Bycatch Estimation and Expansion in STAN

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Load library

```
require(devtools)
#devtools::install_github("eric-ward/bycatch")
library(bycatch)
```

Load data

```
# replace this with your own data frame
d = data.frame("Year"= 2002:2014,
  "Takes" = c(0, 0, 0, 0, 0, 0, 0, 0, 1, 3, 0, 0, 0),
  "expansionRate" = c(24, 22, 14, 32, 28, 25, 30,  7, 26, 21, 22, 23, 27),
  "Sets" = c(391, 340, 330, 660, 470, 500, 330, 287, 756, 673, 532, 351, 486))
```

Fit model

```
fit = bycatch_expansion(time = d[,"Year"], events = d[,"Takes"],
  effort = d[,"Sets"], coverage = d[,"expansionRate"])
```

Make plots

```
plot_expanded(fit, xlab="Year", ylab = "Fleet-level bycatch")
```

Make table of expanded bycatch estimates

```
df = data.frame("time" = d[,"Year"],
  "mean" = apply(fit$expanded_estimates, 2, mean),
  "median" = apply(fit$expanded_estimates, 2, quantile, 0.5),
  "lower95" = apply(fit$expanded_estimates, 2, quantile, 0.025),
  "upper95" = apply(fit$expanded_estimates, 2, quantile, 0.975))

write.table(df, "estimated_bycatch.csv", row.names=F, col.names=T, sep=",")
```

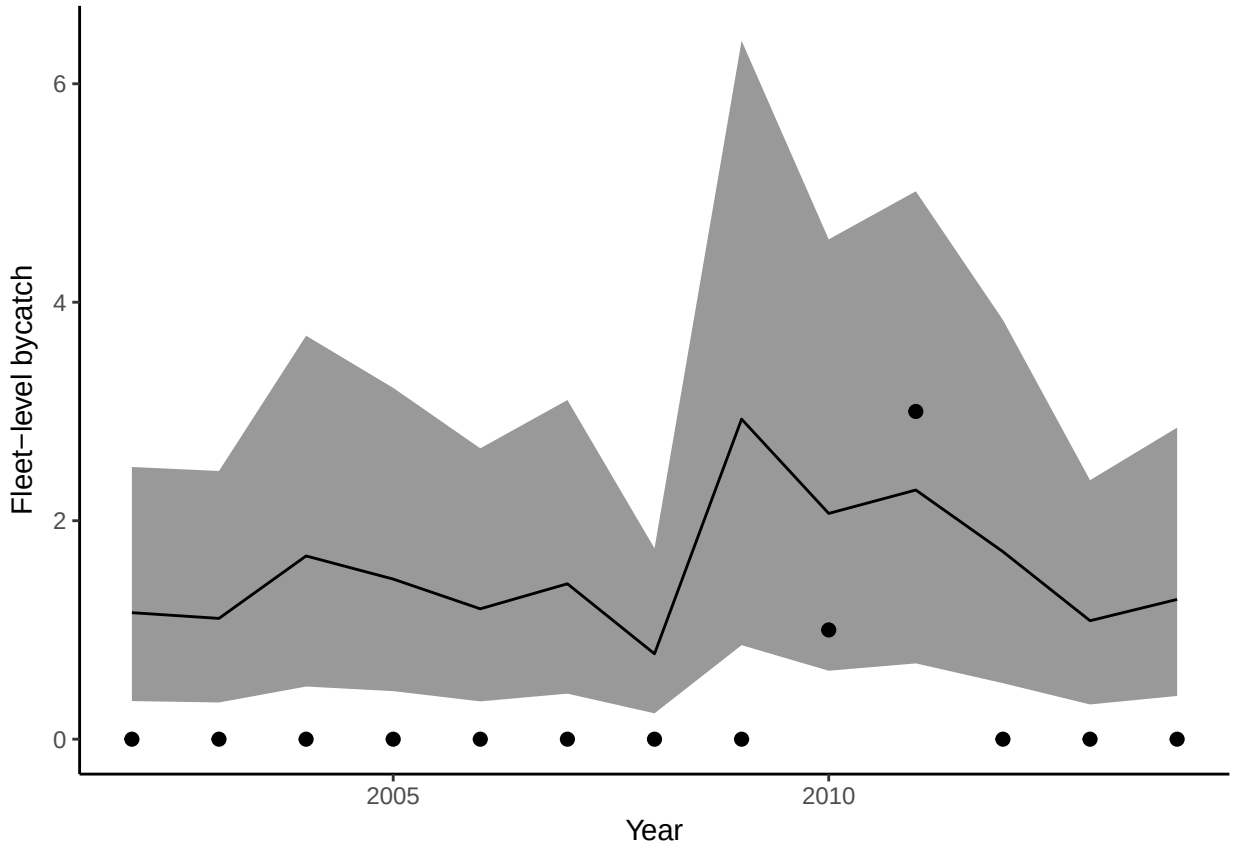

Figure 1: Estimated fleet-level expanded bycatch, incorporating data on takes, effort, and observer coverage. Dots represent observed bycatch events.

Example with covariates

Following Martin et al. 2015 we can include fixed or continuous covariates. This needs to be passed in as a design matrix, so using `model.matrix()` is one easy way to do this.

For example, to add a continuous and indictor covariate to the example above, we can pass in the matrix `covar`,

```
covar = cbind(1, rnorm(nrow(d)), c(rep(0,5), rep(1, nrow(d)-5)))
colnames(covar) = c("intercept","predictor","factor")
print(covar)
```

```
##       intercept  predictor factor
##  [1,]         1  1.2984722      0
##  [2,]         1 -0.7554475      0
##  [3,]         1  0.3133845      0
##  [4,]         1  0.3021499      0
##  [5,]         1 -0.7793519      0
##  [6,]         1  0.3121021      1
##  [7,]         1  0.7209901      1
##  [8,]         1 -1.2765082      1
##  [9,]         1  1.0691644      1
## [10,]         1 -1.1765097      1
## [11,]         1  0.8324918      1
## [12,]         1  0.2038970      1
## [13,]         1  0.5376143      1
```

```
fit = bycatch_expansion(time = d[,"Year"], events = d[,"Takes"],
  effort = d[,"Sets"], coverage = d[,"expansionRate"], covar = covar)
```