The Likely Suspects Framework for Atlantic salmon: cooperatively building the foundations for a life-cycle approach to guide future management

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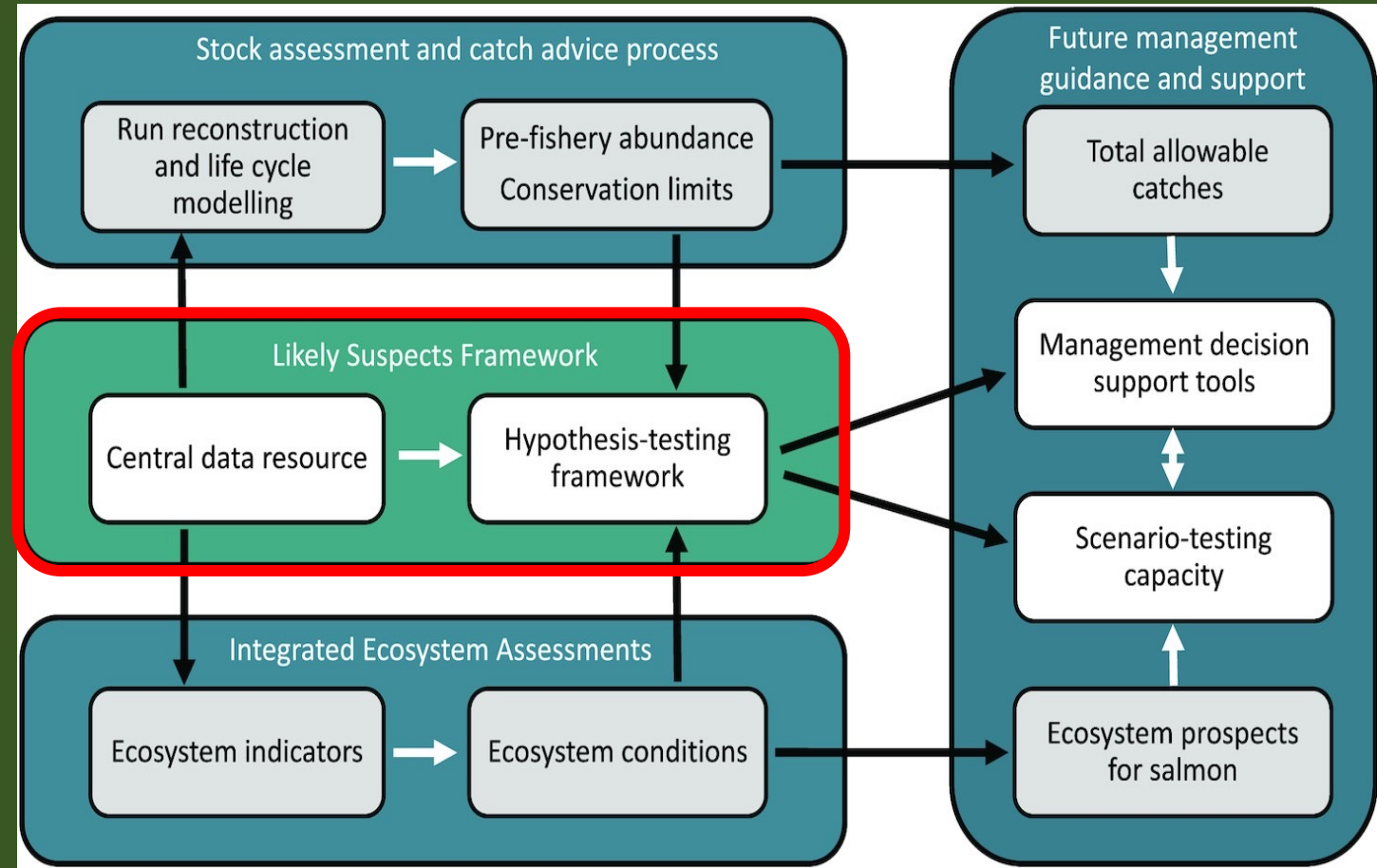Stirling
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Likely Suspects Framework for Atlantic salmon

Aim : Providing an intellectual and resourcing framework to assist cooperative research into salmon mortality drivers

Objective :
Providing salmon managers with access to high value decision-support advice that considers the efficacy of their management activities within the context of other factors at play (i.e. taking a full lifetime survival view)

THE MISSING SALMON ALLIANCE

So what ?

Help inform stock assessment, develop new management support tools (expectation management) and possible coordinated responses

NASCO-ICES WKSALMON workshop series:
To advance knowledge of at-sea mortality in salmon and lead to more accurate stock assessment

Explore how best to integrate available data on salmon, specifically data on marine survival for use in models

Enable the provision, collation and standardisation of salmon data that are currently unavailable.

- WKsalmon 1– data sources (June 2019)

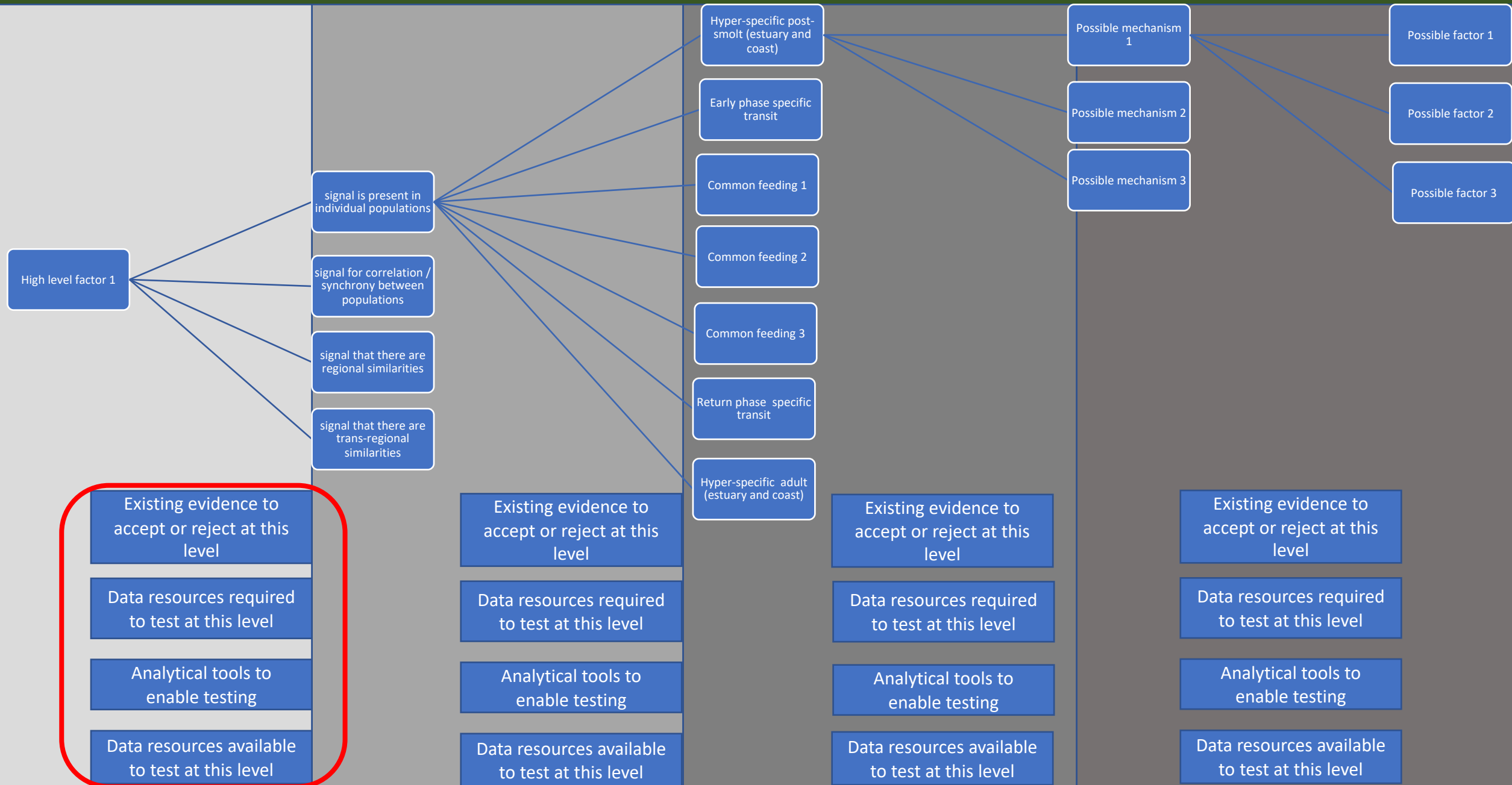- WKsalmon2 – questions and data mobilisation (August 2022)

- WkSalmon3 ……….
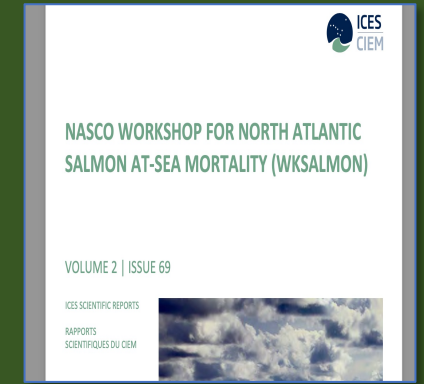
Current work packages

1. Knowledge exchange hub mobilising environmental and biological data for salmon science and management (SalHub)

2. An analytical mortality framework

3. Interactive salmon management tool providing whole life-cycle context, and scenario testing

4. Explore ecosystem indicators linked to salmon survival prospects

Hypothesis and possible factor	Sub-hypothesis	Possible mechanism	Climate change drivers-ocean and atmosphere	Salmon marine distribution	Salmon marine growth and condition	Salmon freshwater growth and condition	Smolt migration phenology	Predator popn dynamics and feeding behaviours	Prey availability and quality	Competitor popn dynamics	Commercial fishing pressure	Salmon farming data	Fish diseases
1 Predation	1a	Increased predation pressure	X	X				X			X		
	1b	Post-smolts in poorer physiological state are more susceptible to predation	X	X	X	X		X	X	X			X
	1c	Smaller post-smolts are more susceptible to predation	X	X	X	X	X	X					
2 Growth	2a	Variation in the quality and quantity of suitable prey	X	X	X				X	X	X		
	2b	Increased competition for available prey	X	X	X				X	X			
	2c	Mis-match between initial marine migration phenology and availability of prey resources	X	X	X		X		X	X			
	2d	Energetic costs in marine phase increasing	X	X	X	X			X	X			
	2e	Smaller post-smolts have less energy storage and lower resilience during period/s of reduced feeding opportunity	X	X	X	X			X	X			X
3 Disease	3a	Cumulative stressors increasing disease severity	X	X	X				X	X		X	X
4 Salmon aquaculture	4a	Increased mortality risk resulting from aquaculture mediated ectoparasite encounters	X	X	X							X	X
5 Fisheries	5a	Variation in the incidence and severity of commercial by-catch	X	X							X		

Developing marine mortality hypotheses (WKSALMON2)

1. The Salmon Ecosystem Data Hub (SalHub)

An online portal providing a unique platform for Atlantic salmon knowledge mobilisation
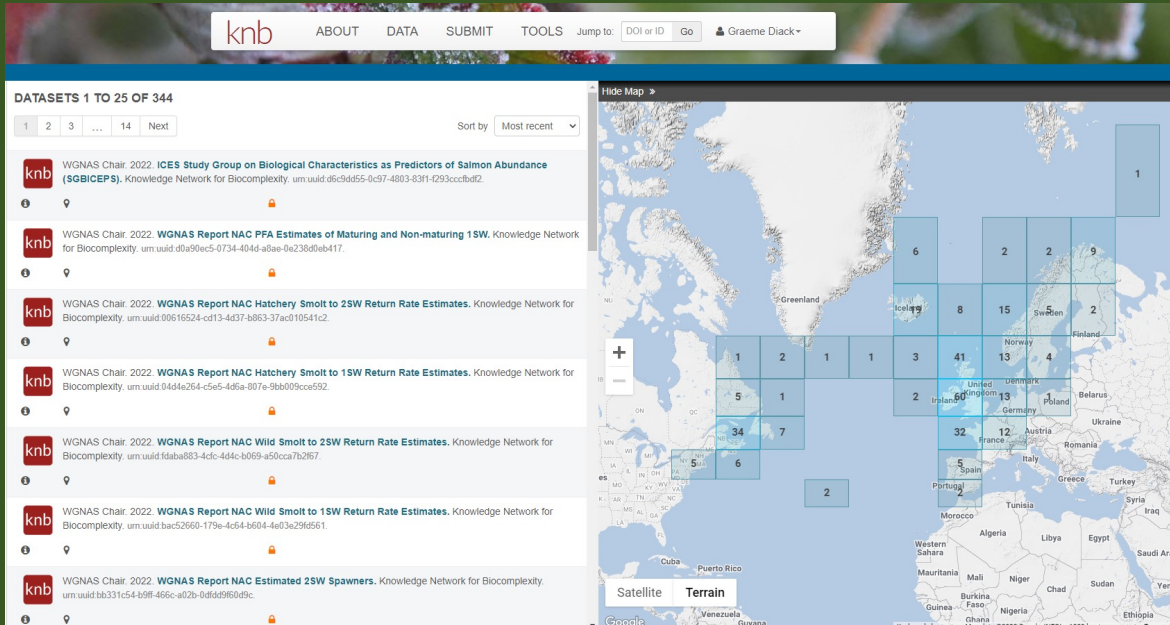
Context Specific Metadata Catalogue
- Reduces the friction to metadata publishing
- Incremental Data Mobilisation (towards FAIR data)
- Provides a focus for accessing diverse knowledge resources across the Atlantic salmon life-cycle.
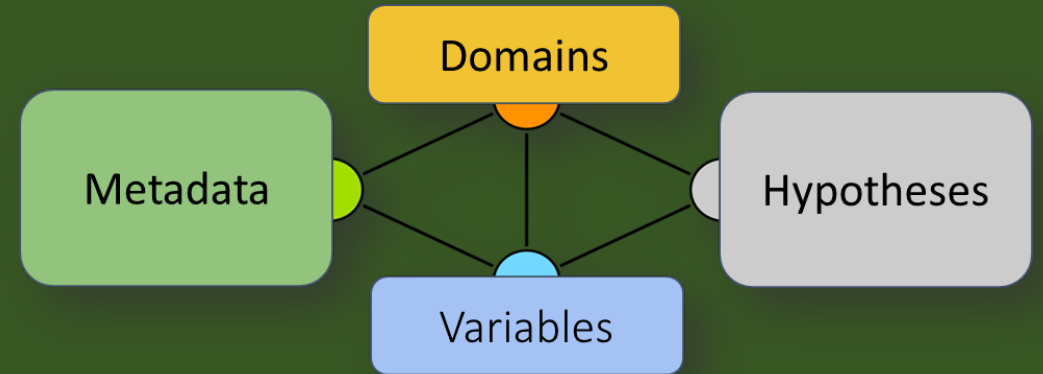
Diack *et al.*,2022 Enhancing data mobilisation through a centralised data repository for Atlantic salmon (Salmo salar L.): Providing the resources to promote an ecosystem-based management framework. https://doi.org/10.1016/j.ecoinf.2022.101746

The Salmon Ecosystem Data Hub (SalHub)

Interoperable Metadata

https://knb.ecoinformatics.org/
https://cran.r-project.org/web/packages/dataone/index.html
https://eml.ecoinformatics.org/

Simplified representation of index structure

Represents a starting point for cooperative future development

https://shiny.missingsalmonalliance.org/SalHub/

Organising and mobilising data sources : variable classes established within The Salmon Ecosystem Data Hub (SalHub)

Hypothesis and possible factor	Sub-hypothesis	Possible mechanism
1 Predation	1a	Increased predation pressure
	1b	Post-smolts in poorer physiological state are more susceptible to predation
	1c	Smaller post-smolts are more susceptible to predation
2 Growth	2a	Variation in the quality and quantity of suitable prey
	2b	Increased competition for available prey
	2c	Mis-match between initial marine migration phenology and availability of prey resources
	2d	Energetic costs in marine phase increasing
	2e	Smaller post-smolts have less energy storage and lower resilience during period/s of reduced feeding opportunity
3 Disease	3a	Cumulative stressors increasing disease severity
4 Salmon aquaculture	4a	Increased mortality risk resulting from aquaculture mediated ectoparasite encounters
5 Fisheries	5a	Variation in the incidence and severity of commercial by-catch

Variable classes (column headers and their entries):

Climate change drivers- ocean and atmosphere
- Air Temperature
- Salinity (marine surface)
- Salinity (marine subsurface)
- Water Temperature (marine surface)
- Water Temperature (marine subsurface)
- Currents (marine subsurface)
- Currents (marine surface)
- Water Temperature (freshwater)
- Hydrology (freshwater)

Salmon marine distribution
- Tagging, Marking and Tracking
- Targetted Harvest Fishery

Salmon marine growth and condition
- Growth Rate From Scales
- Abundance (pfa)
- Age Structure (pfa)
- Sex Ratio (pfa)
- Maturation Rate (pfa)

Salmon freshwater growth and condition
- Growth Rate From Scales
- Prey Indices (freshwater)
- Abundance (juvenile standing stock)
- Maturation Rate (juvenile standing stock)
- Age Structure (juvenile standing stock)
- Condition (juvenile standing stock)
- Nutritional State (juvenile standing stock)
- Health State (juvenile standing stock)
- Sex ratio (juvenile standing stock)

Smolt migration phenology
- Fish Population Dynamics and Ecology
- Migration Timings (smolt emigration)
- Abundance (smolt)
- Age Structure (smolt)
- Condition (smolt)
- Nutritional State (smolt)
- Health State (smolt)
- Sex Ratio (smolt)

Predator popn dynamics and feeding behaviours
- Fish Population Dynamics and Ecology (predator)
- Mammal Population Dynamics and Ecology
- Avian Population Dynamics and Ecology

Prey availability and quality
- Fish Population Dynamics and Ecology (Prey)
- Phytoplankton Biomass and Diversity
- Zooplankton Biomass and Diversity

Competitor popn dynamics
- Fish Population Dynamics and Ecology (competitor)
- Avian Population Dynamics and Ecology
- Ichthyoplankton Indices

Commercial fishing pressure
- Commercial Fishing Bycatch
- Targetted Harvest Fishery

Salmon farming data
- Fish Parasites, Pathogens and Disease

Fish diseases
- Fish Parasites, Pathogens and Disease
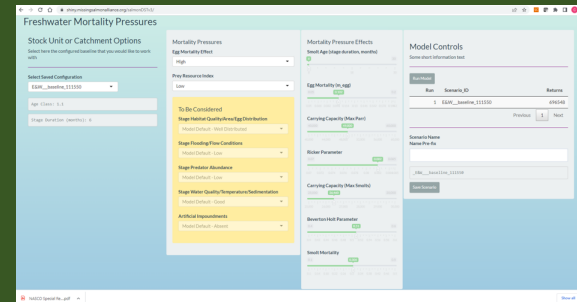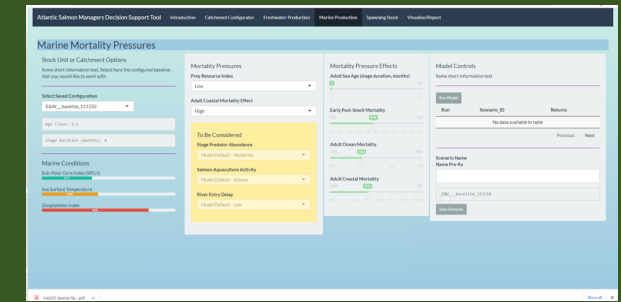
Building a management decision support tool
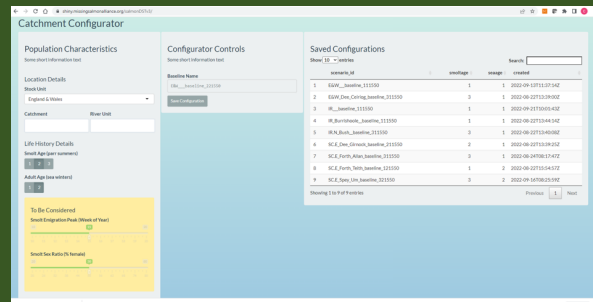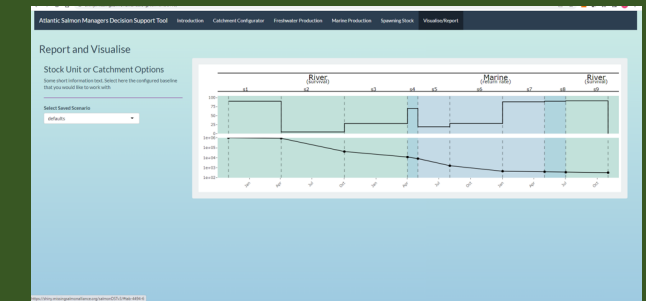

Catchment and population configurator

Freshwater stage conditions

Marine stage conditions

Outputs

- Creates a user archive to save multiple scenarios
- Outputs can represent current marine conditions and possible ranges of effects and management "levers" on whole lifetime success
- Linkages to SalHub knowledge resources
- Provides a framework for expansion: loop in models representing specific situations / mechanisms/ groups

# 4. Ecosystem indicators linked to salmon survival prospects

Aims:

- Provide evaluation of possible ecosystem indicators (physical and biological) for salmon survival during early marine phase

Delivering :

- Collation and synthesis of new ecosystem time series data resources
- Assessment of the importance of the abundance, composition and timing of prey resources at sea.
- Exploration of the potential role of additional factors (both marine and freshwater) on marine survival patterns
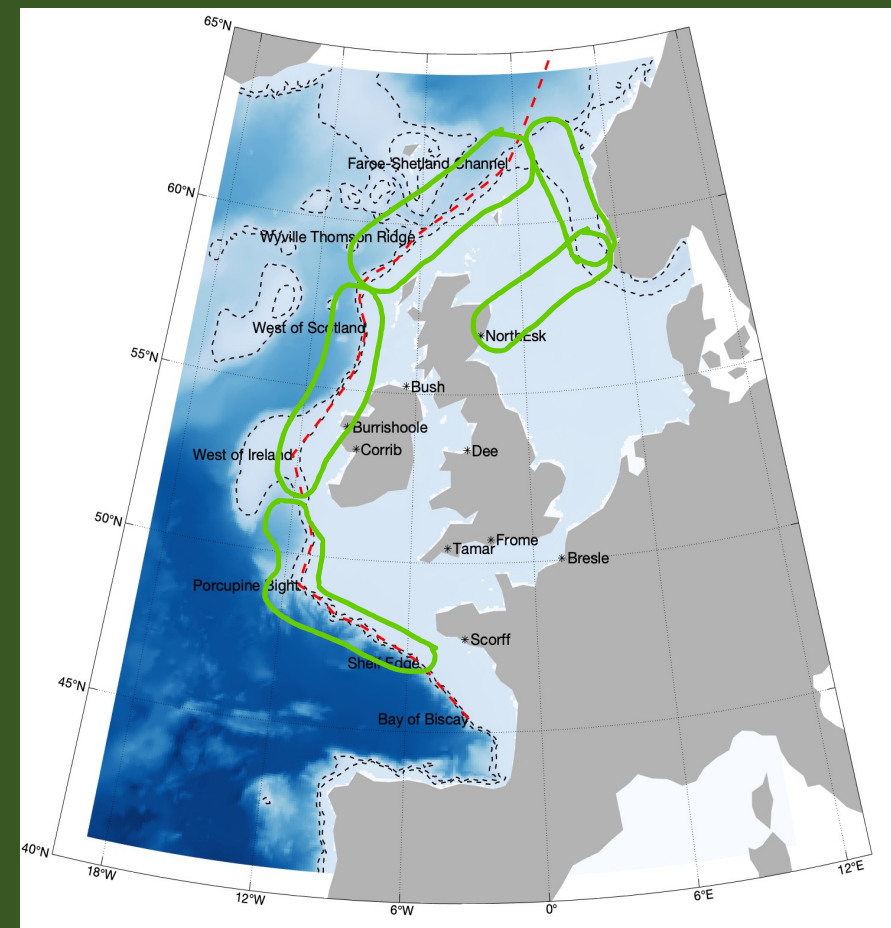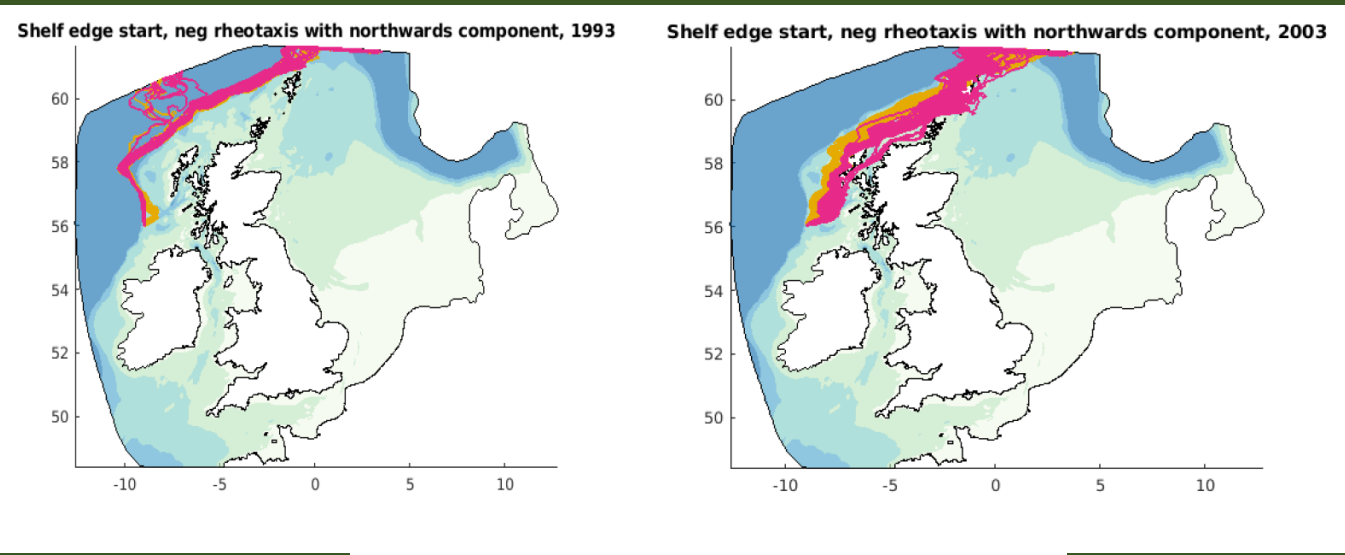

emma.tyldesley@strath.ac.uk
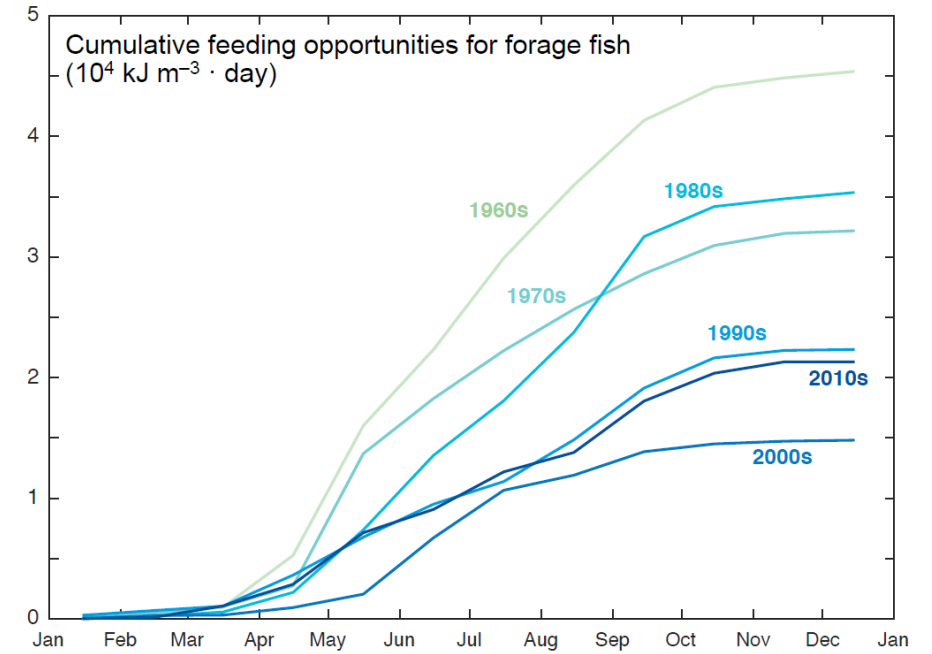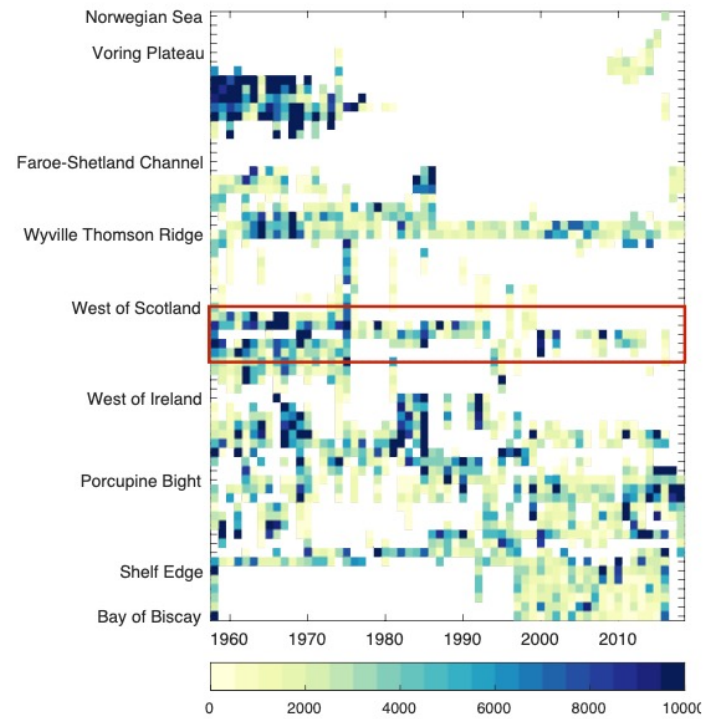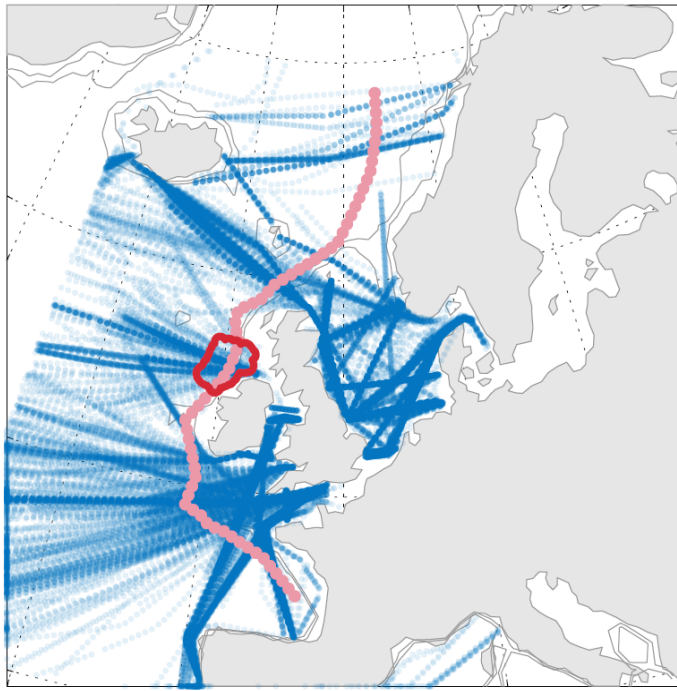
Trends in available zooplankton energy 1958-2018

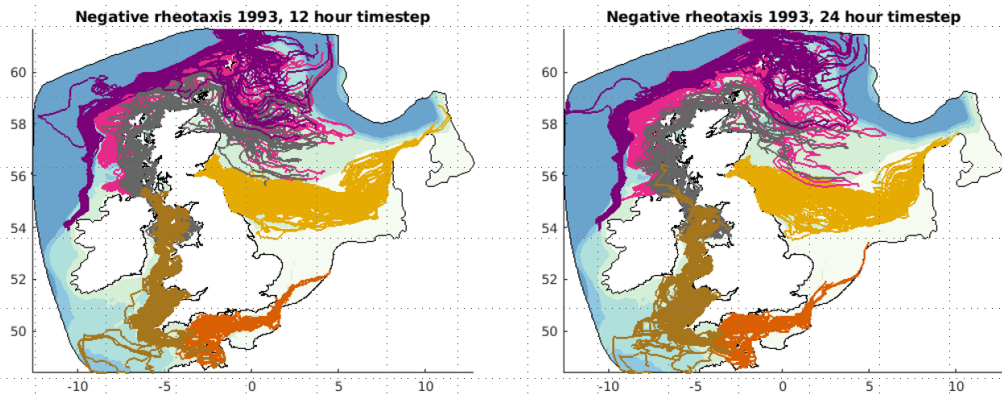# Using zooplankton survey data: providing energy for larval fish (prey)

neil.banas@strath.ac.uk

https://www.cprsurvey.org/

Modelling approach of initial migratory routes of post-smolts from selected UK rivers.

aislinn.borland@strath.ac.uk

Shelf edge start, neg rheotaxis with northwards component, 1993

Shelf edge start, neg rheotaxis with northwards component, 2003

Shelf edge start, neg rheotaxis with northwards component, 1993

Particle tracking time steps

Negative rheotaxis 1993, 12 hour timestep

Negative rheotaxis 1993, 24 hour timestep

UNIVERSITY of STIRLING

The FISHMONGERS' Company
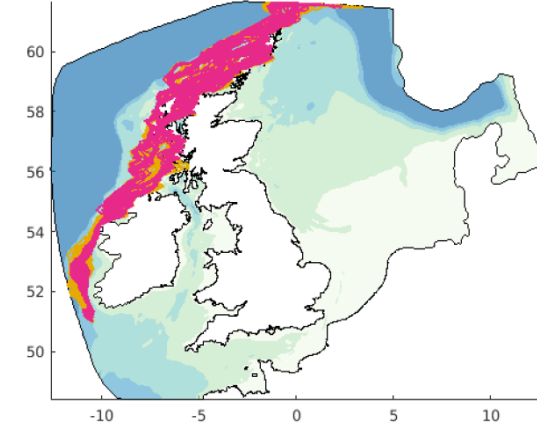
NERC SCIENCE OF THE ENVIRONMENT

University of Strathclyde Glasgow

THE MISSING SALMON ALLIANCE

Game & Wildlife CONSERVATION TRUST

ANGLING TRUST

Fisheries Management Scotland

The Rivers Trust

Next steps for the Missing Salmon Alliance Likely Suspects Framework initiative

- Deliver agreed workplan
- Demonstrate value and opportunities to salmon managers
- Promote cooperative development of resources
- Secure continuing support

Thankyou for your attention

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Emma Tyldesley
Aislinn Borland
Graeme Diack
Nigel Milner
Walter Crozier

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https://missingsalmonalliance.org/likely-suspects-framework-home