# Response_Ratios_V3

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## Create response ratio function

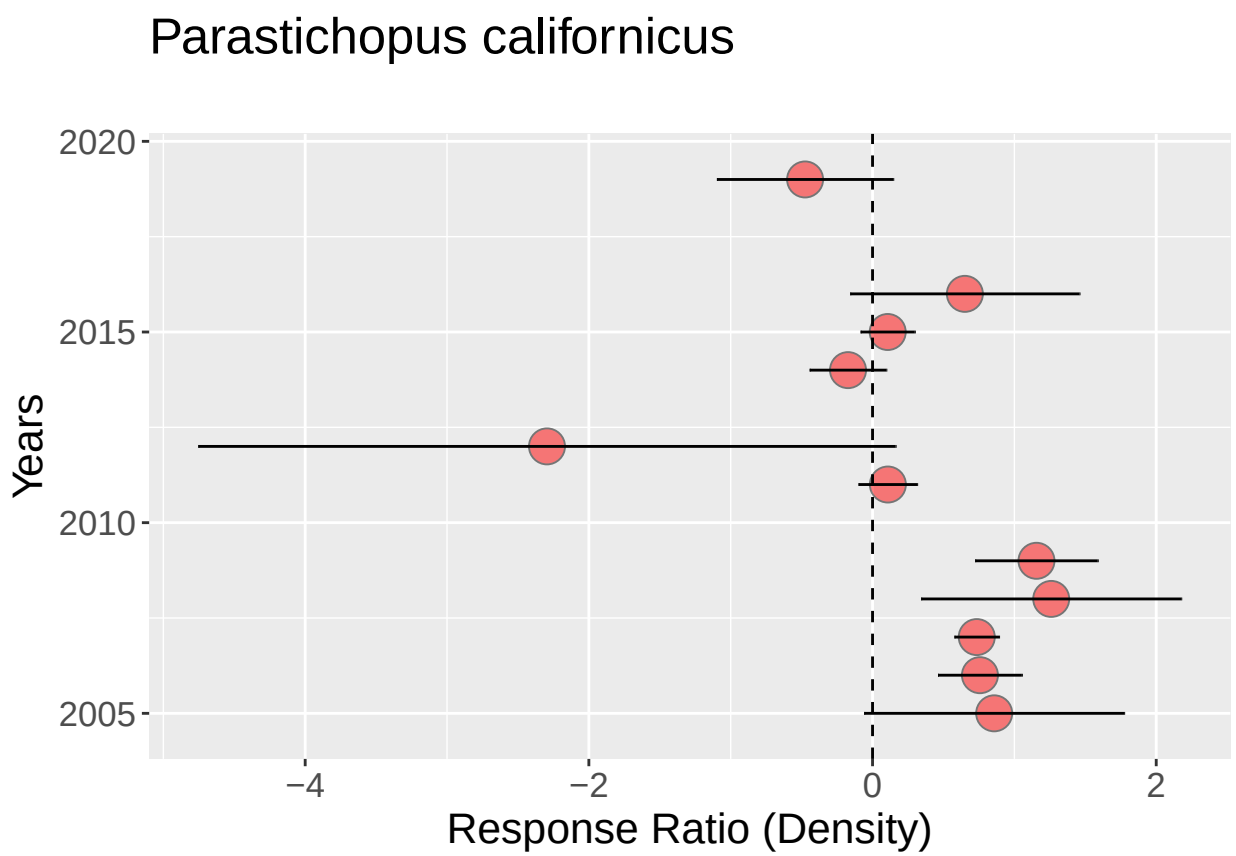
```
# response_ratio is the function, and it uses 4 imputs:
# df is a data frame being referenced
# column is the column in the data frame with the density of the taxon
# title is a character, the name of the taxon being graphed
# subtitle is a character, the region/substrate being graphed

response_ratio <- function(df, column, title, subtitle){

  MPAs <- subset(df, Designation == "MPA") # create data frame of only MPA
  References <- subset(df, Designation == "Reference") # vice versa for Ref

  logmean <- function(MPAs, References, column, year){
    x <- subset(MPAs, Year == as.character(year))
    y <- subset(References, Year == as.character(year))
    log(mean(x[,column])/mean(y[,column])) # Setup function to take the natural
    # log of: average density in the MPA over the average density in the Ref
    # This data will create the points on each graph
  }

  std <- function(x){
    sd(x)/sqrt(length(x))
    # function for standard error
  }

  logerror <- function(MPAs, References, column, year){
    x <- subset(MPAs, Year == as.character(year))
    y <- subset(References, Year == as.character(year))
    log(std(x[,column])/std(y[,column])) # Setup function to take the natural
    # log of: average standard error in the MPA over the average standard error
    # in the Ref. This data will create the error bars on each graph
  }

  logmeans <- c(logmean(MPAs, References, column, 2005),
                logmean(MPAs, References, column, 2006),
                logmean(MPAs, References, column, 2007),
                logmean(MPAs, References, column, 2008),
                logmean(MPAs, References, column, 2009),
                logmean(MPAs, References, column, 2011),
                logmean(MPAs, References, column, 2012),
```

```
                logmean(MPAs, References, column, 2014),
                logmean(MPAs, References, column, 2015),
                logmean(MPAs, References, column, 2016),
                logmean(MPAs, References, column, 2019))
  # Creates a vector of response ratios log(mean MPA/mean Ref) for each year

  logerrors <- c(logerror(MPAs, References, column, 2005),
                 logerror(MPAs, References, column, 2006),
                 logerror(MPAs, References, column, 2007),
                 logerror(MPAs, References, column, 2008),
                 logerror(MPAs, References, column, 2009),
                 logerror(MPAs, References, column, 2011),
                 logerror(MPAs, References, column, 2012),
                 logerror(MPAs, References, column, 2014),
                 logerror(MPAs, References, column, 2015),
                 logerror(MPAs, References, column, 2016),
                 logerror(MPAs, References, column, 2019))
  # Creates a vector of error bars log(error MPA/error Ref) for each year

  Year <- c(2005,2006,2007,2008,2009,2011,2012,2014,2015,2016,2019)
  # Creates a vector of years

  data <- data.frame(logmeans, logerrors, Year)
  # Generates a data frame of response ratios and standard error for each year

  ggplot(data, aes(x=Year, y=logmeans)) +
    geom_point(shape=21,size=6, alpha=0.5, position=position_dodge(0.9),
               fill="red")+
    ylab('Response Ratio (Density)')+
    xlab('Years')+ geom_hline(yintercept = 0, linetype="dashed")+
    geom_errorbar(aes(ymax=logmeans+logerrors, ymin=logmeans-logerrors),
                  position=position_dodge(0.9), width=0)+
    scale_y_continuous(breaks= pretty_breaks())+coord_flip()+
    ggtitle(title, subtitle)+
    theme(text = element_text(size = 16))
  # Plots the response ratios and standard error with the title and subtitle
  # plugged into the function
}
```

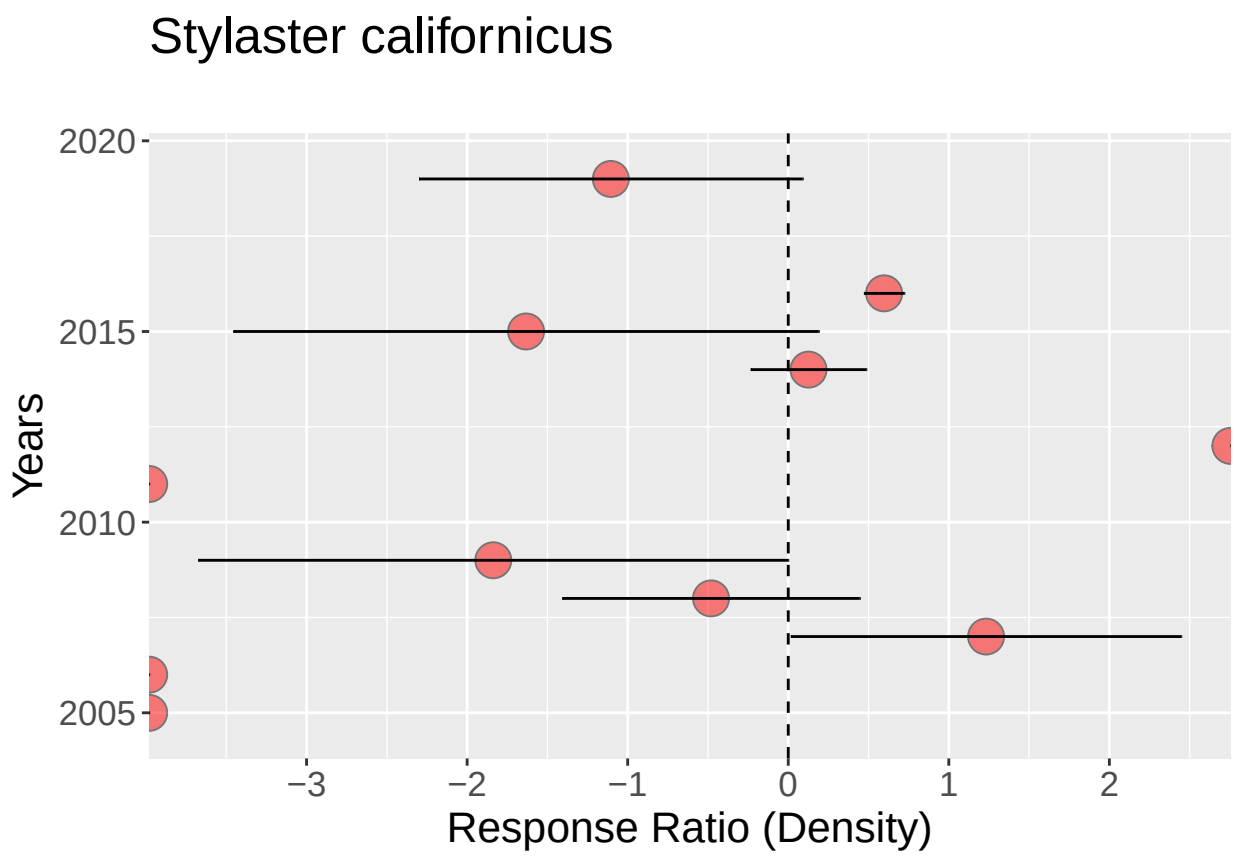
## Run response ratios and all permutations

```
### Start running data sets ###

base_data <- data.frame(read.csv("V3f.csv"))
# Imports version 3 final data into R
base_data <- na.omit(base_data)
# Removes unusable lines of the data frame that return NAs

## Run response ratios ##
## First using statewide data ##
## Species ##
```

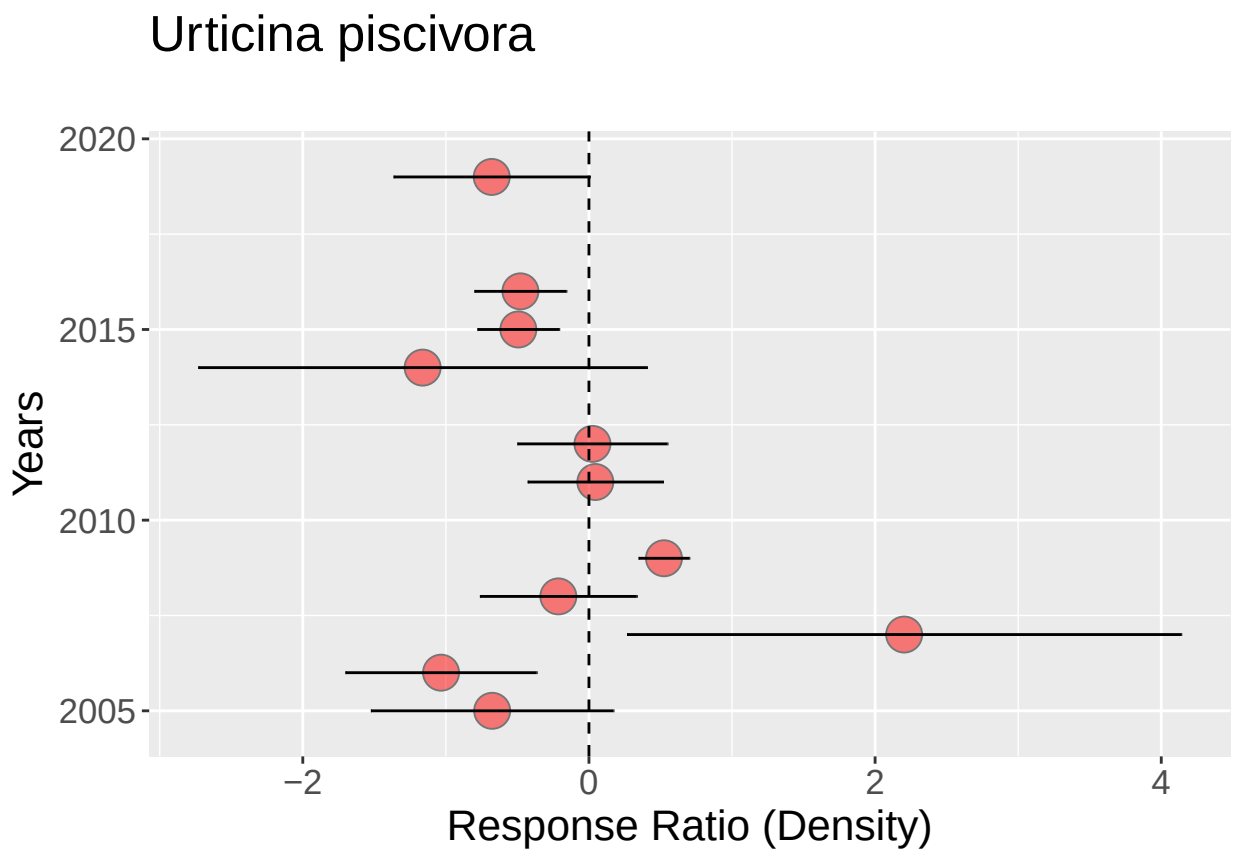
```
response_ratio(base_data, 176, "Parastichopus californicus", " ") ## sea cucumber ##
```



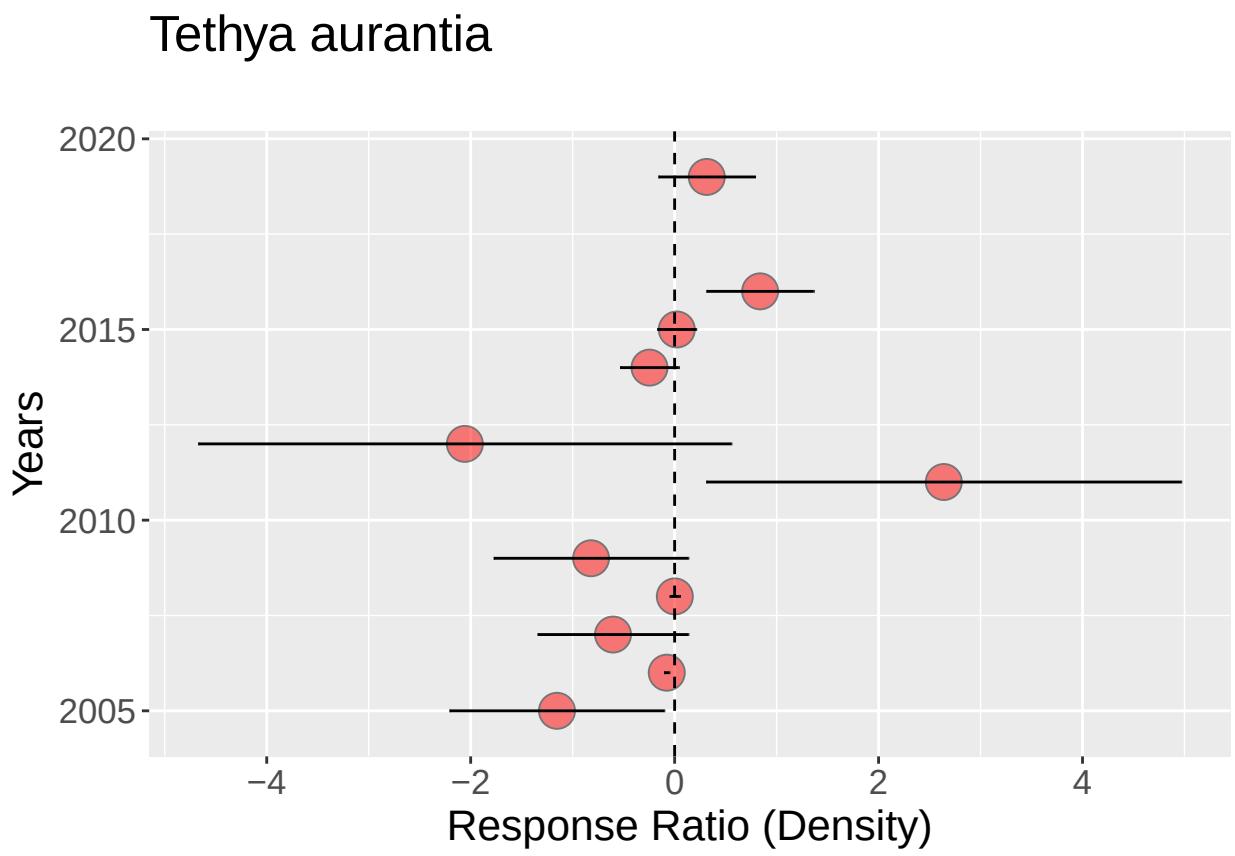

```
response_ratio(base_data, 175, "Stylaster californicus", " ") ## hydrocoral ##
```



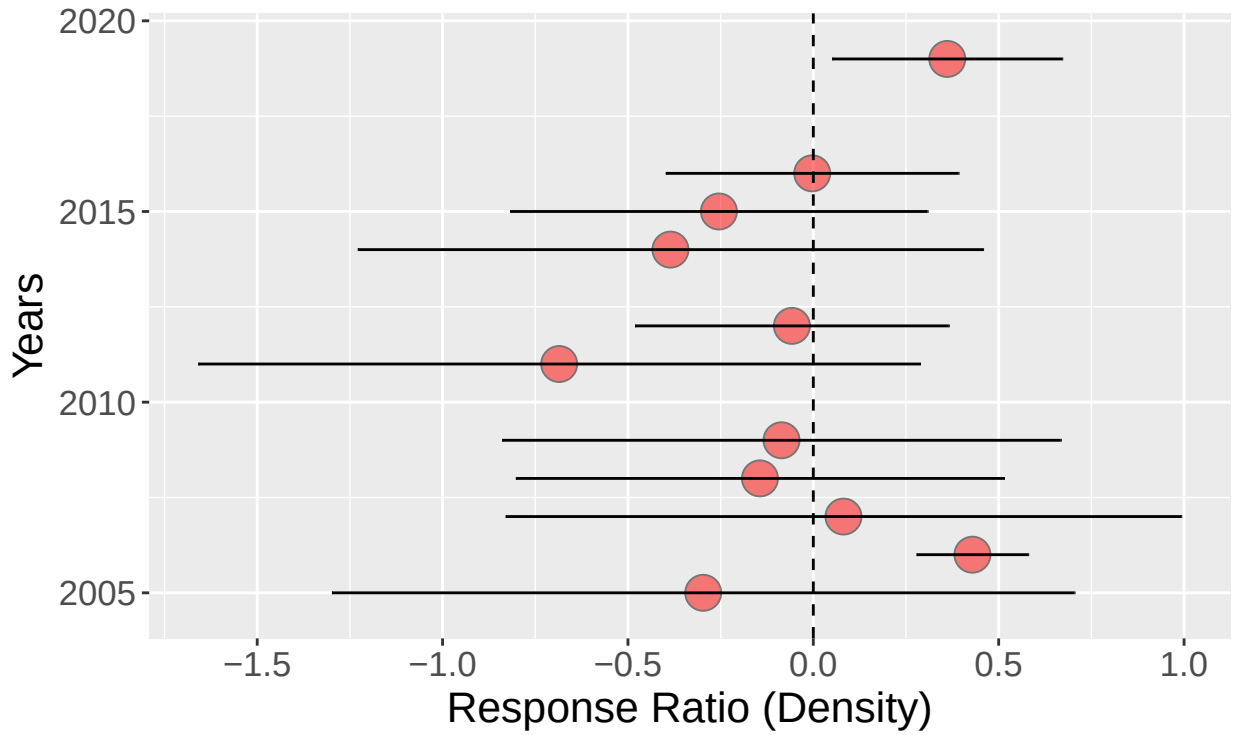

```
response_ratio(base_data, 177, "Urticina piscivora", " ") ## Fish-eating anemone ##
```




```
response_ratio(base_data, 178, "Tethya aurantia", " ") ## Puffball sponge ##
```

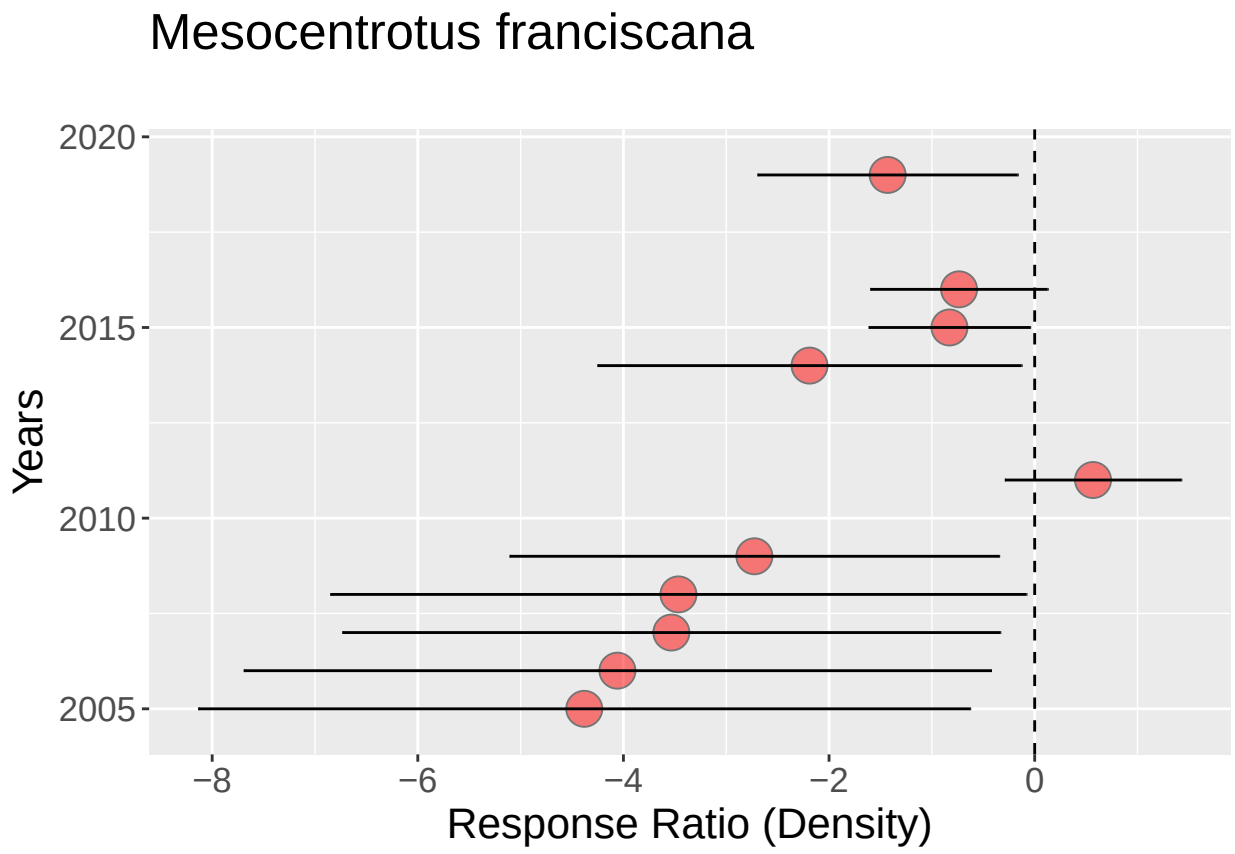



```
response_ratio(base_data, 179, "Mediaster aequalis", " ") ## Red sea star ##
```



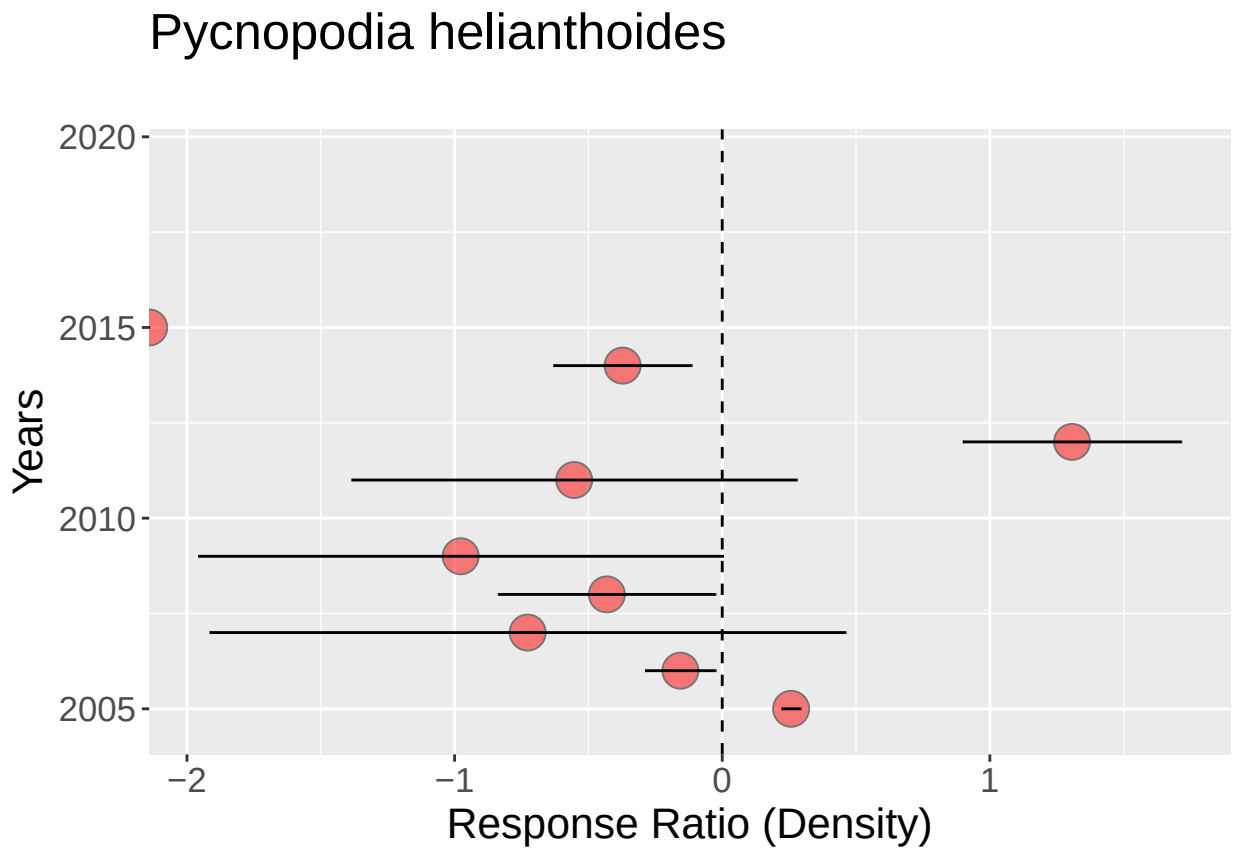

```
response_ratio(base_data, 180, "Mesocentrotus franciscana", " ") ## Red sea urchin ##
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```

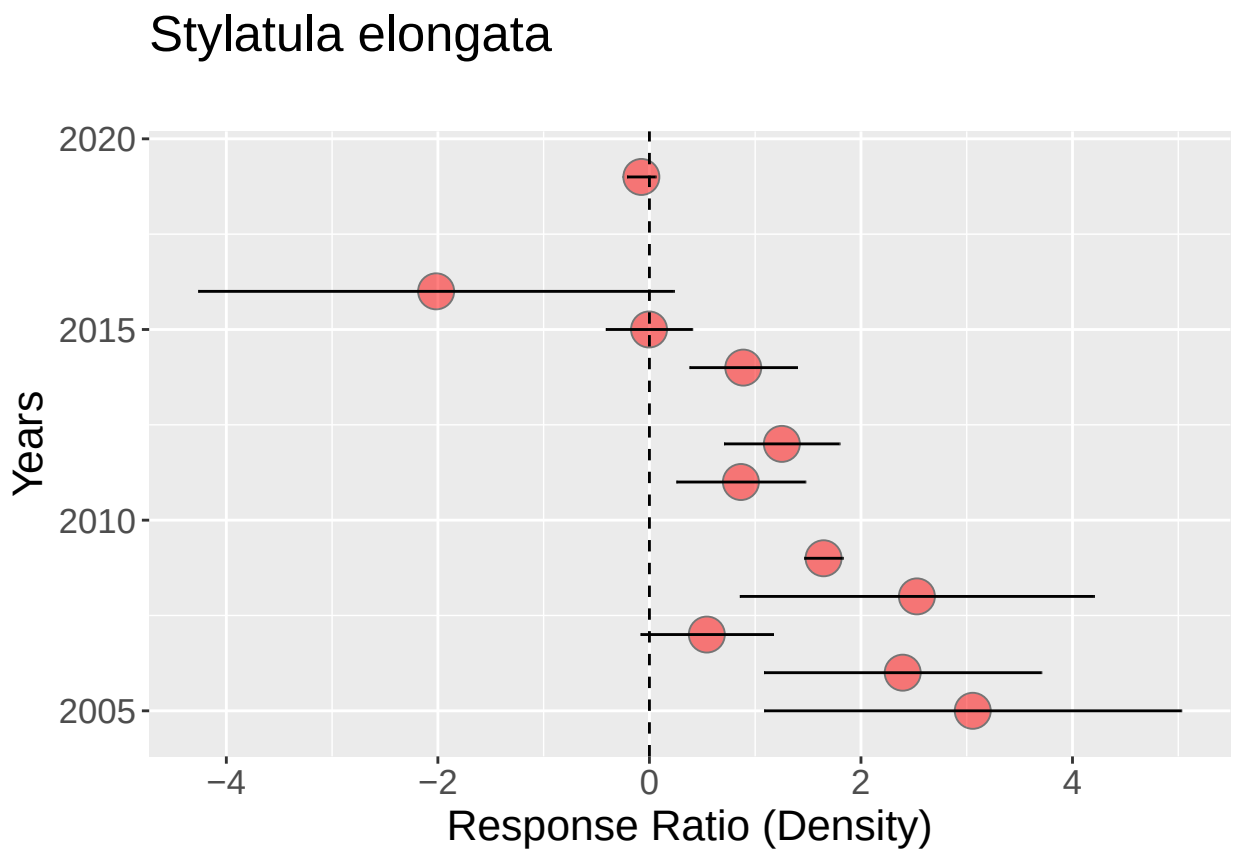



```
response_ratio(base_data, 181, "Pycnopodia helianthoides", " ") ## Sunflower star ##
```

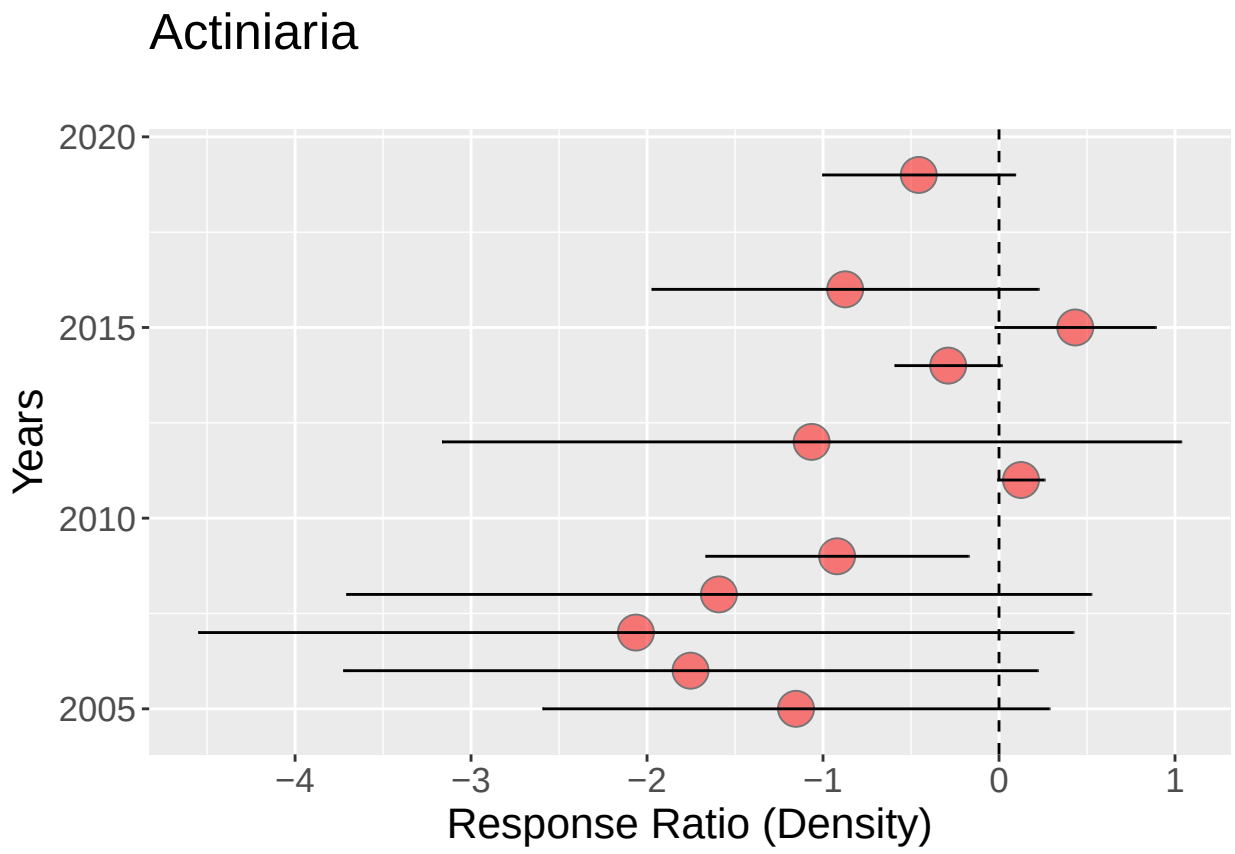
```
## Warning: Removed 2 rows containing missing values (geom_point).
```



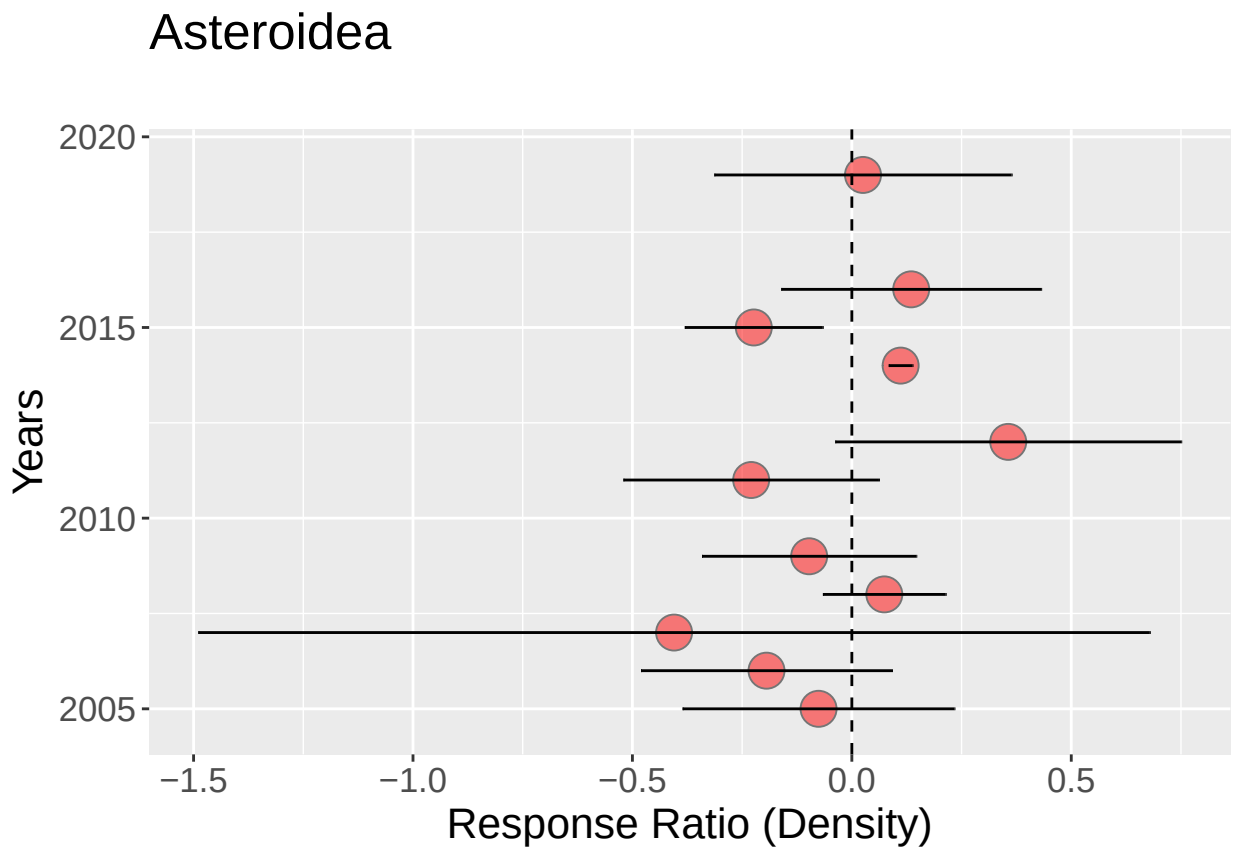

```
response_ratio(base_data, 182, "Stylatula elongata", " ") ## White sea pen ##
```



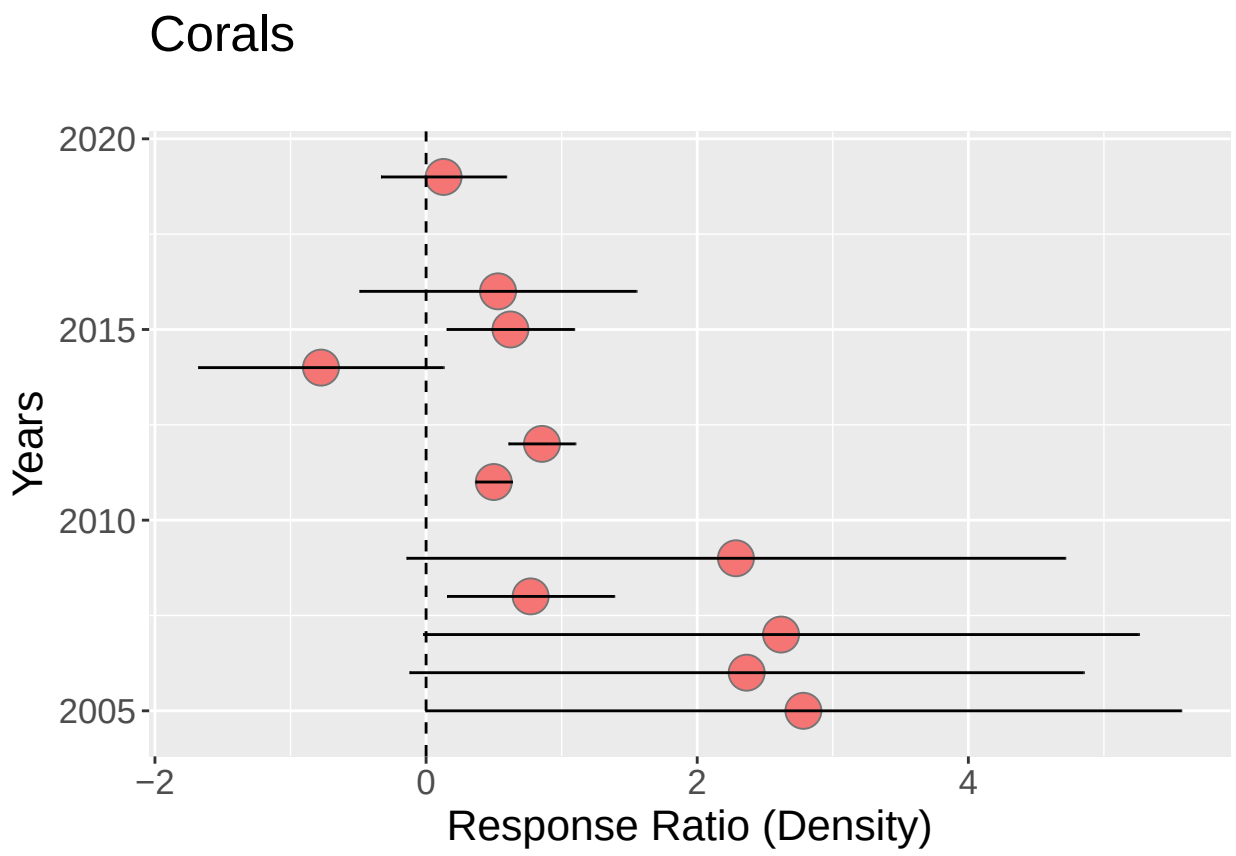

```
## Functional Groups ##

response_ratio(base_data, 183, "Actiniaria", " ") ## Anemones ##
```




```
response_ratio(base_data, 184, "Asteroidea", " ") ## Sea stars ##
```

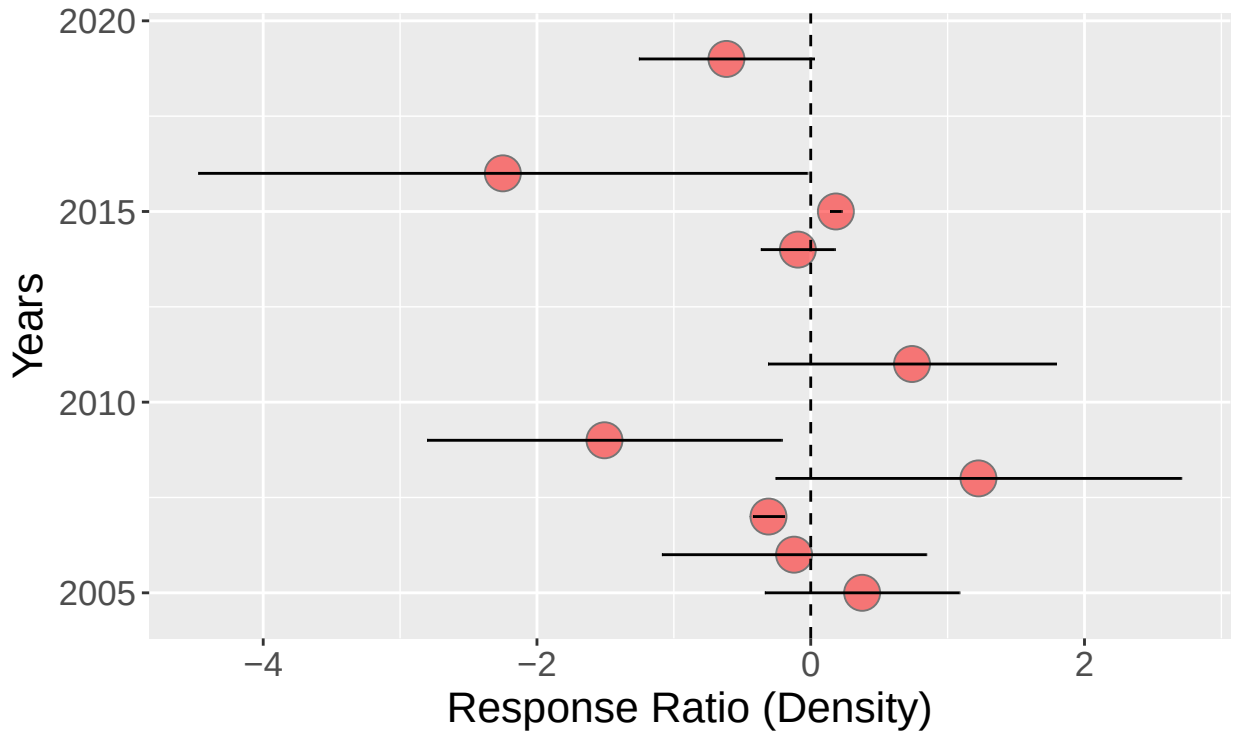



```
response_ratio(base_data, 185, "Corals", " ") ## Reef-forming cnidarians ##
```

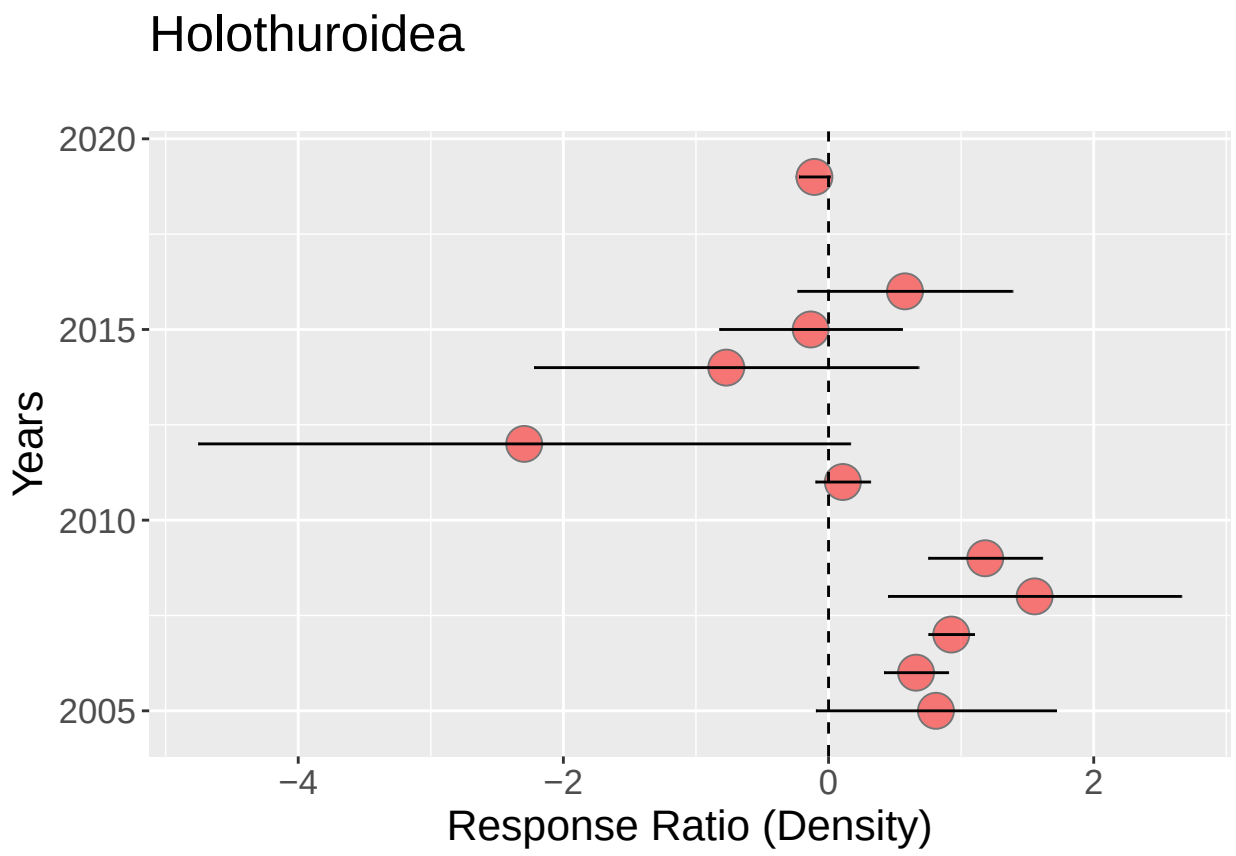



```
response_ratio(base_data, 186, "Echinoidea", " ") ## Sea urchins ##
```

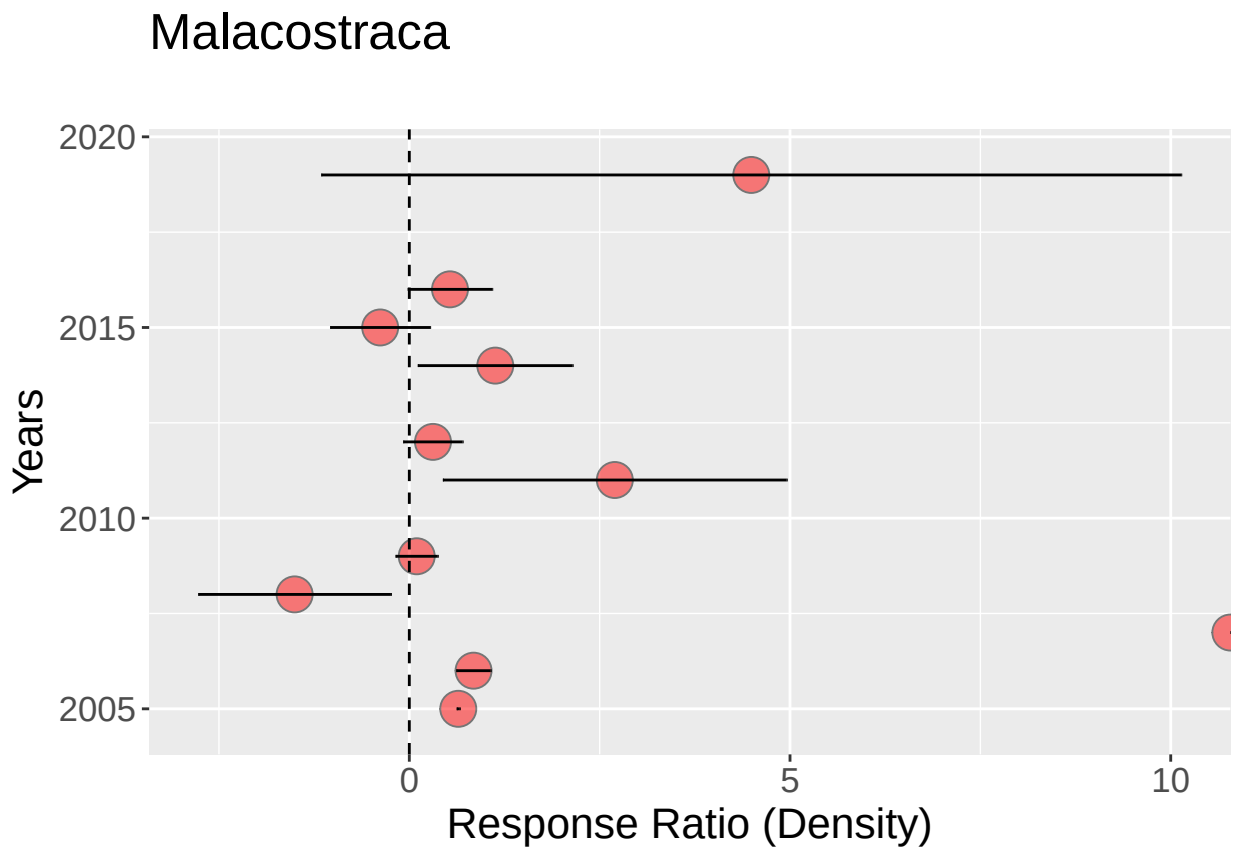
```
## Warning: Removed 1 rows containing missing values (geom_point).
```



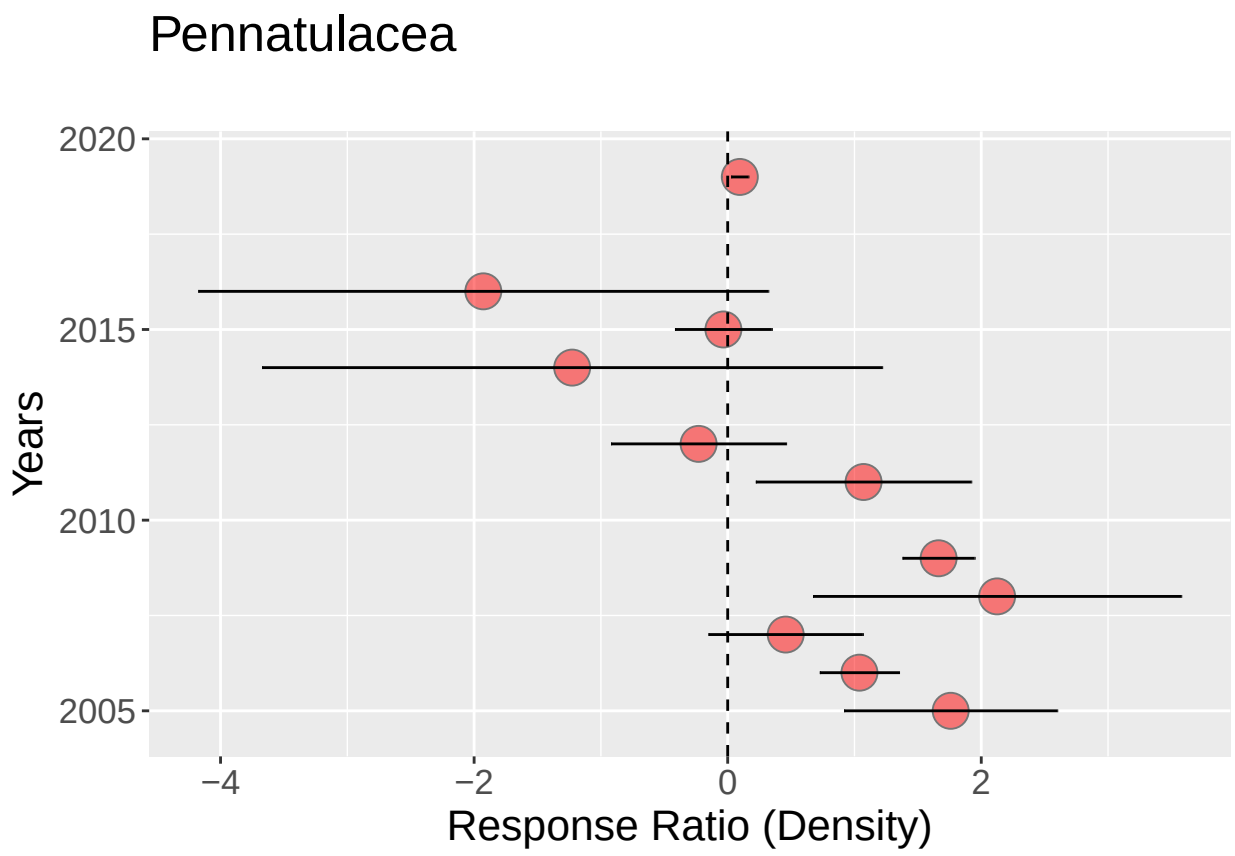

```
response_ratio(base_data, 187, "Holothuroidea", " ") ## Sea cucumbers ##
```



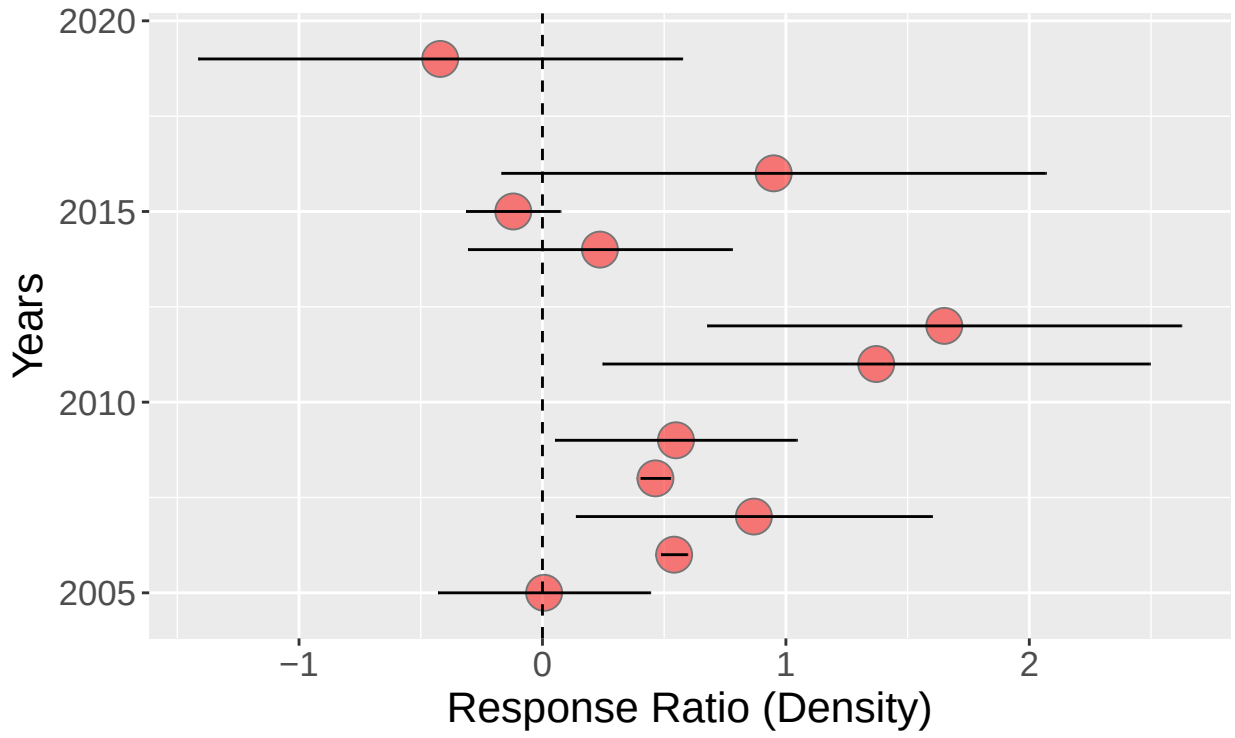

```
response_ratio(base_data, 188, "Malacostraca", " ") ## Crabs and allies ##
```




```
response_ratio(base_data, 189, "Pennatulacea", " ") ## Sea pens ##
```

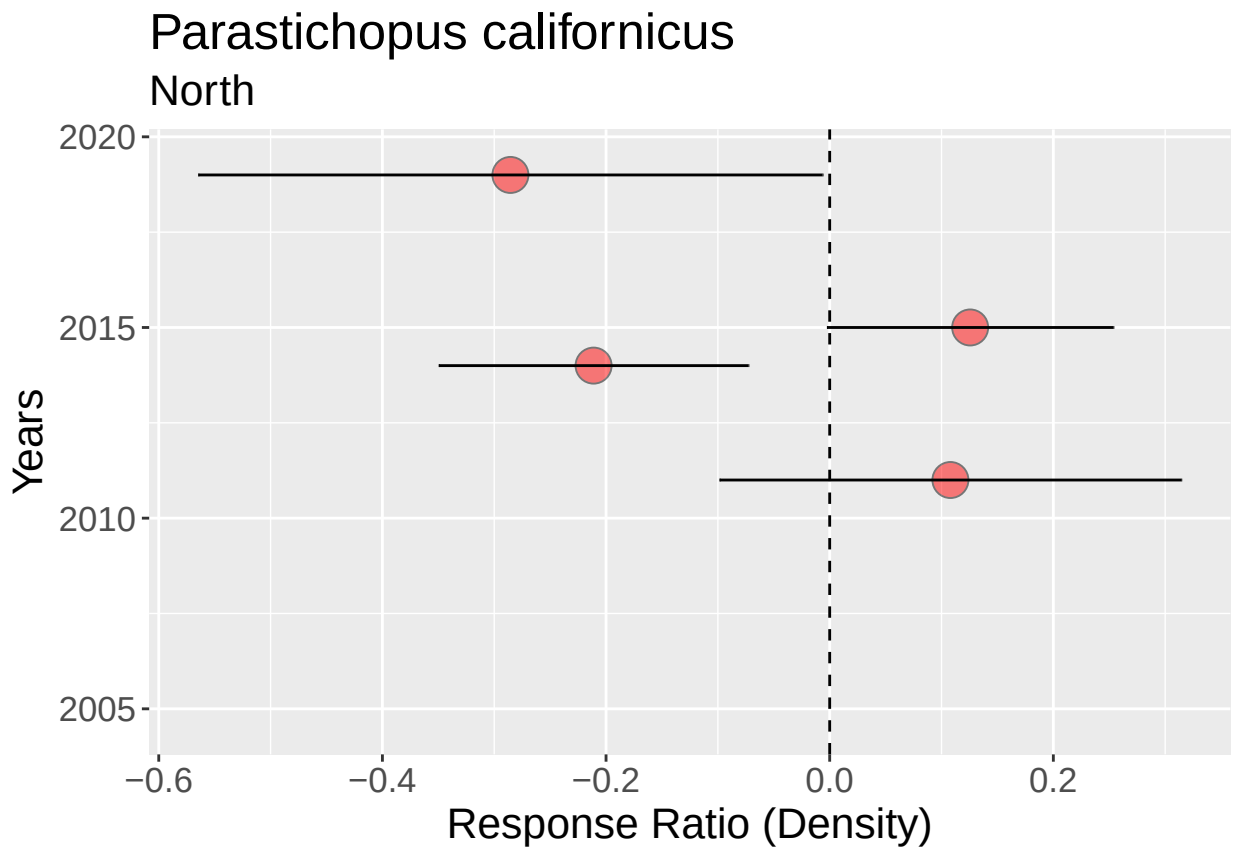



```
response_ratio(base_data, 190, "Porifera", " ") ## Sponges ##
```



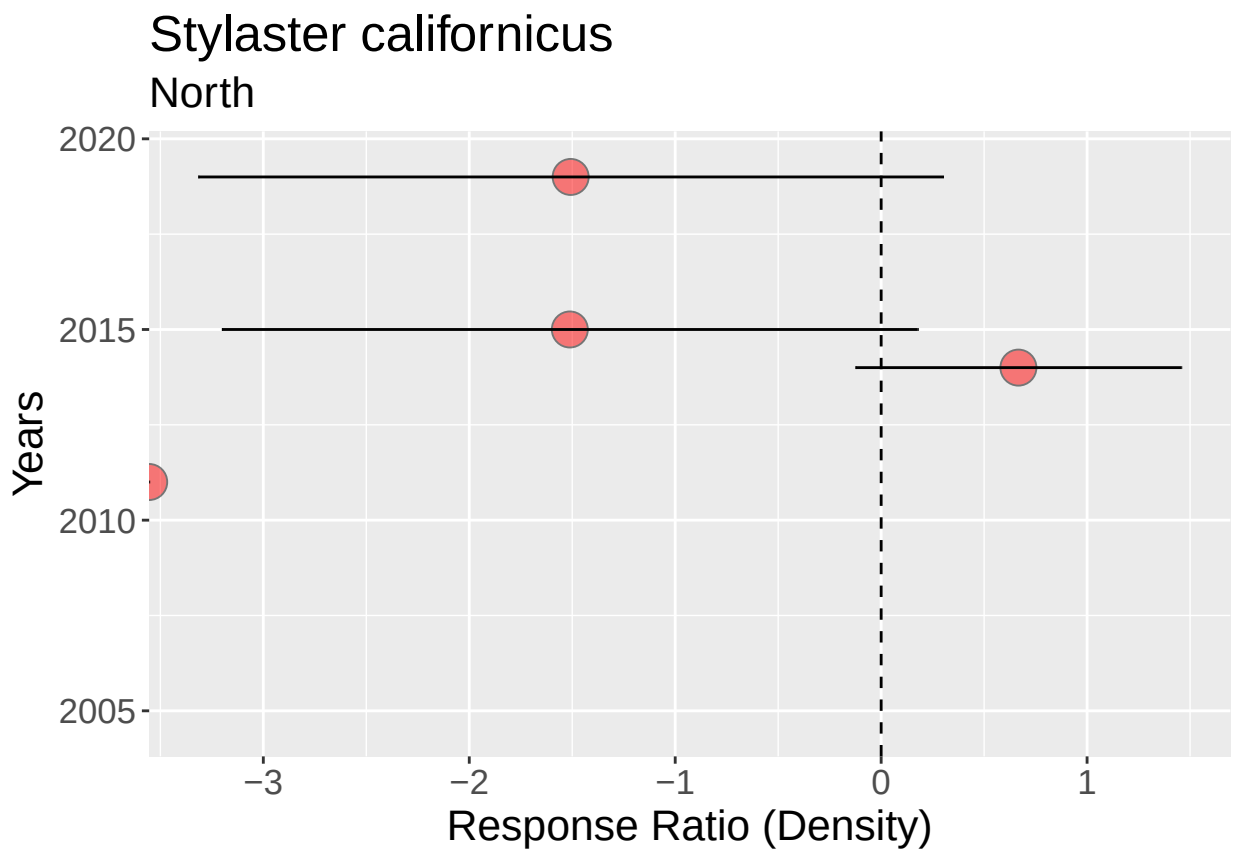

```
## Next, run response ratios on regional data

North <- subset(base_data, Region == "North" | Region == "North Central" | Region == "North Coast")
Central <- subset(base_data, Region == "Central")
South <- subset(base_data, Region == "South" | Region == "Channel Islands")
Channel.Islands <- subset(base_data, Region == "Channel Islands")

### North ###

## Species ##

response_ratio(North, 176, "Parastichopus californicus", "North") ## sea cucumber ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



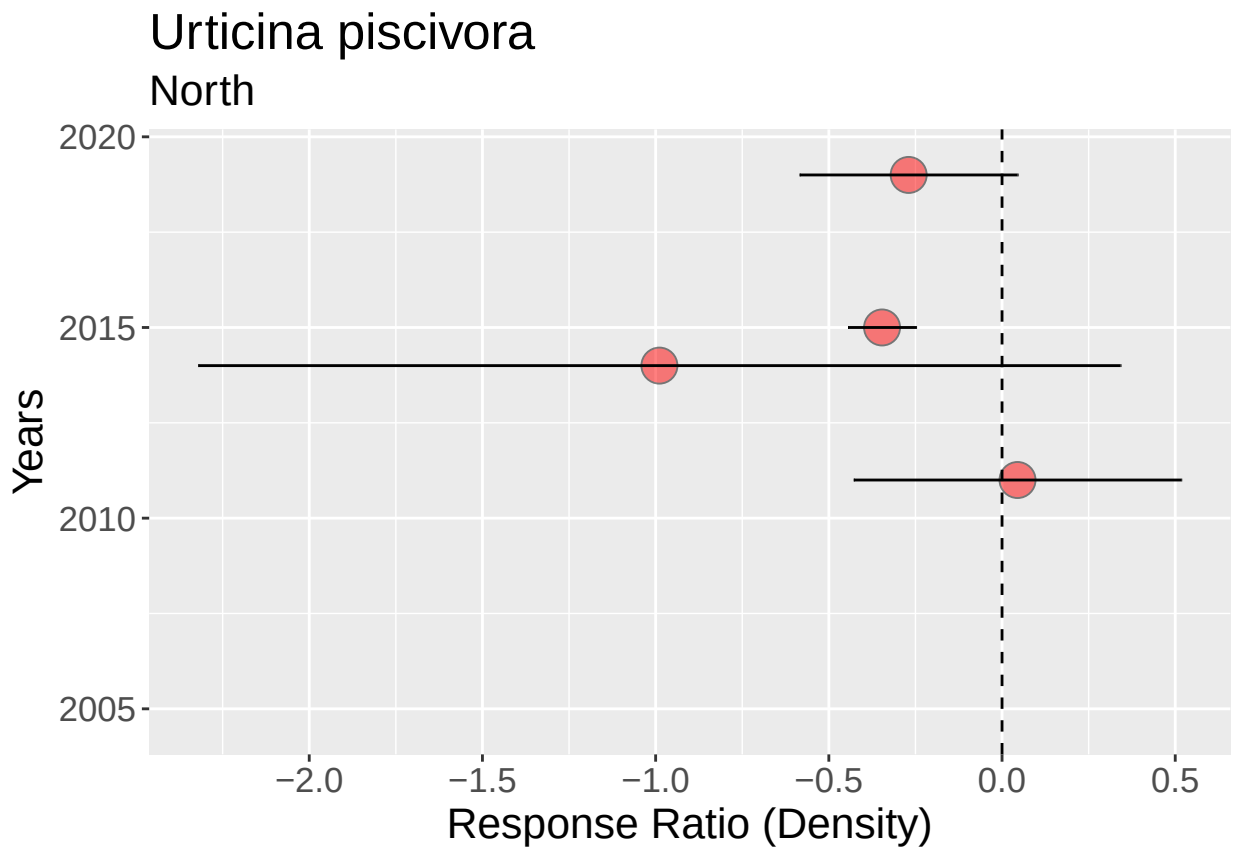

```
response_ratio(North, 175, "Stylaster californicus", "North") ## hydrocoral ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



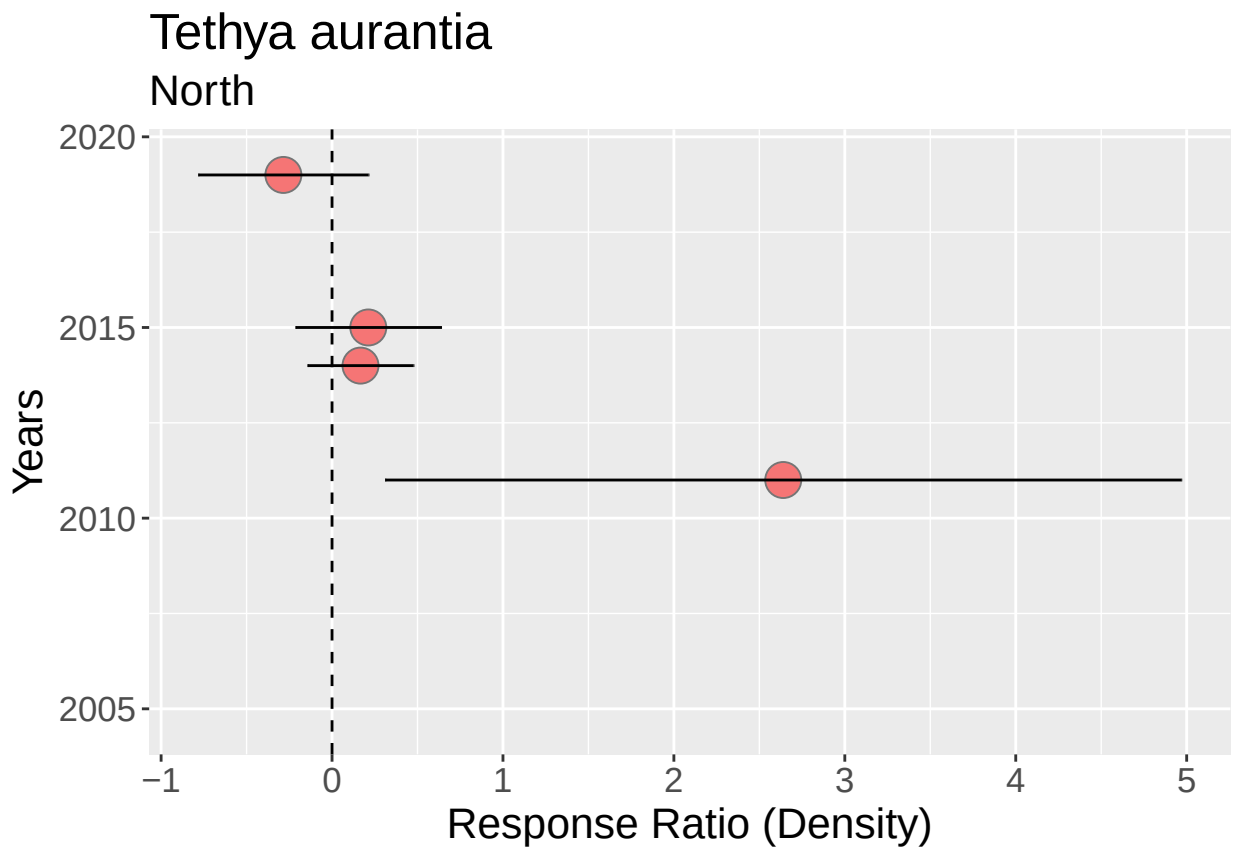

```
response_ratio(North, 177, "Urticina piscivora", "North") ## Fish-eating anemone ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



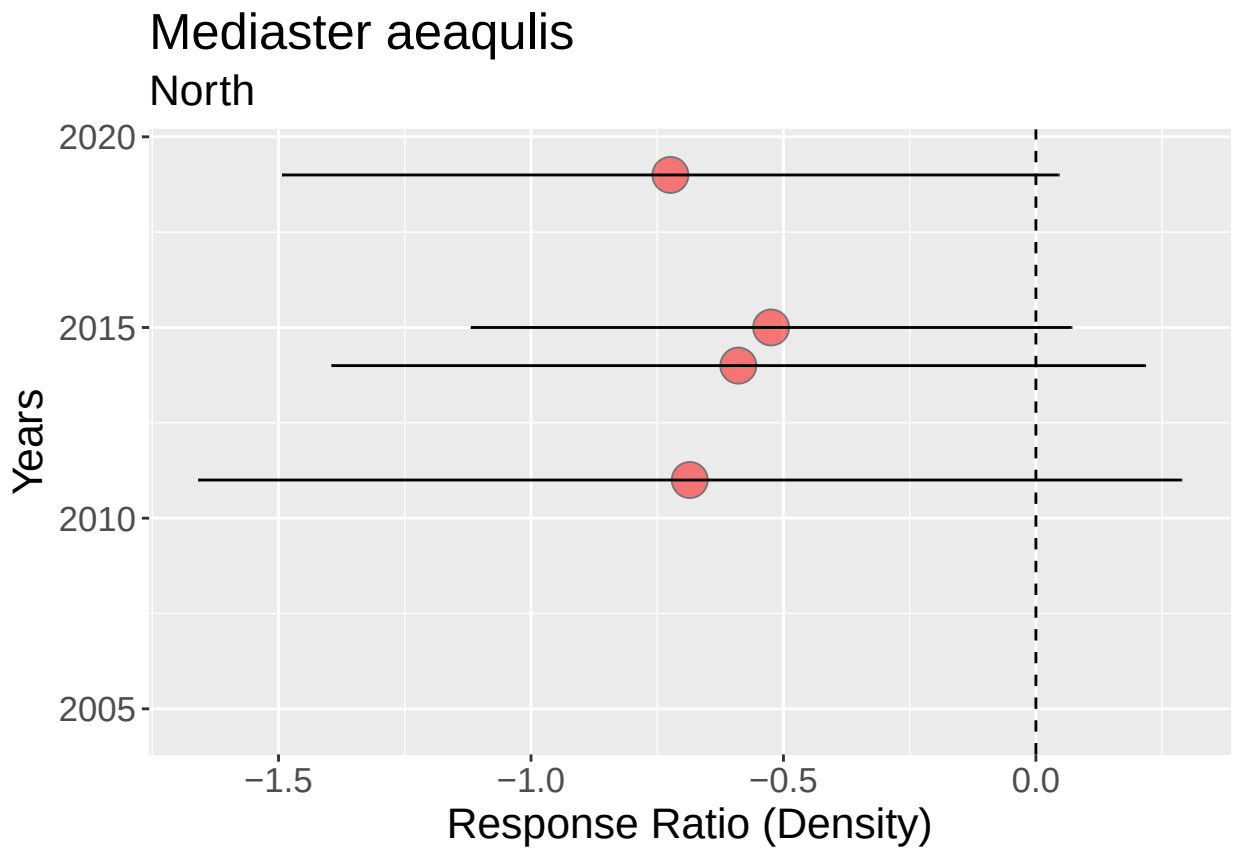

```
response_ratio(North, 178, "Tethya aurantia", "North") ## Puffball sponge ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



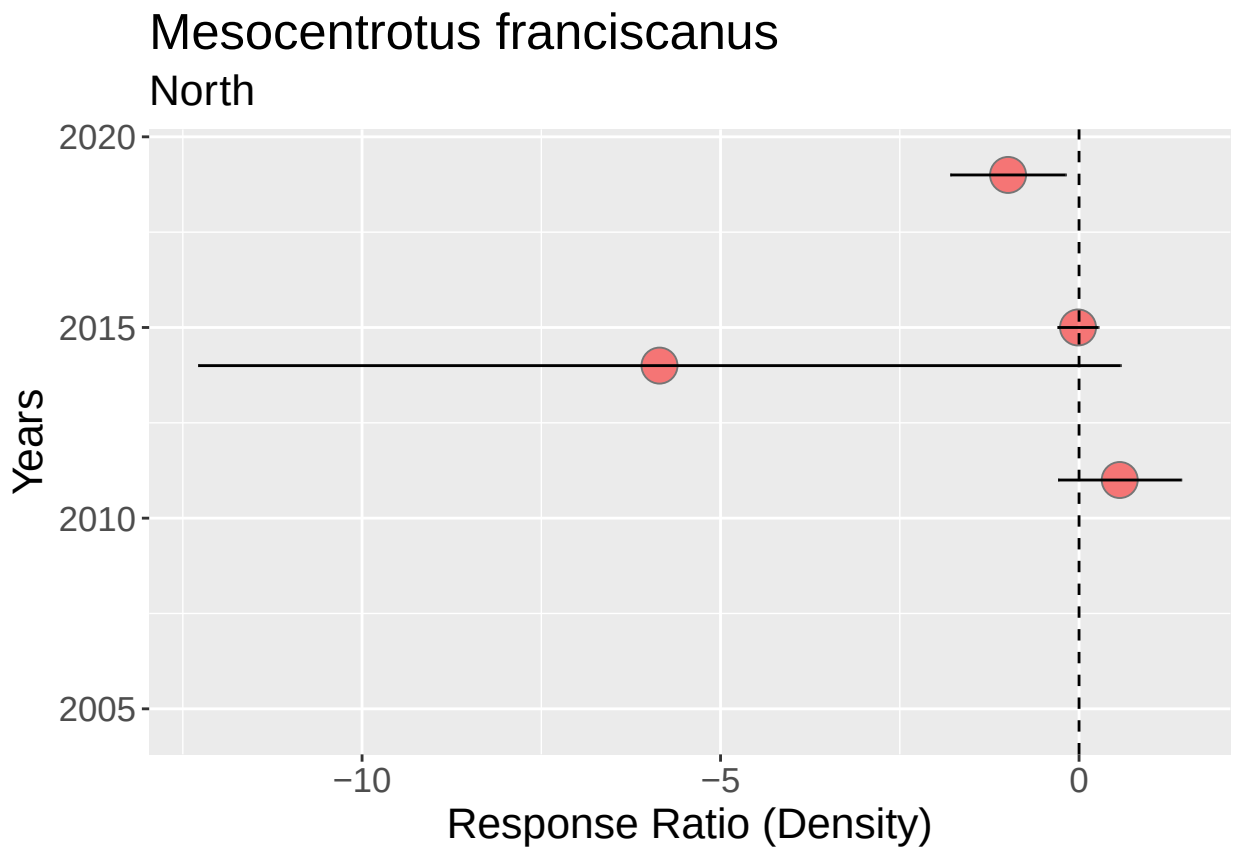

```
response_ratio(North, 179, "Mediaster aeaqulis", "North") ## Red sea star ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



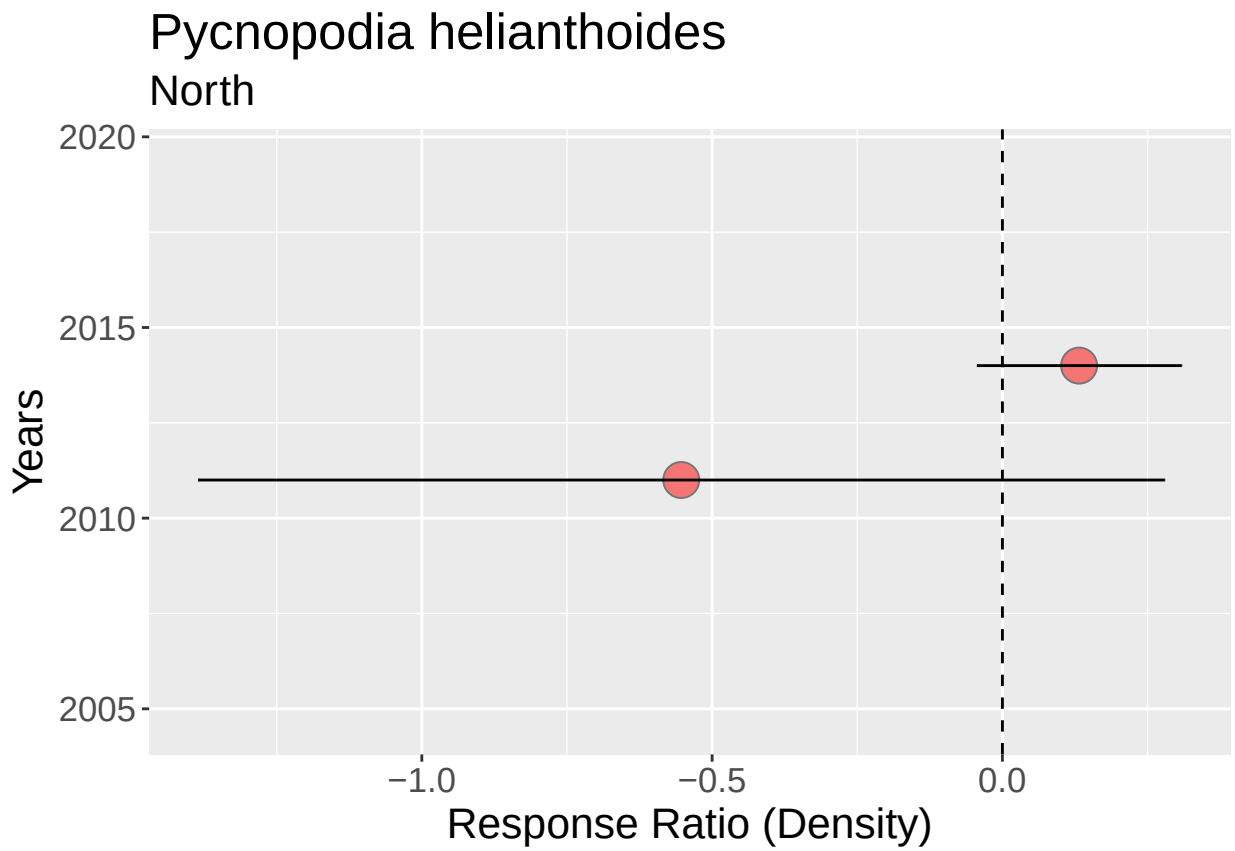

```
response_ratio(North, 180, "Mesocentrotus franciscanus", "North") ## Red sea urchin ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



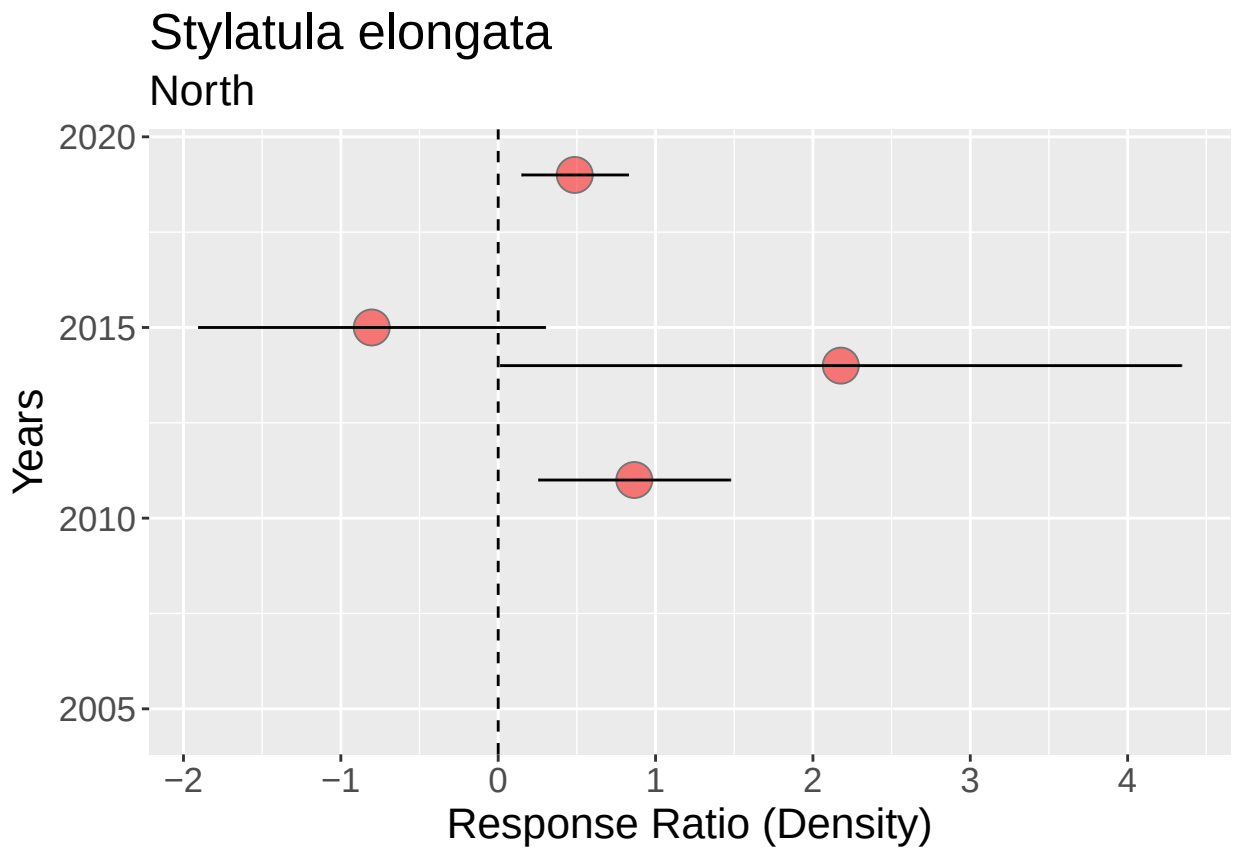

```
response_ratio(North, 181, "Pycnopodia helianthoides", "North") ## Sunflower star ##
```

```
## Warning: Removed 9 rows containing missing values (geom_point).
```



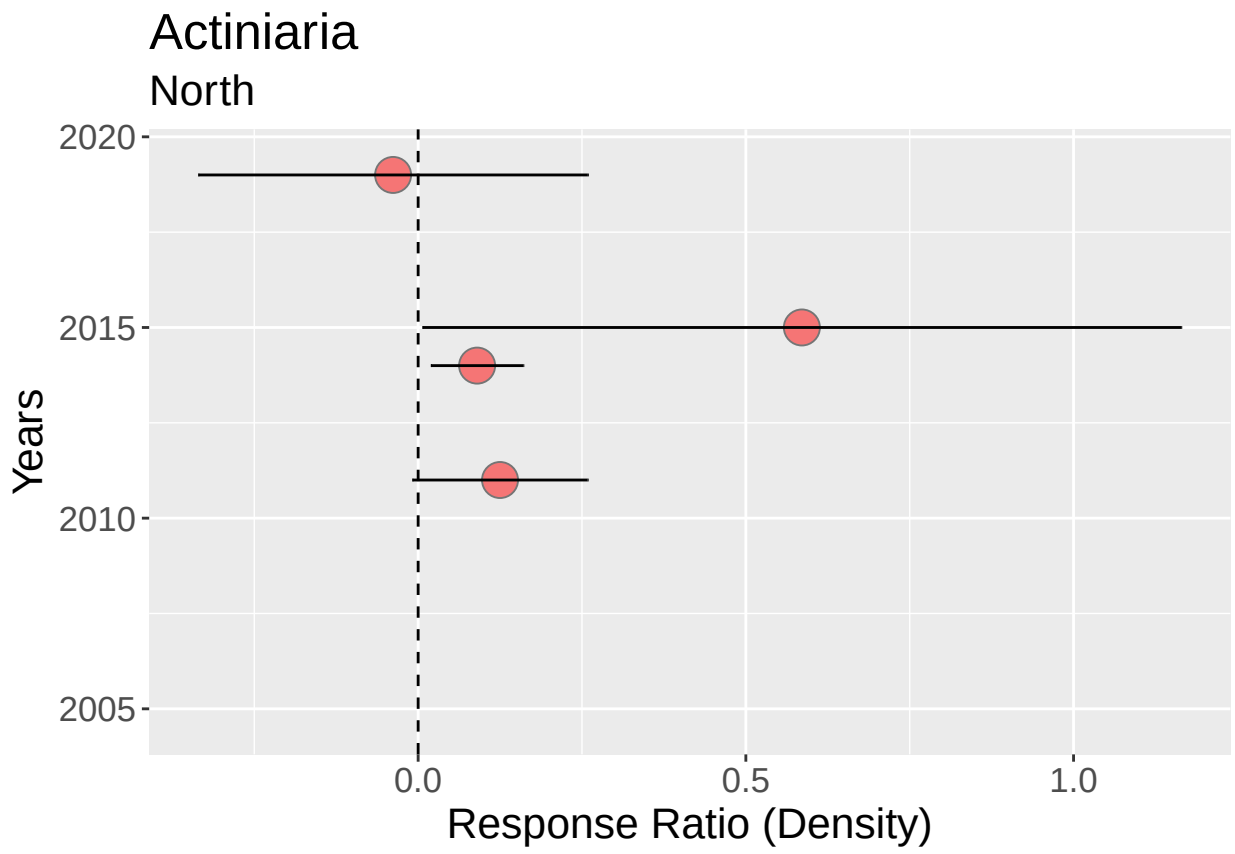

```
response_ratio(North, 182, "Stylatula elongata", "North") ## White sea pen ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



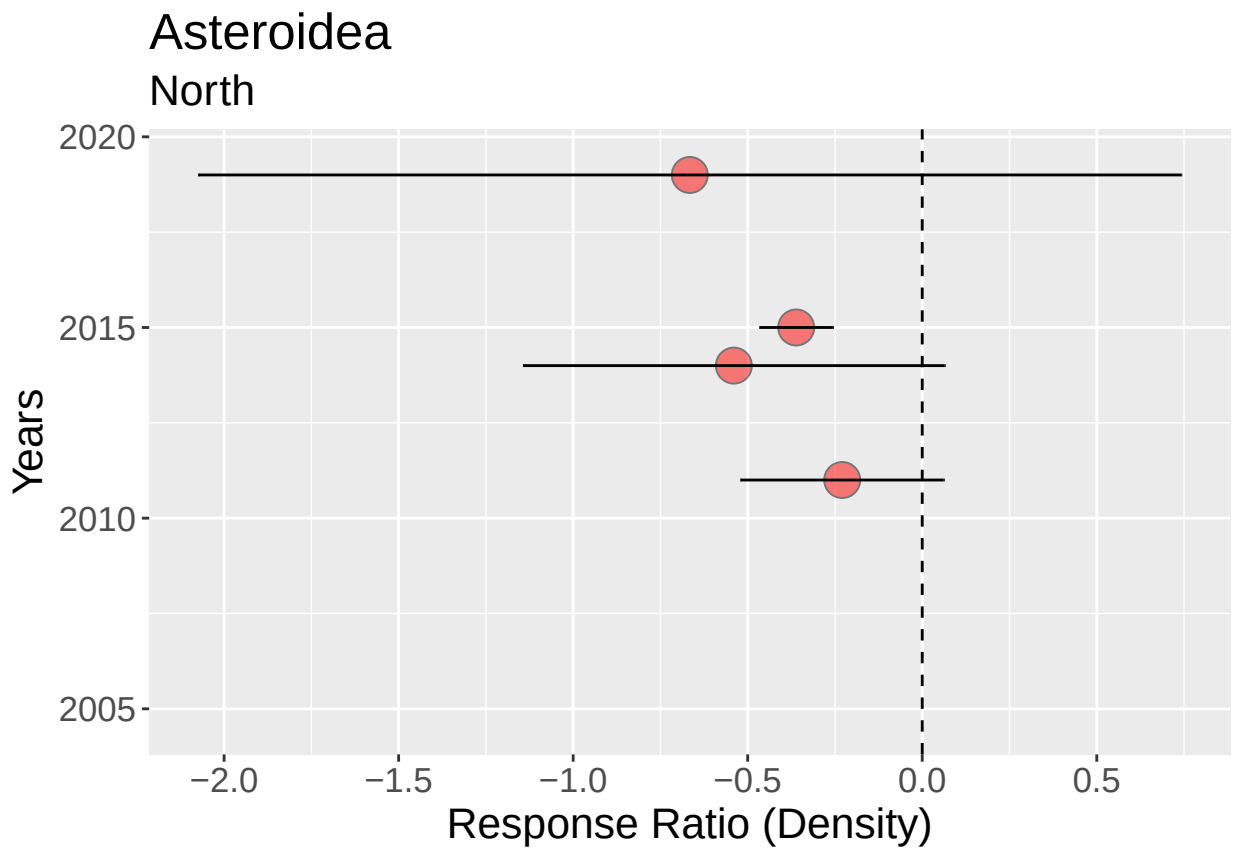

```
## Functional Groups ##

response_ratio(North, 183, "Actiniaria", "North") ## Anemones ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



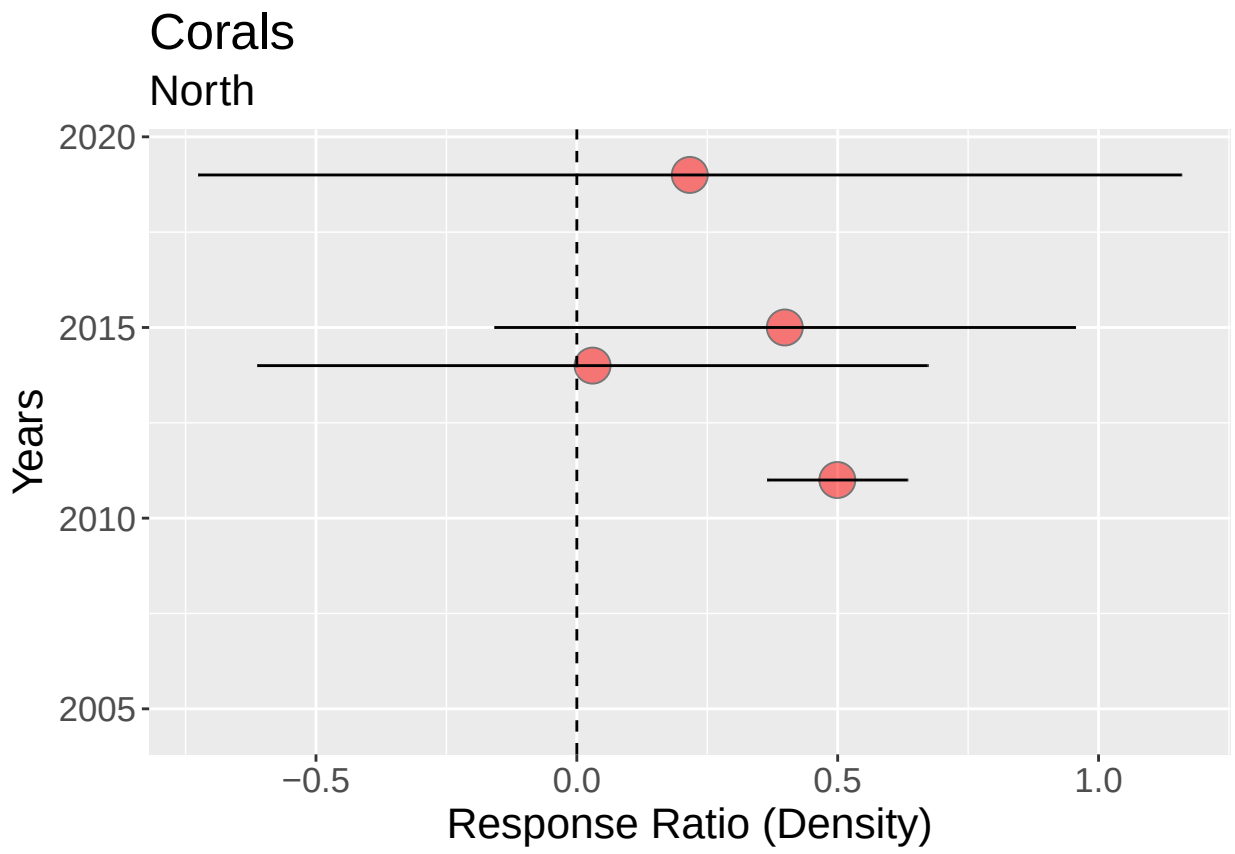

```
response_ratio(North, 184, "Asteroidea", "North") ## Sea stars ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



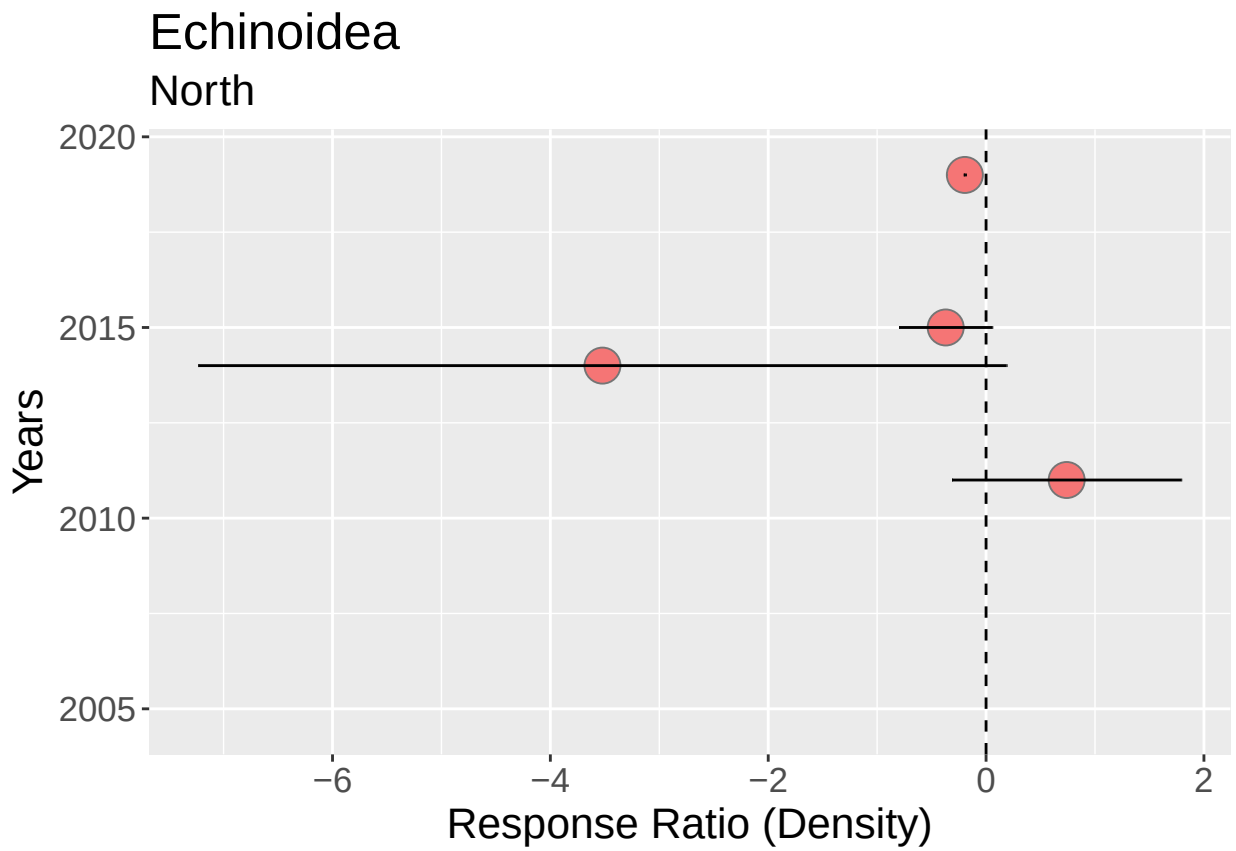

```
response_ratio(North, 185, "Corals", "North") ## Reef-forming cnidarians ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



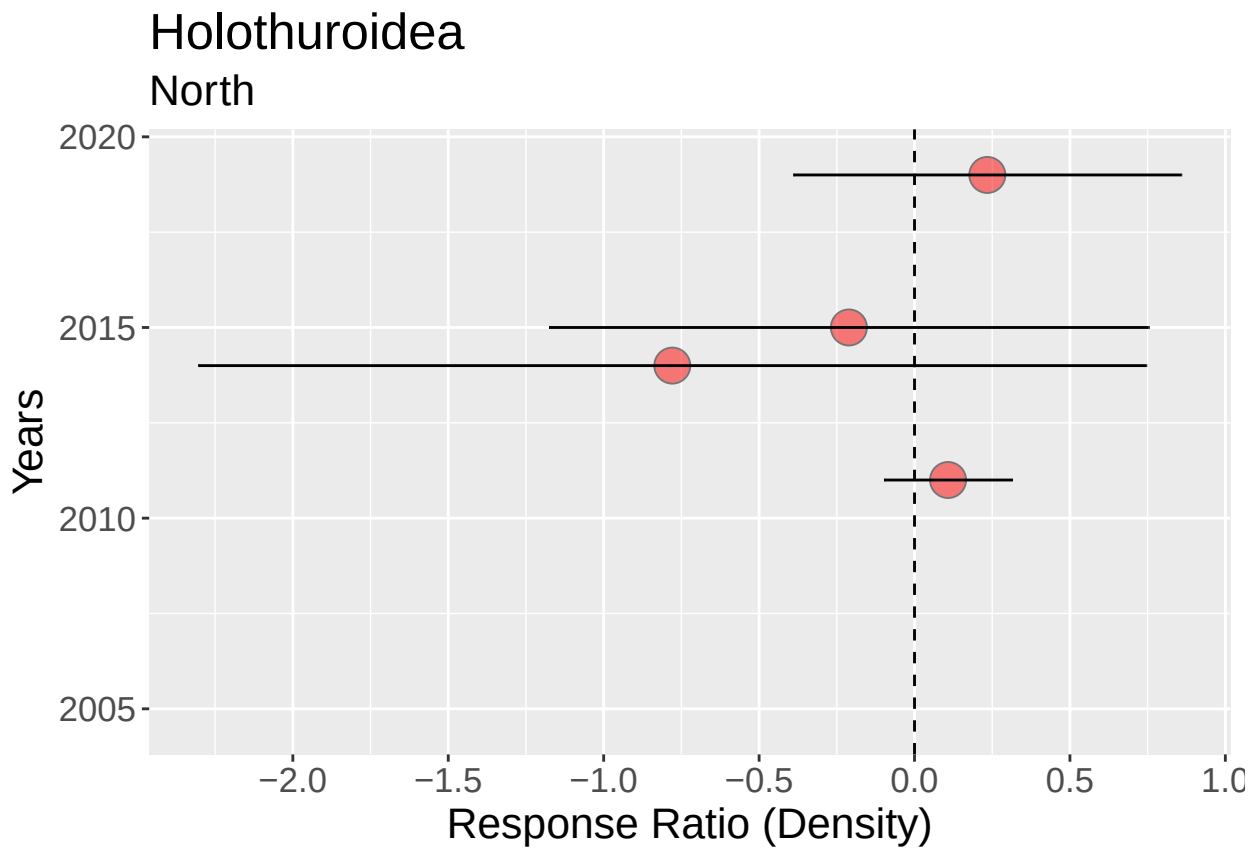

```
response_ratio(North, 186, "Echinoidea", "North") ## Sea urchins ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



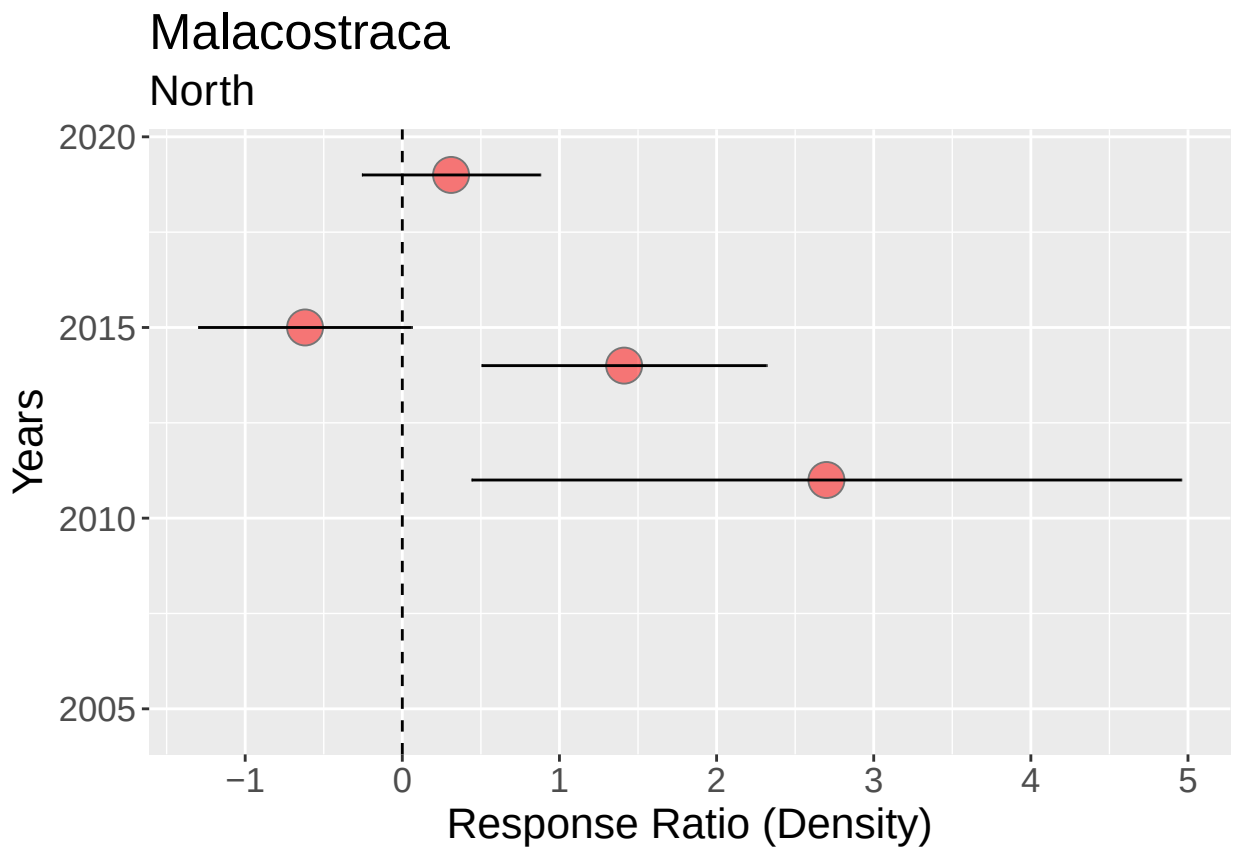

```
response_ratio(North, 187, "Holothuroidea", "North") ## Sea cucumbers ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



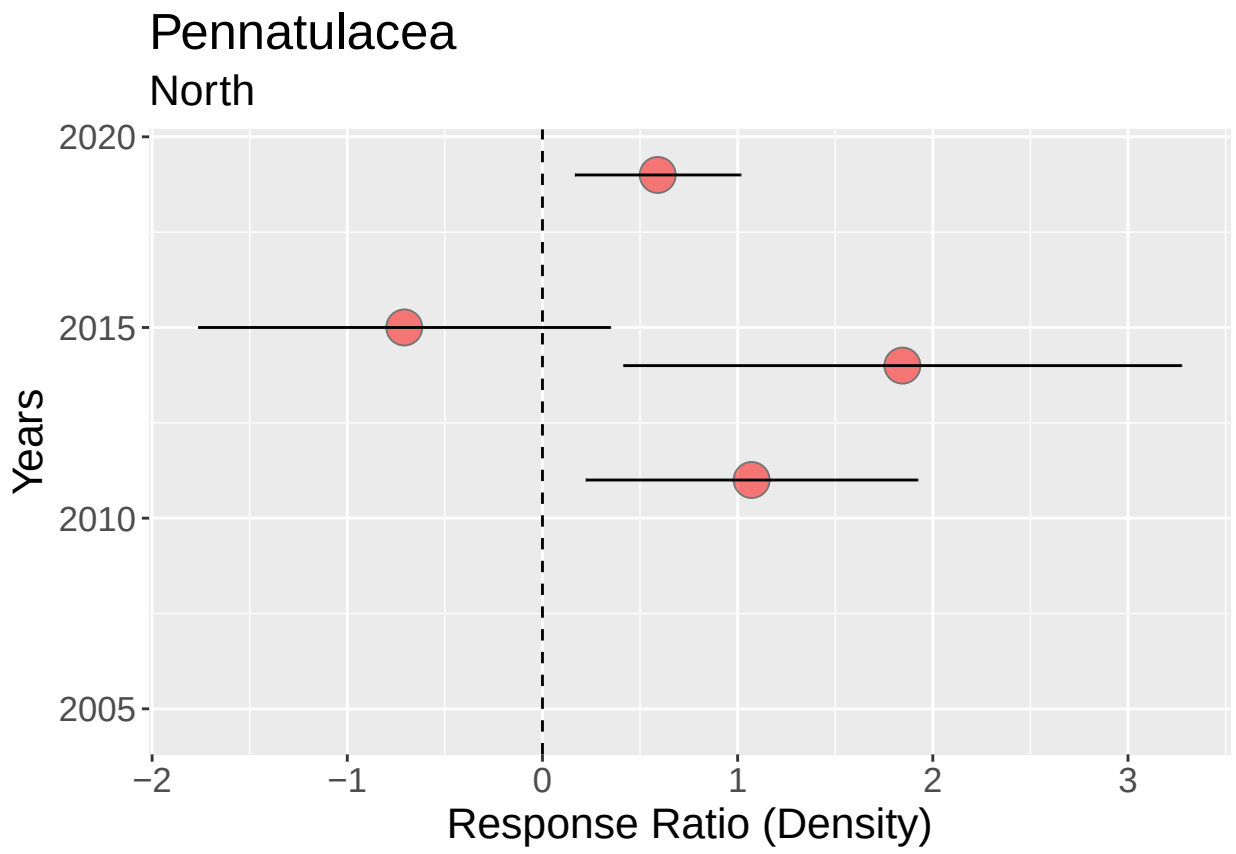

```
response_ratio(North, 188, "Malacostraca", "North") ## Crabs and allies ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



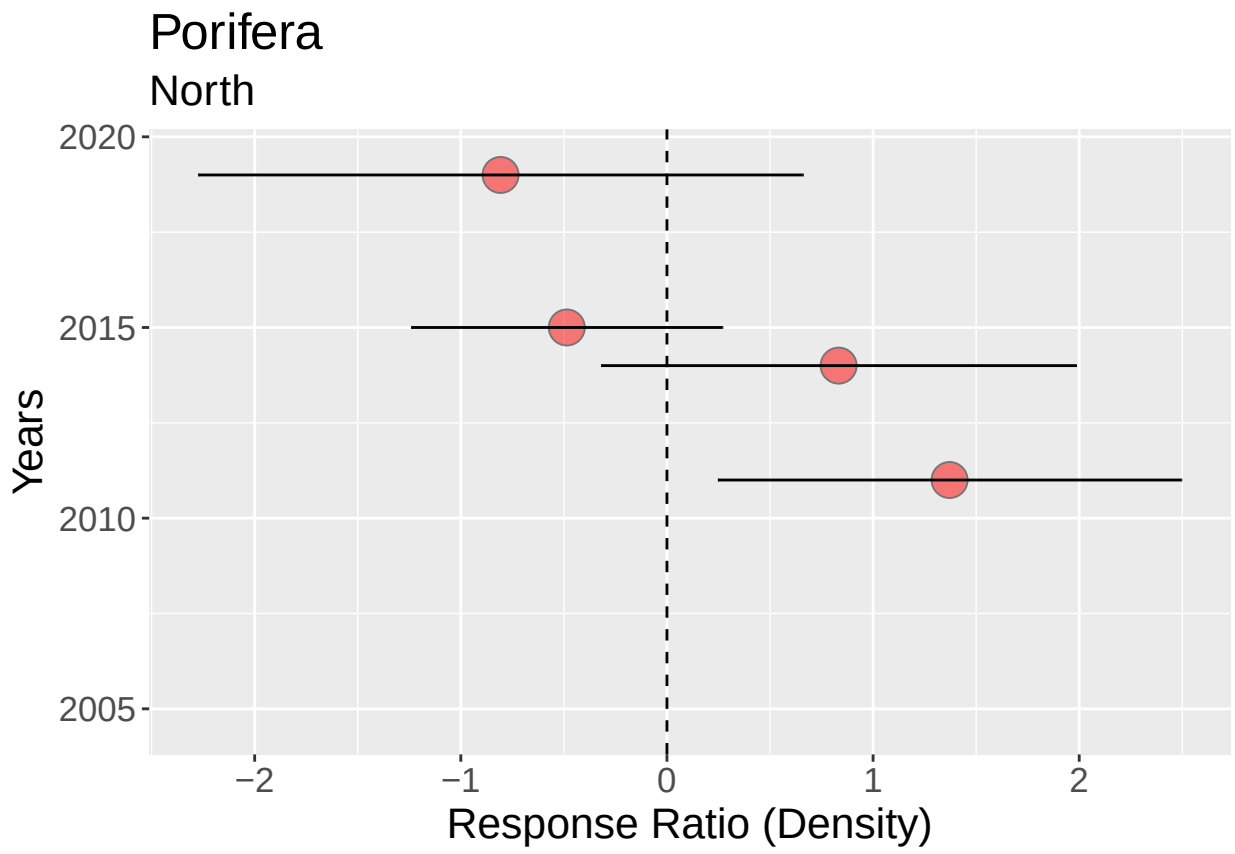

```
response_ratio(North, 189, "Pennatulacea", "North") ## Sea pens ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



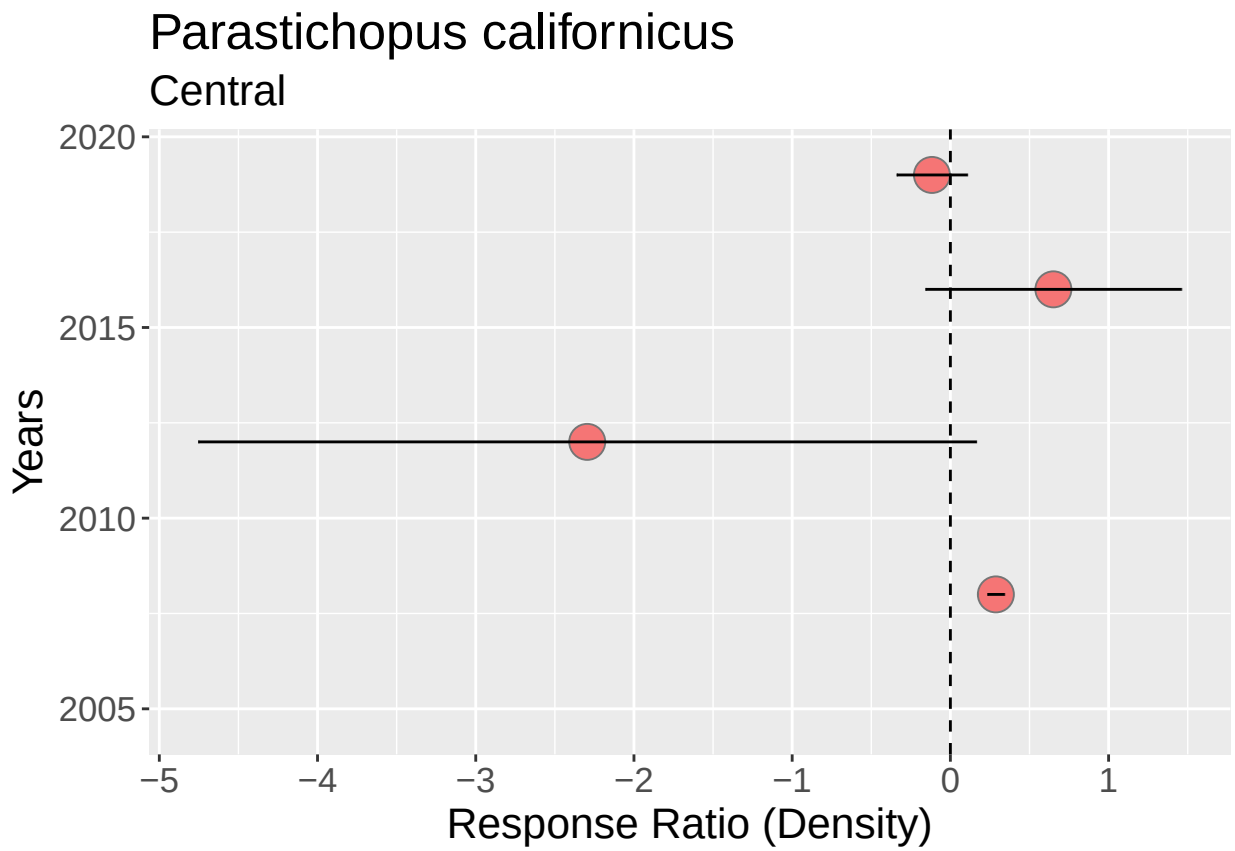

```
response_ratio(North, 190, "Porifera", "North") ## Sponges ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



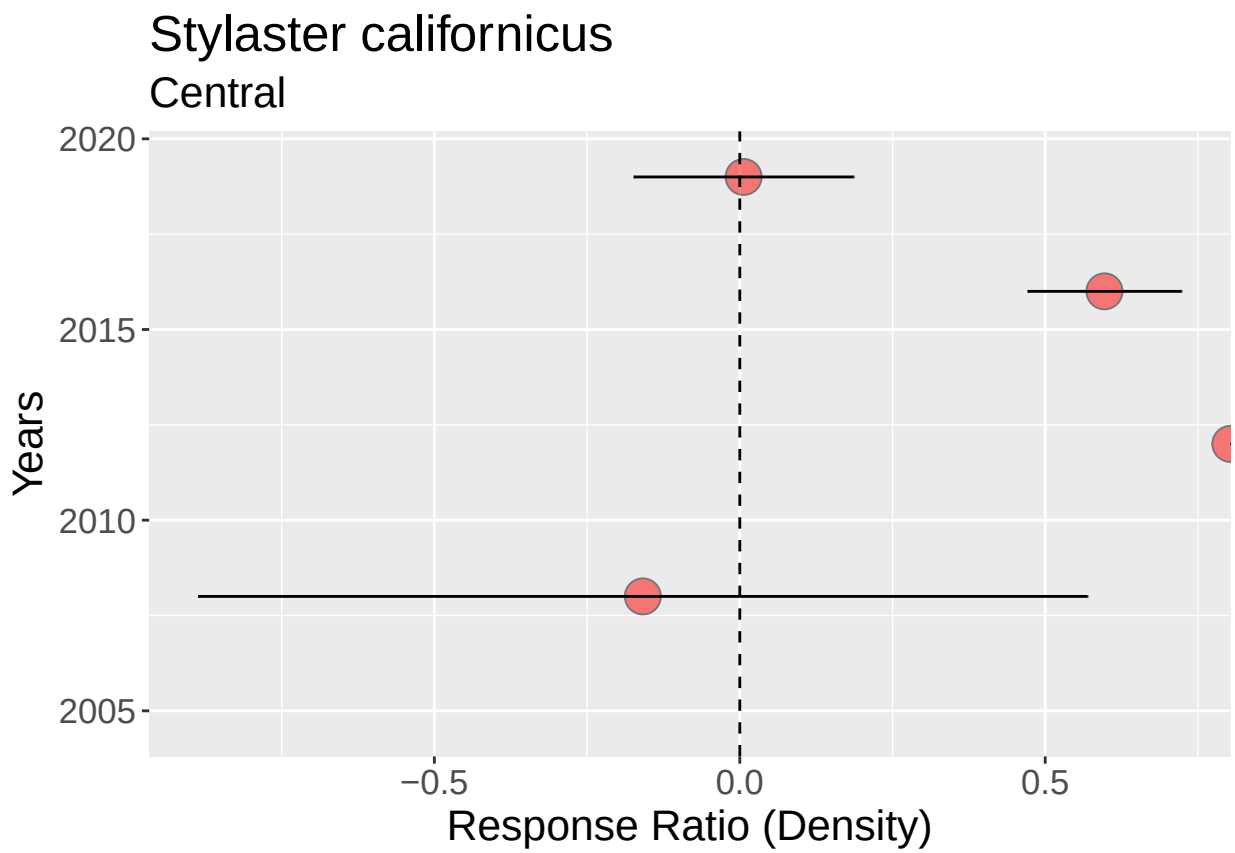

```
### Central ###

## Species ##

response_ratio(Central, 176, "Parastichopus californicus", "Central") ## sea cucumber ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



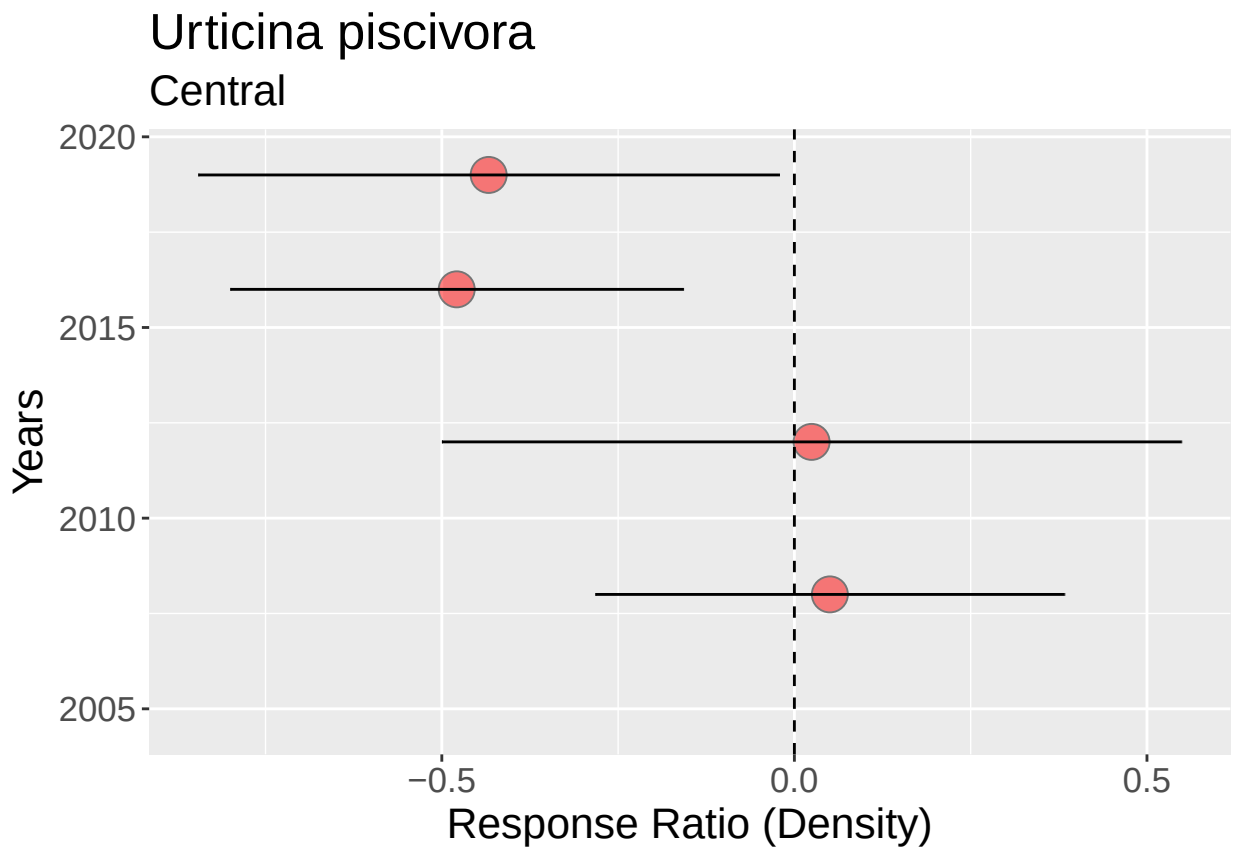

```
response_ratio(Central, 175, "Stylaster californicus", "Central") ## hydrocoral ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



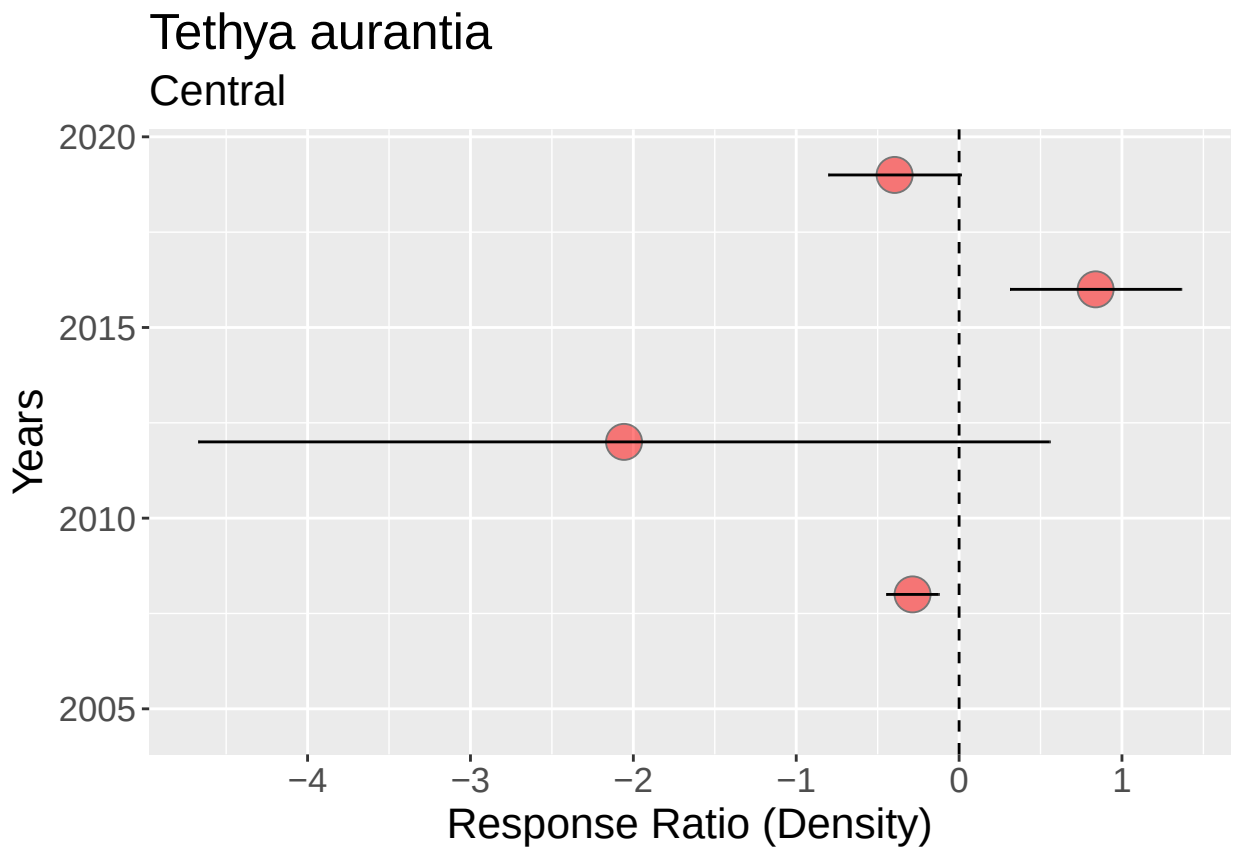

```
response_ratio(Central, 177, "Urticina piscivora", "Central") ## Fish-eating anemone ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



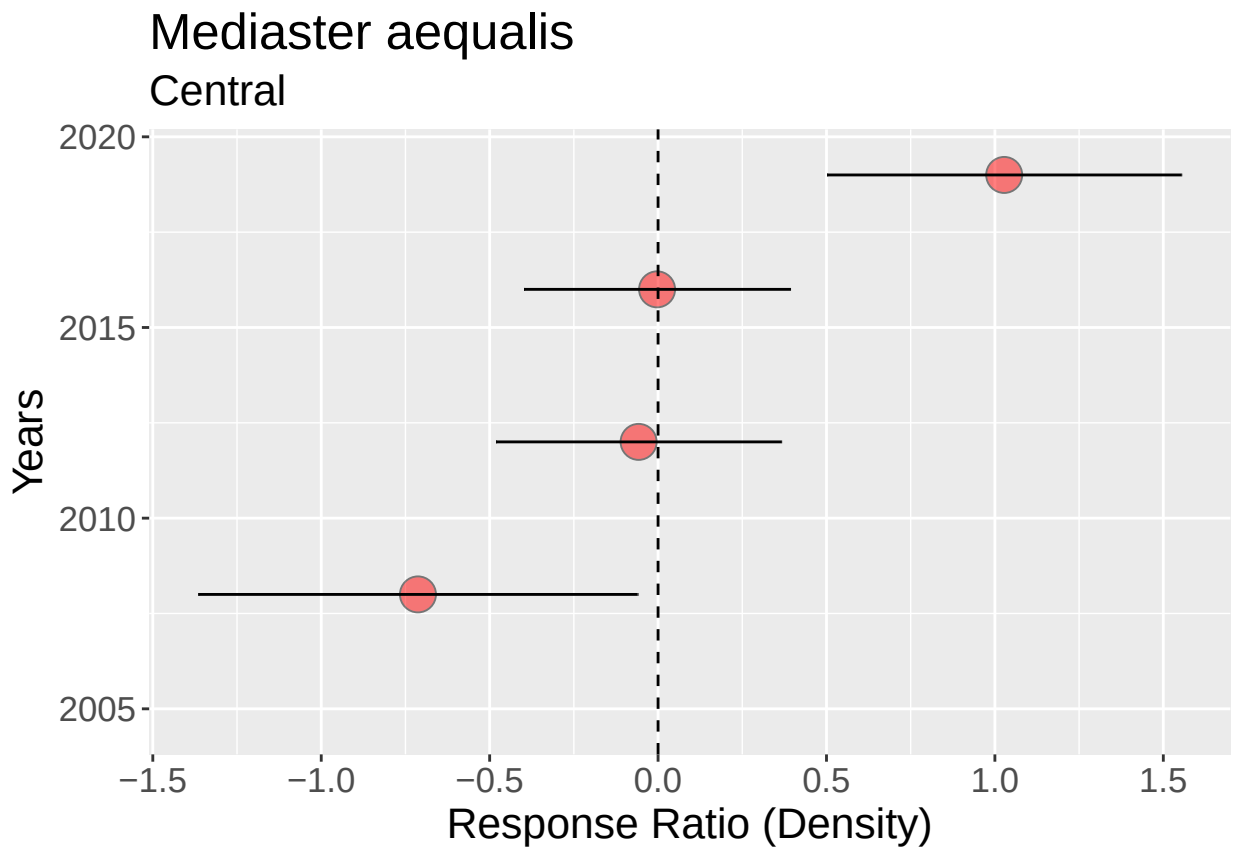

```
response_ratio(Central, 178, "Tethya aurantia", "Central") ## Puffball sponge ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



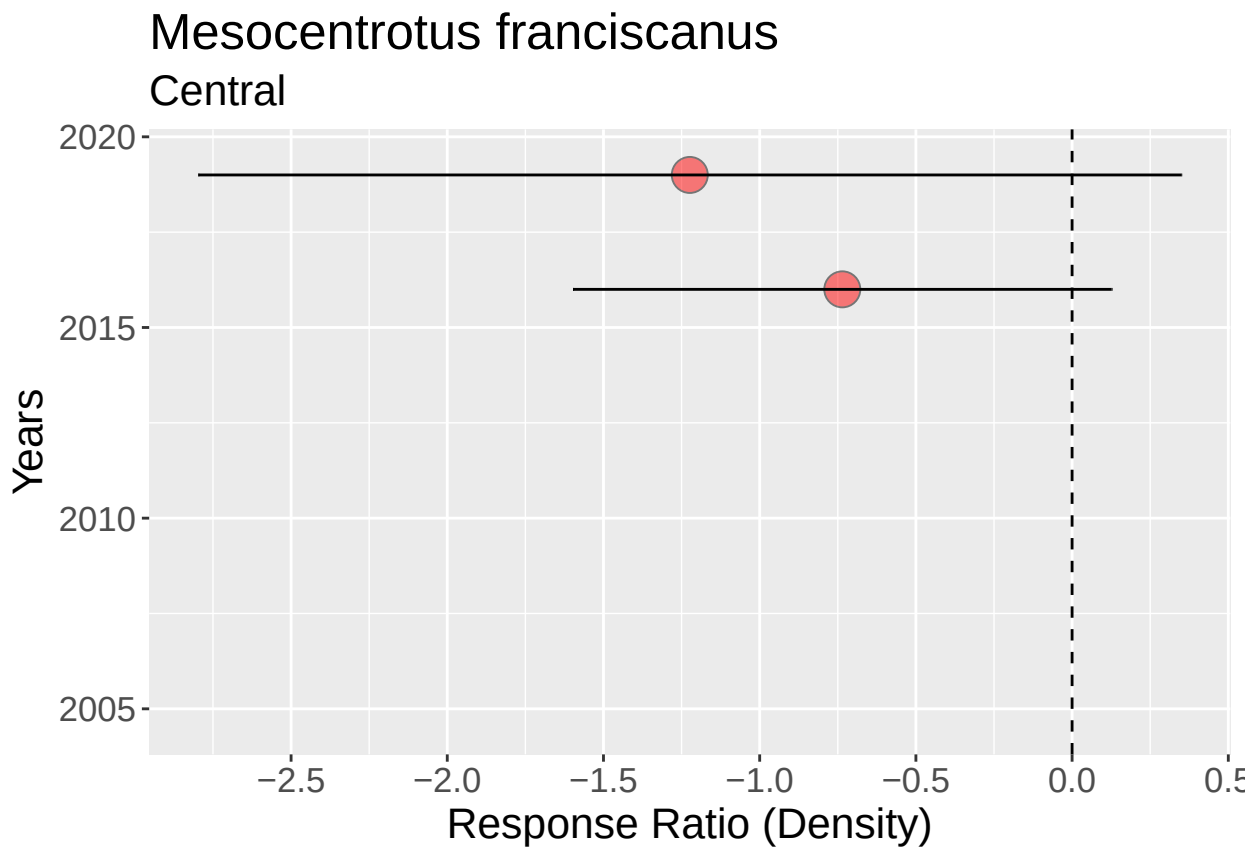

```
response_ratio(Central, 179, "Mediaster aequalis", "Central") ## Red sea star ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



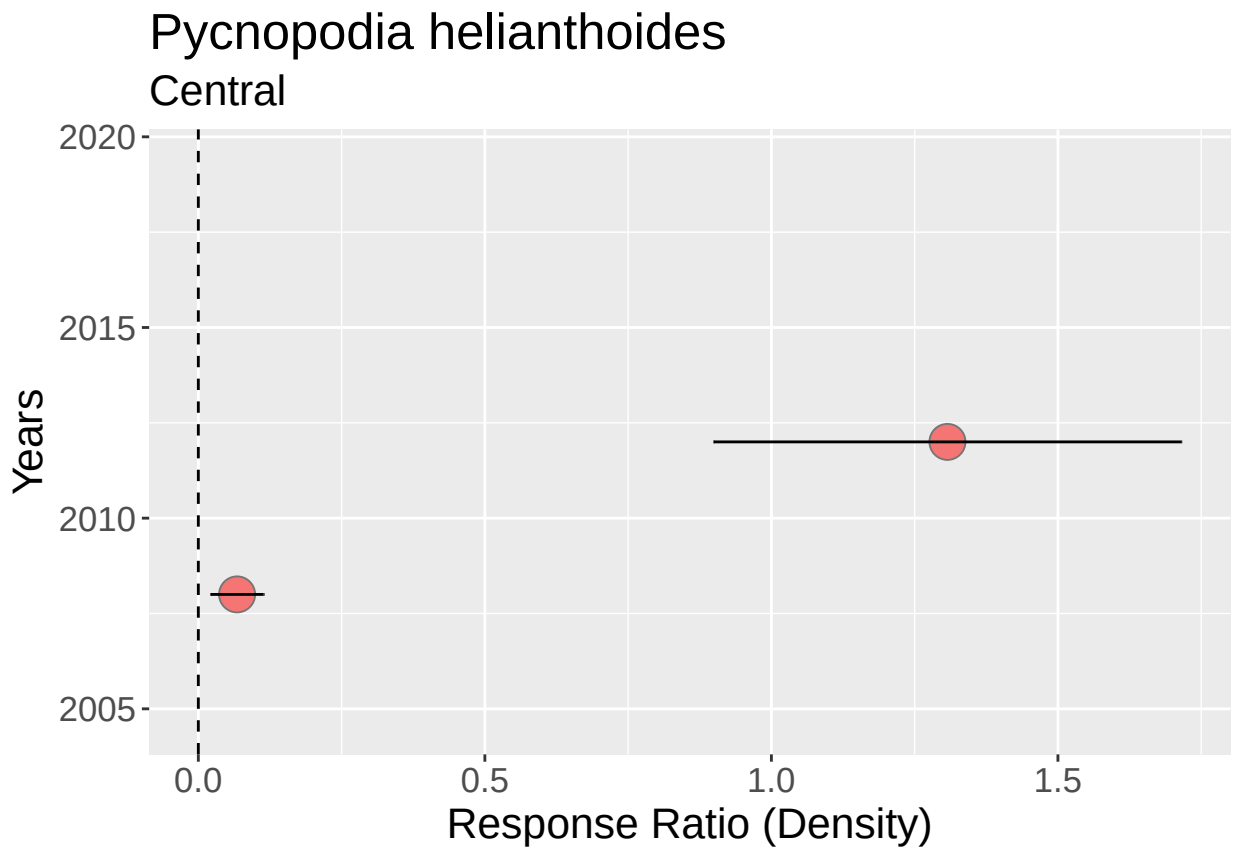

```
response_ratio(Central, 180, "Mesocentrotus franciscanus", "Central") ## Red sea urchin ##
```

```
## Warning: Removed 9 rows containing missing values (geom_point).
```



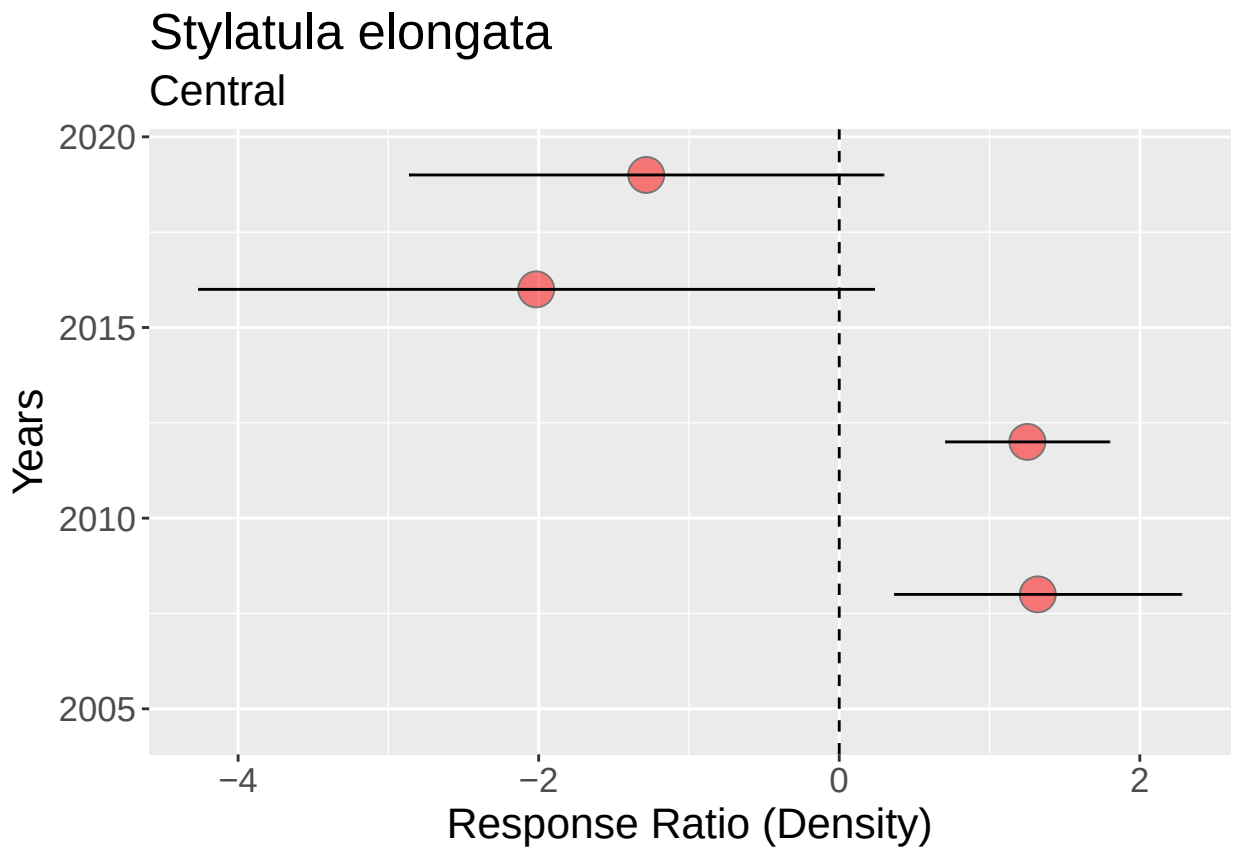

```
response_ratio(Central, 181, "Pycnopodia helianthoides", "Central") ## Sunflower star ##
```

```
## Warning: Removed 9 rows containing missing values (geom_point).
```



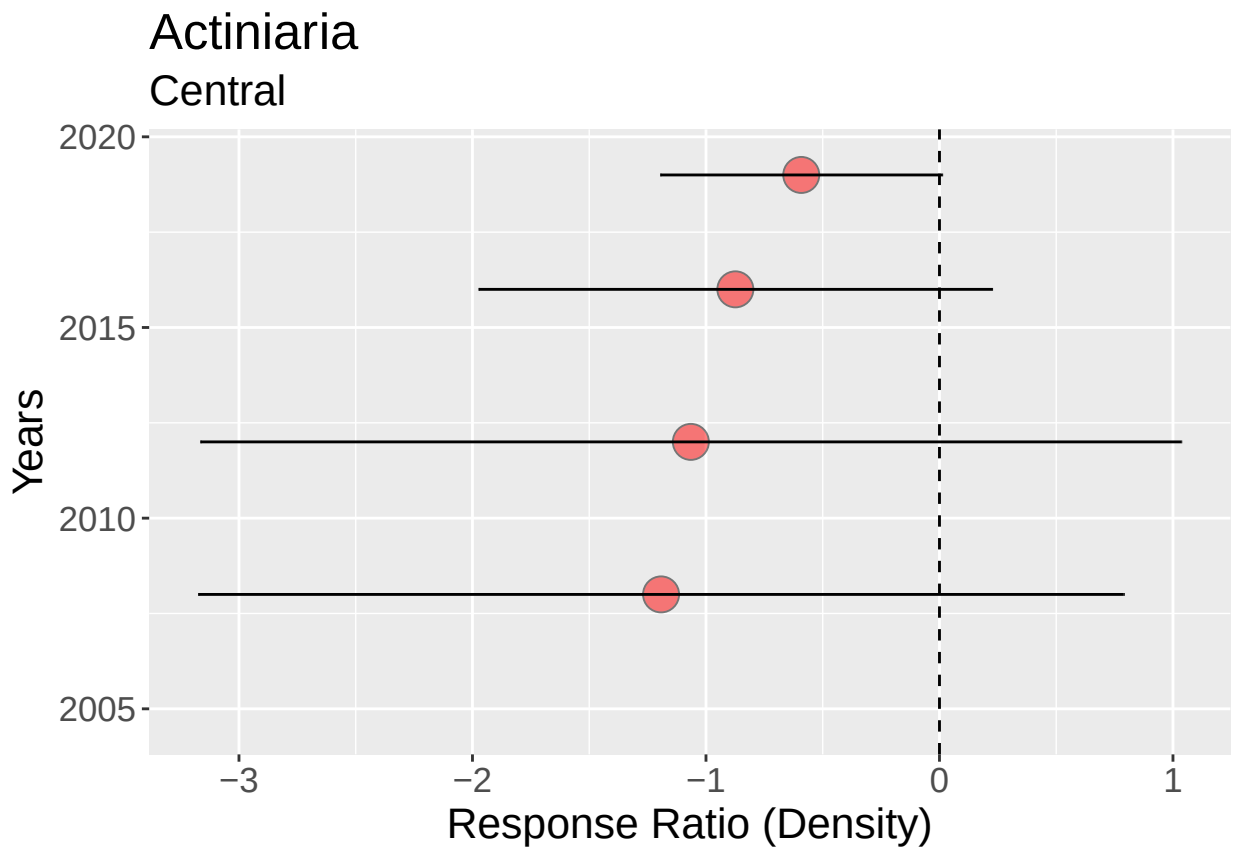

```
response_ratio(Central, 182, "Stylatula elongata", "Central") ## White sea pen ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



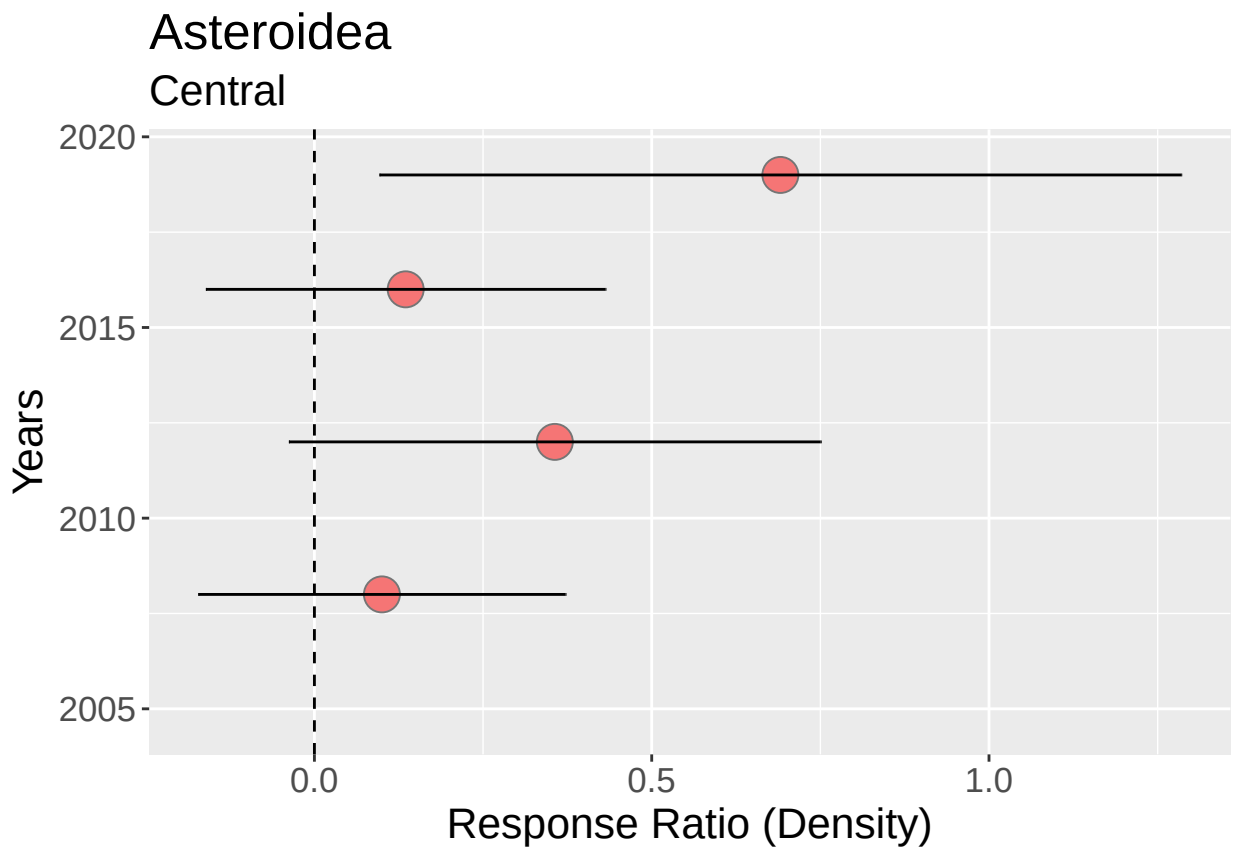

```
## Functional Groups ##

response_ratio(Central, 183, "Actiniaria", "Central") ## Anemones ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



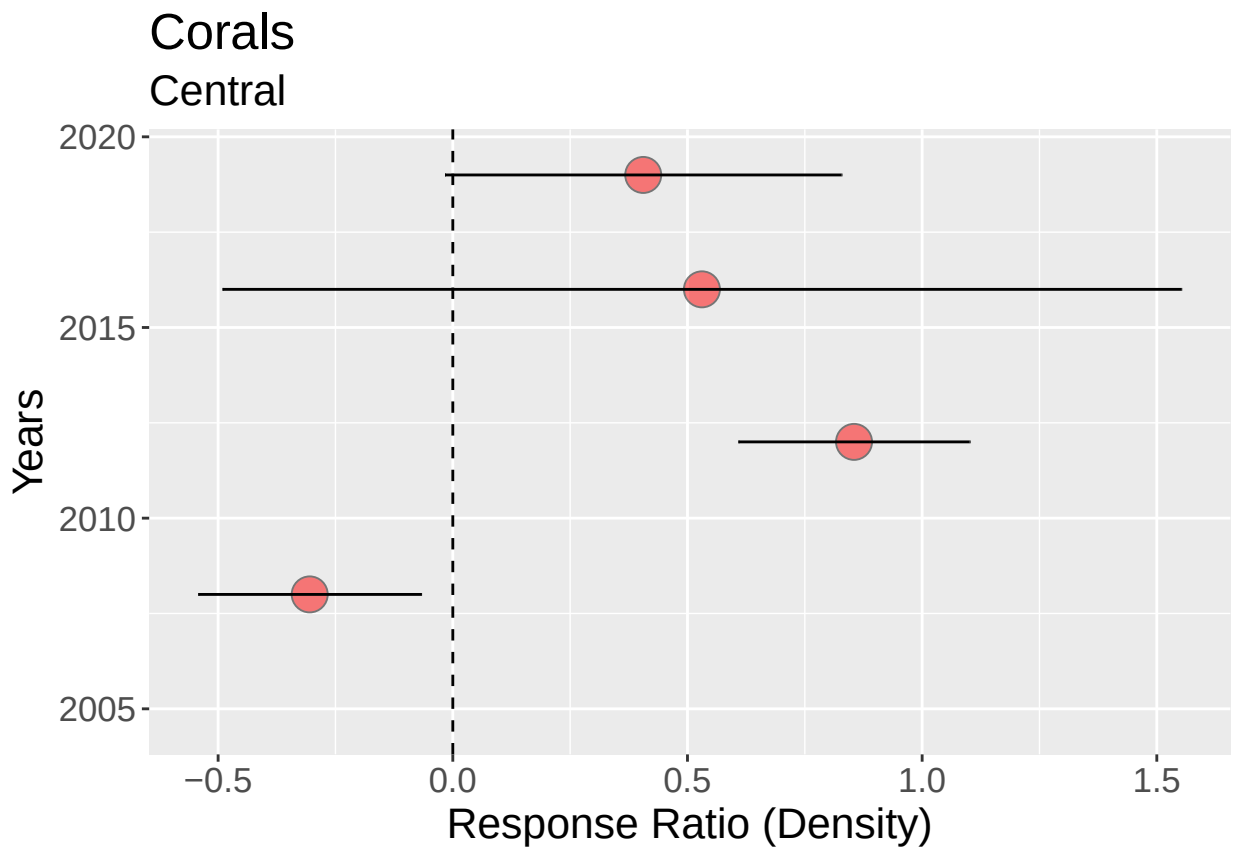

```
response_ratio(Central, 184, "Asteroidea", "Central") ## Sea stars ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



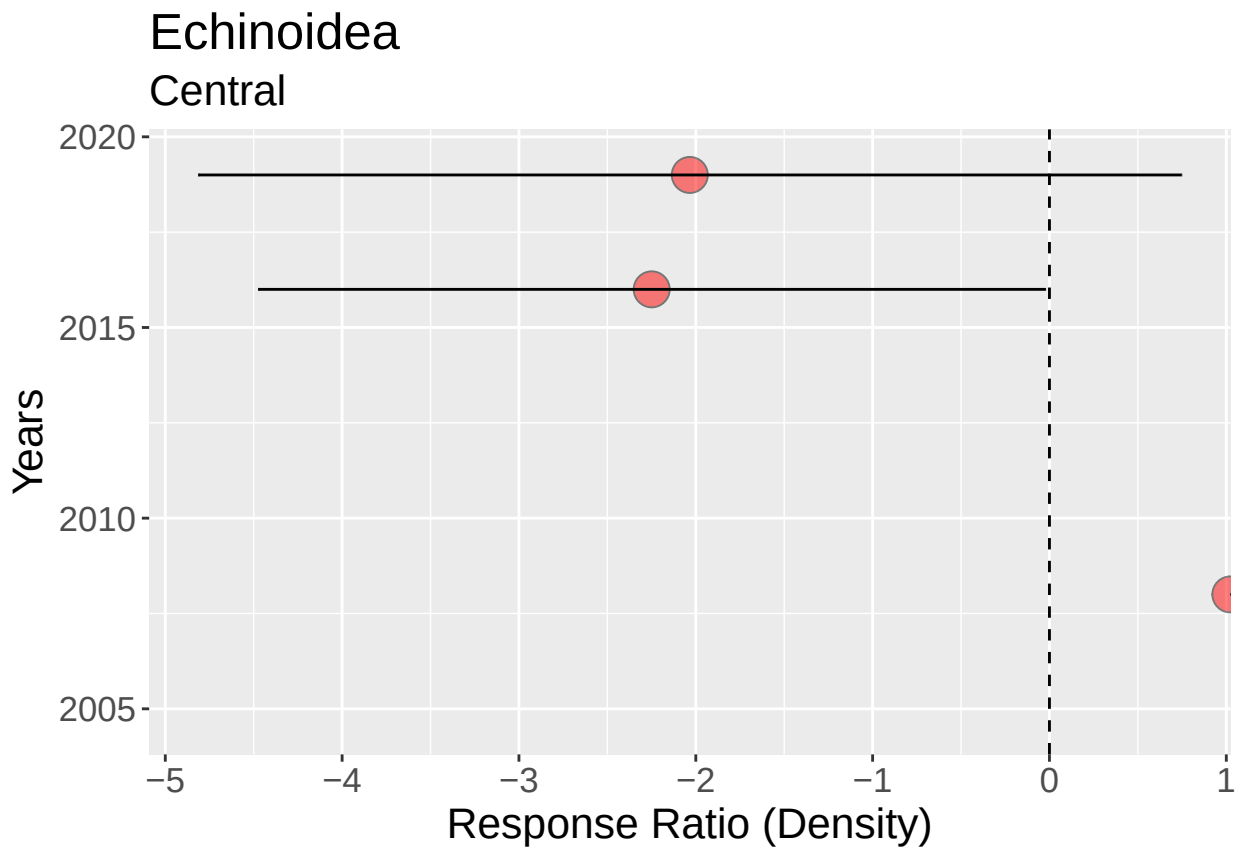

```
response_ratio(Central, 185, "Corals", "Central") ## Reef-forming cnidarians ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



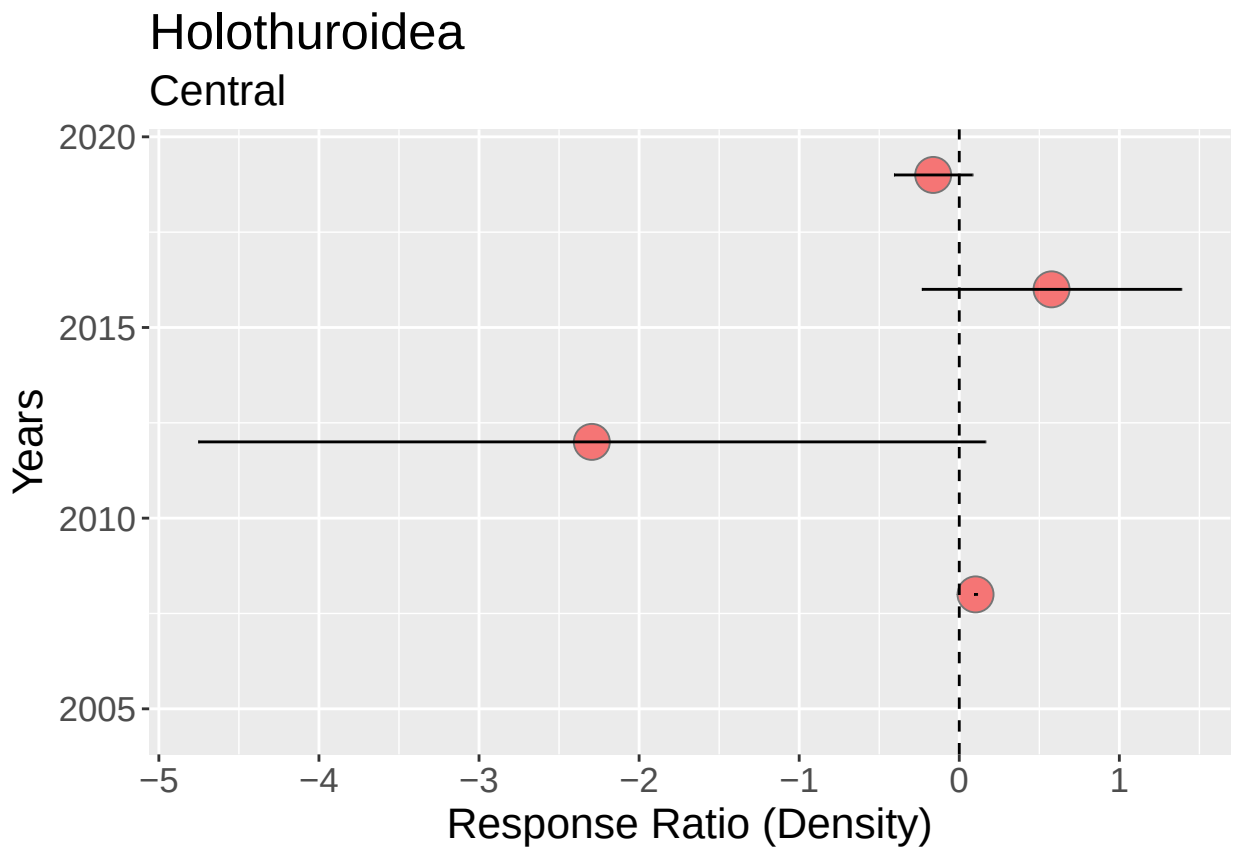

```
response_ratio(Central, 186, "Echinoidea", "Central") ## Sea urchins ##
```

```
## Warning: Removed 8 rows containing missing values (geom_point).
```



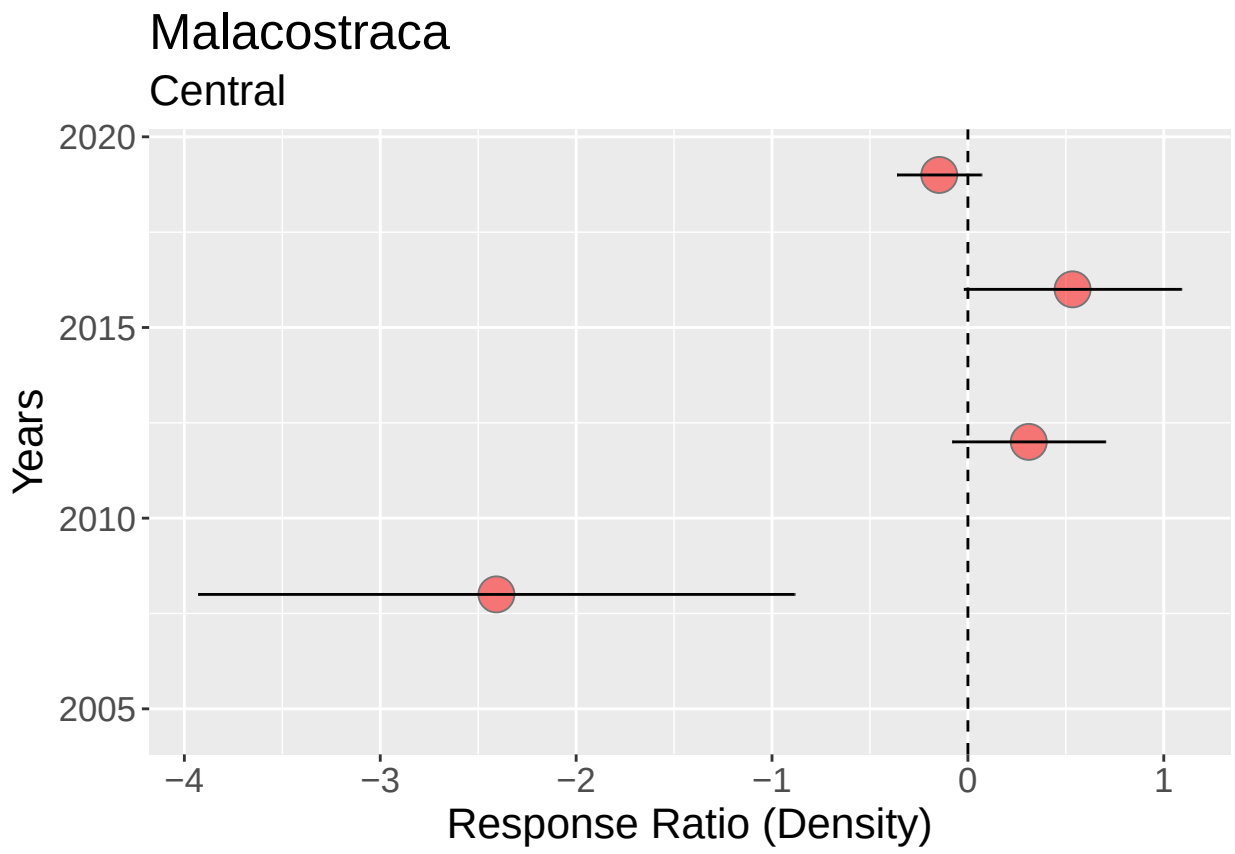

```
response_ratio(Central, 187, "Holothuroidea", "Central") ## Sea cucumbers ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



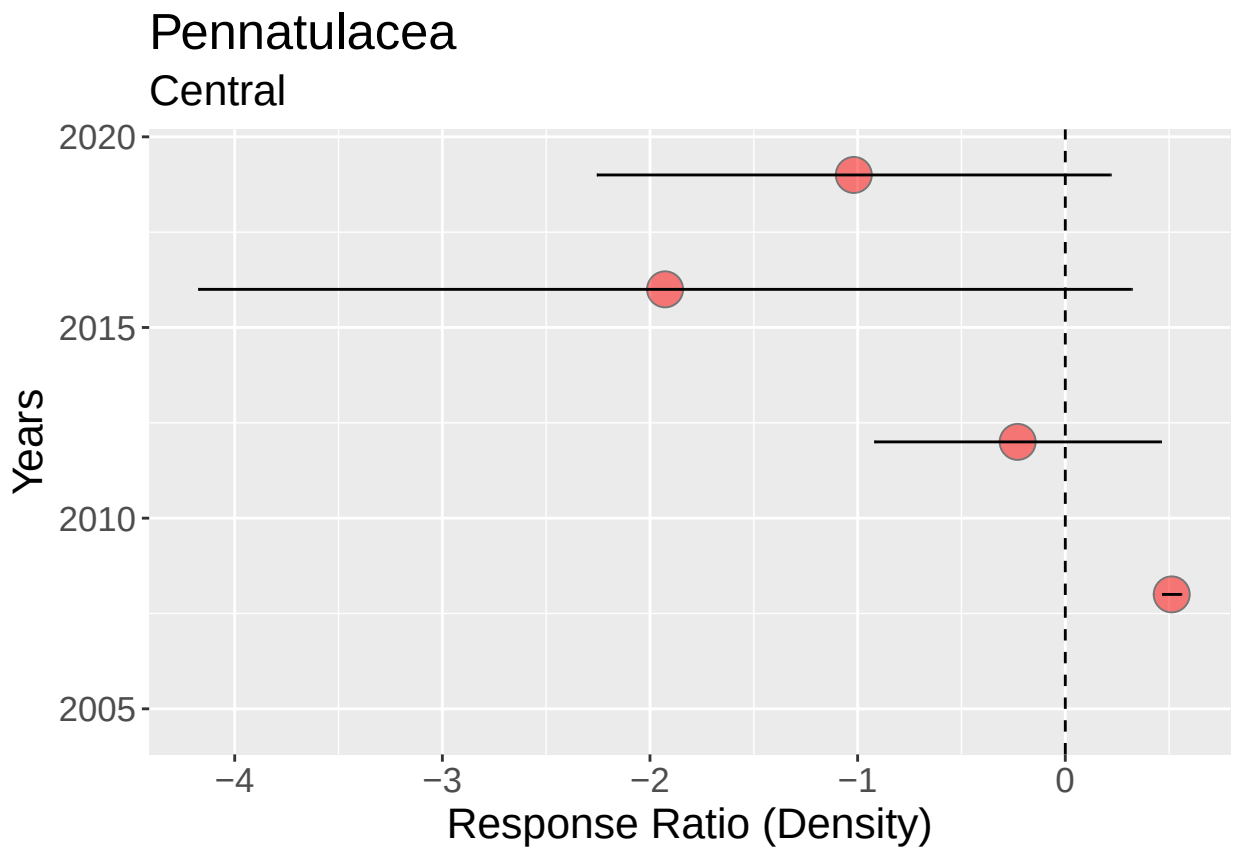

```
response_ratio(Central, 188, "Malacostraca", "Central") ## Crabs and allies ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



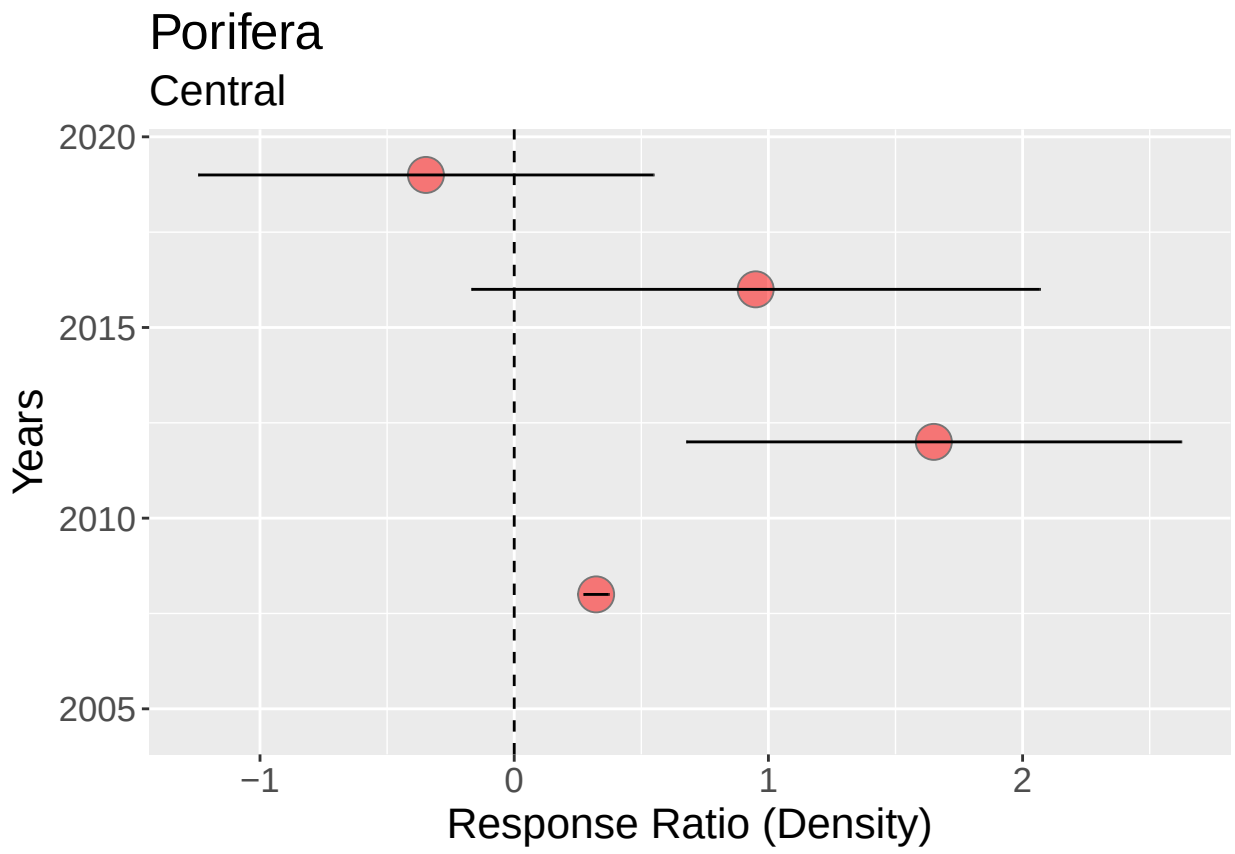

```
response_ratio(Central, 189, "Pennatulacea", "Central") ## Sea pens ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



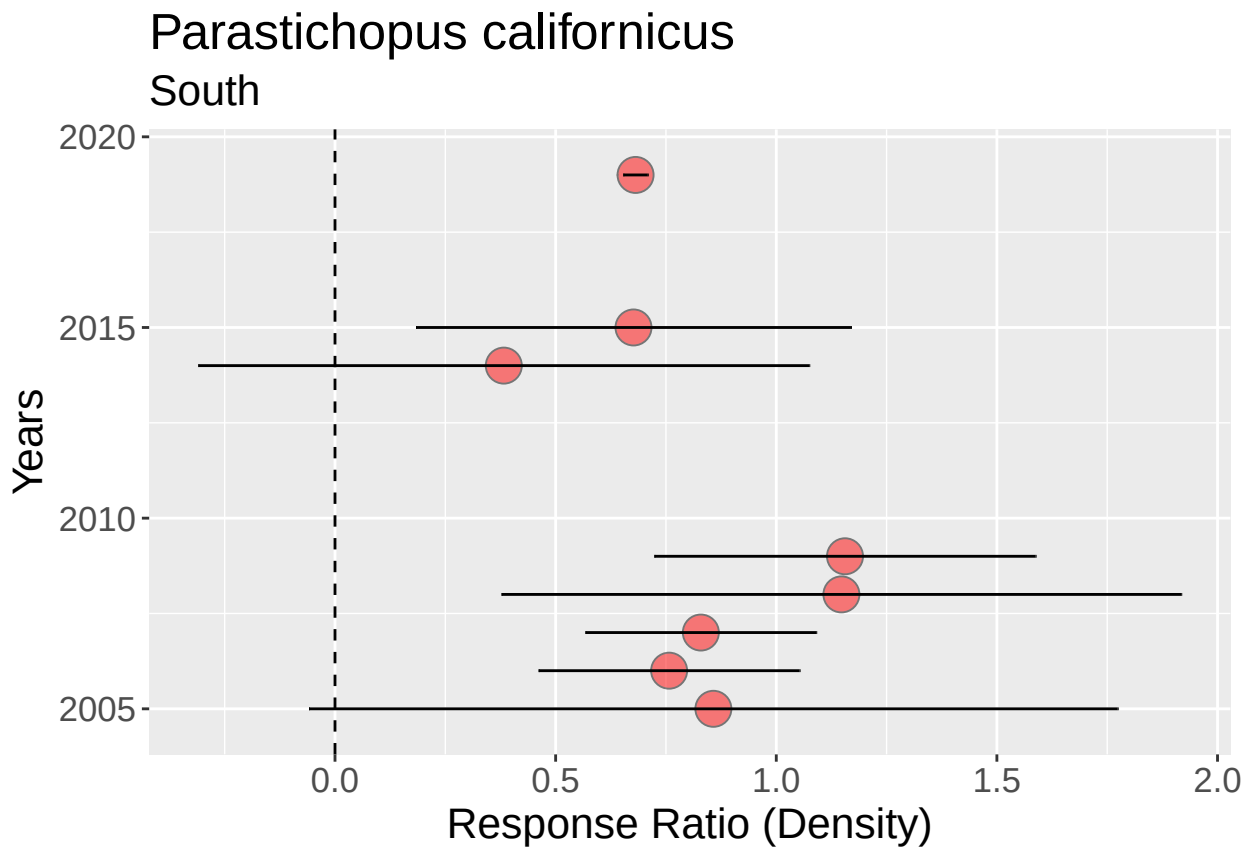

```
response_ratio(Central, 190, "Porifera", "Central") ## Sponges ##
```

```
## Warning: Removed 7 rows containing missing values (geom_point).
```



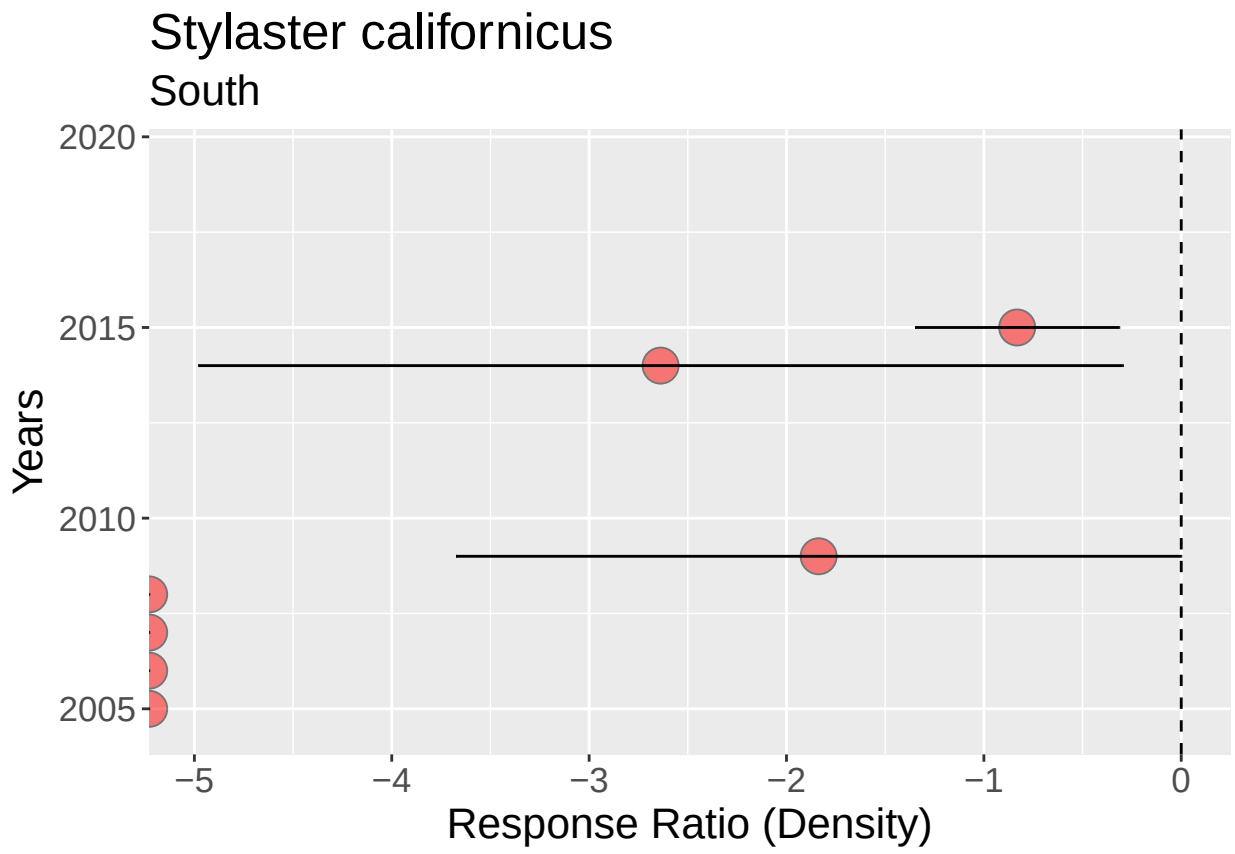

```
### South ###

## Species ##

response_ratio(South, 176, "Parastichopus californicus", "South") ## sea cucumber ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



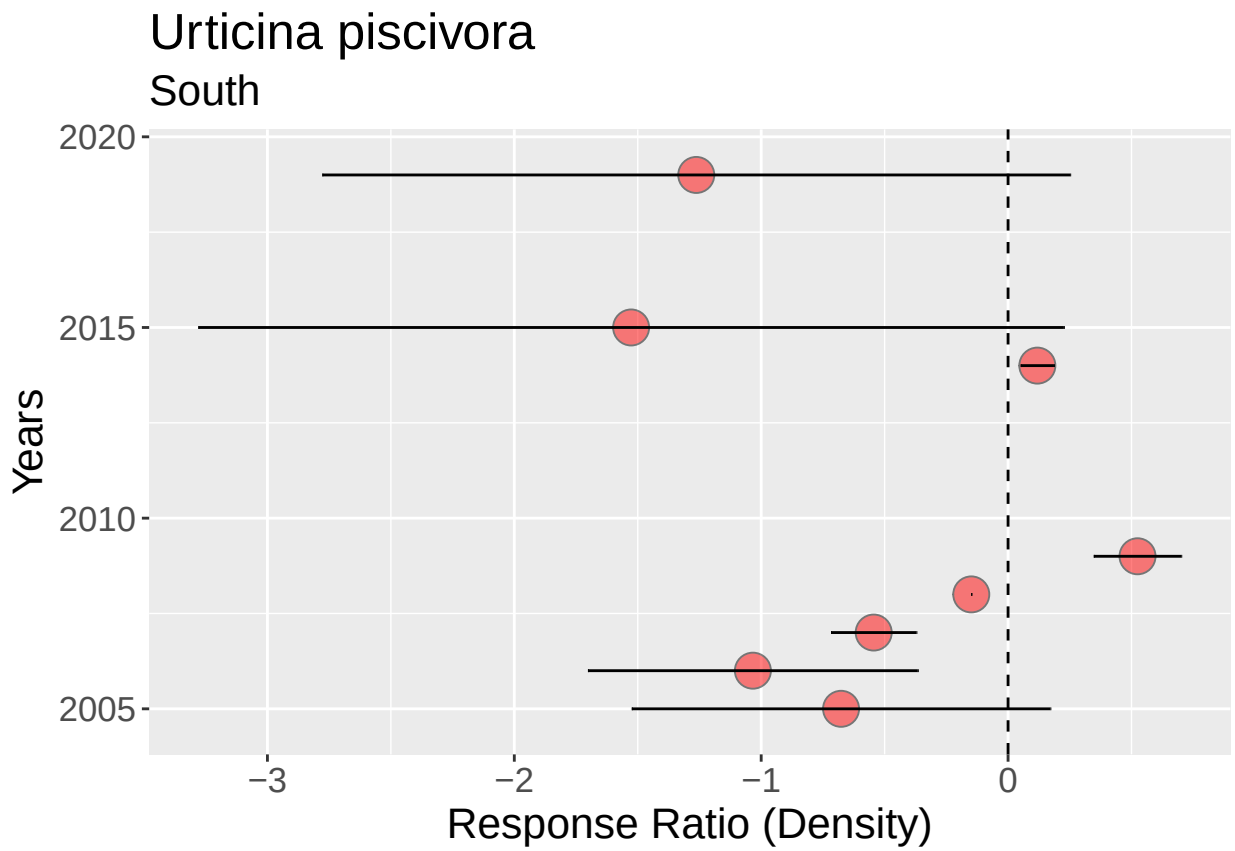

```
response_ratio(South, 175, "Stylaster californicus", "South") ## hydrocoral ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



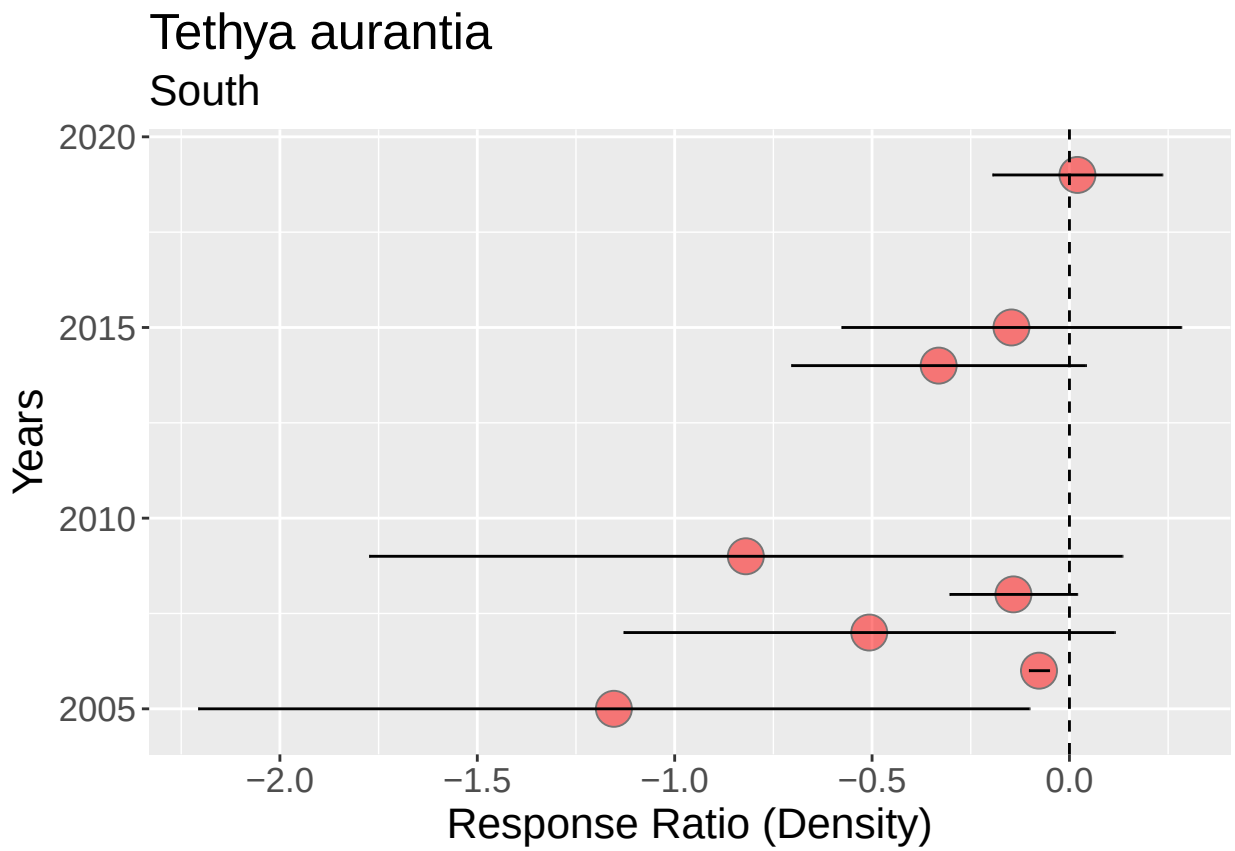

```
response_ratio(South, 177, "Urticina piscivora", "South") ## Fish-eating anemone ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



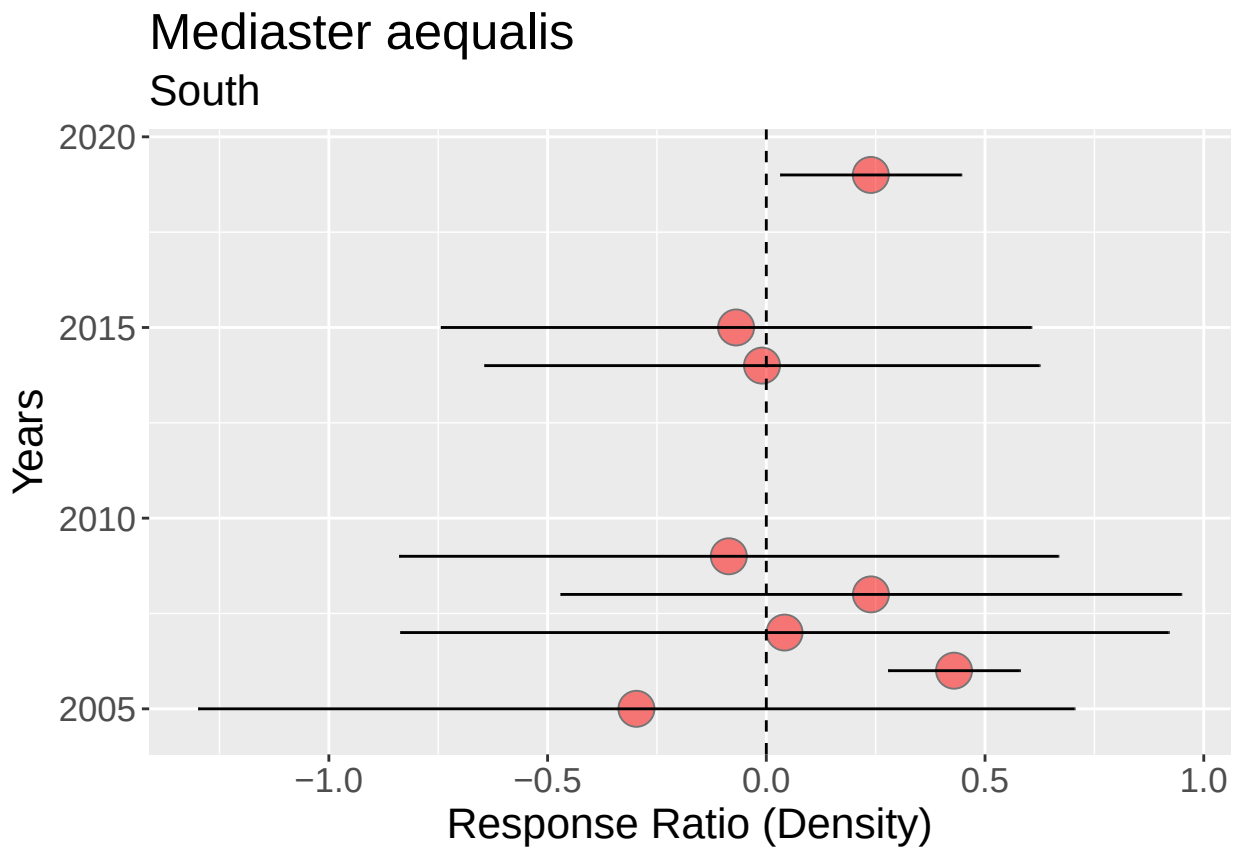

```
response_ratio(South, 178, "Tethya aurantia", "South") ## Puffball sponge ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



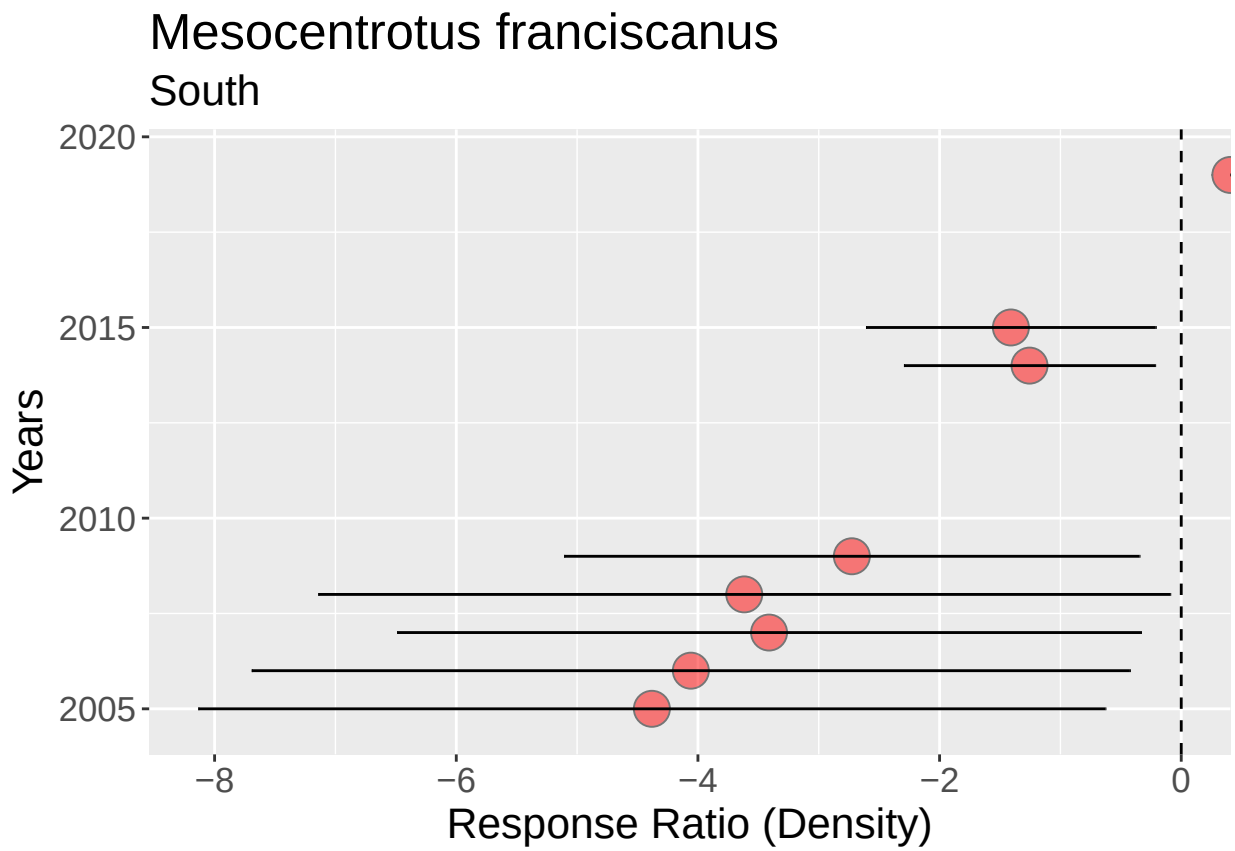

```
response_ratio(South, 179, "Mediaster aequalis", "South") ## Red sea star ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



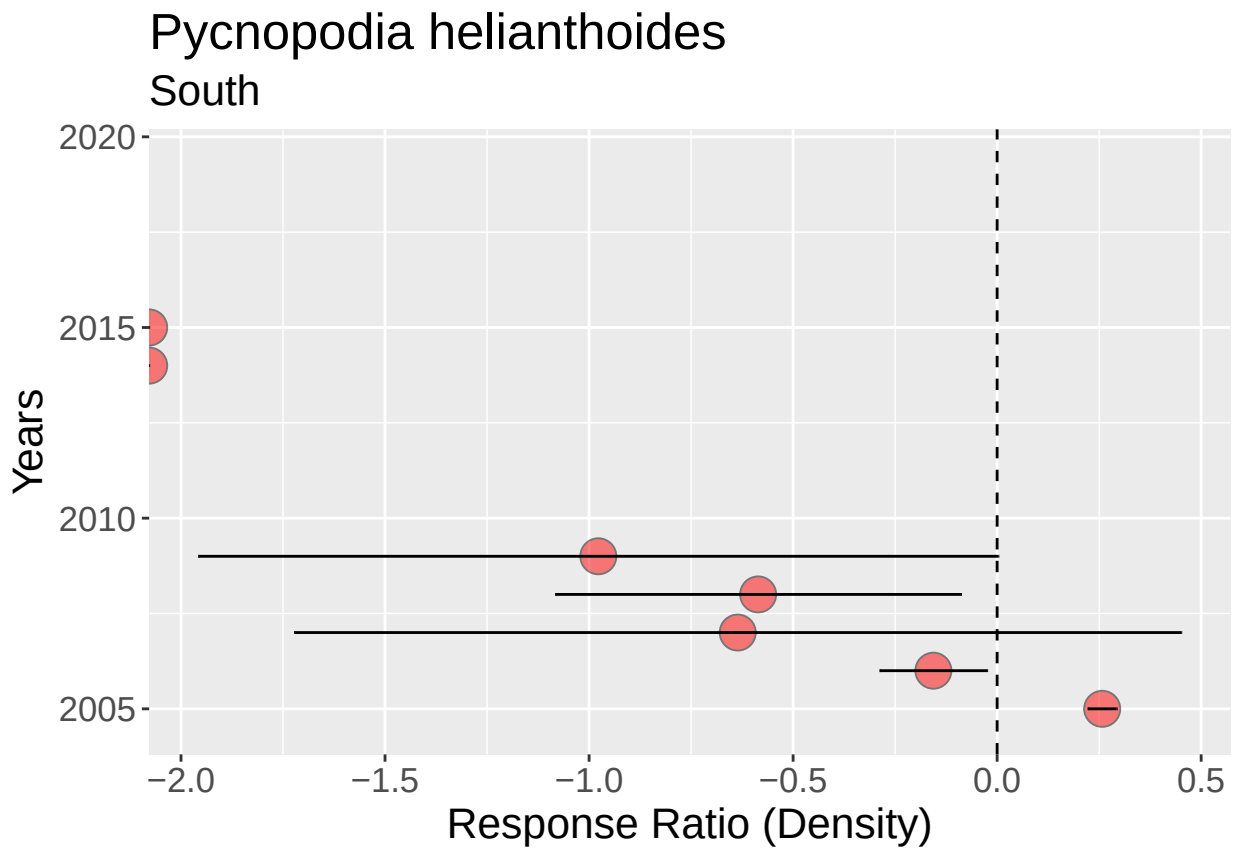

```
response_ratio(South, 180, "Mesocentrotus franciscanus", "South") ## Red sea urchin ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



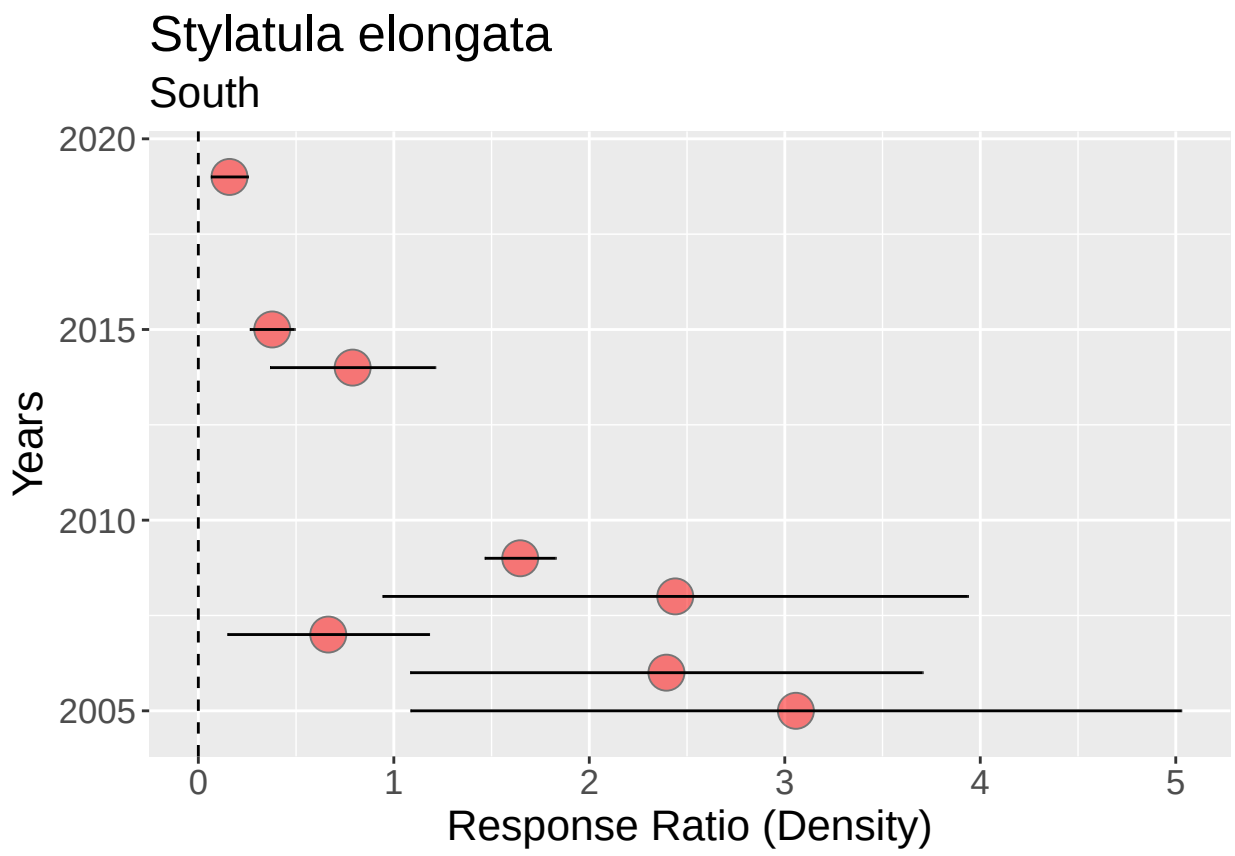

```
response_ratio(South, 181, "Pycnopodia helianthoides", "South") ## Sunflower star ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



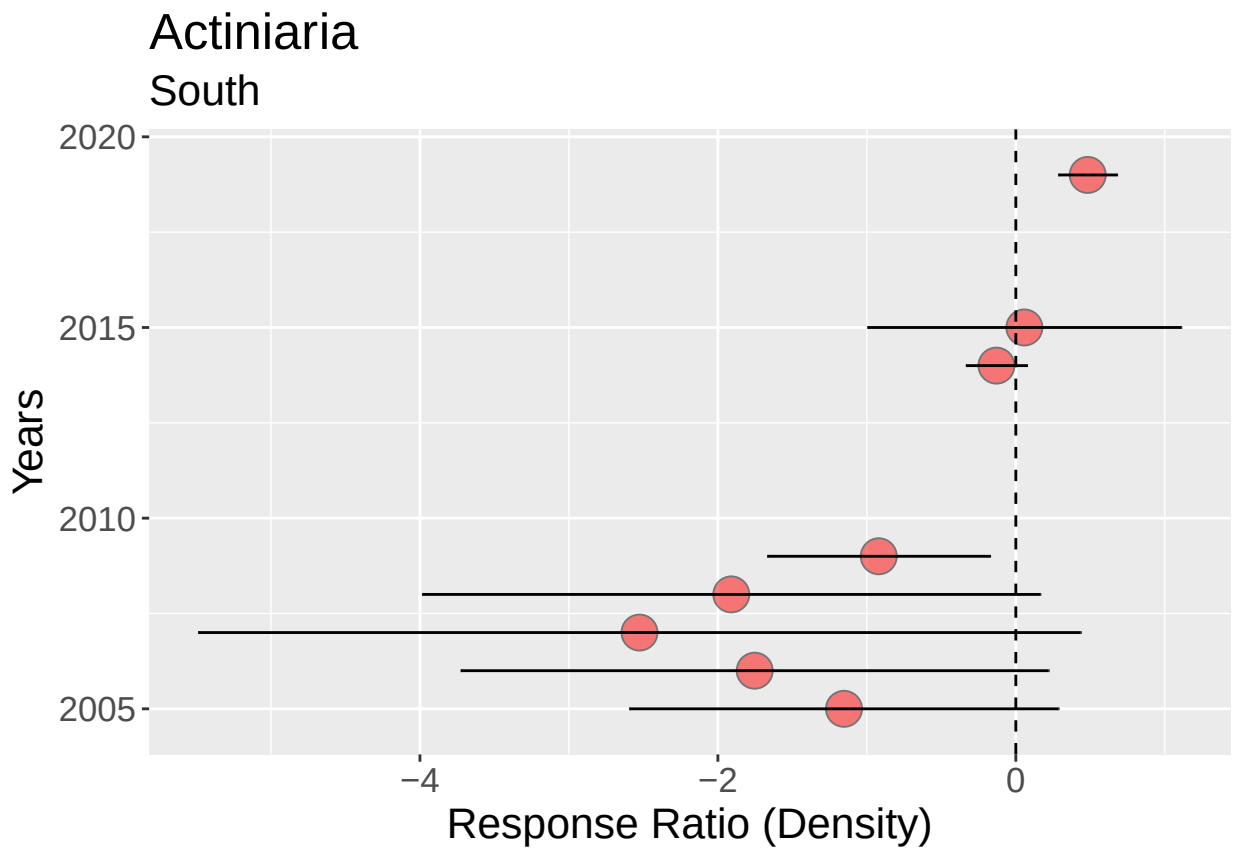

```
response_ratio(South, 182, "Stylatula elongata", "South") ## White sea pen ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



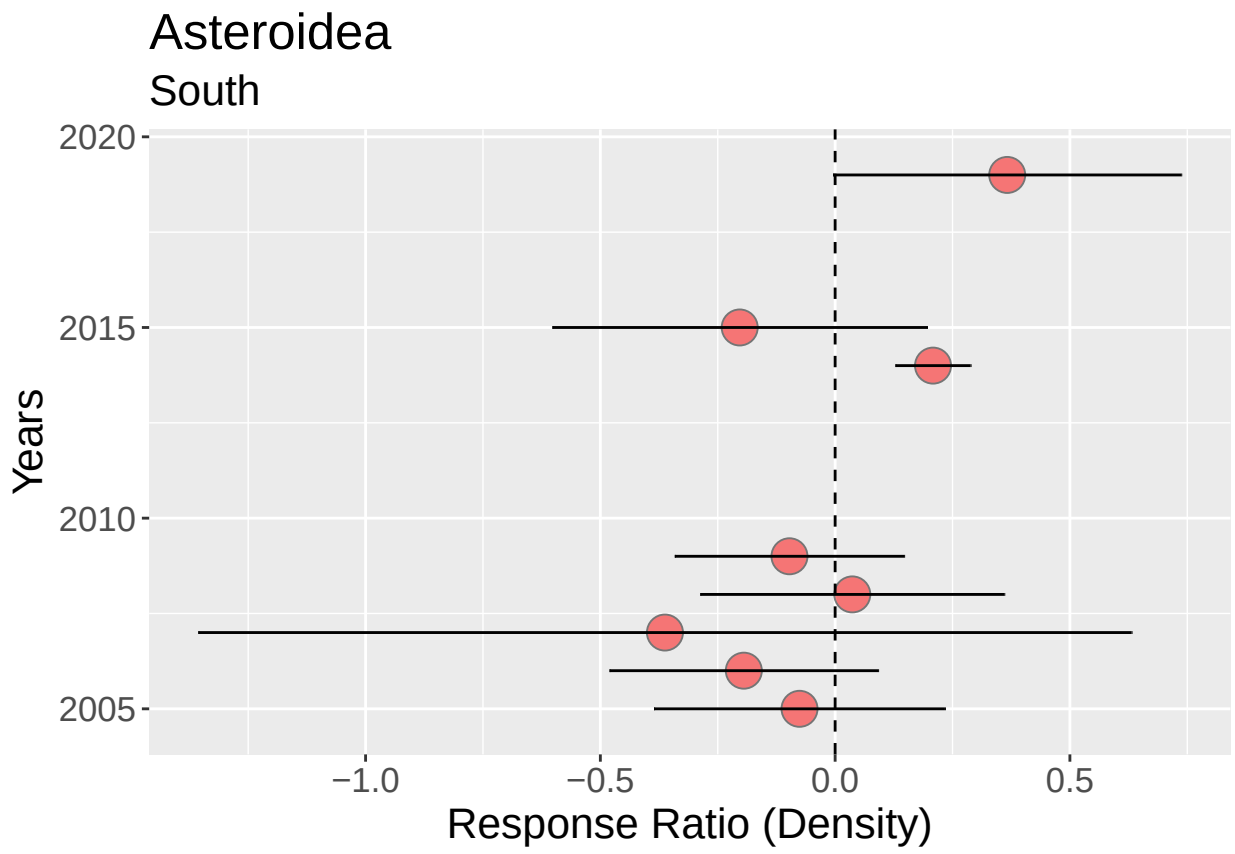

```
## Functional Groups ##

response_ratio(South, 183, "Actiniaria", "South") ## Anemones ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



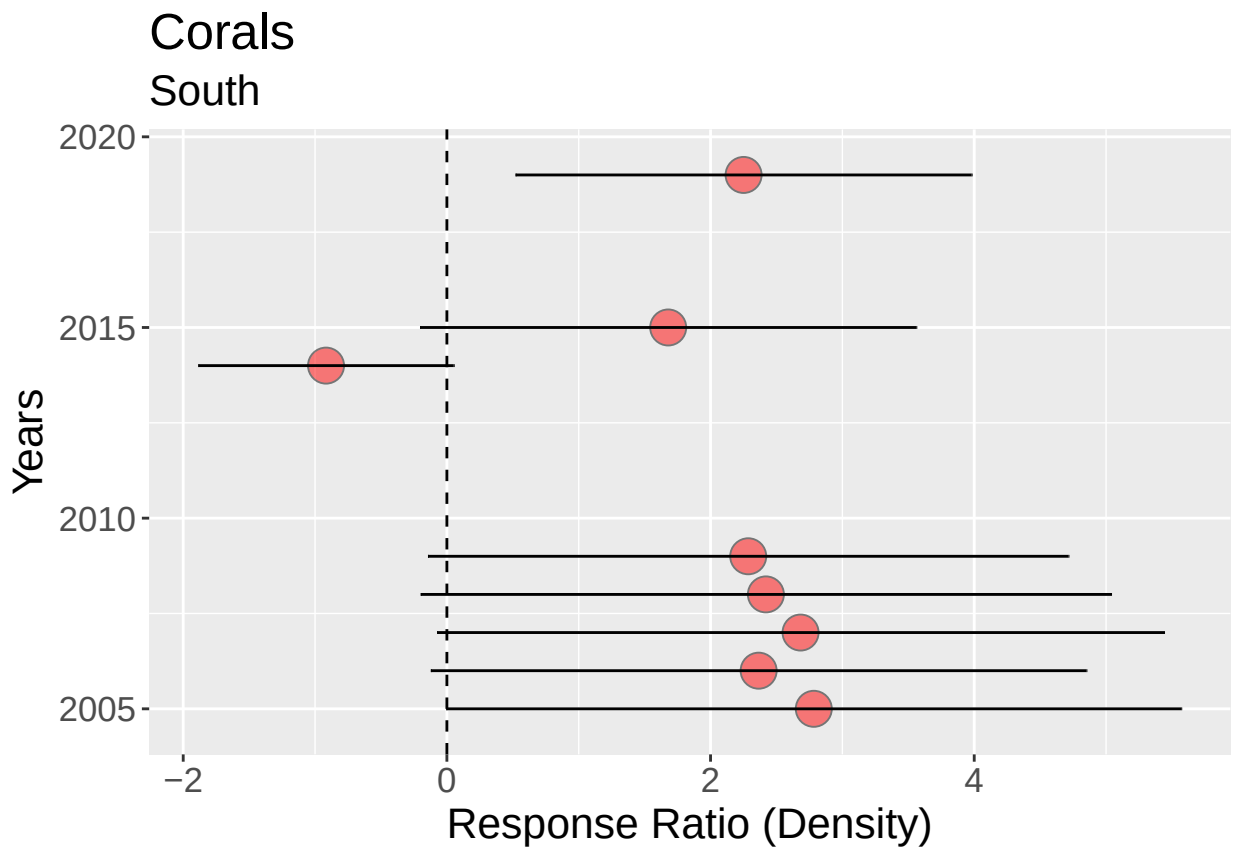

```
response_ratio(South, 184, "Asteroidea", "South") ## Soft corals ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



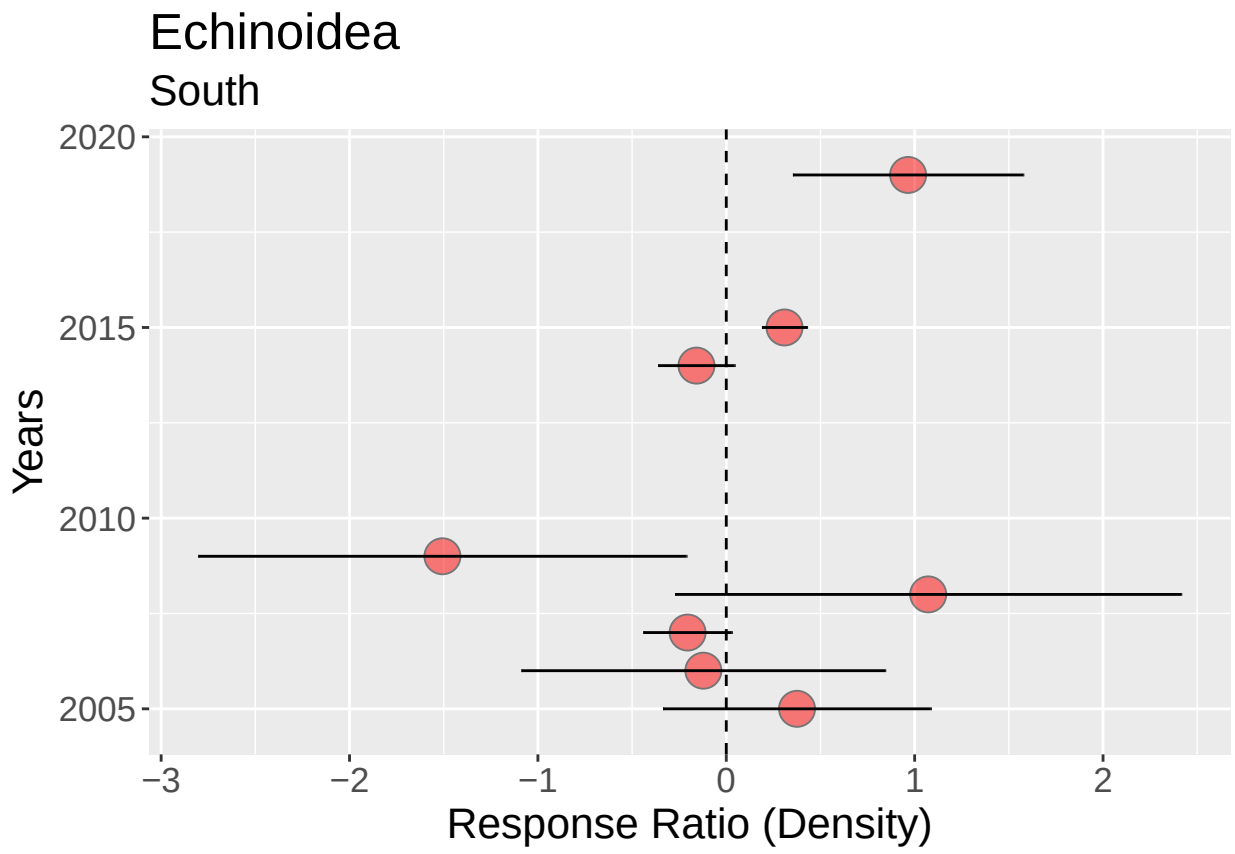

```
response_ratio(South, 185, "Corals", "South") ## Reef-forming cnidarians ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



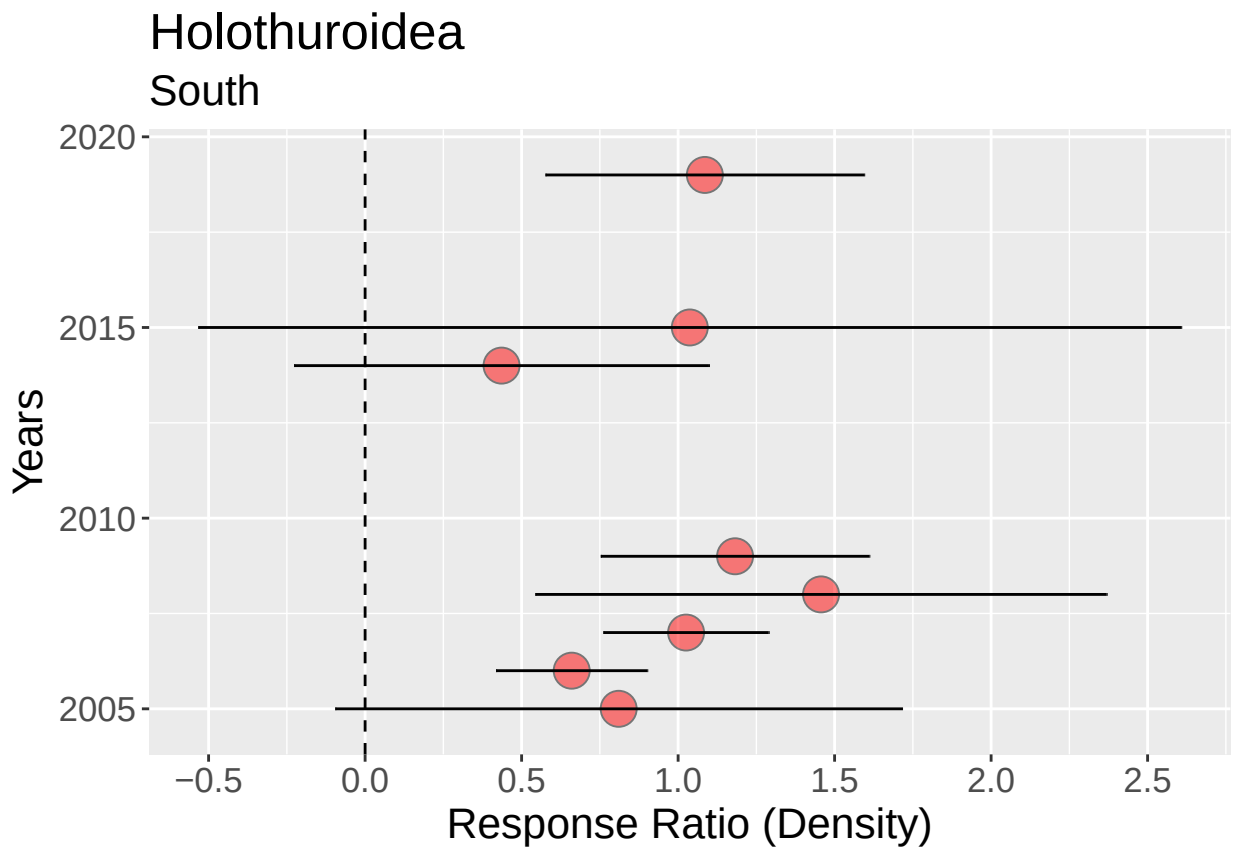

```
response_ratio(South, 186, "Echinoidea", "South") ## Sea urchins ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



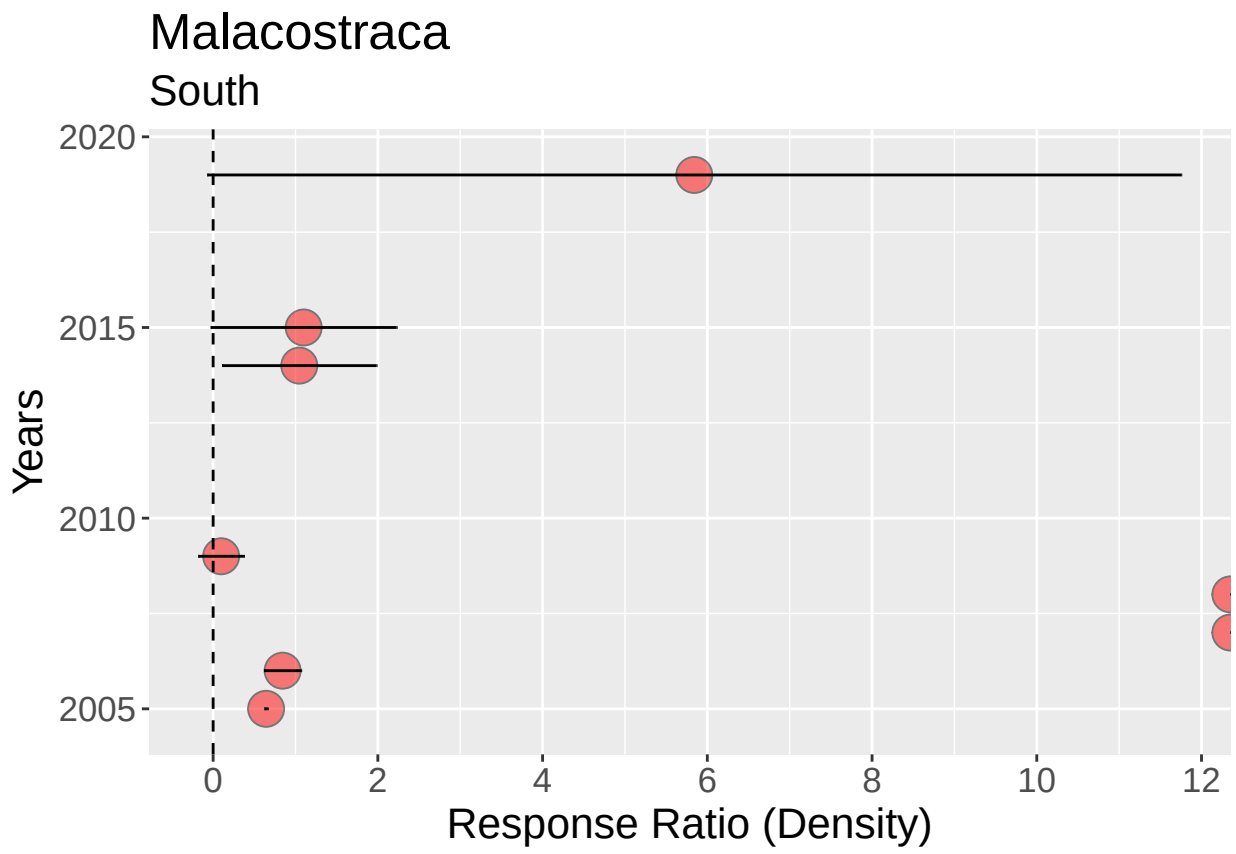

```
response_ratio(South, 187, "Holothuroidea", "South") ## Sea cucumbers ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



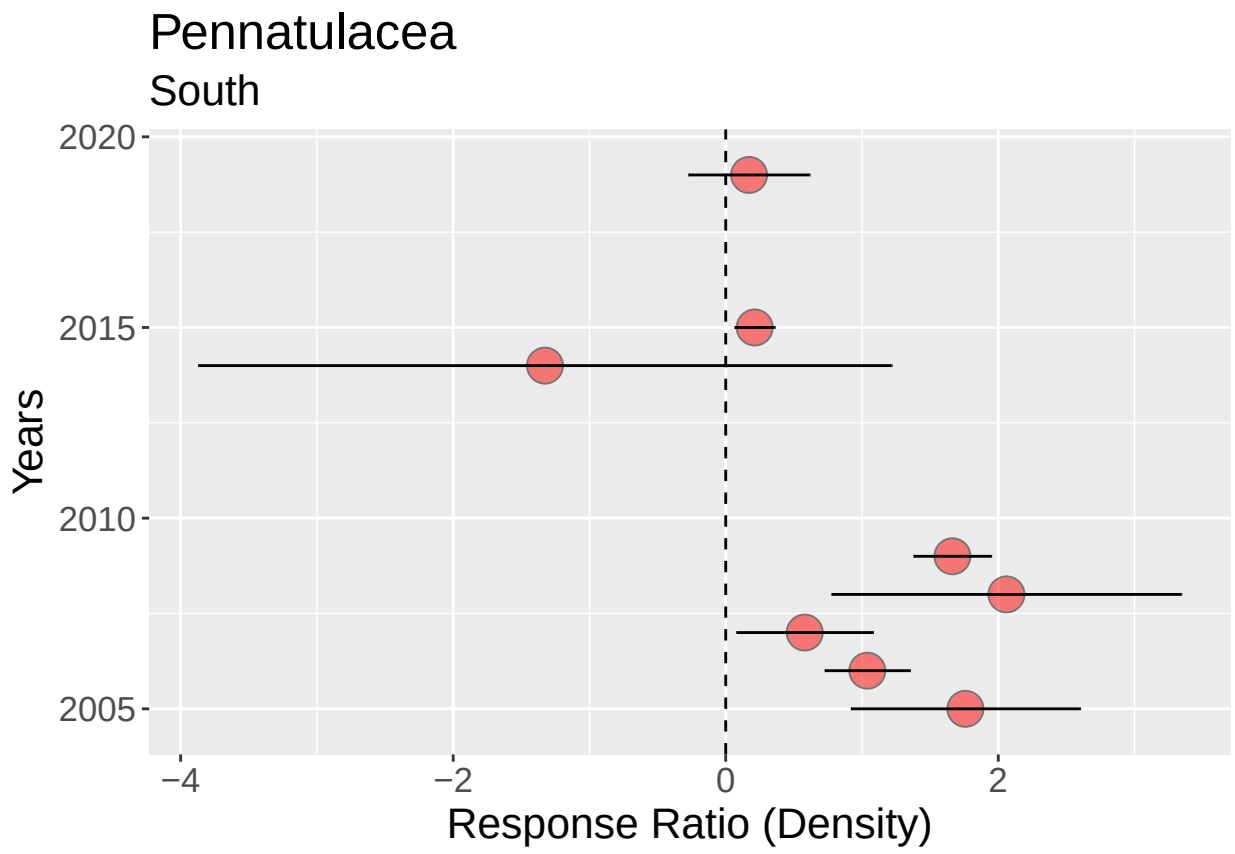

```
response_ratio(South, 188, "Malacostraca", "South") ## Crabs and allies ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



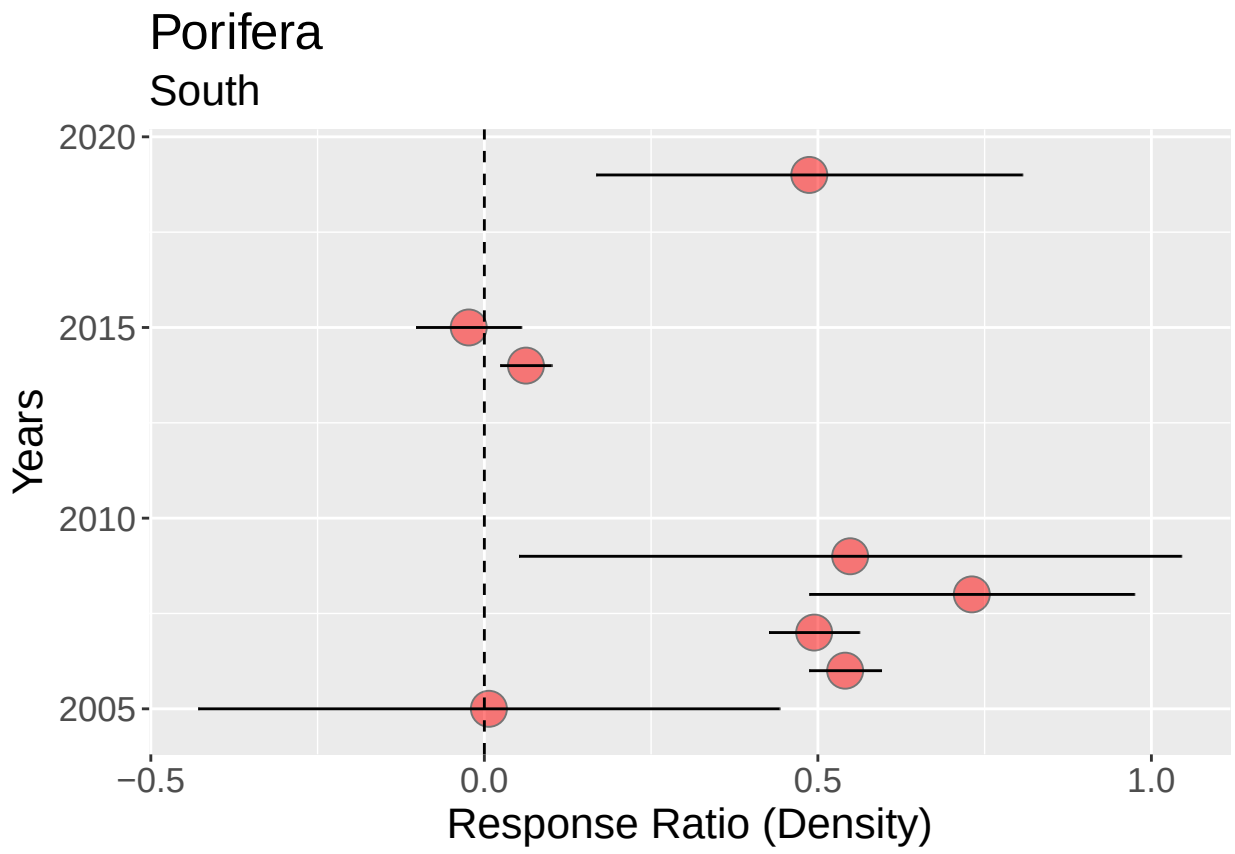

```
response_ratio(South, 189, "Pennatulacea", "South") ## Sea pens ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



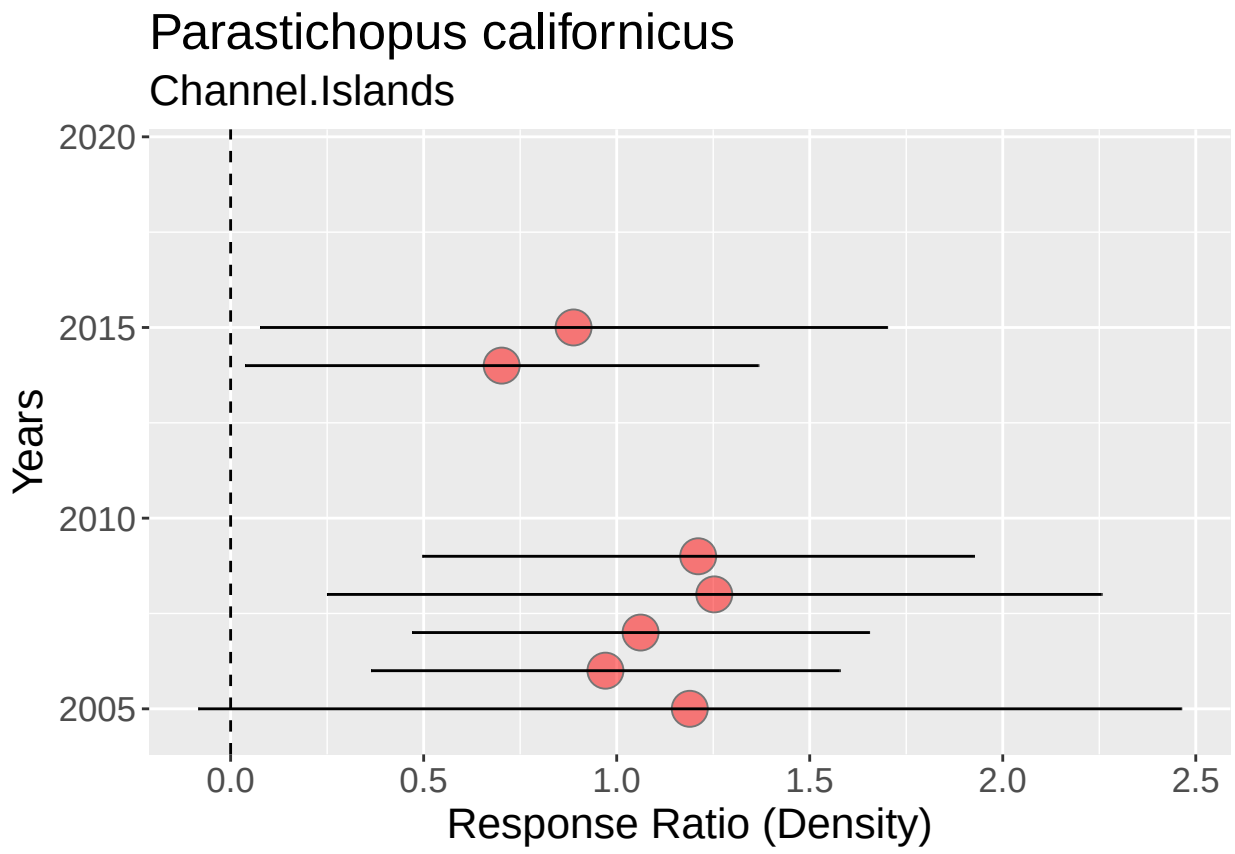

```
response_ratio(South, 190, "Porifera", "South") ## Sponges ##
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```



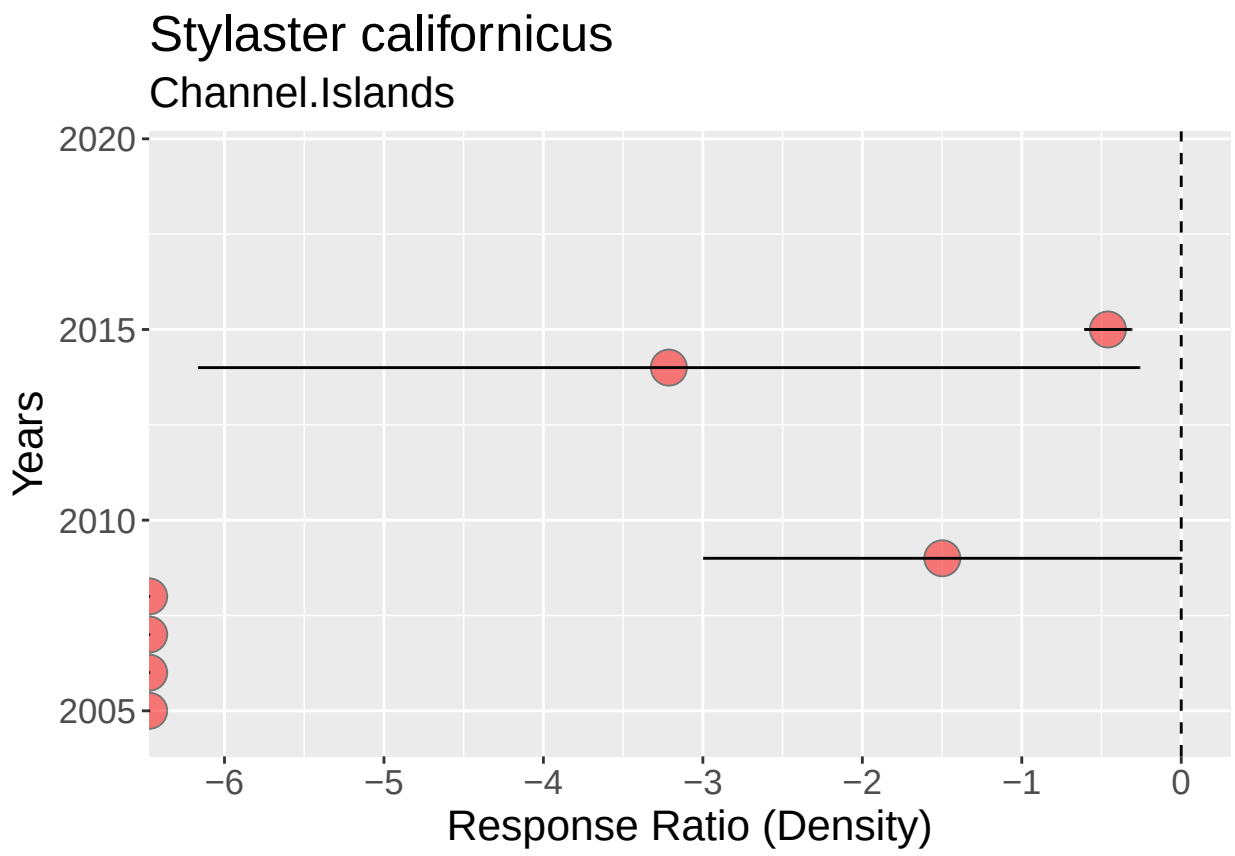

```
### Channel Islands ###

## Species ##

response_ratio(Channel.Islands, 176, "Parastichopus californicus", "Channel.Islands") ## sea cucumber #
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



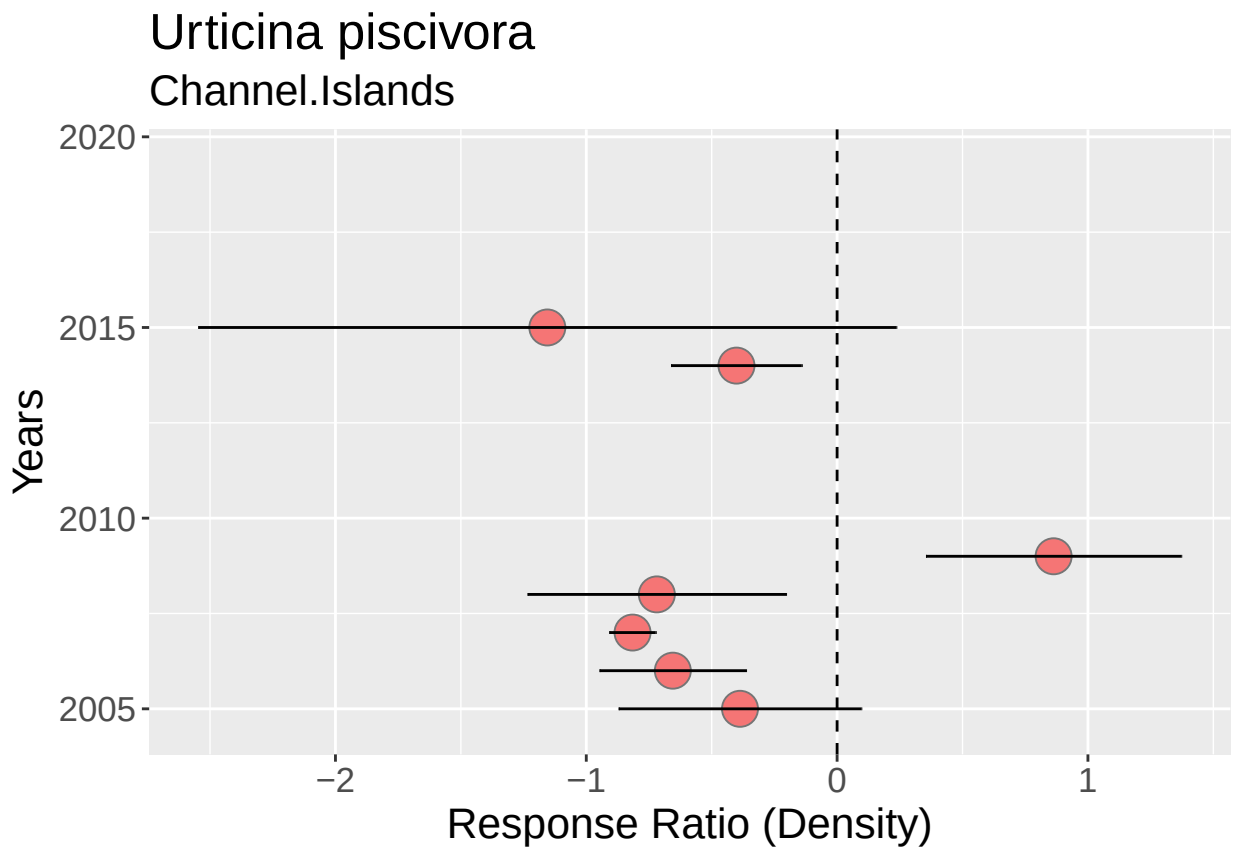

```
response_ratio(Channel.Islands, 175, "Stylaster californicus", "Channel.Islands") ## hydrocoral ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



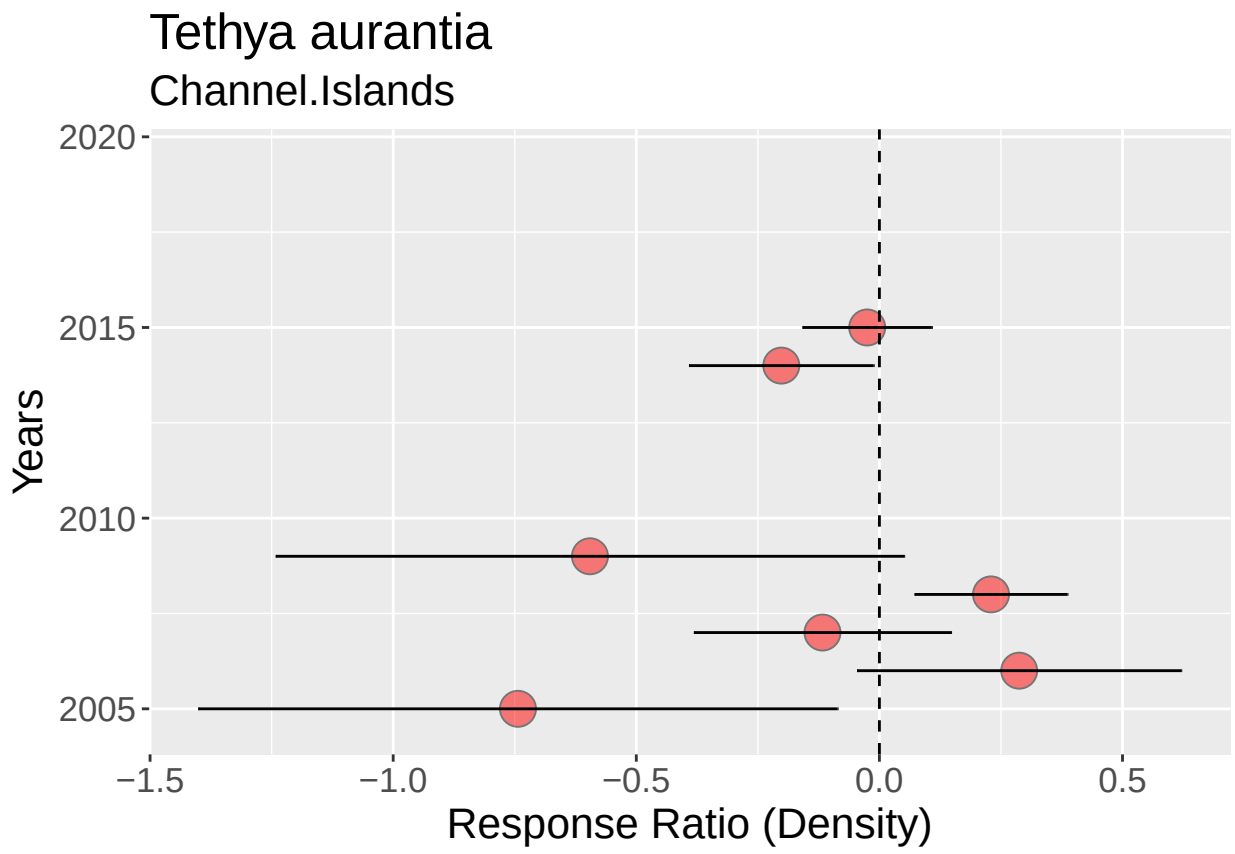

```
response_ratio(Channel.Islands, 177, "Urticina piscivora", "Channel.Islands") ## Fish-eating anemone ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



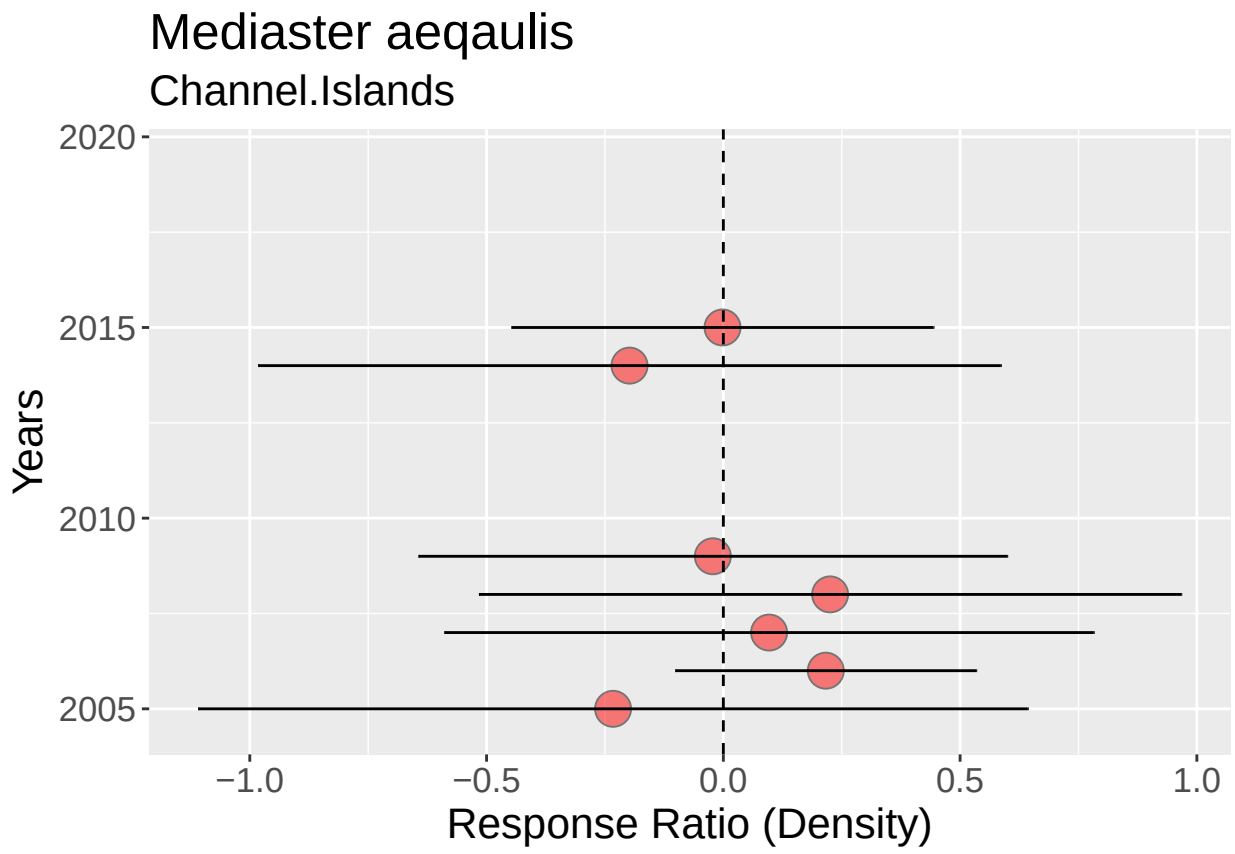

```
response_ratio(Channel.Islands, 178, "Tethya aurantia", "Channel.Islands") ## Puffball sponge ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



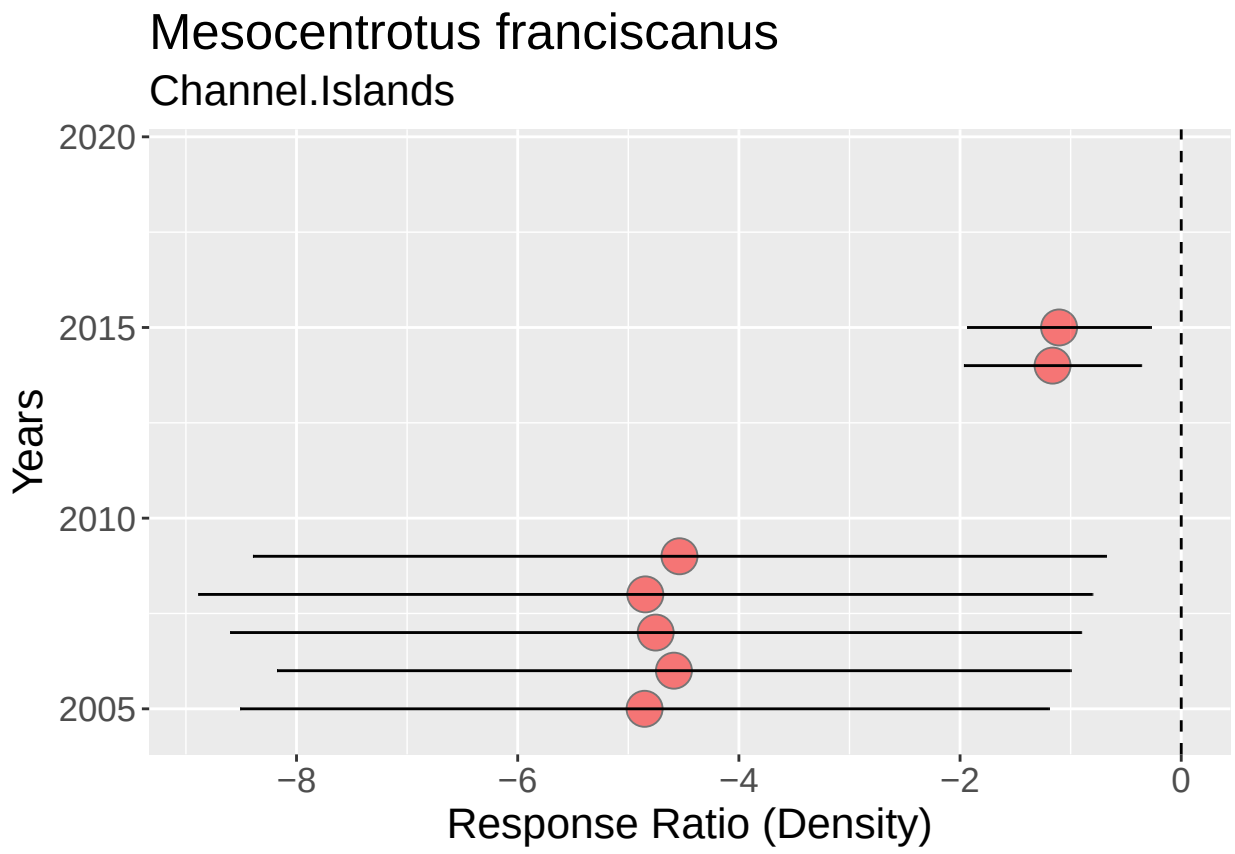

```
response_ratio(Channel.Islands, 179, "Mediaster aeqaulis", "Channel.Islands") ## Red sea star ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



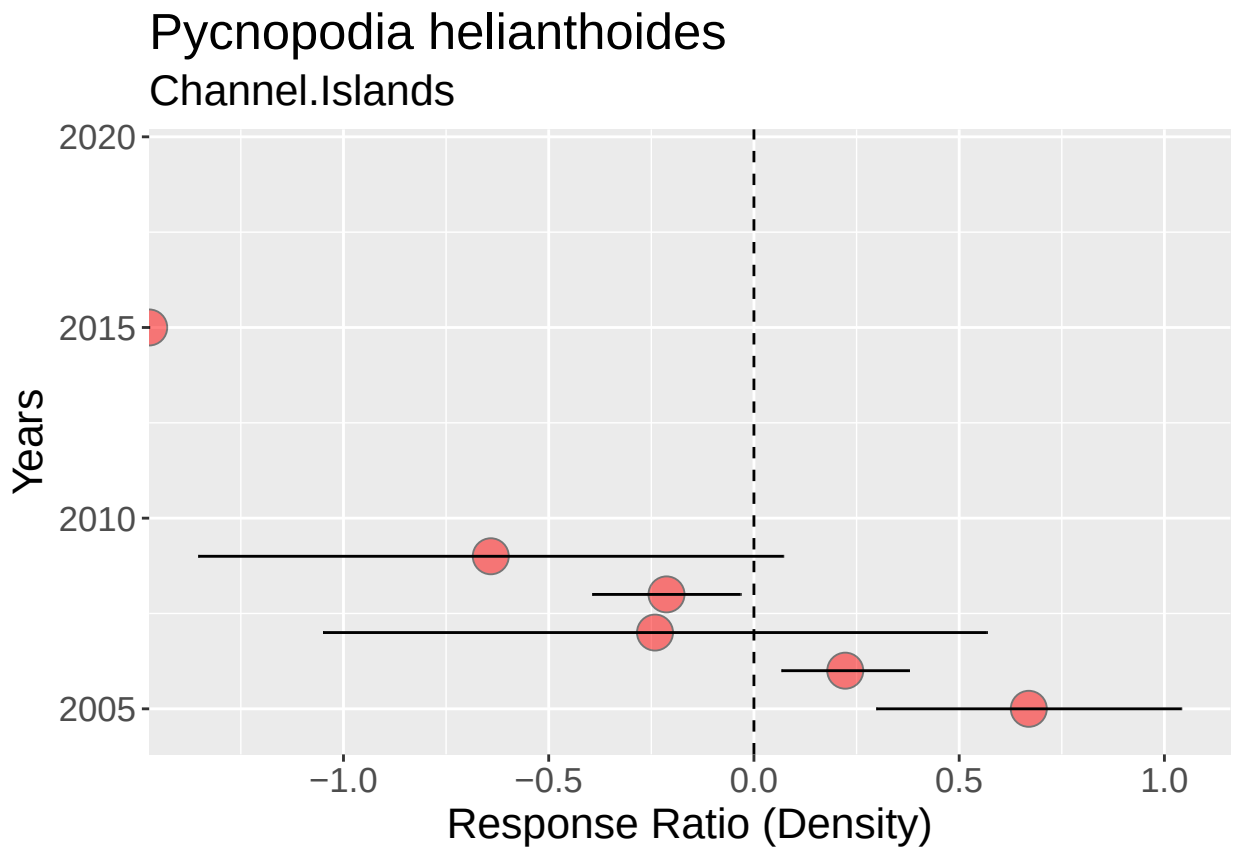

```
response_ratio(Channel.Islands, 180, "Mesocentrotus franciscanus", "Channel.Islands") ## Red sea urchin
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



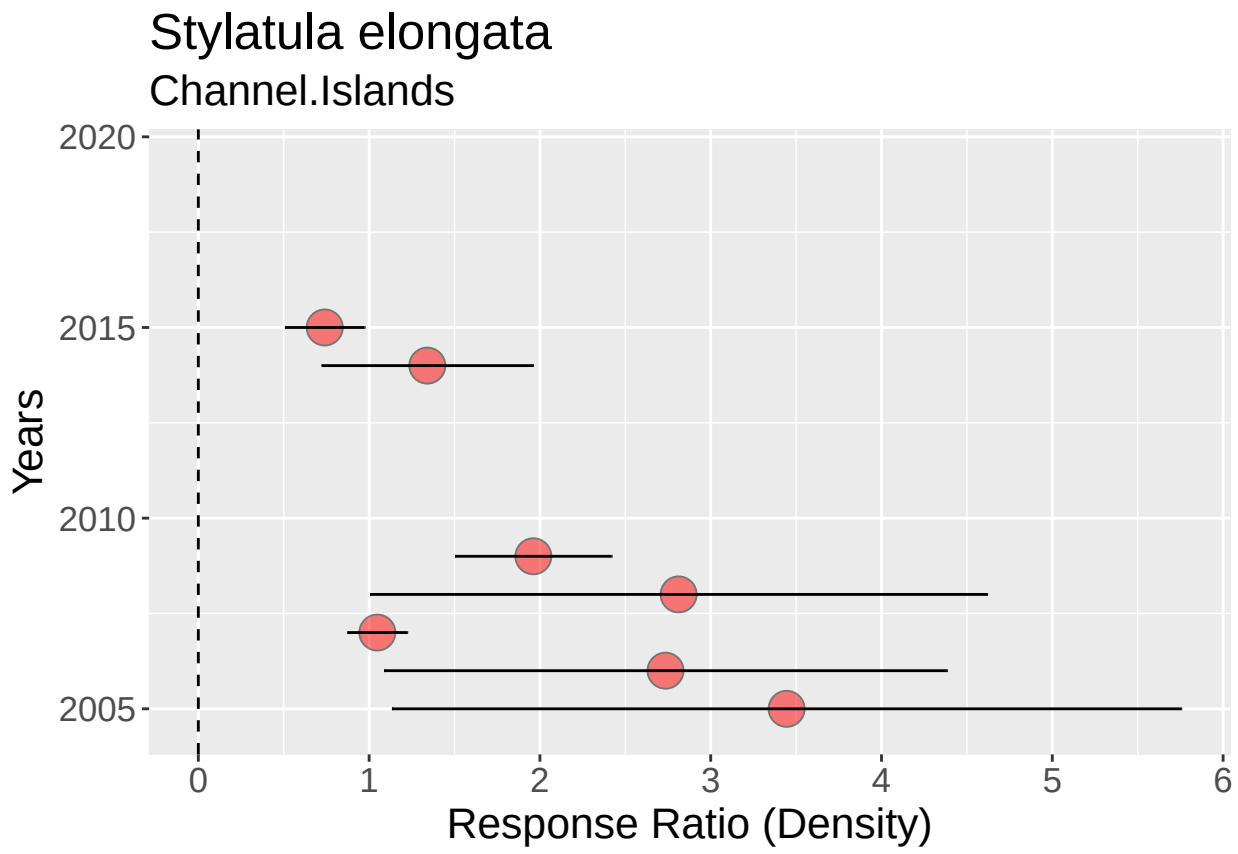

```
response_ratio(Channel.Islands, 181, "Pycnopodia helianthoides", "Channel.Islands") ## Sunflower star #
```

```
## Warning: Removed 5 rows containing missing values (geom_point).
```



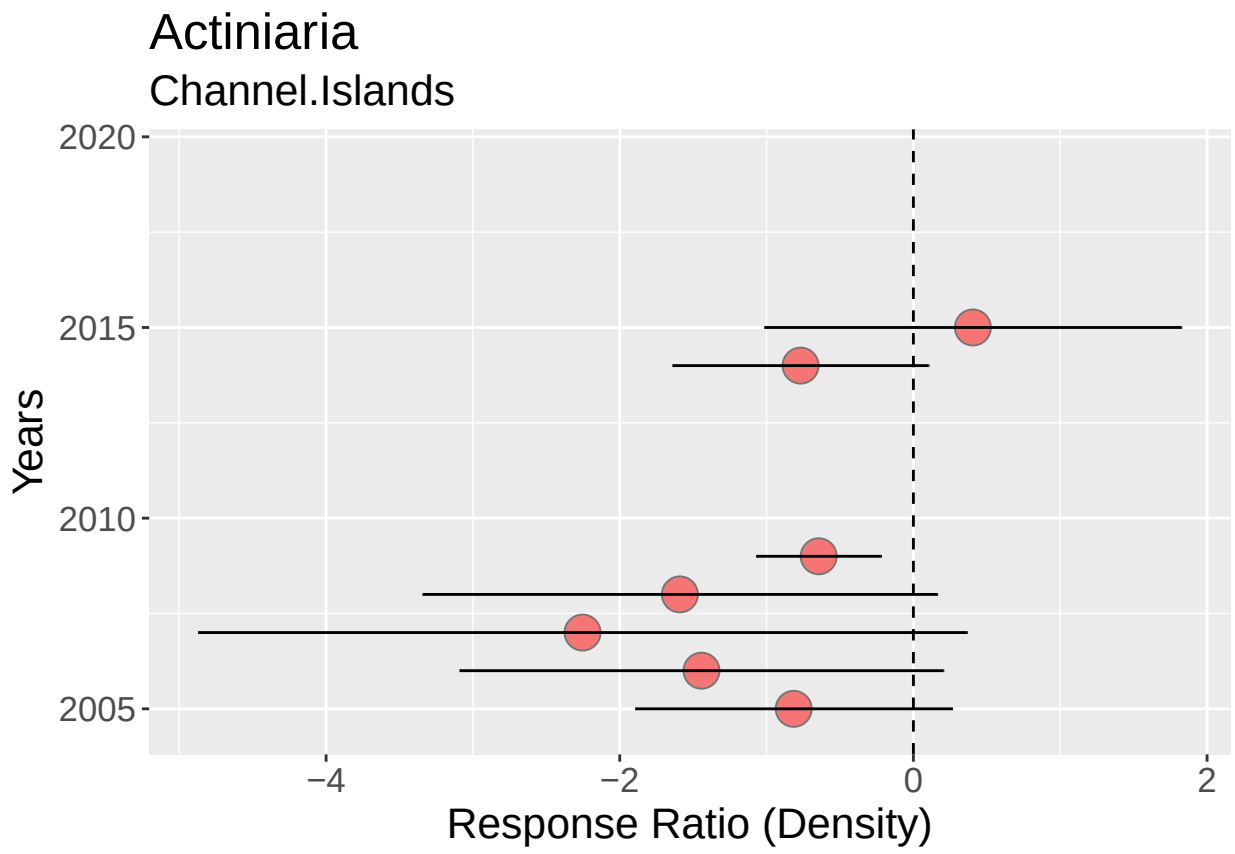

```
response_ratio(Channel.Islands, 182, "Stylatula elongata", "Channel.Islands") ## White sea pen ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



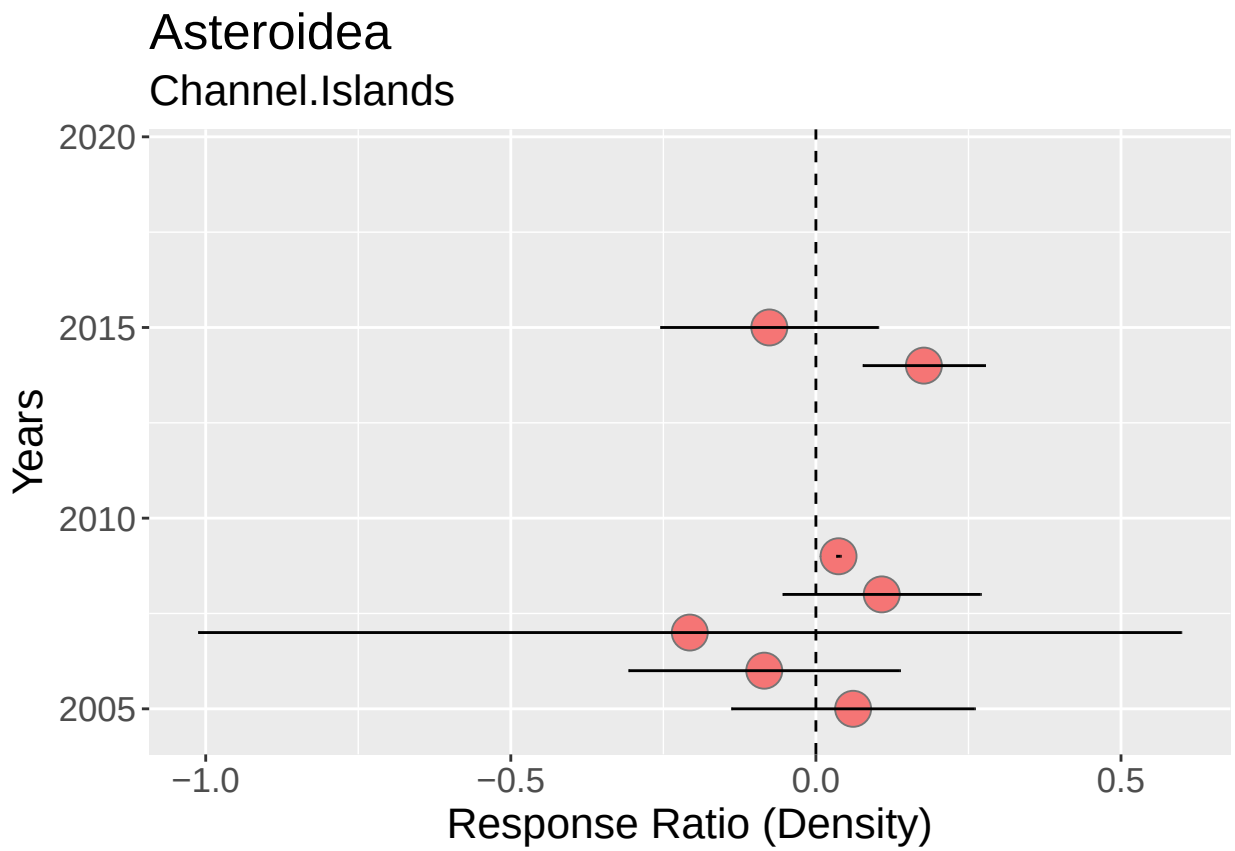

```
## Functional Groups ##

response_ratio(Channel.Islands, 183, "Actiniaria", "Channel.Islands") ## Anemones ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



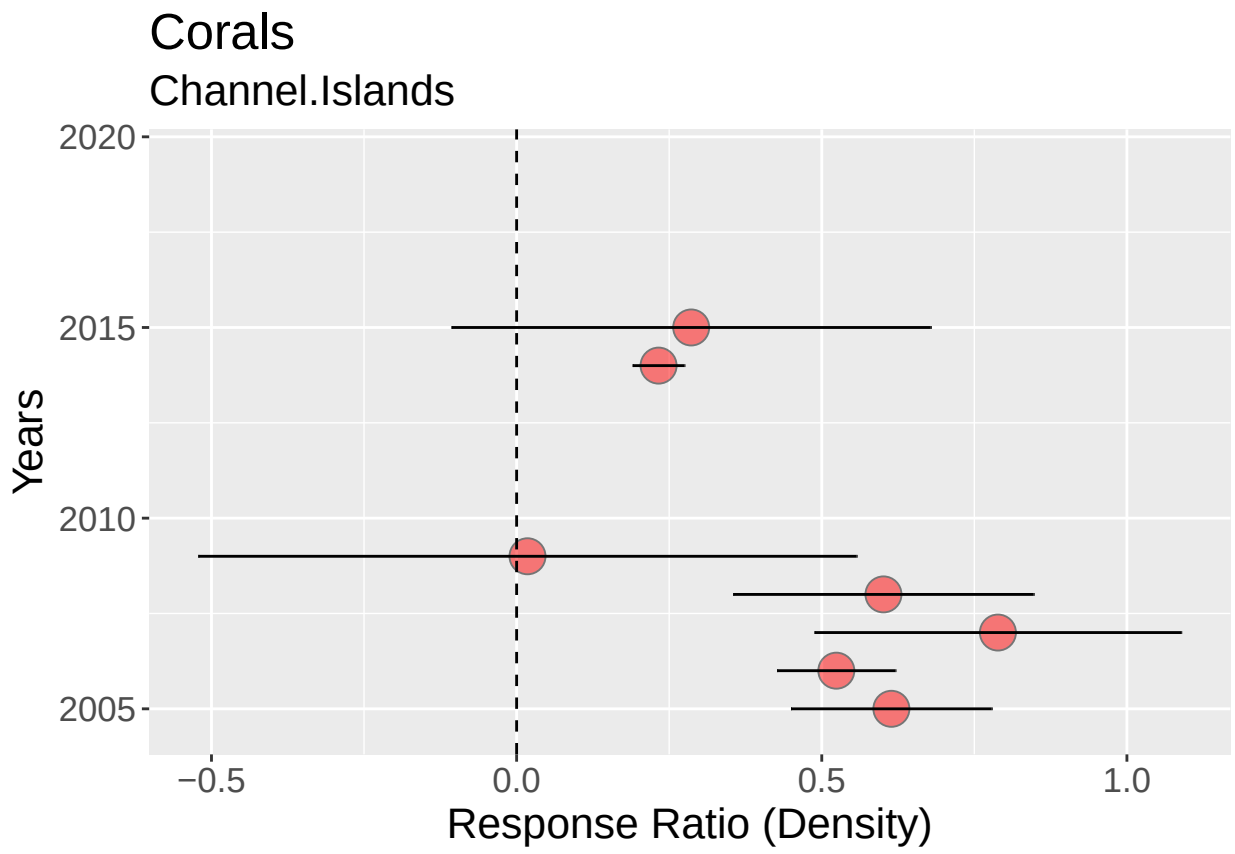

```
response_ratio(Channel.Islands, 184, "Asteroidea", "Channel.Islands") ## Sea stars ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



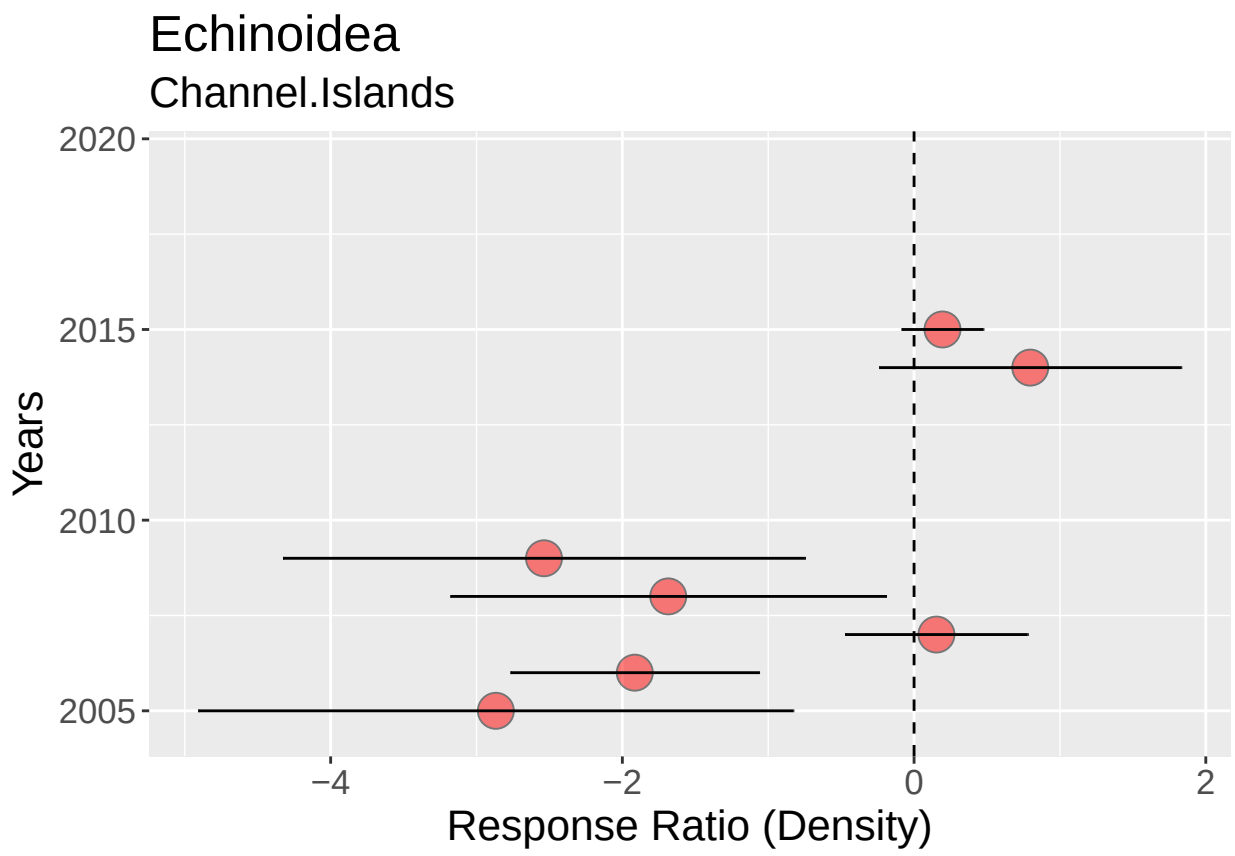

```
response_ratio(Channel.Islands, 185, "Corals", "Channel.Islands") ## Reef-forming cnidarians ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



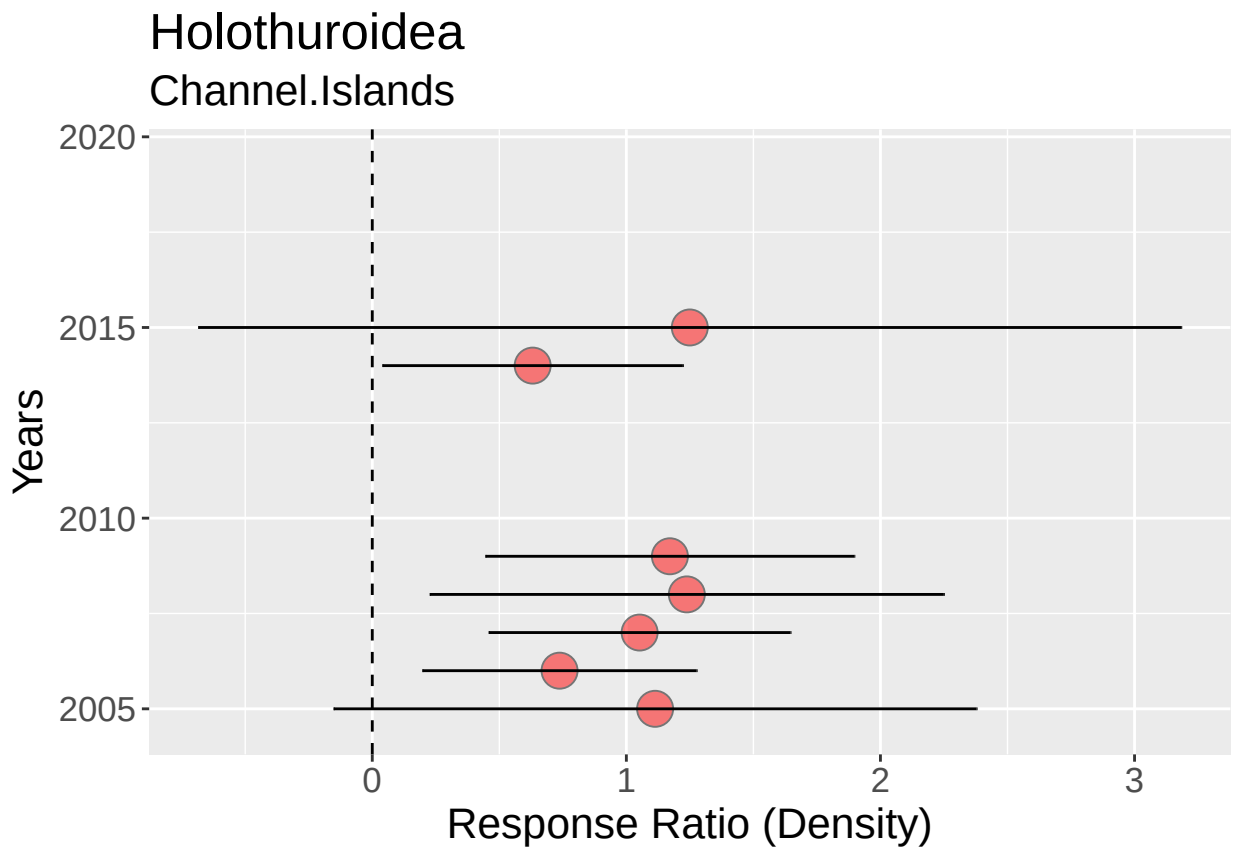

```
response_ratio(Channel.Islands, 186, "Echinoidea", "Channel.Islands") ## Sea urchins ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



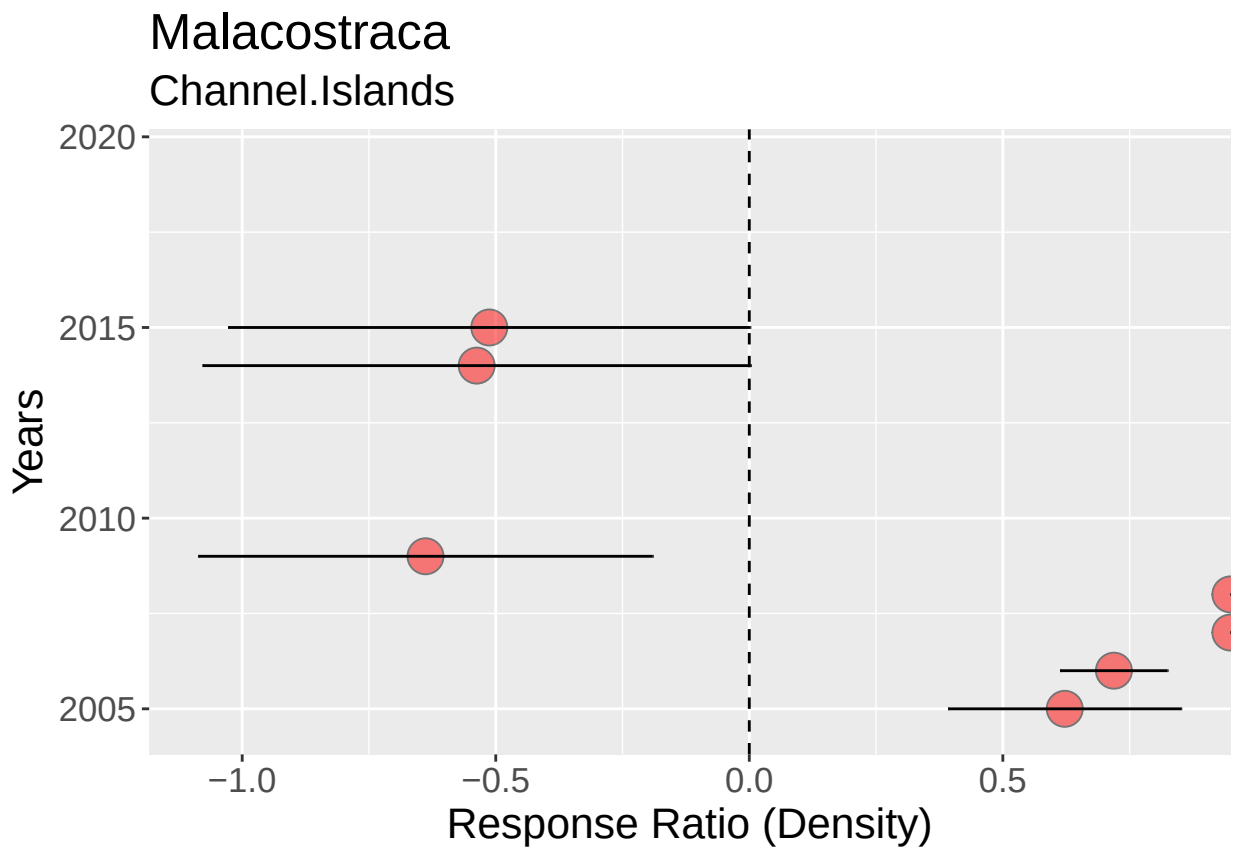

```
response_ratio(Channel.Islands, 187, "Holothuroidea", "Channel.Islands") ## Sea cucumbers ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



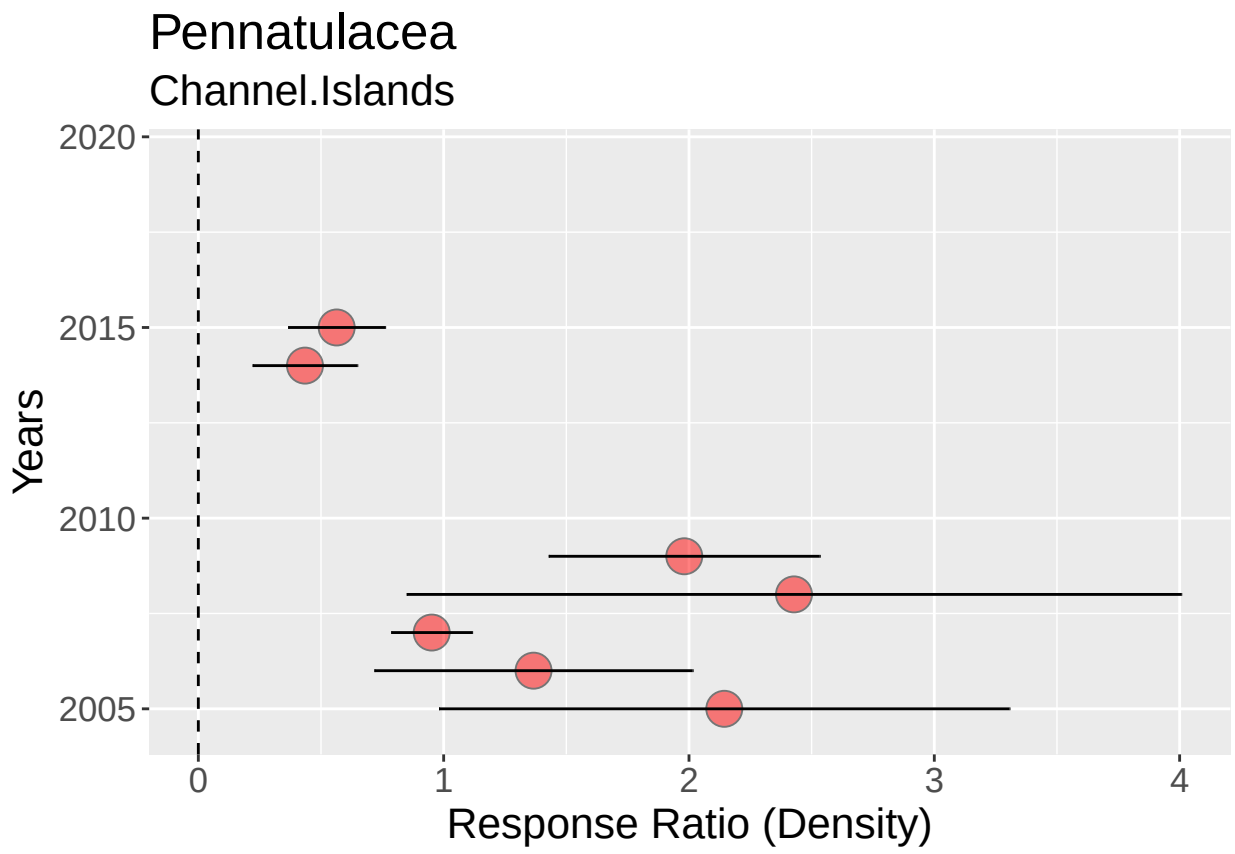

```
response_ratio(Channel.Islands, 188, "Malacostraca", "Channel.Islands") ## Crabs and allies ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```



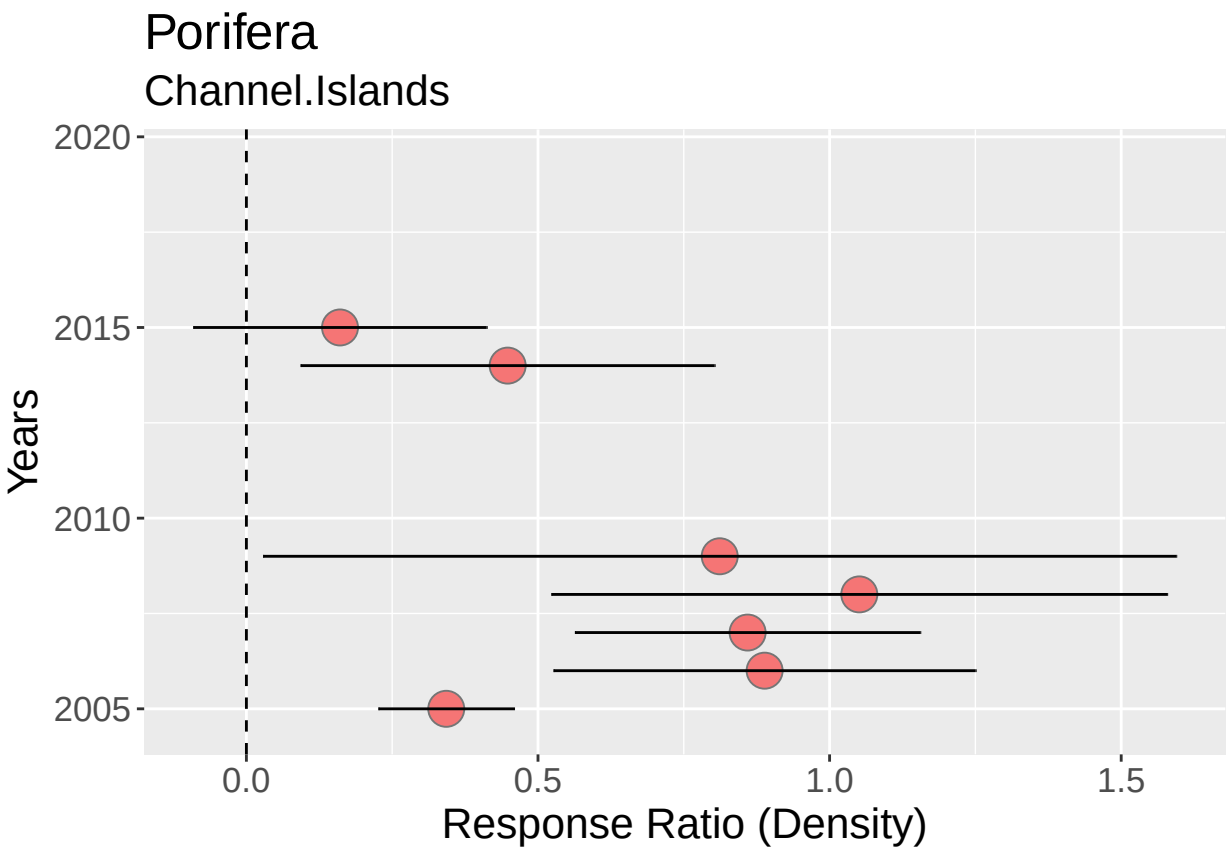

```
response_ratio(Channel.Islands, 189, "Pennatulacea", "Channel.Islands") ## Sea pens ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```




```
response_ratio(Channel.Islands, 190, "Porifera", "Channel.Islands") ## Sponges ##
```

```
## Warning: Removed 4 rows containing missing values (geom_point).
```


Porifera
Channel.Islands
2020
2015
2010
2005
Years
0.0
0.5
1.0
1.5
Response Ratio (Density)