

# ASSESSING SPILLOVER FROM MARINE PROTECTED AREAS TO ADJACENT FISHERIES: Baltic and North Seas, Atlantic EU Western Waters and Outermost Regions



EASME/EMFF/2018/011 Lot 1  
EASME/EMFF/2018/011 Lot 2

Specific contract NO.11



Joint NWWAC/PelAC Focus Group Spatial Dimension  
**7/11/2024**



## Goal of project

Provide an overview of the role that MPAs may play for local fisheries through spillover effects.



By reviewing existing studies that have attempted to assess either ecological or fishery spillover effects from MPAs in EU waters, and the benefits this can have on local fisheries through higher catch and/or economic yield.

Also assess the various methodologies that can be used to gather direct evidences of recruitment and spillover effects. To suggest an optimal monitoring plan.



Large-scale assessment + case studies

# Project objectives



Aim 1: Extent of spillover



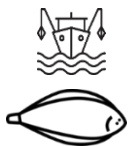
Aim 2: Features driving spillover



Aim 3: Methodological approaches



Aim 4: Likelihood of spillover effects (large, small, non-existent)

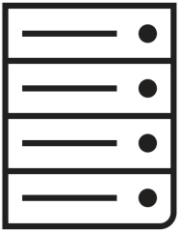


Aim 5: Methodological design and assess spillover

Case studies

+ stakeholder consultation

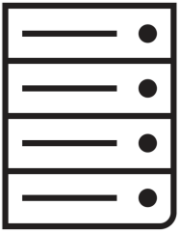




# Extent of spillover

First systematic review of empirical evidence regarding spillover from MPAs in the EU and other temperate regions.

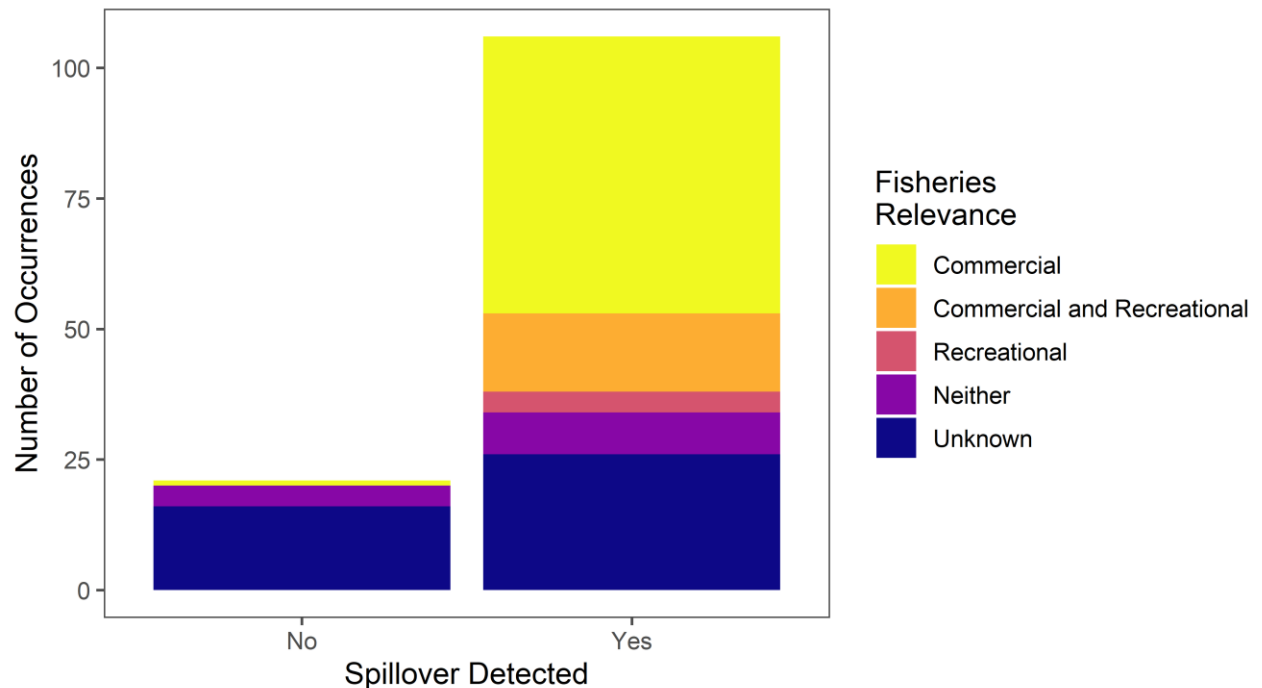
- A positive detection of spillover is reported in 83% of cases (106/127 unique combinations of articles, MPAs and species) that investigated spillover.
- The diversity of MPA contexts and species demands a large number of samples so all combinations can be investigated.
- Researchers and publishers should be encouraged to report negative results where spillover is investigated but not detected to better inform future meta-analyses.
- Empirical studies should aim to document the spatial scale and magnitude (abundance, biomass) of spillover rather than only identifying its occurrence.

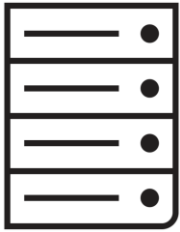


# Extent of spillover

Positive detection of spillover in 83% of *cases*.

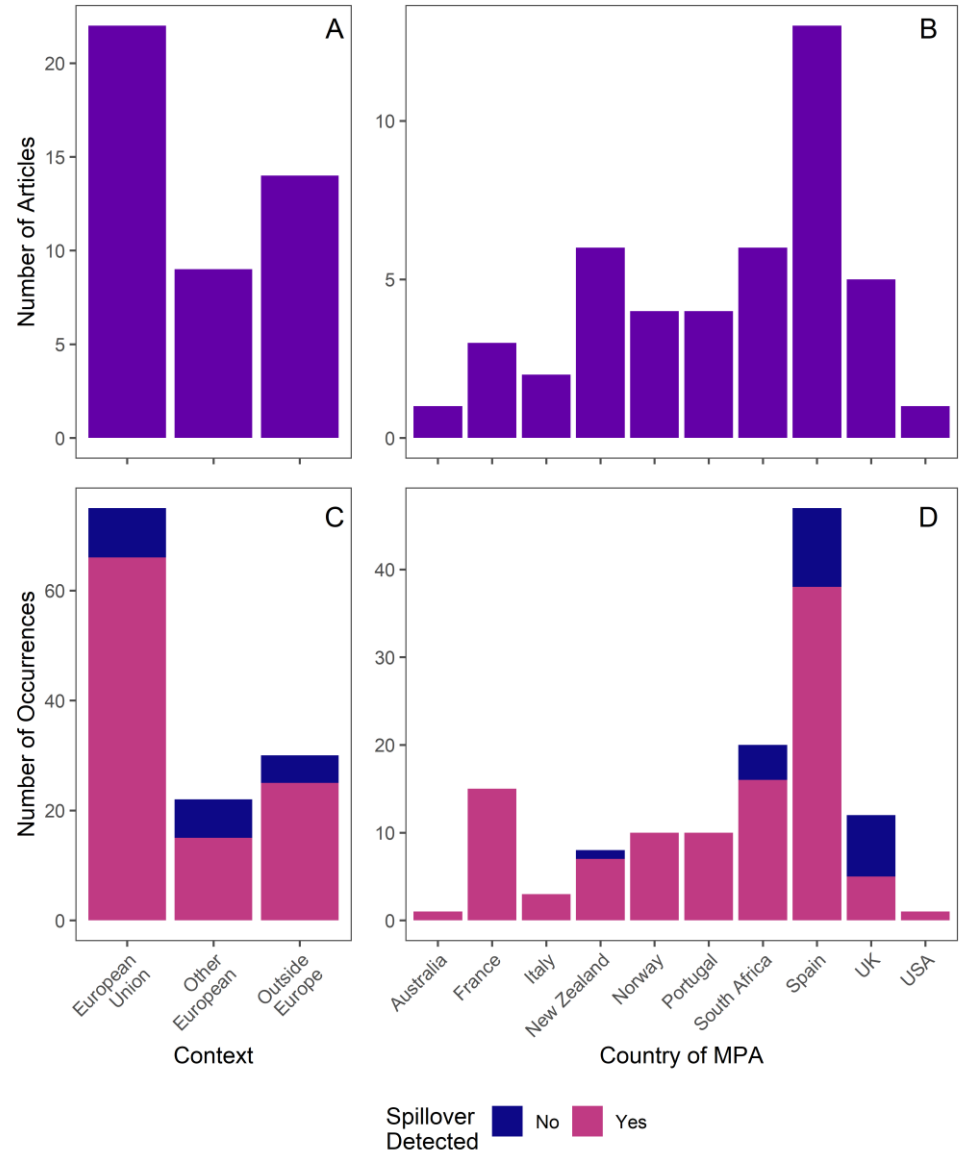
Majority of spillover cases were relevant for commercial fisheries (64%).

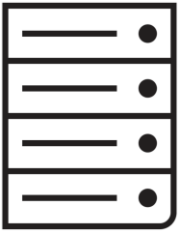




# Extent of spillover

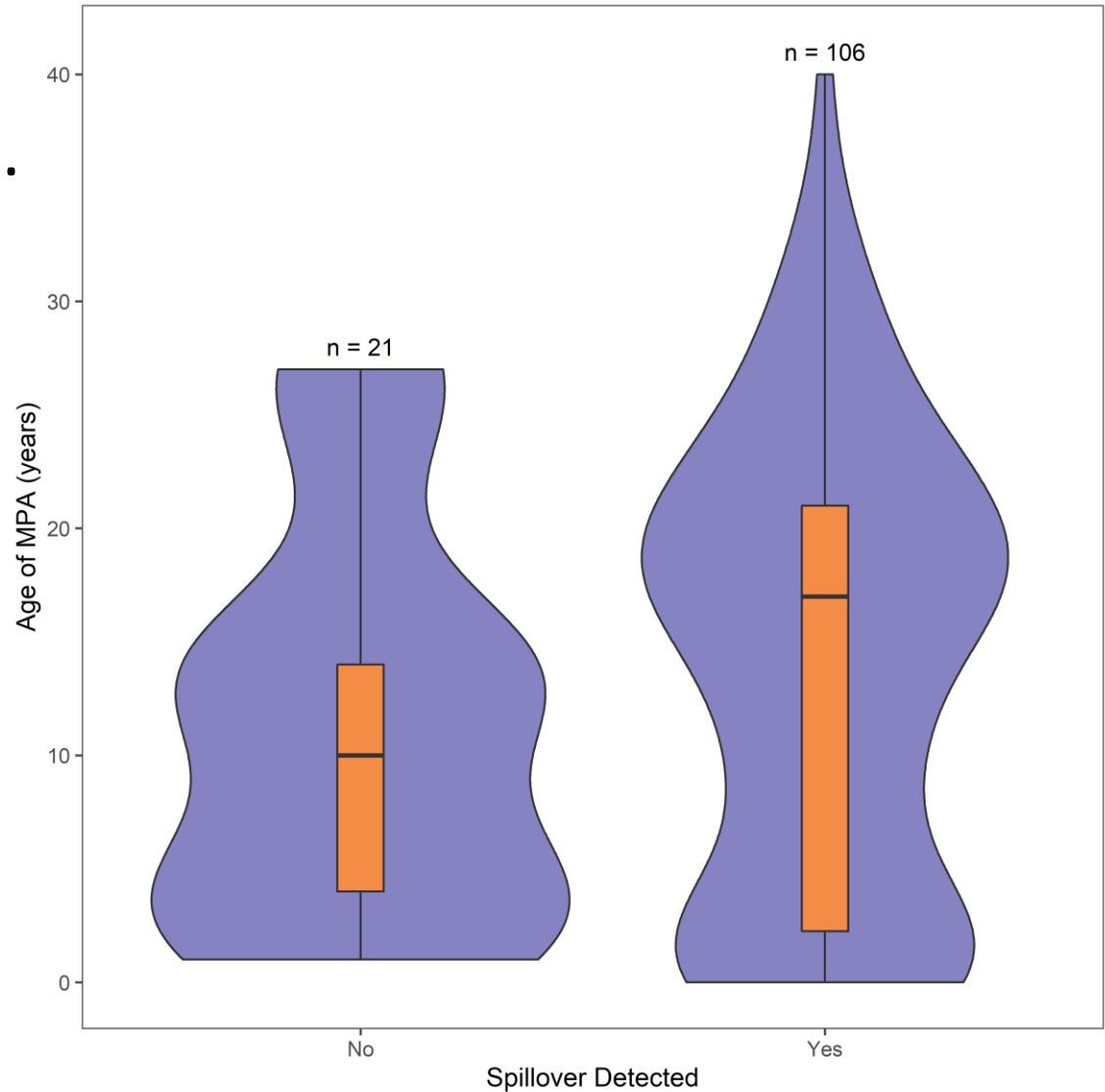
- European cases remained dominant in the literature.
- Only *one case* attempted to quantify magnitude of spillover (E.g. abundance)





# Extent of spillover

Influence of MPA Age.





# Features driving spillover

A meta-analysis of various factors related to MPA characteristics and species traits has shown a number of emergent patterns in relation to spillover effects.

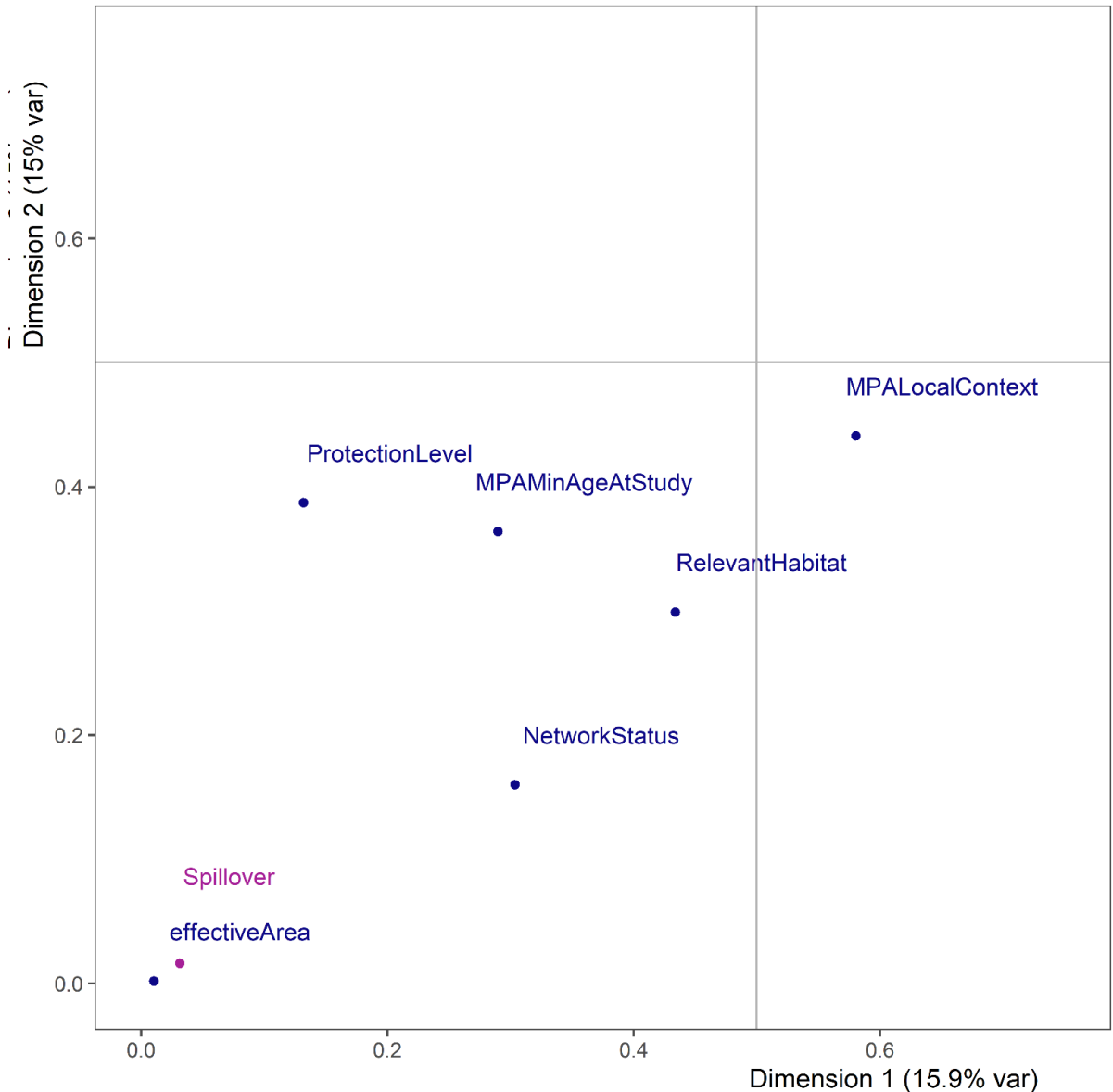
- A select combination of MPA characteristics (MPA age, local context and network status) proved capable of predicting the occurrence of spillover, and are therefore key considerations in the design of MPAs that have spillover as an objective.
- There is some evidence that species mobility (free swimming versus sessile or walking) and reproductive strategies (broadcast spawners versus brooders) are important factors for the occurrence of spillover.
- Empirical studies need to quantify magnitudes of spillover (export of numbers of individuals or biomass), and the temporal frequency and spatial scale with which these occur.





# Features driving spillover

- MPA characteristics
  - MPA FAMD
    - Area (km<sup>2</sup>) investigated
    - Age of the
    - Local context
    - Level of protection
    - MPA relationship [NetworkStatus]
    - Whether the extended feature [RelevantHabitat]

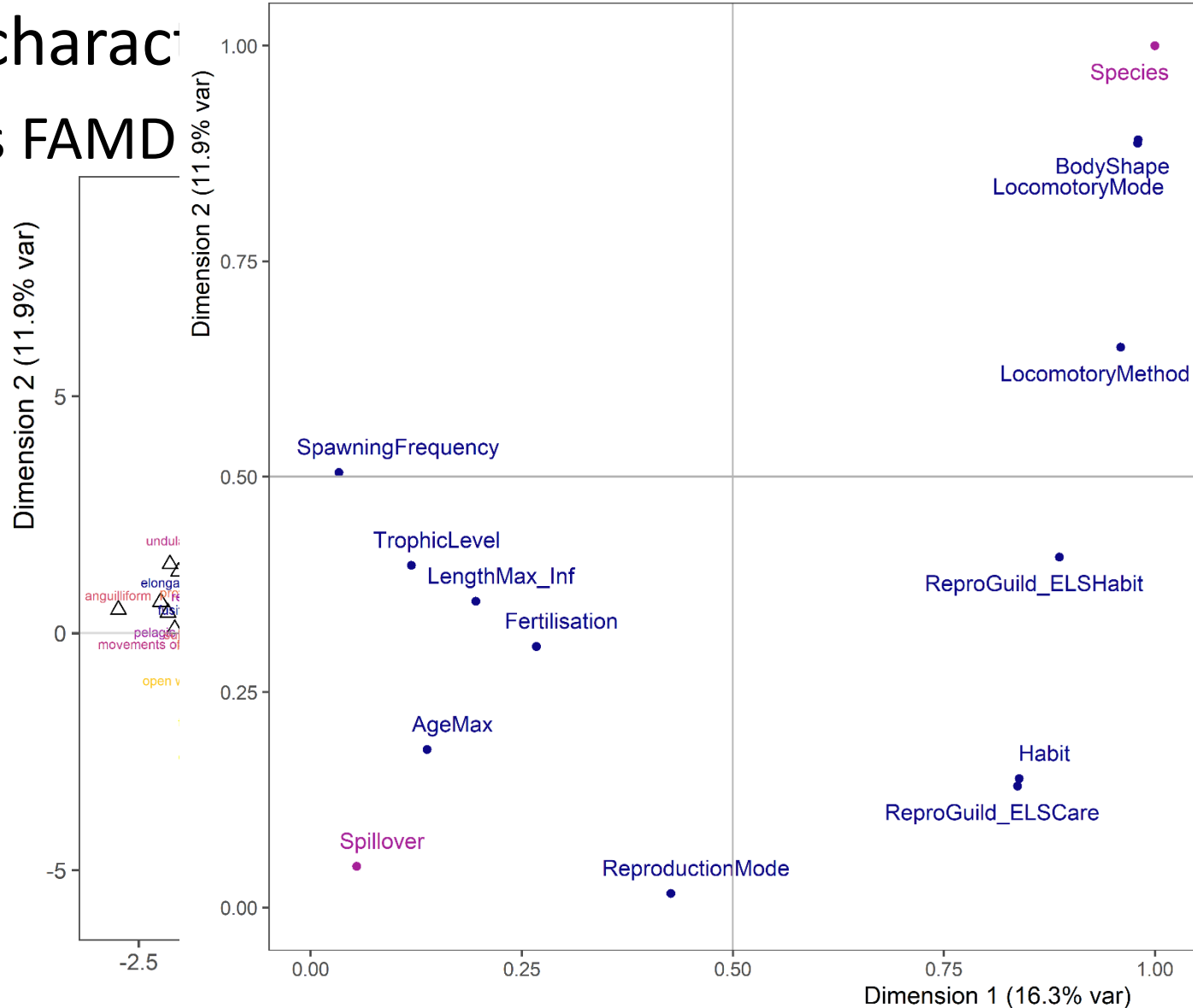


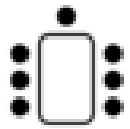


# Features driving spillover

- Species characteristics
- Species FAMD

Trait Variable
Habit
BodyShape
ReproductionMode
Fertilisation
SpawningFrequency
ReproGuild_ELSCare
ReproGuild_ELSHabit
LocomotoryMethod
LocomotoryMode
LengthMax_Inf
TrophicLevel
AgeMax



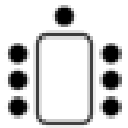


# Methodological approaches

There are a wide range of methodological approaches (sampling designs, sampling methods, statistical analyses) used to investigate spillover effects.

- To assess spillover, a Before After Control Impact (BACI) design should be favoured with a distance gradient sampling scheme that is integrated over time.
- The ideal sampling method addresses the research question being asked and is adapted to the species of interest and the site characteristics.
- The ideal data analysis is largely dependent on the sampling design and sampling method, but it needs to be appropriate for the acquired data set. A statistician or modeller should be preferably involved in the design and data analysis.
- A combination of approaches, using both biological sampling and tagging, gives a much more complete picture of potential spillover effects.

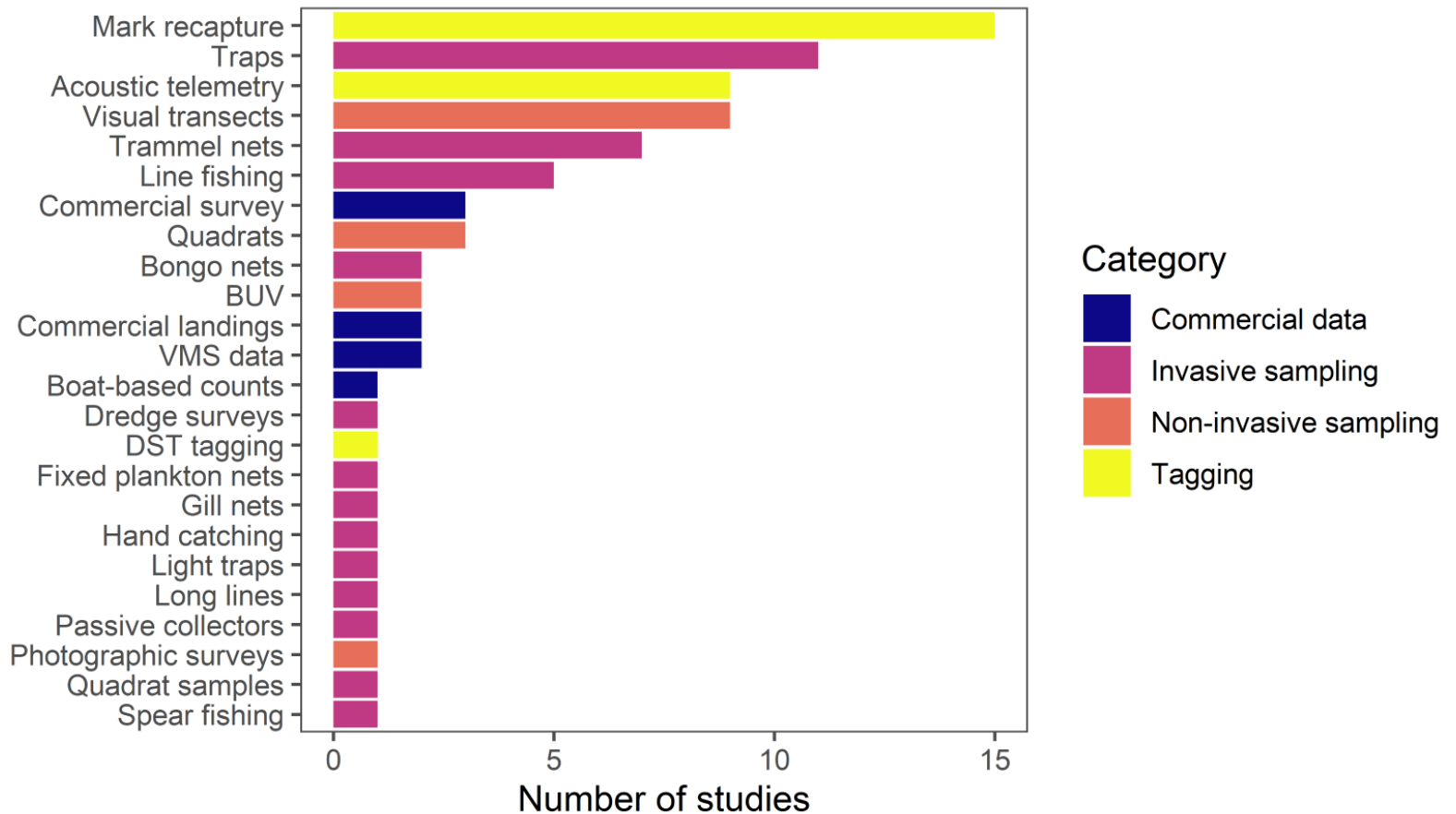


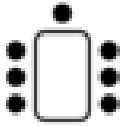


# Methodological approaches

- Field methods

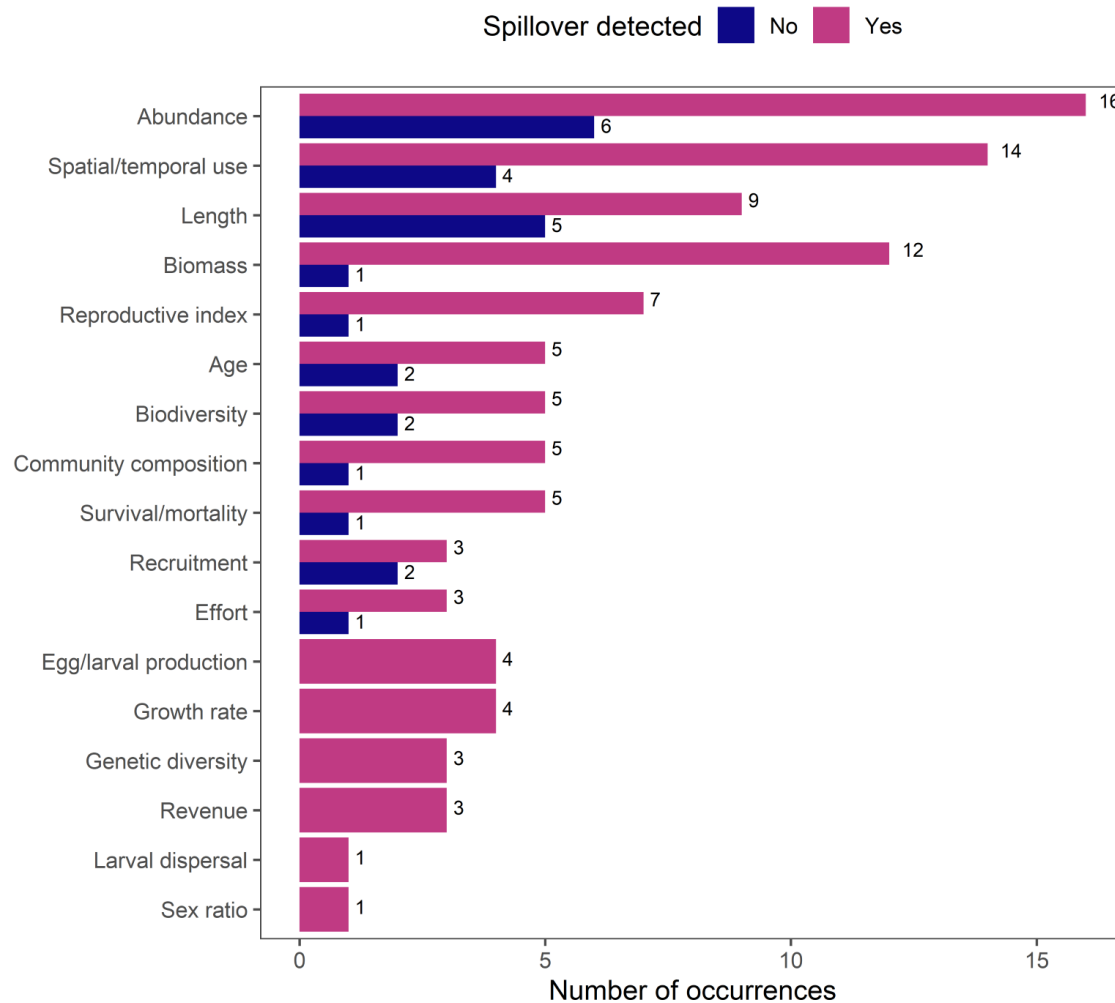
Field methods





# Methodological approaches

- Variables to be measured





# Likelihood of spillover effects

A conceptual model tool was developed (SPILLEST) to estimate likelihood of spillover for existing and proposed MPAs

- The tool integrates the potential environmental, social and economic factors that contribute to the occurrence, magnitude and detectability of spillover.
- Based on literature and a meta-analysis, SPILLEST can be applied for any relevant species and allows users to explore various MPA configurations and their contribution to spillover.
- SPILLEST was tested and validated in several MPA case studies and was found to largely conform with expectations of the relevant experts.



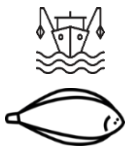
# Likelihood of spillover effects

## Excel-based tool

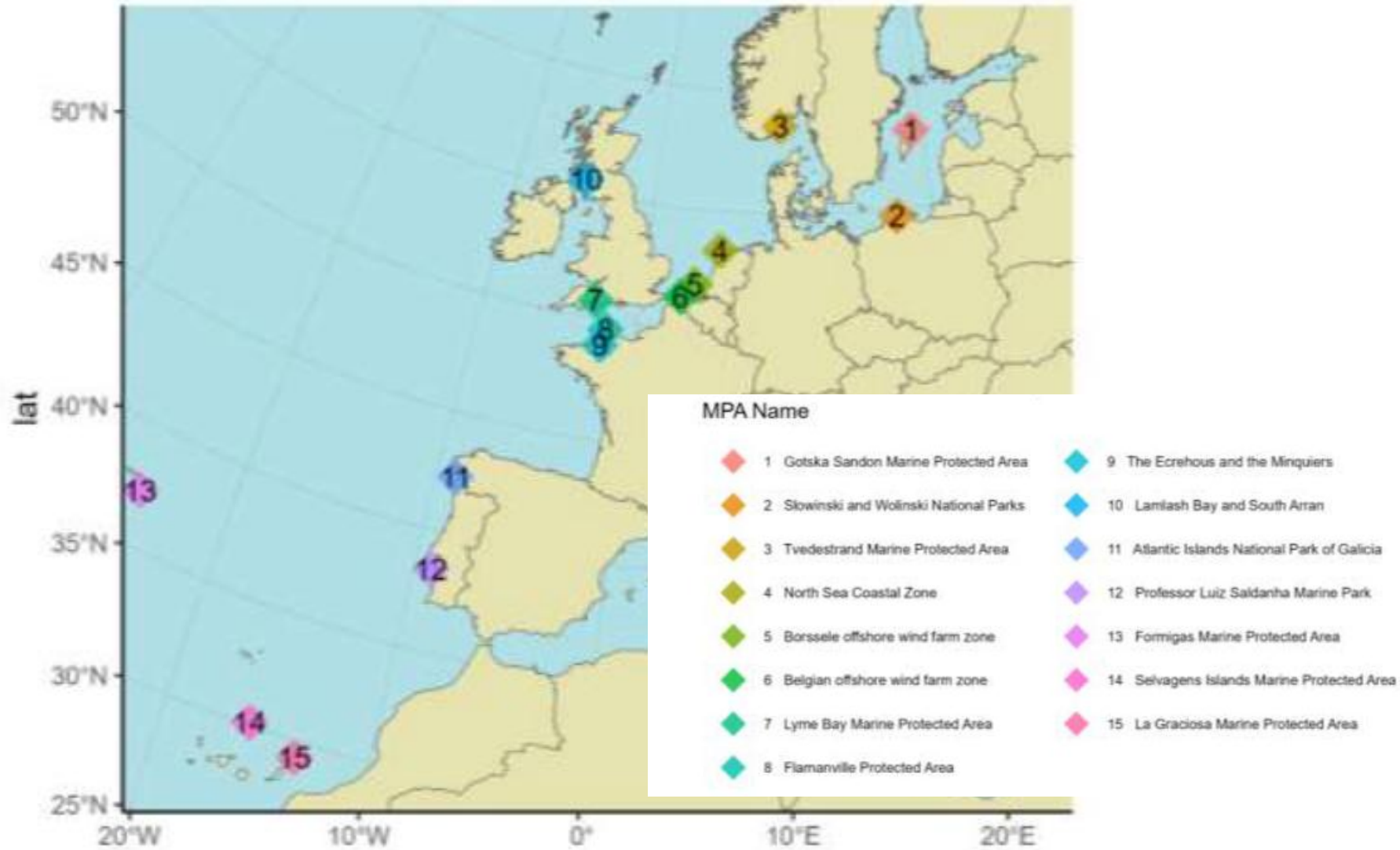
	B	C	D	E	F	
	Question	Answer (drop-down menu)	Contribution of chosen answer relative to maximum			
1						
2	How large is the MPA compared to the area used by individuals of the species (their home range)?	Much larger	0%			
3	What is the value of the species compared to other target species of the local fishery	Higher than average	75%			
4	To what extent is the habitat around the MPA similar to that within its borders?	Some of the habitat protected by the MPA also exists in the surrounding area	50%		<p>The total relative strength of spillover-promoting factors is</p> <p><b>25%</b></p> <p>This number indicates the (relative) degree to which the chosen MPA settings contribute to the likelihood and magnitude of spillover</p>	
5	Is there a buffer zone around the MPA where fishing is more restricted than in the surrounding area?	No	0%			
6	How long has the MPA been in place, compared to the approximate generation time of the focus species	One to three generation times	50%			
7	Is the MPA located along the coast, in the open sea or (almost) fully surrounding an island?	Open sea or surrounding an island	0%			
8	Is the MPA part of a network of protected areas?	No	0%			
9	Is the MPA fully closed (no fishing zone) or partially closed (open part of the year, open to certain gear types, etc)?	Partially closed	0%			
10	How mobile is the species considered?	Partly - It is (nearly) sessile a substantial part of its life	50%			
22	END OF QUESTIONNAIRE					
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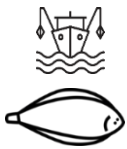
Excel interface details: Spillover\_Tool\_Final.xlsx, Last Modified: Just now, Kooten, Tobias van, Comments, Share, User interface, Admin Answers and Scores, Admin Dropdown Texts, Admin ...





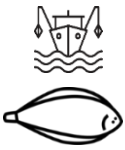
# Assessing spillover: Case study results





# Assessing spillover: Case study results

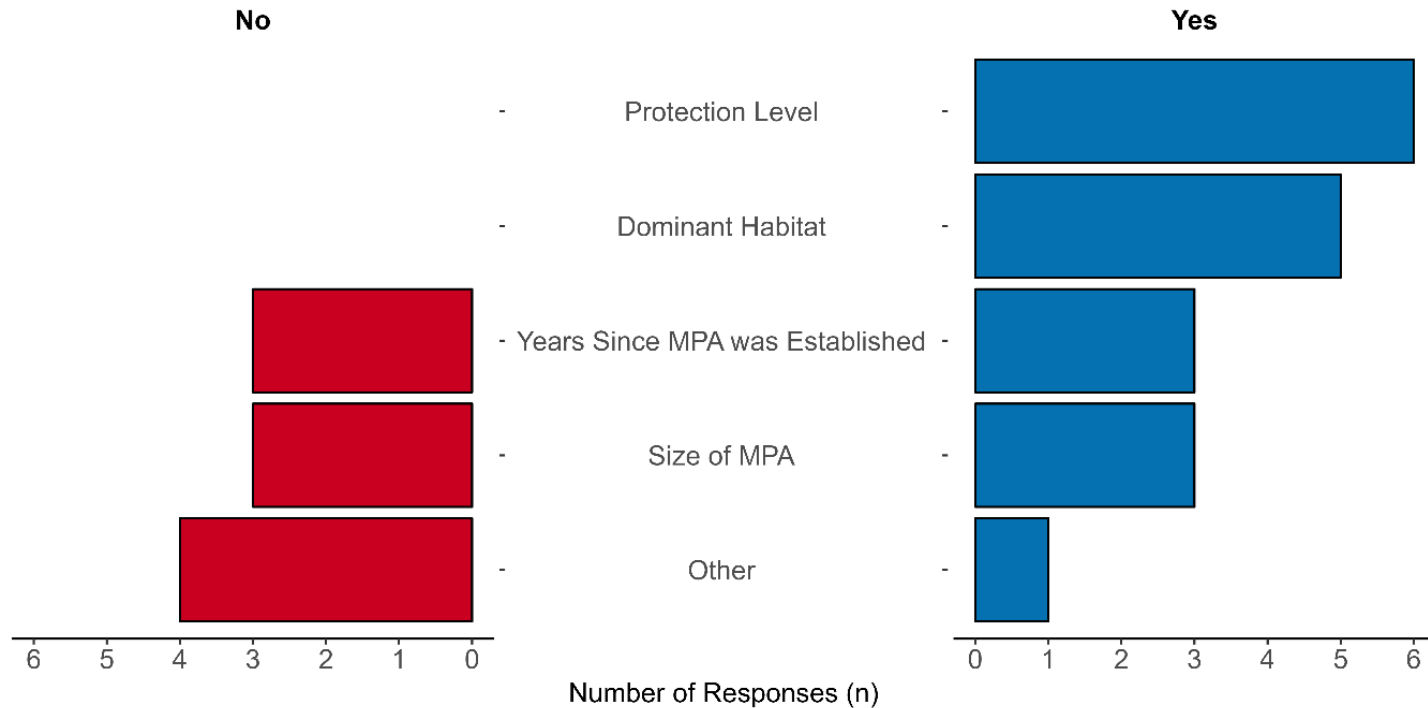
Regional Sea	MPA	Protection	Species EN	Spillover	Why?
Baltic Sea	Gotska Sandön MPA	High	Turbot & Flounder	Potentially	Larval spillover, but not consistent over time
	Slowinski and Wolinski National Parks	Low	Commercial fish species	No	Steady reduction in catches in the fishing squares where the parks are located. No perceptible spillover effects according to stakeholders.
Skagerrak	Tvedestrand MPA	High	Lobster	Potentially	CPUE increased outside MPA, but no effect of MPA proximity
North Sea	North Sea Coastal Zone	Moderate-High	Grey shrimp	Potentially	Increased CPUE, but reduced competition
	Borssele offshore wind farm zone	High	Sole, Common dab, Tub gurnard	No	No increased biomass / CPUE around the OWF
	Belgian offshore wind farm zone	High	Sole Plaice	No Potentially	No increased biomass / CPUE around the OWF Increased CPUE, but reduced competition
English Channel	Lyme Bay MPA	High	Multiple species	No	Biomass is building up only inside of the MPA
	Flamanville Protected Area	High	Lobster Crab	Yes No	Increase in species abundance and size around MPA Biomass lower around MPA after establishment
	The Écréhous and the Minquiers	Moderate	Crustaceans	No	Stakeholders indicate little chance of spillover, and no direct evidence
Celtic Sea	Lamlash Bay and South Arran	High	Commercial fish species	No	Changes in catches have not followed a clear pattern
			Crustaceans	No	Just as many import as export of crustaceans in MPA
			Scallops & lobsters	Yes	Higher reproductive biomass (larval export), abundances correlated with proximity of MPA, but BACI is needed
Iberian Coast	Atlantic Islands National Park of Galicia	Low	Nektobenthic carnivorous fish	No	Lack of comprehensive fishing restrictions in the MPA
	Professor Luiz Saldanha Marine Park	High	Sole, seabream and skates	Potentially	Reported movement of individuals from inside to outside of park but no reports of increased fisheries catches
Macaronesia	Formigas MPA	Moderate	Commercial fish species	Unclear	Conflicting views of stakeholders
	Selvagens Islands MPA	Low-High	Commercial fish species	Unclear	Conflicting views of stakeholders
	La Graciosa MPA	Moderate	Med. Parrotfish & Blacktail comber	Yes	Increased abundance and biomass around MPA
			Comb grouper	Potentially	Increased abundance in MPA, not confirmed out of MPA
			Emerald wrasse, Zebra sea bream, dreamfish	No	No changes in biomass



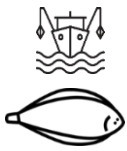
# Assessing spillover: Case study results

Stakeholder consultation (fishery, management, NGO and scientists)

*In your opinion, is there spillover of either fish or larvae from your MPA that is helping fisheries?  
If yes, what factors are contributing to spillover effects?*



There are different perspectives on the presence/absence of spillover in the case study MPAs even within the same stakeholder group.



# Assessing spillover: Case study results

- It is **challenging to source enough case studies** in the regional seas surrounding Europe with suitable data for the analysis of spillover effects.
- Half of the case studies showed evidence of spillover effects or the potential of spillover effects. Their non-uniform nature makes it difficult to attribute common factors to the occurrence of spillover.
- MPAs can lead to increased spillover of species, but the **patterns will be species-specific**, and spillover effects will take **a long time to be relevant for fisheries**.
- While all stakeholders acknowledge the MPAs' role in protecting biodiversity, fishers express concerns about the impacts of fishing restrictions on their livelihoods.
- There is **hope** amongst stakeholders that MPAs can **provide benefits to both biodiversity and fisheries**, but empirical **spillover evidence is lacking** in many cases.

# SPILLOVER Conclusions

- The study substantially increased the availability of information on spillover in EU waters and other temperate regions worldwide. It also identified the areas that need further research.
- There is **evidence for spillover from MPAs to adjacent waters in Europe**. On the one hand, the combination of three **MPA characteristics**: its **age**, **where it is situated** (estuarine, surrounding an island, or in open water) and whether it is **part of a network** of MPAs is important. On the other hand, the way that **species move around and reproduce have an influence on its ability to spillover**.
- **Spillover patterns are species-specific** and that **spillover effects may take a relatively long time** (multiple years) **before they benefit fisheries**.

# SPILLOVER Conclusions

- To improve the knowledge on spillover, larger datasets of studies are needed, including both studies that did and did not detect spillover. Therefore, **further field studies** are needed that should be **published in primary literature**.
- The field studies should quantify the **magnitude**, the temporal **frequency** and **spatial scale** with which spillover occurs. Additionally, to improve the knowledge about the relation between fishing activities and spillover, a requirement is the **collection and documentation of more catch and effort data** inside the protected area and outside, with varying distances to the protected area.
- Comparing data before and after implementation of an MPA, measured inside and outside the area (“BACI design”) is the **recommended approach**. Gradients over time and distance to the MPA need to be included in this approach. This in combination with tagging studies is advised.

# Thank you





# SPILLOVER Recommendations

- To better **understand the drivers of spillover**, future research should be based on larger datasets and include negative results. This demands that further field studies are both promoted and undertaken and then published in primary literature.
- More information on the **magnitude and scale of spillover** is needed. Therefore, empirical studies should start quantifying the magnitude, and the temporal frequency and spatial scale with which spillover occur.
- There is a need to investigate a **broader range of protection levels** in MPAs and other relevant areas, such as ‘other effective area-based conservation measures’ (OECMs).
- There is also a need for further emphasis on using data from a **diverse range of habitats and commercial species**, as well as determining the **level of juvenile and subadult spillover**.



# SPILLOVER Recommendations

- To improve the knowledge about **the relationship between (changes in) fishing activities and spillover**, through collection and documentation of more catch and effort data inside protected areas and outside, with varying distances to the protected areas.
- There is a need to **distinguish between ecological and fishery spillover** in future research. Being able to better predict and quantify fishery spillover would be beneficial to the dialogue among stakeholders. Fishery spillover could provide direct benefit to local fisheries and serve as an incentive for the fishing sector, potentially offsetting the impact of fishery restrictions.

# SPILLOVER Recommendations

- To aim for **comparable perspectives on absence or presence of spillover between stakeholders**, by improving knowledge about what spillover is through data collection in line with the above recommendations and through raising awareness on spillover effects and benefits.
- The **SPILLEST conceptual model** could be used as a tool in stakeholder dialogues when discussing features driving spillover. The tool can be updated when new knowledge becomes available.

# SPILOVER Recommendations

- Specific **recommendations on methodologies** for monitoring and assessment of spillover effects are: For **monitoring (data collection)**: it is recommended (i) to use a BACI design with a distance gradient sampling scheme that is integrated over time when implementing an MPA; (ii) to use a combination of traditional (biological) sampling and tagging studies, as it provides a much more complete picture of potential spillover effects; (iii) to assess different response variables simultaneously (e.g. abundance, biomass, reproductive index). Nevertheless, the ideal sampling method should address the research question being asked and be adapted to the species of interest and the MPA site characteristics.
- For **assessing spillover (data analyses)**: the ideal data analysis method is largely dependent on the sampling design, method and data availability. Therefore, it is important to take into account spatial and temporal ranges, the number of observations, MPA characteristics (e.g. age) and species traits (exploitation history, mobility and reproductive strategies), potential population-level effects and fisheries' response to the MPA. Some more detailed guidance for future assessments is given in the 'advisory protocol'.