JNCC Report
No: 585

Conceptual Ecological Modelling of Shallow Sublittoral Sand Habitats to Inform Indicator Selection

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List of Appendices

In addition to the appendices listed, a spreadsheet containing ancillary electronic information supporting the literature review also accompanies this report, as referred to within the main report sections.

JNCC Report No. 585: Development of Conceptual Ecological Models – Shallow Sublittoral Sand Habitats

Appendix 1 – List of species included in project scope

Please see accompanying spreadsheet for full species list and details of how this list was refined.

Acrocnida brachiata
Abra alba
Alcyonidium diaphanum
Ammodytes tobianus
Ampelisca brevicornis
Aonides paucibranchiata
Arenicola marina
Aricidea cerrutii
Asterias rubens
Astropecten irregularis
Bathyporeia elegans
Carcinus maenas
Cerianthus lloydii
Chaetozone setosa
Chamelea gallina
Crassicorophium crassicorne
Diastylis rathkei
Echinocardium cordatum
Echinocyamus pusillus
Ensis ensis
Eudorellopsis deformis
Eurydice pulchra
Flustra foliacea
Gastrosaccus spinifer
Glycera lapidum
Goniada maculata
Hydrallmania falcata
Kurtiella bidentata
Lanice conchilega
Liocarcinus depurator
Lumbrineris latreilli
Magelona mirabilis
Moerella pygmaea
Nephtys cirrosa
Nucula nitidosa
Ophelia borealis
Ophiura ophiura
Owenia fusiformis
Pagurus bernhardus
Parexogone hebes
Phaxas pellucidus
Philine quadripartita
Pholoe inornata
Polydora ciliata
Sabella pavonina
Saccharina latissima
Scoloplos armiger
Sertularia cupressina
Sphaerosyllis bulbosa
Spio filicornis
Spiophanes bombyx
Spisula subtruncata
Tellina fabula
Thracia phaseolina
Travisia forbesii
Urothoe elegans
Urticina felina

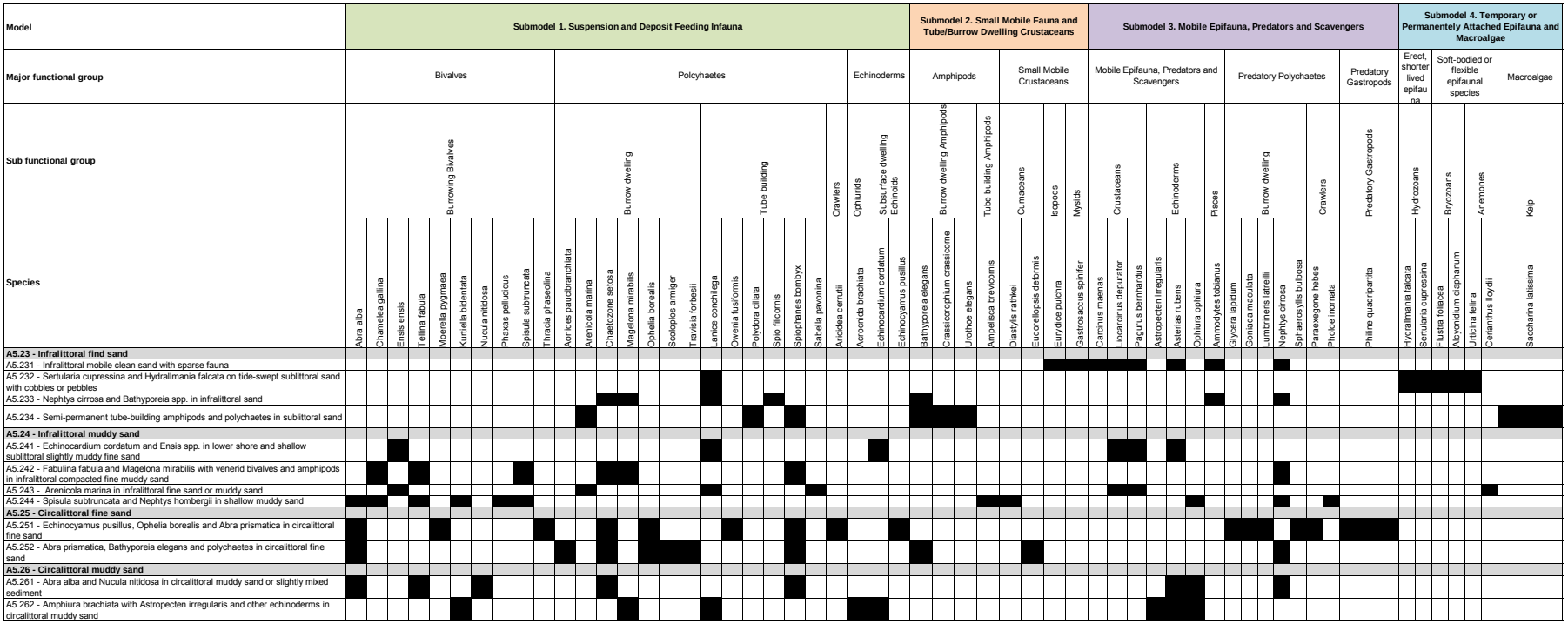
JNCC Report No. 585: Development of Conceptual Ecological Models – Shallow Sublittoral Sand Habitats

Appendix 2 – List of keywords used as search terms

Amphipod
Annelida
Annual variation
Anoxia
Bacteria
Benthic
Biodeposition
Bioengineering
Biogeochemical process
Bioirrigation
Biological driver
Biotope
Bioturbation
Bioturbation
Bivalve
Brittlestar
Burrowing
Circalittoral
Climate
Climate variation
Crustacea
Currents
Currents
Deposit feeder
Depth
Depth range
Diatoms
Dissolved oxygen
Echinodermata
Ecology
Ecosystem functioning
Ecosystem process
Ecosystem service
Environmental driver
Environmental position
Epifauna
Feeding behaviour
Feeding Habits
Feeding method
Filter feeding
Fine sands
Food resource
Food web
Functional group
Geology
Growth form
Habitat provision
Habitat stability
Holothuroidea
Hydrodynamic flow
Hypoxia
Infauna
Infralittoral
Interstitial
Lifespan
Light attenuation
Macrofauna
Marine
Microbial activity
Mobility
Muddy sand
Natural variability
Nitrogen flux
Nutrient cycling
Nutrient provision
Ocean acidification
Organic Carbon
Organic matter
Physical driver
Physiographic
Phytoplankton
Polychaete
POM
Predator
Prey
Primary production
Response
Salinity
Sand
Sand bank
Sand ripples
Sand waves
Seabed energy
Seabed mobility
Seasonal variability
Secondary production
Sediment
Sediment dynamics
Sediment resuspension
Sediment stability
Sediment transport
Sparse fauna
Species trait
Species trait
Sublittoral
Substratum
Subtidal
Suspension feeder
Suspension feeding
Temperature
Temporal variability
Tidal stress
Tolerance
Trophic level
Troughs
Tube dwelling
Turbidity
Variability
Water chemistry
Water composition
Water flow
Wave energy

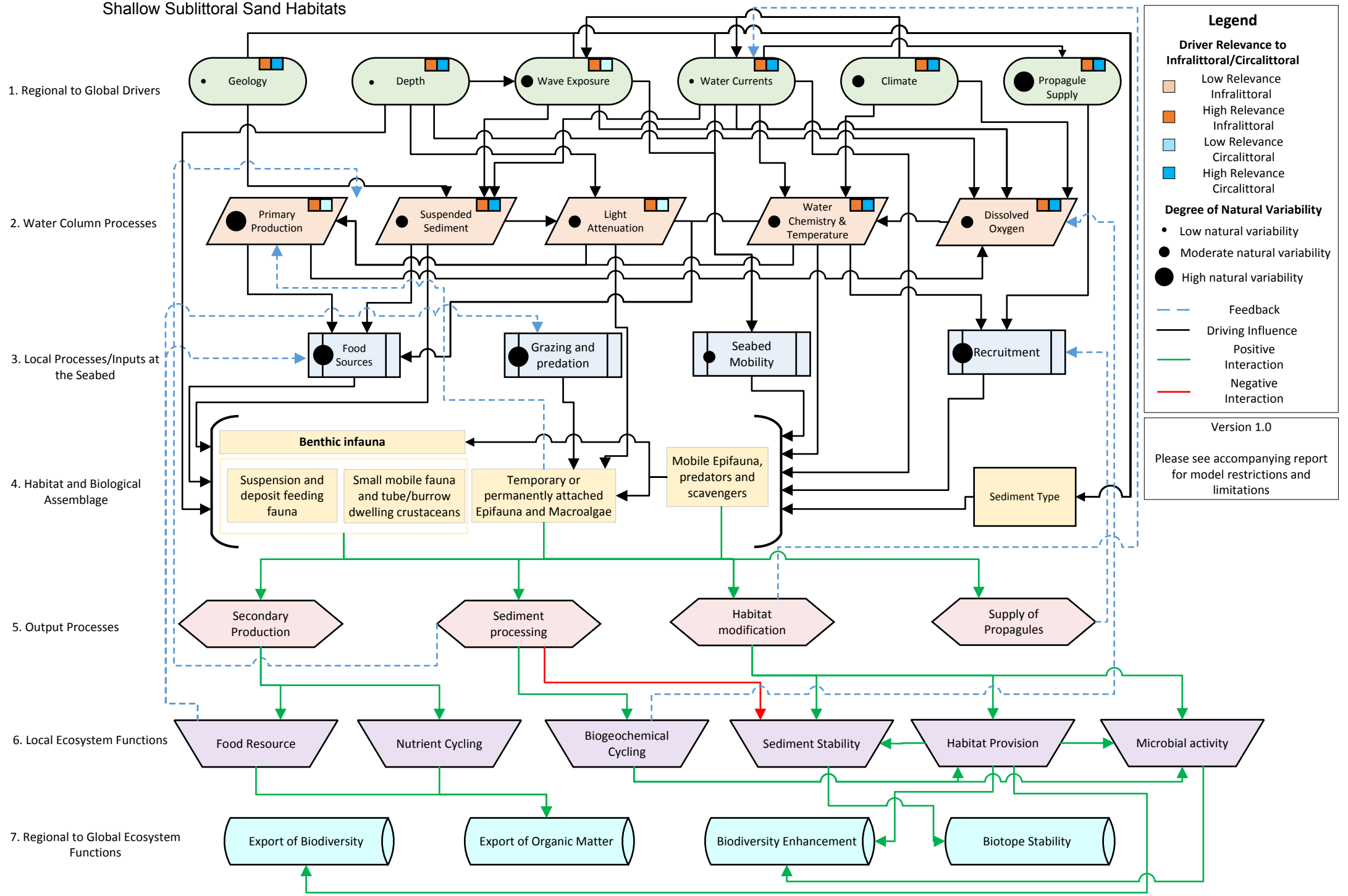
In addition to the search words used above, each of the selected species names were also searched for individually.

Appendix 3. Species Biotope Model Matrix



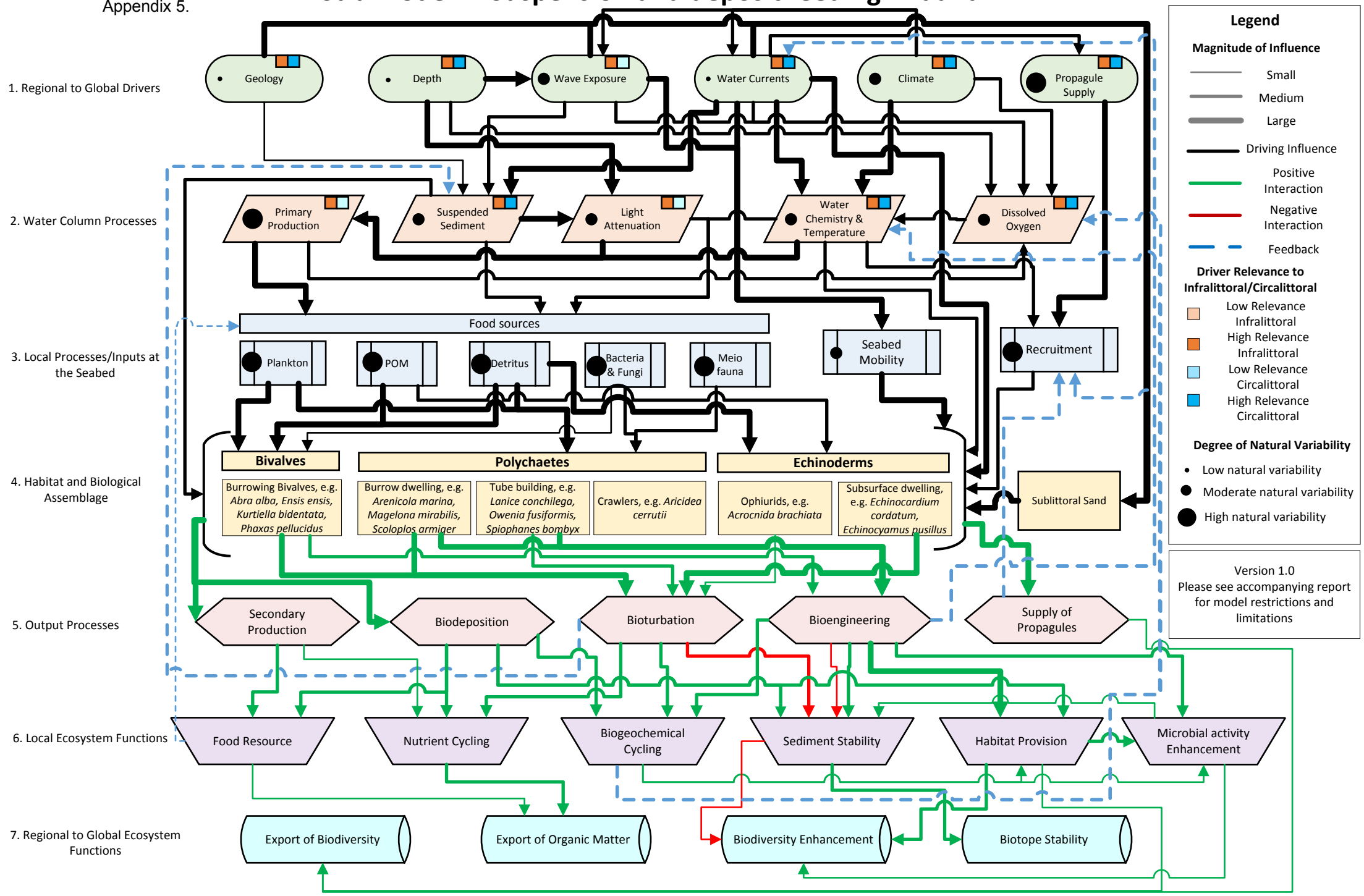
JNCC Report No. 585
Appendix 4. General Control Model - Shallow Sublittoral Sand Habitats

Shallow Sublittoral Sand



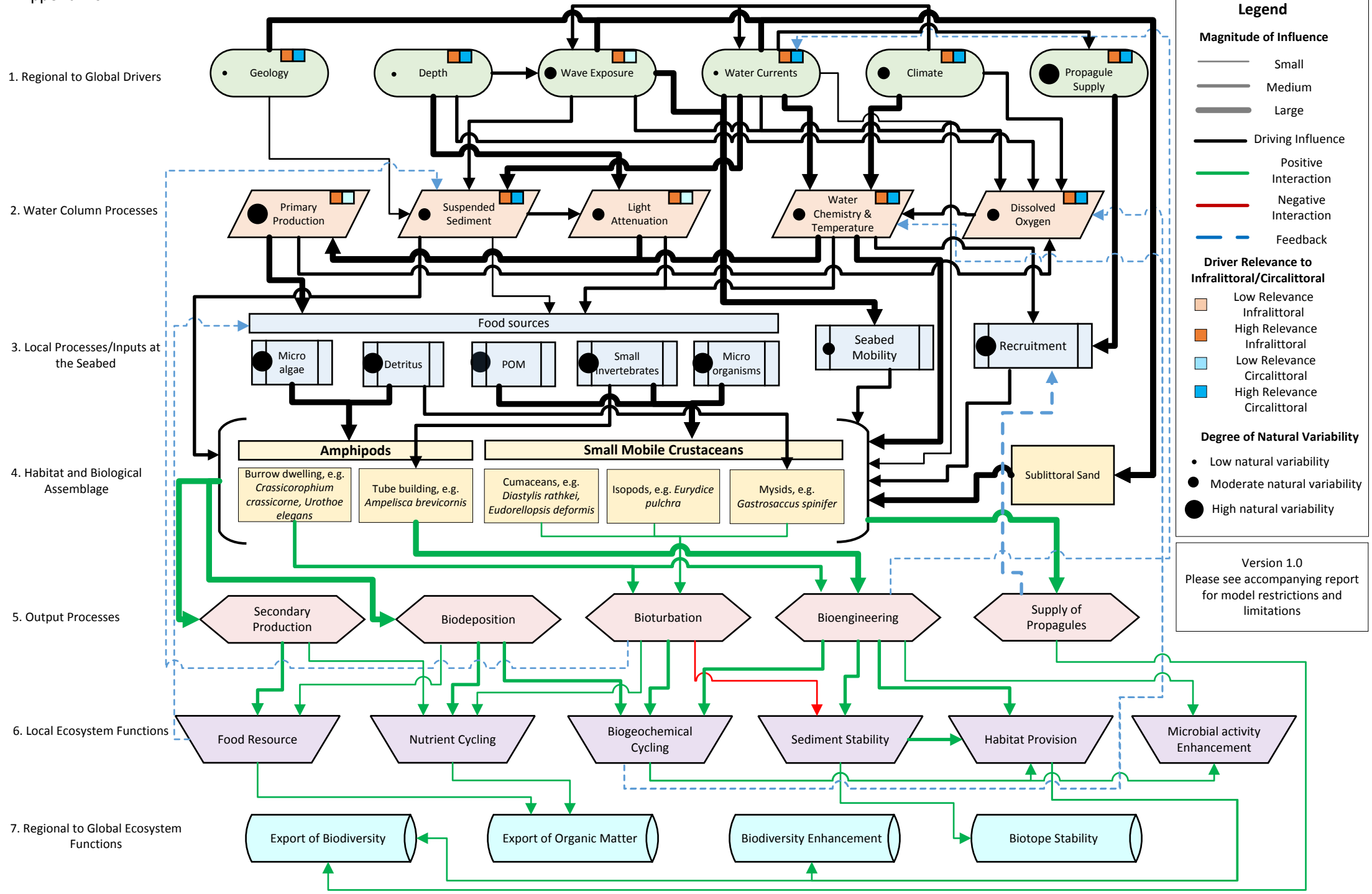
JNCC Report No. 585
Appendix 5.

Sub-model 1. Suspension and deposit feeding infauna



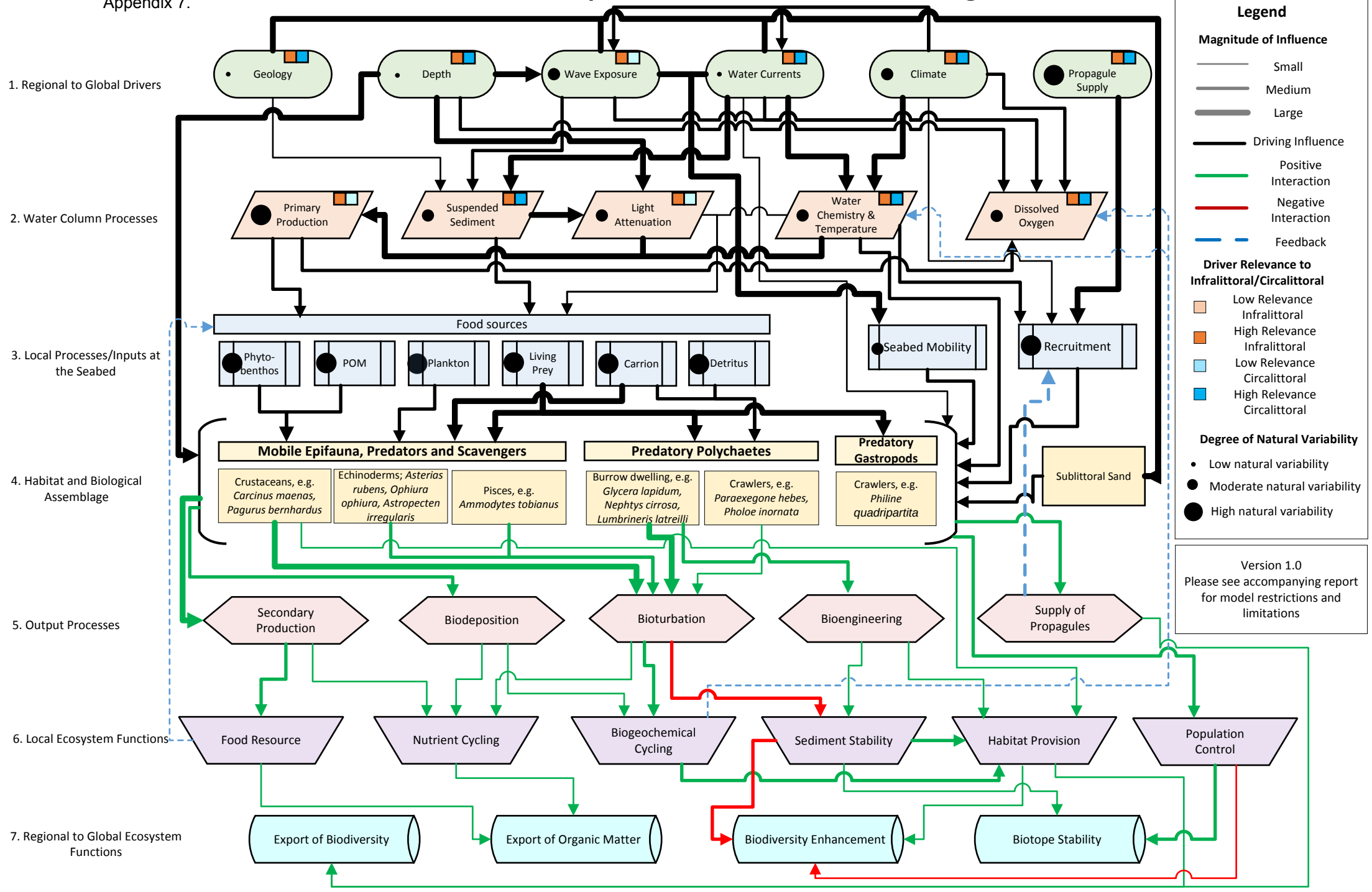
JNCC Report No. 585
Appendix 6.

Sub-model 2. Small Mobile Fauna and Tube/Burrow Dwelling Crustaceans



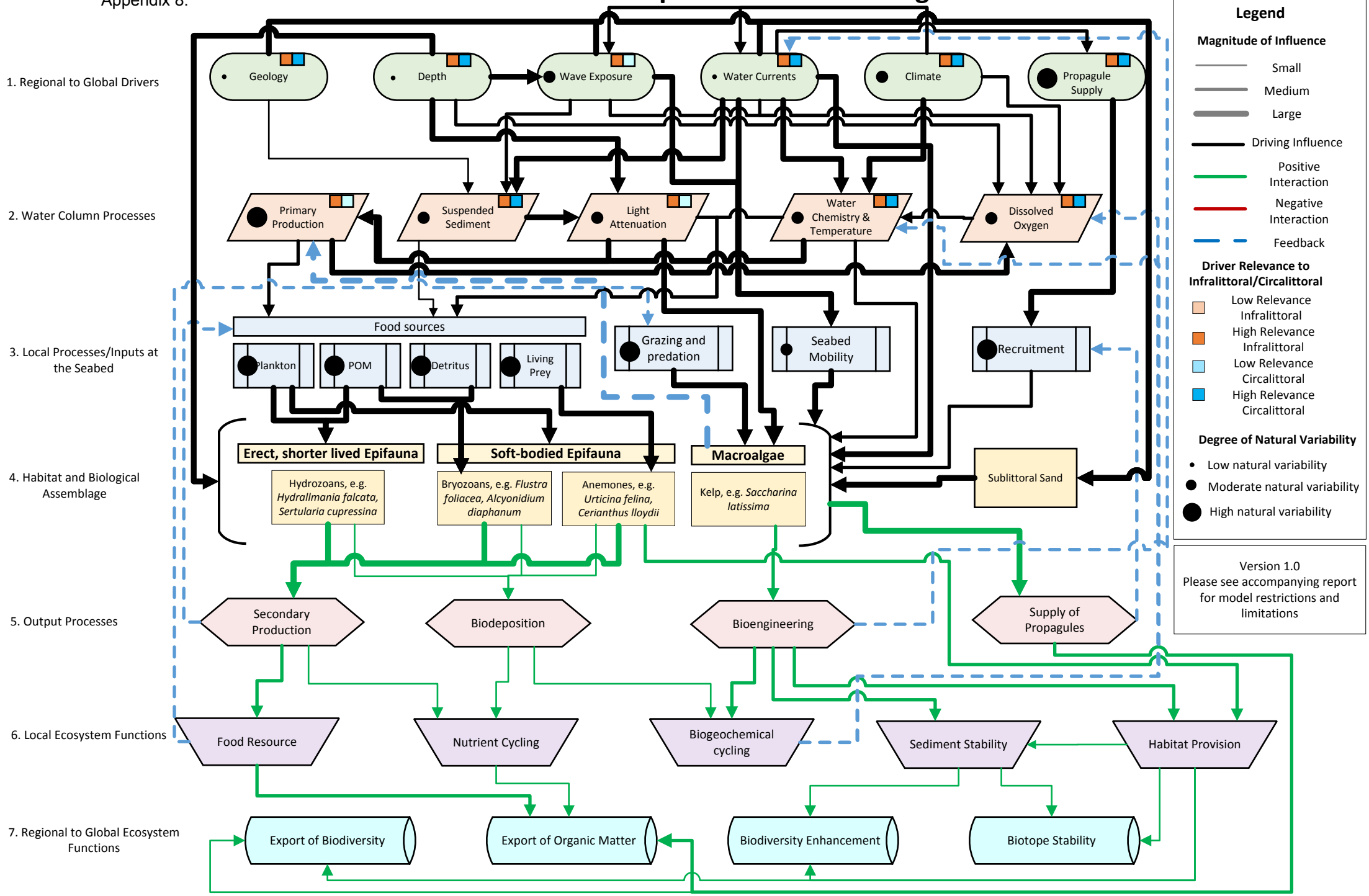
JNCC Report No. 585
Appendix 7.

Sub-model 3. Mobile Epifauna, Predators and Scavengers



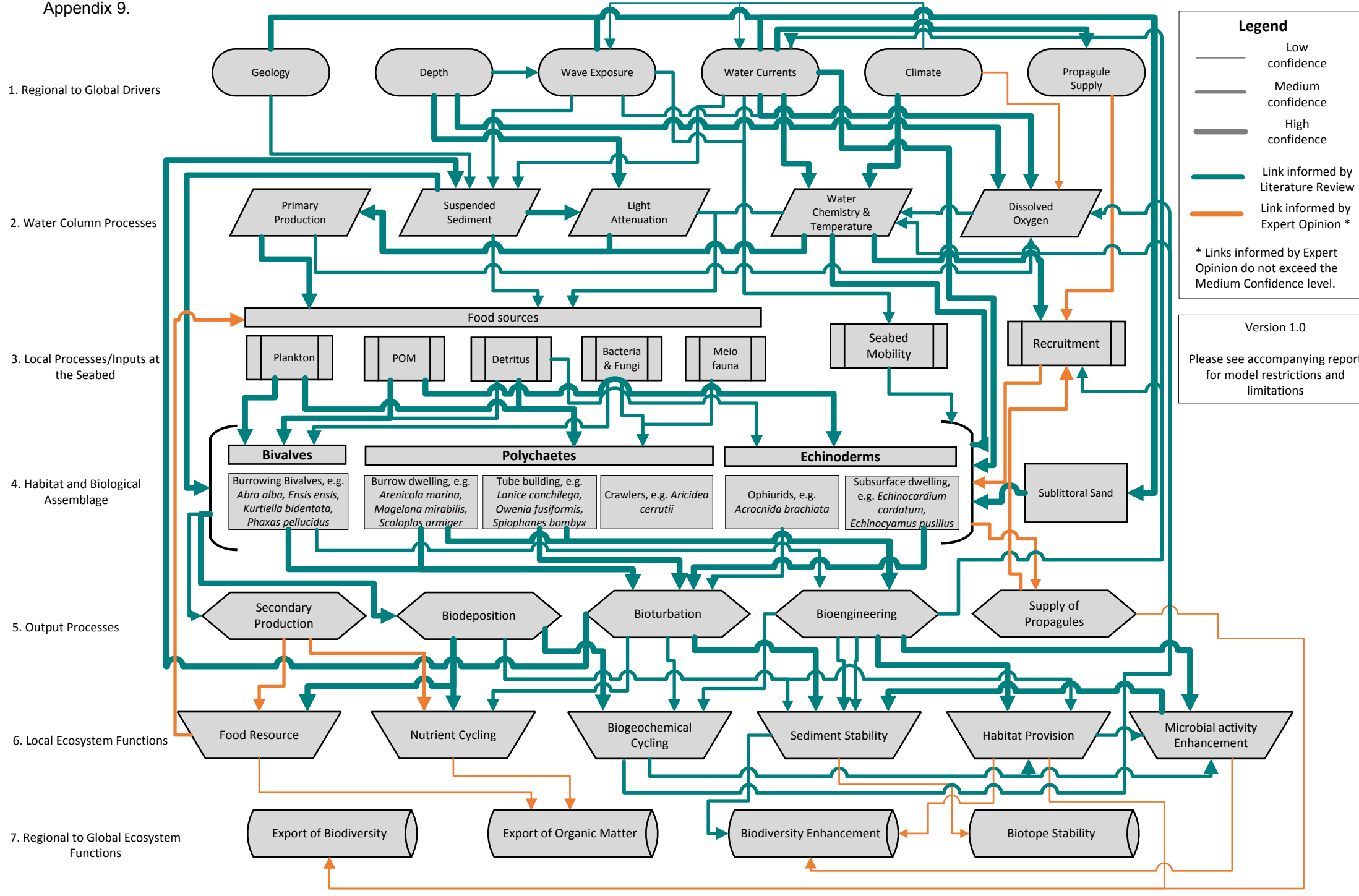
JNCC Report No. 585
Appendix 8.

Sub-model 4. Attached Epifauna and Macroalgae



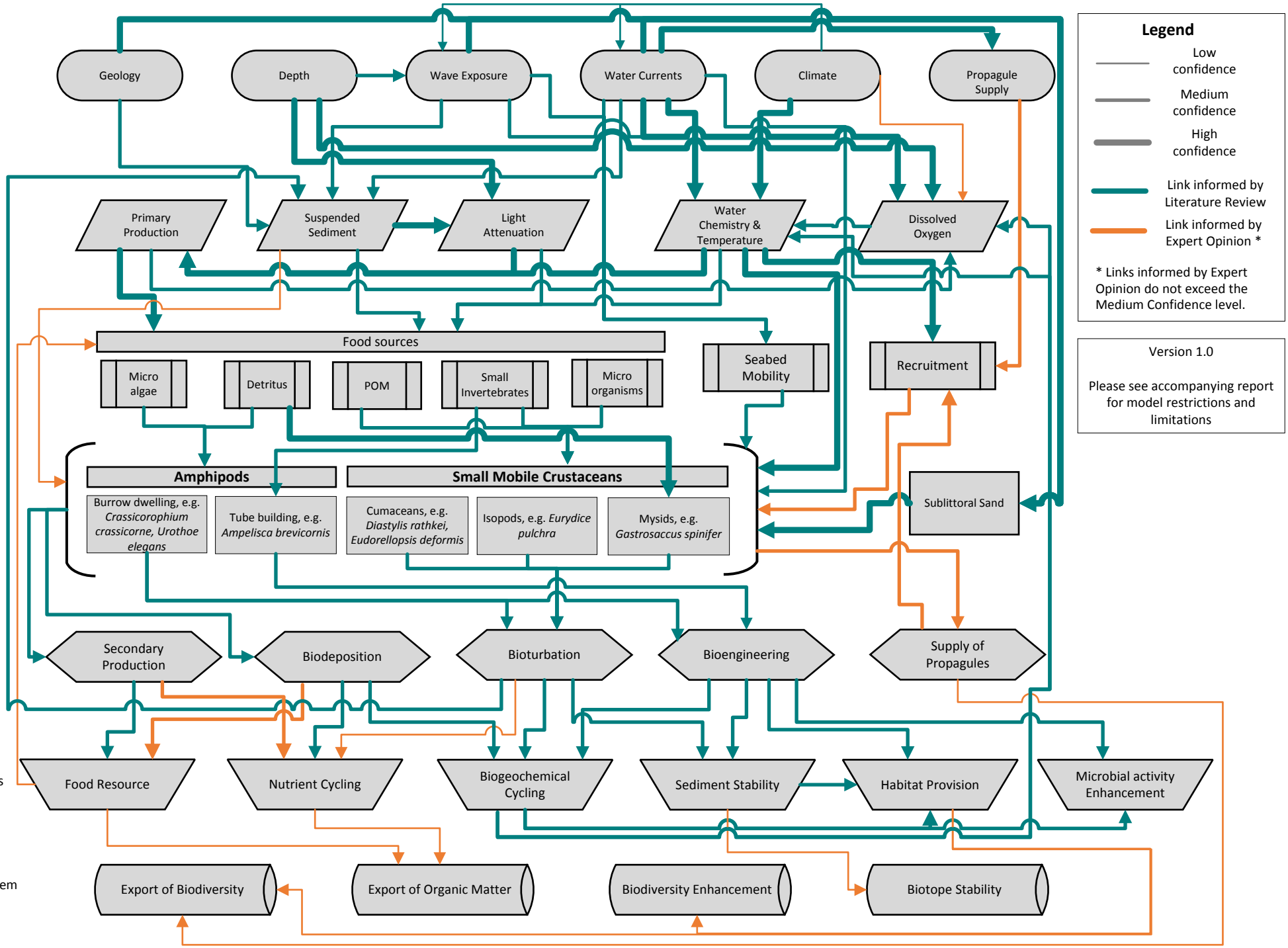
JNCC Report No. 585
Appendix 9.

Sub-model 1. Suspension and deposit feeding infauna - CONFIDENCE



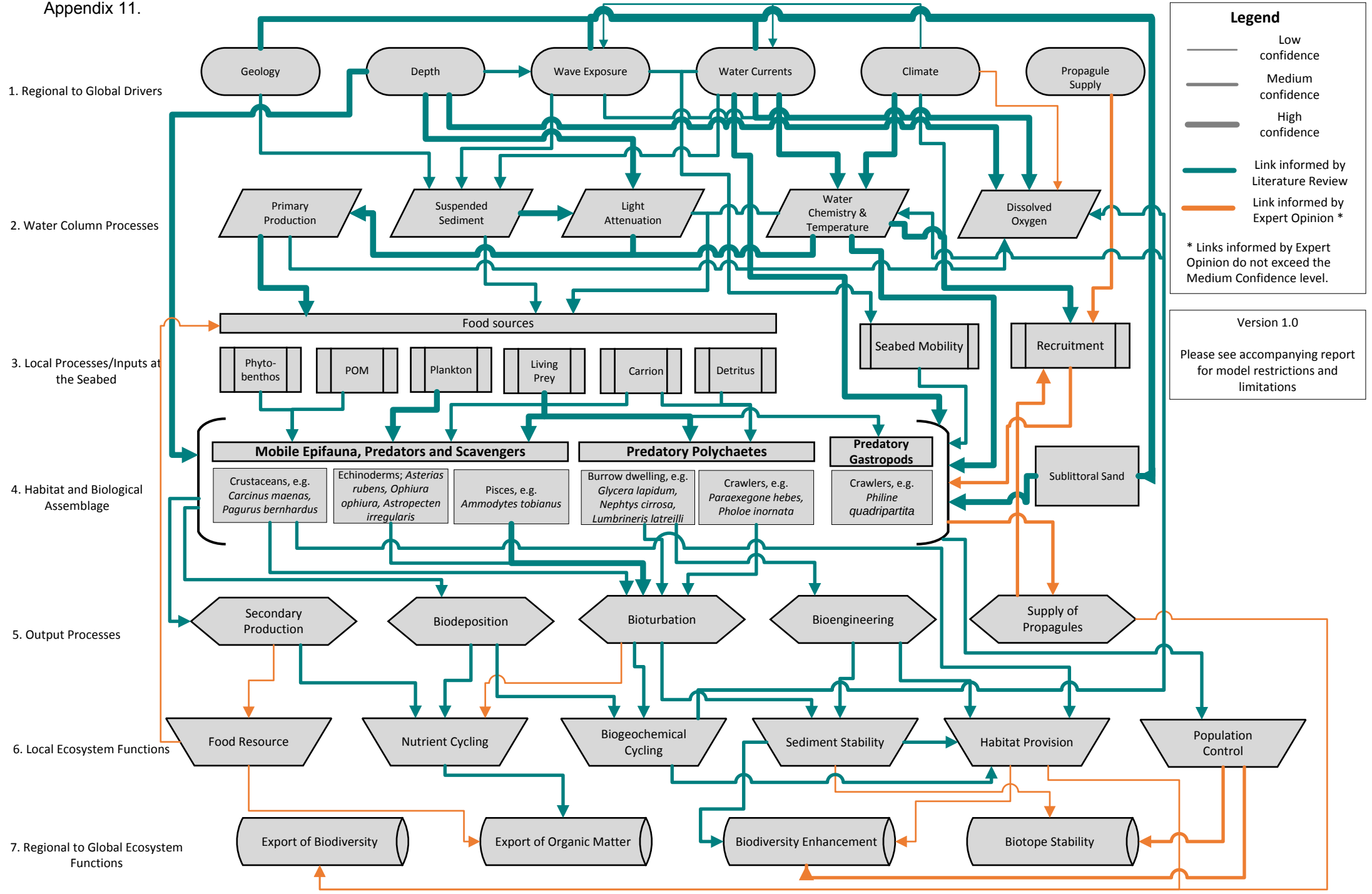
JNCC Report No. 585
Appendix 10.

Sub-model 2. Small Mobile Fauna and Tube/Burrow Dwelling Crustaceans



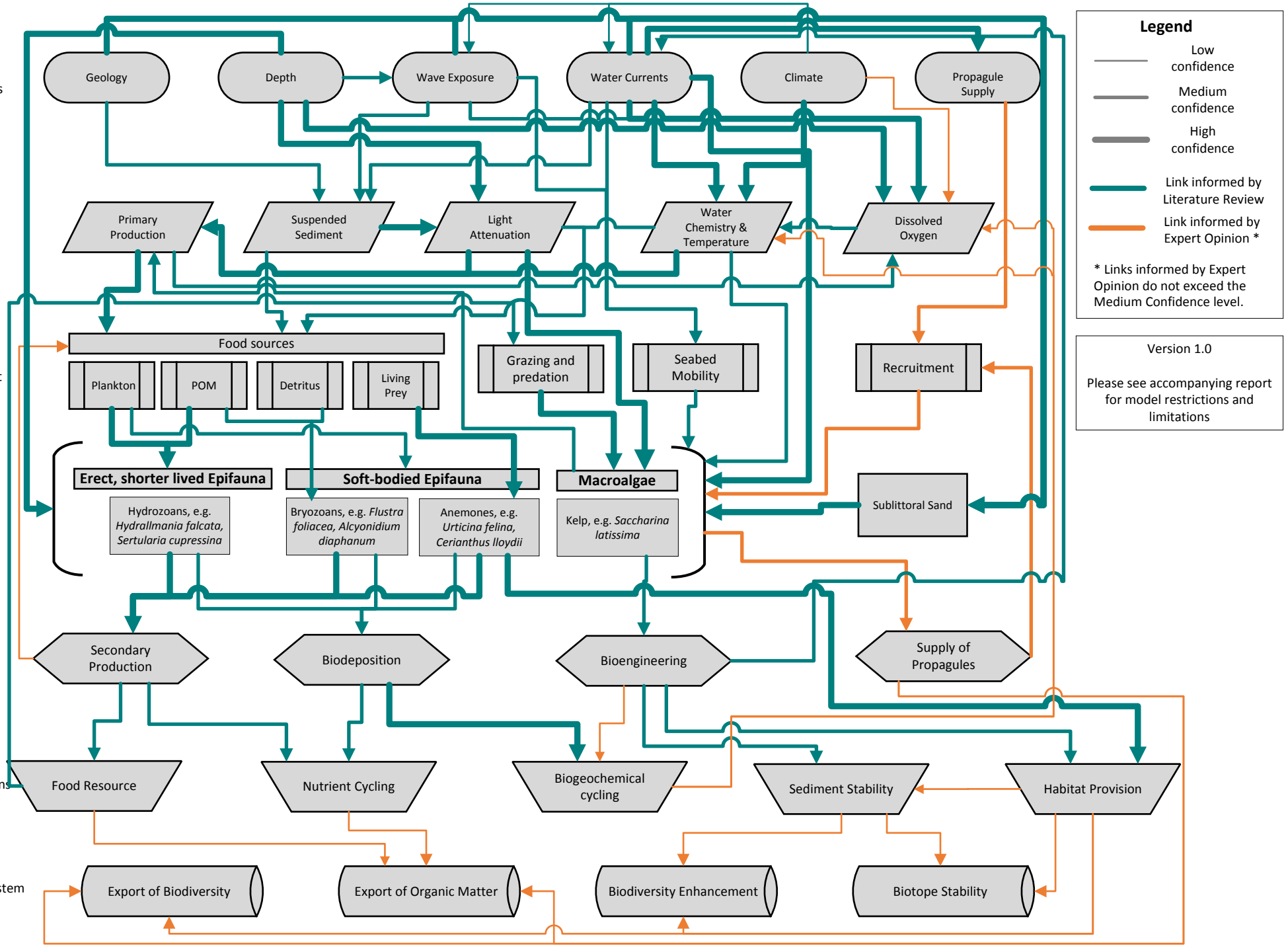
JNCC Report No. 585
Appendix 11.

Sub-model 3. Mobile Epifauna, Predators and Scavengers



JNCC Report No. 585
Appendix 12.

Sub-model 4. Attached Epifauna and Macroalgae - CONFIDENCE



Appendix 13 – Pressure descriptions

List of anthropogenic pressures relevant to shallow sublittoral sand habitats. Pressures and descriptions are taken from the Intercessional Correspondence Group on Cumulative Effects (ICG-C).

Pressure theme	Pressure	Description	Benchmark (Tillin et al, 2010)
Biological pressures	Removal of non-target species	By-catch associated with all fishing activities. The physical effects of fishing gear on sea bed communities are addressed by the "abrasion" pressure type so this addresses the direct removal of individuals associated with fishing/ harvesting. Ecological consequences include food web dependencies, population dynamics of fish, marine mammals, turtles and sea birds (including survival threats in extreme cases, e.g. Harbour Porpoise in Central and Eastern Baltic).	Removal of features through pursuit of a target fishery at a commercial scale
Physical damage (Reversible Change)	Changes in suspended solids (water clarity)	Changes in water clarity from sediment & organic particulate matter concentrations. It is related to activities disturbing sediment and/or organic particulate matter and mobilising it into the water column. Could be 'natural' land run-off and riverine discharges or from anthropogenic activities such as all forms of dredging, disposal at sea, cable and pipeline burial, secondary effects of construction works, e.g. breakwaters. Particle size, hydrological energy (current speed & direction) and tidal excursion are all influencing factors on the spatial extent and temporal duration. This pressure also relates to changes in turbidity from suspended solids of organic origin (as such it excludes sediments - see the "changes in suspended sediment" pressure type). Salinity, turbulence, pH and temperature may result in flocculation of suspended organic matter. Anthropogenic sources mostly short lived and over relatively small spatial extents.	A change in one rank on the WFD (Water Framework Directive) scale e.g. from clear to turbid for one year
Physical damage (Reversible Change)	Abrasion/disturbance of the substrate on the surface of the seabed	The disturbance of sediments where there is limited or no loss of substrate from the system. This pressure is associated with activities such as anchoring, taking of sediment/geological cores, cone penetration tests, cable burial (ploughing or jetting), propeller wash from vessels, certain fishing activities, e.g. scallop dredging, beam trawling. Agitation dredging, where sediments are deliberately disturbed by and by gravity & hydraulic dredging where sediments are deliberately disturbed and moved by currents could also be associated with this pressure type. Compression of sediments, e.g. from the legs of a jack-up barge could also fit into this pressure type. Abrasion relates to the damage of the sea bed surface layers (typically up to 50cm depth). Activities associated with abrasion can cover relatively large spatial areas and include: fishing with towed demersal trawls (fish & shellfish); bio-prospecting such as harvesting of biogenic features such as maerl beds where, after extraction, conditions for recolonisation remain suitable or relatively localised activities including: seaweed harvesting, recreation, potting, aquaculture. Change from gravel to silt substrate would adversely affect herring spawning grounds.	Damage to seabed surface features
Physical damage (Reversible	Habitat structure changes -	Unlike the "physical change" pressure type where there is a permanent change in sea bed type (e.g. sand to gravel, sediment to a hard artificial substrate) the	Extraction of sediment to 30cm

Change)	removal of substratum (extraction)	"habitat structure change" pressure type relates to temporary and/or reversible change, e.g. from marine mineral extraction where a proportion of seabed sands or gravels are removed but a residual layer of seabed is similar to the pre-dredge structure and as such biological communities could re-colonise; navigation dredging to maintain channels where the silts or sands removed are replaced by non-anthropogenic mechanisms so the sediment typology is not changed.	
Physical damage (Reversible Change)	Siltation rate changes, including smothering (depth of vertical sediment overburden)	When the natural rates of siltation are altered (increased or decreased). Siltation (or sedimentation) is the settling out of silt/sediments suspended in the water column. Activities associated with this pressure type include mariculture, land claim, navigation dredging, disposal at sea, marine mineral extraction, cable and pipeline laying and various construction activities. It can result in short lived sediment concentration gradients and the accumulation of sediments on the sea floor. This accumulation of sediments is synonymous with "light" smothering, which relates to the depth of vertical overburden. “Light” smothering relates to the deposition of layers of sediment on the seabed. It is associated with activities such as sea disposal of dredged materials where sediments are deliberately deposited on the sea bed. For “light” smothering most benthic biota may be able to adapt, i.e. vertically migrate through the deposited sediment. “Heavy” smothering also relates to the deposition of layers of sediment on the seabed but is associated with activities such as sea disposal of dredged materials where sediments are deliberately deposited on the sea bed. This accumulation of sediments relates to the depth of vertical overburden where the sediment type of the existing and deposited sediment has similar physical characteristics because, although most species of marine biota are unable to adapt, e.g. sessile organisms unable to make their way to the surface, a similar biota could, with time, re-establish.	up to 30cm of fine material added to the seabed in a single event
Physical loss (Permanent Change)	Physical change (to another seabed type)	The permanent change of one marine habitat type to another marine habitat type, through the change in substatum, including to artificial (e.g. concrete). This therefore involves the permanent loss of one marine habitat type but has an equal creation of a different marine habitat type. Associated activities include the installation of infrastructure (e.g. surface of platforms or wind farm foundations, marinas, coastal defences, pipelines and cables), the placement of scour protection where soft sediment habitats are replaced by hard/coarse substrate habitats, removal of coarse substrate (marine mineral extraction) in those instances where surficial finer sediments are lost, capital dredging where the residual sedimentary habitat differs structurally from the pre-dredge state, creation of artificial reefs, mariculture i.e. mussel beds. Protection of pipes and cables using rock dumping and mattressing techniques. Placement of cuttings piles from oil & gas activities could fit this pressure type, however, there may be an additional pressures, e.g. "pollution and other chemical changes" theme. This pressure excludes	Permanent loss of existing saline habitat

		navigation dredging where the depth of sediment is changes locally but the sediment typology is not changed.	
Pollution and other chemical changes	Nutrient enrichment	Increased levels of the elements nitrogen, phosphorus, silicon (and iron) in the marine environment compared to background concentrations. Nutrients can enter marine waters by natural processes (e.g. decomposition of detritus, riverine, direct and atmospheric inputs) or anthropogenic sources (e.g. waste water runoff, terrestrial/agricultural runoff, sewage discharges, aquaculture, atmospheric deposition). Nutrients can also enter marine regions from 'upstream' locations, e.g. via tidal currents to induce enrichment in the receiving area. Nutrient enrichment may lead to eutrophication (see also organic enrichment). Adverse environmental effects include deoxygenation, algal blooms, changes in community structure of benthos and macrophytes.	Compliance with WFD criteria for good status
Pollution and other chemical changes	Organic enrichment	Resulting from the degraded remains of dead biota & microbiota (land & sea); faecal matter from marine animals; flocculated colloidal organic matter and the degraded remains of: sewage material, domestic wastes, industrial wastes etc. Organic matter can enter marine waters from sewage discharges, aquaculture or terrestrial/agricultural runoff. Black carbon comes from the products of incomplete combustion (PIC) of fossil fuels and vegetation. Organic enrichment may lead to eutrophication (see also nutrient enrichment). Adverse environmental effects include deoxygenation, algal blooms, changes in community structure of benthos and macrophytes.	A deposit of 100gC/m^2/yr