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Marine Matters

Potential Socio-Economic Impacts of Ocean Acidification: An Ecosystem Service Approach

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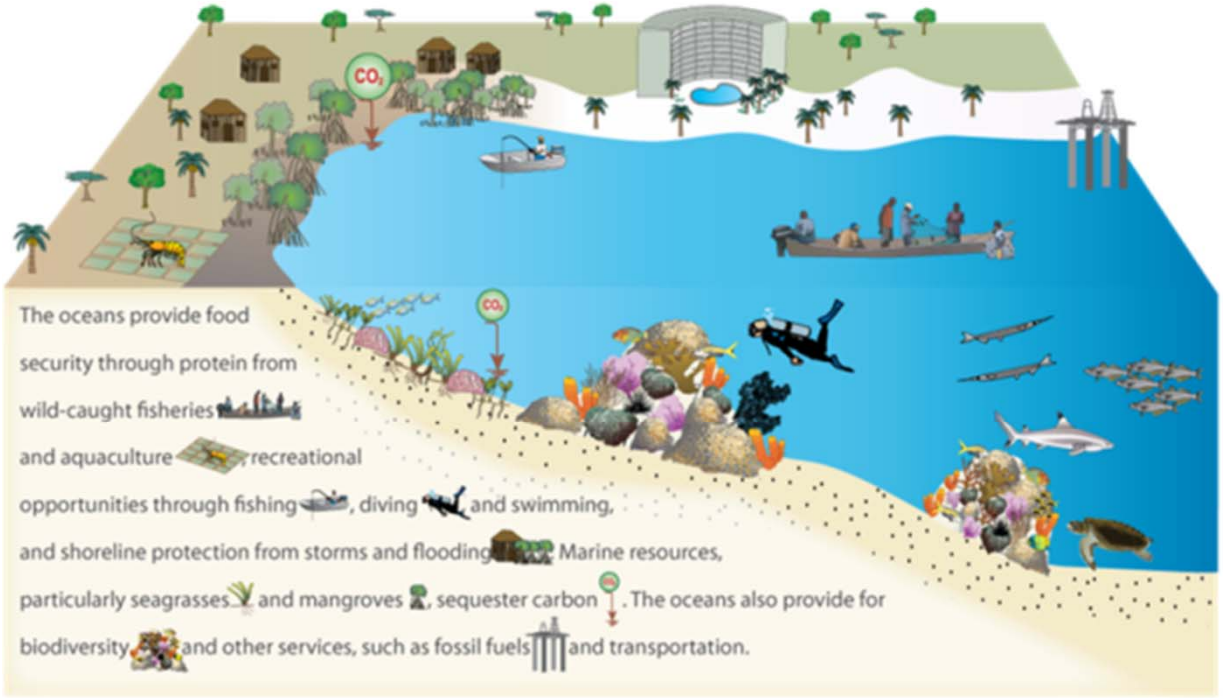
The Ecosystem Service (ES) Approach



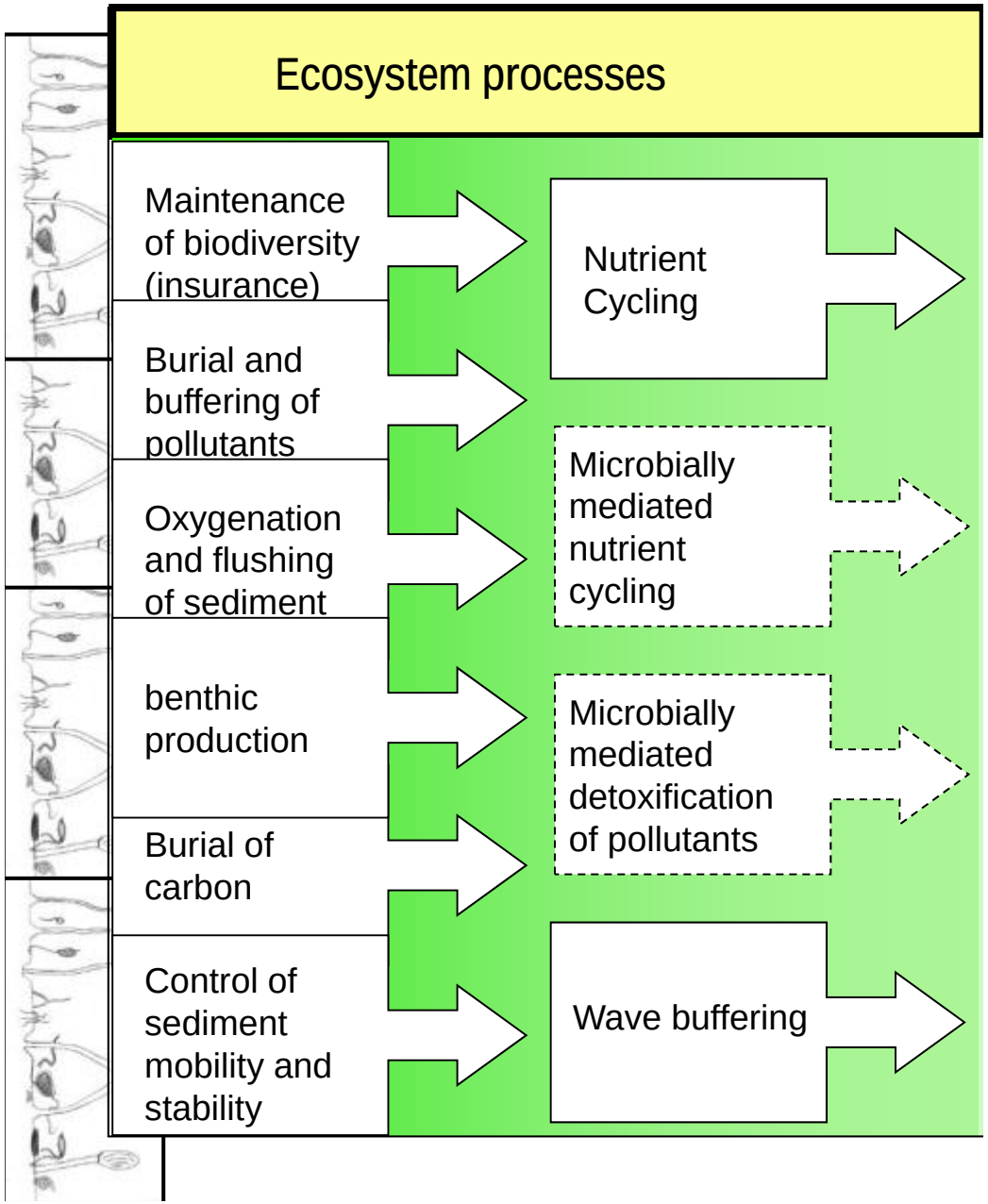
Conceptual diagram illustrating the ecosystem services provided by oceans and the ways in which humans depend on oceans.

Symbols library courtesy of the Integration and Application Network (ian.umces.edu/symbols), University of Maryland Center for Environmental Science.

Conceptual diagram illustrating the ecosystem services provided by oceans and the ways in which humans depend on oceans.
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Samonte G, Karrer L, Orbach M. 2010. *People and Oceans*. Science and Knowledge Division, Conservation International, Arlington, Virginia, USA.

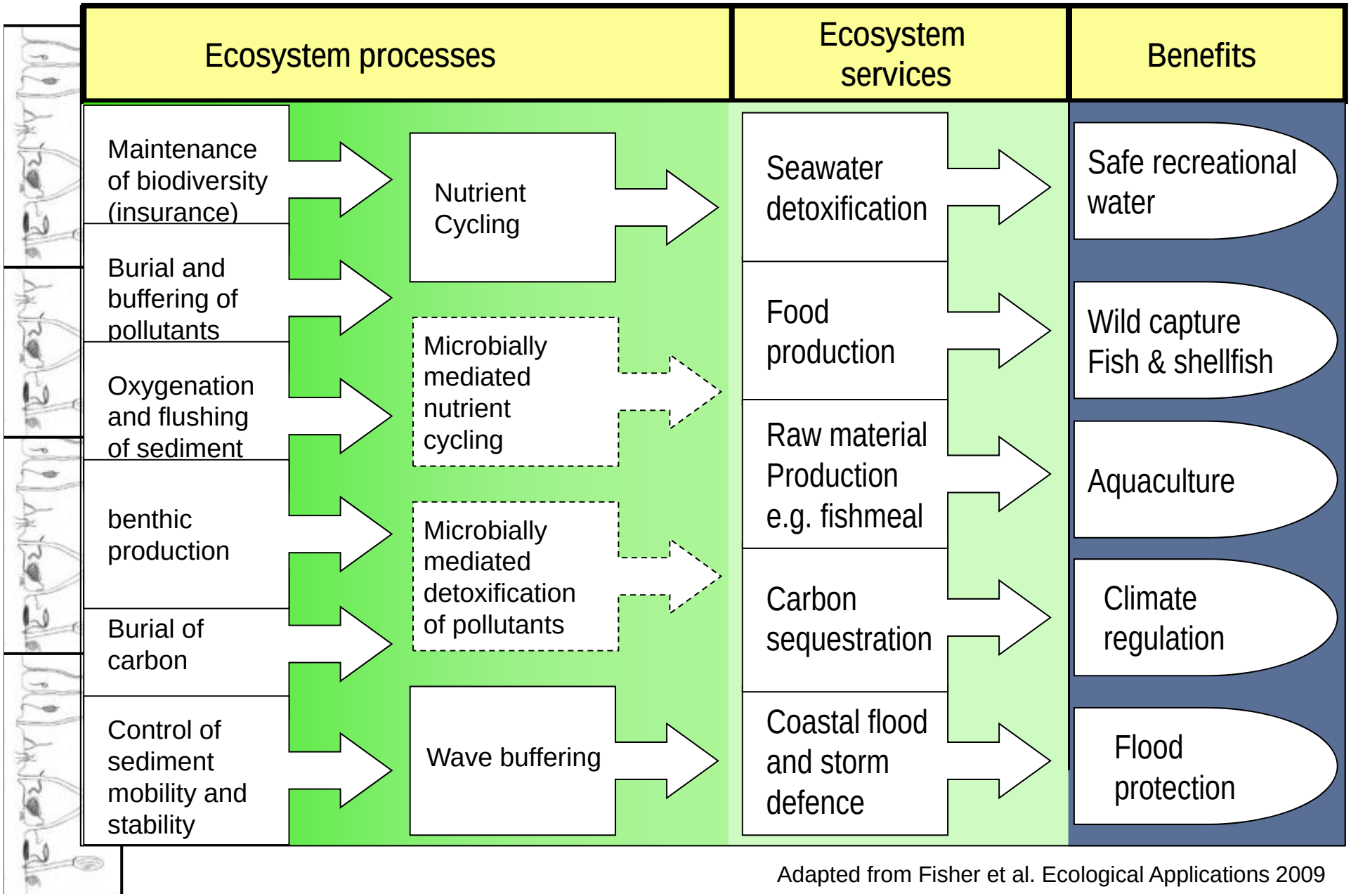
"the aspects of ecosystems utilised (actively or passively) to produce human well-being" (Fisher et al. 2009)

Benthic Environment (Sea Bed)



Adapted from Fisher et al. Ecological Applications 2009

Benthic Environment (Sea Bed)



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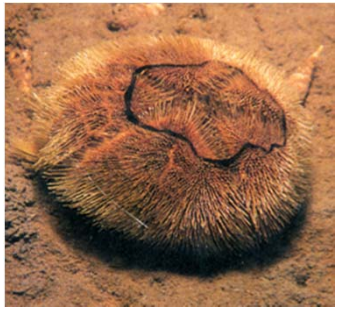
Ecosystem services assessed

- Food provision: fisheries and fleet dynamics

- Bioremediation of waste: the removal of contaminants through storage, burial and recycling



- Climate regulation: the maintenance of the chemical composition of the atmosphere and oceans by marine living organisms

- Cultural benefits: cognitive development and public perceptions of changing marine environment

OA impacts on commercial fisheries (Gorka Merino)

1) Project scenarios of potential OA impacts on key commercial species.

2) Utilise experimental evidence from other modules to assess the impact on fisheries production and profits for a set of OA scenarios.

3) Assess alternative management measures to elucidate optimal regulation to mitigate the effects of OA.

Non-commercial impacts

Use an ecosystem services approach to:

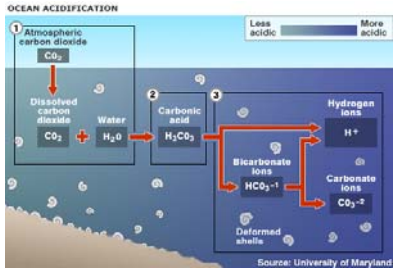
1) Identify the wider benefits society obtains from the marine environment (Yr 1) (Hattam et al. 2012, under review)

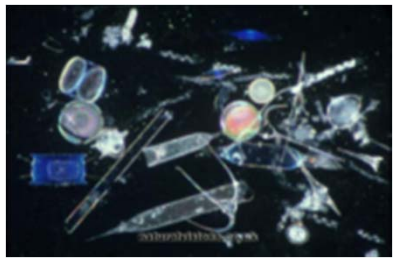
2) Assess potential change resulting from OA (Yr 1&2)

3) Value the changes predicted in ecosystem service (Yr3)

4) Discuss findings with stakeholder groups (Yr3)

Utilised the Ecosystem Service Approach



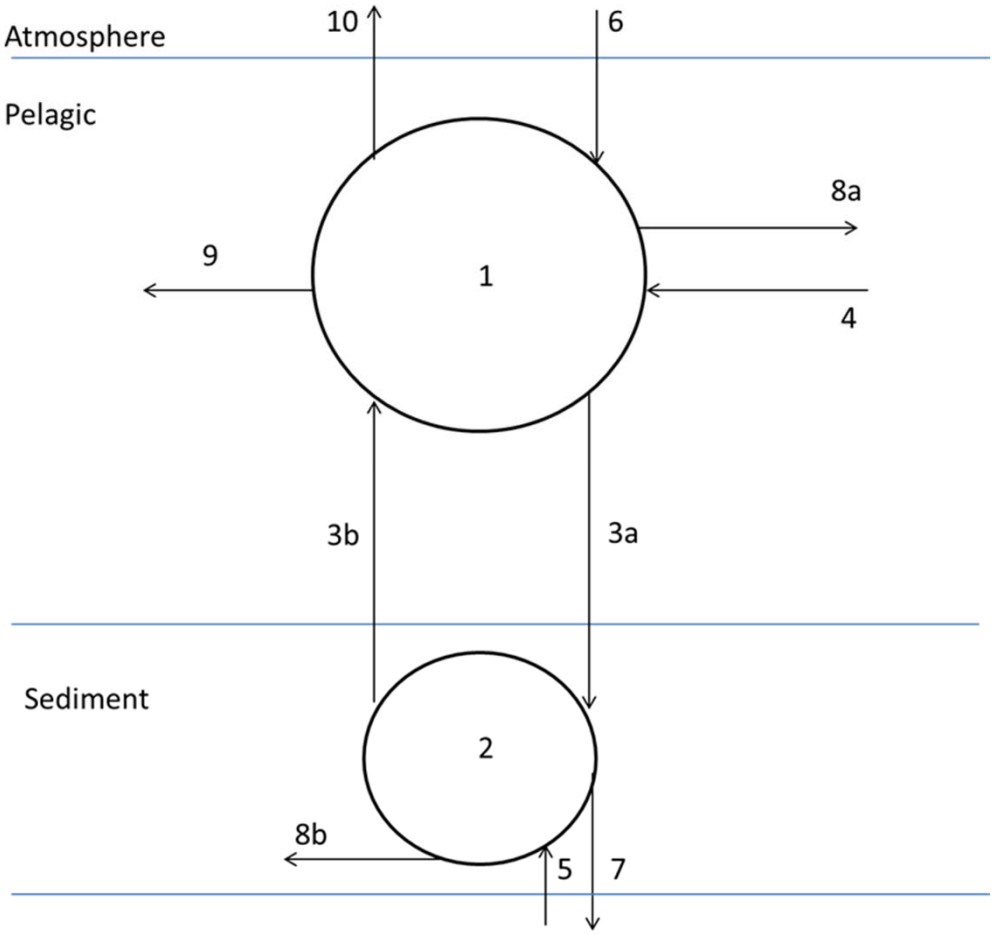


IMPACT: e.g.OA → Ecosystem Process: e.g.primary productivity → Ecosystem Service: e.g. bioremediation of waste → Ecosystem Benefit: e.g. Healthy seas

- OA workshop 3rd November 2011
- 20 inter-disciplinary participants

Picture acknowledgements: bbc.co.uk; aufaitmaroc.com

Bioremediation of waste



Cycling (steps 1,2,and 3) This will result in bioaccumulation and concentrating in areas.

Inputs (steps 4, 5, and 6)

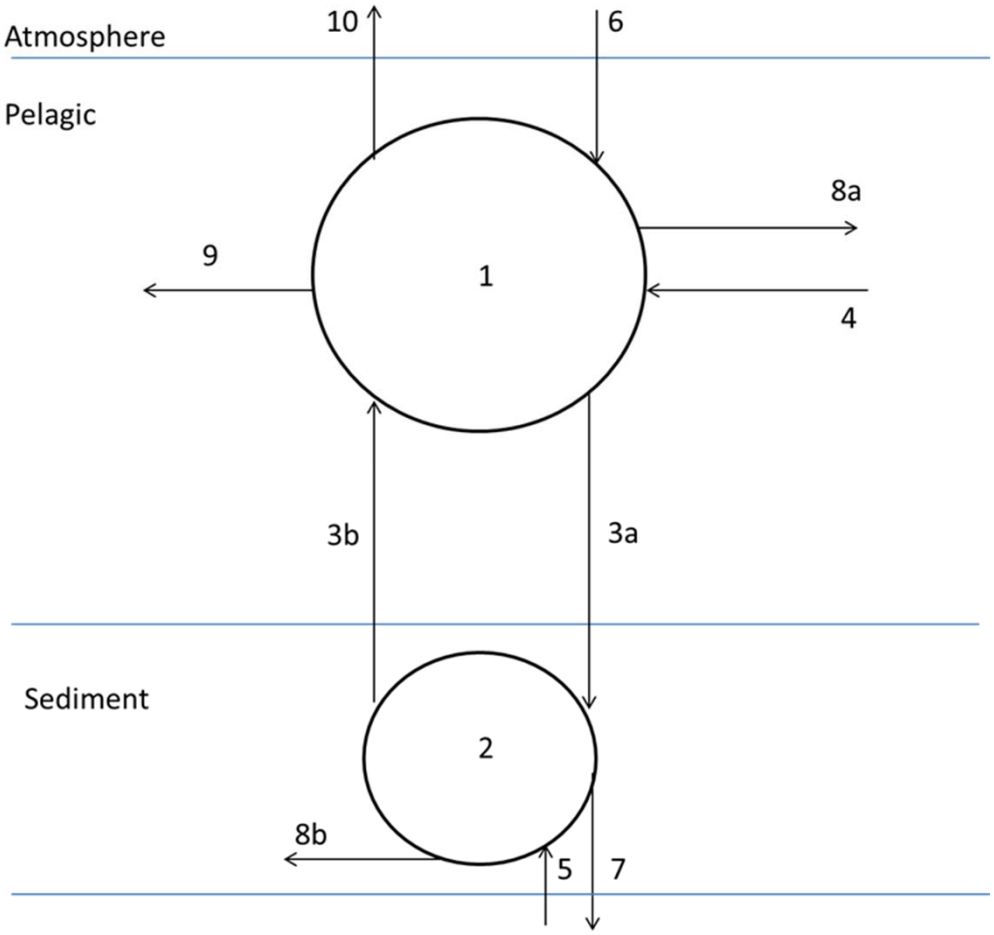
Exports (steps 7, 8, 9 and 10) Export is defined as rendering the contaminant harmless

It is the **export** processes which we need to manage if we want to maximise the value of this ES.

OA impacts on ecosystem processes contributing to bioremediation of waste : Pelagic and Benthic Cycling

Processes	1	2
Primary production	+	+?
Calcification	+/- (net-)	+/- (net -)
Nitrification	-	0 [1]
Denitrification	NA	+/-?
Anammox	NA	? [2]
N2 fixation	+	NA
N uptake	?	?
Trophic transfer	?	?
Ammonia generation	?	? [3]
Health maintenance	?-	? [4]
N-P stoichiometry	+ to N	?

OA impact on bioremediation of waste



This approach was undertaken for all processes 1-10.

i. Understand process

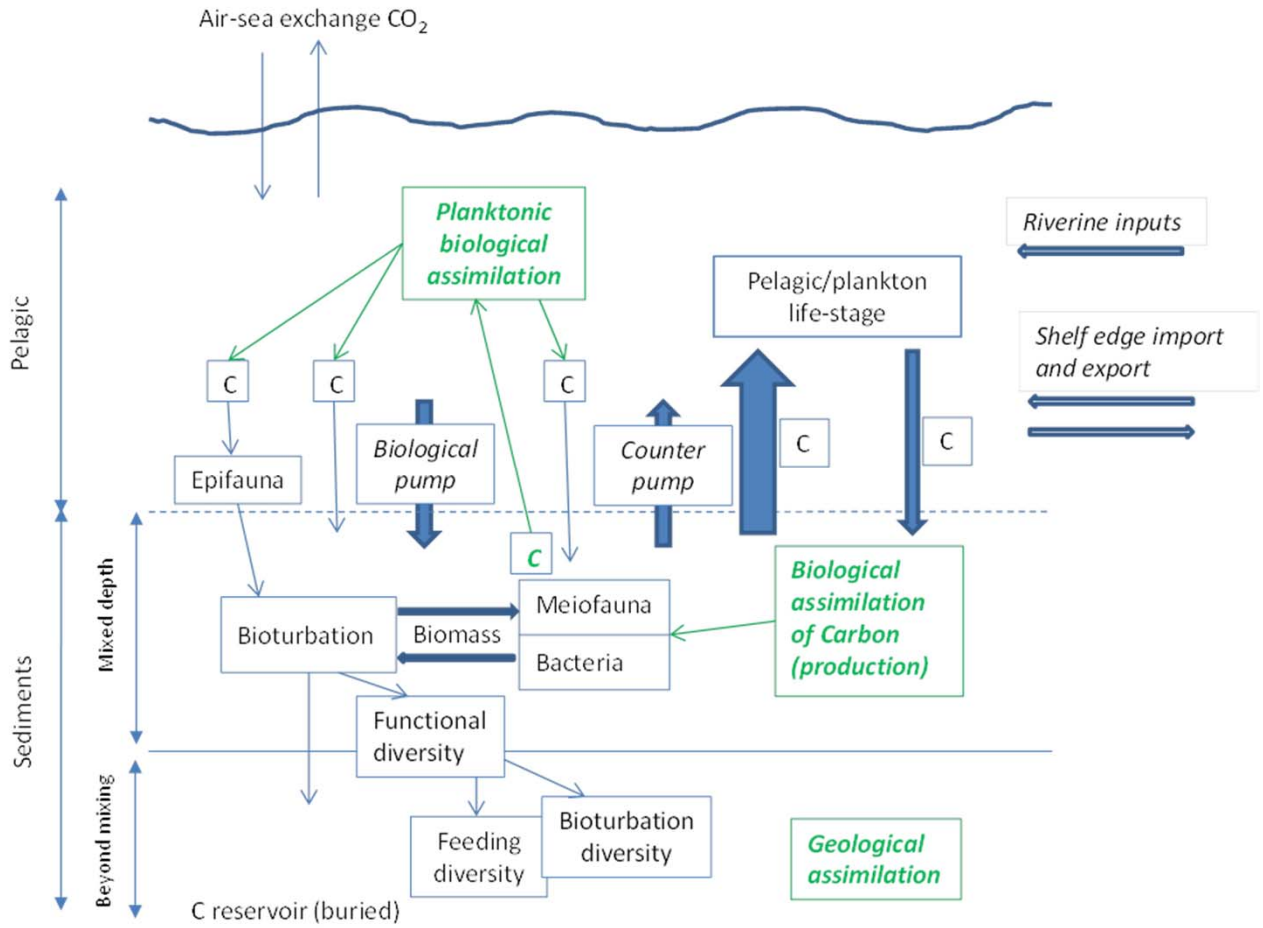
ii. Assess vulnerability of process to OA and temperature change

iii. Develop model of how OA will impact bioremediation of waste

iv. Value changes in this service under different OA scenarios

Publication in preparation

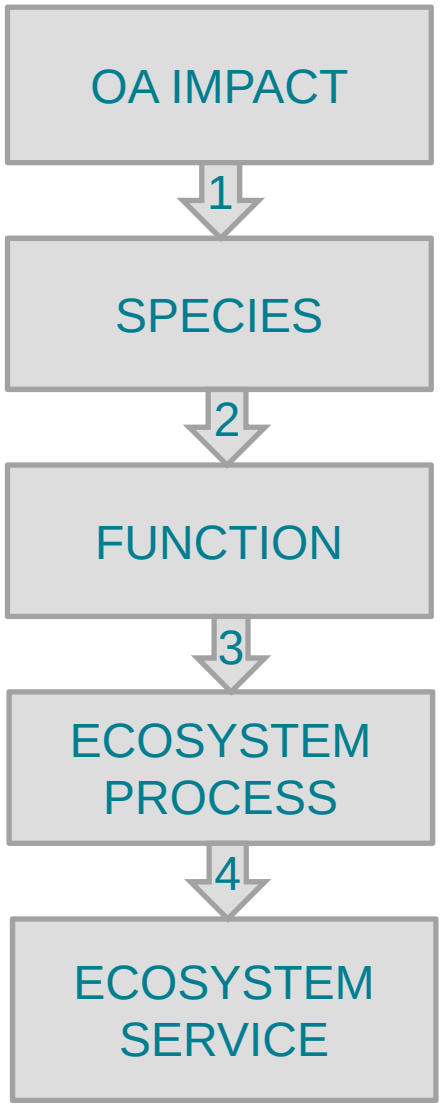
Ecosystem processes influencing carbon sequestration



Also discussed:

Indicators
Evidence

OA impact on carbon sequestration



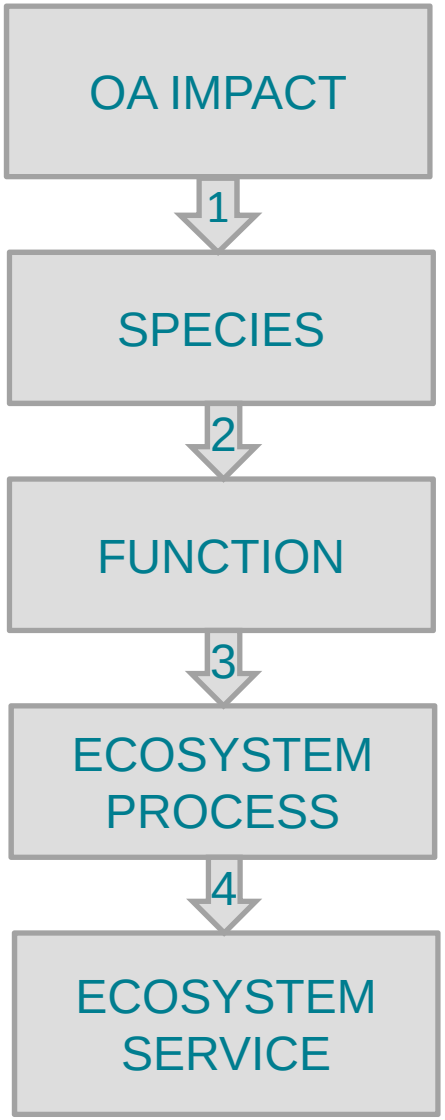
1. Are species affected by OA?

Species group	OA effect?
Cnidarians	- (coral)
Molluscs	-
Arthropods	-/ +
Annelids	+
Echinoderms	- Except brittle star pisaster
Nematodes	+
Bacteria	?

2. Link Species to Function i.e. Biota functional group (what they do)

	Stabiliser	Surface modifer	Tube – head up	Tube – head down	Biodiff	Gallery	Regen
Cnid							
Moll	+				+		+
Arth		+	+		+	+	+
Ann	+		+	+	+	+	
Echin		+					+
Nem		+			+		
Bact	+	+					

OA impact on carbon sequestration



3: Linking function to relevant ecosystem process

	Stabiliser	Surface modifer	Tube – head up	Tube – head down	Biodiff	Gallery	Regen
Burial	+	n/a	+	-	n/a	+	-
Resuspension / recycling	-	+	-	+	+	+	+
Benthic prod surf	+	+	_	+	+	+	+
Benthic productivity sub-surface	-	n/a	+	-	+	+	+

4.Linking ecosystem process to carbon sequestration

EP	C Seq
Burial	
Resuspension / recycling	
Benthic prod surf	
Benthic productivity sub-surface	

Publication in development

Next steps

- Publication of two papers currently in preparation
- Development of carbon sequestration and bioremediation research, with accompanying valuation mechanisms
- Commercial fisheries research
- Cultural services
  - Development of method for estimating cognitive benefits
  - Development of questionnaire for assessing public perceptions to changing marine environment
- Knowledge exchange: 2 workshops with the aquaculture industry