

benthic species-habitat dashboards

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Producing habitat summaries and visual dashboards for European marine benthic species

The processed EMODnet benthic numerical abundance product files, now matched to sediment properties and the EMODnet broadscale seabed habitat map, are here read in and used to feed functions to provide a summary of the habitat affinities of individual named benthic species. Where habitat affinity data is available for that species from Biotic, this is included too.

First, load required packages:

```
library(tidyverse)
library(ggribbles)
library(worrms)
library(ggtext)
library(patchwork)
```

Now, load the datasets (column types are fully specified for benth_events to avoid parsing errors):

```
benth_events <- read_csv(here::here(
  "data", "derived_data/benthic_abundance_sampling_events_seabed_habs.csv"),
  col_types = cols(
    datasetid = col_double(),
    datecollected = col_datetime(format = ""),
    decimallongitude = col_double(),
    decimallatitude = col_double(),
    minimumdepthinmeters = col_double(),
    sampid = col_double(),
    eventNumber = col_double(),
    MudPercent = col_double(),
    SandPercent = col_double(),
    GravelPercent = col_double(),
    TotalD50 = col_double(),
    SandD50 = col_double(),
    GravelD50 = col_double(),
    Rock10cm = col_double(),
    Rock50cm = col_double(),
    log_D50 = col_double(),
    Biozone = col_character(),
    Energy = col_character(),
    Substrate = col_character(),
    Salinity = col_character(),
    Oxygen = col_character(),
    EUNIScomb = col_character(),
```

```

    EUNIScombD = col_character(),
    Allcomb = col_character(),
    AllcombD = col_character(),
    SalcombD = col_character(),
    MSFD_BBHT = col_character()
  ))
benth_abundances <- read_csv(here::here(
  "data", "derived_data/benthic_abundances_long.csv"))
benth_taxa <- read_csv(here::here(
  "data", "derived_data/benthic_taxa.csv"))
benth_substrate_prefs <- read_csv(here::here(
  "data", "derived_data/benthic_species_substratum_prefs.csv"))
benth_substrate_key <- read_csv(here::here(
  "data", "derived_data/substrate_values_key.csv"))

```

Getting habitat summaries for a single species

This code loads a function which takes a species Aphia ID and returns basic summary information about the benthic habitats that it has been recorded in (from the EMODnet numerical abundance product). For continuous variables (e.g. ‘Percent Mud’) the function returns the arithmetic mean value of the variable from all sampling events the species was recorded in, weighted by its abundance in each event. For categorical variables (e.g. ‘Substrate’) the function returns the relative frequency of occurrence in each category (again weighted by abundance). Finally, the function checks if the species is one of those occurring in our Biotic substrate dataset, and adds relevant information about its recorded habitat preferences if so.

```
source(here::here("scripts", "get_species_habitats.R"))
```

An example of running for one species:

```
get_species_habitats(103228)
```

```

## # A tibble: 1 x 80
##   AphiaID total_occ total_ab mean_ab GravelD50 GravelPercent log_D50 MudPercent
##   <dbl>      <int>      <dbl>  <dbl>      <dbl>          <dbl>  <dbl>      <dbl>
## 1  103228      3002  154156.   51.4      8.06          22.5  -0.208    3.03
## # ... with 72 more variables: Rock10cm <dbl>, Rock50cm <dbl>, SandD50 <dbl>,
## #   SandPercent <dbl>, TotalD50 <dbl>, Energy_High energy <dbl>,
## #   Energy_Low energy <dbl>, Energy_Moderate energy <dbl>,
## #   Energy_No energy information <dbl>, Energy_NA <dbl>,
## #   Biozone_Arctic mid bathyal <dbl>, Biozone_Atlantic upper bathyal <dbl>,
## #   Biozone_Atlanto-Arctic upper bathyal <dbl>,
## #   Biozone_Deep circalittoral <dbl>, Biozone_Infralittoral <dbl>,
## #   Biozone_Shallow circalittoral <dbl>, Biozone_NA <dbl>,
## #   Substrate_Coarse substrate <dbl>, Substrate_Fine mud <dbl>,
## #   Substrate_Mixed sediment <dbl>, Substrate_Muddy sand <dbl>,
## #   Substrate_Rock or other hard substrata <dbl>, Substrate_Sand <dbl>,
## #   Substrate_Sandy mud <dbl>, Substrate_Sandy mud or Muddy sand <dbl>,
## #   Substrate_Seabed <dbl>, Substrate_Sediment <dbl>, Substrate_NA <dbl>,
## #   Salinity_NA <dbl>, Oxygen_NA <dbl>, EUNIScomb_A3.1 <dbl>,
## #   EUNIScomb_A4.1 <dbl>, EUNIScomb_A4.2 <dbl>, EUNIScomb_A4.27 <dbl>,
## #   EUNIScomb_A4.3 <dbl>, EUNIScomb_A5 <dbl>, EUNIScomb_A5.13 <dbl>,
## #   EUNIScomb_A5.14 <dbl>, EUNIScomb_A5.15 <dbl>,
## #   EUNIScomb_A5.23 or A5.24 <dbl>, EUNIScomb_A5.25 or A5.26 <dbl>,
## #   EUNIScomb_A5.27 <dbl>, EUNIScomb_A5.33 <dbl>, EUNIScomb_A5.35 <dbl>,

```

```
## # EUNIScomb_A5.36 <dbl>, EUNIScomb_A5.37 <dbl>, EUNIScomb_A5.43 <dbl>,
## # EUNIScomb_A5.44 <dbl>, EUNIScomb_A5.45 <dbl>, EUNIScomb_A6 <dbl>,
## # EUNIScomb_A6.3 or A6.4 <dbl>, EUNIScomb_A6.5 <dbl>, EUNIScomb_Na <dbl>,
## # EUNIScomb_NA <dbl>, MSFD_BBHT_Circalittoral coarse sediment <dbl>,
## # MSFD_BBHT_Circalittoral mixed sediment <dbl>,
## # MSFD_BBHT_Circalittoral mud <dbl>,
## # MSFD_BBHT_Circalittoral rock and biogenic reef <dbl>,
## # MSFD_BBHT_Circalittoral sand <dbl>,
## # MSFD_BBHT_Infralittoral coarse sediment <dbl>,
## # MSFD_BBHT_Infralittoral mixed sediment <dbl>,
## # MSFD_BBHT_Infralittoral mud <dbl>,
## # MSFD_BBHT_Infralittoral rock and biogenic reef <dbl>,
## # MSFD_BBHT_Infralittoral sand <dbl>, MSFD_BBHT_Na <dbl>,
## # MSFD_BBHT_Offshore circalittoral coarse sediment <dbl>,
## # MSFD_BBHT_Offshore circalittoral mixed sediment <dbl>,
## # MSFD_BBHT_Offshore circalittoral mud <dbl>,
## # MSFD_BBHT_Offshore circalittoral rock and biogenic reef <dbl>,
## # MSFD_BBHT_Offshore circalittoral sand <dbl>,
## # MSFD_BBHT_Upper bathyal sediment <dbl>, MSFD_BBHT_NA <dbl>
```

Getting habitat summaries for all

This simply runs the above function over all species:

```
sp_habitat_summaries <- benth_taxa %>%
  mutate(aphia = AphiaID) %>%
  group_by(aphia) %>%
  group_modify(~ get_species_habitats(sp_id = .$AphiaID)) %>%
  ungroup() %>%
  dplyr::select(-aphia)
```

To neaten up this output, gather together similar columns:

```
sp_habitat_summaries <- sp_habitat_summaries %>%
  dplyr::select(AphiaID:mean_ab, inf_epi,
    TotalD50, log_D50, GravelD50, GravelPercent,
    MudPercent:SandPercent,
    starts_with("Energy"),
    starts_with("Biozone"),
    starts_with("Substrate"),
    starts_with("Salinity"),
    starts_with("EUNIS"),
    starts_with("MSFD"),
    everything())
```

For comparative purposes, it is also useful to have summaries of the distributions and frequencies of habitat types across all sampling events. This loads a function to do that:

```
source(here::here("scripts", "get_event_habitats.R"))
```

So means / frequencies of different habitat types are:

```
event_habitat_summaries <- get_event_habitats()
```

We can write these two data products to file:

```
write_csv(sp_habitat_summaries,
  here::here(
    "product", "benthic_species_habitat_summaries.csv"))
write_csv(event_habitat_summaries,
  here::here("product", "benthic_sampling_event_habitat_summaries.csv"))
```

There are a lot of variables in the summary datasets. This provides some meta-data - a three-column dataset with the variable name, a brief description, and its source. For additional information on the EUNIS classifications, see <https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification>.

```
sp_habitat_summaries_meta <- tibble(
  variable_name = names(sp_habitat_summaries),
  variable_description = c(
    "Taxon AphiaID",
    "Total number of sampling events the species occurred in",
    "Total abundance of the species across all sampling events",
    "Mean abundance of the species across the sampling events in which it occurred (i.e. excluding zeros)",
    "Information on species habitat position, Infaunal, Epifaunal, or Both for species in Biotic, NA otherwise",
    "Mean of the median grain size of the whole sediment across all occurrences matched to sediment data",
    "Mean of the logged (base 10) median grain size of the whole sediment across all occurrences matched to sediment data",
    "Mean of the median grain size of the gravel fraction of sediment across all occurrences matched to sediment data",
    "Mean percentage of surface sediment on seabed composed of gravel across all occurrences matched to sediment data",
    "Mean percentage of surface sediment on seabed composed of mud across all occurrences matched to sediment data",
    "Mean percentage of area made up of surface rock across all occurrences matched to sediment data, where rock is defined as coarse sand or larger",
    "Mean percentage of area made up of rock in the top 50cm across all occurrences matched to sediment data",
    "Mean of the median grain size of the sand fraction of sediment across all occurrences matched to sediment data",
    "Mean percentage of surface sediment on seabed composed of sand across all occurrences matched to sediment data",
    "Abundance-weighted frequency of occurrence in moderate energy habitats",
    "Abundance-weighted frequency of occurrence in high energy habitats",
    "Abundance-weighted frequency of occurrence in low energy habitats",
    "Abundance-weighted frequency of occurrence in habitats with missing energy classification",
    "Abundance-weighted frequency of occurrence in habitats with no energy classification",
    "Abundance-weighted frequency of occurrence in the deep circalittoral biozone",
    "Abundance-weighted frequency of occurrence in the infralittoral biozone",
    "Abundance-weighted frequency of occurrence in the shallow circalittoral biozone",
    "Abundance-weighted frequency of occurrence in the habitats with missing biozone information",
    "Abundance-weighted frequency of occurrence in the Arctic lower bathyal biozone",
    "Abundance-weighted frequency of occurrence in the Arctic mid bathyal biozone",
    "Abundance-weighted frequency of occurrence in the Atlantic upper bathyal biozone",
    "Abundance-weighted frequency of occurrence in the Atlanto-Arctic upper bathyal biozone",
    "Abundance-weighted frequency of occurrence in the Arctic upper abyssal biozone",
    "Abundance-weighted frequency of occurrence in coarse substrate",
    "Abundance-weighted frequency of occurrence in mixed substrate",
    "Abundance-weighted frequency of occurrence in sand substrate",
    "Abundance-weighted frequency of occurrence in habitats with missing substrate information",
    "Abundance-weighted frequency of occurrence in fine mud substrate",
    "Abundance-weighted frequency of occurrence in sandy mud substrate",
    "Abundance-weighted frequency of occurrence in fine mud or muddy sand substrate",
    "Abundance-weighted frequency of occurrence in muddy sand substrate",
    "Abundance-weighted frequency of occurrence on rock or other hard substrate",
    "Abundance-weighted frequency of occurrence in sandy mud or muddy sand substrate",
    "Abundance-weighted frequency of occurrence on seabed substrate",
    "Abundance-weighted frequency of occurrence in sediment substrate",
    "Abundance-weighted frequency of occurrence in habitats with missing salinity information",
```

"Abundance-weighted frequency of occurrence in mesohaline habitats",
 "Abundance-weighted frequency of occurrence in oligohaline habitats",
 "Abundance-weighted frequency of occurrence in polyhaline habitats",
 "Abundance-weighted frequency of occurrence in euhaline habitats",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.15",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.13",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.14",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.27",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.45",
 "Abundance-weighted frequency of occurrence in habitats with missing EUNIS 2007 codes",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A6.5",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A3.5",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A3.6",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.6",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.23",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.23 or A5.24",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.24",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.24 or A5.33 or A5.34",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.25",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.26 or A5.35 or A5.36",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.33",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.34",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.36",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.37",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.43",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.44",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.1",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.35",
 "Abundance-weighted frequency of occurrence in habitats with missing EUNIS 2007 codes",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.2",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.25 or A5.26",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A6",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A6.2",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A6.3 or A6.4",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A3.2",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A3.1",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A6.11",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A3.3",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.3",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.27",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.26",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.33",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.5",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4.4",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A3.4",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A5.27 or A5.37",
 "Abundance-weighted frequency of occurrence in EUNIS 2007 habitat A4",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type offshore circalittoral",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type circalittoral coarse",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type infralittoral coarse",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type offshore circalittoral",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type offshore circalittoral"

"Abundance-weighted frequency of occurrence in habitats with missing MSFD Benthic Broad Habitat Type",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type lower bathyal sediments",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type circalittoral mixed sediments",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type circalittoral mud or sand",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type circalittoral rock and rubble",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type circalittoral sand",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type infralittoral mixed sediments",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type infralittoral mud",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type infralittoral mud or sand",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type infraalittoral rock and rubble",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type infraalittoral sand",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type offshore circalittoral",
 "Abundance-weighted frequency of occurrence in habitats with missing MSFD Benthic Broad Habitat Type",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type upper bathyal sediments",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type upper bathyal rock and rubble",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type offshore circalittoral",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type abyssal",
 "Abundance-weighted frequency of occurrence in MSFD Benthic Broad Habitat Type offshore circalittoral",
 "Abundance-weighted frequency of occurrence in habitats with missing oxygen concentration information",
 "Does the species have planktonic larvae? Yes / No / Unknown for species in Biotic, NA otherwise",
 "Does the species occur on bedrock? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on cobbles? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on large or very large boulders? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on small boulders? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on mud? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on muddy gravel? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on muddy sand? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on sandy mud? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on coarse sand? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on fine sand? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on other species? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on pebbles? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on artificial substrates? 1 if yes in Biotic, NA otherwise",
 "Does the species occur in caves? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on overhangs? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on gravel shingle? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on algae? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on mixed sediments? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on salt marsh? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on seagrass? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on biogenic reefs? 1 if yes in Biotic, NA otherwise",
 "Does the species occur under boulders? 1 if yes in Biotic, NA otherwise",
 "Does the species occur in crevices? 1 if yes in Biotic, NA otherwise",
 "Does the species occur in rockpools? 1 if yes in Biotic, NA otherwise",
 "Does the species occur in the pelagic zone? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on muddy gravelly sand? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on sandy gravelly mud? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on maerl beds? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on clay? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on gravelly sand? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on muddy sandy gravel? 1 if yes in Biotic, NA otherwise",
 "Does the species occur on the strandline? 1 if yes in Biotic, NA otherwise"


```

),
source = c("WoRMS", rep("Derived", 3), "Biotic", rep("Wilson et al.", 9),
           rep("EMODnet broadscale habitat map", 100), rep("Biotic", 33))
)

```

Write this to file:

```

write_csv(sp_habitat_summaries_meta,
          here::here(
            "product", "benthic_species_habitat_summaries_metadata.csv"))

```

The final function here produces a series of summary plots for a given species:

```

source(here::here("scripts", "plot_species_habitats.R"))

```

This requires a species Aphia ID (`sp_id`). Other arguments have sensible defaults. You can print the compiled plot to your device (set `print_plot = TRUE`) - though beware, this is unlikely to look good unless your graphics device window is large. You can also save the plot to file (set `save_plot = TRUE`) - this will create a subdirectory within the 'product' directory called `species_hab_plots` (if it does not already exist), and save a species plot as an A4 pdf file, with the filename starting with the species Aphia ID and ending with 'habitat_plot'. Try for one species:

```

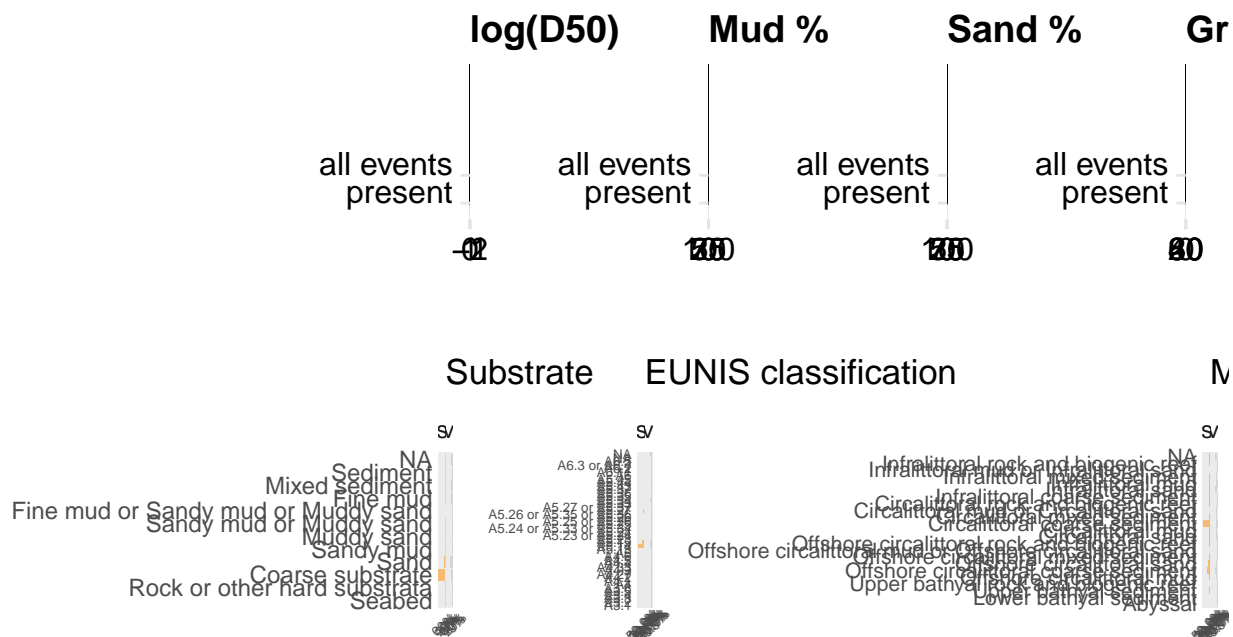
plot_species_habitats(sp_id = 103228, print_plot = TRUE, save_plot = TRUE)

```

Urothoe elegans (Aphia ID: 103228)

2740 occurrences matched to sediment and 2985 matched to habitat

No habitat preference data in Biotic



To create and save these composite plots for all species:

```

invisible(
  sp_habitat_summaries %>%
    filter(total_occ > 20) %>%
    mutate(aphia = AphiaID) %>%
    group_by(aphia) %>%
    group_map(~ plot_species_habitats(sp_id = .$AphiaID,

```

```

    print_plot = FALSE,
    save_plot = TRUE,
    replace_plot = FALSE))
)

```

Reproducibility

Reproducibility receipt

```

## datetime
Sys.time()

```

```
## [1] "2021-04-01 14:21:12 BST"
```

```

## repository
git2r::repository()

```

```

## Local:      master /Users/tom/Google Drive/emodnet habitats/EMODnet_occs_habs
## Remote:     master @ origin (https://github.com/EMODnet/EMODnet-Biology-Benthic-Habitats-Occurrences-T
## Head:       [f9dd58f] 2021-04-01: Trying to deal with conflicts with rendered documents

```

```

## session info
sessionInfo()

```

```

## R version 3.6.2 (2019-12-12)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: macOS Catalina 10.15.7
##
## Matrix products: default
## BLAS:      /Library/Frameworks/R.framework/Versions/3.6/Resources/lib/libRblas.0.dylib
## LAPACK:    /Library/Frameworks/R.framework/Versions/3.6/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_GB.UTF-8/en_GB.UTF-8/en_GB.UTF-8/C/en_GB.UTF-8/en_GB.UTF-8
##
## attached base packages:
## [1] stats      graphics  grDevices  utils      datasets  methods   base
##
## other attached packages:
## [1] patchwork_1.0.0 ggtext_0.1.1   worrms_0.4.0   ggribes_0.5.3
## [5] forcats_0.4.0  stringr_1.4.0 dplyr_1.0.4    purrr_0.3.4
## [9] readr_1.3.1    tidyr_1.0.0    tibble_3.0.6   ggplot2_3.3.3
## [13] tidyverse_1.3.0
##
## loaded via a namespace (and not attached):
## [1] Rcpp_1.0.6      lubridate_1.7.4 here_0.1        assertthat_0.2.1
## [5] rprojroot_1.3-2 digest_0.6.27  utf8_1.1.4     R6_2.5.0
## [9] cellranger_1.1.0 plyr_1.8.6     backports_1.1.5 reprex_0.3.0
## [13] evaluate_0.14   highr_0.8      httr_1.4.2     pillar_1.5.0
## [17] rlang_0.4.10    curl_4.3       readxl_1.3.1   rstudioapi_0.13
## [21] rmarkdown_2.7   labeling_0.3    urltools_1.7.3 triebeard_0.3.0
## [25] munsell_0.5.0   gridtext_0.1.4 broom_0.7.2     compiler_3.6.2
## [29] modelr_0.1.5    xfun_0.21       pkgconfig_2.0.3 htmltools_0.5.1.1
## [33] tidyselect_1.1.0 httpcode_0.2.0 fansi_0.4.2     crayon_1.4.1
## [37] dbplyr_1.4.2    withr_2.1.2     crul_0.9.0     grid_3.6.2

```


## [41]	jsonlite_1.7.2	gtable_0.3.0	lifecycle_1.0.0	DBI_1.1.1
## [45]	git2r_0.26.1	magrittr_2.0.1	scales_1.1.0	cli_2.3.1
## [49]	stringi_1.5.3	farver_2.0.3	fs_1.3.1	xml2_1.3.2
## [53]	ellipsis_0.3.1	generics_0.1.0	vctrs_0.3.6	tools_3.6.2
## [57]	glue_1.4.2	markdown_1.1	hms_0.5.3	yaml_2.2.1
## [61]	colorspace_1.4-1	rvest_0.3.5	knitr_1.31	haven_2.2.0