Mechanism figure: climate change extinctions

March 25th, 2024

```
knitr::opts_chunk$set(echo = TRUE, cache.lazy = FALSE, cache = TRUE)
```

Load libraries and data

```
rm(list = ls())
 root.dir = "C:/Users/mcu08001/Documents/1New Research/CC MetaRisk2/Analysis"
library(ggplot2); library(dplyr); library(ggpubr)

dataP<-read.table("Metarisk2 aggthres 5.txt",header=T);
```

Number of mechanisms

```
dataP$any.mech <- rowSums(dataP[,20:25] == "Y")
cat("maximum number of mechanisms in any study = ", max(dataP$any.mech))

## maximum number of mechanisms in any study =  5

mech.p.time <- dataP %>%
  group_by(Study) %>%
  summarize(Year = max(Year), mech.S = max(any.mech)) %>%
  group_by(Year) %>%
  #summarize(N.mech = sum(as.numeric(any.mech.2)), N.models = n(), P.mech = s
um(as.numeric(any.mech.2))/n()) %>%
  summarize(N.models = n(),
            N.mech.1 = sum(as.numeric(mech.S == 1)),
            N.mech.2 = sum(as.numeric(mech.S == 2)),
            N.mech.3 = sum(as.numeric(mech.S == 3)),
            N.mech.4 = sum(as.numeric(mech.S == 4)),
            N.mech.5 = sum(as.numeric(mech.S == 5))
            ) %>%
  #mutate(cum.mech = cumsum(N.mech), cum.N = cumsum(N.models), cum.P.mech = c
um.mech/cum.N)
  mutate(cum.N = cumsum(N.models),
         cum.N.1 = cumsum(N.mech.1),
         cum.N.2 = cumsum(N.mech.2),
         cum.N.3 = cumsum(N.mech.3),
         cum.N.4 = cumsum(N.mech.4),
         cum.N.5 = cumsum(N.mech.5),
         cum.p.1 = cum.N.1/cum.N,
         cum.p.2 = cum.N.2/cum.N,
         cum.p.3 = cum.N.3/cum.N,
```

```
          cum.p.4 = cum.N.4/cum.N,
          cum.p.5 = cum.N.5/cum.N,
          cum.p.6 = 1-(cum.N.1+cum.N.2+cum.N.3+cum.N.4+cum.N.5)/cum.N
          )
n.mechs = 6; # number of mechanisms
n.times = nrow(mech.p.time)
data.2.plot <- data.frame(Year = rep(mech.p.time$Year,n.mechs),Mechanisms = r
ep(c("1 mechanism","2 mechanisms","3 mechanisms", "4 mechanisms", "5 mechanis
ms","No mechanisms"),each = n.times),
                          Proportions = c(mech.p.time$cum.p.1,mech.p.time$cum
.p.2,mech.p.time$cum.p.3,mech.p.time$cum.p.4,mech.p.time$cum.p.5,mech.p.time$
cum.p.6))
data.2.plot$Mechanisms <- factor(data.2.plot$Mechanisms, levels=c("No mechani
sms","5 mechanisms","4 mechanisms", "3 mechanisms","2 mechanisms","1 mechanis
m"))
```

What mechanisms

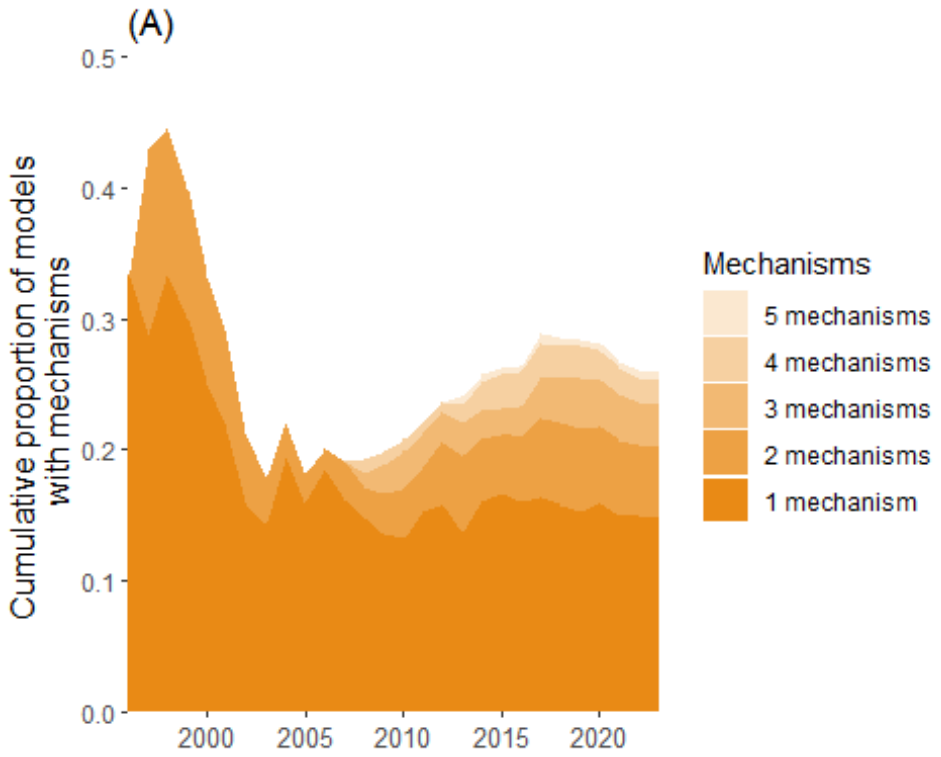
```
mech.time <- dataP %>%
  group_by(Study) %>%
  summarize(Year = max(Year),
            Disp.y = any(Dispersal == "Y"),
            Sp.int.y = any(Sp.int == "Y"),
            phys.y = any(Physiology == "Y"),
            Adaptation.y = any(Adaptation == "Y"),
            Pop.diff.y = any(Pop.diff == "Y"),
            Demo.y = any(Demography.LH == "Y")
            ) %>%
  group_by(Year) %>%
  #summarize(N.mech = sum(as.numeric(any.mech.2)), N.models = n(), P.mech = s
um(as.numeric(any.mech.2))/n()) %>%
  summarize(N.models = sum(Disp.y,Sp.int.y,phys.y,Adaptation.y,Pop.diff.y,Dem
o.y),#n(),
            N.disp = sum(Disp.y),
            N.spint = sum(Sp.int.y),
            N.phys = sum(phys.y),
            N.adapt = sum(Adaptation.y),
            N.pdiff = sum(Pop.diff.y),
            N.demo = sum(Demo.y)
            ) %>%
  #mutate(cum.mech = cumsum(N.mech), cum.N = cumsum(N.models), cum.P.mech = c
um.mech/cum.N)
  mutate(cum.N = cumsum(N.models),
         cum.disp.N.1 = cumsum(N.disp),
         cum.spint.N.1 = cumsum(N.spint),
         cum.phys.N.1 = cumsum(N.phys),
         cum.adapt.N.1 = cumsum(N.adapt),
         cum.pdiff.N.1 = cumsum(N.pdiff),
```

```
          cum.demo.N.1 = cumsum(N.demo),

          cum.disp.p.1 = cum.disp.N.1/cum.N,
          cum.spint.p.1 = cum.spint.N.1/cum.N,
          cum.phys.p.1 = cum.phys.N.1/cum.N,
          cum.adapt.p.1 = cum.adapt.N.1/cum.N,
          cum.pdiff.p.1 = cum.pdiff.N.1/cum.N,
          cum.demo.p.1 = cum.demo.N.1/cum.N
           )

n.mechs = 6; # number of mechanisms
n.times = nrow(mech.time)
data.2.plot.2 <- data.frame(Year = rep(mech.time$Year,n.mechs),
        Mechanisms = rep(c("Dispersal", "Sp. interaction", "Physiology", "Ada
ptation", "Pop. difference", "Demography"),each = n.times),
    Proportions = c(mech.time$cum.disp.p.1, mech.time$cum.spint.p.1, mech.tim
e$cum.phys.p.1, mech.time$cum.adapt.p.1, mech.time$cum.pdiff.p.1, mech.time$c
um.demo.p.1))

data.2.plot.2$Mechanisms <- factor(data.2.plot.2$Mechanisms, levels=c("Adapta
tion","Pop. difference","Demography","Dispersal","Sp. interaction","Physiolog
y"))
```

Create figures

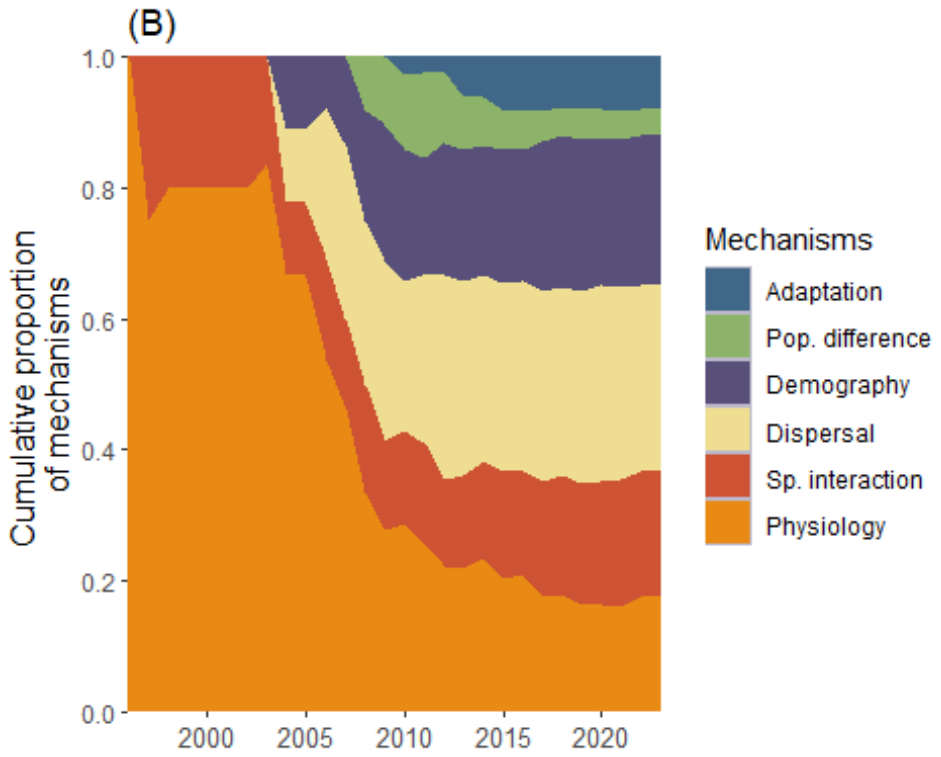
```
Fig5a <- ggplot(data.2.plot, aes(x = as.numeric(Year), y = Proportions, fill
= Mechanisms)) +
  geom_area() +
  #ylim(0,.5) + xlim(1995,2023) +
  scale_fill_manual(values = c("#fbe8d0","#f6d0a1","#f2b973","#eda144","#e98a
15")) +
    scale_x_continuous(limits = c(1996,2023), expand = c(0, 0)) +
  scale_y_continuous(limits = c(0,.5), expand = c(0, 0),breaks = seq(0,.5,.1)
) +
    theme(axis.title.y=element_text(size=12), axis.title.x=element_blank(), a
xis.text.x = element_text(size = 10),panel.grid.major = element_blank(), pane
l.grid.minor = element_blank(),panel.background = element_rect(fill = "white"
)) +
  #geom_text(aes(label = "No mechanisms"),x = 0,y = 0, size = 12) +
  ggtitle("(A)") +
  labs(y = "Cumulative proportion of models \n with mechanisms")
Fig5a
```

```
## Warning: Removed 40 rows containing non-finite outside the scale range
## (`stat_align()`).
```

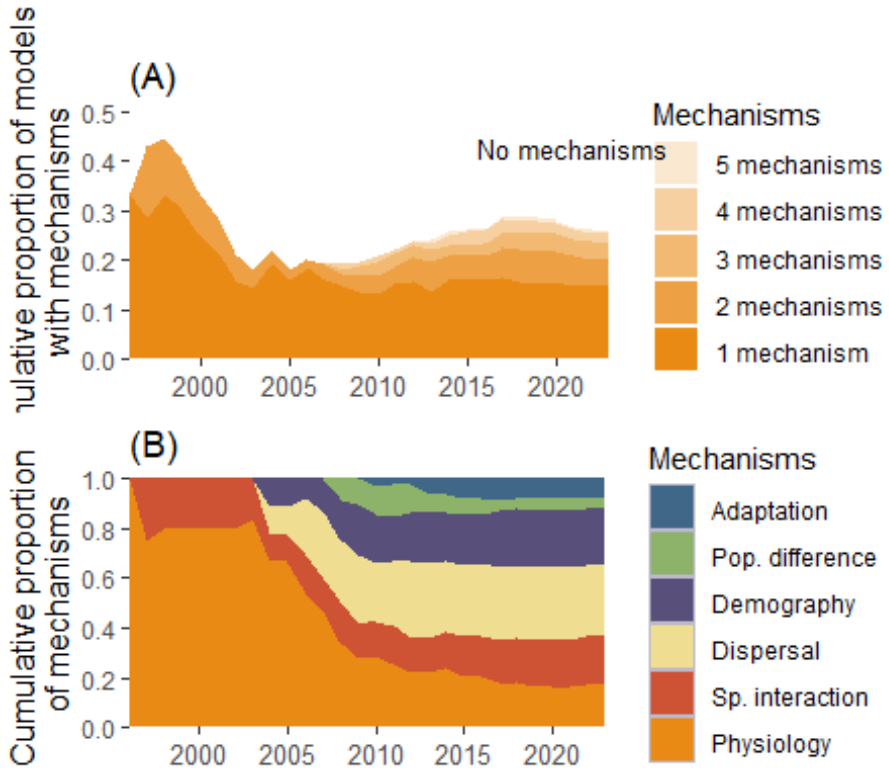



```
#"#bcb9ca"
Fig5b <- ggplot(data.2.plot.2, aes(x = as.numeric(Year), y = Proportions, fil
l = Mechanisms)) +
  geom_area() +
      scale_x_continuous(limits = c(1996,2023), expand = c(0, 0)) +
  scale_y_continuous(limits = c(0,1), expand = c(0, 0), breaks = seq(0,1,.2))
+
  scale_fill_manual(values = c("Adaptation" ="#416788","Pop. difference" ="#8
cb369","Demography" = "#58507A","Dispersal" = "#EFDE92","Sp. interaction" = "
#CD5334","Physiology" = "#e98a15"),
    limits = c("Adaptation","Pop. difference","Demography","Dispersal", "Sp.
interaction","Physiology")) +
    theme(axis.title.y=element_text(size=12), axis.title.x=element_blank(), a
xis.text.x = element_text(size = 10),panel.background = element_rect(fill = "
#bcb9ca"),panel.grid.major = element_blank(), panel.grid.minor = element_blan
k()) + ggtitle("(B)") +
  labs(y = "Cumulative proportion \n of mechanisms ")

Fig5b
```

```
## Warning: Removed 12 rows containing non-finite outside the scale range
## (`stat_align()`).
```




```
Fig5all <- ggarrange(Fig5a, NULL, Fig5b, NULL, ncol = 2, nrow=2, heights = c(
4,4,4,4), widths = c(6,.4,6,.05))

## Warning: Removed 40 rows containing non-finite outside the scale range
## (`stat_align()`).

## Warning: Removed 12 rows containing non-finite outside the scale range
## (`stat_align()`).

annotate_figure(Fig5all,
                top = text_grob("No mechanisms",size = 10,vjust = 6,hjust = 0
),
                fig.lab.pos = "top.right")
```




```
#
#ggsave("Metarisk2 mechanisms.png",width=8,height=6,unit="in",dpi="print")
```