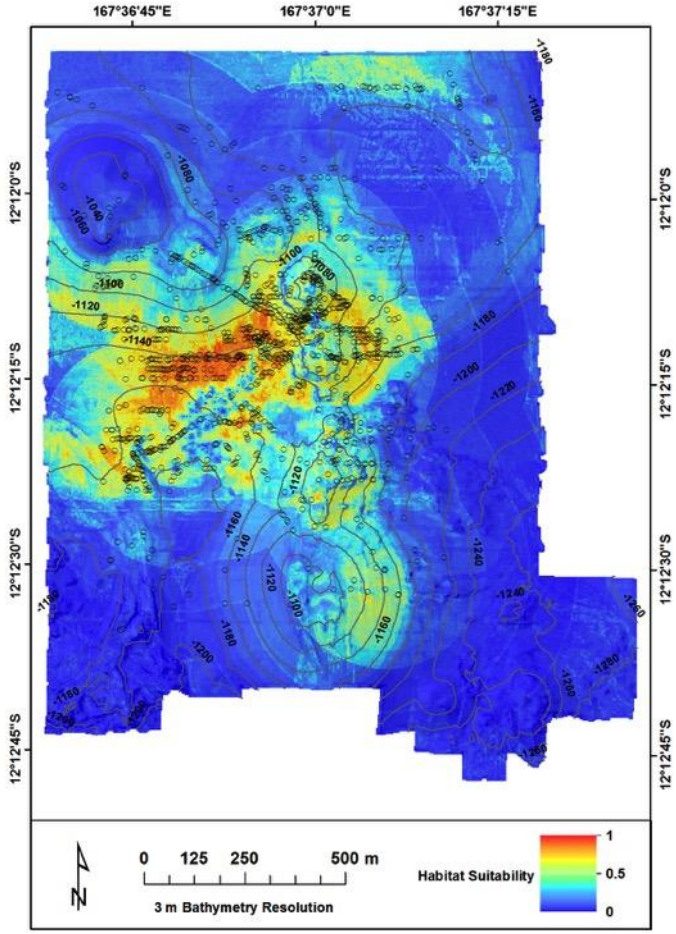


Source: TOML CCZ15

Physical Habitats x Biological Pattern and Process

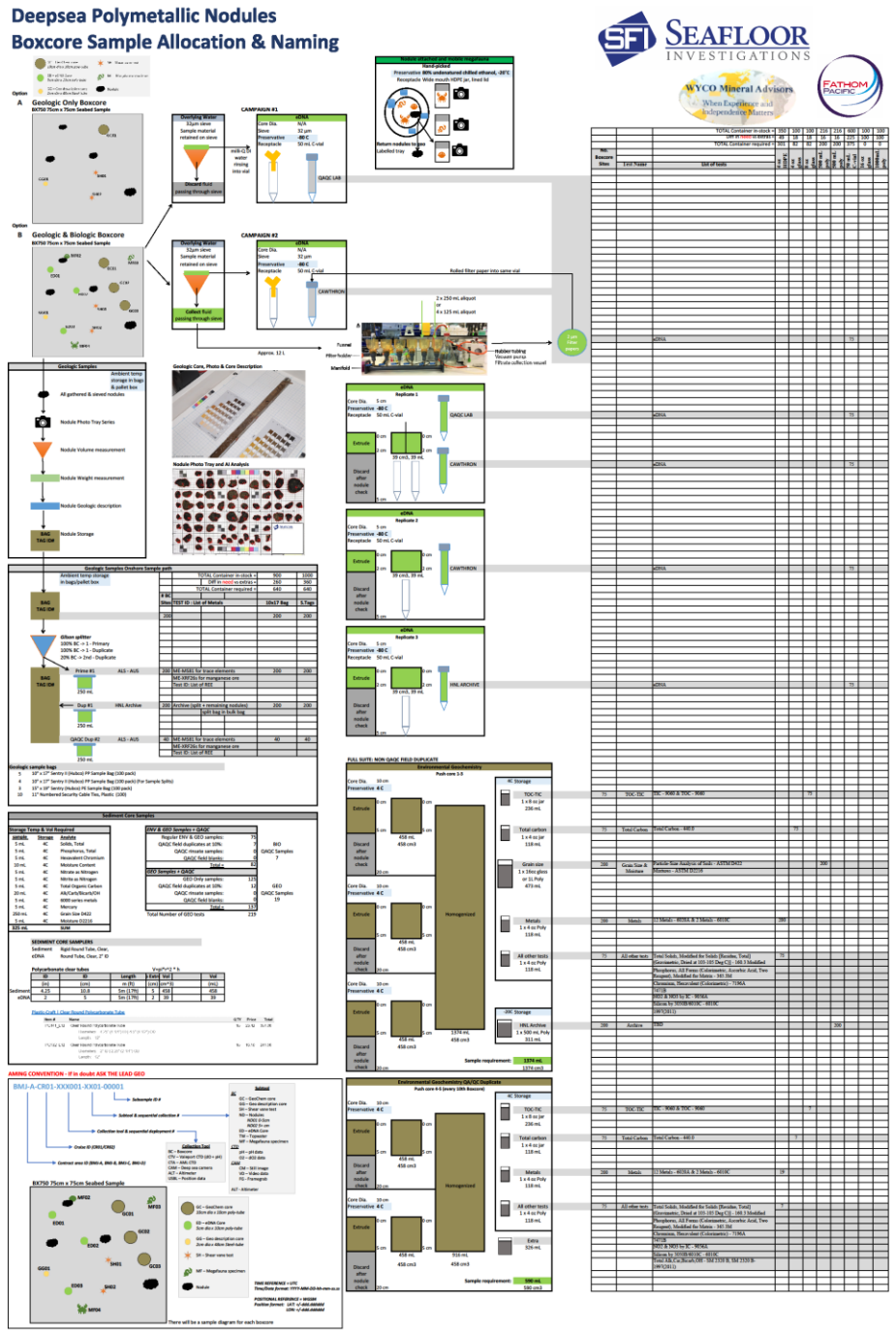


Community Composition Distribution Representativeness

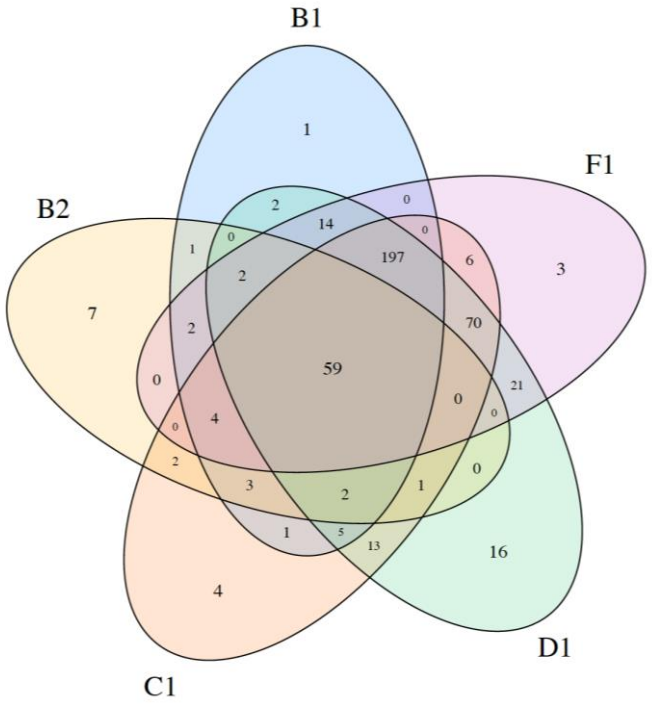


EMP Outputs – Benthic ecosystem

- Benthic sampling example
  - Workflows that harmonise GEO and ENV requirements
  - Making use of nodule, sediment, overlying water to maximum extent
  - Physical-chemical-biological



EMP Outputs – eDNA metagenomics



998 • OTU ← Very high diversity detected

38 • Phyla ← 36 matched to taxonomic phyla

105 • Class

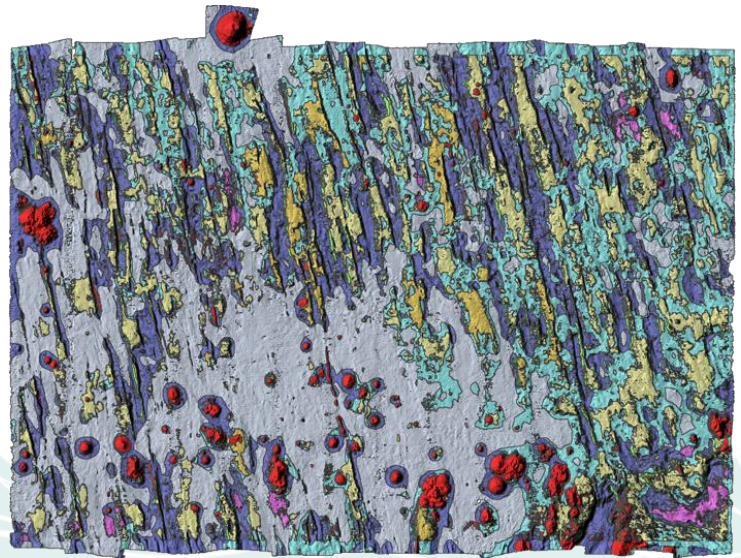
162 • Order

231 • Family ← 100 matched to taxonomic families

281 • Genus

286 • Species

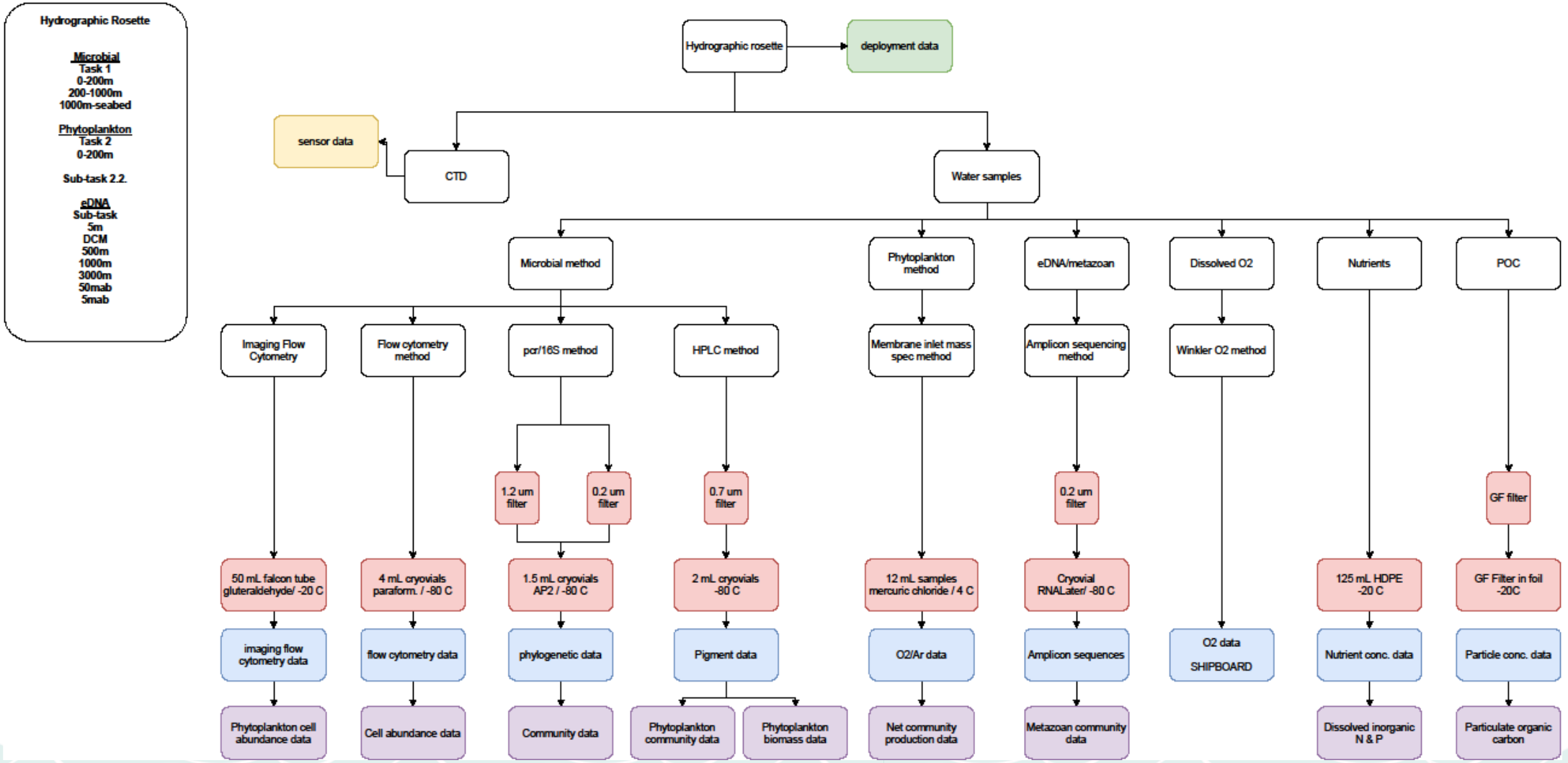
Resolution at these levels = power to detect change at ecol. significant levels



Source: TOML CCZ15

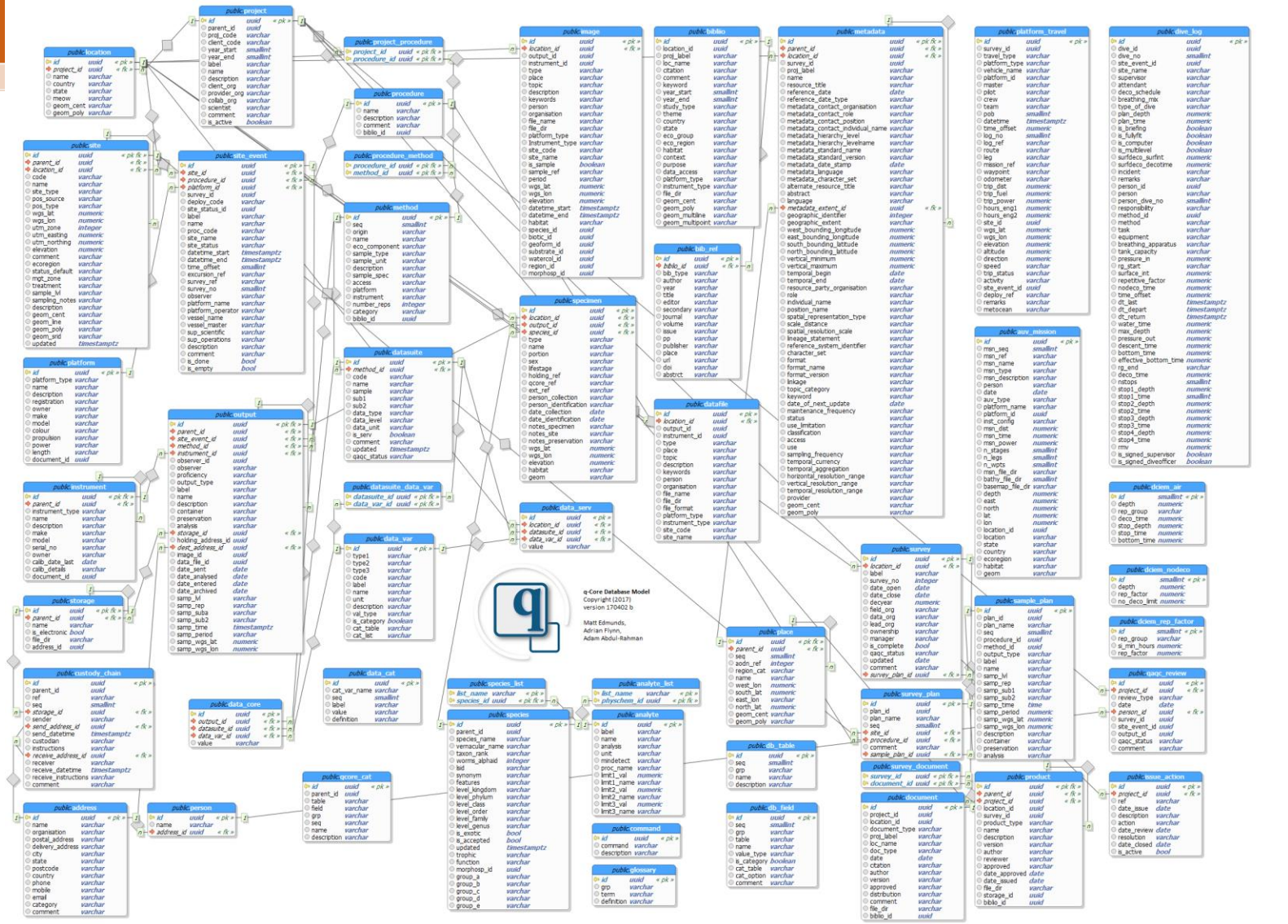
EMP Outputs - Data

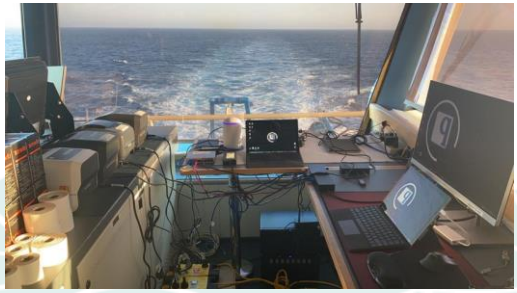
- Pelagic sampling example



EMP Outputs

- Data systems
  - Provide MML with corporate data governance.
  - Provide data insights for ESIA.
  - Provide reports and summaries of complex datasets to stakeholders.
  - Support contractor-MSR collaboration.
  - Support FAIR principles: findability, accessibility, interoperability, and reusability



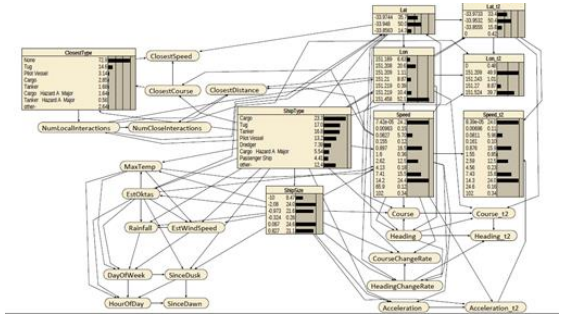


EMP Outputs – EBM Framework

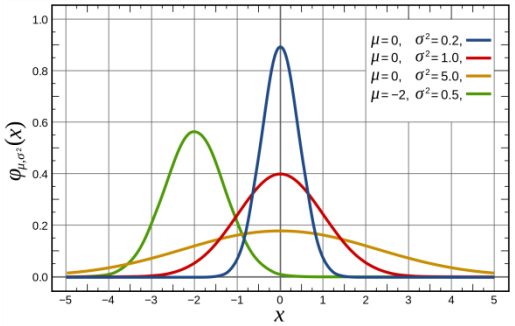
Probabilistic Graphical Models

For a target system…

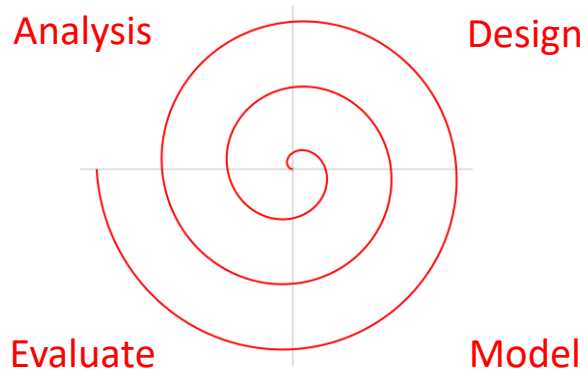
… capture the process structure (not a black box)



…and quantify the uncertainty



Process

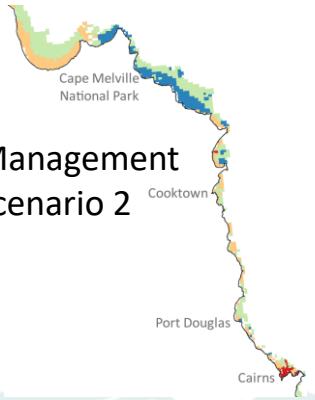


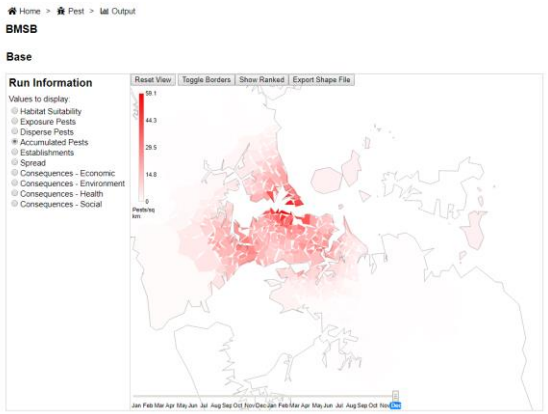
Spatialised outputs

Current seagrass condition

Management scenario 1

Management scenario 2



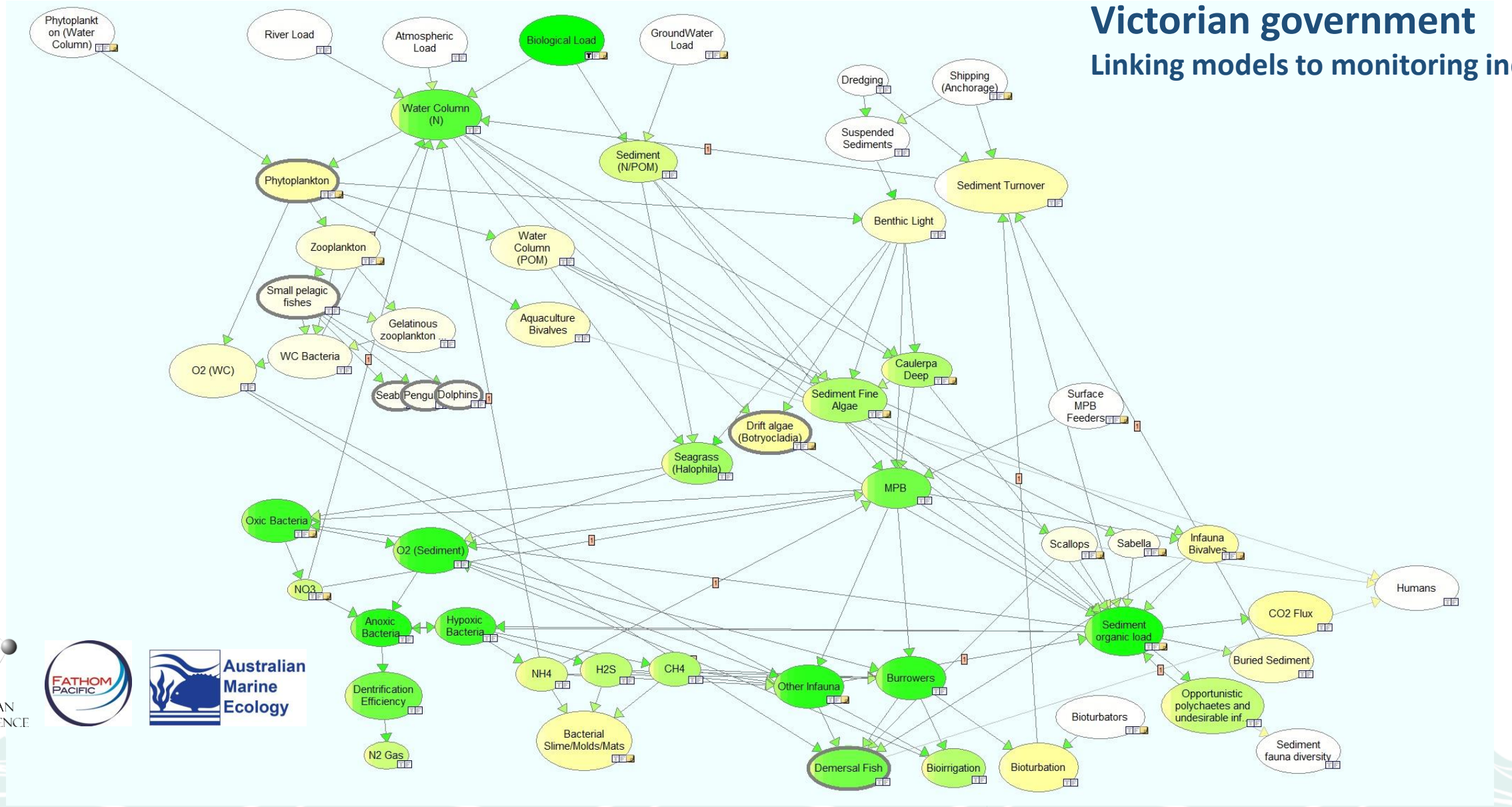


National Environmental Research Program TROPICAL ECOSYSTEMS hub

BAYESIAN INTELLIGENCE

ARC Centre of Excellence Coral Reef Studies

EMP Outputs – Operationalising EBM



Victorian government

Linking models to monitoring indicators

BAYESIAN INTELLIGENCE

FATHOM PACIFIC

Australian Marine Ecology

EMP – Studies

Field studies

Physical Oceanography
- Currents
- Water column structure
- Noise and biological sounds
- Sediment flux
- Opportunistic moored sensors
- Mooring operations

Benthic habitat structure and function
- Acoustic surveys
- Imaging survey
- Seafloor sampling

Pelagic habitat structure and function
- Water column structure
- Water quality

Toxicology
- Sediment and nodule physiochemistry
- Water quality
- Sediment toxicological risk
- Nodule toxicological risk

Benthic ecosystem
- Megafauna and benthic ecology imaging surveys
- Seafloor sampling

Abyssopelagic and Benthic boundary layer ecosystem
- Abyssopelagic plankton and particulates
- Abyssopelagic fishes, scavengers, and other megafauna
- Opportunistic sensors

Pelagic production
- Primary production
- Midwater particulates
- Midwater zooplankton
- Midwater micronekton

Surface ecosystem
- Megafauna observation
- Cetacean acoustic sensing
- Megafauna movements and migrations

Ecological function
- Distributions and biogeography
- Biodiversity
- Food webs
- Population connectivity

Ecosystem services
- Provisioning services – commercial fishing
- Provisional services – artisanal and recreational fisheries
- Cultural services
- Climate regulation and Greenhouse gas

Integrative technical studies

Ecosystem modelling
- Model components and definitions
- Level 1 provisional indicators
- Level 2 model update, indicators and thresholds
- Model operationalisation

Habitat mapping and spatial planning
- Geoform mapping
- Substrate mapping
- Biotope mapping
- Spatial planning

Noise modelling
- Source levels
- Noise models

Plume modelling
- Plume model design criteria
- Provisional, desktop Level 1 benthic plume model
- Provisional Level 2 benthic plume model
- Provisional Level 2 midwater plume model
- Final Level 3 benthic plume model
- Final Level 3 midwater plume model

Hazards assessment and oil spill modelling
- Natural hazards
- Accidents

Greenhouse emissions and climate change
Greenhouse gas assessment

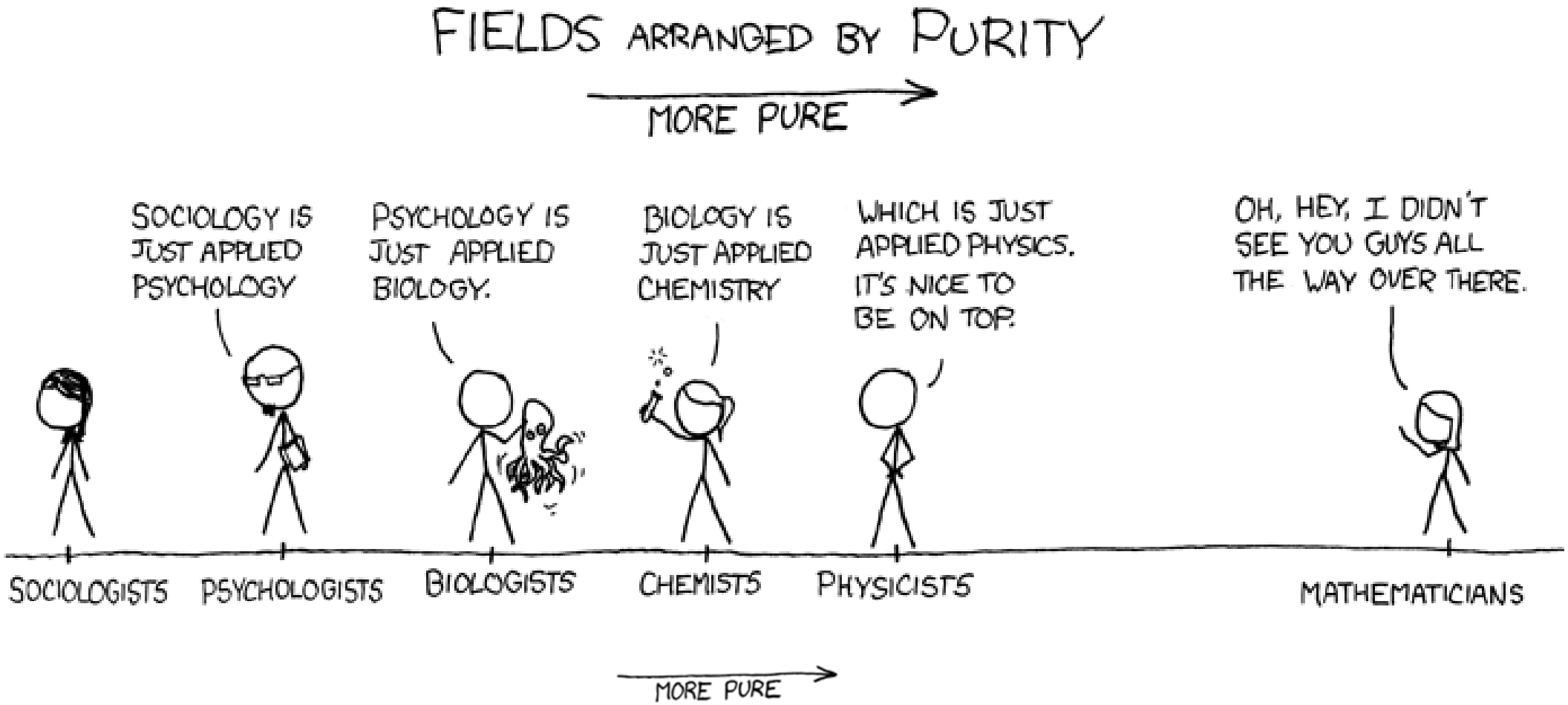
EMP – Studies

Economic impact	Subsistence & livelihoods	Cultural heritage
• Revenue • Other benefits • Industry impacts • Gender and disadvantaged cohorts	• Subsistence/ artisanal marine resource use • Contribution to nutrition	• Values, beliefs, customs and traditions that relate to the marine environment. • Mapping of important cultural features (e.g. seafaring routes, fauna migration routes).

Methods:

- Stakeholder engagement and informal interviews
- Desktop assessment
- Environmental field studies
- Limited modelling/projections (economic analysis)

Images: Prioritising community values such as small businesses, waste management services, and a healthy ecosystem. Source: Cook Islands Economic Development Strategy 2030


FIELDS ARRANGED BY PURITY
MORE PURE
SOCIOLOGY IS JUST APPLIED PSYCHOLOGY
PSYCHOLOGY IS JUST APPLIED BIOLOGY.
BIOLOGY IS JUST APPLIED CHEMISTRY
WHICH IS JUST APPLIED PHYSICS. IT'S NICE TO BE ON TOP.
OH, HEY, I DIDN'T SEE YOU GUYS ALL THE WAY OVER THERE.
SOCIOLOGISTS
PSYCHOLOGISTS
BIOLOGISTS
CHEMISTS
PHYSICISTS
MATHEMATICIANS
MORE PURE

XKCD.COM