8_Vis_IS_results

Kurt Ingeman

6/27/2021

```
rm(list = ls())

library(here)
```

```
## here() starts at /Users/kurtingeman/github/CORE
```

```
library(tidyr)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
library(fmsb)
library(forcats)
library(RColorBrewer)
```

```
load(here("CORE EDM analysis", "Output", "Rdata", "4_IS", "SMAP_best_embeddings_ESU_rec4n.RData"))
rec4_ESU <- out_results
rm(out_results)

load(here("CORE EDM analysis", "Output", "Rdata", "4_IS", "SMAP_best_embeddings_Imnaha_rec4n.RData"))
rec4_IMN <- out_results
rm(out_results)

load(here("CORE EDM analysis", "Output", "Rdata", "4_IS", "SMAP_best_embeddings_Middle Fork Salmon_rec4
rec4_MFS <- out_results
rm(out_results)

load(here("CORE EDM analysis", "Output", "Rdata", "4_IS", "SMAP_best_embeddings_Upper Salmon_rec4n.RDat
rec4_UPS <- out_results
rm(out_results)
```

create domains (Ocean, Human, Predator)

```
rec4_ESU<-  rec4_ESU %>%
  mutate(domain = case_when(
    grepl("npgo", FP) ~ "ocean",
    grepl("pdo", FP) ~ "ocean",
    grepl("arc", FP) ~ "ocean",
    grepl("upw", FP) ~ "ocean",
    grepl("hatch", FP) ~ "human",
    grepl("harv", FP) ~ "human",
    grepl("hseal", FP) ~ "pred",
    grepl("orca", FP) ~ "pred",
    grepl("csl", FP) ~ "pred",
    grepl("ssl", FP) ~ "pred",
    TRUE ~"other"))


rec4_IMN<-  rec4_IMN %>%
  mutate(domain = case_when(
    grepl("npgo", FP) ~ "ocean",
    grepl("pdo", FP) ~ "ocean",
    grepl("arc", FP) ~ "ocean",
    grepl("upw", FP) ~ "ocean",
    grepl("hatch", FP) ~ "human",
    grepl("harv", FP) ~ "human",
    grepl("hseal", FP) ~ "pred",
    grepl("orca", FP) ~ "pred",
    grepl("csl", FP) ~ "pred",
    grepl("ssl", FP) ~ "pred",
    TRUE ~"other"))

rec4_MFS <-  rec4_MFS %>%
  mutate(domain = case_when(
    grepl("npgo", FP) ~ "ocean",
    grepl("pdo", FP) ~ "ocean",
    grepl("arc", FP) ~ "ocean",
    grepl("upw", FP) ~ "ocean",
    grepl("hatch", FP) ~ "human",
    grepl("harv", FP) ~ "human",
    grepl("hseal", FP) ~ "pred",
    grepl("orca", FP) ~ "pred",
    grepl("csl", FP) ~ "pred",
    grepl("ssl", FP) ~ "pred",
    TRUE ~"other"))

rec4_UPS <-  rec4_UPS %>%
  mutate(domain = case_when(
    grepl("npgo", FP) ~ "ocean",
    grepl("pdo", FP) ~ "ocean",
    grepl("arc", FP) ~ "ocean",
    grepl("upw", FP) ~ "ocean",
    grepl("hatch", FP) ~ "human",
    grepl("harv", FP) ~ "human",
    grepl("hseal", FP) ~ "pred",
    grepl("orca", FP) ~ "pred",
```

```
    grepl("csl", FP) ~ "pred",
    grepl("ssl", FP) ~ "pred",
    TRUE ~"other"))
```

ESU

2a. What variables are in the top models? In what frequency?

To do that right, we need to actually through ALL the vars in the SMAP hopper, not just the top ones

But I can get an highest and average rank model that each var shows up in

```
unique(rec4_ESU$FP)
```

```
##  [1] "rec4n"      "rec4n_-1"   "rec4n_-3"   "rec4n_-5"   "npgo.win.3"
##  [6] "upw.tdmi.5" "rec4n_-4"   "rec4n_-2"   "pdo.spr.2"  "arc.win.2"
```

```
unique(rec4_ESU$embedding)
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
## [26] 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
## [51] 51 52 53 54
```

```
rec4_mods <- rec4_ESU %>%
  group_by(embedding, FP) %>%
  summarise() %>%
  group_by(FP) %>%
  mutate(
    best_mod = min(embedding), # lowest number (highest rank) model
    scale_mod = 1 / best_mod, # above expressed as 0-1
    rank_mod = mean(embedding)/54, # average rank of model that that they are in
    total_num = length(embedding), # number of models that they are in
    prop_mod = total_num/54, # proportion of model that they are in
    weight = 54-embedding, # reverse of rank
    integrated = sum(weight)/(54*55/2)) %>% # integrate rank and weight
  slice(1) %>%
  filter(!grepl("rec4", FP)) %>%
  arrange(prop_mod) %>%
  ungroup()
```

```
## `summarise()` has grouped output by 'embedding'. You can override using the `.groups` argument.
```

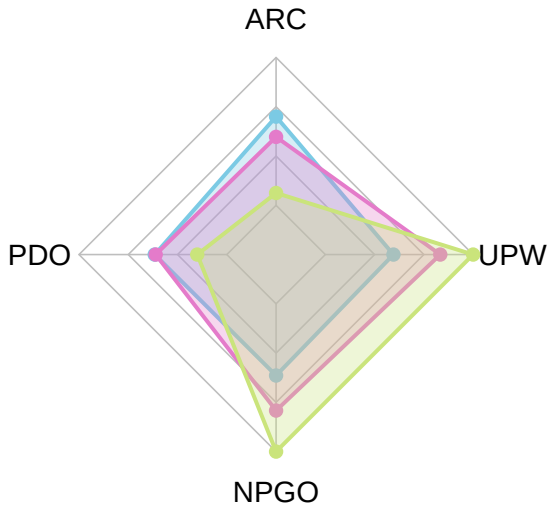
```
# organize vars by Ocean, People, Biol

levels(rec4_mods$FP)
```

```
## NULL
```

```
rec4_spider <- data.frame(rbind(rep(1,4), rep(0,4),
                                rec4_mods $rank_mod, rec4_mods $prop_mod, rec4_mods $scale_mod
                                  ))
colnames(rec4_spider) <- rec4_mods$FP

trans.pal <- c("#7BCAE44D", "#E47BCA4D", "#CAE47B4D")
pal <- c("#7BCAE4", "#E47BCA", "#CAE47B")
```

```
# op <- par(mar = c(1, 1, 1, 1))
# par(mar = c(1, 0, 1, 5))

radarchart(rec4_spider, axistype=0,
           #custom polygon
           pcol=pal, pfcol=trans.pal,  plwd=2, plty=1, seg = 3,
           #custom the grid
           cglcol="grey", cglty=1, cglwd=0.8,
           #custom labels
           vlcex=.9, vlabels = c("ARC", "PDO", "NPGO", "UPW"),
           title="What variables are found in top models?")
```

What variables are found in top models?

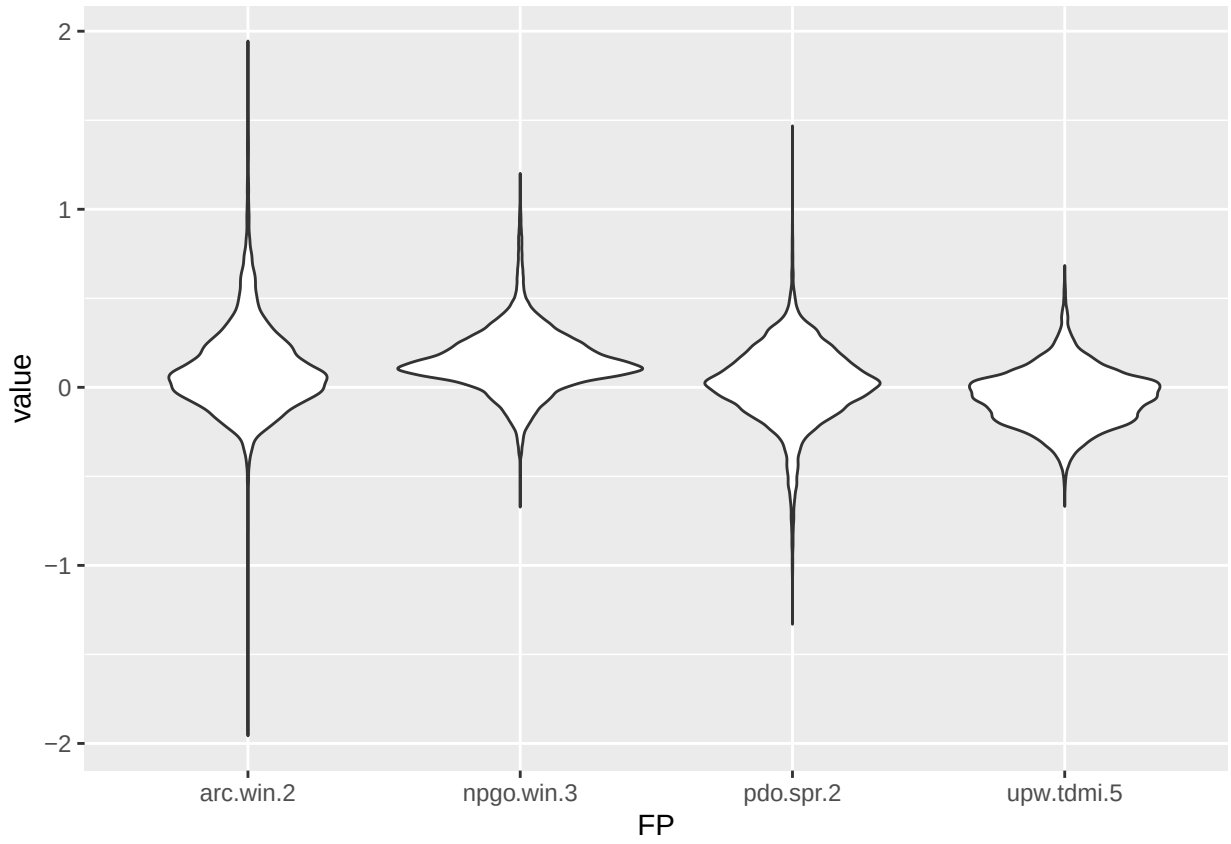



```
# legend(x=.9, y=.8, legend = c("Ave Rank", "No. Models", "Highest Rank"), bty = "n", pch=20 , col=pal,


# par(op)
```

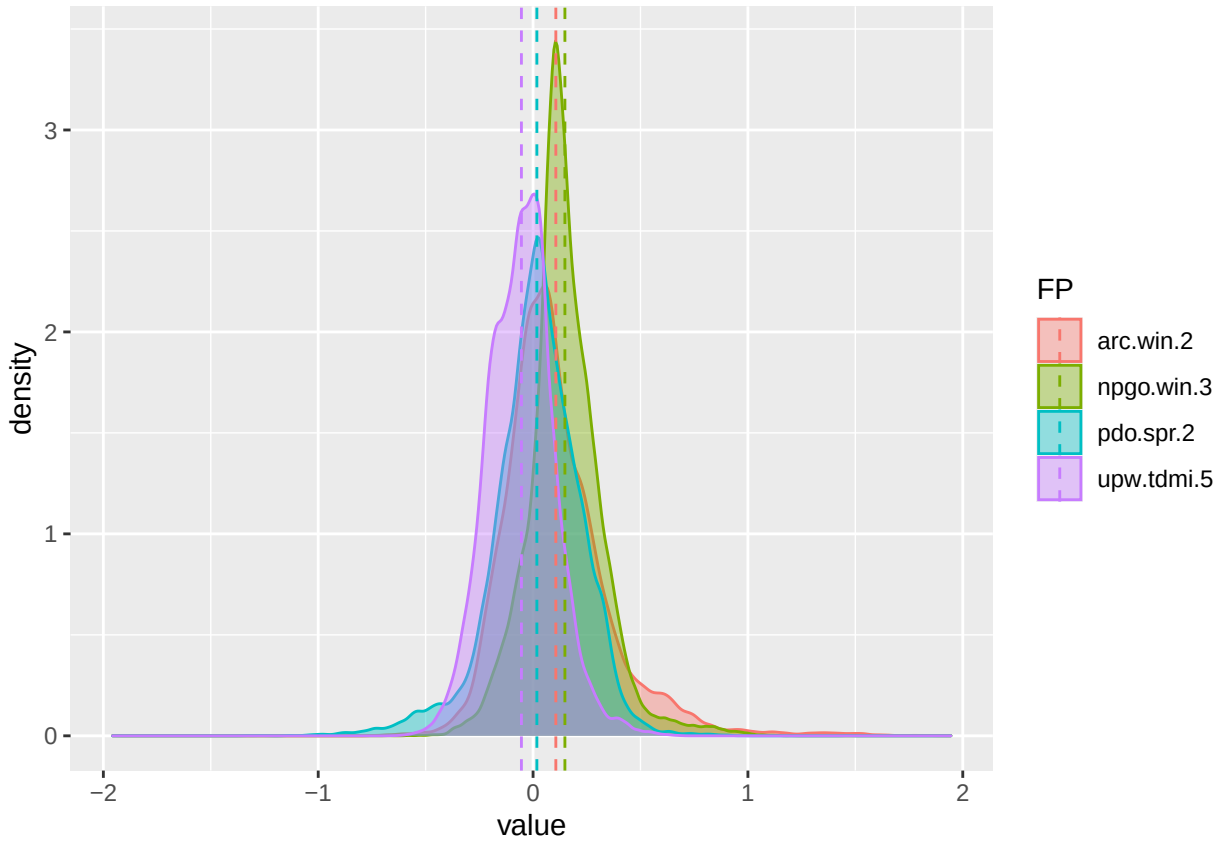
2b. How do predator interaction strengths compared to variables from other domains (ocean, human)?

Distribution of partial derivatives, averaged across stocks, and across years, for each var

```
rec4_ESU <-  rec4_ESU %>%
  filter(!grepl("rec4", FP)) %>%
  group_by(FP) %>%
  mutate(mu = mean(value, na.rm=TRUE)) %>%
  ungroup()

ggplot(rec4_ESU, aes(x = FP, y = value)) +
  geom_violin()
```




```
ggplot(rec4_ESU, aes(x = value, color = FP, fill = FP)) +
  geom_density(alpha = 0.4) +
  geom_vline(aes(xintercept = mu, color = FP),
             linetype = "dashed")
```

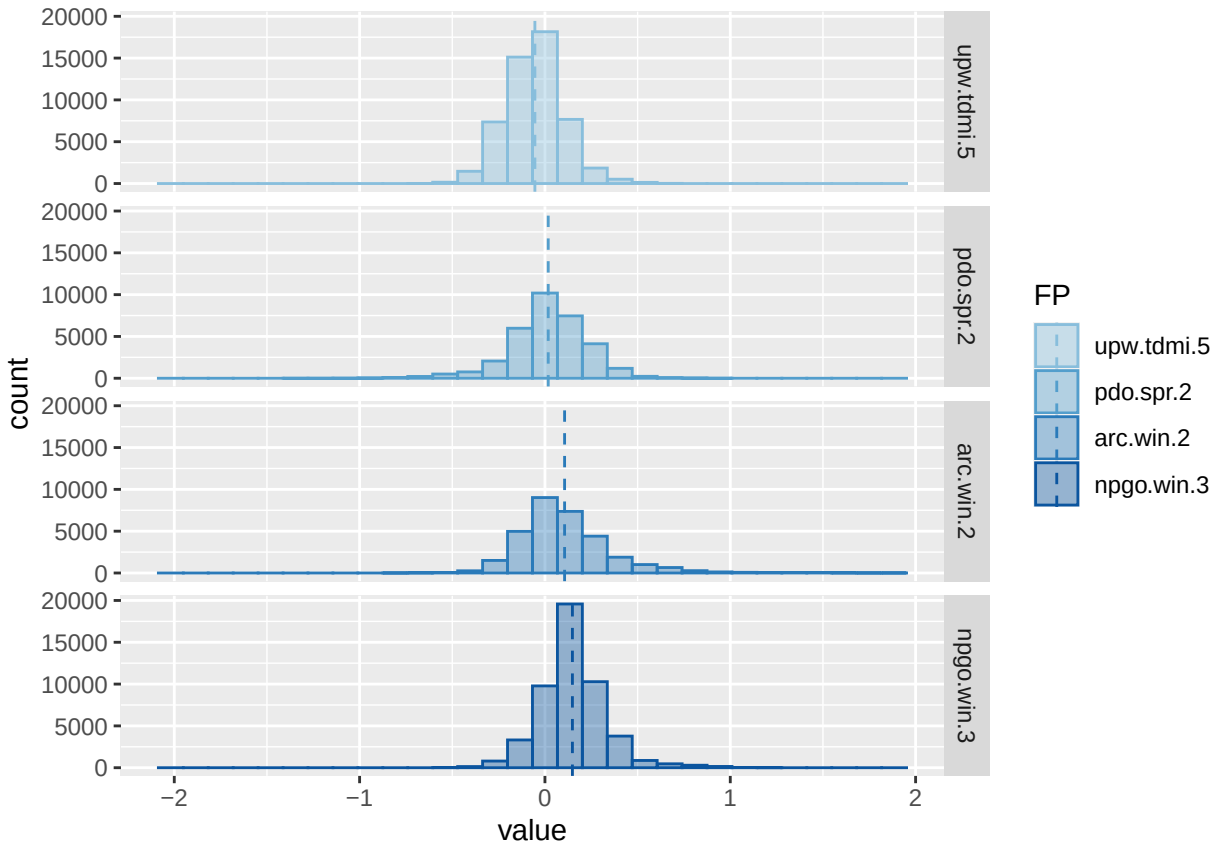



```
# Tough to see differences in this style
unique(rec4_ESU$FP)
```

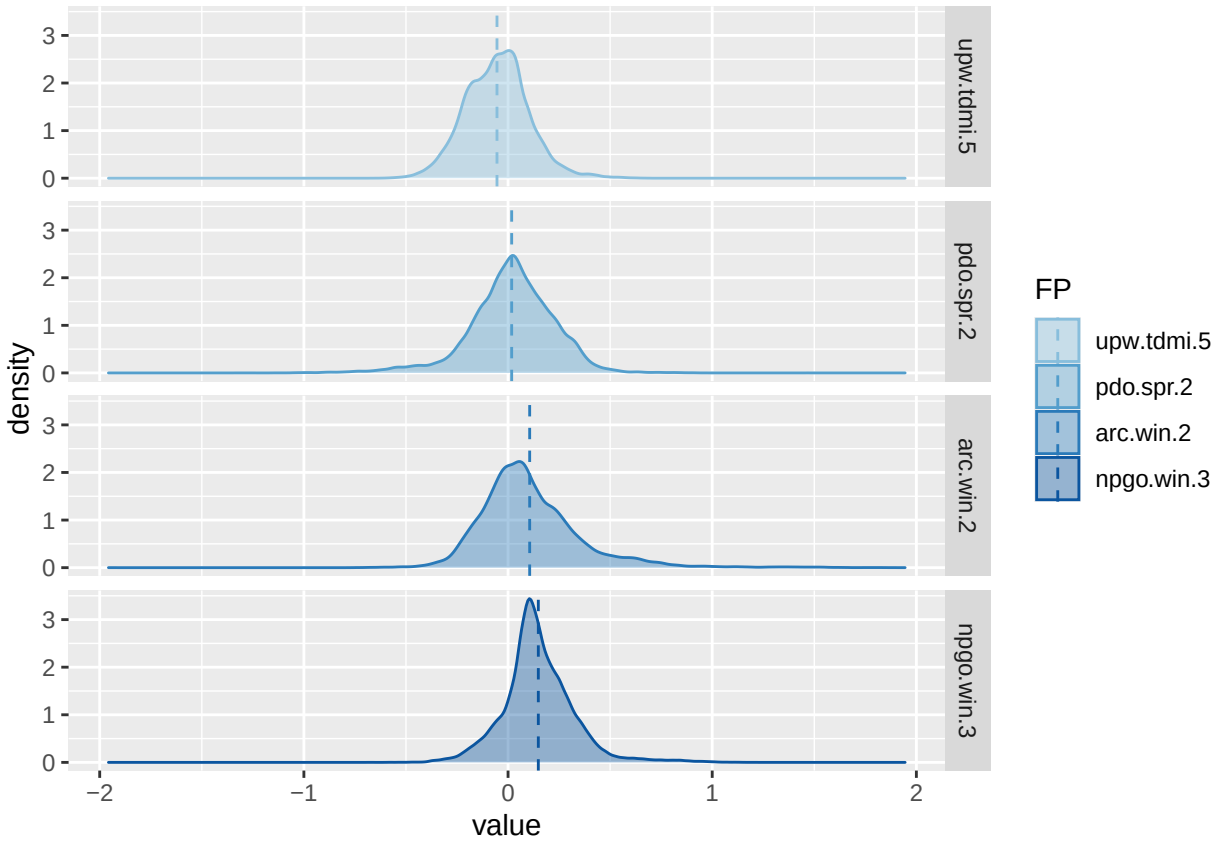
```
## [1] "npgo.win.3" "upw.tdmi.5" "pdo.spr.2"  "arc.win.2"
```

```
rec4_ESU$FP = factor(rec4_ESU$FP, levels=c('upw.tdmi.5',
                                           'pdo.spr.2',
                                           'arc.win.2',
                                           'npgo.win.3'))



ggplot(rec4_ESU, aes(x = value, color = FP, fill = FP)) +
  geom_histogram(position = "identity", alpha = 0.4) +
  scale_color_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
  scale_fill_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
    geom_vline(aes(xintercept = mu, color = FP),
               linetype = "dashed")+
  facet_grid(FP ~ .)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
ggplot(rec4_ESU, aes(x = value, color = FP, fill = FP)) +
  geom_density(alpha = 0.4) +
  scale_color_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
  scale_fill_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
    geom_vline(aes(xintercept = mu, color = FP),
               linetype = "dashed")+
  facet_grid(FP ~ .)
```

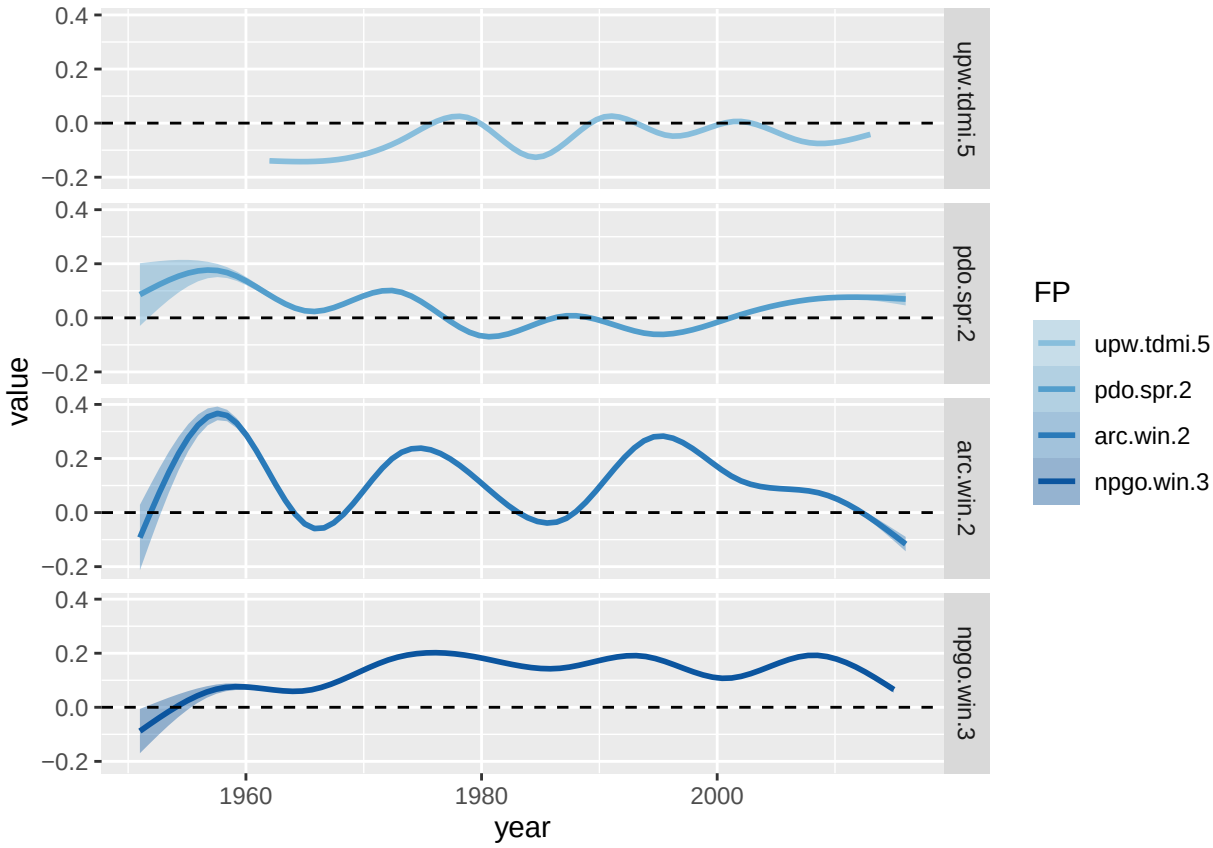


3. How do predator interaction strengths (and vars from other domains) vary through time?

Times series of partial Derivatives, averaged across stocks, for each var

```
ggplot(rec4_ESU, aes(x = year, y = value, fill = FP, color = FP)) +
  geom_smooth() +
  scale_fill_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
  scale_color_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
    geom_hline(aes(yintercept = 0),
               linetype = "dashed") +
  facet_grid(FP ~ .)
```

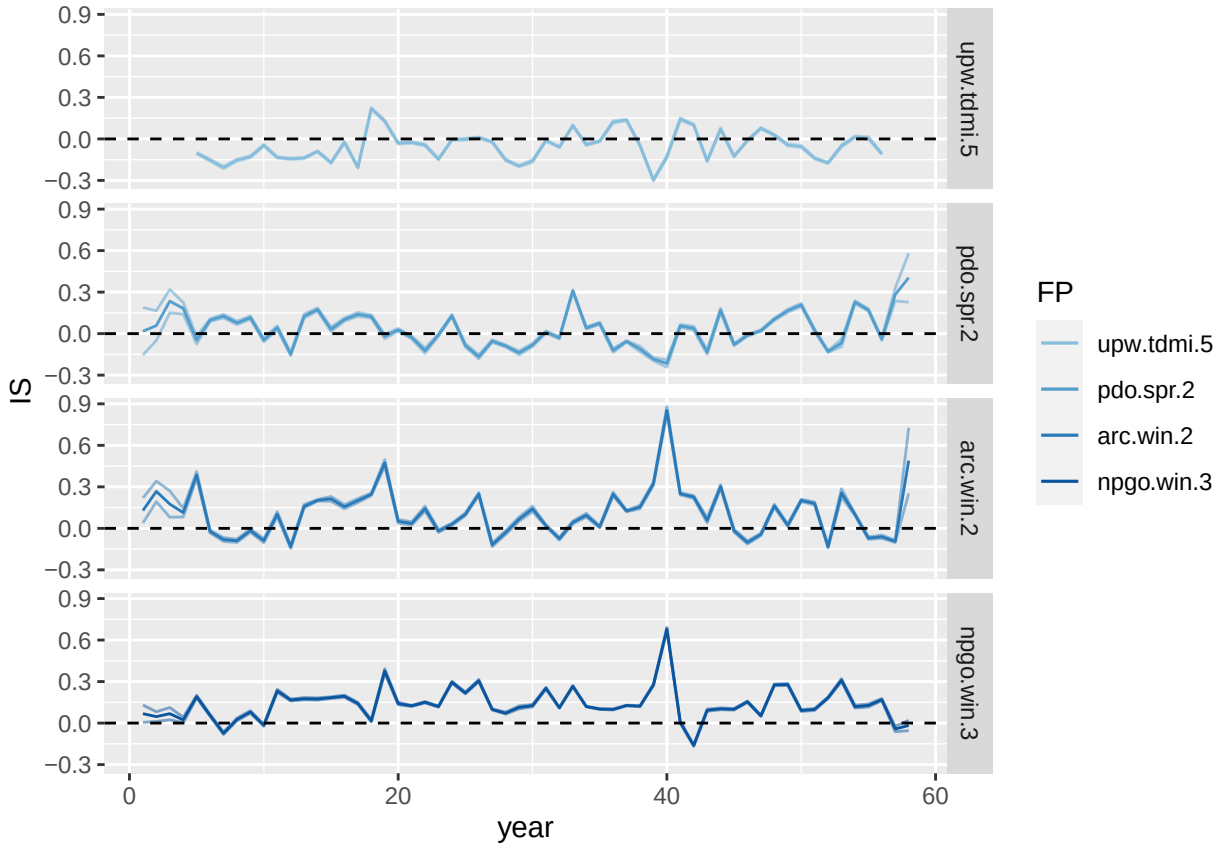
```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



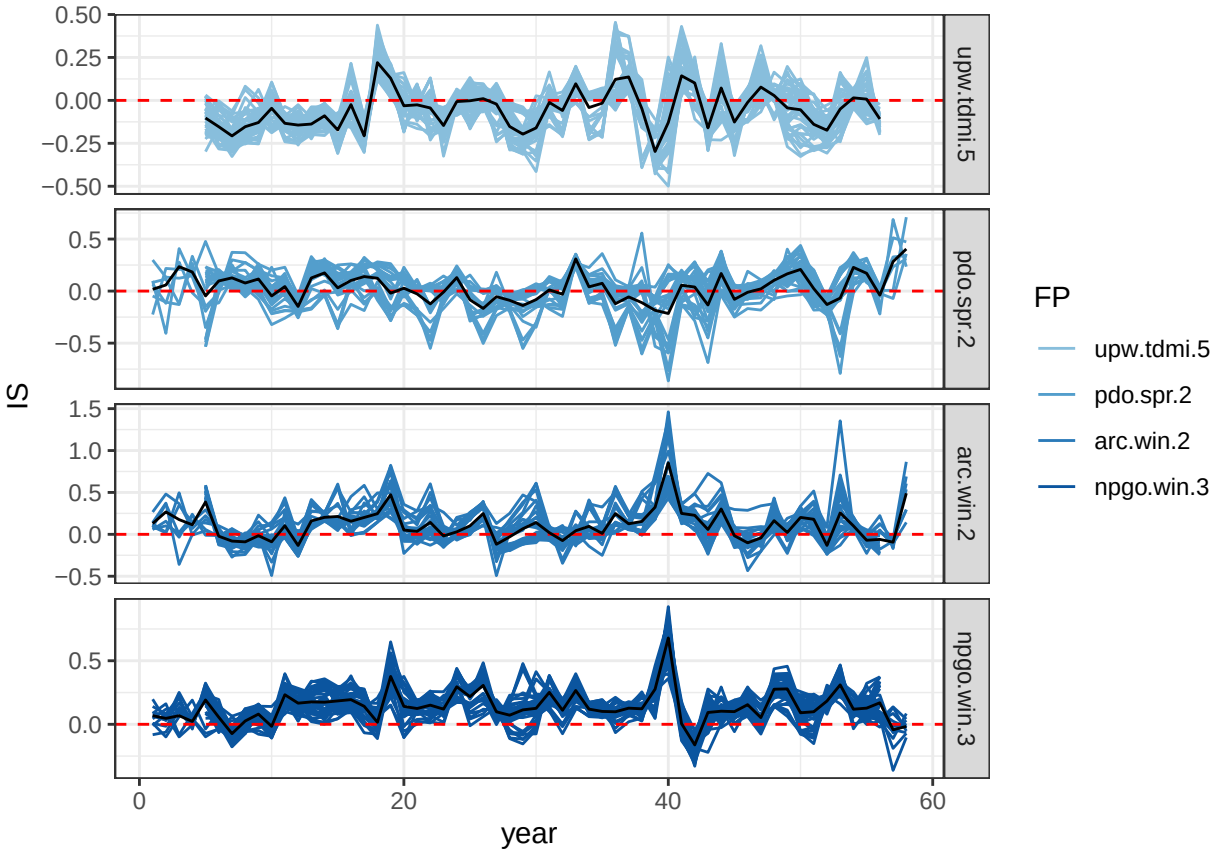

```
rec4_ESU_ts <- rec4_ESU %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP) %>%
  summarise(IS = mean(value, na.rm = TRUE),
            sd = sd(value, na.rm = TRUE),
            n = n()) %>%
  mutate(se = sd / sqrt(n),
         lower = IS - qt(1 - (0.05 / 2), n - 1) * se,
         upper = IS + qt(1 - (0.05 / 2), n - 1) * se) %>%
  mutate(year = as.integer(year)) %>%
ungroup() %>% ungroup()
```

```
## `summarise()` has grouped output by 'year'. You can override using the `.groups` argument.
```

```
ggplot(rec4_ESU_ts, aes(x = year, color = FP, fill = FP)) +
  geom_line(aes(y = IS)) +
  geom_line(aes(y = upper), alpha = 0.5) +
  geom_line(aes(y = lower), alpha = 0.5) +
  geom_hline(aes(yintercept = 0),
             linetype = "dashed") +
    scale_fill_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
  scale_color_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
     facet_grid(FP ~ .)
```




```
rec4_ESU_lines <- rec4_ESU %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP, embedding) %>%
  mutate(IS = mean(value)) %>%
  mutate(year = as.integer(year))


ggplot() +
  geom_line(rec4_ESU_lines, mapping = aes(x=year, y=IS, col=FP, group=embedding)) +
  geom_hline(rec4_ESU_lines, mapping = aes(yintercept = 0),linetype = "dashed", color = "red") +
  scale_fill_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
  scale_color_manual(values = colorRampPalette(brewer.pal(9, "Blues"))(8)[4:7]) +
  geom_line(rec4_ESU_ts, mapping = aes(x=year, y=IS), color = "black") +
  facet_grid(FP ~ ., scales = "free") +
  theme_bw()
```



IMN

2a. What variables are in the top models? In what frequency?

```
unique(rec4_IMN$FP)
```

```
##  [1] "rec4n"              "rec4n_-3"           "flow.gageht.4"
##  [4] "npgo.yrsum.3"       "pdo.spr.4"          "upw.tdmi.4"
##  [7] "harv.COL.4"         "orca.SRKWpodJKL.4" "rec4n_-2"
## [10] "rec4n_-5"           "rec4n_-4"           "rec4n_-1"
## [13] "csl.males6.5"       "hatch.all.1"
```

```
unique(rec4_IMN$embedding)# 54
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
## [26] 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
## [51] 51 52 53 54
```

```
rec4_mods <- rec4_IMN %>%
  group_by(embedding, FP) %>%
  summarise() %>%
  group_by(FP) %>%
  mutate(
    best_mod = min(embedding), # lowest number (highest rank) model
    scale_mod = 1 / best_mod, # above expressed as 0-1
    rank_mod = mean(embedding)/54, # average rank of model that that they are in
```

```
    total_num = length(embedding), # number of models that they are in
    prop_mod = total_num/54, # proportion of model that they are in
    weight = 54-embedding, # reverse of rank
    integrated = sum(weight)/(54*55/2)) %>% # integrate rank and weight
  slice(1) %>%
  filter(!grepl("rec4", FP)) %>%
  filter(!FP == "flow.gageht.4") %>%
  ungroup()
```

```
## `summarise()` has grouped output by 'embedding'. You can override using the `.groups` argument.
```

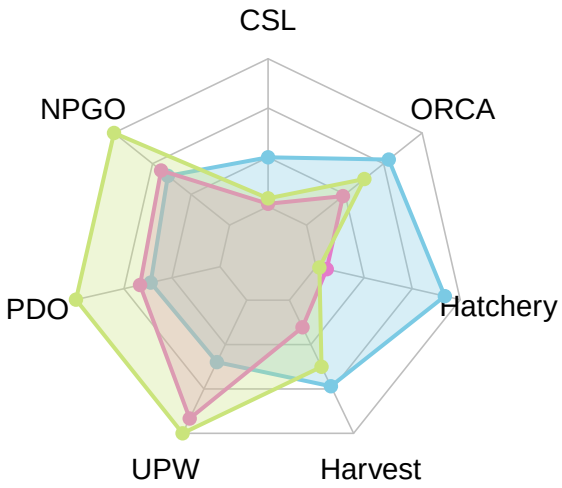
```
unique(rec4_mods$FP)
```

```
## [1] "csl.males6.5"      "harv.COL.4"        "hatch.all.1"
## [4] "npgo.yrsum.3"      "orca.SRKWpodJKL.4" "pdo.spr.4"
## [7] "upw.tdmi.4"
```

```
# organize vars by Ocean, People, Biol
```

```
trans.pal <- c("#7BCAE44D", "#E47BCA4D", "#CAE47B4D")
pal <- c("#7BCAE4", "#E47BCA", "#CAE47B")

temp <- rec4_mods %>%
  select(FP,prop_mod, scale_mod, rank_mod) %>%
  mutate(ord = c(1,5,6,2,7,3,4)) %>%
  arrange(ord)

rec4_spider <- data.frame(rbind(rep(1,7), rep(0,7),
                                temp$rank_mod, temp$prop_mod, temp$scale_mod
                                  ))
colnames(rec4_spider) <- temp$FP

radarchart(rec4_spider, axistype=0,
           #custom polygon
           pcol=pal, pfcol=trans.pal,  plwd=2, plty=1, seg = 3,
           #custom the grid
           cglcol="grey", cglty=1, cglwd=0.8,
           #custom labels
           vlcex=.9, vlabels = c("CSL", "NPGO", "PDO", "UPW",  "Harvest",
                                 "Hatchery", "ORCA"),
           title="What variables are found in top models?")
```

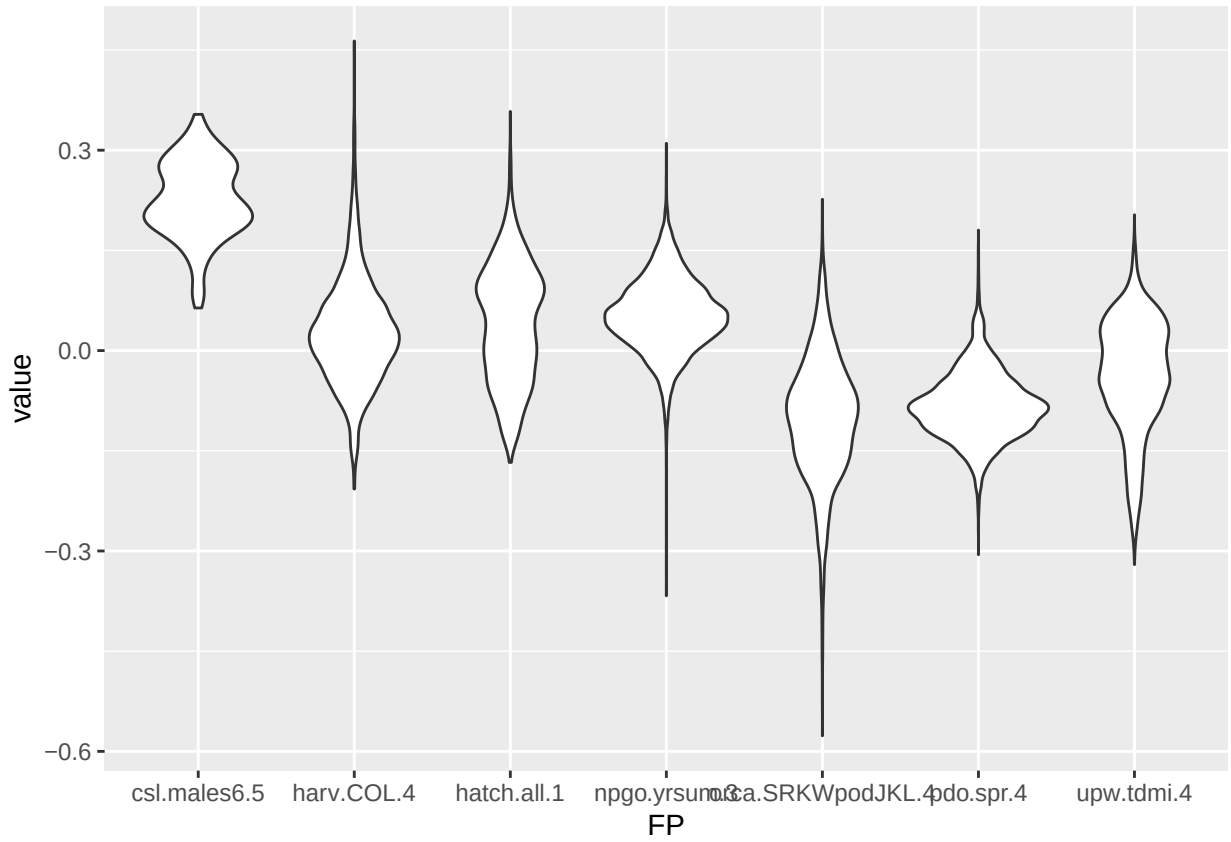
What variables are found in top models?



2b. How do predator interaction strengths compared to variables from other domains (ocean, human)?

Distribution of partial derivatives, averaged across stocks, and across years, for each var

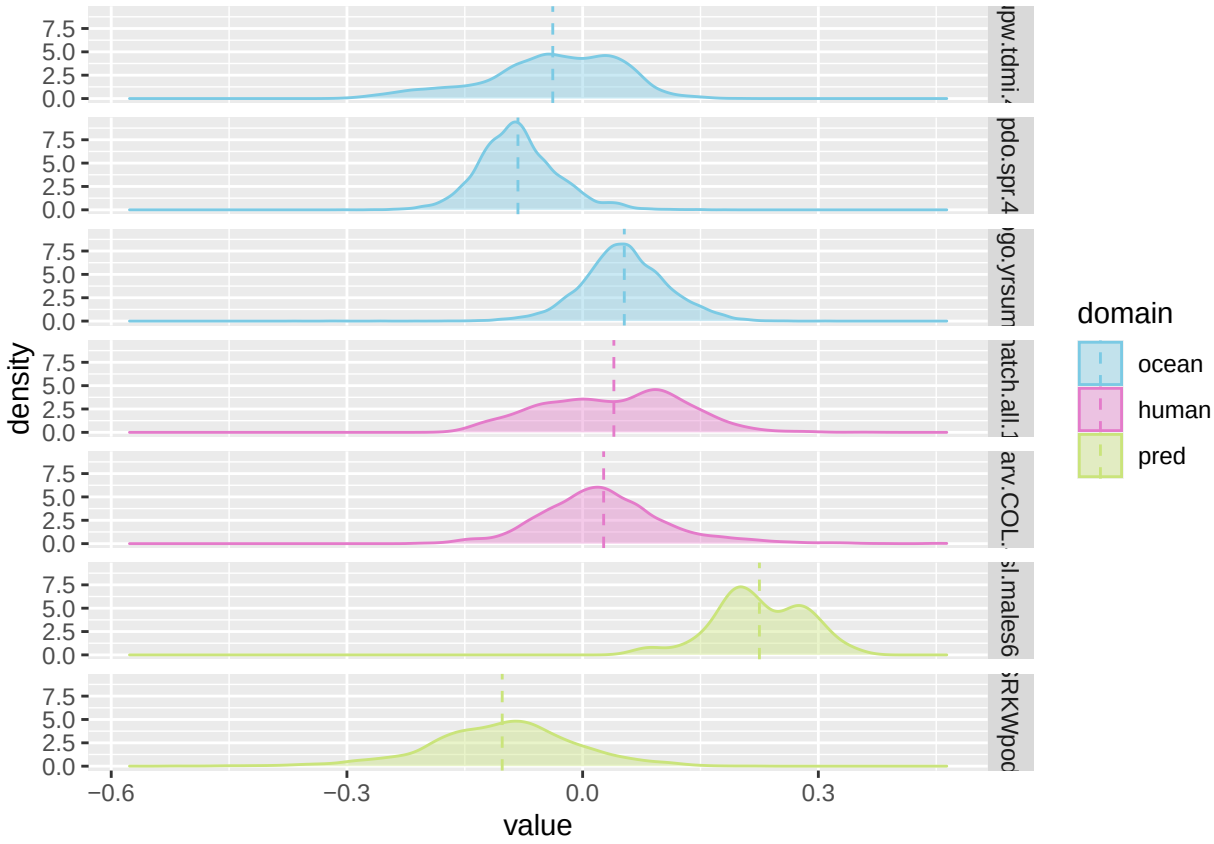
```
rec4_IMN<-  rec4_IMN  %>%
  filter(!grepl("rec4", FP)) %>%
  filter(!grepl("flow", FP)) %>%
  group_by(FP) %>%
  mutate(mu = mean(value, na.rm=TRUE)) %>%
  ungroup()

ggplot(rec4_IMN, aes(x = FP, y = value)) +
  geom_violin()
```




```
rec4_IMN$domain = factor(rec4_IMN$domain, levels = c( "ocean" , "human", "pred"))
unique(rec4_IMN$FP)
```

```
## [1] "npgo.yrsum.3"      "pdo.spr.4"         "upw.tdmi.4"
## [4] "harv.COL.4"        "orca.SRKWpodJKL.4" "csl.males6.5"
## [7] "hatch.all.1"
```

```
rec4_IMN$FP = factor(rec4_IMN$FP,
                levels=c('upw.tdmi.4',
                         'pdo.spr.4',
                         'npgo.yrsum.3',
                           'hatch.all.1',
                         "harv.COL.4",
                          "csl.males6.5",
                        "orca.SRKWpodJKL.4"

                        ))

ggplot(rec4_IMN, aes(x = value, color = domain, fill = domain)) +
  geom_density(alpha = 0.4) +
  scale_color_manual(values = pal) +
  scale_fill_manual(values = pal) +
    geom_vline(aes(xintercept = mu, color = domain),
               linetype = "dashed") +
  facet_grid(FP ~ .)
```

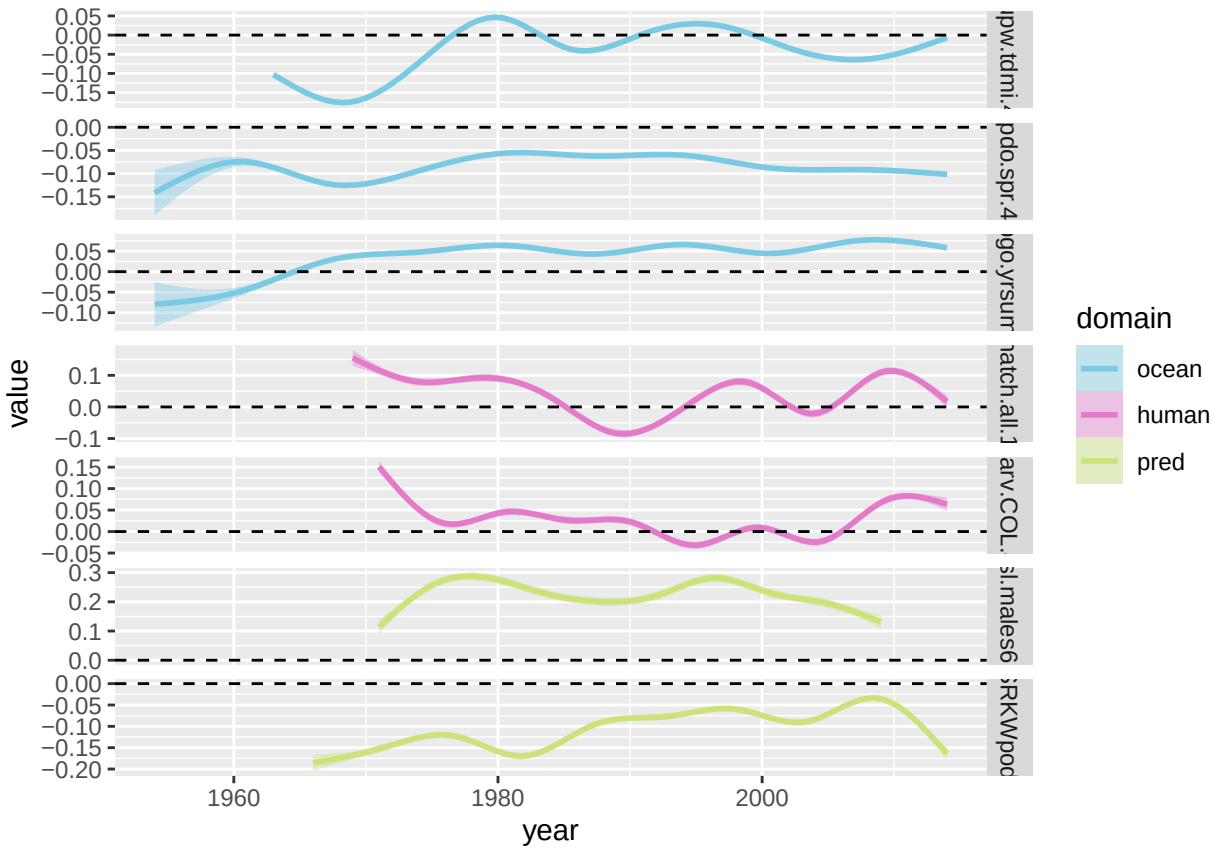


3. How do predator interaction strengths (and vars from other domains) vary through time?

Times series of partial Derivatives, averaged across stocks, for each var

```
ggplot(rec4_IMN, aes(x = year, y = value, fill = domain, color = domain)) +
  geom_smooth() +
  scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
    geom_hline(aes(yintercept = 0),
               linetype = "dashed") +
  facet_grid(FP ~ ., scales = "free")
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

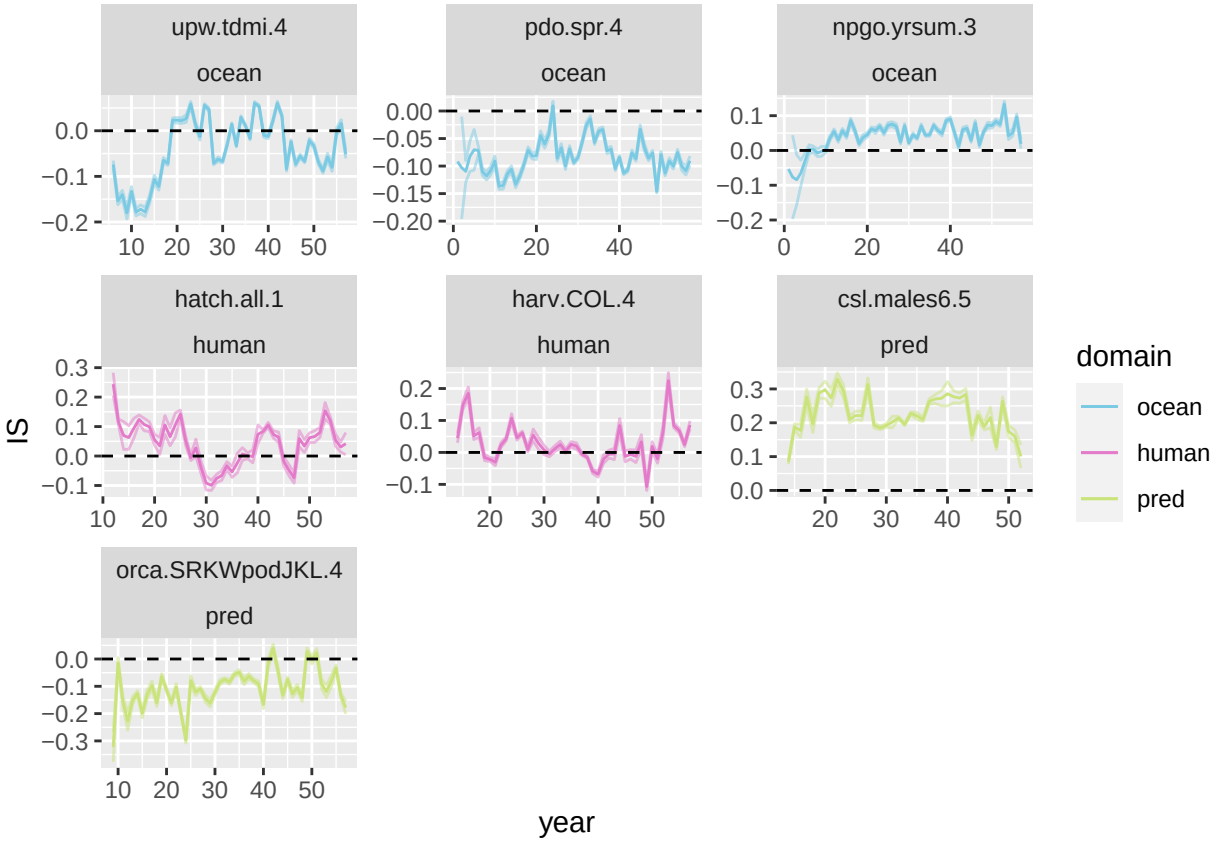



```
rec4_IMN_ts <- rec4_IMN %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP) %>%
  mutate(IS = mean(value, na.rm = TRUE),
            sd = sd(value, na.rm = TRUE),
            n = n()) %>%
  mutate(se = sd / sqrt(n),
         lower = IS - qt(1 - (0.05 / 2), n - 1) * se,
         upper = IS + qt(1 - (0.05 / 2), n - 1) * se) %>%
  mutate(year = as.integer(year))
```

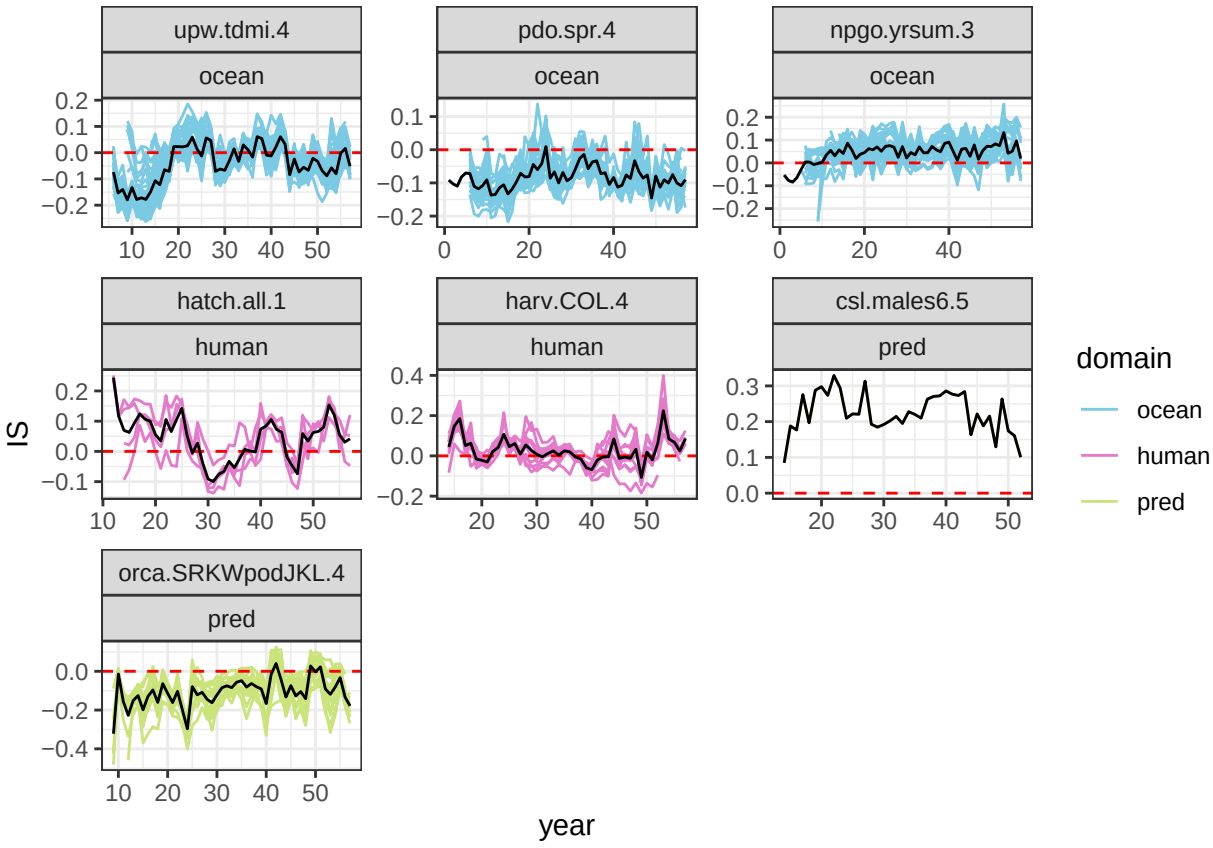
```
## Warning in qt(1 - (0.05/2), n - 1): NaNs produced

## Warning in qt(1 - (0.05/2), n - 1): NaNs produced

## Warning in qt(1 - (0.05/2), n - 1): NaNs produced

## Warning in qt(1 - (0.05/2), n - 1): NaNs produced
```

```
ggplot(rec4_IMN_ts, aes(x = year, color = domain, fill = domain)) +
  geom_line(aes(y = IS)) +
  geom_line(aes(y = upper), alpha = 0.5) +
  geom_line(aes(y = lower), alpha = 0.5) +
  geom_hline(aes(yintercept = 0),
             linetype = "dashed") +
```

```
    scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
     facet_wrap(~ FP + domain, scales = "free")
```




```
rec4_IMN_lines <- rec4_IMN %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP, embedding) %>%
  mutate(IS = mean(value)) %>%
  mutate(year = as.integer(year))


ggplot() +
  geom_line(rec4_IMN_lines, mapping = aes(x=year, y=IS, col=domain, group=embedding)) +
  scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
  geom_hline(rec4_IMN_lines, mapping = aes(yintercept = 0),linetype = "dashed", color = "red") +
  geom_line(rec4_IMN_ts, mapping = aes(x=year, y=IS), color = "black") +
  facet_wrap(FP + domain ~ ., scales = "free") +
  theme_bw()
```



MFS

```
unique(rec4_MFS$FP)
```

```
##  [1] "rec4n"          "rec4n_-1"       "rec4n_-4"       "arc.win.5"
##  [5] "harv.CRsport.4" "pdo.sum.2"      "rec4n_-3"       "npgo.spr.3"
##  [9] "rec4n_-2"       "upw.tdmi.4"     "hatch.SNAK.3"   "rec4n_-5"
```

```
unique(rec4_MFS$embedding)
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
## [26] 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
```

```
rec4_mods <- rec4_MFS %>%
  group_by(embedding, FP) %>%
  summarise() %>%
  group_by(FP) %>%
  mutate(
    best_mod = min(embedding), # lowest number (highest rank) model
    scale_mod = 1 / best_mod, # above expressed as 0-1
    rank_mod = mean(embedding)/44, # average rank of model that that they are in
    total_num = length(embedding), # number of models that they are in
    prop_mod = total_num/44, # proportion of model that they are in
    weight = 44-embedding, # reverse of rank
    integrated = sum(weight)/(44*45/2)) %>% # integrate rank and weight
  slice(1) %>%
  filter(!grepl("rec4", FP)) %>%
```

```
  arrange(prop_mod) %>%
  ungroup()
```

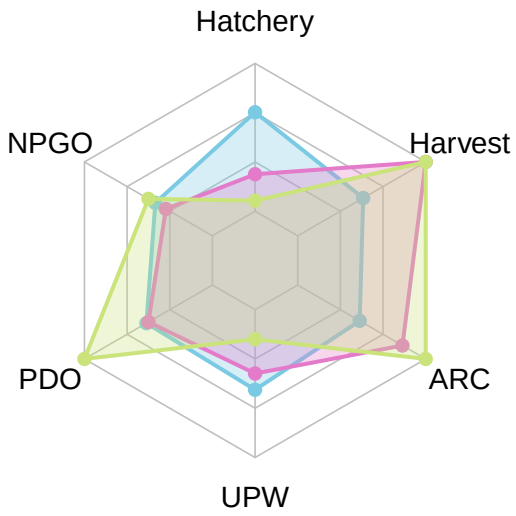
```
## `summarise()` has grouped output by 'embedding'. You can override using the `.groups` argument.
```

```
unique(rec4_mods$FP)
```

```
## [1] "hatch.SNAK.3"   "npgo.spr.3"     "upw.tdmi.4"     "pdo.sum.2"
## [5] "arc.win.5"      "harv.CRsport.4"
```

```
temp <- rec4_mods %>%
  select(FP, prop_mod, scale_mod, rank_mod) %>%
  mutate(ord = c(1,2,4,3,5,6)) %>%
  arrange(ord)

rec4_spider <- data.frame(rbind(rep(1,6), rep(0,6),
                                temp$rank_mod, temp$prop_mod, temp$scale_mod
                                  ))
colnames(rec4_spider) <- temp$FP

trans.pal <- c("#7BCAE44D", "#E47BCA4D", "#CAE47B4D")
pal <- c("#7BCAE4", "#E47BCA", "#CAE47B")

# op <- par(mar = c(1, 1, 1, 1))
# par(mar = c(1, 0, 1, 5))

radarchart(rec4_spider, axistype=0,
           #custom polygon
           pcol=pal, pfcol=trans.pal,  plwd=2, plty=1, seg = 3,
           #custom the grid
           cglcol="grey", cglty=1, cglwd=0.8,
           #custom labels
           vlcex=.9, vlabels = c("Hatchery", "NPGO", "PDO", "UPW", "ARC", "Harvest"),
           title="What variables are found in top models?")
```

What variables are found in top models?

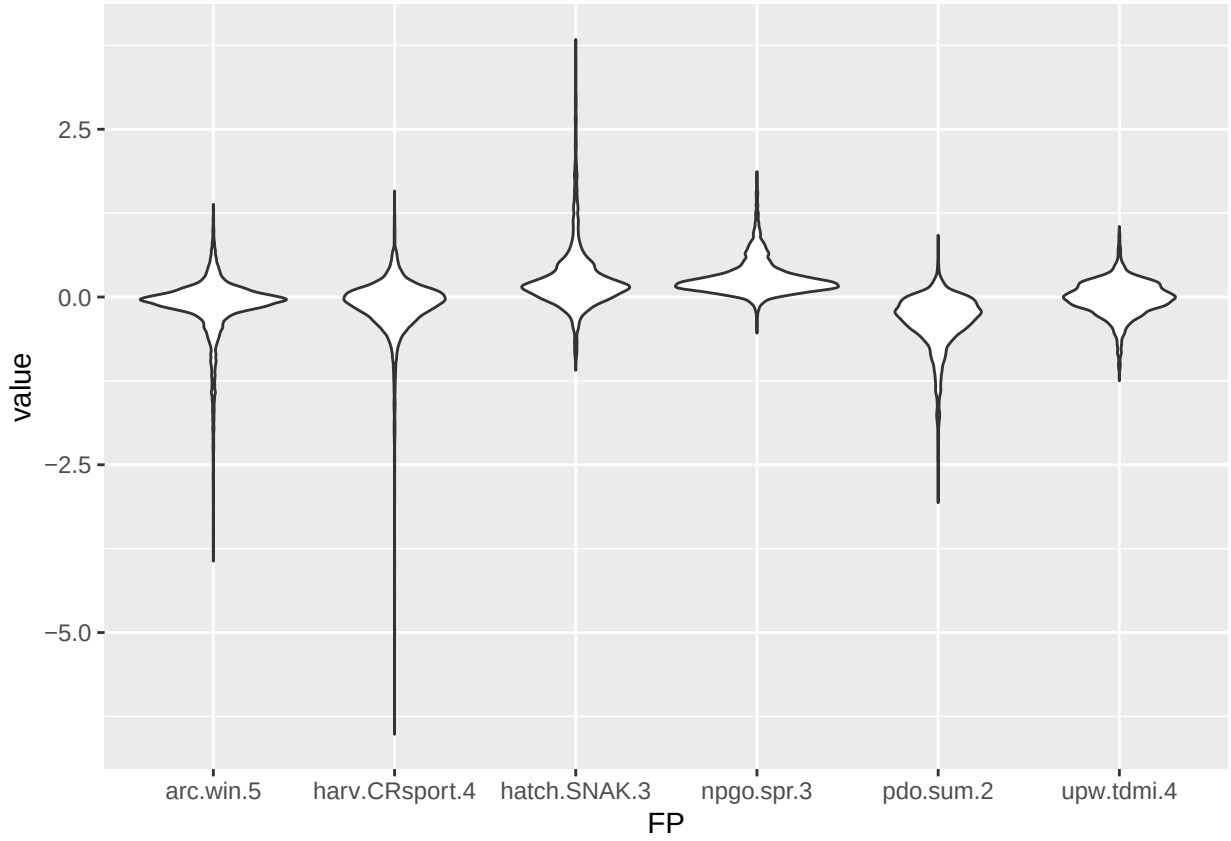


```
# legend(x=.9, y=.8, legend = c("Ave Rank", "No. Models", "Highest Rank"), bty = "n", pch=20 , col=pal,


# par(op)
```

2b. How do predator interaction strengths compared to variables from other domains (ocean, human)?

Partial Derivatives, averaged across stocks, and across years, for each

```
rec4_MFS<-  rec4_MFS  %>%
  filter(!grepl("rec4", FP)) %>%
  filter(!grepl("flow", FP)) %>%
  group_by(FP) %>%
  mutate(mu = mean(value, na.rm=TRUE)) %>%
  ungroup()

ggplot(rec4_MFS, aes(x = FP, y = value)) +
  geom_violin()
```

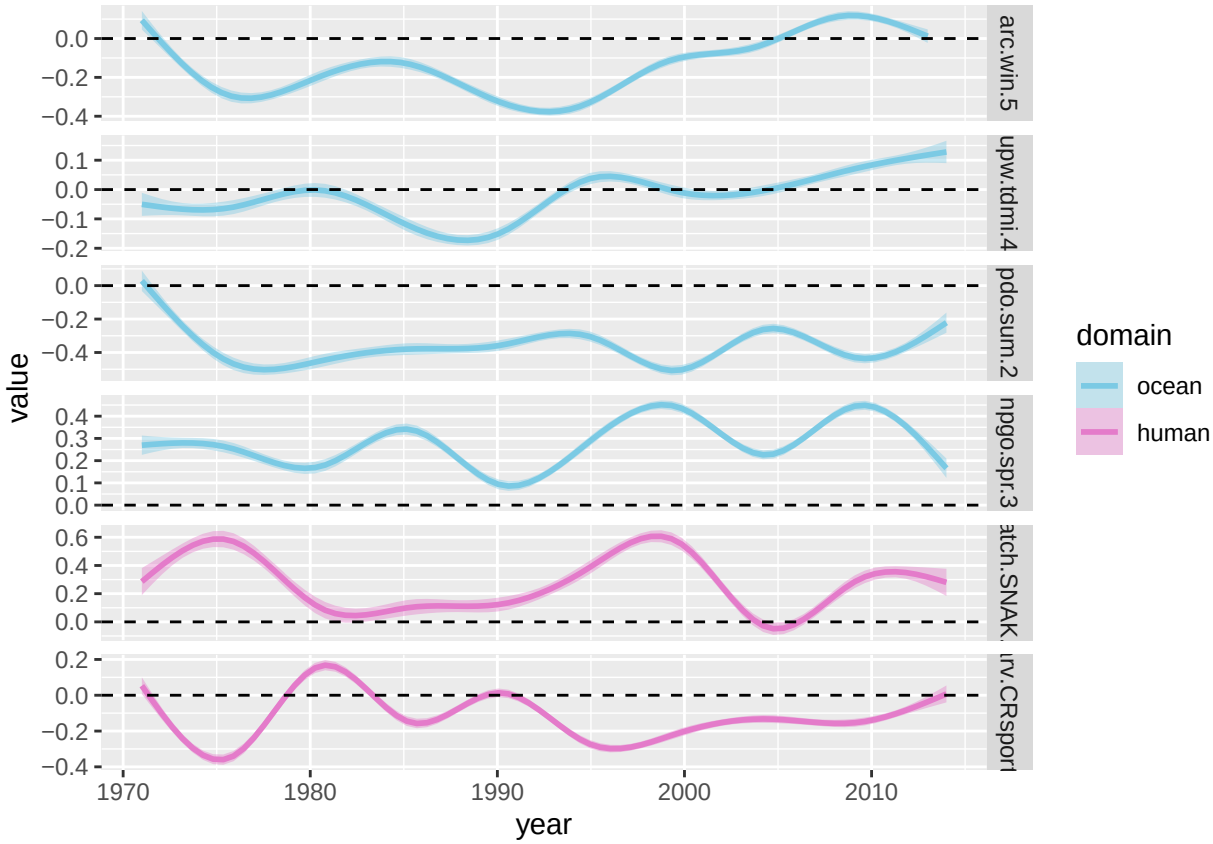



```
rec4_MFS$domain = factor(rec4_MFS$domain, levels = c( "ocean", "pred", "human"))
unique(rec4_MFS$FP)
```

```
## [1] "arc.win.5"      "harv.CRsport.4" "pdo.sum.2"      "npgo.spr.3"
## [5] "upw.tdmi.4"     "hatch.SNAK.3"
```

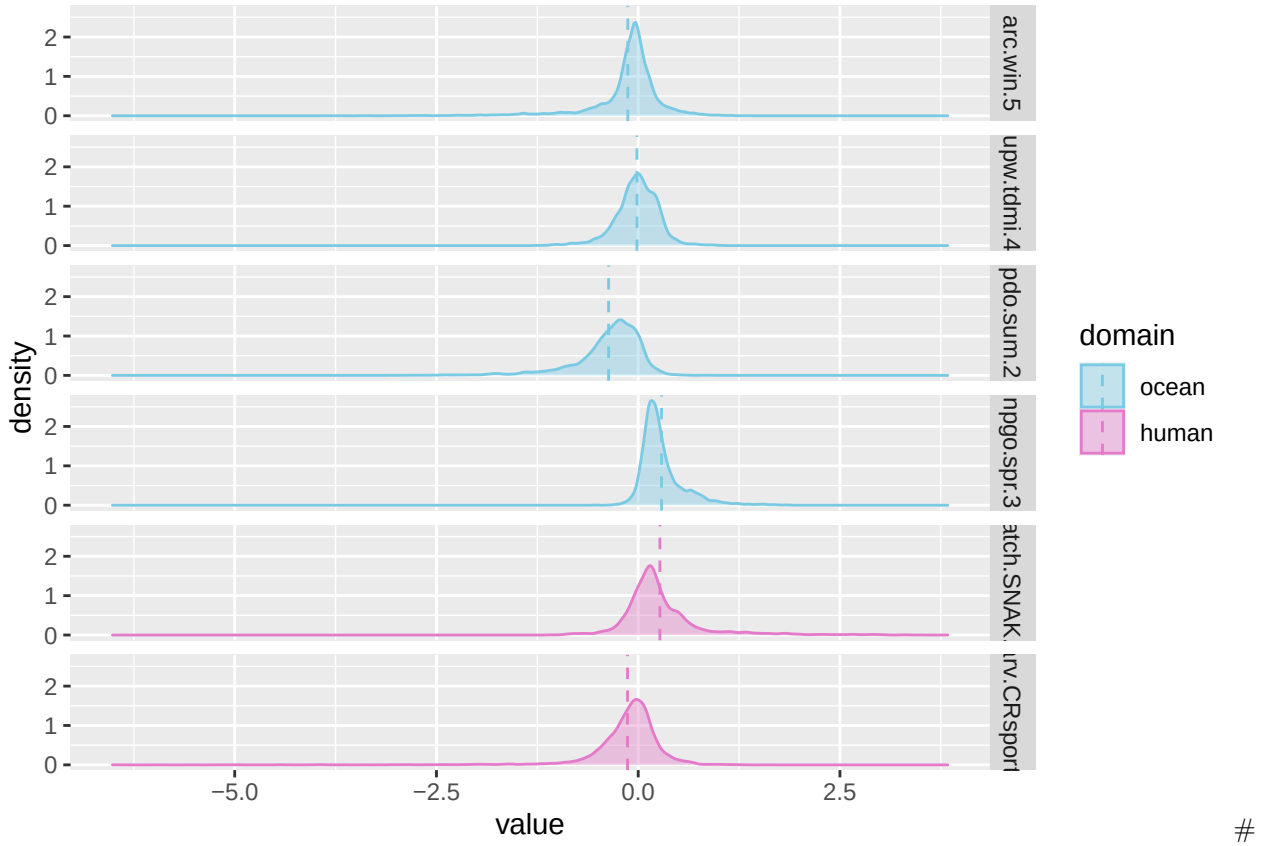
```
rec4_MFS$FP = factor(rec4_MFS$FP,
                levels=c('arc.win.5',
                         'upw.tdmi.4',
                         'pdo.sum.2',
                         'npgo.spr.3',
                         'hatch.SNAK.3',
                         "harv.CRsport.4"
                        ))

ggplot(rec4_MFS, aes(x = year, y = value, fill = domain, color = domain)) +
  geom_smooth() +
  scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
    geom_hline(aes(yintercept = 0),
               linetype = "dashed") +
  facet_grid(FP ~ ., scales = "free")
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
# distribution

ggplot(rec4_MFS, aes(x = value, color = domain, fill = domain)) +
  geom_density(alpha = 0.4) +
  scale_color_manual(values = pal) +
  scale_fill_manual(values = pal) +
    geom_vline(aes(xintercept = mu, color = domain),
               linetype = "dashed") +
```

```
  facet_grid(FP ~ .)
```

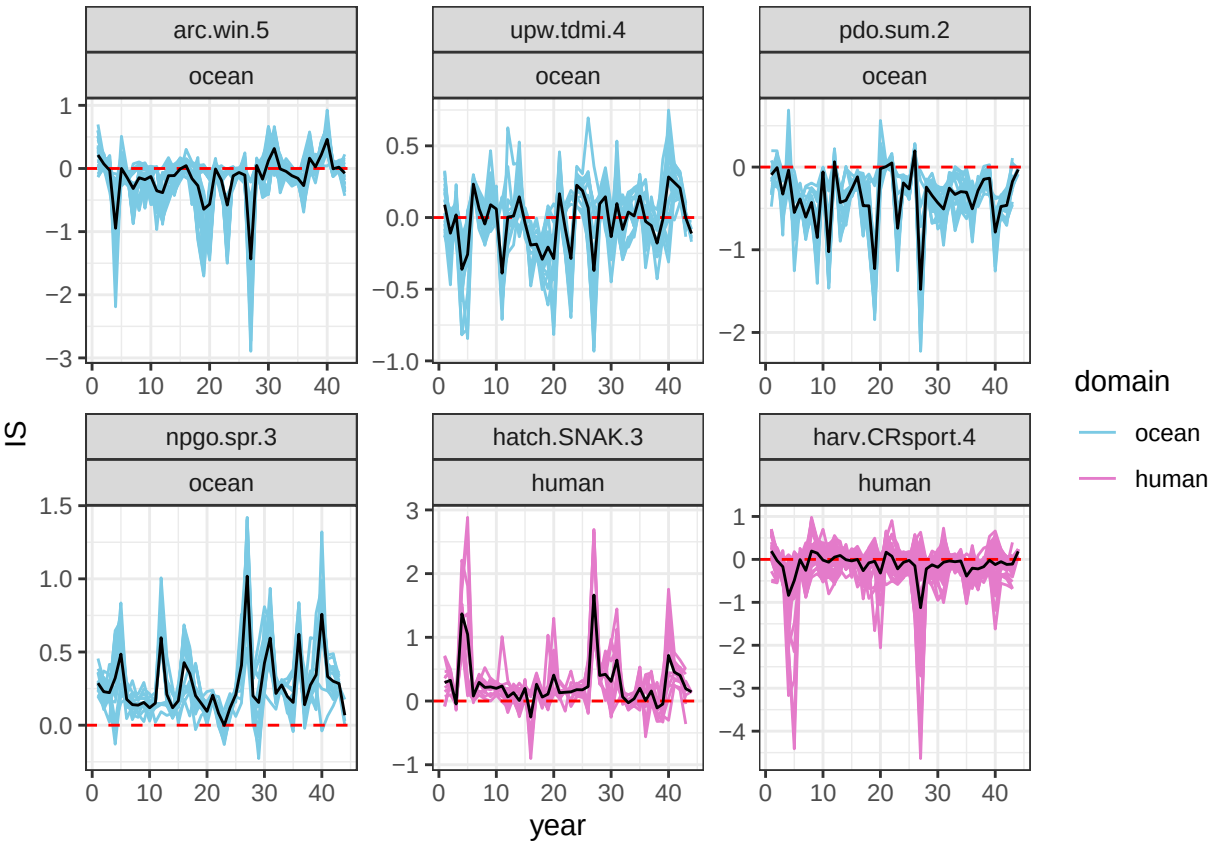


#

3. How do predator interaction strengths (and vars from other domains) vary through time? ### Times series of partial Derivatives, averaged across stocks, for each var

```
rec4_MFS_ts <- rec4_MFS %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP) %>%
  mutate(IS = mean(value, na.rm = TRUE),
            sd = sd(value, na.rm = TRUE),
            n = n()) %>%
  mutate(se = sd / sqrt(n),
         lower = IS - qt(1 - (0.05 / 2), n - 1) * se,
         upper = IS + qt(1 - (0.05 / 2), n - 1) * se) %>%
  mutate(year = as.integer(year))

ggplot(rec4_MFS_ts, aes(x = year, color = domain, fill = domain)) +
  geom_line(aes(y = IS)) +
  geom_line(aes(y = upper), alpha = 0.5) +
  geom_line(aes(y = lower), alpha = 0.5) +
  geom_hline(aes(yintercept = 0),
             linetype = "dashed") +
    scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
     facet_wrap(~ FP + domain, scales = "free")
```


```
rec4_MFS_lines <- rec4_MFS %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP, embedding) %>%
  mutate(IS = mean(value)) %>%
  mutate(year = as.integer(year))


ggplot() +
  geom_line(rec4_MFS_lines, mapping = aes(x=year, y=IS, col=domain, group=embedding)) +
  scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
  geom_hline(rec4_MFS_lines, mapping = aes(yintercept = 0),linetype = "dashed", color = "red") +
  geom_line(rec4_MFS_ts, mapping = aes(x=year, y=IS), color = "black") +
  facet_wrap(FP + domain ~ ., scales = "free") +
  theme_bw()
```



UPS

2a. What variables are in the top models? In what frequency?

To do that right, we need to actually through ALL the vars in the SMAP hopper, not just the top ones

But I can get an highest and average rank model that each var shows up in

```
unique(rec4_UPS$FP)
```

```
##  [1] "rec4n"                "rec4n_-1"             "harv.PACtot.5"
##  [4] "hseal.COL.3"          "hatch.total.1"        "pdo.sum.5"
##  [7] "ssl.COL.4"            "orca.SRKWdeathsJKL.5" "rec4n_-3"
## [10] "csl.Dpups.0"          "npgo.spr.2"           "upw.tdmi.5"
## [13] "rec4n_-2"             "flow.mean.1"
```

```
rec4_mods <- rec4_UPS %>%
  group_by(embedding, FP) %>%
  summarise() %>%
  group_by(FP) %>%
  mutate(
    best_mod = min(embedding), # lowest number (highest rank) model
    scale_mod = 1 / best_mod, # above expressed as 0-1
    rank_mod = mean(embedding)/16, # average rank of model that that they are in
    total_num = length(embedding), # number of models that they are in
    prop_mod = total_num/12, # proportion of model that they are in
```

```
    weight = 17-embedding, # reverse of rank
    integrated = sum(weight)/(16*17/2)) %>% # integrate rank and weight
  slice(1) %>%
  filter(!grepl("rec4", FP)) %>%
  arrange(prop_mod) %>%
  filter(!FP == "flow.mean.1") %>%
  filter(!FP == "hseal.COL.3") %>%
  ungroup()
```

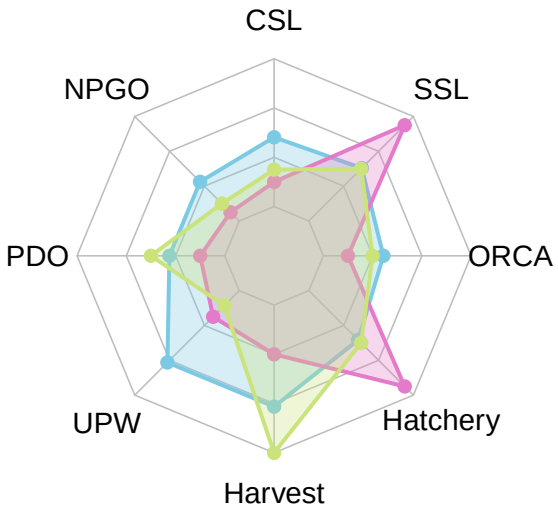
```
## `summarise()` has grouped output by 'embedding'. You can override using the `.groups` argument.
```

```
rec4_mods$FP <- factor(rec4_mods$FP, levels = c("npgo.spr.2",
                                                "pdo.sum.5",
                                                "upw.tdmi.5",
                                                "harv.PACtot.5",
                                                "hatch.total.1",
                                                "csl.Dpups.0",
                                                "orca.SRKWdeathsJKL.5",
                                                "ssl.COL.4"))


# organize vars by Ocean, People, Biol

levels(rec4_mods$FP)
```

```
## [1] "npgo.spr.2"           "pdo.sum.5"            "upw.tdmi.5"
## [4] "harv.PACtot.5"        "hatch.total.1"        "csl.Dpups.0"
## [7] "orca.SRKWdeathsJKL.5" "ssl.COL.4"
```

```
temp <- rec4_mods %>%
  select(FP, prop_mod, scale_mod, rank_mod) %>%
  mutate(ord = c(2,1,7,3,4,5,6,8)) %>%
  arrange(ord)

rec4_spider <- data.frame(rbind(rep(1,8), rep(0,8),
                                temp$rank_mod, temp$prop_mod, temp$scale_mod
                                  ))
colnames(rec4_spider) <- temp$FP

trans.pal <- c("#7BCAE44D", "#E47BCA4D", "#CAE47B4D")
pal <- c("#7BCAE4", "#E47BCA", "#CAE47B")

# op <- par(mar = c(1, 1, 1, 1))
# par(mar = c(1, 0, 1, 5))

radarchart(rec4_spider, axistype=0,
           #custom polygon
           pcol=pal, pfcol=trans.pal,  plwd=2, plty=1, seg = 3,
           #custom the grid
           cglcol="grey", cglty=1, cglwd=0.8,
           #custom labels
           vlcex=.9, vlabels = c("CSL", "NPGO", "PDO", "UPW",  "Harvest",
                                 "Hatchery", "ORCA", "SSL"),
           title="What variables are found in top models?")
```

What variables are found in top models?



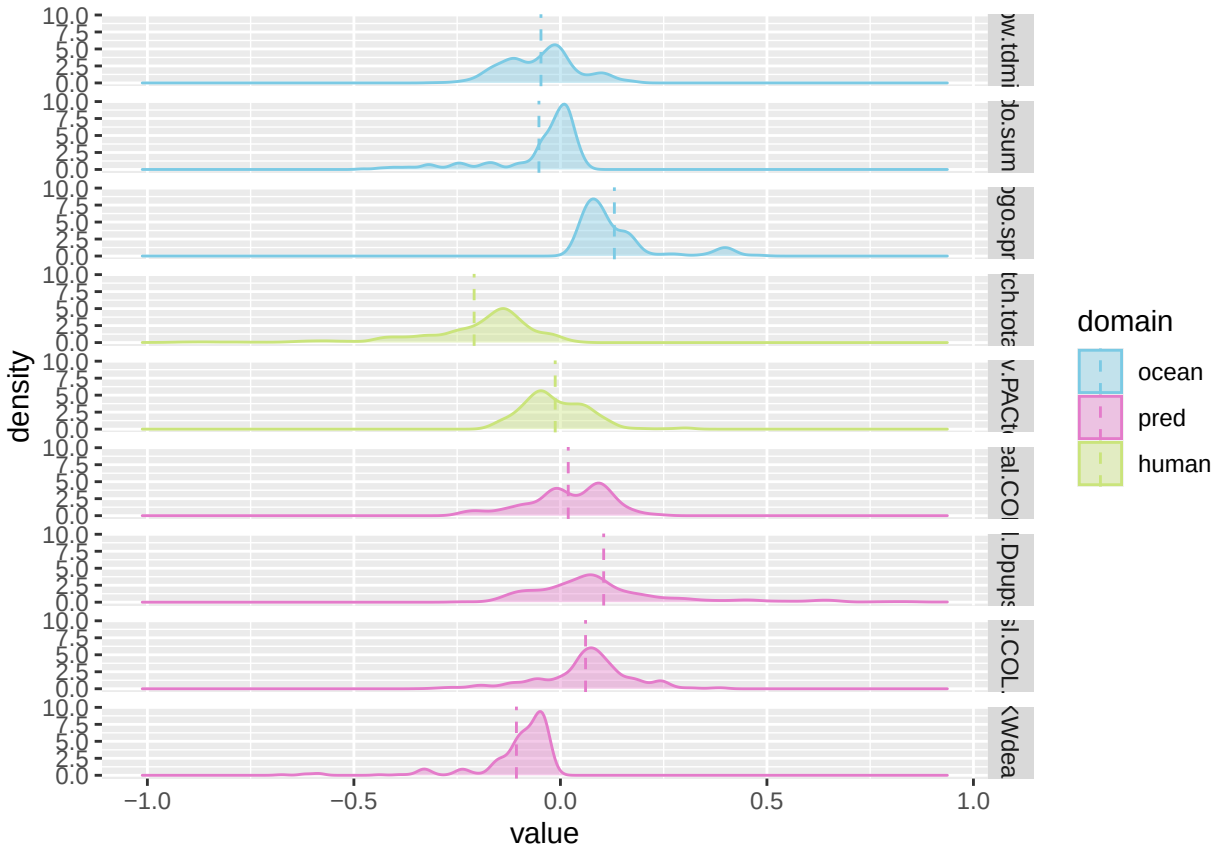

```
# legend(x=.9, y=.8, legend = c("Ave Rank", "No. Models", "Highest Rank"), bty = "n", pch=20 , col=pal,


# par(op)
```

2b. How do predator interaction strengths compared to variables from other domains (ocean, human)?

Partial Derivatives, averaged across stocks, and across years, for each

```
rec4_UPS<-  rec4_UPS  %>%
  filter(!grepl("rec4", FP)) %>%
  filter(!grepl("flow", FP)) %>%
  group_by(FP) %>%
  mutate(mu = mean(value, na.rm=TRUE)) %>%
  ungroup()

ggplot(rec4_UPS, aes(x = FP, y = value)) +
  geom_violin()
```


```
rec4_UPS$domain = factor(rec4_UPS$domain, levels = c( "ocean", "pred", "human"))

rec4_UPS$FP = factor(rec4_UPS$FP,
                levels=c('upw.tdmi.5',
                         'pdo.sum.5',
                         'npgo.spr.2',
                         'hatch.total.1',
                         "harv.PACtot.5",
                         "hseal.COL.3",
                        "csl.Dpups.0",
                        "ssl.COL.4",
                        "orca.SRKWdeathsJKL.5"
                        ))

ggplot(rec4_UPS, aes(x = value, color = domain, fill = domain)) +
  geom_density(alpha = 0.4) +
  scale_color_manual(values = pal) +
  scale_fill_manual(values = pal) +
    geom_vline(aes(xintercept = mu, color = domain),
               linetype = "dashed") +
  facet_grid(FP ~ .)
```

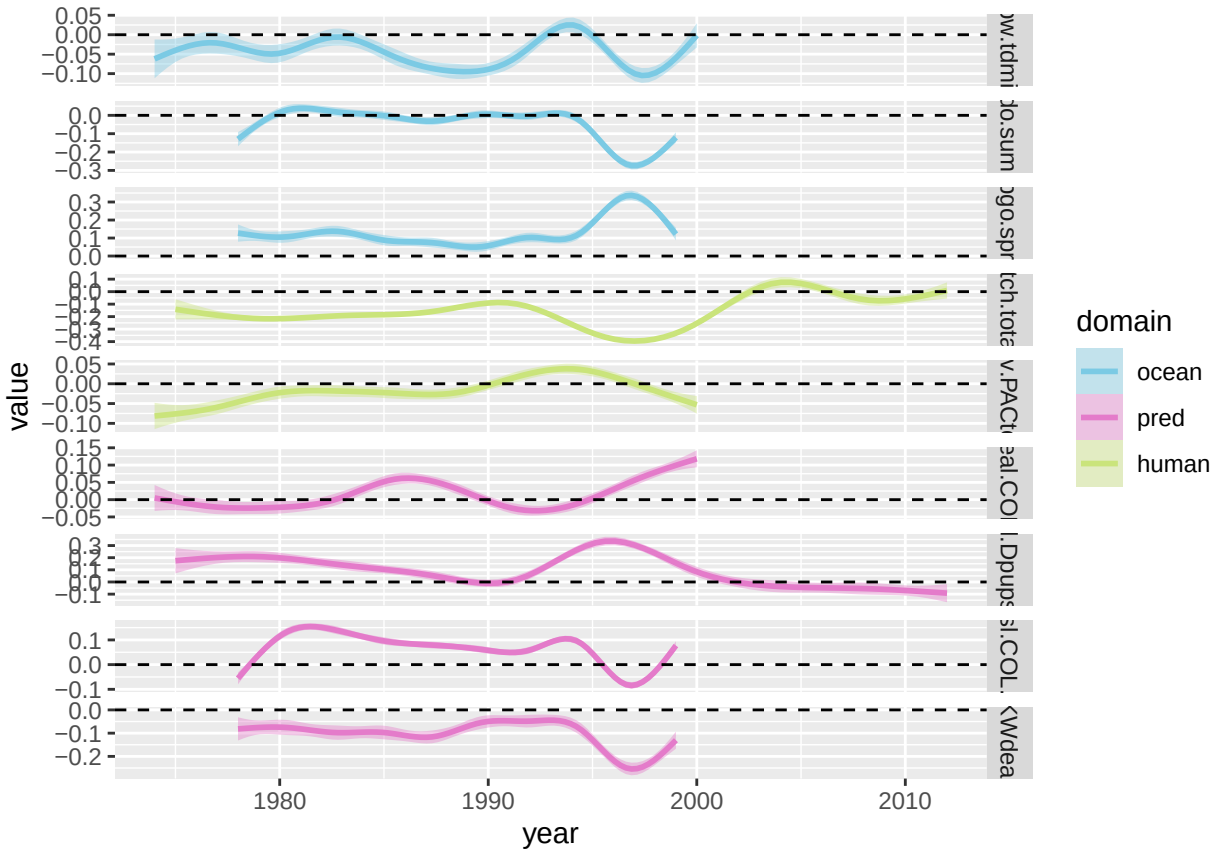


3. How do predator interaction strengths (and vars from other domains) vary through time?

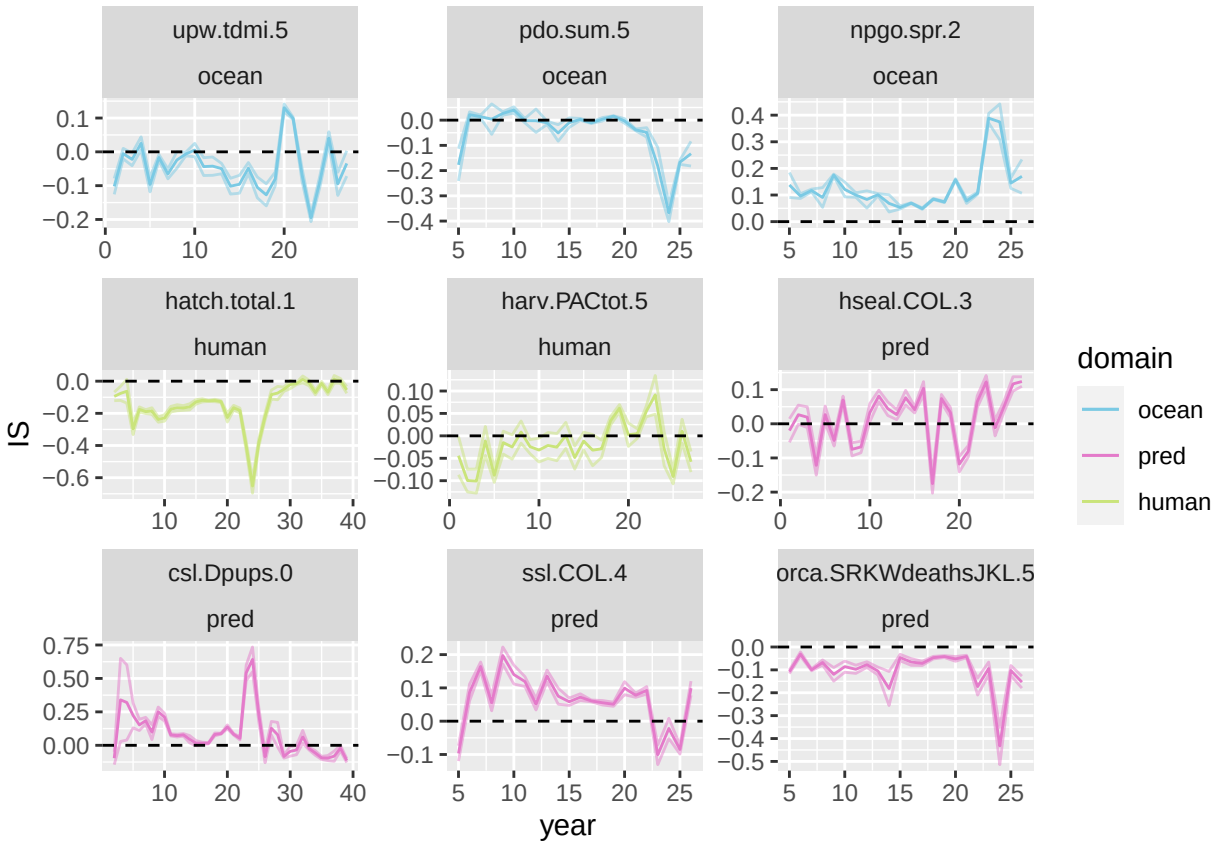
Times series of partial Derivatives, averaged across stocks, for each var

```
ggplot(rec4_UPS, aes(x = year, y = value, fill = domain, color = domain)) +
  geom_smooth() +
  scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
    geom_hline(aes(yintercept = 0),
               linetype = "dashed") +
  facet_grid(FP ~ ., scales = "free")
```

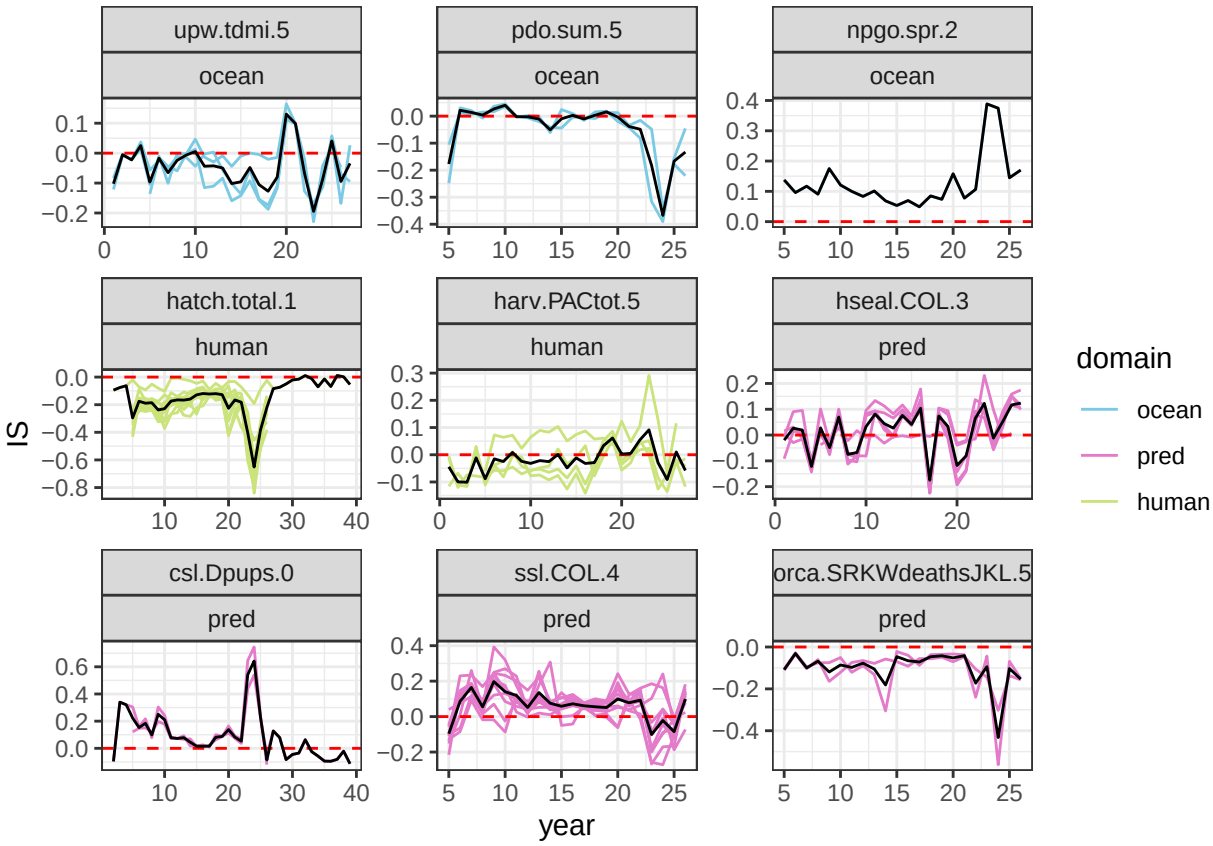
```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
rec4_UPS_ts <- rec4_UPS %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP) %>%
  mutate(IS = mean(value, na.rm = TRUE),
             sd = sd(value, na.rm = TRUE),
             n = n()) %>%
  mutate(se = sd / sqrt(n),
         lower = IS - qt(1 - (0.05 / 2), n - 1) * se,
         upper = IS + qt(1 - (0.05 / 2), n - 1) * se) %>%
  mutate(year = as.integer(year))

ggplot(rec4_UPS_ts, aes(x = year, color = domain, fill = domain)) +
  geom_line(aes(y = IS)) +
  geom_line(aes(y = upper), alpha = 0.5) +
  geom_line(aes(y = lower), alpha = 0.5) +
  geom_hline(aes(yintercept = 0),
             linetype = "dashed") +
    scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
     facet_wrap(~ FP + domain, scales = "free")
```




```
rec4_UPS_lines <- rec4_UPS %>%
  filter(year > 1957) %>%
  filter(year < 2016) %>%
  mutate(year = factor(year)) %>%
  group_by(year, FP, embedding) %>%
  mutate(IS = mean(value)) %>%
  mutate(year = as.integer(year))


ggplot() +
  geom_line(rec4_UPS_lines, mapping = aes(x=year, y=IS, col=domain, group=embedding)) +
  scale_fill_manual(values = pal) +
  scale_color_manual(values = pal) +
  geom_hline(rec4_UPS_lines, mapping = aes(yintercept = 0),linetype = "dashed", color = "red") +
  geom_line(rec4_UPS_ts, mapping = aes(x=year, y=IS), color = "black") +
  facet_wrap(FP + domain ~ ., scales = "free") +
  theme_bw()
```


upw.tdmi.5
ocean
pdo.sum.5
ocean
npgo.spr.2
ocean
hatch.total.1
human
harv.PACtot.5
human
hseal.COL.3
pred
csl.Dpups.0
pred
ssl.COL.4
pred
orca.SRKWdeathsJKL.5
pred
IS
year
domain
ocean
pred
human

Fin