SURE Project

October 09, 2022

Objective

Summarize results.

```
# clear environment
rm(list = ls())

# set a directory
d.dir <- here('data')
r.dir <- '/Volumes/Chunting HD/Git_Repositories/Chunting_Spatial_Analyses/spatial_data'
```

Predicted Kelp Density

Calculate the average of predicted kelp density for each resolution from 2004 to 2021 in the North Coast.

```
year <- 2004:2021
res <- c(120, 300, 900, 1500)

# initialize an empty data frame
kelp.density <- data.frame(year = factor(),
                           resolution = factor(),
                           fit = numeric(),
                           se.fit = numeric())

# calculate the mean and standard error of predicted kelp density for every year
for (i in res) {
  res.dir <- paste(r.dir, paste0('sp_predictions_', i, 'm'), sep = '/')
  for (j in year) {
    mean.fit <- rast(paste0(res.dir, paste0('/', j, '_Log_Nereo_NC.tif'))) %>%
      values() %>%
      data.frame() %>%
      summarise_at(vars(fit), list(mean = mean, se = std.error), na.rm = TRUE) %>%
      mutate(year = factor(j), resolution = factor(i), .before = mean)
    kelp.density <- rbind(kelp.density, setNames(mean.fit, names(kelp.density)))
  }
}

head(kelp.density) %>% pander()
```

year	resolution	fit	se.fit
2004	120	0.2381	0.0006466
2005	120	0.1787	0.0005047

year	resolution	fit	se.fit
2006	120	0.2646	6e-04
2007	120	3.454	0.00991
2008	120	10.52	0.01837
2009	120	5.562	0.01504

Landsat Kelp Area

Calculate the average of Landsat kelp area from 2004 to 2021 in the North Coast.

```
area <- read.csv(paste(d.dir, 'NC_Landsat_kelp_area_1984_2021.csv', sep = '/')) %>%
  filter(quarter == 3) %>%
  mutate_at(vars(year, quarter), list(as.factor))

# calculate the mean and standard error of Landsat kelp area for every year
kelp.area <- area %>%
  group_by(year) %>%
  summarise_at(vars(area), list(mean.area = mean, se.area = std.error), na.rm = TRUE) %>%
  filter(year %in% c(2004:2021))

head(kelp.area) %>% pander()
```

year	mean.area	se.area
2004	20.04	0.3403
2005	10.69	0.2478
2006	14.88	0.3281
2007	44.89	0.5203
2008	117.2	0.8296
2009	72	0.6099

Observed Data

Calculate the average of "in situ" survey data from 2006 to 2021 in the North Coast.

```
# read and transform the observed data to the log scale
obs.data <- read.csv(paste(d.dir,
                           'RCCA_kelp_inverts_NC_depth-zones_wave_clim_temp_nit_subs_orbvel_npp.csv',
                           sep = '/')) %>%
  dplyr::select(site_name, year, transect, zone, latitude, longitude, den_NERLUE) %>%
  mutate_at(vars(year, transect, zone, site_name), list(as.factor)) %>%
  mutate(log_den_NERLUE = log(den_NERLUE))

# note that log(0) returns -Inf
obs.data$log_den_NERLUE <- replace(obs.data$log_den_NERLUE, obs.data$log_den_NERLUE == -Inf, 0)

# calculate the mean and standard error of kelp density of every year
obs.density <- obs.data %>%
  group_by(year) %>%
  summarise_at(vars(log_den_NERLUE), list(mean.obs = mean, se.obs = std.error), na.rm = TRUE)
```

```
head(obs.density) %>% pander()
```

year	mean.obs	se.obs
2006	0	0
2007	2.45	0.2429
2008	3.425	0.2049
2009	3.734	0.1958
2010	2.411	0.3009
2011	1.666	0.2656

Plot

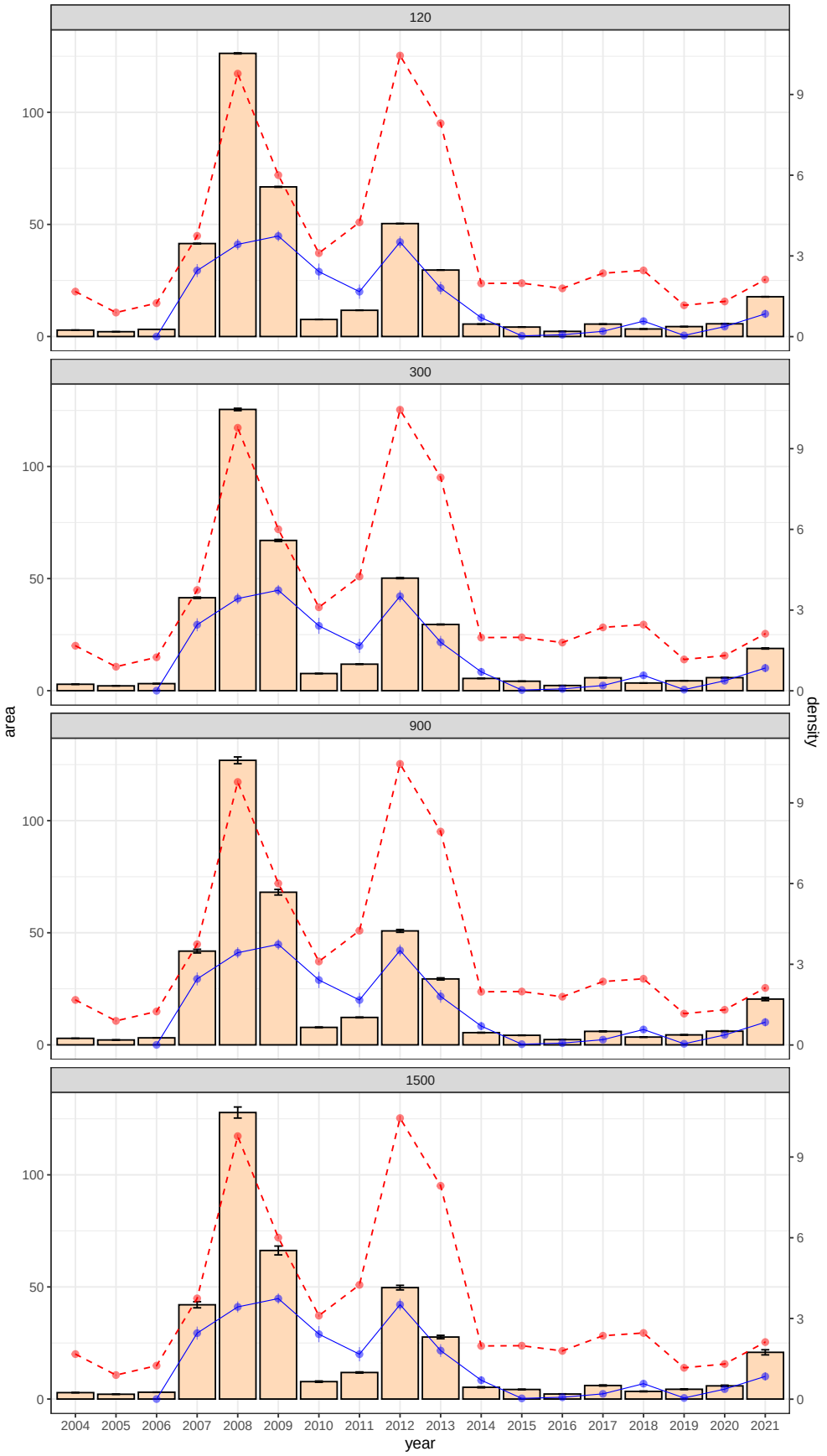
```
# put all data frames into list
df.list <- list(kelp.density, kelp.area, obs.density)
# merge all data frames together
df <- df.list %>% reduce(full_join, by = 'year')
```

```
filter(df, year == '2008') %>% pander()
```

year	resolution	fit	se.fit	mean.area	se.area	mean.obs	se.obs
2008	120	10.52	0.01837	117.2	0.8296	3.425	0.2049
2008	300	10.45	0.04439	117.2	0.8296	3.425	0.2049
2008	900	10.58	0.1265	117.2	0.8296	3.425	0.2049
2008	1500	10.65	0.2056	117.2	0.8296	3.425	0.2049

```
max <- filter(df, resolution == 900) %>%
  summarise(across(c(fit, mean.area), ~max(.x, na.rm = TRUE), .names = 'max_{.col}')) %>%
  mutate(ratio = max_mean.area / max_fit) %>%
  select(ratio)
factor = 12

ggplot(df, aes(x = year, y = fit*factor)) +
  geom_bar(stat = 'identity', color = 'black', fill = 'peachpuff', position = position_dodge()) +
  geom_errorbar(aes(ymin = (fit - se.fit)*factor, ymax = (fit + se.fit)*factor),
                width = 0.2, position = position_dodge(0.9)) +
  geom_pointrange(aes(x = year, y = mean.obs*factor,
                      ymin = (mean.obs - se.obs)*factor, ymax = (mean.obs + se.obs)*factor),
                  alpha = 0.5, size = 0.3, color = 'blue') +
  geom_line(aes(x = year, y = mean.obs*factor, group = 1), size = 0.3, color = 'blue') +
  geom_pointrange(aes(x = year, y = mean.area,
                      ymin = mean.area - se.area, ymax = mean.area + se.area),
                  alpha = 0.5, size = 0.3, color = 'red') +
  geom_line(aes(x = year, y = mean.area, group = 1), linetype = 'dashed', color = 'red') +
  scale_y_continuous(name = 'area',
                     sec.axis = sec_axis(~. / factor, name = 'density')) +
  facet_wrap(. ~ resolution, nrow = 4) +
  theme_bw()
```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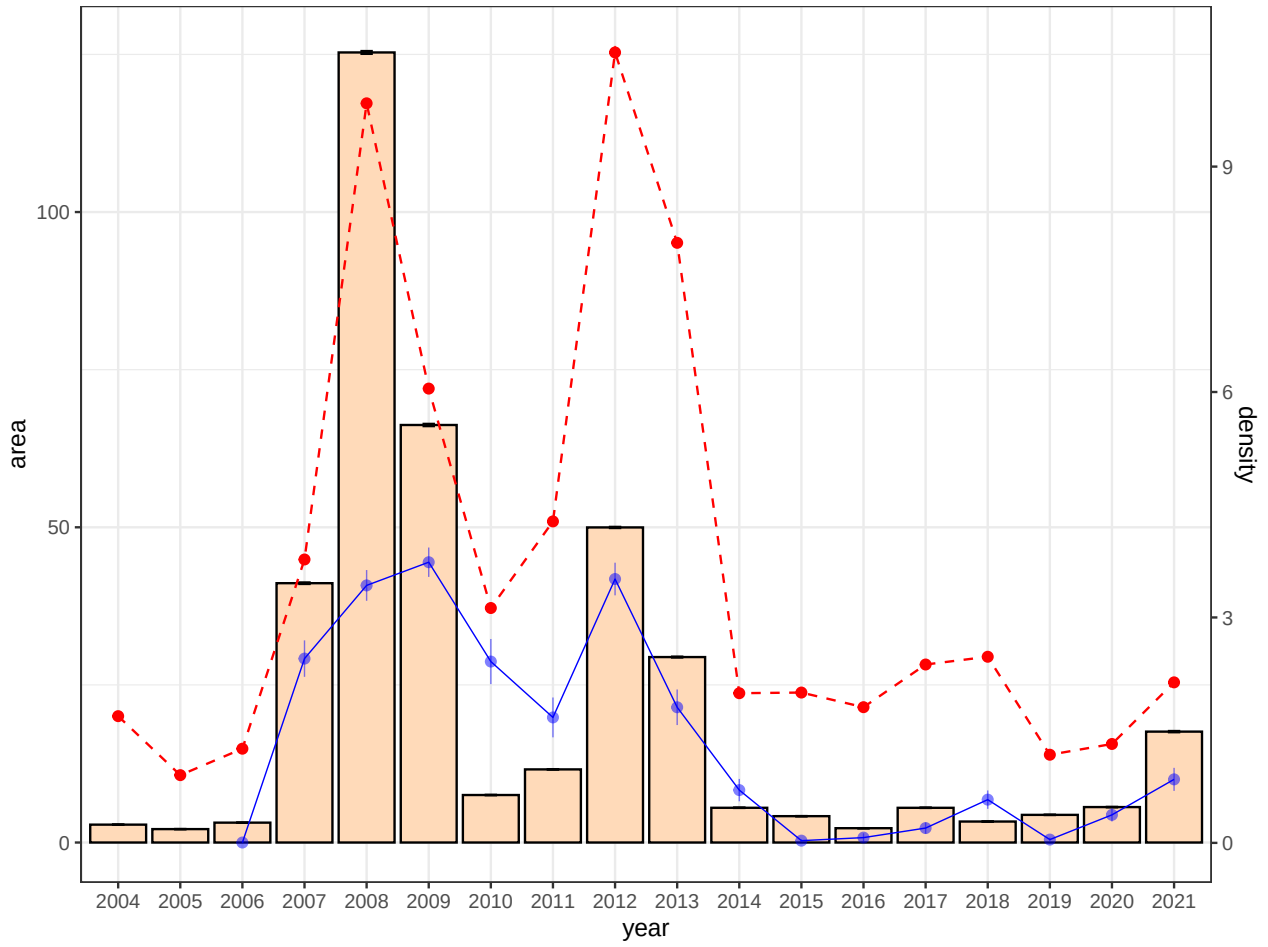
2021

```r
for (i in res) {
  max <- filter(df, resolution == i) %>%
    summarise(across(c(fit, mean.area), ~max(.x, na.rm = TRUE), .names = 'max_{.col}')) %>%
    mutate(ratio = max_mean.area / max_fit) %>%
    select(ratio)
  factor = max$ratio

  plot <- ggplot(filter(df, resolution == i), aes(x = year, y = fit*factor)) +
    geom_bar(stat = 'identity', color = 'black', fill = 'peachpuff', position = position_dodge()) +
    geom_errorbar(aes(ymin = (fit - se.fit)*factor, ymax = (fit + se.fit)*factor),
                  width = 0.2, position = position_dodge(0.9)) +
    geom_pointrange(aes(x = year, y = mean.obs*factor,
                        ymin = (mean.obs - se.obs)*factor, ymax = (mean.obs + se.obs)*factor),
                    alpha = 0.5, size = 0.3, color = 'blue') +
    geom_line(aes(x = year, y = mean.obs*factor, group = 1), size = 0.3, color = 'blue') +
    geom_pointrange(aes(x = year, y = mean.area,
                        ymin = mean.area - se.area, ymax = mean.area + se.area),
                    alpha = 1, size = 0.3, color = 'red') +
    geom_line(aes(x = year, y = mean.area, group = 1), linetype = 'dashed', color = 'red') +
    scale_y_continuous(name = 'area', sec.axis = sec_axis(~. / factor, name = 'density')) +
    theme_bw()

  print(plot)
}
```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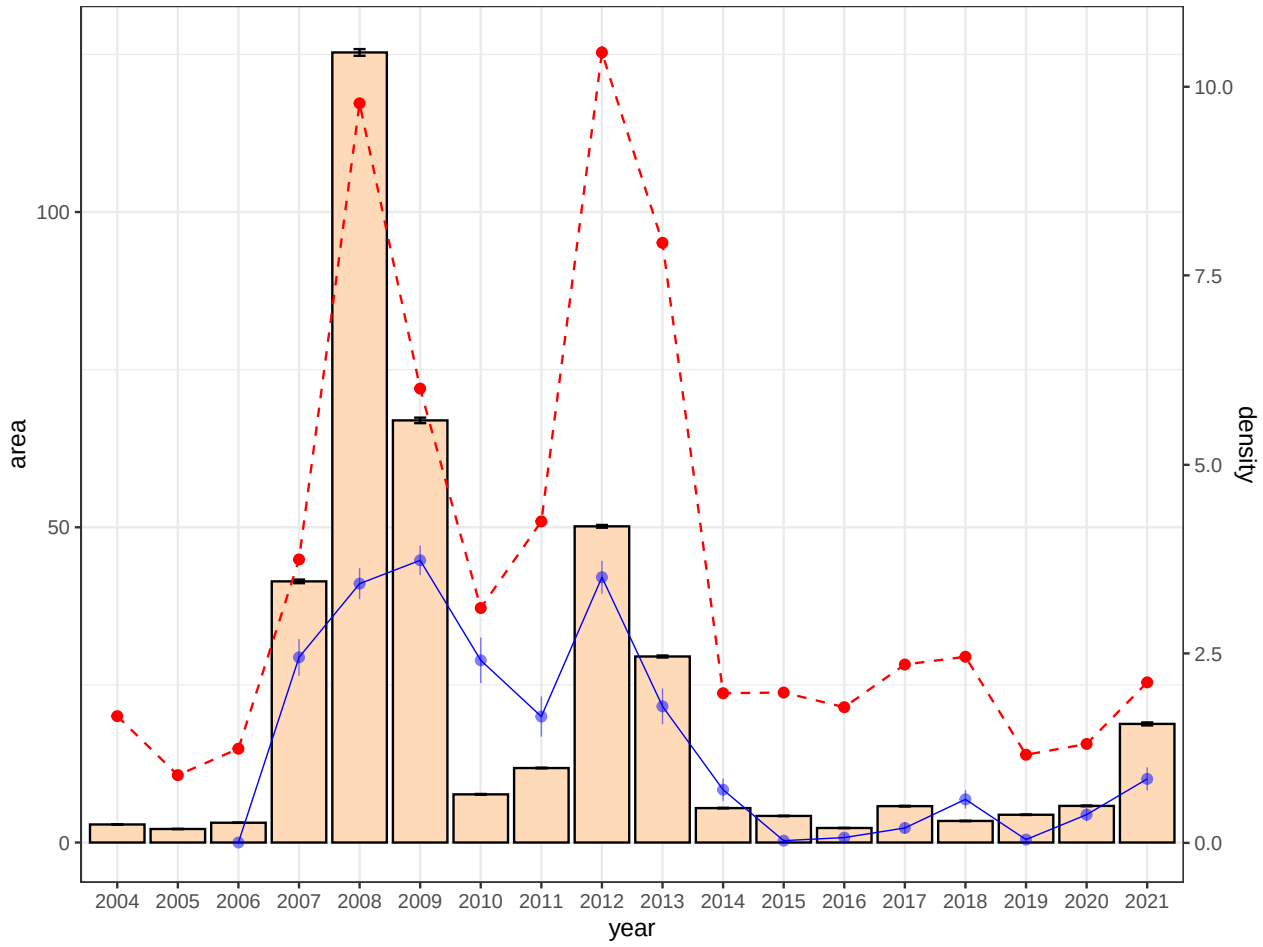
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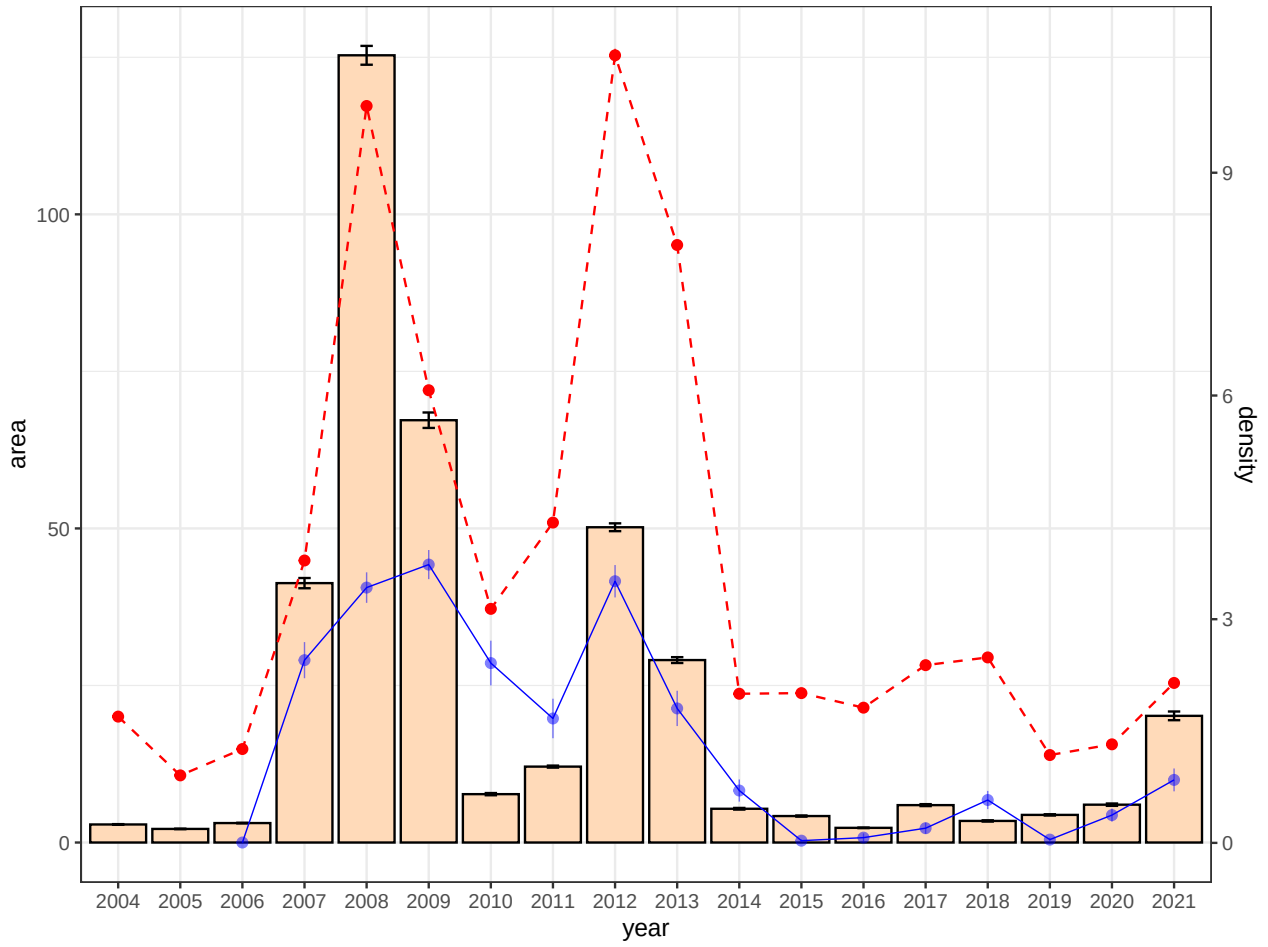
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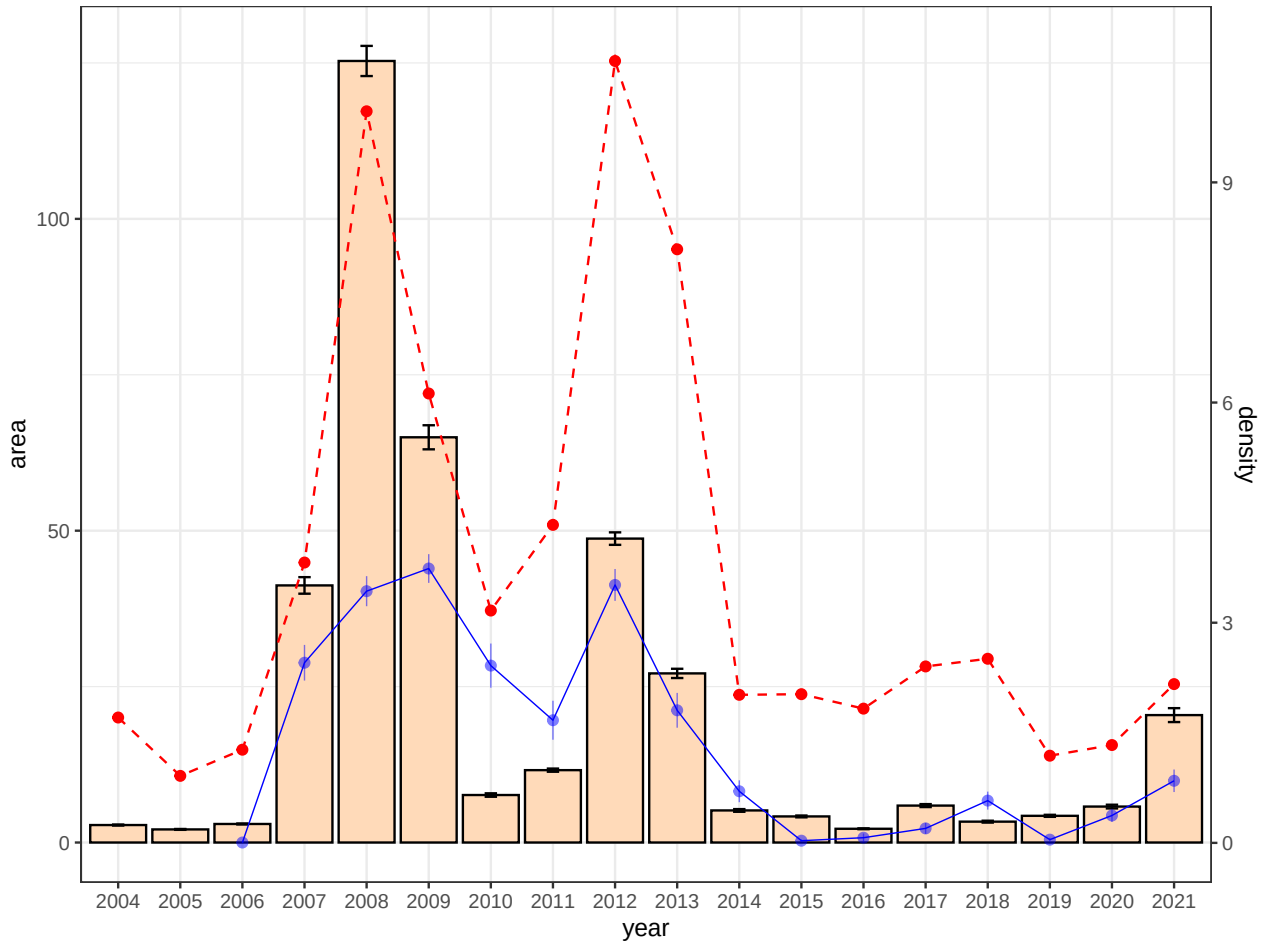
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