

List of Environmental Effects of MHK Devices

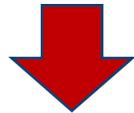
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Teresa Simas (Wave Energy Centre)
André Moura (Wave Energy Centre)
Daniel Conley (University of Plymouth)

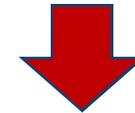
Methodology

Framework to evaluate environmental effects of OREDs
(Bohelert & Gill, 2010; adapted by McMurray, 2008)



Stressors

Features of the environment that may change with project implementation



Receptors

Ecosystem elements with potential for some form of response to the stressor

Effect or Impact?

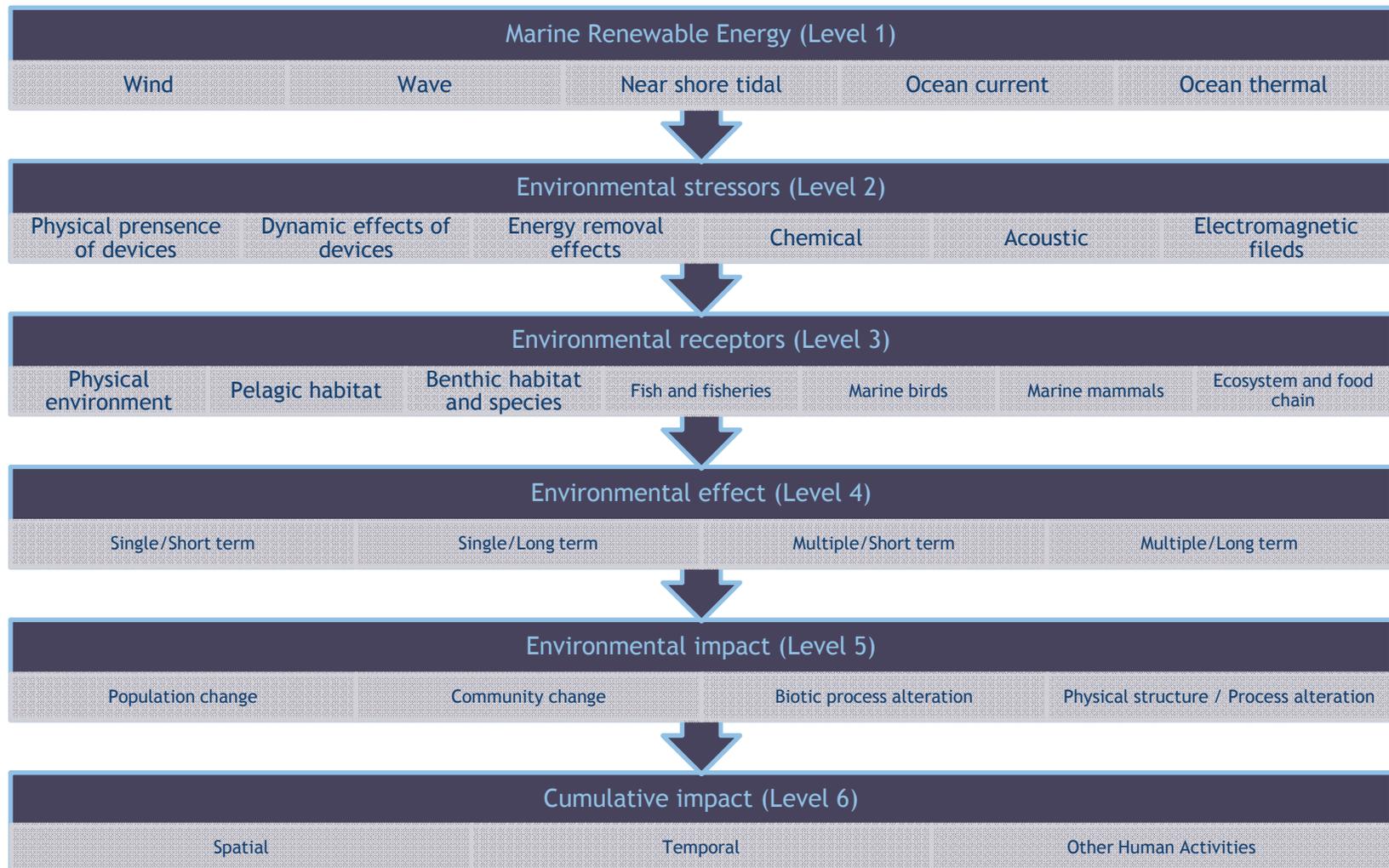
Impact is a classified effect (severity, intensity, duration and direction)

Effect → impact, it should be significant enough to cause change on the receptor

Current knowledge: at the effect's level; more data are needed

Methodology

Framework for evaluating environmental effects of OREDS



Listing environmental effects



Matrix developed for each MHK technology type

...	...	...	Stressors	
...	...	...	Receptors	
...	...	...	Description	Effects
...	...	...	Concerned project stage	
...	...	...	Duration	
...	...	...	General measures (stressor specific)	Mitigation measures
...	...	...	Measures at the receptor level	
...	...	...	Effect specific measures	
...	...	...	Monitoring methods	
			Knowledge gaps	
...	...	...	Key references	

Listing environmental effects

Results

Level 1 Wave energy		Level1 Tidal and ocean current energy	
Level 2 Stressors	Level 3 Receptors	Level 2 Stressors	Level 3 Receptors
Physical presence of devices	<ul style="list-style-type: none"> • Physical environment • Benthos • Fish • Marine mammals • Sea turtles • Marine birds • Ecosystem and food chain • Humans 	Physical presenc of devices	<ul style="list-style-type: none"> • Physical environment • Benthos • Fish • Marine mammals • Marine birds • Sea turtles • Ecosystem and food chain • Humans
-		Dynamic effects of the devices	
Chemical		Chemical	
Acoustics		Acoustics	
Electromagnetic fields		Electromagnetic fields	

Effects of MHK devices



Example

Stressor: Acoustic		
Receptors	Marine mammals	Physical – Auditory (permanent or temporal damages on hearing) or non-auditory (another tissues)
		Behavioural (e.g. interference with mother-calf interaction, avoidance of the area)
		Perceptual (e.g. communication, vocalization adaptation, prey/predator detection)
		Chronic/Stress (e.g. sensitivity, diseases vulnerability)
	Fish	Avoidance, displacement, mortality or behavioural changes
	Sea turtles	Avoidance, displacement or behavioural changes
	Benthos (crustaceans)	Avoidance, displacement
	Humans	Aerial noise disturbance of onshore devices (eg. OWC devices)

Effects of MHK devices

Stressor: Electromagnetic fields		
Receptors	Benthos	Effects of electrical fields on benthic species
	Fish	Electrical fields: interference with prey location, orientation and reproduction
	Marine mammals	Magnetic fields: interference with migrations
	Sea turtles	Interference with orientation and migration

Your feedback is important!



- Level 1: more MHK types?

- Stressors / Receptors: any additions?

- Effects: Is there anything missing? Are they well formulated? Are they well distributed among stressors and receptors?

- Ongoing projects / key references

- Areas which need further investigation: EMF, acoustics, birds, collision and strike, more??

- Any other issue/suggestion to improve our work?

Mitigation

Definition: Mitigate- to make less harsh or hostile.

Aspects of MHK mitigation:

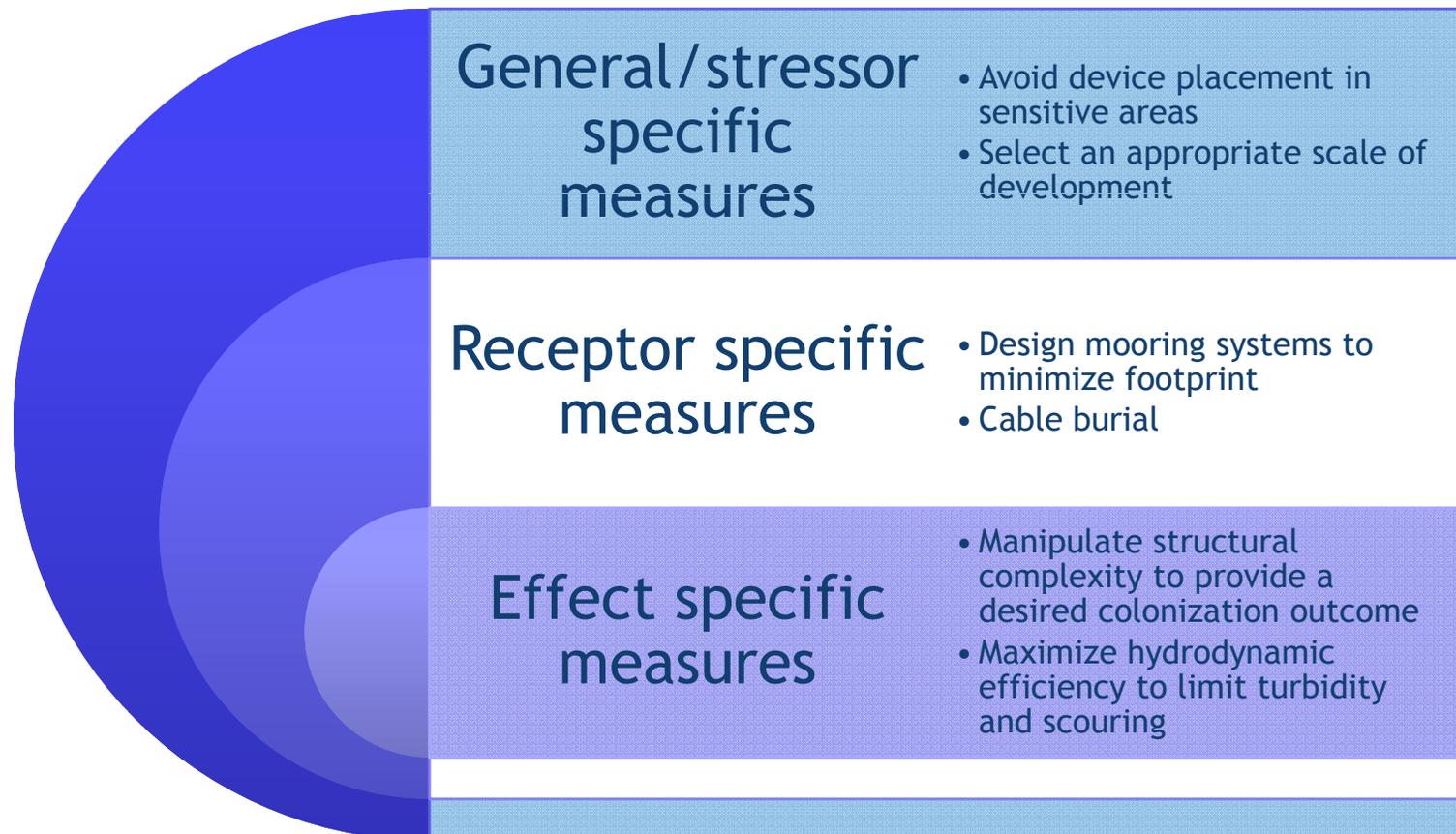
- Unknown factor –
 - Doubts regarding effects, let alone mitigation
 - Device, project, location specificities
- Few examples of implementation – Few projects to date with feedback of effectiveness
- Most measures suggested stem from common sense and similarities with other marine activities

Mitigation (cont)

Problem: Too much repetition

Solved by grouping mitigation measures

(eg Physical presence – Benthos – colonization/scouring below)



Mitigation overview



- Uncertainty - problem
- Can learn from similar offshore technologies - wind
- Expected to have a large development in the near future - feedback from deployments
- Database must allow for flexibility and inputs
- Experts input is crucial to have comprehensive/exhaustive understanding - particularly at the effects level