Data Repository – PART II

Interaction Summaries

This document summarizes the raw data (based on coding of articles) of the project Ocean Sector Interactions and Outcomes. It forms the basis of the database and interactive network tool https://gedb.shinyapps.io/OceanInteractions/.

A summary sheet is created for each distinct sector-sector interaction, or sector-mediating activity interaction. Each summary sheet contains the following information:

- **Sectors involved in the interaction**
- **Number of reviewed research articles that contain the interaction.** Each MAXQDA code was checked in a second round of analysis and thus the final number of articles with each interaction may differ from this value if codes were later excluded (see clarification below)
- **Distribution of intensity codes used.** Intensity codes were not used in the final round of analysis**.** The codebook testing process revealed that articles were not consistent in their description of interactions. As such, it was impossible to establish a clear definition of what constituted 'high' versus 'low' intensity of interaction between sectors.
- **Descriptions of the interaction examples found in the literature.** In cases where there were only a handful of examples, all are listed and cited. However for interactions where there were several examples (sometimes hundreds), the examples are summarized and a selection of citations from the reviewed literature is provided. If there was only one example found, '*only example*' is indicated.

Decisions regarding inclusion in the final interactions database is documented for each example. In some cases, the interactions were not included in the database due to the following reasons:

1. For rare interactions (such as those where only one or a few examples were found in the review), there must be empirical evidence of the interaction for inclusion. If the interaction is vague, discusses a 'potential' interaction only, or is a mere suggestion by the author, we will not include it in the database. E.g. Potential space constraints hypothesized between nearshore mining and mariculture by virtue of them occurring in the same area (Cabral and Aliño, 2011). This interaction would not be included if it is the only example available.

   However, we acknowledge that potential and/or hypothesized interactions may be more common for 'newer' sectors, such as renewable energy and deep-sea mining. Therefore if the information reviewed includes a well-explained hypothesized mechanism, or the example is from an article entirely about the potential interaction, then it is justified to include it as there is therefore a stronger evidence base. E.g. In a paper by (Rodríguez-Rodríguez *et al.*, 2016) the potential interactions between wind farms and MPAs are modelled and potential effects of co-location are assessed. The entire paper is focused on this topic and thus inclusion as a wind-mpa interaction would be accepted based on this paper.

2. Construction impacts are not included since these are limited and temporary. E.g. Construction of a desalination plant that results in increased ship traffic and has temporary impacts on other users of the coastal space is not included in the database (Bombar, Dölgen and Alpaslan, 2016).

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DRED-ECO 2
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DISP-ECO 2
FISH-MPA 2
TOU-ECO 2
DRIL-ECO 2
SHIP-ECO 2
FISH-ECO 2

WIND-MIN

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs	PRESENCE
100% (N=1)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100% (N=1)	**0%**

Examples

Only example

- Competition for space in the Polish EEZ due to opposing development proposals from both sectors (Andrulewicz et al, 2010). At the time of writing it was unclear how the conflicting proposals would be resolved, however it was clear that marine spatial planning is needed.

→ *Entered as wind-min, space crowd since this is an observed example of these two sectors competing for space.*

WAVE-MIN

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Potential spatial competition between the wave sector and areas set aside for mining, suggested in the Wave Hub (2006) compendia (Langhamer et al, 2010).

→ *Since this a suggestion of a potential conflict and has not been empirically observed, wave-min (space-crowd) is not included in the database.*

WAVE- DISP

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

Only example

- Dolman et al. 2010 questions the "Fate of decommissioned plants".

  → *This example is very vague and is not empirical evidence disposal-mediated impacts of decommissioned wave facilities and thus is not included in the database.*

TOU-CAB

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

Only example

- In Sawale et al. (2011) a list of competing activities is mentioned in relation to coastal zone management, including submarine cables and tourism amongst others.

  → *Since this is only one example with a sentence that is quite vague and does not explicitly state which or how the listed sectors interact, this is not included in the database.*

TEL-WAVE

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- A modelling study (Flocard et al. 2016) identifies telecommunication cables as exclusion zones for potential wave energy facilities, in accordance with European guidelines.

  → *Since it is stated in European guidelines that telecommunication cables are exclusion zones for new wave energy facilities this was coded as tel-wave, space-crowd.*

TEL-SHIP

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Damaged telecommunication cables from shipping anchors has occurred and creates repair costs and lost revenue (Coffen-Smout and Herbert, 2000).

  → *This is entered in the database as tel-cab-ship, operation-dimin.*

TEL-REN

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
100% (N=1)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100% (N=1)	**0%**

Examples

Only example

- In Oregon, an application for a marine renewable energy facility will only be accepted if it does not interfere with existing telecommunications cables (Johnson, 2014).

  → *Entered in the database as ren-cab-tel, space-crowd, since this example is an observed regulation in place that limits space for the renewable energy sector.*

TEL-PIPE

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Coffen-Smout and Herbert (2000) state that the International Cable Protection Committee (ICPC) have made recommendations regarding crossings between cables and pipelines/power cables, and state that there are increasing risks of interference between cables and pipelines/power cables that call into question the 'freedom to lay cables'.

  → *This is included in the database as tel-cab-pipe-dril since the article is focused on telecommunications cables.*

TEL-MPA

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
100% (N=1)	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Only example

- "Increasingly, coastal states have also designated areas of their EEZs as MPAs with the potential to restrict cable routes." (Friedman, 2017)
- "there is no reason why cables and marine protected areas are mutually exclusive, but this presumes that the former does not unduly burden the latter." (Friedman, 2017)

→ *This article vaguely speaks of space-crowd as a 'potential' outcome but does not empirically observe this phenomenon. Thus it is not included in the database.*

TEL-MIN

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Due to increasing intensification, increasing risk of sector-sector interference (Coffen-Smout and Herbert, 2000).

→ *Since this statement is hypothetical, and this has not been mentioned or observed in any other reviewed studies it is not included in the database.*

TEL-MIL

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=1)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

Only example

- It is important that naval operations are aware of position of cables (Coffen-Smout and Herbert, 2000).

  → *This statement is very vague and unclear regarding how these sectors may interact. Since this is the only reviewed article where this is mentioned, tel-cab-mil is not included.*

TEL-DRIL

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=1)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

Only example

- Due to increasing intensification, increasing risk of sector-sector interference (Coffen-Smout and Herbert, 2000).

  → *Since this statement is hypothetical, and this has not been mentioned or observed in any other reviewed studies it is not included in the database.*

REN-REC

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Reclaimed land between islands could be realised as potential sites for tidal energy (Pollard et al. 2014).

  → *Since renewable energy is not clearly linked to an ocean-based sector here this example is not included in the database. Land reclamation is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods).*

REN-MIN

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
100% (N=1)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Only example

- Soukissian et al. (2017) state that conflicts and interactions between mining and renewable energy need to be explored.

  → *Since this is a hypothetical/suggested interaction that is not empirically observed, it is not included in the database.*

MIN-REC

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Ma et al. (2017) suggests that mine tailings could be used for land reclamation purposes.

→ *Since this interaction is hypothetical and is not clearly linked to another ocean sector, this example is not included in the database. Land reclamation is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods).*

MIN-DRED

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- In order to be able to mine phosphate, a layer of sediment needs to be dredged away (Levin et al, 2016).

→ *Dredging is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods). Since this example does not clearly link mining to another ocean-based sector as per our definition it will not be included in the database.*

MIN-CAB

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Due to increasing intensification, increasing risk of sector-sector interference (Coffen-Smout and Herbert, 2000).

  → *Since this statement is hypothetical, and this has not been mentioned or observed in any additional reviewed studies it is not included in the database.*

MIN-AQUA

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Potential space constraints in nearshore mining and mariculture by virtue of them occurring in the same area. (Cabral and Alino, 2011).

  → *Since this example is very hypothetical and because there are no other min-aqua interactions found in the review it is not included in the database.*

MIL-REN

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Renewable energies applications are either completely rejected or restricted in areas of military activity (Soukissian et al, 2017).

→ *Since this is empirically observed it is included in the database as mil-ren, space crowd (context-specific).*

MIL-REC

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Reclamation of Wadden Sea was considered in mid-60s (but never done). Although it would affect many sectors, it would likely provide a more convenient area for military training (Wolff and Zijlstra, 1980).

→ *Since this is the only example found in the review and a suggestion/hypothesis from the author, it is not included in the database.*

MIL-DRED

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs	PRESENCE
100% (N=1)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Only example

- Dredging could drag up toxic and hazardous munitions that have previously been disposed of by the military (Carton and Jagusiewicz, 2009).

  → *Dredging is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods). Since this example does not clearly link the military sector to another ocean-based sector as per our definition it will not be included in the database. It is also not an empirical example and is the only such example found in the review.*

DES-WIND

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- "Further, the company Hexicon AB, situated in Stockholm, Sweden, has developed an offshore solution primarily for wind energy production but states that it is possible to integrate complementary technologies to use the platform for multi-purpose: e.g., wave power, tidal power, solar power, desalination, fish farming, and oxygenation "(Stuiver, 2016).

→ *Since this technology is not empirically observed and there are no other des-wind examples found in the review, this is not included in the database.*

DES-REN

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- "Two membrane-based technologies are mainly used to harness salinity gradient energy... recovering energy from production processes such as desalination" (Soukissian et al, 2017).

→ *This is included in the database as des-ren, operation-enhance since this is an observed technology where the renewable sector is benefitting from desalination processes in a manner that enhances the operation of the renewable technology.*

DES-MPA

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY	vs	PRESENCE
0%		**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Fox et al (2013) states that coastal MPA planners and managers should consider increasing demands on the marine environment such as desalination plants, implying that these sectors act in the same space.

→ *Since this example is quite vague and this is the only des-mpa example found in the review this example not included in the database.*

DES-DRIL

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
100% (N=1)	**100% (N=1)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- An oil spill would completely shut down desalination plants. Of particular worry is the Persian Gulf where both of these industries are present (Meshkati and Tabibzadeh, 2016).

  → *This is included in the database as des-eco-dril, natcap dimin, since this is a stated fact (rather than a hypothesis or suggestion from the authors).*

DES-AQUA

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- Growing brine shrimp in brine disposal ponds is suggested as a brine management strategy. (Abdul-Wahab and Al-Weshahi, 2009).

→ *Since this example is a suggestion only, this is not included in the database.*

BIO-DISP

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- "The areas that may currently seem opportune areas for depositing waste may be future areas of bioprospecting" (Thurber et al, 2014).

  → *Disposal is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods). Since this example does not clearly link bioprospecting to another ocean-based sector as per our definition it will not be included in the database. In other words, it is not clear what ocean-based sector the bioprospecting is interaction with (i.e. who is performing the waste dumping).*

AGG-TEL

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- The telecommunications sector excavates sand in order to cover the cables. However, in most cases sand is excavated at the site of cable placement and returned there, thus maintaining the sand balance (Trop, 2017).

→ *This example is not entirely clear regarding whether the aggregate sector is involved or not. Thus it is not added to the database.*

AGG-DES

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

- The desalination sector also excavates sand in order to cover outlet pipes. However, in most cases sand is excavated at the site of the pipe placement and returned there, thus maintaining the sand balance (Trop, 2017).

→ *This example is not entirely clear regarding whether the aggregate sector is involved. Thus it is not added to the database.*

AGG-AQUA

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs PRESENCE	
100% (N=1)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Only example

- Gravel extraction may limit the selection of sites available for aquaculture or set specific requirements for aquaculture development (Jansen et al, 2016).

→ *Since there are no other examples of agg-aqua found in the review and this statement is posed as a possibility rather than something that has been observed, this is not included in the final database.*

AGG-AQUA

NUMBER OF ARTICLES:
1 (0.3%)

INTENSITY vs	PRESENCE
100% (N=1)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Only example

- Gravel extraction may limit the selection of sites available for aquaculture or set specific requirements for aquaculture development (Jansen et al, 2016).

→ *Since there are no other examples of agg-aqua found in the review and this statement is posed as a possibility rather than something that has been observed, this is not included in the final database.*

WIND-DRED

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs	PRESENCE
0%	**100% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- During construction of wind turbine, intensive dredging for the base/foundation is needed. This stirs up sediment in the water column which can be lost from site and creates other kinds of environmental impacts (Soukissian et al, 2017; Zanuttigh et al, 2015).

  → *This phenomenon may impact the wind turbine itself and the surrounding ecosystem, however from the examples reviewed it is not clear that this has an impact on any other ocean-based economic sectors. Dredging is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods).*

TEL-AQUA

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs	PRESENCE
100% (N=2)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Jansen et al (2016) identifies a 'potential risk' to cables from aquaculture farms or boat anchoring, but suggests that they can share service vessels and the use of space.
- Side and Jowitt (2002) state that salmon farming 'may restrict' the freedom of other users such as cables.

→ *Both of these examples are written in a hypothetical way as potential interactions, with little detail and justification and thus are not included in the database. There are no empirical examples found in the review.*

REC-MPA

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs	PRESENCE
0%	**100% (N=2)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Chung et al. 2015 and Fox et al. 2013 describe how protected areas can restrict development (such as land reclamation)

→ *From these examples it is not clear what sector MPAs are interacting with (our review does not consider general land reclamation as a sector in itself – see methods). It is thus not included in the database.*

REC-DISP

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
50% (N=1)	**100% (N=2)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Wolff and Zijlstra (1980) discuss how hypothetically land reclamation would have impacted ongoing waste disposal activities.
  → *Disposal and land reclamation are not stand-alone sectors in our framework since we have defined both as mechanisms (see methods). This example is also hypothetical. Thus it is not included in the database.*

- "New harbour construction and the maintenance of existing structures require the dredging and disposal of considerable amounts of sediments" (Petrucci et al, 2011).

→ *Dredging and land reclamation are mechanisms used by the shipping industry for port development. Since there is no connection to another sector as per our framework we have not included this phenomenon in the database based on this example.*

PIPE-MPA

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
0%	**100% (N=2)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Potential space conflicts, restricting pipeline activity in MPAs (Almada and Bernardino 2017).

→ *This is a hypothesized interaction and is not observed empirically. Thus it is not included in the database.*

- MPAs may restrict 'intake pipes' (Fox et al 2013).

→ *It is unclear what kind of intake pipes are mentioned briefly in this article, thus this is not included in the database. It is also a hypothetical example.*

MIN-PIPE

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
0%	**100% (N=2)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- "There is also potential impact from leakage of material through riser pipes" (Ellis et al 2017).

→ *This is not included in the database as there is not an interaction with another ocean economic sector (pipes are a mechanism according to our framework – see methods).*

- Pipes as a mechanism for disposal of terrestrial mine waste.

→ *This is not included in the database as there is not an interaction with another ocean economic sector (pipes and disposal are mechanisms according to our framework).*

MIL- MIN

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
50% (N=1)	**50% (N=1)**

HIGH **0%**	LOW **0%**
UNCERTAIN **100%**	UNKNOWN **0%**

Examples

- Mineral exploitation activities could potentially come across toxic and hazardous munitions that have previously been disposed of and be 'potentially hazardous' (Carton and Jagusiewicz 2009).

→ *This is stated as a potential effect. It has not been empirically observed (although recovery of munitions has been observed by fishermen and during pipeline construction). Thus mil-min will not be included.*

- Co-location in space (Ulyanova and Danchenkov, 2016)

→ *This example is not clear regarding whether there is any interaction that occurs and is thus not included.*

DRED-PIPE

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
0%	**100% (N=2)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

- Dredging "runs afoul of" pipelines (Charlier and Charlier, 1992).

→ *This is an unclear statement and there are no other articles reviewed with this example. Thus it is not included in the database.*

DRED-CAB

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs	PRESENCE
0%	**100% (N=2)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

- Dredging is used to bury cables ("cable trenching") which disturbs the seabed (Hammar et al, 2017).
  → *We do not include construction impacts in our database. This shows an impact on the ecosystem however dredging is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods).*

- Dredging "runs afoul of" cables (Charlier and Charlier, 1992).

→ *This statement is too vague to be included in the database.*

DES-TOU

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs	PRESENCE
50% (N=1)	**50% (N=1)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- It is possible that construction of desalination plants can cause negative effects for recreational activities but limited since only during construction time (Bombar et al 2016).

→ *We do not include construction effects in our database.*

- Brine discharge acts as a continuous and cumulative source of pollution, resulting in damage to the biota within the plume's vicinity. Hence most of the long outfalls contain diffusers to dilute the brine. Brine discharge should be placed well away from recreation and tourism activities (Abdul-Wahab and Al-Weshahi, 2009).

→ *Since this is very vague in terms of whether these sectors actually interact or not, this is not included in the database.*

DES-PIPE

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
0%	**100% (N=2)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

Common Examples

- Water comes in and waste goes out from desalination plant via pipeline (and the pipeline in turn has eco effects) (Bombar et al. 2016; Abdul-Wahab and Al-Weshahi, 2009).

→ *Pipes are not a stand-alone sector in our framework as we have defined it as a mechanism (see methods). Thus this example is not included in the database.*

DES-FISH

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
50% (N=1)	**50% (N=1)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Construction of desalination plants can cause negative effects for fishing but limited since only during construction time (Bombar et al, 2016).

  → *Construction impacts are not included in the database.*

- Brine discharge acts as a continuous and cumulative source of pollution, resulting in damage to the biota within the plume's vicinity. Hence most of the long outfalls contain diffusers to dilute the brine. Brine discharge should be placed well away from fishing (Abdul-Wahab and Al-Weshahi, 2009).

→ *Since this is the only example of this interaction and is very vague in terms of whether these sectors actually interact or not, this is not included in the database.*

CAB-DISP

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
50% (N=1)	**50% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- In Sawale et al. (2011) a list of competing activities is mentioned in relation to coastal zone management, including submarine cables and waste disposal amongst others.

  → *Since this example is quite vague and does not explicitly indicate how the listed sectors interact, this is not included in the database. Also, cables and disposal are mechanisms, not stand-alone sectors, according to our framework. Thus this example is not included.*

- The 1945 memorandum of the U.S. Chief of Naval Operations (CNO) states that disposal of explosives, ammunition, and chemical munitions should be done away from marine cables (Carton and Jagusiewicz, 2009).

  → *Since this statement comes from 1945 it can be assumed that the cables are telecommunication cables. It is unclear and vague whether an interaction is actually occurring from this statement. Thus mil-disp/cab-tel is not included in the database.*

BIO-FISH

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs	PRESENCE
100% (N=2)	**0%**

HIGH	LOW
0%	**50%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

Common Examples

- The bioprospecting uses of krill might help put krill fisheries on 'sound economic footing' (Nicol and Endo, 1999).

→ *This statement is a suggestion by the authors and is the only such example found in the review. Thus it is not included.*

- Fishing and pharmaceuticals resource exploitation ecologically overlap in places, potentially affecting the health of each other (i.e. potentially same species – contrasting uses) (D'Arcy, 2014).

→ *This is stated as a potential interaction. Although it involves a 'newer' sector (bioprospecting), this is the only example and is very vague. Thus it will not be included.*

AQUA-PIPE

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
100% (N=2)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Potential space restrictions and damage to pipes from farms or boat anchoring. Existing pipelines may limit aquaculture development. However there is also the potential for co-location (Jansen et al, 2016, Side and Jowitt, 2002).
  → *These examples are potential interactions and have not been observed empirically. Thus they are not included in the database.*

AQUA-DRED

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs PRESENCE	
0%	**100% (N=2)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

Common Examples

- Dredging is used to make space for aquaculture (Goulletquer and Le Moine, 2002; Yan et al, 2017).

  → *Dredging is not a stand-alone sector in our framework as we have defined it as a mechanism (see methods). Thus there is not a link between aquaculture and another sector based on this example. It is not included in the database.*

AQUA-CAB

NUMBER OF ARTICLES:
2 (0.7%)

INTENSITY vs	PRESENCE
100% (N=2)	**0%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Only example

- Potential space restrictions and damage to cables from farms or boat anchoring. Existing cables may limit aquaculture development. However there is also the potential for co-location (Jansen et al, 2016, Side and Jowitt, 2002).

→ *Both of these examples are potential interactions and have not been observed empirically and thus are not included in the database.*

WIND-DISP

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Decommissioning of wind farms may involve potential disposal impacts (Dolman and Simmond, 2010).

→ *This example is a hypothesis and is thus not included.*

- Off-shore turbine construction also creates drill cuttings that need to be disposed of (Wilson et al, 2010).

→ *It is unclear what other sector would be impacted from this example and thus it is not included. Disposal is a mechanism according to our framework.*

- Intersecting space between wind farm proposals and historic dumping of chemical weapons (Mileriene et al, 2014).

→ *This example is vague as to whether these industries are actually interacting by traversing in space. Thus it is not included.*

TOU-PIPE

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

- In Sawale et al. (2011) a list of competing activities is mentioned in relation to coastal zone management, including pipelines and tourism amongst others.
  → *Since example is quite vague and does not explicitly state which or how the listed sectors interact, it is not included in the database*
- Building of pipeline dislodged disposed munitions which washed up on shores and burned beachgoers.

→ *This is captured as mil-disp-tou (see mil-tou) as it is an empirical example.*

- Pipelines have been deployed for enhancing recreational diving due to their function as artificial reefs (Feary, Burt and Batholomew, 2011).

→ *This is included as dril→pipe→tou, value-enhance as it is an empirical example.*

TEL-FISH

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs PRESENCE	
33% (N=1)	**100% (N=3)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
100%	**XX%**

Examples

- Space conflict and de-facto exclusion zones for fishing due to fear of litigation and liability if damages occur, sacrificing fishing gear or anchor to avoid damaging cables (Coffen-Smout and Herbert, 2000; Friedman 2017; Benn et al, 2010)

  → *tel-cab-fish, space-crowd since there are multiple empirical examples.*

- Fishing gear destroying cables is a large contributor to cable damage (Coffen-Smout and Herbert, 2000; Friedman 2017)
  → *tel-cab-fish, operation-dimin.*

- Alteration of fish habitat due to cable burial and repair damage (Coffen-Smout and Herbert, 2000).

→ *Since this is a limited impact that takes place during construction/cable burial it is not included.*

SHIP-PIPE

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

- In Sawale et al. (2011) a list of competing activities is mentioned in relation to coastal zone management, including pipelines and shipping amongst others.

  → *Since this is only one example with a sentence that is quite vague and does not explicitly state which or how the listed sectors interact, this is not included in the database.*

- General coexistence possible/compatible (Astariz and Iglesias, 2017; Jongbloed et al, 2014).

  → *It is not clear if this example indicates whether these sectors (drilling and shipping, via pipelines) interact based on this notion. Thus it is not included.*

REN-WIND

NUMBER OF ARTICLES:
3 (1%)

INTENSITY	vs	PRESENCE
33% (N=1)		**67% (N=2)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**100%**

Examples

- It is possible to integrate complementary technologies to create multi-purpose tidal and wind power platforms (Stuiver et al, 2016; Wilson et al, 2010; Zanuttigh et al, 2016).

  → *Since this is a technology that is being developed and there are entire papers dedicated to this topic that were reviewed (Zanuttigh et al, 2016) it is included in the database as ren-wind, space-syn.*

REN-WAVE

NUMBER OF ARTICLES:
3 (1%)

INTENSITY	vs	PRESENCE
33% (N=1)		**67% (N=2)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- It is possible to integrate complementary technologies to create multi-purpose tidal and wave power platforms (Zanuttigh et al, 2016).
  → *Since this is a technology that is being developed and there are entire papers dedicated to this topic that were reviewed (Zanuttigh et al, 2016) it is included in the database as ren-wave, space-syn.*

- Competing space use (low) between wave energy facilities and 'offshore energy' (Kim et al, 2012).

→ *This example is vaguely reported in a table and in the context of the paper it is unclear if renewable energies and wave facilities are competing. Thus it is not included.*

REN-DRED

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- In renewable energy installations (including tidal) dredging is required (Hammar et al, 2017; Dolman and Simmonds, 2010). This has ecological impacts.
  → *This is not linked to another economic ocean sector (dredging is not a sector on its own in our framework) and is thus not included.*

- Oregon will not accept applications for marine renewable energy (MIRE) development within dredged material disposal sites (Johnson, 2014).

  → *It is unclear which sector is responsible for the dredged disposal as dredging is a mechanism in our framework (see methods). Thus this is not enterable in the database.*

REN-DISP

NUMBER OF ARTICLES:
3 (1%)

INTENSITY	vs	PRESENCE
33% (N=1)		**67% (N=2)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- The potential of utilizing industrial seaweed wastes for the production of biomethane has been tested, with promising results (Barbot et al, 2016).

→ *There is not a clear link to another sector here. Seaweed waste is not an industry according to our framework. Thus it is not included.*

- Oregon will not accept applications for marine renewable energy (MIRE) development within dredged material disposal sites (Johnson, 2014).

  → *It is unclear which sector is responsible for the dredged disposal as dredging is not a stand-alone sector in our framework (see methods), thus this is not enterable in the database.*

- Dolman et al. 2010 questions the "Fate of decommissioned plants".

  → *This statement is too vague for inclusion in the database.*

MIL-WAVE

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- "For their part, military areas cover 14% of the North Sea... Munitions dumping areas are not available for offshore parks. All remaining military use categories are possibly available for coexisting with energy farms. In the case of zones designated for military aircraft manoeuvres the offshore farm should not use more than 20% of the area." (Astariz and Iglesias, 2017)
- New wave facilities need to avoid military areas, including world war 2 dump sites (Flocard et al, 2016; Langhamer et al, 2010)

→ *This was entered as mil-wave, space-crowd, and mil-disp-wave, space-crowd.*

MIL-TOU

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
67% (N=2)	**67% (N=2)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

- Contact between tourists and disposed toxic munitions due to washing up on shores, or in-water activities (Carton and Jagusiewicz, 2009). It has been observed and there is significant concern from affected countries.
  → *This example is captured in the database as mil→disp→tou, value-dimin.*
- Observed negative effect on whale watching tourism during periods of military training (fewer sightings) (Scott and Parsons, 2005).
  → *This example is captured in the database as mil→eco→tou, value-dimin.*
- Expected competing space use between recreational boaters and military training (Wolff and Zijlstra, 1980)

  → *This is a hypothesized interaction, and is the only example of a mil-tou space conflict interaction found in the review. Thus it is not included in the database.*

MIL-PIPE

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
33% (N=1)	**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- General coexistence possible/compatible (Astariz and Iglesias, 2017; Jongbloed et al, 2014).

  → *It is not clear if this example indicates whether or how these sectors (drilling and shipping, via pipelines) interact based on this notion. Thus it is not included.*

- Pipeline construction has dislodged disposed munitions and there is concern over a possible detonation rupturing a pipeline. Concerns have resulted in route modifications of a pipeline in the Baltic (Carton and Jakusiewicz, 2009).

→ *This is captured as space-crowd, mil-disp (+pipe as extra mechanism)-dril since there is empirical evidence of this mechanism causing a spatial conflict.*

DRIL-REC

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Drilling causing heavy metal pollution of sediments and those sediments then being used for land reclamation (Cui et al, 2016).
- Building artificial islands and piers (land reclamation) for the purpose for oil and gas exploration (Andrulewicz et al, 2010; Charlier and Charlier, 1992).

→ Land reclamation is not considered a sector in itself in our framework, rather it is a mechanism (see methods). It is not clear from these examples if drilling is linked to another sector via land reclamation so this is not included in the database.

DRIL-DRED

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Dredging of harbours to allow for size of oil tankers (Depellegrin et al, 2010; Andrulewicz et al, 2010)
- Dredging is needed in oil and gas development (Lakhal et al, 2009).

→ *Drilling is not clearly linked to another economic ocean sector from these examples as our framework does not consider dredging to be a sector in itself (it is considered a mechanism). Thus no codes are included in the database based on this information.*

DES-SHIP

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
33% (N=1)	**67% (N=2)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- During the construction of desalination plant, ship traffic would increase (Bombar et al, 2016).
  → *Construction effects are not included.*
- Barges travelling to and from desalination plants to provide fuel (Gladstone, 2000).
  → *The use of ships for fuel provision by the desalination sector can be considered a 'within' desalination activity rather than an interaction with the shipping sector. Thus it is not included in the database.*
- "The Persian Gulf states should be concerned with the vulnerability of their whole ecosystem to a man-made or natural disaster given the large number and proximity of seawater desalination plants and nuclear power plants to each other, as well as offshore oil and gas operations and maritime shipping" (Meshkati and Tabibzadeh, 2016). E.g. oil spill from ship on water supply.

  → *This is included as des-ship, space-crowd, since 'large number and proximity' is stated explicitly in the context of crowding.*

CAB-PIPE

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

- In Sawale et al. (2011) a list of competing activities is mentioned in relation to coastal zone management, including submarine cables and pipelines amongst others.

  → *Since this is only one example with a sentence that is quite vague and does not explicitly state which or how the listed sectors interact, this is not included in the database.*

- Cables and pipelines operate in the same marine space (Ulyanova and Danchenkov, 2016).

  → *This example does not indicate clearly if they interact and is thus not included.*

- Coffen-Smout and Herbert (2000) state that the International Cable Protection Committee (ICPC) have made recommendations regarding crossings between cables and pipelines/power cables, and state that there are increasing risks of interference between cables and pipelines/power cables that call into question the 'freedom to lay cables'.

  → *This is included in the database as tel-cab/pipe-dril, space-crowd since there are observed regulations in place due to this interaction.*

BIO-MPA

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
33% (N=1)	**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Discussions surrounding if bioprospecting should be allowed in ABNJ MPAs (Queffelec et al, 2009).
- MPAs can be used as a tool to protect ecologically significant areas from threats such as extraction of marine genetic resources (De Santo, 2018). However this would likely carry implications for a diverse range of activities such as pharmaceuticals (Blasiak and Yagi, 2016).

→ Two of these articles are primarily focused on protected areas in ABNJ (Blasiak and Yagi, 2016; De Santo, 2018) and one article is about Integrated Coastal Management (Queffelec et al, 2009). All three discuss the implications of these management tools on other activities such as biosprospecting. Although the examples above are not empirical examples, since bioprospecting is a newer sector (it is less likely that there are empirical examples yet) and there are multiple examples with well-explained reasoning, bio-mpa, space-crowd was added to the database.

AGG-WAVE

NUMBER OF ARTICLES:
3 (1%)

INTENSITY	vs	PRESENCE
0%		**100% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- In a wave energy modelling paper, marine sand extraction areas were considered as an exclusion factor (Galparsoro et al, 2012).
- The aggregate mining and wave sectors in the North Sea will have to share the same space as wave projects develop. The aggregate mining areas limit access for wave farms. There is limited probability of coexistence (Astariz and Iglesias, 2017).
- A potential conflict for wave site selection may occur with areas set aside for agg purposes (Langhamer et al, 2010).

→ *Since 2/3 of these examples state that aggregate mining areas exclude/crowd the wave sector, agg-wave, space-crowd was added to the database, with a 'context-dependent' flag to highlight that in some cases exclusion occurs.*

AGG-DISP

NUMBER OF ARTICLES:
3 (1%)

INTENSITY vs	PRESENCE
0%	**100% (N=3)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

- Sand extraction and dumping (e.g. for beach replenishment, reclamation or mining of previously dumped sand) (Trop, 2017).

  → *There is not a clear link to another economic ocean sector from this example (disposal is a mechanism according to our framework), so it is not included in the database. See agg-eco-tou for interactions between aggregate mining and tourism via beach replenishment.*

- Areas investigated for sand extraction purposes transverse areas that have been used to dump chemical weapons (Mileriene et al, 2014).

  → *It is not clear if the agg and mil sectors actually interact from this example as thus this is not included in the database.*

- The agg industry has dredged up dumped munitions which have then been detected in resulting construction materials used to pave driveways (Carton and Jagusiewicz, 2009).

  → *Since this is a very rare example and there is no description of this affecting the agg industry ('detected' munitions doesn't necessarily mean there is an effect on the industry) this is not included in the database. In this case the responsibility fell solely on the military sector (the U.S Department of Defence) when an investigation was launched.*

WIND-PIPE

NUMBER OF ARTICLES:
4 (1.3%)

INTENSITY vs PRESENCE	
25% (N=1)	**100% (N=4)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- In modelling exercises, Jonhbloed Van der Wal and Lindeboom (2014) and Astariz and Iglesias (2017) say that pipelines are exclusion zones for wind farms and no/limited possibility of co-existence.
- Cieluch, Krause and Buck (2009) and Buck et al (2008) say that pipelines are a 'conflicting activity' for wind farms.

→ *Since this is a statement made in multiple articles it is included in the database as wind-pipe-dril, space-crowd.*

WAVE-PIPE

NUMBER OF ARTICLES:
4 (1.3%)

INTENSITY vs PRESENCE	
25% (N=1)	**75% (N=3)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- In wave energy converter modelling papers, pipelines are considered as an exclusion areas with limited/no possibility of co-existence (Galparsoro et al, 2012; Astariz and Iglesias, 2017; Flocard, Ieroiaconou, and Coghlan, 2016).
- Langhamer, Haikonen and Sundberg (2010) say that pipelines restrict the establishment of wave power, but likely on a smaller scale (since it is a small area).

→ *Since this is a statement made in multiple articles it is included in the database as wave-pipe-dril, space-crowd.*

WAVE-DRED

NUMBER OF ARTICLES:
4 (1.3%)

INTENSITY	vs	PRESENCE
25% (N=1)		**100% (N=4)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Dredging is required during installation/construction of wave plant which can disrupt the ecosystem (Zanuttigh et al, 2015; Hammar et al, 2017).

  → *construction impacts are not included in the database.*

- In a modelling exercise, Galpalsoro et al (2012) consider dredged material dumping areas to be exclusion zones.
- Langhamer, Haikonen and Sundberg (2010) say that there are potential conflicts between the placement of wave energy converters and dredging of sand and gravel.

→ *In both of these examples it is unclear what sector the wave converters conflict with as we do not consider dredging a sector on its own (it is included if it acts as a mechanism, according to our framework). We also do not include 'potential' conflicts. Thus this is not included in the database.*

MIN-SHIP

NUMBER OF ARTICLES:
4 (1.3%)

INTENSITY	vs	PRESENCE
25% (N=1)		**75% (N=3)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- The mining and shipping industry can be present in the same EEZ (Ulyanova and Danchenkov, 2016).

  → *From this example it is unclear if there is actually an interaction, so it is not included.*

- The mining industry uses ships (Ellis et al, 2017; Rayfuse 2007).

→ *This fact alone does not mean that there is an interaction with the shipping sector.*

- Seabed mining impacts have the potential to conflict with shipping activities due to the creation of surface exclusion zones (Miller et al, 2018). Disputes could arise if there is an impact on navigational routes. It could also cause an increase in maritime traffic.

→ *This is posited as a potential impact on the shipping industry. Since it is not an empirical example, it is not included in the database.*

DRED-MPA

NUMBER OF ARTICLES:
4 (1.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=4)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Use of MPAs as exclusion zones for dredging however using MPAs for this has been seen to slow implementation process. Therefore, flexibility and selective permission of these activities have are seen (Fox et al, 2013; Ulyanova and Danchenkov, 2016).
- MPAs, when prohibiting dredging activity, have positive impacts on the ecosystem (Langhamer, Haikonen and Sundberg, 2010).

  → *There is not a clear link between MPA and another sector here as dredging alone is not considered to be a sector in our framework (it is a 'mechanism' – see methods). Thus this is not included in the database.*

DES-DISP

NUMBER OF ARTICLES:
4 (1.3%)

INTENSITY vs PRESENCE	
50% (N=2)	**75% (N=3)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Disposal of desalination brine, process chemicals, "heated sludge", and various wastes during construction (e.g. dredging waste, hazardous waste, human waste) (Bombar et al, 2016; Abdul-Wahab and Al-Weshahi, 2009; Campbell and Jones, 2005). This can impact the ecosystem.

→ *Construction impacts are not included. There is not a link to another economic sector (disposal is a mechanism in our framework) in this example so it is not included.*

WAVE-DRIL

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY	vs	PRESENCE
20% (N=1)		**100% (N=5)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- In a modelling exercise, Galparsoro et al (2012) considers pipelines as exclusion zones for wave facilities due to 'potential interference'.
- → *Examples of 'potential' interactions are not included.*
- Wave facilities and oil exploitation have to share space, especially in crowded marine areas like the North Sea (Astariz and Iglesias, 2017).
  → *This is too vague to be included in the database.*
- Flocard, Ieroiaconou, and Coghlan (2016) site European guidelines which state that pipelines are exclusion zones for wave facilities.
- Astariz and Iglesias (2017) say that pipelines and drilling platforms are exclusion zones in their modeling exercise, with no/limited probability of co-existence.
- Langhamer, Haikonen and Sundberg (2010) say that pipelines restrict the establishment of wave power, but likely on a smaller scale (since it is a small area), and that oil and gas fields limit future establishment.
  → *Wave-pipe-dril, and wave-dril, space-crowd is included in the database based on the above examples.*

WAVE-AQUA

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs PRESENCE	
80% (N=4)	**80% (N=4)**

HIGH	LOW
0%	**25%**
UNCERTAIN	UNKNOWN
75%	**0%**

Examples

Common Examples

- In Flocard et al (2016)'s modelling exercise, aquaculture zones are considered not to be a possible co-location zones for future wave energy projects due to uncertainty.
  → *It is unclear from this example if there is a space-crowd interaction occurring, but due to the uncertainty stated in this example, and the fact that it is the only example, it is not included in the database.*
- There have been proposals and applications for multi-use platforms, and co-location opportunities are often discussed (Soukissian et al, 2017). Weiss et al (2018) however highlight the difficulty in finding areas appropriate for both due to different abiotic requirements (i.e. aquaculture wants sheltered areas, wave requires high wave exposure). But if successful, it could make offshore aquaculture more cost-effective. Prototypes have been developed and the idea has been explored extensively in other papers such as Zanuttigh et al (2015,2016).

  → *This is included in the database as wave-aqua, space-syn since there are prototypes and papers that focus on this subject.*

TOU-DRED

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
0%	**100% (N=5)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Dredging to expand marinas can have an ecological impact (Polychronidou, Liolios and Tselentis, 2002).
- Tourism driving dredging for beach replenishment (Thinh et al, 2018; Charlier and Charlier, 1992)
- Suggestion to use dredged material from tourist harbour expansion to replenish beaches (Petrucci, Montanaro and Merli, 2011)
- Dredging for water ski lanes (through reef flat) (Graham et al, 2007)
- Stirred up sediment, and noise from dredging may discourage touristic activities (Charlier and Charlier, 1992).

→ Dredging is not considered a sector on its own in our framework (it is a 'mechanism' – see methods). Based on these examples tourism is not interacting with other economic sectors via dredging, thus these examples are not included in the database. See tou-eco for ecological impacts via dredging.

REN-TOU

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
20% (N=1)	**100% (N=5)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- Removing macroalgae from beaches and using for biomethane also supports touristic activities, as macroalgae are already removed by tourism industry since tourists find it unpleasant (Barbot, Al-Ghaili and Benz, 2016). Renewable energy plants (including tidal) act as artificial reefs, increasing abundance and biodiversity of marine life. This is positive for tourism (Soukissian et al, 2017)

→ *This is captured as ren →tou, value-enhance*

- Competition for space between renewable energy installations (including tidal) and tourism areas.
- It is important to choose renewable energy sites where interferences with other uses such as tourism are minimal (Stuiver et al, 2016)
- General 'interference' and spatial exclusion (to what degree varies, however) (Soukissian et al, 2017; Alexander, Meyjes, and Heymans, 2016)

→ *This is captured as ren-tou space-crowd, context dependent.*

REN-AQUA

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
0%	**100% (N=5)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Multi-use platforms/co-location opportunities (Weiss et al, 2018; Zanuttigh et al, 2016)

→ *There are entire papers dedicated to this topic, so this is captured as ren-aqua, space-syn.*

- Renewable energy installations are excluded from aquaculture areas or under a restricted status in the Mediterranean Sea (Soukissian et al, 2017)

→ *captured as ren-aqua, space-crowd, context-dependent.*

PIPE-DISP

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs PRESENCE	
20% (N=1)	**100% (N=5)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- In Sawale et al. (2011) a list of competing activities is mentioned in relation to coastal zone management, including waste disposal and pipelines amongst others.

  → *Since this is only one example with a sentence that is quite vague and does not explicitly state which or how the listed sectors interact, this is not included in the database.*

- Pipelines are used for waste-water or brine disposal (Galpalsoro et al, 2012) which may leak extra chemicals (Abdul-Wahab and Al-Weshahi, 2009).

  → *This does not describe an interaction between two sectors, but rather a mechanism for the desalination sector only.*

- Construction of pipeline has dislodged disposed munitions (Carton and Jagusiewicz, 2009)

  → *This is captured elsewhere, see mil-tou.*

MIL-WIND

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
20% (N=1)	**100% (N=5)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Jongbloed, van der Wal and Lindeboom (2014) consider military munition dumping areas as exclusion zones for wind parks, and say there is no/limited possibility of co-existence with the military in general. However they say areas designated for military aircraft maneuvers are possibility acceptable, as are other military use categories as long as no more than 5-20% of the area is used. Compromises will need to be reached. Their paper devotes a large section to this interaction although it is a modelling paper.
- Spatial competition mentioned is mentioned in Buck et al, 2008 and Astariz and Iglesias, 2017.
- In general, how impactful it is/will be is varied and vague. Likely that compatibility will depend on what type of military activity (e.g. dumping of munitions not compatible but military air training probably compatible). Intensity is thus dependent on level of exclusion between zones.

→ *Since there are papers such as Jongbloed, van der Wal and Lindeboom (2014) that devote a large portion of their research papers to this topic it is clear that these sectors interact. This is captured in the database as a) mil-wind, space-crowd, context-dependent and b) mil-disp-wind, space-crowd, context-dependent. The latter is context dependent because it is a very small area that would be excluded and likely not enough to fully exclude the wind sector from an area (hence why the term 'limited' co-existence is used).*

MIL-DRIL

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
20% (N=1)	**100% (N=5)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- 'No/limited co-existence possible' and 'spatial conflicts' (Jongbloed, van der Wal and Lindeboom, 2014; Ulyanova and Danchenkov, 2016; Astariz and Iglesias, 2017)

→ *These are modelling papers however the bulk of the papers focus on these kind of conflicts. There is thus sufficient detail for a direct mil-dril spatial conflict to be added in the database.*

- Pipeline construction has dislodged disposed munitions and there is concern over a possible detonation rupturing a pipeline. Concerns have resulted in route modifications of a pipeline in the Baltic (Carton and Jakusiewicz, 2009).

→ *This is captured as space-crowd, mil-disp (+pipe as extra mechanism)-dril since there is empirical evidence of this mechanism causing a spatial conflict.*

CAB-MPA

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
40% (N=2)	**80% (N=4)**

HIGH	LOW
50%	**0%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

Common Examples

- Overlap between cable sites and MPAs (Mileriene, Blazaukas, and Gulbinskas, 2014; Christie et al, 2014).
- 'General co-existence possible' (Jongbloed, van der Wal and Lindeboom, 2014)
- MPAs 'have the potential to restrict cable routes' but there is 'no reason why cables and MPAs are mutually exclusive, but this presumes that the former does not unduly burden the latter' (Friedman, 2017).

→ *These examples are all stated as hypotheses or in a 'potential' manner. The examples also illustrate that these are relatively benign to each other. Thus this is not included in the database.*

BIO-MIN

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
100% (N=5)	**20% (N=1)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- "Despite the significant economic value [from bioprospecting] of deep-sea discoveries, there are concerns that mineral mining could destroy genetic resources before they have been fully understood or even discovered" (Miller et al, 2018).
- Extensive exploitation of sulfide deposits could interfere with bioprospecting uses (Van Dover et al, 2018; Levin et al, 2016)
- "Bioprospecting activities may compete with seabed mining" (Jaeckel, 2015)
- Seabed mining and bioprospecting "may potentially affect the health" of each other (D'Arcy 2014). Seabed mining may destroy flora and fauna that also have economic and medicinal value for humanity.

→ *These are both relatively 'new' sectors and thus it is reasonable that uncertain language is used in the above examples. Since there are multiple papers that discuss this topic in depth, this is included in the database as min →eco →bio, natcap-dimin (finite impact), context-dependent.*

AQUA-DISP

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs PRESENCE	
60% (N=3)	**80% (N=4)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- Disposal of wastes from aquaculture farms, including ammonia, dead fish, "blood water", chemical for sea lice control, nets, ropes, plastic, antibiotics (Qin et al, 2005; Wiber, Young and Wilson, 2012; Scott and Parsons, 2005).
- Competing space use, incompatibility of waste disposal and aquaculture facilities. (Xue et al, 2004).

→ *These do not highlight specific interactions with other ocean industries in our framework and are thus not included in the database as a sector-sector interaction. See agg-eco for the ecological impacts.*

AGG-WIND

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
40% (N=2)	**80% (N=4)**

HIGH	LOW
50%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Competing space use (Ashley, Mangi, and Rodwell, 2014; Buck et al, 2008; Astariz and Iglesias, 2017; Blazauskas et al, 2015)
- Jongbloed, van der Wal and Lindeboom (2014) say that areas for sand extraction are exclusion zones for wind farms.

→ *captured as agg-wind space crowd, context-dependent*

AGG-PIPE

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
0%	**100% (N=5)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Little possibility of co-existence, 'first come first served' (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017)
- Competing space use (Ulyanova and Danchenkov, 2016)
- Aggregates dredging "runs afoul of" pipelines (Charlier and Charlier, 1992)

→ *The examples above come from modelling papers and are thus not empirical examples, however since there are multiple papers where this is stated and the cited papers focus on spatial interactions, agg-pipe-dril space-crowd is included in the database, with context-dependent because exclusion sometimes occurs.*

AGG-MPA

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs PRESENCE	
20% (N=1)	**100% (N=5)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- The aggregates industry perceives MPAs to be associated with higher environmental restrictions and impact assessment procedures. However, conflict was low if "multi-use MPA", since co-location is sometimes possible. (Rodriguez-Rodriguez et al, 2015;Mileriene et al, 2014; Jongbloed, van der Wal and Lindeboom, 2014; Ulyanova and Danchenjov, 2016)
- The Cape Code Ocean Sanctuary prohibits drilling or removal of sand within its boundary (Johnson, 2014)

→ *Captured as agg-mpa, space-crowd, context-dependent.*

AGG-DRIL

NUMBER OF ARTICLES:
5 (1.6%)

INTENSITY vs	PRESENCE
0%	**100% (N=5)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Competing space use and can create exclusion zones, oil and gas sector often takes precedence (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017).
- Spatial overlap of aggregate licencing areas and hydrocarbon fields (Smith, Ballinger and Stojanovic, 2012)

→ *Some of the examples above come from modelling papers and are thus not empirical examples, however since there are multiple papers where this is stated and the cited papers focus on these kind of spatial interactions, agg-dril, space-crowd, context-dependent is added to the database.*

- Aggregate mining is used to create artificial islands for oil and gas exploration (Charlier and Charlier, 1992).

→ *This is not included in the database, as purchasing a product in the supply chain does not count as an interaction in our framework.*

WAVE-MPA

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs PRESENCE	
83% (N=5)	**50% (N=3)**

HIGH	LOW
40%	**60%**
UNCERTAIN	UNKNOWN
40%	**0%**

Examples

- In a modelling exercise, Galparsoro et al (2012) considers MPAs as exclusion zones for wave energy facilities. Spatial exclusion impact may be low since few MPAs are in areas of high wave energy.
- Overlap of MPAs with potential wave energy facilities (Plummer and Feist, 2016).
- Chances of conflict (Zanuttigh et al, 2016).
- MPAs would be highly restrictive for nearshore zones but not very restrictive for offshore zones in regards to placing wave energy facilities (modelling paper) (Flocard, Ierodiaconou, and Coghlan, 2016)

→ *Although most of the examples come from modelling papers and are'potential' interactions, since this interaction was a large focus within them, there is enough evidence to include wave-mpa, space-crowd.*

- Wave "installations have the potential to act as de-facto marine protected areas (MPAs) by providing artificial reefs, fish aggregating devices and exclusion zones to destructive fishing activities therefore augmenting fisheries and benefiting coastal areas" (Ashley, Mangi and Rodwell, 2014).

→ *This is a potential wave-eco/wave-fish impact but is stated in a hypothetical manner. It is not included in the database as a wave-mpa interaction.*

TEL-ECO

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs	PRESENCE
50% (N=3)	**100% (N=6)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
67%	**0%**

Examples

Common Examples

- Abrasion from cable laying and burial, affecting for example fish habitat. (Note that in the deep sea, cables are not buried).

  → *We do not include construction impacts.*

- Obstruction of habitat due cables on top of benthos has an impact (Foden, Rogers and Jones, 2011) however it is mostly benign (Coffen-Smout and Herbert, 2000; Friedman, 2017)
- Note that often impact on benthos is low from cable laying, e.g. due to the small area if buried. "Cables have little to no chemical interaction with the ocean once deployed, although they may displace sediment over their lifetime depending on environmental conditions like currents and wave action." Cables are often also located as to avoid environmentally sensitive areas (Friedman, 2017).

→ *Because there is a benign impact according to the reviewed examples, no tel-eco interaction is included in the database.*

REN-CAB

NUMBER OF ARTICLES:
6 (2%)

INTENSITY	vs	PRESENCE
17% (N=1)		**83% (N=5)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- Energy transmission cables are needed for offshore renewable energy plants. These cables emit electromagnetic fields (and could thus interfere with biota) (Soukissian et al, 2017; Hammar et al, 2017; Dolman and Simmonds, 2010).

→ *This is a ren-cab-eco impact.*

MIL-SHIP

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs	PRESENCE
17% (N=1)	**100% (N=6)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Conflicting space use, however co-existence is possible under certain conditions (Ulyanova and Danchenkov, 2016; Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017)
- 'conflicts are preordained' (Michler-Cieluch, Krause, and Buck, 2009)
- → *Although some of these examples come from modelling papers (as opposed to empirical examples), they focus the paper on these kinds of interactions. There are also several papers that discuss this. Thus it is justified to include mil-ship, space-crowd in the database.*

- Disposed munitions have been found during harbour maintenance (Carton and Jakusiewicz, 2009)
- "In an April 24, 1945 memorandum, the CNO [U.S. Chief of Naval Operations] also required that sea-disposal sites [of munitions] be located outside regular shipping lanes" (Carton and Jakusiewicz, 2009).

→ *These are both 'one time' examples and do not necessitate that in general mil and ship interact via disposal. This mil-disp-ship is not included in the database.*

MIL-CAB

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs PRESENCE	
17% (N=1)	**83% (N=5)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Generally co-existence is possible (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2014)
- Activities located in the same area (Milerience, Blazauskas, and Gulbinskas, 2014).
- It is important that other ocean users such as naval operations are aware of the position of cables (Coffen-Smout and Herbert, 2000).
- "The CNO [U.S. Chief of Naval Operations] also required that sea-disposal sites [of munitions] be located well away from marine cables."
  → *These examples highlight that cables and the military may be located in the same space but do not indicate that they necessarily interact. It is unclear whether awareness and avoiding cables (the latter examples) means that an interaction is occurring. Overall these examples are too vague for inclusion in the database.*

- "there is the question over a state's ability to deploy cables for military applications on another coastal state's continental shelf without its consent"

→ *This example only highlights that the military uses cables. It is not included in the database.*

FISH-PIPE

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs	PRESENCE
0%	**100% (N=6)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- co-existence is possible under certain conditions (often in favour of pipelines) (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017)
- Space use conflict, but not mutually exclusive use (Ulyanova and Danchenkov, 2016)

The above examples are from modelling papers (and thus are not observed examples), however all three indicate that some space-crowding occurs. Since there are multiple papers describing this interaction, dril-pipe-fish, space-crowd, context-dependent is included.

- Oil platforms and their associated pipelines can act as artificial reefs, which attracts a variety of commercially utilized fish and invertebrate species, and can form important source populations (Feary, Burt and Bartholomew, 2011)

→ *There is evidence of a direct dril-fish interaction via artificial reefs (see dril-fish summary page), however the above is the only example where pipelines are mentioned explicitly. Since the majority of the evidence for the oil and gas sector's artificial reef effect comes from the drilling platforms themselves, and not pipelines, dril-pipe-fish, natcap-enhance is not included. Instead, this is captured as dril-fish, natcap-enhance.*

- Pipeline projects in mangrove areas can affect fish nurseries (Price et al, 2000)

→ *This is included as dril-pipe/eco-fish, natcap-dimin.*

DISP-MPA

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs PRESENCE	
33% (N=2)	**83% (N=5)**

HIGH	LOW
0%	**50%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

- Ships are unable to discharge food waste of any sort when they are within Particularly Sensitive Sea Areas (PSSA) (Polglaze, 2003) → *This example on its own does not clearly indicate whether this induces a space-crowd/exclusion effect via disposal. However ship-mpa, space-crowd is captured on the ship-mpa summary sheet.*
- Pressures in MPAs from marine litter from coastal tourism (Rodriguez-Rodriguez et al, 2015). → *See tou-mpa.*
- MPAs place restrictions on dumping activities (Davies et al, 2007).
- In Massachusetts Cape Code Ocean Sanctuary, dumping of wastes is prohibited (Johnson, 2014).
- In the United States, penalties for illegal dumping within a National Marine Sanctuary are higher than in undesignated areas (Boersma and Parrish, 1999).

→ *These examples highlight that there are restrictions on disposal in MPAs, however it is not clear that this causes any kind of space-crowd or other interactions. Thus this is not included in the database. See tou-mpa for the tourism-related example.*

DES-ECO

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs PRESENCE	
83% (N=5)	**83% (N=5)**

HIGH	LOW
80%	**40%**
UNCERTAIN	UNKNOWN
20%	**20%**

Examples

Common Examples

- "the concentrate and chemical discharges, which may impair sea water quality and affect marine life… noise generation" "impurities and pollutants may be fatal for marine life, and cause modifications in bottom habitat and ecosystem" Brine discharge is 30-70% higher salinity than natural seawater. Thermal pollution. (Bombar et al, 2016)
- "use of open intakes may result in losses of aquatic organisms when these collide with intake screens (impingement) or are drawn into the plant with the source water (entrainment)." (Bombar et al, 2016).
- Environmental effect from construction of pipelines needed as well as from construction of plant itself (effects on benthos, resuspension of sediment, noise pollution, increased ship traffic) (Bombar et al, 2016).

→ *Construction effects are not included. The des-eco impact is recorded in the database.*

AGG-SHIP

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs	PRESENCE
0%	**100% (N=6)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- "Marine sand resources are used in the modern era for many purposes, such as land reclamation (e.g., for building/extension of ports)". Sand that is mined is extracted from entrance channels to ports and ship maneuvering areas (which is helpful for the shipping sector). Shipping-related authorities are consumers of marine sand for port development, breaker construction. (Trop, 2017)

→ *This is included as agg-rec-ship, operation-enhance code.*

- generally co-existence is possible (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017)
- Spatial conflict (observed in Belgium) (Ulyanova and Danchenkov, 2016; Charlier and Charlier, 1992).

→ *Since there are observed cases of spatial conflict, agg-ship, space-crowd is included.*

AGG-REC

NUMBER OF ARTICLES:
6 (2%)

INTENSITY vs	PRESENCE
17% (N=1)	**83% (N=5)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Aggregates are for land reclamation. High due to the high demand. (Trop, 2017; (Jongbloed, van der Wal and Lindeboom, 2014; Charlier and Charlier, 1992)
  → *See agg-ship summary sheet.*

- Aggregates are used to build artificial islands in the Beaufort Sea for purposes of oil and gas exploration (Charlier and Charlier, 1992).

→ *See agg-dril summary sheet.*

AGG-CAB

NUMBER OF ARTICLES:
6 (2%)

INTENSITY	vs	PRESENCE
0%		**100%**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

Common Examples

- No/limited possibility of co-existence (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017; Ulyanova and Danchenkov, 2016)

→ *All three articles are modelling papers and focus on these kind of spatial interactions, however the agg-cable interaction is not well explained and only mentioned briefly. Thus this is not included.*

- Possibility of nearshore aggregate mining interfering with cables (Charlier and Charlier, 1992).

→ *This is a hypothetical interaction posited by the authors and is thus not included.*

WIND-DRIL

NUMBER OF ARTICLES:
7 (2.3%)

INTENSITY vs PRESENCE	
29% (N=2)	**86% (N=6)**

HIGH	LOW
0%	**50%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

Common Examples

- Competing space use, exclusion (often with the oil and gas sector taking precedence) (Ulyanova and Danchenkov, 2016; Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017; Blazauskas et al, 2015)

→ *The above comes from modelling papers but the reasoning is explained well. Thus wind-dril, space-crowd, context-dependent is included in the database (since not all examples state exclusion outright).*

- More attention should be given to synergism between new offshore wind parks and both operational and decommissioned oil and gas platforms (Jongbloed, van der Wal and Lindeboom, 2014).

→ *This is too hypothetical and vague for inclusion.*

MIL-MPA

NUMBER OF ARTICLES:
7 (2.3%)

INTENSITY vs	PRESENCE
29% (N=2)	**100% (N=7)**

HIGH	LOW
0%	**50%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

Common Examples

- co-existence can occur under some circumstances (Jongbloed, van der Wal and Lindeboom, 2014; Yucel-Gier, Arisoy, and Pazi, 2010; Gladstone, 2000)
- Consideration of military areas needs to be made when planning MPAs (Fox et al, 2013)
- Representatives from the United States Department of Defense (DoD) wished to ensure that military activities related to national security were not hindered by proposed MPA regulations (Fox et al, 2013).

→ *These examples highlight that mil and mpa are able to occupy the same space, with limitations. Thus space-crowding is occurring since there is not unhindered use of the mutual spaces. Included as mil-mpa, space-crowd.*

- Exclusion (Ulyanova and Danchenkov, 2016).

→ *This is a modelling paper where this exclusion is only briefly mentioned in a table and not well explained. Thus inclusion is not warranted based on this.*

MIL-DISP

NUMBER OF ARTICLES:
7 (2.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=7)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Redundant munitions (including chemical weapons and radioactive waste) dumped in the sea (including the deep sea). Historic disposal, but problems are present (Thiel, Schriever, and Foell, 2005; Eglingston, Israel, and Vartanov, 1998, Carton and Jakusiewicz, 2009)

→ *See other summary sheets where this has had an impact on other sectors such as fishing and tourism.*

- Disposed munitions have resulted in injuries to fishers.

→ *mil-disp-fish is included, see mil-fish.*

AGG-TOU

NUMBER OF ARTICLES:
7 (2.3%)

INTENSITY vs	PRESENCE
14% (N=1)	**86% (N=6)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- Sand mining leading to eroded beaches, affecting tourism both through loss of beaches but also erosion damage to coastal properties. Also stirred sediment may discourage tourism (Cesar et al, 1997, Kim 2009, Thinh et al, 2018).
- Sand mining to replenish beaches, for tourism benefit (Kim, 2009, Trop 2017, Charlier and Charlier, 1992)
- Note that we include coral mining in this category.

→ *agg-eco-tou, value-dimin and enhance are included.*

AGG-MIL

NUMBER OF ARTICLES:
7 (2.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=7)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

- The Israel Defense Forces are consumers of aggregates for building military ports (Trop, 2017).

→ *This example is too rare and vague for inclusion. It can be considered a 'one-time' example since this is the only such example found in the review. Thus it is not included.*

- co-existence possible under some conditions (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Inglesias, 2017)
  → *co-existence doesn't necessarily mean they interact, and this example does not hint at how they interact. Thus it is not included in the database.*
- Munitions have been dredged up by the aggregate industry and found in driveways (Carton and Jakusiewicz, 2009).
  → *Since this is a very rare example and there is no description of this affecting the agg industry ('detected' munitions doesn't necessarily mean there is an effect on the industry) this is not included in the database. In this case the responsibility fell solely on the military sector (the U.S Department of Defence) when an investigation was launched.*
- Nearshore mining has the possibility "of running into explosive naval ordnance" (Charlier and Charlier, 1992)→ *This is hypothesized and vague and is thus not enough evidence for this interaction to be included based on this.*

WAVE-TOU

NUMBER OF ARTICLES:
8 (2.6%)

INTENSITY vs PRESENCE	
50% (N=4)	**75% (N=6)**

HIGH	LOW
0%	**25%**
UNCERTAIN	UNKNOWN
75%	**0%**

Examples

- Potential conflicts, but spatial overlap can sometimes be low (Zanuttigh et al, 2015, 2016 Kim et al, 2012;) → *The 'conflicts' are hypothesized in these examples and spatial overlapping occurring does not make clear how or whether wave and tou interact via crowding. Thus space-crowd is not included.*
- "Commensality can be seen in the development of surfing and fishing-based tourism around wave power structures. Tourism benefits through provision or enhancement of a biological or physical resource (fish or waves), while wave energy enterprises are unaffected by the presence of surfers and fishermen" (Klinger et al, 2018).
- Tourists can find wave farms aesthetically displeasing negatively affecting tourism (e.g. recreational fishers or whale-watching) (Klinger et al, 2018; Kim et al, 2012; Plummer and Fiest, 2016)
- Wave farms as artificial reefs increasing the abundance and biodiversity of marine life, which can be positive for tourism (Soukissian et al, 2017, Kim et al, 2012).

→ *The above examples are evidence for wave-tou, value enhance and dimin (context-dependent) to be included.*

SHIP-CAB

NUMBER OF ARTICLES:
8 (2.6%)

INTENSITY vs	PRESENCE
12.5% (N=1)	**87.5% (N=7)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- "Competing activities" (Sawale, 2011) → *Too vague for inclusion*
- generally co-existence is possible (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Inglesias, 2017) → *Too vague for inclusion.*
- High voltage energy link in the Baltic Sea has altered shipping routes and anchoring sites (Mileriene, Blazauskas, and Gulbinskas, 2014) → *Land-based electricity sector is not included in our review.*
- It is of particular interest for the offshore wind farm operators to minimise the cable length in the area of shipping routes. In many cases conflicts of interest could be resolved by measures such as altering maritime routes or establishing corridors between wind turbines (Astariz and Iglesias, 2017). → *This statement is made as a suggestion by the authors and is not an empirical example. Thus it is not included in the database.*
- "the presence of a large array with its power cables may cause electronic/magnetic interferences of radar and underwater communication systems, which may be a potential risk to navigation." → *This is only hypothesized and is thus not included.*
- Ships are used for wave energy converter cable laying (Flocard, Ierodiaconou, and Coghlan, 2016; Coffen-Smout and Herbert, 2000). → *This takes place within the wave sector and does not show an interaction with the shipping sector.*
- Damaged cables from anchoring has occurred, and anchors have been "sacrificed" to avoid damage (Coffen-Smouth and Herbert, 2000). → *tel-cab-ship, operation dimin included. Bidirectional.*

MIN-DISP

NUMBER OF ARTICLES:
8 (2.6%)

INTENSITY vs	PRESENCE
12.5% (N=1)	**87.5% (N=7)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- Disposal of processing water (containing sediment and heavy metals) and mine tailings. This includes deliberate disposal in the ocean of mine tailings from terrestrial mining and has an ecological impact (Miller et al, 2018, Ma, Schott and Lodewijks, 2017)

→ *This is an ecological impact, included as min-disp-eco.*

- Mining could potentially come into contact with disposed military munitions (Carton and Jakusiewicz, 2009). → *This is vague and a hypothesized interaction and is thus not included.*

DRIL-CAB

NUMBER OF ARTICLES:
8 (2.6%)

INTENSITY vs	PRESENCE
0%	**100% (N=8)**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

Common Examples

- 'Use conflicts' (Smith and Lalwani, 1996)
- 'Crossings between cables and pipelines' (Coffen-Smout and Herbet, 2000)
- Coffen-Smout and Herbert (2000) state that the International Cable Protection Committee (ICPC) have made recommendations regarding crossings between cables and pipelines/power cables, and state that there are increasing risks of interference between cables and pipelines/power cables that call into question the 'freedom to lay cables'.
  → *This is included in the database as tel-cab-pipe-dril, space-crowd.*
- Oil and gas platforms also require cables to be run to platforms (Guerra et al, 2015)
  → *This does not show an interaction with another industry sector.*

DRED-REC

NUMBER OF ARTICLES:
8 (2.6%)

INTENSITY vs	PRESENCE
12.5% (N=1)	**87.5% (N=7)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Dredging to use material for land reclamation (including submerged breakwaters) (Trop 2017, Harding 1980)
- Dredging and reclamation both leading to erosion due to disruption of natural sediment flows or direct physical impact on the benthos (Valadez-Rocha and Ortiz-Lozano, 2013).
- Land reclamation changing water and sedimentation flows, resulting in more dredging needed (Xue, Hong and Charles, 2004).

→ *Dredging and land reclamation are not sectors on their own (they are 'mechanisms' according to our framework – see methods). There is not sufficient information from these examples to link these mechanisms to interactions amongst sectors.*

REN-SHIP

NUMBER OF ARTICLES:
9 (3%)

INTENSITY vs	PRESENCE
22% (N=2)	**78% (N=7)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Depending on site selection, there could be interference with other uses such as shipping, for reasons such as increases in shipping traffic (Stuiver et al, 2016; Zanuttigh et al, 2016; Dolman and Simmonds, 2010)
- MRE applications are completely excluded from maritime transport routes (Soukissian et al, 2017).
- It will also lead to changes in access to the area of installation for users of the sea including shipping (Alexander, Meyjes and Heymans, 2016; Zanuttigh et al, 2016).
  → *ren-ship, space-crowd context dependent is included*.
- "Developed concepts for multi-purpose use, including energy extraction, aquaculture, and transport." (Stuiver et al, 2016). → *This is too vague for an interaction to be added to the database.*
- "Another emerging priority relating MRE [marine renewable energy] use and maritime transport is cold ironing (ship electrification) for ships while at berth" (Soukissian et al, 2017) → *ship-ren, operation enhance included.*
- "The presence of a large array [renewable energy] with its power cables may cause electronic/magnetic interferences of radar and underwater communication systems, which may be a potential risk to navigation." (Soukissian et al, 2017). -> *This is a hypothesized interaction and is thus not included.*
- 'The literature also suggests to consider the risk for navigation due to use of marine space, and "Mooring failure" leading to drifting farms, potentially interfering with navigation. (Zanuttigh et al, 2016). → *This is captured under space-crowd.*

REN-MPA

NUMBER OF ARTICLES:
9 (3%)

INTENSITY vs	PRESENCE
44% (N=4)	**56% (N=5)**

HIGH	LOW
25%	**0%**
UNCERTAIN	UNKNOWN
75%	**0%**

Examples

- Co-location opportunities have been discussed (Soukissian et al, 2017). "Marine renewable energy devices might exist within marine protected areas at some future time, but not until they have been demonstrated as being benign, or indeed a benefit to biodiversity" (Dolman and Simmonds, 2010).

→ *Although this is a potential synergy, it is discussed in depth (see Soukissian et al, 2017), so ren-mpa, space-syn is included in the database (context dependent).*

- Competing space use (Yates, Schoeman, and Klein 2015), especially if the space required is large (Zanuttigh et al, 2016).
- "consistent with the Ocean Sanctuaries Act, the Massachusetts Plan does not allow for renewable energy development within the Prohibited Area."…"Oregon will not accept applications for marine renewable energy (MIRE) development within Renewable Energy Exclusion Areas. These are designated special management areas and include dredged material disposal sites, marine reserves, and marine protected areas. (Johnson, 2014)
- Many seabirds in Scotland breed within Special Protection Areas (SPAs) and so are protected by law (Scottish Habitats Regulations), potentially creating a conflict between energy generation and seabird conservation (Furness et al, 2012).

→ *Ren-mpa, space-crowd, context-dependent added.*

FISH-DRED

NUMBER OF ARTICLES:
9 (3%)

INTENSITY vs	PRESENCE
33% (N=3)	**89% (N=8)**

HIGH	LOW
67%	**0%**
UNCERTAIN	UNKNOWN
67%	**0%**

Examples

- Resulting economic damage to fisheries from dredging activities (e.g. sediment plumes affecting larvae, benthic destruction), direct fatalities of benthic biota (e.g. crustaceans) is considered high impact, indirect effects include changes is food web dynamics due to changed habitat, dredging changes the abiotic conditions (e.g. flow and salinity) of the water which can have positive or negative effects on fishing, changed fishing patterns due to dredging activity (i.e. to avoid the detrimental effects), Uncertainty relating to impact is partly due to the variable impact on different fish species (e.g. benthic or pelagic or sedentary or mobile) (Bolam 2003, Kim and Grigalunas, 2009; Gasalla and Gandini, 2016; Charlier and Charlier, 1992; Nairn et al, 2004)
  → *These are all general impacts on fishing through eco impacts from dredging. This needs to be linked to another industry sector for inclusion (dredging is not a sector on its own in our framework, it is a 'mechanism'). See agg-fish.*
- "Focus on the ports' needs to dredge channels and berths to accommodate deep-draft vessels, and estimate the economic damage to commercial and recreational fisheries from disposal of clean dredged sediments in Providence Harbour, Rhode Island". There are also ecological impacts from dredging for shipping lanes (Doldan-Garcia, Chas-Amil and Touza, 2011; Perez-Ruzafa and Marcos, 2012). → *ship-eco-fish, natcap-dimin.*

TEL-CAB

NUMBER OF ARTICLES:
10 (3.3%)

INTENSITY vs	PRESENCE
0%	**100% (N=10)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Only example

Common Examples

- Cables is the way the telecommunications sector has an impact in the sea.

This is a mechanism and is not relevant for interactions without a connection to another industry sector.

MIL-FISH

NUMBER OF ARTICLES:
10 (3.3%)

INTENSITY vs	PRESENCE
10% (N=1)	**100% (N=10)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Generally co-existence is possible (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017; Ulyanova and Danchenkov, 2016).
- Exclusion of fishing vessels from military zones (Yucel-Gier, Arisoy and Pazi, 2010; Carton and Jakusiewicz, 2009)
- 'Conflicts with naval authorities' (Baine et al, 2007), 'the Navy—the principal guardian of marine territory—was not eager to share property rights with artisanal fishermen' in Chile (Meltzoff and Lichtensztajn, 2002).

→ *mil-fish, space-crowd is included (context-dependent, as sometimes there is full exclusion).*

- Fishing equipment inadvertently recovering disposed munitions, which has resulted in injury and fatalities. Fishing activities may also have spread munitions further than their dumping site (Carton and Jakusiewicz, 2009).
- Post-1970 (post-1945 in some places), regulations are in place (in some places) to limit disposal of munitions to not interact with fishing (Carton and Jakusiewicz, 2009).

→ *mil-disp-fish, operation-dimin.*

- Uncertain effect on fish stocks on seepage of toxic material from disposed munitions (Carton and Jakusiewicz, 2009).

→ *This is written as a potential impact hypothesized from the authors. Since this is the only example this is not included in the database.*

FISH-CAB

NUMBER OF ARTICLES:
10 (3.3%)

INTENSITY vs	PRESENCE
40% (N=4)	**90% (N=9)**

HIGH	LOW
50%	**0%**
UNCERTAIN	UNKNOWN
75%	**0%**

Examples

- 'Conflicts' (Smith and Lalwani, 1996; Ulyanova and Danchenkov, 2016).
- Co-existence possible under certain conditions. Cables often taking precedence (but examples of both ways) (Jongbloed, van der Wal and Lindeboom, 2014; Astariz and Iglesias, 2017)
- Fishing, especially trawling can damage submarine cables (however traps and pots could perhaps co-exist). Sacrificing fishing gear to avoid cable damage. Suggestion of 'cable corridor' exclusion zones to prevent damage (Coffen-Smouth and Herbert, 2000; Friedman 2017,).
  → *fish-cab-tel, operation dimin. Not including space-crowd because the cable corridor example was a suggestion.*
- Trawling could damage wind/wave farm cables. It is a great risk (Christie et al, 2014; Astariz and Iglesias, 2017).

→ *wind-cab-fish and wave-cab-fish, operation-dimin*

- Uncertain effects of the electromagnetic field energy wind cables create on electro-sensitive fish species or on fish migration (Wilson et al, 2010; Andrulewicz, Otremba and Kaminska, 2010).

→ *wind-cab-eco, natcap-dimin.*

- Destruction of bottom habitat due during cable trenching and potential effect on fish populations (Wilson et al, 2010; Friedman 2017).

→ *This example is not included as this is a temporary construction impact.*

DRIL-AQUA

NUMBER OF ARTICLES:
10 (3.3%)

INTENSITY vs	PRESENCE
40% (N=4)	**90% (N=9)**

HIGH	LOW
50%	**0%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

Common Examples

- Oil spills can have a direct harmful effect on aquaculture production, but also the indirect effects of changed consumer perception of aquatic products from the region (Klinger et al, 2018; Cho 2007; Harzl and Pickl, 2012; Stead 2005; Hong, 1995; Singcran, 2013)

→ *dril-eco-aqua, natcap-dimin.*

- Jansen et al (2016) assume that drifting aquaculture infrastructure could damage gas platform foundations → *This is a hypothetical examples and is thus not included.*
- Existing oil and gas activities 'may limit' or 'restrict' aquaculture site selection (Jansen et al, 2016; Side and Jowitt, 2002)→ *This is a statement posited by the authors and is not an empirical example. It is thus not included.*
- For example in several locations worldwide, "rigs to reefs" and "rigs to riches" programmes exist whereby disused oil platforms are used for the creation of artificial reefs, or as a basis for aquaculture (Christie et al, 2014).
  → *dril-aqua, operation-enhance (as opposed to space-syn, since oil sector is no longer present at time of use).*

WAVE-WIND

NUMBER OF ARTICLES:
11 (3.6%)

INTENSITY	vs	PRESENCE
18% (N=2)		**100% (N=11)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Multi-purpose energy platforms for both wind and wave energy (Stuiver et al, 2016; Soukissian et al, 2017; Azzellino et al, 2013; Weiss et al, 2018; Astariz and Iglesias, 2017). However in co-location increased risks of damage in case of mooring failure (Zanuttigh et al, 2015, 2016).

  → *Wind-wave, space-syn is included.*

- Already existing offshore activities limit future establishments, including offshore wind power parks (Langhamer, Haikonen, and Sundberg, 2010).
  → *wave-wind, space-crowd*
- Similar environmental impact, which could be cumulative (in this case on seabirds) (Greaves et al, 2016).

  → *See wave-eco and wind-eco summary pages.*

WAVE-CAB

NUMBER OF ARTICLES:
11 (3.6%)

INTENSITY vs	PRESENCE
9% (N=1)	**91% (N=10)**

HIGH	LOW
0%	**100%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- Modelling exercises consider underwater cables as an exclusion zone for wave energy centres (Galparsoro et al, 2012; Flocard, Ierodiaconou, and Coghlan, 2016).
- "Existing pipelines and cables further restrict establishment of wave power, although most likely on a smaller scale" (Langhamer, Haikonen, and Sundberg, 2010).
  → *See tel-wave*
- Energy cables are needed for wave energy platforms (with associated environmental effects) (Soukissian et al, 2017; Side and Jowitt; 2002; Zanuttigh et al, 2015). → *Relevant when considering eco impacts, but not relevant for sector-sector interactions.*
- If a wave cable gets damaged the energy cannot be transmitted. (Christie et al, 2014; Astariz and Jakusiewicz, 2017). → *See fish-cab.*

TOU-AQUA

NUMBER OF ARTICLES:
11 (3.6%)

INTENSITY vs	PRESENCE
36% (N=4)	**73% (N=8)**

HIGH	LOW
25%	**0%**
UNCERTAIN	UNKNOWN
75%	**0%**

Examples

- Conflicts due to aquaculture moving into new grounds, space competition (Goulletquer and Le Moine, 2002; Gimpel et al, 2015; Jansen et al, 2016; Side and Jowitt ,2002; Zanuttigh et al, 2016; Yucel-Gier, Arisoy and Pazi, 2010; Xue, Hong and Charles, 2004)
- 'Competitors' (Yucel-Gier, Arisoy and Pazi, 2010; Queffelec, Cummins and Bailly, 2009)

  → *Included as space-crowd, tou-aqua.*

- Close proximity may be synergistic due to reputation, e.g. eco-tourism and sustainable aquaculture, or interesting for gastronomy (Klinger et al, 2018; Buck et al, 2008; Xue, Hong and Charles, 2004; Buck et al, 2008). There have also been discussions of an offshore hotel combined with seaweed and mussel farming (Stuiver et al, 2016).

  → *Included as tou-aqua, value-enhance. The hotel idea had not been implemented and thus space-syn is not included.*

- Potentially 'detracts from amenity value for tourists' (Side and Jowitt, 2002).
  → *Potential interactions where there is only one example are not included in the database.*

MIN-FISH

NUMBER OF ARTICLES:
11 (3.6%)

INTENSITY vs PRESENCE	
64% (N=7)	**64% (N=7)**

HIGH	LOW
43%	**0%**
UNCERTAIN	UNKNOWN
86%	**14%**

Examples

- Competing space use, either directly (e.g. fishing and mining on seamounts) (Klinger et al, 2018) or could potentially (but likely) occur due to surface exclusion zones for benthic mining, or destruction of nursery, breeding or spawning habitats (Miller et al, 2018; Kirkman et al, 2016; Ulyanova and Danchenkov, 2016). There are already conflicting proposals with fishing areas (Andrulewicz, Otremba, and Kaminska, 2010).
  → *Space-crowd, min-fish.*
- Environmental alteration from deep sea mining (and their disposed tailings) influences fisheries and could potentially cause serious harm (Ma, Schott, and Lodewijks, 2017; Levin et al, 2016). In deep sea systems, the lack of re-growth potential after mining has occurred may influence fisheries into the future (Levin et al, 2016).
- Tin mining activities in Thailand nearly wiped out nearby fisheries (Charlier and Charlier, 1992)
- Significant fisheries resources need to be protected from deep sea mining (Ellis et al, 2017)
  → *min-eco-fish, natcap-dimin, with the temporality as 'context' dependent since it could be finite, we just don't know yet. Some of the above examples are 'potential' due to the fact that deep sea mining is a 'newer' sector. Since there are many examples with detailed explanations this is included.*

BIO-ECO

NUMBER OF ARTICLES:
12 (3.9%)

INTENSITY vs PRESENCE	
50% (N=6)	**58% (N=7)**

HIGH	LOW
0%	**17%**
UNCERTAIN	UNKNOWN
67%	**17%**

Examples

Common Examples

- Since so little is known about deep sea ecosystems there is a lot of uncertainty surrounding the impact in the deep sea.
- "the most immediate current threat to deep-sea biodiversity (other than bottom trawling) appears to be the work being carried out around active hydrothermal vents, which may include bioprospecting" (Lodge, 2004)
- "Bioprospecting, when undertaken using non-harvest approaches, is environmentally friendly" (Van Dover et al, 2018)
- To protect biodiversity, many articles argues for protection under the precautionary approach in the face of bioprospecting (Queffelec, Cummins and Bailly, 2009; De Santo, 2018; Lodge, 2004; Amon et al, 2017; De La Fayette, 2008)
- Bioprospecting and destructive scientific sampling is a threat to cold water corals (Salomidi et al, 2012)
  → *It is clear that there is an ecological impact, however the intensity is unclear as this is a very new field. Context-dependent bio-eco is included.*

WAVE-SHIP

NUMBER OF ARTICLES:
13 (4.3%)

INTENSITY vs	PRESENCE
39% (N=5)	**100% (N=13)**

HIGH	LOW
40%	**40%**
UNCERTAIN	UNKNOWN
80%	**0%**

Examples

- Competing space use, and increases in shipping traffic due to wave farm maintenance activities (Astariz and Iglesias, 2017; Plummer and Feist, 2016; Langhamer, Haikonen and Sundberg, 2010; Kim et al, 2012).
- Shipping lanes and areas where material is dumped from dredging shipping lanes are exclusion factors in modelling studies. (Galparsoro et al, 2012)
- Limited probability of co-existence. Shipping lanes often act as exclusion zone for new installations (Flocard et al, 2016).
- Conflicts (some 'potential') with the transportation sector, but ship routes can be reassigned (Stuiver et al, 2016; Zanuttigh et al, 2015; Plummer and Feist, 2016).
  → *wave-ship, space-crowd is included based on the above examples.*
- Ships are required for the installation of wave installment, therefore the location of harbours in relation to intended installation is of economic interest due to potential space synergies (Flocard et al, 2016). Proximity to a port where there are facilities for servicing wave converters is a major consideration (Galparsoro et al, 2012).
  → *wave-ship, space-syn is included.*
- 'The literature suggests' that mooring failure could lead to increased risks to shipping sector or could create 'navigational hazards' (Zanuttigh et al, 2016; Plummer et al, 2016)
  → *These are hypothesized outcomes made by these authors, and there are no empirical examples found in the review. Thus this is not included in the database.*

TOU-REC

NUMBER OF ARTICLES:
13 (4.3%)

INTENSITY vs	PRESENCE
15% (N=2)	**100% (N=13)**

HIGH	LOW
50%	**0%**
UNCERTAIN	UNKNOWN
50%	**0%**

Examples

Common Examples

- Land reclamation for tourism facilities, including indirectly through coastal defences (sub-surface breakwaters). But protective structures may also hinder some tourism activities (e.g. swimming) (Sherman, 2014; Frihy, 1995; Zhang, Su and Ding, 2017; Thinh et al, 2018; Valadez-Rocha and Ortiz-Lozano, 2013; Wolff and Zijlstra, 1980).
- Land reclamation activities negatively affecting tourism, including indirectly such as loss of habitats (e.g. mangroves) (Yu, 1994).

→ *Reclamation is a mechanism and not a sector on its own in our framework (see methods). Thus this is not included in the database.*

DRIL-TOU

NUMBER OF ARTICLES:
13 (4.3%)

INTENSITY vs	PRESENCE
23% (N=3)	**100% (N=13)**

HIGH	LOW
67%	**0%**
UNCERTAIN	UNKNOWN
33%	**0%**

Examples

Common Examples

- Tourists finding drilling platforms unaesthetic (Rivera-Arriaga and Villalobos, 2001; Klinger et al, 2018)
- 'conflicts occur' between a prospective proven oil field and recreational activity (Ulyanova and Danchenkov, 2016)
  → *captured as dril-tou, value-dimin.*
- Tourism being negatively affected by oil spills or chronic oil pollution (Harzl and Pickl, 2012; Depellegrin, Blazauskas, and de Groot, 2010; Singkran, 2013).
  → *captured as dril-eco-tou, value-dimin.*
- Turning decommissioned platforms into artificial reefs for tourism activities (e.g. diving and angling). (Sayer and Baine, 2002; Lakhal, Khan and Islam, 2009; Feary, Burt and Batholomew, 2011)
  → *Captured as dril-tou, value-enhance.*

AQUA-REC

NUMBER OF ARTICLES:
13 (4.3%)

INTENSITY vs PRESENCE	
15% (N=2)	**92% (N=12)**

HIGH	LOW
100%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Land reclamation (often of mangroves) for aquaculture (e.g. shrimp farming) has ecological impacts (Sherman 2014, Islam, 2003; Liang et al, 2018; Zhang, Su and Ding, 2017; Yan et al, 2017; Zue, Hong and Charles, 2004) → *See aqua-eco.*
- Land reclamation resulting in the loss of space for aquaculture or loss of supporting habitats for aquaculture (Hong, 1995). → *Reclamation is a mechanism and not a sector on its own in our framework. Thus this is not included in the database.*

AQUA-MPA

NUMBER OF ARTICLES:
13 (4.3%)

INTENSITY	vs	PRESENCE
31% (N=4)		**85% (N=11)**

HIGH	LOW
0%	**25%**
UNCERTAIN	UNKNOWN
75%	**0%**

Examples

Common Examples

- Competing space use (Yucel-Gier, Arisoy, and Pazi, 2010; Zanuttigh et al, 2016; Fox et al, 2013; Jansen et al, 2013; Fernandez and Castilla, 2005; Salomidi et al, 2012)
  → *aqua-mpa, space-crowd.*
- Ecological pressures on MPAs from fish farms (Rodriguez-Rodriguez et al, 2015) as well as increased vulnerability to risk a negative image from aquaculture (Bennett and Dearden, 2014).
  → *This is included in the database as aqua-eco-mpa, natcap-dimin.*

WIND-TOU

NUMBER OF ARTICLES:
14 (4.6%)

INTENSITY	vs	PRESENCE
43% (N=6)		**79% (N=11)**

HIGH	LOW
0%	**17%**
UNCERTAIN	UNKNOWN
83%	**0%**

Examples

- Competing space use (Buck et al, 2008).
  → *Included as wind-tou, space-crowd.*
- The perception of wind farms may be positive or negative by tourists depending on context, thus impacting tourist activities (Klinger et al, 2018). Eg. Visual impacts, noise, or appreciation of carbon-free energy production (Soukissian et al, 2017; Christie et al, 2014; Lacroix and Pioch, 2011; Andrulewicz, Ottrembam and Kaminska, 2010; Ashley, Mangi and Rodwell, 2014).
- Whales avoid wind farm areas, which has negative implications for whale watching tourism. But it is unclear if avoidance is permanent or only during construction. (White, Halpern and Kappel, 2012; Dolman and Simmonds, 2010).
  → *These examples above are captured as value enhance and dimin, wind-tou.*
- Multi-purpose platform potentially designed as artificial reef for touristic activities, or co-location of hotel and wind farm or sightseeing trips to wind farms (Lacroix and Pioch, 2011; Stuiver et al, 2016; Christie et al, 2014)
  → *These are all potential ideas and designs for synergistic space use. Although they are not yet empirical examples, these papers focus on these ideas and thus this is captured in the database as wind-tou, space-syn.*

TOU-DISP

NUMBER OF ARTICLES:
14 (4.6%)

INTENSITY vs PRESENCE	
14% (N=2)	**100% (N=14)**

HIGH	LOW
50%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

Common Examples

- Wastewater and brine discharge from recreational boats can lead to fecal coliform which affects bathing tourism (Can and Alp, 2012).
  → *This example is tourist-driven waste discharge affecting the tourism industry and is thus not cross-sectoral (disposal is a mechanism). Thus this is not included in the database.*
- Accumulation of many individual tourists and tourist industries (e.g. Cruises) disposing of waste (e.g. plastic) in ocean. (Loyoza et al, 2015; de La Fayette, 2008).
  → *This is an eco-impact via disposal, see tou-eco.*
- Disposed munitions washing up on beaches and in nearshore areas or releasing toxins, creating dangers for tourists (Carton and Jakusiewicz, 2009)
  → *This is captured under mil-tou.*

FISH-DISP

NUMBER OF ARTICLES:
14 (4.6%)

INTENSITY	vs	PRESENCE
14% (N=2)		**100% (N=14)**

HIGH	LOW
50%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Disposal (or abandonment) of fishing gear, waste or bilge water, sewage, old debris and fish waste (Levin, Kark and Danovaro, 2018; Rajasuriya et al, 1995; Loyoza et al, 2015; Edgar et al, 2010).
  → *These examples demonstrate an eco-impact, see fish-eco.*
- Disposal of dredging material having a negative impact on fisheries (Dolda-Garcia, Chas-Amil and Touza, 2011; Bolam and Rees, 2003).
  → *This is captured under ship-fish where dredging is performed for port development. Otherwise it is not clear from these examples which sector is performing the dredging that is then impacting fishing (dredging is a 'mechanism' in our framework – see methods)*
- Current areas of disposal of waste may be areas of future fishing opportunity (competition for space in time) (Thurber et al, 2014). → *This is a hypothesized interaction and is not linked clearly to another sector as disposal is a 'mechanism' in our framework (see methods). Thus it is not included.*
- Disposed munitions being uncovered in fishing nets, or moved along the seafloor, causing injury and death to fishers (Carton and Jakusiewicz, 2009) → *Captured under mil-fish.*
- Brine discharge acts as a continuous and cumulative source of pollution, resulting in damage to the biota within the plume's vicinity. Hence most of the long outfalls contain diffusers to dilute the brine. Brine discharge should be placed well away from fishing (Abdul-Wahab and Al-Weshahi, 2009).
  → *Since this is the only example of this interaction and is very vague in terms of whether these sectors actually interact or not, this is not included in the database.*
- Disposed material acting as aggregating devices for commercially important species (Eg. Tires) (Feary, Burt and Bartholomew, 2011).
  → *There is not an ocean-based sector performing the disposal in this example (eg. Tire disposal is land-based/sourced) and it is thus not included.*

DRED-DISP

NUMBER OF ARTICLES:
14 (4.6%)

INTENSITY	vs	PRESENCE
14% (N=2)		**100% (N=14)**

HIGH **50%**	LOW **0%**
UNCERTAIN **50%**	UNKNOWN **0%**

Examples

Common Examples

- Disposal of dredged material (Dolda-Garcia, Chas-Amil and Touza, 2011; Yu, 1994; Foden, Rogers and Jones, 2011; Bolam and Rees, 2003; Petrucci, Mantanaro and Merli, 2011; Andrulewicz, Otremba, and Kaminska, 2010)

→ *Dredging is a mechanism according to our framework (see methods). Thus it is not included in the database.*

- Dredging could potentially uncover disposed munitions (Carton and Jakusiewicz, 2009).
  → *This is a potential, hypothesized example only. Thus it is not included in the database.*

DRIL-MPA

NUMBER OF ARTICLES:
15 (4.9%)

INTENSITY vs PRESENCE	
7% (N=1)	**100% (N=15)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Competing space use (Almada and Bernardino, 2017; Mileriene, Blazauskas, and Gulbinskas, 2014; Fox et al, 2013; Davis, Roberts and Hall-Spencer, 2007; Jobstvogt et al, 2014), no/limited possibility of co-existence (Jongbloed, van der Wal, and Lindeboom, 2014; Ulyanova and Danchenkov, 2016)
- Conflicts and disagreements between the oil and gas industry and conservation/marine parks (May, 1992)
- Understanding where areas are of potential oil and gas exploration is important for MPA design as they could help mitigate impacts on the ecosystem if placed strategically (Amon et al, 2017; Almada and Bernardino, 2017).
- → *These examples are dril-mpa, space-crowd.*
- Negative eco-impacts in MPA areas can occur due to nearby drilling activities (Xie, Ma and Liu, 2014; Singkran, 2013 → *This is captured as dril-eco-mpa.*
- De-facto MPAs around oil and gas platforms (Friedlander et al, 2014; Feary, Burt and Bartholomew, 2011). → *see dril-eco.*

WAVE-FISH

NUMBER OF ARTICLES:
16 (5.3%)

INTENSITY vs	PRESENCE
50% (N=8)	**75% (N=12)**

HIGH	LOW
12.5%	**25%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Competing space use with limited probability of co-existence. In modelling studies, more active fishing areas are considered as a limiting factor or exclusion zones for wave energy installation sites (Galparsoro et al, 2012; Astariz and Iglesias, 2017; Flocard, Ierodiaconou, and Coghlan, 2016; Plummer and Feist, 2016; Kim et al, 2012). It also depends on the area occupied by the wave farms (Kim et al, 2012).
  → *Included as wave-fish, space-crowd, context-dependent. Although most of the above examples come from modelling studies, this is included since there are many articles that discuss this interaction.*
- Wave installations act as de-facto MPAs and exclude fishing activities, but also augment fish stocks through artificial reef/fish aggregating function. (Soukissian et al, 2017; Zanuttigh et al, 2015; Hammar et al, 2017; Greaves et al, 2016; Langhamer, Haikonen, and Sundberg, 2010; Kim et al, 2012; Furness et al, 2012)
  → *Included as wave-fish, natcap-enhance.*
- Uncertainty about impact is mainly due to the low number of wave installations to date (that have been studied) (Flocard, Ierodiaconou, and Coghlan, 2016).
- Potential negative implication on fish stocks from wave farms, e.g. habitat modification, acoustic trauma and electromagnetic barriers (Greaves et al, 2016).
  → *This is not included as it is only one example of a 'potential' impact.*

REN-FISH

NUMBER OF ARTICLES:
16 (5.3%)

INTENSITY vs	PRESENCE
63% (N=10)	**69% (N=11)**

HIGH	LOW
20%	**10%**
UNCERTAIN	UNKNOWN
100%	**0%**

Examples

- Competing space use (E.g. Fishing effort displacement) with limited probability of co-existence. In modelling studies, more active fishing areas are considered as a limiting factor or exclusion zones (de Groot et al, 2014; Stuiver et al, 2016; Soukissian et al, 2017; Alexander, Meyjes, and Heymans, 2016; Yates, Schoeman and Klein, 2015). Uncertainty about impact is mainly due to the low number of installations to date (that have been studied) (Flocard, Ierodiaconou, and Coghlan, 2016).
  → *Included as ren-fish, space-crowd due to the volume of articles that discuss this interaction in detail.*
- Discussion about co-location with renewable fishing sites and static fishing gear as well as modelling the impacts on cost if co-located (Yates, Schoeman and Klein, 2015)
  → *This is a 'potential' interaction only and is the only example. Thus it is not included.*
- Renewable energy installations acting as de-facto MPAs and excluding fishing activities (the 'exclusion zone effect', but also augmenting fish stocks through artificial reef/fish aggregating function (the 'artificial reef effect'), with examples of changes in stock size due to exclusion zones (Alexander, Meyjes, and Heymans, 2016; Alexander, Wilding, and Heymans, 2013; Dolman and Simmonds, 2010).
  → *Included as ren-fish, natcap-enhance.*
- Potential negative implication on fish stocks from renewable energy installations, e.g. habitat modification, changes in fish behaviour, effects of electromagnetic fields. (Alexander, Wilding, and Heymans, 2013; Soukissian et al, 2017; Dolman and Simmonds, 2010).
  → *These are all potential impacts that are mentioned as 'unknowns' that should be investigated in the future. The statements are made very briefly and thus there is not enough evidence for inclusion in the database (in contrast to space-crowd, where the papers focus mostly on spatial interactions).*
- Potential entanglement issues with fishing gear and tidal energy (Greaves et al, 2016)
  → *This is a 'potential' interaction only and is the only example. Thus it is not included.*

AGG-DRED

NUMBER OF ARTICLES:
16 (5.3%)

INTENSITY	vs	PRESENCE
0%		**100%**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Dredging as a mechanism for aggregate mining, which has negative ecological impacts (Ellis et al, 2017; Trop, 2017; Foden, Rogers, and Jones, 2011; Nayak et al, 1989; Kim and Grigalunas, 2009; Charlier and Charlier, 1992; Nairn et al, 2004)
  → *See agg-eco.*
- Loss to fisheries due to the ecological impacts of sand mining from dredging (Kim and Grigalunas, 2009) → *included as agg-dred/eco-fish, natcap-dimin.*

WIND-CAB

NUMBER OF ARTICLES:
17 (6%)

INTENSITY vs PRESENCE	
12% (N=2)	**94% (N=16)**

HIGH	LOW
0%	**50% (N=1)**
UNCERTAIN	UNKNOWN
50% (N=1)	**0%**

Examples

Common Examples

- Wind turbines use cables to transport power. A change in the distribution of cables is expected with the growth of offshore wind power.
- In modelling studies cables from other sectors are considered to be exclusion zones for wind farm placement (a 500m safety zone on either side of the cables, so that the cables can be accessed for inspection) (Astariz and Iglesias, 2017; Jongbloed, vander wal, and Lindeboom, 2014).
  → *This example comes from modelling papers and are not empirically observed. The statement is also too vague to decipher what other sectors the wind sectors may be interacting with (i.e. what sectors the 'other cables' come from).*
- There may be impacts from cable electromagnetic fields on marine organisms (Bergstrom, Sundqvist, and Bergstrom, 2013; Hooper and Austen, 2014; Soukissian et al, 2017; Hammar et al, 2017; Wilson et al, 2010) in addition to impacts from burying and impact on soft bottom assemblages (Zanuttigh et al, 2015) → *See wind-eco.*
- "it is of particular interest for the offshore wind farm operators to minimize the cable length in the area of shipping routes" (Astariz and Iglesias, 2017)
  → *This is a suggestion made by the authors, and is too vague for inclusion in the database (see wind-ship).*
- Trawling could pose a danger to wind farm infrastructure such as buried cabling (Christie et al, 2014). "the greatest conflict with offshore projects would come from heavy fishing, especially for the cables of the energy parks." (trawling) (Astariz and Iglesias, 2017). → *See wind-fish.*

SHIP-TOU

NUMBER OF ARTICLES:
17 (6%)

INTENSITY vs	PRESENCE
18% (N=3)	**82% (N=14)**

HIGH	LOW
67% (N=2)	**33% (N=1)**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Shipping and tourism are 'competing activities' (Sawale and Mahadevia, 2011)
- As marinas develop, interference is expected from shipping (Wolff and Zijlstra, 1980)
- "It is possible that the movement of marine vessels could disturb recreational users in the area, especially fishing activities, and affect ultimately public safety" (Bombar et al, 2016).
  → *ship-tou, space-crowd included.*
- industries that rely on ports as an input to production (e.g. tourism and transportation) can share facilities and reduce overall input costs (Klinger et al, 2018). Port development for the shipping industry will attract more tourists as a new harbour will allow mooring of passenger ferries (Ulyanova and Danchenkov, 2016)
  → *Ship-tou, space-syn included.*
- Oil pollution from ships other than tankers has negatively impacted recreational activities and tourism (May, 1992; Thia-Eng et al, 2000). As port traffic expands, conservation measures and a strict water quality standard is needed to facilitate the compatible function of tourism (Xue, Hong, and Charles, 2004)
  → *ship-tou-eco, value-dimin included.*

SHIP-MPA

NUMBER OF ARTICLES:
17 (6%)

INTENSITY	vs	PRESENCE
12% (N=2)		**100% (N=17)**

HIGH	LOW
50% (N=1)	**50% (N=1)**
UNCERTAIN	UNKNOWN
50% (N=1)	**0%**

Examples

Common Examples

- Conflicts for space:
  - MPAs may have restrictions on shipping (Blasiak and Yagi, 2016; Dalton, 2004) and thus face opposition (Ounanian et al, 2012).
  - Space conflicts cause higher fuel costs due to rerouting of shipping lanes (Blasiak and Yagi, 2016)
  - Prohibition of operational shipping discharges in MARPOL-declared "special areas" of the Southern Ocean (Joyner, 1995) and Particularly Sensitive Sea Areas (PSSA) such as the Great Barrier Reef (Polglaze, 2003)
    → *ship-mpa, space-crowd, context dependent since sometimes there is full exclusion.*
- Ships exert pressure on MPAs (ecological impacts) (Rodriguez-Rodriguez et al, 2015)
  - E.g. A MPA in Saudi Arabia overlapped with shipping activities such as ferry services, water taxis, transportation of diesel fuel to supply desalination plants, cargo ships, and oil tankers. Impacts included littering and oil leakage, erosion, and decline in fish catches (Gladstone, 2000).
    → *ship-eco-mpa, natcap-dimin.*

FISH-REC

NUMBER OF ARTICLES:
17 (6%)

INTENSITY	vs	PRESENCE
41% (N=7)		**88% (N=15)**

HIGH	LOW
57% (N=4)	**0%**
UNCERTAIN	UNKNOWN
57% (N=4)	**0%**

Examples

Common Examples

- land reclamation harms fish habitats (Hong, 1995; Zhang, Su and Ding, 2017). For example:
  - alters water transparency and dissolved oxygen, which affects fish growth (Cui et al, 2016)
  - Rec harms mangroves and coastal wetlands which serve as fisheries resources (Yu, 1994; Chung, Kang and Choi, 2015)

→ *Land reclamation is a 'mechanism' sector in our framework and thus must act as a connection between another ocean-based sector for inclusion in the database. Thus the above examples are not included as it is not clear what sector is implementing land reclamation.*

- Land reclamation such as breakwaters can act as artificial reefs, which attract commercially important species (Feary, Burt and Bartholomew, 2011) → *See ship-fish. This is included in the database as ship-rec-fish, natcap-enhance.*
- Added docking facilities could provide a safer way for small scale fishers to get to and from the sea in areas where fishermen throw themselves overboard and are subsequently towed to the mainland because there is no fishing dock (da Costa Oliveira et al, 2016). → *This is a hypothetical example that is suggested by the authors. Since it is the only example it is not included in the database.*

AGG-FISH

NUMBER OF ARTICLES:
17 (6%)

INTENSITY	vs	PRESENCE
29% (N=5)		**88% (N=15)**

HIGH	LOW
40% (N=2)	**0%**
UNCERTAIN	UNKNOWN
100% (N=5)	**0%**

Examples

Common Examples

- damages fish habitat, mortality to eggs and larvae (Kim and Grigalunas, 2009; Kim 2009; Doldan-Garcia, Chas-Amil, and Touza, 2011) which decreases fish catch (Kim and Grigalunas, 2009; Tidd et al, 2015)
    - "aggregate mining activity heavily influences fisher decision making, possibly due to knowledge of the habitat that scallops live in, coupled with past experience" (Tidd et al, 2015).

  → *agg-eco-fish, natcap-dimin.*
- Competition for space (Tidd et al, 2015; Kim and Grigalunas, 2009)
  → *agg-fish, space-crowd.*
- Fear of damage to fishing gear (Tidd et al, 2015)
  → *This is too vague and hypothetical, thus it is not included in the database.*

SHIP-REC

NUMBER OF ARTICLES:
18 (6%)

INTENSITY	vs	PRESENCE
11% (N=2)		**94% (N=17)**

HIGH	LOW
100% (N=2)	**0%**
UNCERTAIN	UNKNOWN
50% (N=1)	**0%**

Examples

Common Examples

- Reclaiming land for ports, breakwaters, driven by surge in cargo-handling needs (Deidun and Vella, 2011; Firth et al, 2016; Zhang, Su and Ding, 2017)

→ *Reclamation is a 'mechanism' sector and thus are not added into the database unless as an example of a connection between two sectors. See ship-eco, ship-fish.*

MIL-ECO

NUMBER OF ARTICLES:
18 (6%)

INTENSITY vs PRESENCE	
50% (N=9)	**78% (N=14)**

HIGH	LOW
56% (N=5)	**44% (N=4)**
UNCERTAIN	UNKNOWN
44% (N=4)	**22% (N=2)**

Examples

Common Examples

- Disturbance on ecosystem (E.g. military exercises, weapons testing) (Nayak et al, 1989, Wolff and Zijlstra, 1980; Scott and Parsons, 2005; Benn et al, 2010)
  → *mil-eco, natcap-dimin*

- **Mil**→disp→eco: dumped unexploded bombs, munitions, chemical weapons, waste from submarines, nuclear waste products, leakage and explosions can spread contaminants (Benn et al, 2010; Carton and Jakusiewicz, 2009)
  → *mil-disp-eco, natcap-dimin*

DRIL-DISP

NUMBER OF ARTICLES:
18 (6%)

INTENSITY	vs	PRESENCE
11% (N=2)		**100% (N=18)**

HIGH	LOW
50% (N=1)	**0%**
UNCERTAIN	UNKNOWN
100% (N=2)	**0%**

Examples

Common Examples

- Disposal of drilling wastes (Ball, Stewart, and Schliephake, 2012; Hastie et al, 2009; Foden, Rogers and Jones, 2011; Mashkati and Tabibzadeh, 2016; Benn et al, 2010)
    - "wastes include machinery cooling water, deck drainage, domestic sewage, drill cuttings, drilling fluids and produced waters."… "Major discharges associated with drilling operations are drill cuttings and drilling fluids. Drill cuttings are particles of crushed, relatively inert sedimentary rock contaminated with drilling fluid residue and thus a potential source of several trace metal pollutants.." (Hastie et al, 2009)

→ *Disposal is a 'mechanism' sector and thus are not added into the database unless as an example of a connection between two 'industry' sectors. See dril-eco.*

SHIP-AQUA

NUMBER OF ARTICLES:
19 (6%)

INTENSITY vs PRESENCE	
42% (N=8)	**74% (N=14)**

HIGH	LOW
38% (N=3)	**13% (N=1)**
UNCERTAIN	UNKNOWN
63% (N=5)	**0%**

Examples

Common Examples

- Competing claims for coastline space, encroachment (Yu, 1994; Xue et al, 2004; Goulletquer and Le Moine, 2002). Aquaculture could potentially be a navigational hazard (Jansen et al, 2016; Zanuttigh et al, 2016).
    - "The expansion of mariculture operation demanded larger ocean space, which took over parts of shipping channels. During the peak of fish harvest season, fishing vessels were interfering cargo shipping operations. Although there was no report of shipping accidents due to the conflicts, mariculture and fishing operations caused significant delay in shipping traffic" (Peng et al, 2006)

  → *ship-aqua, space-crowd included.*

- dril→**ship**→eco→**aqua:** vessel traffic and tanker oil spills negatively impact aqua. There are about 300 cases annually in Korea (Cho, 2007)
  → *aqua-eco-ship included.*

- Multi-purpose use: "To increase insight into the practical implementation possibilities of MUPS, a European FP7 project called MERMAID developed concepts for multi-purpose use, including energy extraction, **aquaculture, and transport**." (Zanuttigh et al, 2015).

→ *This is too vague for inclusion in the database.*

MIN-MPA

NUMBER OF ARTICLES:
19 (6%)

INTENSITY	vs	PRESENCE
16% (N=3)		**100% (N=19)**

HIGH	LOW
0%	**0%**
UNCERTAIN	UNKNOWN
100% (N=3)	**0%**

Examples

Common Examples

- MPAs can forbid/restrict mining, depending on location (Blasiak and Yagi, 2016; Levin, Kark and Danovaro, 2018; Johnson, 2014). There are also "overlapping claims" (E.g. in New Zealand waters) (Levin et al, 2016)
    - "An article published in Science in 2015 called for the ISA to suspend approval for new exploration contracts and not approve any exploitation contracts until marine protected areas are designed and implemented for the high seas. These authors also suggested that protected areas are designated before new exploration contracts are awarded." (Miller et al, 2018)
    - "It was recommended that the (MPAs) should be placed so as to protect as many seamounts within a sub-region as possible and avoid or minimize overlap with mining exploration areas" (Lodge et al, 2014)
    - MPAs as management/protective tool: "ecosystem reserves are seen as key tools to manage the different spatial scales of benthic community structure and mining impacts". Also used as reference areas for comparison when assessing min→eco impacts. This is required by the ISA. MPAs may form a network to allow for genetic connectivity among sites to facilitate recolonization, if habitat regeneration occurs (Ellis et al, 2017; Wedding et al, 2013; Boschen et al, 2016).

→ *min-mpa, space crowd added*

- Adverse impacts on MPAs: "a buffer zone of 100 km around an MPA is required to protect the core area from significant impacts from near-bottom sediment plumes, which may come from any direction" (Wedding et al, 2013)
  → *This is a suggestion by the authors. No empirical data is recorded, and this is the only example of this found in the literature. Thus it is not included in the database.*

WIND-MPA

NUMBER OF ARTICLES:
20 (7%)

INTENSITY	vs	PRESENCE
35% (N=7)		**80% (N=16)**

HIGH	LOW
14% (N=1)	**0%**
UNCERTAIN	UNKNOWN
71% (N=5)	**14% (N=1)**

Examples

Common Examples

- Spatial exclusion and competition can occur (Rodriguez-Rodriguez et al, 2016). Windfarms cannot be placed in certain ecologically-sensitive MPAs. Applications have been rejected in the past (Christie et al, 2014). The wind sector making claims on space 'removes area previously available for wildlife' location (Jongbloed, van der Wal, and Lindeboom, 2014)

  → *wind-mpa, space-crowd*

- Wind farms could be placed in protected areas, depending on location (Jongbloed, van der Wal, and Lindeboom, 2014). Co-locating wind farms and marine protected areas could be a feasible option for reducing pressure of conflicts on other marine activities (Christie et al, 2014). However there would be a risk of wind-eco impacts.
  - "Closing these areas near underwater obstructions may increase fisheries yield by protecting juvenile fish that are associated with underwater obstructions while simultaneously acting to lower the risk of gear loss or damage. Although recreational anglers could likely operate in the vicinity of wind turbines, their exclusion or limited entry may benefit the fisheries for several species because total yield may be increased with the addition of an MPA" (Fayram and de Risi, 2007). → *This hypothesis has not been proven with an empirical observation by any other study and thus is not included in the database.*

  → *wind-mpa, space-syn added. A lot of the articles discuss this as a 'potential' synergy. However since there are multiple articles that focus large sections on this subject we consider this enough evidence for inclusion.*

SHIP-DRED

NUMBER OF ARTICLES:
20 (7%)

INTENSITY vs	PRESENCE
5% (N=1)	**100% (N=20)**

HIGH	LOW
100% (N=1)	**0%**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples – mostly part of mechanisms

- Dredging for port development and maintenance causes turbidity (absorbs radiant energy in upper water layers which reduces depth of photosynthesis, which reduces suitable habitats for various species), resettles bottom sediments (can clog gills and impair oxygen exchange), resuspension of organics causes a temporary decrease of the dissolved oxygen, destruction of coral, reduction in tidal flushing capacity, impacts on fauna (Xue, Hong and Charles, 2004; Griffiths et al, 2004; Muttamara and Baldisimo, 1988; Valadez-Rocha and Lozano, 2013)
- Widening inlets via dredging for shipping channels can cause changes in salinity and colonization of new species (Marcos et al, 2015)
- Creating and maintain shipping lanes, as well as harbour construction, requires dredging with subsequent disposal of the dredged material (Petrucci, Montanaro, and Merli; 2011; Blazauskas et al, 2015).
- "Need to develop port facilities to allow for ever-growing ship sizes", therefore need to dredge to deepen these areas (Harding, 1980)

→ *Dredging is a 'mechanism' sector and thus are not added into the database unless as an example of a connection between two sectors. See ship-eco-fish, ship-dred-eco.*

PIPE-ECO

NUMBER OF ARTICLES:
21 (7%)

INTENSITY vs PRESENCE	
43% (N=9)	**76% (N=16)**

HIGH	LOW
11% (N=1)	**11% (N=1)**
UNCERTAIN	UNKNOWN
89% (N=8)	**0%**

Examples

Common Examples

- Obstruction on seabed, abrasion, turbidity and re-suspended sediments due to pipeline burial (Jobstvogt et al, 2014; Salomidi et al, 2012; Guerra et al, 2015; Foden, Rogers and Jones, 2011)
- Dril→pipe→eco: oil spills from pipelines (Price et al, 2000)
  → *Although construction impacts are not included, dril-pipe-eco, natcap-dimin is included in the database due to oil spills and seabed obstruction impacts*
- Can have some function as habitat provision (Firth et al, 2016; Feary, Burt and Bartholomew, 2011)
  → *dril-pipe-eco, natcap-enhance*
- Discharged desalination wastewater via pipelines can have high salinity, increased temperature, chemicals from pre-treatment, and metals picked up by the brine in contact with the pipeline (Bombar et al, 2016; Abdul-Wahab and Al-Weshahi, 2009). → *see des-eco*

WIND-AQUA

NUMBER OF ARTICLES:
22 (7%)

INTENSITY	vs	PRESENCE
46% (N=10)		**100% (N=22)**

HIGH	LOW
10% (N=1)	**20% (N=2)**
UNCERTAIN	UNKNOWN
90% (N=9)	**0%**

Examples

Common Examples

- Multi-use platforms
  - Sharing of equipment, operation and maintenance reduces costs, turbines provide attachment devices and energy which allows aqua to operate offshore (Wever, Krause and Buck, 2015)
  - Increases acceptability of both sectors amongst population (a 'selling' point) (Buck et al, 2008)
  - Optimizes use of space, reduces start-up costs and conflicts with other sectors, and increases the amount of open ocean territory left (Christie et al, 2014; Wever, Krause and Buck, 2015)
  - Harsher offshore conditions pose a limiting factor in the selection of species, however water quality and lack of traffic within a MUP favor cultivation of several species (wind farm 'protects' aqua from boat collisions, for example) (Wever, Krause and Buck, 2015; Hooper and Austen, 2014)
  - Some extra risk involved such as physical damages to each other, E.g. interference of energy converters on farmed species, collision damages to aqua from wind maintenance boats, drifting anchors drifting into power cables. Could have high insurance premiums. (Jansen et al, 2016; Michler-Cieluch and Krause, 2008; Stuiver et al, 2016).

→ *included as wind-aqua, space-syn. Although most articles discuss this synergy as a potential, there are multiple papers that focus entirely on this subject, and thus we consider this enough evidence for inclusion in the database.*

WAVE-ECO

NUMBER OF ARTICLES:
7% (N=22)

INTENSITY vs PRESENCE	
73% (N=16)	**86% (N=19)**

HIGH	LOW
50% (N=8)	**44% (N=7)**
UNCERTAIN	UNKNOWN
100% (N=16)	**0%**

Examples

Common Examples

- noise, vibrations, biofouling, sedimentation, disruption of animal migrations, habitat displacement, changes in hydrodynamics and coastal morphology (which can impact benthic communities), footprints on the seabed (Zanuttigh et al, 2015, 2016; Greaves et al, 2016; Kim et al, 2012, Dolman and Simmonds, 2010; Guerra et al, 2015; Plummer and Feist, 2016; Soukissian et al, 2017)
- diving birds, fish and mammals can collide with underwater elements (McGowan et al, 2013; Furness et al, 2012; Flocard, Ierodiaconou, and Coghlan, 2016, Hammar et al, 2017)
  → *wave-eco, natcap-dimin included*
- Can function as artificial reef (Alexander, Meyjes, and Heymans, 2016; Langhamer, Haikonen, and Sundberg, 2010; Ashley, ;Mangi and Rodwel, 2014)
  → *wave-eco, natcap-enhance*
- **wave**→cab→**eco**: electromagnetic fields can interfere with fish and mammals (Greaves et al, 2016; Soukissian et al, 2017)
  → wave-cab-eco, natcap-dimin

- construction/installation of the wave devices may increase sediment suspension and water turbidity, decreasing light penetration and interfering with primary production (Hammar et al, 2017; Dolman and Simmonds, 2010; Zanuttigh et al, 2015) → *construction impacts are not included.*

WIND-SHIP

NUMBER OF ARTICLES:
24 (8%)

INTENSITY	vs	PRESENCE
29% (N=7)		**88% (N=21)**

HIGH	LOW
14% (N=1)	**29% (N=2)**
UNCERTAIN	UNKNOWN
57% (N=4)	**0%**

Examples

Common Examples

- Competing uses and claims over space is a problem in heavily shipped areas (Jay, 2012; Burkhard et al, 2011; Azzellino et al, 2013; Astariz and Iglesias, 2017)
    - In modelling studies, major shipping routes are considered as exclusion zones for new wind farms (Jongbloed, van der Wal, and Lindeboom, 2014; Astariz and Iglesias, 2017).
    - Risk of vessels colliding with wind farms (E.g. if there is engine trouble) (Burdon et al, 2018; Jay 2012)

  → *wind-ship, space crowd is included.*

- It is of particular interest for the offshore wind farm operators to minimise the cable length in the area of shipping routes. In many cases conflicts of interest could be resolved by measures such as altering maritime routes or establishing corridors between wind turbines (Astariz and Iglesias, 2017).
  → *This statement is made as a suggestion by the authors and is the only example of the shipping sector interacting with the wind sector via cables. Thus it is not included in the database.*

REN-ECO

NUMBER OF ARTICLES:
26 (9%)

INTENSITY vs PRESENCE	
54% (N=14)	**77% (N=20)**

HIGH	LOW
57% (N=8)	**7% (N=1)**
UNCERTAIN	UNKNOWN
86% (N=12)	**0%**

Examples

Common Examples

- *Tidal*:
  - Possible Impacts on wave driven processes and coastal morphology (Soukissian et al, 2017),
  - The explosive underwater sound pressure from pile driving may cause damage and stress to fish and marine mammal (Hammar et al, 2017; Dolman and Simmonds, 2010).
  - Placement of tidal energy converters will have to consider corridors used by migrating fish, mammals and diving birds due to collision risks (E.g. with turbine blades) (Langhamer, Haikonen, and Sundberg, 2010; Hammar et al, 2017; Dolman and Simmonds, 2010, Furness et al, 2012)
  - Habitat degradation (Dolman and Simmonds, 2010)
- *Thermal energy*
  - Could impact water exchange since water is relocated to different depths with altered temperature. A massive discharge of water could also relocate nutrients. (Hammar et al, 2017)
  - Seabirds can be disturbed by accompanying boat traffic (Furness et al, 2012).
  - Entrainment (fish transported along with the flow of water) and impingement in vulnerable deep-sea ecosystems (Hammar et al, 2017). Fish entrainment has been reported at test sites

→ *ren-eco, natcap-dimin*

- power cables can produce electromagnetic field effects which may disturb fish and mammals who are electrosensitive, impacts from cable trenching (Hammar et al, 2017)

→ *ren-cab-eco, natcap-dimin*

- The structures can act as artificial reefs, providing additional habitat (Alexander, Meyjes, and Heymans, 2016; Hammar et al, 2017; Dolman and Simmonds, 2010)
  → *ren-eco, natcap-enhance is included.*

CAB-ECO

NUMBER OF ARTICLES:
27 (9%)

INTENSITY vs	PRESENCE
56% (N=15)	**67% (N=18)**

HIGH	LOW
20% (N=3)	**33% (N=5)**
UNCERTAIN	UNKNOWN
73% (N=11)	**0%**

Examples

Common Examples

- Physical disturbance and obstruction on the seabed, abrasion and suspended sediments from cable burying, alteration of habitat (loss or increase in complexity), changes to species richness and abundance (Zanuttigh et al, 2015; Hammar et al, 2017; Wilson et al, 2010; Foden, Rogers and Jones, 2011). However concerns surrounding such impacts are low as impacts are limited (Friedman 2017)
- Impacts from cable laying (Coffen-Smout and Herbert, 2000; Jobstvogt et al, 2014)
- wind farm power cables can produce electromagnetic field effects which may disturb fish and mammals who are electrosensitive (Punt et al, 2009; Bergstrom et al, 2014, 2013; Wilson et al, 2010). Evidence is 'scarce but should not be ruled out' (Hammar et al, 2017).

→ *Cables are a 'mechanism' sector and thus are not added into the database unless they are an example of a connection between two sectors.*

DRIL-SHIP

NUMBER OF ARTICLES:
30 (10%)

INTENSITY vs PRESENCE	
7% (N=2)	**100% (N=30)**

HIGH	LOW
100% (N=2)	**50% (N=1)**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Increasing crowding from additional oil tankers and ships will likely have impacts in future for shipping. E.g. Re-routing, demand for port development (Harding, 1980; Mileriene, Blazauskas, Gulbinskas, 2014; Jay, 2012; Lakhal, Khan and Islam, 2009). A high volume of ships and crowded ports increases the likelihood of shipping accidents and resulting spills from tankers (Cho, 2007; de La Fayette, 2008)
  → *These examples are hypotheses, however there are multiple articles that discuss this interaction. Thus it is included as dril-ship, space-crowd.*
- Ports contribute to supporting the offshore drilling activity as a base of logistic support for regional oil and gas production. E.g. Coruna port in Spain was built partially so that there were other ships available that could potentially help in an emergency situation (da Costa Oliveira et al, 2016)
  → *Included as dril-ship, space-syn.*

SHIP-DISP

NUMBER OF ARTICLES:
31 (10%)

INTENSITY vs	PRESENCE
10% (N=3)	**100% (N=31)**

HIGH	LOW
67% (N=2)	**33% (N=1)**
UNCERTAIN	UNKNOWN
0%	**0%**

Examples

Common Examples

- Disposal of shipboard wastes (solid waste, sewage, oily wastes, bilge) can be consumed by marine life and harm digestive systems (ex. Albatross) or cause entanglement, bilge spreads invasive species. Deep sea dumping (plastics, metal, glass, radioactive waste in metal drums) can smother and contaminate. → *This is captured as ship-disp-eco, see ship-eco*

- Disposed munitions have been found during harbour maintenance (Carton and Jakusiewicz, 2009)
- "In an April 24, 1945 memorandum, the CNO [U.S. Chief of Naval Operations] also required that sea-disposal sites [of munitions] be located outside regular shipping lanes" (Carton and Jakusiewicz, 2009).

→ *See mil-ship. These are both 'one time' examples and do not necessitate that in general mil and ship interact via disposal. This mil-disp-ship is not included in the database.*

DRIL-PIPE

NUMBER OF ARTICLES:
31 (10%)

INTENSITY	vs	PRESENCE
0%		**100%**

HIGH **0%**	LOW **0%**
UNCERTAIN **0%**	UNKNOWN **0%**

Examples

Always coded as part of a mechanism with the oil and gas sector. See the corresponding summary sheets for more detail.

- **Dril→pipe→**tou: pipelines can act as artificial reefs that are diving hotspots (*see dril-tou*)
- **Dril→pipe→**wave: pipelines restrict establishment of wave energy converters due to spatial exclusion (*see dril-wave)*
- **Dril→pipe**/cab→tel: crossings between pipelines and cables (*see tel-pipe, cab-pipe, dril-cab*)

AGG-ECO

NUMBER OF ARTICLES:
31 (10%)

INTENSITY vs	PRESENCE
52% (N=16)	**87% (N=27)**

HIGH	LOW
75% (N=12)	**13% (N=2)**
UNCERTAIN	UNKNOWN
56% (N=9)	**0%**

Examples

Common Examples

- Harm to benthic communities and reduction of species diversity, creation of sediment plumes and turbidity, alteration to bottom topography and contributions to coastal erosion, excess mortality of eggs and larvae, release of toxic material (accidental or from the actual mining). Removal of substrates that serve as habitats, causes anoxic depressions, harmful suspended sediment levels, modification of hydrologic conditions (changes in depth and current strength). (Charlier and Charlier, 1992; Kim and Grigalunas, 2009; Nairn et al, 2004; Foden, Rogers and Jones, 2011; Nayak et al, 1989; Kim 2009; Ellis et al, 2017)
  → *agg-dred-eco, natcap-dimin, since the mechanism by which agg mining occurs is through dredging.*
- Limestone and coral mining (used in construction) leads to large-scale reef destruction (Rajasuriya and White, 2008) → *agg-eco, natcap-dimin.*
- "All aspects of the effects of dredging are not, however, negative. For instance, pollutants absorbed in the water column may be tied-in in bottom sediments, nutrients will be re-suspended, and water mixing results, whereupon sediments are re-oxygenated, and polluted sediments may be removed" (Charlier and Charlier, 1992). → *This is a hypothesized mechanism and is the only example of a positive agg-eco interaction. Thus it is not included.*

TOU-FISH

NUMBER OF ARTICLES:
35 (12%)

INTENSITY vs	PRESENCE
31% (N=11)	**86% (N=30)**

HIGH	LOW
55% (N=6)	**9% (N=1)**
UNCERTAIN	UNKNOWN
64% (N=7)	**0%**

Examples

Common Examples

- Attractive sites for tourism overlap with fishing grounds which leads to conflict (McClanahan and Mangi, 2000; Rivera-Arriga and Villalobos, 2001; Fabinyi, 2010; Maynour et al, 2013). Privatization lead by the tourism industry can displace fishermen (Cabral and Alino, 2011). Competition between fish industry and recreational fishers (Gomez et al, 2006; Lloret et al, 2008; Maynou et al, 2013). → *Space-crowd, tou-fish.*
- Negative impacts on biodiversity due to fishing efforts or practices diminishes the appeal of touristic activities (ex. Diving, penguin viewing) (Boersma and Parrish, 1999; Greiner et al, 2000; Cesar et al, 1997; Merino, Maynou and Boncoeur, 2009) → *fish-eco-tou, value-dimin.*
- MPAs may be created in order to attract tourism and may displace or limit access to fishing grounds. There are also arguments that have taken place over access and use of MPAs. (Fabinyi, 2008; Diedrich, 2007; Oracion, Miller and Christie, 2005) → *tou-mpa-fish, space-crowd (context-dependent, as there is sometimes full exclusion).*
- Fishing is associated with cultural identity and heritage which is a tourist interest (Ashley, Mangi, and Rodwell, 2014) → *included as tou-fish, value-enhance (context-dependent, since values held by tourists are heterogeneous).*

DRIL-FISH

NUMBER OF ARTICLES:
35 (12%)

INTENSITY vs PRESENCE	
26% (N=9)	**97% (N=34)**

HIGH	LOW
56% (N=5)	**11% (N=1)**
UNCERTAIN	UNKNOWN
55% (N=5)	**0%**

Examples

Common Examples

- Drilling platforms act as artificial reefs which can aggregate fish. There exists 'rigs to reef' programs where decommissioned rigs can be used for such purposes (Salomidi et al, 2012; Friedlander et al, 2014; Bergstrom et al, 2013; Streich et al, 2017; Rabaoui et al, 2015; Lakhal, Khan and Islam, 2009; Feary, Burt and Bartholomew, 2011). Higher catch per effort is reported near drilling platforms (Rabaoui et al, 2015).
  → *dril-fish, natcap-enhance included.*
- The oil and gas industry causes environmental damage to fishing grounds through effects such as pollution from oil spills and noise (Cho, 2007; Harzl and Pickl, 2012; Yu, 1994; Levin, Kark and Danovaro, 2018; Klinger et al, 2018; Hong, 1995; Quist and Nygren, 2015)
  → *dril-eco-fish, natcap-dimin.*
- Offshore drilling activities result in restricted access or exclusion of certain types of fisheries (e.g. trawl fishing) (Friedlander et al, 2014; Fayram and de Risi, 2007; Rabaoui et al, 2015; Gasalla and Gandini, 2016). Spatial exclusion has forced fishermen to fish in riskier, further away waters (Quist and Nygren, 2015)
  → *dril-fish, space-crowd (context-dependent – since there is not always full exclusion)*

TOU-MPA

NUMBER OF ARTICLES:
36 (12%)

INTENSITY vs	PRESENCE
36% (N=13)	**97% (N=35)**

HIGH	LOW
23% (N=3)	**23% (N=3)**
UNCERTAIN	UNKNOWN
85% (N=11)	**0%**

Examples

Common Examples

- The tourism industry uses and benefits from MPAs (e.g. Heritage, visual beauty, scuba diving, wildlife watching). Tourism revenue is sometimes used to maintain MPAs. (Badalamenti et al, 2000; Luna, Valle Perez, and Sanchez-Lizaso, 2009; Fabinyi, 2010; Claudet and Pelletier, 2004; Merino, Maynou and Boncoeur, 2009; Diedrich, 2008, Oracion, Miller and Christie, 2005)
  → *mpa-tou, value-enhance, and tou-mpa, operation enhance included.*
- Negative ecological impacts from tourists can affect quality of MPAs (ex. Anchoring from recreational boats, diving) (Badalamenti et al, 2000; Garcia-Charton et al, 2008).
  Tou-eco-mpa, natcap-dimin added.
- Certain tourism activities are prohibited in MPAs (ex. Diving, anchoring) which the tourism industry has opposed (Salmona and Verardi, 2001; Lopes et al, 2015; Rodriguez-Rodriguez et al, 2015)
  → *tou-mpa, space-crowd (context-dependent) included.*

SHIP-FISH

NUMBER OF ARTICLES:
36 (12%)

INTENSITY	vs	PRESENCE
31% (N=11)		**86% (N=31)**

HIGH	LOW
36% (N=4)	**18% (N=2)**
UNCERTAIN	UNKNOWN
55% (N=6)	**0%**

Examples

- Space competition and conflicts between fishing vessels and maritime traffic, as well as port activity. There are sometimes exclusion zones for fishing activities in areas of high shipping traffic (Miller et al, 2018; de Costa Oliviera et al, 2016; Tidd et al, 2015; Yu, 1994). Co-existence may be possible (Jongbloed, van der Wal and Lindeboom, 2014; Peng et al, 2006).
  → *ship-fish, space-crowd added.*
- Pollution due to oil spills from shipping accidents harms the fishing sector (Thia-Eng et al, 2000; Cho, 2007)
- Land reclamation driven by the shipping sector (E.g. Ports) can negatively affect the ecosystem of fishing grounds (Doldan-Garcia, Chas-Amil, and Touza, 2011; Marcos et al, 2015; Peterson, 1993; Xue et al, 2004)
  → *ship-eco-fish, natcap-dimin.*
- "The port structures will serve as artificial habitats for marine organisms and may boost the production of commercial fishes" (Muttamara and Baldisimo, 1988). Growth rates could be enhanced from artificial structures such as piers (Bergstrom et al, 2013). Commercially-important fish communities are associated with breakwater structures (Feary, Burt and Bartholomew, 2011).
  → *ship-rec-fish, natcap-enhance.*
- Added docking facilities could provide a safer way for small scale fishers to get to and from the sea in areas where fishermen throw themselves overboard and are subsequently towed to the mainland because there is no fishing dock (da Costa Oliveira et al, 2016). → *This is a hypothetical example that is suggested by the authors. Since it is the only example it is not included in the database.*

AQUA-FISH

NUMBER OF ARTICLES:
36 (12%)

INTENSITY vs	PRESENCE
33% (N=12)	**92% (N=33)**

HIGH	LOW
50% (N=6)	**25% (N=3)**
UNCERTAIN	UNKNOWN
50% (N=6)	**0%**

Examples

Common Examples

- Aquaculture technologies to enhance or restore fisheries in natural ecosystems. E.g. Hatchery rearing. (Lorenzen, 2014; Nash, Iwamoto, and Mahnken, 2000; Ormerad, 2003; Bell et al, 2008)
- Aquaculture operations can act as fish aggregating devices, enhancing the catchability of fish (Klinger et al, 2018).
  → *The above are aqua-eco-fish, natcap-enhance.*
- However, stock enhancement/hatchery rearing tends to induce domestication effects that can modify traits of hatchery fish relative to those found in the wild population. There are also issues with bycatch and impacts on the genetic integrity of wild fish. Escaped fish from fish farms can have similar effects (Primavera, 2006; Lorenzen, 2014; Walters et al, 2008). Collection of seedstock for aquaculture "can have consequences for wild fisheries in terms of high rates of bycatch" (Primavera, 2006).
- Increasing pressure on fisheries for aqua fish feed (e.g. Krill fisheries) (Nicol and Endo, 1999; Alder et al, 2008; Merino et al, 2012)
- Pollution from the fish farms (ex. Chemical leakage and sewage) harms commercial species via impact on water quality (Martinez-Alier, 2001; Wiber, Young and Wilson, 2012).
- Destruction of mangroves for creating aqua ponds harms nurseries of commercial species (Thia-Eng et al, 2000; Bennett and Reynolds, 1993)
  → *The above are aqua-eco-fish, natcap-dimin.*
- Conflicts over space (displacement of fishers) (Primavera, 2006; Wiber, Young and Wilson, 2012)
  → *aqua-fish, space-crowd.*

WIND-FISH

NUMBER OF ARTICLES:
37 (12%)

INTENSITY vs	PRESENCE
38% (N=14)	**89% (N=33)**

HIGH	LOW
50% (N=7)	**14% (N=2)**
UNCERTAIN	UNKNOWN
64% (N=9)	**7% (N=1)**

Examples

Common Examples

- Competition for space as wind farms decrease the grounds for fishermen and lead to fishing in other, more crowded areas. However this is dependent on the type of fishery (static gear could still be used) (Ashley, Mangi and Rodwell, 2014; Jongbloed, van der Wal, and Lindeboom, 2014; Soukissian et al, 2017; Yates, Schoeman and Klein, 2015)
  → *wind-fish, space-crowd, context dependent.*
- Through acting as de facto artificial reefs/fish aggregators and no-take zones, there are spillover effects that benefit fisheries. However, this is still uncertain (Hooper and Austen, 2014; Lacroix and Pioch, 2011; Wilson et al, 2010; Bergstrom et al, 2014).
  → *Although some studies state this is uncertain, this is a common example found in the review. Thus it is included as wind-fish, natcap-enhance.*
- EM fields could affect various species and fish behaviour, however there is little direct evidence available (Fayram and de Risi, 2007; Wilson et al, 2010)
  → *See wind-eco.*

WIND-ECO

NUMBER OF ARTICLES:
40 (13%)

INTENSITY vs PRESENCE	
78% (N=31)	**90% (N=36)**

HIGH	LOW
36% (N=11)	**32% (N=10)**
UNCERTAIN	UNKNOWN
90% (N=28)	**7% (N=2)**

Examples

Common Examples

- Spatial extent of wind farms and availability of hard substrate alters habitats and communities. Also acts as artificial reefs that can attract fish and other species (including non-native) (Bergstrom et al, 2014; Ashley, Mangi and Rodwell, 2014; Janssen et al, 2013; Lacroix and Pioch, 2011).
- habitat loss and degradation, noise and vibration disturbance, abrasion (turbine foundation scour), dredging impacts such as turbidity, use of toxic paint (Bergstrom et al, 2014; Klinger et al, 2018; Soukissian et al, 2017; Zanuttigh et al, 2016; Wilson et al, 2010).
- Changes to wave propagation, wave driven processes, flow and circulation patterns (Soukissian et al, 2017).
- act as de facto MPAs/no-take zones via exclusion of fisheries (Burdon et al, 2018).
- Seabird mortality via collision (Punt et al, 2009; Burkhard et al, 2011)

  → *wind-eco, natcap-dimin and natcap-enhance included.*

- **wind**→cab→**eco**: electromagnetic fields disturb fish and mammals, cable impact on soft bottom assemblages (Punt et al, 2009; Soukissian et al, 2017; Bergstrom et al, 2014)
  → *wind-cab-eco, natcap-dimin included.*

REC-ECO

NUMBER OF ARTICLES:
46 (15%)

INTENSITY vs PRESENCE	
59% (N=27)	**87% (N=40)**

HIGH	LOW
96% (N=26)	**4% (N=1)**
UNCERTAIN	UNKNOWN
44% (N=12)	**0% (N=0)**

Examples

Common Examples

- Alters environment, destroys or pollutes mangroves and coastal wetlands, reduces biodiversity, affects water quality, damages coral reefs, stress on sea bottom, loss of fish spawning grounds, reef habitat fragmentation (Valadez-Rocha and Ortiz-Lozano, 2013)
- Provides substrate (ex. Artificial reefs) which can be a potential refuge for endangered (or invasive) species and fill in the gaps of species distribution (Firth et al, 2016; Feary, Burt and Bartholomew, 2011).
- Tidal restriction and hydrological changes affect macrobenthos and increase likelihood of algal blooms. Accelerated erosion, long-shore drift (transport of sand) is affected which can impact larval dispersion, recruitment and survival. (Liang et al, 2015; Cui et al, 2016; Xue, Hong and Charles, 2004).
  → *See the other sector summary pages where reclamation can act as a mechanism (eg. Ship-eco).*
- Aqua→dred/**rec→eco**: dredging impacts for reclaiming land for aquaculture purposes (Sherman, 2014; Liang et al, 2018). → *See aqua-eco.*

DRED-ECO

NUMBER OF ARTICLES:
47 (16%)

INTENSITY vs PRESENCE	
49% (N=23)	**83% (N=39)**

HIGH	LOW
65% (N=15)	**17% (N=4)**
UNCERTAIN	UNKNOWN
57% (N=57)	**0% (N=0)**

Examples

Common Examples

- Habitat loss, release of sediments and increased nutrient load, turbidity, removal of substrate, anoxic depressions, reduces species abundance and benthic biomass, smothering. Adversely affects primary production (ex. light penetration), filter feeders, movements of fish, survival of eggs and larvae, coral mortality (direct or via silt deposition). (Muttamara and Baldisimo, 1988; Foden, Rogers and Jones, 2011; Kim and Grigalunas, 2009; Valadez-Rocha and Ortiz-Lozano, 2013; Charlier and Charlier, 1992; Salomidi et al, 2012).
- Dumping dredged sands (smothering, burial, crushing of benthos) (Bolam and Rees, 2003; Andrulewicz, Otremba, and Kaminska, 2010).
  → *In our framework, dredging is a 'mechanism' sector. Thus it is included when it connects interactions between two sectors.*

Other examples

- Agg→**dred→eco**: same impacts (alteration of bottom topography and sediment composition, burial of habitats, release of harmful material, creation of plumes) → *See agg-eco*
- Ship → **dred** → **eco**: dredging impacts for creating shipping channels, harbour construction (Petrucci, Montanaro, and Merli, 2010; Griffiths et al, 2004) → *See ship-eco*
- Tou→dred→eco: dredging impacts for beach nourishment, water ski lanes (Graham et al, 2007; Petrucci, Montanaro, and Merli, 2010; Nairn et al, 2004). → *See tou-eco*
- Ren→dred→eco: dredging impacts during construction of renewable energy structures (Hammar et al, 2017; Dolman and Simmonds, 2010) → *Construction impacts are not included.*

MIN-ECO

NUMBER OF ARTICLES:
50 (16.4%)

INTENSITY vs	PRESENCE
74% (N=37)	**74% (N=37)**

HIGH	LOW
46% (N=17)	**8% (N=3)**
UNCERTAIN	UNKNOWN
81% (N=30)	**16% (N=6)**

Examples

Common Examples

- Seamounts, hydrothermal vents, and canyons contain economically important metals and are hotspots for many endemic species, as well as species that are not yet identified. Impacts are direct physical impact on seafloor (removal of substrate, fauna), sediment clouds, toxic effects and plumes (ex. Trace metal bioaccumulation), loss of habitat and fragmentation, biodiversity loss, population range shifts, noise and light pollution, mammal behaviour changes (Ellis et al, 2017, Miller et al, 2018; Boschen et al, 2016)
- Very long recovery time of deep sea biota (they are slow growing), if at all (Miller et al, 2018; Boschen et al, 2016; Levin et al, 2016)
  → *Due to the sensitivity of these mining areas, this is min-eco, natcap-dimin, finite, context dependent (may not be finite in every case).*
  Min→disp→**eco**: dumping mine tailings and dewatering waste (overlays benthic organisms, physically alters seabed, releases contaminants, bioaccumulation of heavy metals) (Ma, Schott, and Lodewijks, 2017). *This is min-disp-eco, natcap-dimin.*

MPA-ECO

NUMBER OF ARTICLES:
58 (19%)

INTENSITY vs PRESENCE	
40% (N=23)	**93% (N=54)**

HIGH	LOW
35% (N=8)	**17% (N=4)**
UNCERTAIN	UNKNOWN
78% (N=18)	**4% (N=1)**

Examples

Common Examples

- Maintain genetic diversity, allow populations to restore after overexploitation, protect intrinsic ecosystem function (if sufficient management strategies are practiced), (Claudet and Pelletier, 2004; Moland et al, 2013; Samoilys et al, 2007; Lowry, White and Christie, 2009; Green et al, 2014; McCook et al, 2014; Dimech et al, 2008; Garcia-Charton et al, 2008)
- **Mpa→eco→**fish: improvement of spawning-stock biomass and fishing yields via spillover, increases fish size (Fabinyi, 2008, Goni et al, 2008; Boersma and Parrish, 1999) –> *See mpa-fish summary page.*

→ *mpa-eco, natcap-enhance is included.*

AQUA-ECO

NUMBER OF ARTICLES:
67 (22%)

INTENSITY vs	PRESENCE
58% (N=39)	**87% (N=58)**

HIGH	LOW
64% (N=25)	**26% (N=10)**
UNCERTAIN	UNKNOWN
49% (N=19)	**3% (N=1)**

Examples

There were hundreds of aqua-eco interactions found in the review. Common examples included:

- Eutrophication: Increasing nitrogen, phosphorous levels, decreased dissolved oxygen (excess fish food and excrement) (Chopin et al, 2001; Price et al, 2015, Holmer, Perez and Duarte, 2003).
- Increased turbidity, loss of habitat for other species, water quality problems, damage to seabed, dispersion of antibiotics, invasive species, noise, reduced light penetration impacts seagrass underneath, disease transfer by escaped fish (wild fish also occur near cages) (Wiber, Young and Wilson, 2012; Holmer, Perez and Duarte, 2003; Rodriguez-Rodriguez et al., 2015).
- Stock enhancement/hatchery rearing tends to induce domestication effects that can modify morphological, physiological, behavioural, ecological and genetic traits of hatchery fish relative to those found in the wild population. Impacts genetic integrity of wild fish. Also, collection of seedstock for hatcheries involves high rates of bycatch (Lorenzen, 2014, Primavera, 2006).
  → *aqua-eco, natcap-dimin.*
- **Aqua**→disp→**eco**: 'blood water' from fish processing dumped at sea, garbage dumping, microbial and chemical discharges, wastewater (David et al, 2010). → *aqua-disp-eco, natcap-dimin.*
- **Aqua**→rec/dred→**eco**: habitat loss and physical impacts due to land reclamation/dredging driven by aquaculture. Uprooting mangroves to create shrimp ponds (Thia-Eng et al, 2000; Yu, 1994). → *aqua-rec-eco, natcap-dimin.*

→ *This is not an exhaustive list of all of the aqua-eco examples found in the review (there were hundreds).*

DISP-ECO

NUMBER OF ARTICLES:
76 (25%)

INTENSITY vs	PRESENCE
55% (N=42)	**84% (N=64)**

HIGH	LOW
67% (N=28)	**21% (N=9)**
UNCERTAIN	UNKNOWN
43% (N=18)	**7% (N=3)**

Examples

Common Examples – since disp is a 'mechanism', see the corresponding sector-eco summary sheets for details.

- Dril/min→**disp→eco**: dumping cuttings/tailings and fluids impacts benthos sediment quality and water quality. Causes turbidity, smothers benthos, chemical effects (toxic plumes, heavy metal concentrations), and buries organisms.
- Ship/Tou/Fish→**disp→eco**: boats or ports dumping garbage, food waste, fishing gear, sewage, wastewater/bilge water (degrades water/eco quality and affects marine life via ingestion or entanglement)
- Agg→dred→**disp→eco**: dumping dredged sands (smothering, burial, crushing of benthos)

Special Examples

- Aqua→**disp→eco**: 'blood water' from fish processing dumped at sea, garbage dumping, microbial and chemical discharges
- Mil→**disp→eco**: toxic substances from submerged chemical weapons, explosions impacting marine life, radioactive substances
- Des→pipe→**disp→eco**: brine discharge increases salt/metal concentrations, temperature, turbidity, decreases oxygen, adds chemicals from the processing and metals picked up by the pipeline

FISH-MPA

NUMBER OF ARTICLES:
91 (30%)

INTENSITY vs	PRESENCE
28% (N=25)	**97% (N=88)**

HIGH	LOW
52% (N=13)	**20% (N=5)**
UNCERTAIN	UNKNOWN
60% (N=15)	**0% (N=0)**

Examples

There were hundreds of fish-mpa interactions found in the review. Common examples included:

- Spatial conflict: MPAs decrease grounds for fishers (although often they are still allowed to fish with permits or according to different zoning strategies) (Gelcich, Edwards-Jones and Kaiser, 2005; Badalamenti et al, 2000; Edgar, Barrett and Stuart-Smith, 2009). Spatial exclusion of fishers can concentrate fishers in other, already-fished areas, leading to a larger eco impact than there would have been otherwise, increases in competition, and sometimes an increase in the distance needed to travel in order to fish. (Hattam et al, 2014).
  → *fish-mpa, space-crowd, context-dependent.*
- **Mpa** → eco → **fish**: improvement of fishing yields (spillover effects), although this is site-specific. Can be a good fish industry management measure. (Davies, Roberts and Hall-Spencer, 2007; McClanahan and Mangi, 2000; Badalamenti et al, 2000).
  → *fish-mpa, natcap-enhance.*

→ *This is not an exhaustive list of all of the fish-mpa examples found in the review (there were hundreds).*

TOU-ECO

NUMBER OF ARTICLES:
93 (31%)

INTENSITY vs	PRESENCE
45% (N=42)	**84% (N=78)**

HIGH	LOW
71% (N=30)	**17% (N=7)**
UNCERTAIN	UNKNOWN
48% (N=20=	**0% (N=0)**

Examples

There were hundreds of tou-eco interactions found in the review. Common examples included:

- Consumption of ocean resources (sport fishing, collection of live corals) (Chang, Hong and Lee, 2008), wildlife disruption (e.g. Divers, reef walking, jet skis, noise, fish feeding, whale watching) (Boersma and Parrish, 1999; Garcia-Charton et al, 2008)
- Tourist boats: anchoring or bumping (damages corals, seagrass), waste oil (pollution), spread of invasive species (Polychronidou, Liolios and Tselenti, 2002; Gomez et al, 2006; Edgar et al, 2010)
  → *tou-eco, natcap-dimin.*
- **Tou**→disp→**eco:** littering, illegal discharge of waste (Lozoya et al, 2015)
  → *tou-disp-eco, natcap-dimin.*
- **Tou** → dred → **eco**: dred-eco impacts due to marina construction, beach nourishment, creation of water ski lanes (Graham et al, 2007; Thinh et al, 2018)

  → *tou-dred-eco, natcap-dimin.*

→ *This is not an exhaustive list of all of the tou-eco examples found in the review (there were hundreds).*

DRIL-ECO

NUMBER OF ARTICLES:
101 (33%)

INTENSITY vs	PRESENCE
61% (N=62)	**82% (N=83)**

HIGH	LOW
70% (N=43)	**16% (N=10)**
UNCERTAIN	UNKNOWN
60% (N=37)	**5% (N=3)**

Examples

There were hundreds of dril-eco interactions found in the review. Common examples included:

- Oil spills and leakage: pollutes sediment and water quality, changes fish behaviour, smothers seabirds, impacts mammals (ex. Behaviour changes) (Harzl and Pickl, 2012; Ellis et al, 2013; Singkran, 2013, Grant and Briggs, 2002).
- Physical disturbance of the seabed, noise pollution, coastal modification, can harm sensitive deep sea communities (Foden, Rogers and Jones, 2011).
  → *dril-eco, natcap-dimin.*
- Platforms can act as artificial reefs with diverse, colonized communities. Platforms and pipelines can help spread invasive or maintain native species by providing new artificial habitat, genetic connectivity, and range extensions. They can also serve as efficient no-take zones which help rebuild declining fish stocks (Friedlander et al, 2014; Sammarco et al, 2014; Streich et al, 2017; Rabaoui et al, 2015).

  → *dril-eco, natcap-enhance.*
- **Dril** → disp → **eco**: drilling fluids, cuttings and muds disposed of on-site causes smothering (piles) and has chemical effects (Wilson et al, 2010; Ball, Stewart, and Schliephake, 2012). Discharges of drilling wastes are major contributors to pollution levels (in the Persian Gulf) (Meshkati and Tabibzadeh, 2016).

  → *dril-disp-eco, natcap-dimin.*

→ *This is not an exhaustive list of all of the dril-eco examples found in the review (there were hundreds).*

SHIP-ECO

NUMBER OF ARTICLES:
113 (37%)

INTENSITY vs PRESENCE	
50% (N=56)	**82% (N=93)**

HIGH	LOW
77% (N=43)	**16% (N=9)**
UNCERTAIN	UNKNOWN
43% (N=24)	**7% (N=4)**

Examples

There were hundreds of ship-eco interactions found in the review. Common examples included:

- **Ship** → disp → **eco**: litter, wastewater, sewage, food waste, nuclear waste (Thang To and Kato, 2017; Polglaze, 2003).
- **ship**→ rec →**eco:** reclaiming land for ship berths/ports, breakwaters (Firth et al, 2016).
    - Can be negative (damage/fragmentation/loss of natural habitats, provides artificial habitat for invasive species) or positive (artificial habitats for native species).
- Pollution/debris from ship collisions, oil spillage, paints (impacts water quality) (Ounanian et al, 2012).
- Ballast water: spreads alien/invasive species (Edgar et al, 2010)
- Ship → dred → eco: impacts from dredging for shipping channels (ex. Sediment mobilization, burial) (Bolam and Rees, 2003).

Special Examples

- Impacts on marine mammals ex. Whale strikes (Moore, 2014; Huntington, 2009).
- **Ship → eco** → aqua/fish: ships increasing sediment loads in crowded areas, which impacts aqua and fish. This resulted in lawsuits (Yu, 1994). → *This is included as ship-eco-aqua, ship-eco-fish, natcap-dimin.*
- noise pollution

→ *This is not an exhaustive list of all of the ship-eco examples found in the review (there were hundreds). Ship-eco, ship-disp-eco, ship-rec-eco (natcap enhance and dimin), ship-dred-eco are included.*

FISH-ECO

NUMBER OF ARTICLES:
198 (65%)

INTENSITY vs PRESENCE	
55% (N= 109)	**89% (N=177)**

HIGH	LOW
84% (N=92)	**9% (N=10)**
UNCERTAIN	UNKNOWN
43% (N=47)	**6% (N=6)**

Examples

There were hundreds of fish-eco interactions found in the review. Common examples included:

- Overfishing, bycatch, coral reef damages, fishing practices (Bottom trawling/dredging and boat anchoring has impacted benthic habitats, explosive and cyanide fishing, debalasting, oil pollution, fishery enhancements) (Cesar et al, 1997; Rajasuriya and White, 1995; Bottema and Bush, 2012)
- Part of xxx → **eco** → **fish** mechanism. For example,
  - Dril → **eco** → **fish**: impacted through impact of oil spills on eco
  - Agg→dred→**eco**→**fish**: agg/dred damages ecosystem, and downstream fishery resources
  - Wind→**eco**→**fish**: damages to eco during construction that impacts fisheries
- Dumping fishing gear, fish wastes, ballast water (**fish** → disp → **eco**) (Thia-Eng et al, 2000)

→ *This is not an exhaustive list of all of the fish-eco examples found in the review (there were hundreds). Fish-eco and fish-disp-eco are included in the database.*