Ecological Applications

# Appendix S1 – Metadata for common dataset

## Complementarity and sensitivity of benthic state indicators to bottom-trawl fishing disturbance

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- **Gradient number: 1**

Area: Adriatic Sea – Italian EEZ
Habitat Type: Circalittoral sand
Depth Range: 9-56 m
Sampling Gear: Rapido trawl
Sampling Program: Italian bottom trawl survey (SoleMon); all stations in the circalittoral sand habitat type were selected for the analysis.
Number of stations (samples per station): 12 (1)
Maximum distance between stations (km): 207
Sampling year (month): 2016 (11)
Contact for further information: Saša Raicevich (sasa.raicevich@isprambiente.it)
Reference: Riva (2022)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Beam and otter trawls | SAR per year average from 2012 to 2016 | Sum of OTB and TBB (VMS and AIS data) (Russo et al. 2020) | Kg wet weight per $km^2$ | Numbers per $km^2$ | Depth and net primary production |

- **Gradient number: 2**

Area: Adriatic Sea – Italian EEZ
Habitat Type: Circalittoral mud
Depth Range: 8-87 m
Sampling Gear: Rapido trawl
Sampling Program: Italian bottom trawl survey (SoleMon); all stations in the circalittoral mud habitat type were selected for the analysis.
Number of stations (samples per station): 16 (1)
Maximum distance between stations (km): 233
Sampling year (month): 2016 (11)
Contact for further information: Saša Raicevich (sasa.raicevich@isprambiente.it)
Reference: Riva (2022)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Beam and otter trawls | SAR per year average from 2012 to 2016 | Sum of OTB and TBB (VMS and AIS data) (Russo et al. 2020) | Kg wet weight per $km^2$ | Numbers per $km^2$ | Depth and net primary production |

- **Gradient number: 3**

Area: North Sea – Dutch EEZ "high tidal stress area"
Habitat Type: Sand
Depth Range: 22-36 m
Sampling Gear: Box core (0.078 $m^2$)
Sampling Program: Dutch infauna sampling program (MWTL); stations were selected based on similar depth and grainsize (see van Denderen et al. 2014)
Number of stations (samples per station): 15 (1)
Maximum distance between stations (km): 329
Sampling year (month): 2007 (3)
Contact for further information: Daniel van Denderen (pdvd@aqua.dtu.dk)
Reference: van Denderen et al. (2015)

| **Dominant bottom fisheries in area, if any** | **Pressure intensity unit** | **Method to estimate pressure gradient** | **Biomass unit** | **Abundance unit** | **Environmental information** |
|---|---|---|---|---|---|
| Beam and otter trawls | SAR per year - last 365 days | Estimated from interpolated VMS data from Dutch fisheries on 0.001 x 0.001 grid | Gram ash-free dry weight per 0.078 $m^2$ | Numbers per 0.078 $m^2$ | Sediment type, depth, tidal bed stress |

- **Gradient number: 4**

Area: North Sea – Dogger Bank
Habitat Type: Sand
Depth Range: 25-30 m
Sampling Gear: Hamon grab (0.1 $m^2$)
Sampling Program: Scientific cruise
Number of stations (samples per station): 7 (5)
Maximum distance between stations (km): 20
Sampling year (month): 2003 (9)
Contact for further information: Jan Geert Hiddink (j.hiddink@bangor.ac.uk)
Reference: Queirós et al. (2006)

| **Dominant bottom fisheries in area, if any** | **Pressure intensity unit** | **Method to estimate pressure gradient** | **Biomass unit** | **Abundance unit** | **Environmental information** |
|---|---|---|---|---|---|
| Beam and otter trawls | SAR per year | Queirós et al. (2006) | Gram wet weight per 0.5 $m^2$ | Numbers per 0.5 $m^2$ | Sediment type, depth, tidal bed stress |

- **Gradient number: 5**
  Area: North Sea – Fladen Ground
  Habitat Type: Mud
  Depth Range: 143–153 m
  Sampling Gear: Day grab (0.1 $m^2$)
  Sampling Program: Scientific survey
  Number of stations (samples per station): 14 (5)
  Maximum distance between stations (km): 41
  Sampling year (month): 2004 (6)
  Contact for further information: Jan Geert Hiddink (j.hiddink@bangor.ac.uk)
  Reference: Tillin et al. (2006)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Nephrops otter trawl | SAR per year | See Tillin et al. (2006) | Gram wet weight per 0.5 $m^2$ | Numbers per 0.5 $m^2$ | Sediment type, depth, tidal bed stress |

- **Gradient number: 6**
  Area: North Sea – Long Forties
  Habitat Type: Gravelly sand
  Depth Range: 74–83 m
  Sampling Gear: Hamon grab (0.1 $m^2$)
  Sampling Program: Scientific cruise
  Number of stations (samples per station): 5 (5)
  Maximum distance between stations (km): 19
  Sampling year (month): 2003 (9)
  Contact for further information: Jan Geert Hiddink (j.hiddink@bangor.ac.uk)
  Reference: Tillin et al. (2006)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Scallop dredge | SAR per year | See Tillin et al. (2006) | Gram wet weight per 0.5 $m^2$ | Numbers per 0.5 $m^2$ | Sediment type, depth, tidal bed stress |

- **Gradient number: 7**
  Area: North Sea – Silver Pit
  Habitat Type: Muddy sand
  Depth Range: 68–78 m
  Sampling Gear: Box corer (0.078 $m^2$)
  Sampling Program: Scientific cruise
  Number of stations (samples per station): 6 (4)
  Maximum distance between stations (km): 40
  Sampling year (month): 2002 (7)
  Contact for further information: Stefan Bolam (stefan.bolam@cefas.co.uk)
  Reference: van Denderen et al. (2015); selection of sampling stations and pressure intensity estimates are described in Jennings et al. (2001)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Beam and otter trawls | Relative frequencies of trawling disturbance on a linear scale | Estimated from aerial survey data collected by fisheries inspection services | gram wet weight per 0.31 m2 | Numbers per 0.31 $m^2$ | Sediment type, depth, tidal bed stress |

- **Gradient number: 8**
  Area: North Sea – Thames
  Habitat Type: Sand
  Depth Range: 16–40 m
  Sampling Gear: Box corer (0.078 $m^2$)
  Sampling Program: Scientific cruise
  Number of stations (samples per station): 6 (4)
  Maximum distance between stations (km): 49
  Sampling year (month): 2002 (7)
  Contact for further information: Stefan Bolam (stefan.bolam@cefas.co.uk)
  Reference: van Denderen et al. (2015)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Beam and otter trawls | Relative frequencies of trawling disturbance on a linear scale | Estimated from aerial survey data collected by fisheries inspection services | gram wet weight per 0.31 m2 | Numbers per 0.31 $m^2$ | Sediment type, depth, tidal bed stress |

- **Gradient number: 9**
  Area: Northern Iberian Coast
  Habitat Type: Sand (Offshore circalitoral sand)
  Depth Range: 71-202 m
  Sampling Gear: Otter trawl
  Sampling Program: Spanish IBTS (DEMERSALES); all stations in the offshore circalitoral sand habitat type were selected for the analysis.
  Number of stations (samples per station): 20 (1)
  Maximum distance between stations (km): 594
  Sampling year (month): 2016 (9 – 10)
  Contact for further information: José Manuel Gonzalez (jmanuel.gonzalez@ieo.csic.es)
  Reference: Serrano et al. (2022)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Otter trawl | SAR per year - average over the last 5 years | Estimated from interpolated VMS data from Spanish fisheries and calculated as the sum of the area swept by cell and year | Gram wet weight per $km^2$ | Numbers per $km^2$ | Depth |

- **Gradient number: 10**
  Area: Southern Bay of Biscay/Northern Iberian Coast
  Habitat Type: Several, but mainly mud (upper bathyal sediment)
  Depth Range: 186-936 m
  Sampling Gear: Otter trawl
  Sampling Program: Spanish IBTS (DEMERSALES); all stations in the upper bathyal habitat type were selected for the analysis.
  Number of stations (samples per station): 52 (1)
  Maximum distance between stations (km): 605
  Sampling year (month): 2016 (9 – 10)
  Contact for further information: José Manuel Gonzalez (jmanuel.gonzalez@ieo.csic.es)
  Reference: Serrano et al. (2022)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Otter trawl | SAR per year - average over the last 5 years | Estimated from interpolated VMS data from Spanish fisheries and calculated as the sum of the area swept by cell and year | Gram wet weight per $km^2$ | Numbers per $km^2$ | Depth |

- **Gradient number: 11**
  Area: Baltic Sea – Gotland
  Broad Habitat Type: Muddy sand
  Depth Range: 37-59 m
  Sampling Gear: van Veen grab (0.1 $m^2$)
  Sampling Program: Swedish benthic sampling program
  Number of stations (samples per station): 8 (1)
  Maximum distance between stations (km): 35
  Sampling year (month): 2012 (5)
  Contact for further information: Mattias Sköld (mattias.skold@slu.se)
  Reference: van Denderen et al. (2020)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Otter trawl | SAR per year based on the last year pre-sampling | Estimated from interpolated VMS data from Swedish and Danish fisheries and calculated as the sum of the area swept by trawls within a 250 m radius at each sampling location | Gram wet weight per 0.1 $m^2$ | Numbers per 0.1 $m^2$ | Sediment type and depth |

- **Gradient number: 12**
  Area: Baltic Sea – Polish EEZ
  Habitat Type: Sand
  Depth Range: 70-85 m
  Sampling Gear: Box core (0.06 $m^2$)
  Sampling Program: Scientific cruise
  Number of stations (samples per station): 11 (5)
  Maximum distance between stations (km): 32
  Sampling year (month): 2018 (9)
  Contact for further information: Daniel van Denderen (pdvd@aqua.dtu.dk)
  Reference: van Denderen et al. (2022)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Otter trawl | SAR per year - average of 2012-2018 | ICES VMS at 0.05 x 0.05 resolution (data call year is 2019) | Gram wet weight per 0.3 $m^2$ | Numbers per 0.3 $m^2$ | Sediment type, depth and bottom oxygen concentration |

- **Gradient number: 13**
  Area: NW Atlantic – Flemish Cap
  Habitat Type: Mainly mud (bathyal sediment)
  Depth Range: 786-1236 m
  Sampling Gear: Lofoten bottom trawl
  Sampling Program: Scientific survey
  Number of stations (samples per station): 26 (1)
  Maximum distance between stations (km): 185
  Sampling year (month): 2007 (6-7)
  Contact for further information: Mar Sacau (mar.sacau@ieo.csic.es); Pablo Durán Muñoz (pablo.duran@ieo.csic.es)
  Reference: Murillo et al. (2016, 2020), Muñoz et al. (2020)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Otter trawls | Number of pings by square km | Estimated from VMS data from international fisheries and calculated as the sum of pings by cell and year | Gram wet weight per $km^2$ | n/a | Depth |

- **Gradient number: 14**
  Area: Irish Sea – Sellafield
  Habitat Type: Muddy sand
  Depth Range: 21–42 m
  Sampling Gear: Day grab (0.1 $m^2$)
  Sampling Program: Scientific cruise
  Number of stations (samples per station): 15 (5)
  Maximum distance between stations (km): 42
  Sampling year (month): 2009 (6)
  Contact for further information: Jan Geert Hiddink (j.hiddink@bangor.ac.uk)
  Reference: Hinz et al. (2009); Hiddink et al. (2011).

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| Otter trawl | SAR per year | See Hiddink et al. (2011) | Gram weight per 0.5 $m^2$ | Numbers per 0.5 $m^2$ | Sediment type, depth, tidal bed stress |

- **Gradient number: 15**
  Area: Gulf of Finland
  Habitat Type: Circalittoral mud/Offshore circalittoral mud
  Depth Range: 56–84 m
  Sampling Gear: van Veen grab (0.112 $m^2$)
  Sampling Program: Finnish monitoring program
  Number of stations (samples per station): 8 (3)
  Maximum distance between stations (km): 179
  Sampling year (month): 2015 (5)
  Contact for further information: Henrik Nygård (henrik.nygard@syke.fi)
  Reference: Zoobenthos information system POHJE, Finnish Environment Institute (Syke). https://ckan.ymparisto.fi/dataset/pohjaelaintietojarjestelma-pohje

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| n/a | mg $O_2$/l | Measured dissolved oxygen concentration (1 meter above seafloor) | Gram wet weight per $m^2$ (converted from 0.33$m^2$) | Numbers per $m^2$ (converted from 0.33$m^2$) | Depth, sediment type, nutrients and hydrography |

- **Gradient number: 16**
  Area: Saronikos Gulf
  Habitat Type: Mixed sand / mud
  Depth Range: 20-94 m
  Sampling Gear: Box corer (0.1 $m^2$)
  Sampling Program: Saronikos sampling programme 2012
  Number of stations (samples per station): 8 (2)
  Maximum distance between stations (km): 33
  Sampling year (month): 2012 (2)
  Contact for further information: Sofia Reizopoulou (sreiz@hcmr.gr)
  Reference: Pavlidou et al. (2019)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| n/a | % total N | Data/pressure indicators: % of orgC and total N in the sediment at each sampling location. Pressure is based on total N (correlates with orgC) | Mg dry weight per 0.2 $m^2$ | Numbers per 0.2 $m^2$ | Sediment type, %org C, total N and depth |

- **Gradient number: 17**
  Area: Vigo Estuary
  Habitat Type: Infralitoral Mud
  Depth Range: <30 m
  Sampling Gear: BOUMA box-corer (0.0175 $m^2$)
  Sampling Program: Pollution monitoring program
  Number of stations (samples per station): 20 (1)
  Maximum distance between stations (km): 13
  Sampling year (month): 2004-2006
  Contact for further information: Juan Bellas (juan.bellas@ieo.csic.es)
  Reference: Bellas et al. (2011), Beiras et al. (2012)

| Dominant bottom fisheries in area, if any | Pressure intensity unit | Method to estimate pressure gradient | Biomass unit | Abundance unit | Environmental information |
|---|---|---|---|---|---|
| n/a | Cumulative pollution index | The CPI index combine several pollutants (e.g. Cd, Hg) in one index. See Bellas et al. (2011) for a complete description of CPI method | n/a | Numbers per $km^2$ (converted to $km^2$ from the core data) | Details on specific pollutants are available |

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