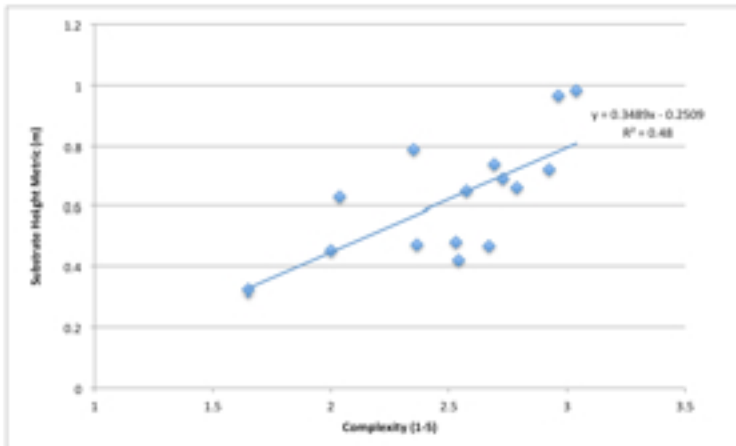
1.2
1
0.8
0.6
0.4
0.2
0
1
1.5
2
2.5
3
3.5
Substrate Height Metric (m)
Complexity (1-5)
y = 0.3489x - 0.2509
R² = 0.48

REGION	ISLAND	N	Hard Coral (%)	Substrate Height (m)	Fish Biomass (gm^{-2}) By Consumer Group and Combined				
					PRIMARY	SECONDARY	PLANKTIVORE	PISCIVORE	ALL FISH
N. Mariana	Farallon de Pajaros	12	21.0 ± 3.0	0.79 ± 0.06	15.7 ± 2.9	8.2 ± 2.4	13.3 ± 3.2	12.4 ± 3.4	49.7 ± 7.2
	Maug	30	35.1 ± 3.0	0.58 ± 0.06	16.2 ± 1.9	4.1 ± 0.6	7.5 ± 2.2	9.1 ± 3.3	36.9 ± 5.9
	Asuncion	20	18.0 ± 2.8	0.70 ± 0.05	16.1 ± 3.0	5.1 ± 0.7	6.9 ± 1.8	9.3 ± 2.7	37.3 ± 6.7
	Agrihan	20	15.9 ± 2.4	0.65 ± 0.06	17.3 ± 3.4	5.9 ± 0.8	14.7 ± 7.2	9.4 ± 2.5	47.3 ± 9.2
	Pagan	29	15.4 ± 2.5	0.68 ± 0.06	13.7 ± 1.7	4.4 ± 0.6	5.9 ± 1.2	5.4 ± 1.1	29.5 ± 3.2
	Sarigan-Guguan-Alamagan	24	22.4 ± 2.8	0.62 ± 0.05	16.1 ± 3.7	7.8 ± 0.7	6.9 ± 2.6	6.9 ± 0.8	37.8 ± 4.7
S. Mariana	Saipan	30	14.5 ± 1.9	0.35 ± 0.05	5.6 ± 1.0	2.9 ± 0/5	1.7 ± 0.2	0.6 ± 0.1	10.7 ± 1.4
	Tinian	19	18.2 ± 3.7	0.37 ± 0.05	7.0 ± 1.3	5.1 ± 1.5	2.7 ± 0.4	1.7 ± 0.7	16.5 ± 2.8
	Aguijan	13	22.8 ± 2.5	0.46 ± 0.08	11.8 ± 2.9	3.9 ± 0.4	2.8 ± 0.6	1.6 ± 0.3	20.0 ± 3.5
	Rota	24	19.5 ± 6.2	0.49 ± 0.09	8.0 ± 1.8	3.5 ± 0.7	1.0 ± 0.2	0.9 ± 0.3	13.3 ± 2.5
	Guam	86	23.0 ± 1.8	0.50 ± 0.03	10.0 ± 0.8	4.3 ± 0.4	2.1 ± 0.2	1.5 ± 0.2	18.0 ± 1.2
NWHI	Kure	30	15.2 ± 1.8	0.64 ± 0.05	19.0 ± 2.9	11.1 ± 1.3	4.2 ± 0.9	5.7 ± 2.8	39.9 ± 4.9
	Midway	17	2.9 ± 0.5	0.65 ± 0.07	48.6 ± 18.4	11.9 ± 1.7	6.3 ± 2.4	6.6 ± 2.3	73.5 ± 19.6
	Pearl & Hermes	48	9.3 ± 1.5	0.68 ± 0.06	12.5 ± 1.5	9.4 ± 1.7	4.1 ± 1.0	5.0 ± 1.2	31.0 ± 3.1
	Lisianski	59	37.2 ± 3.6	0.87 ± 0.08	18.0 ± 1.9	8.4 ± 1.6	3.1 ± 1.5	33.5 ± 22.3	62.9 ± 22.1
	Laysan	23	9.7 ± 2.0	0.40 ± 0.05	12.8 ± 3.1	8.6 ± 2.0	1.3 ± 0.6	13.0 ± 6.2	35.6 ± 6.9
	Maro	21	32.5 ± 5.1	0.63 ± 0.07	21.6 ± 5.5	5.6 ± 0.9	5.7 ± 2.5	9.6 ± 4.6	42.4 ± 7.5
	French Frigate	18	32.8 ± 6.8	0.46 ± 0.06	12.7 ± 2.4	9.3 ± 2.8	5.6 ± 2.5	5.9 ± 1.6	33.5 ± 6.5
MHI	Kauai	63	6.4 ± 0.6	0.32 ± 0.03	6.1 ± 0.9	6.2 ± 0.8	2.4 ± 0.6	1.6 ± 0.4	16.3 ± 1.9
	Niihau	41	3.1 ± 0.4	0.46 ± 0.06	19.7 ± 4.9	12.0 ± 3.1	2.8 ± 1.0	6.1 ± 1.1	40.4 ± 7.3
	Oahu	139	10.7 ± 0.8	0.29 ± 0.02	3.4 ± 0.4	3.6 ± 0.3	0.9 ± 0.2	0.3 ± 0.1	8.3 ± 0.7
	Molokai	99	22.0 ± 2.2	0.49 ± 0.04	13.1 ± 2.1	5.3 ± 0.6	1.5 ± 0.3	1.7 ± 0.4	21.6 ± 2.5
	Lanai	74	23.1 ± 2.6	0.50 ± 0.03	8.9 ± 1.0	4.4 ± 0.5	3.3 ± 0.6	3.4 ± 0,9	19.9 ± 1.8
	Maui	113	18.6 ± 1.3	0.64 ± 0.04	9.7 ± 1.3	5.6 ± 0.7	2.0 ± 0.3	1.4 ± 0.2	18.6 ± 1.6
	Hawaii	101	23.9 ± 1.3	0.65 ± 0.03	10.6 ± 0.9	5.5 ± 0.5	3.0 ± 0.6	2.1 ± 0.4	21.2 ± 1.7
PRIA	Wake	30	24.1 ± 2.2	0.69 ± 0.04	21.3 ± 1.9	4.1 ± 0.5	6.3 ± 2.0	3.4 ± 0.5	35.1 ± 3.5
	Johnston	17	12.2 ± 2.7	0.64 ± 0.12	25.1 ± 5.4	3.7 ± 0.7	17.1 ± 3.1	4.7 ± 1.6	50.6 ± 9.0
	Kingman	45	30.8 ± 1.8	0.50 ± 0.02	28.7 ± 13.6	12.6 ± 2.2	44.0 ± 10.4	44.3 ± 4.2	129.6 ± 18.3
	Palmyra	80	24.6 ± 1.3	0.55 ± 0.03	43.0 ± 12.1	20.4 ± 4.1	28.2 ± 9.1	25.2 ± 3.4	116.8 ± 17.3
	Howland	55	34.4 ± 2.5	0.68 ± 0.03	15.9 ± 2.4	10.8 ± 1.6	22.1 ± 4.1	15.5 ± 1.4	64.3 ± 5.9
	Baker	45	32.9 ± 3.3	0.67 ± 0.06	18.5 ± 3.9	6.0 ± 0.8	14.2 ± 1.9	17.3 ± 4.8	55.7 ± 7.3
	Jarvis	72	20.4 ± 1.3	0.55 ± 0.03	34.4 ± 3.4	13.7 ± 2.4	28.9 ± 4.6	27.3 ± 3.8	104.2 ± 8.8
Am. Samoa	Swains	62	38.4 ± 3.0	0.92 ± 0.09	8.8 ± 1.8	4.1 ± 0.6	10.4 ± 1.1	3.8 ± 0.4	27.1 ± 2.3
	Ofu & Olosega	60	24.7 ± 1.5	0.71 ± 0.06	26.1 ± 2.4	8.5 ± 1.4	6.4 ± 1.2	4.4 ± 0.9	45.4 ± 4.5
	Tau	46	22.3 ± 1.9	0.55 ± 0.07	17.4 ± 1.8	6.8 ± 1.2	4.5 ± 1.0	2.4 ± 0.3	31.1 ± 3.3
	Tutuila	212	21.8 ± 1.0	0.70 ± 0.03	13.9 ± 0.6	3.6 ± 0.3	6.0 ± 0.9	1.9 ± 0.4	25.5 ± 1.5
	Rose	57	18.6 ± 1.8	0.74 ± 0.05	14.7 ± 1.4	3.1 ± 0.3	6.3 ± 0.8	6.0 ± 0.9	30.1 ± 2.3

REGION	ISLAND	SURVEY BIOMASS (mean ± SE, g m^{-2})	PREDICTED BIOMASS (mean ± SE, g m^{-2})	DIFFERENCE (ACTUAL relative to PREDICTED)
N. Mariana	Farallon de Pajaros	49.7 ± 7.2	50.4 ± 5.6	-1%
	Maug	36.9 ± 5.9	38.5 ± 5.4	-4%
	Asuncion	37.3 ± 6.7	41.7 ± 4.4	-11%
	Agrihan	47.3 ± 9.2	37.0 ± 4.0	28%
	Pagan	29.5 ± 3.2	36.7 ± 4.1	-20%
	Sarigan-Guguan-Alamagan	37.8 ± 4.7	53.5 ± 6.2	-29%
S. Mariana	Saipan	10.7 ± 1.4	35.2 ± 4.6	-69%
	Tinian	16.5 ± 2.8	42.1 ± 5.3	-61%
	Aguijan	20.0 ± 3.5	52.8 ± 6.8	-62%
	Rota	13.3 ± 2.5	43.6 ± 5.3	-69%
	Guam	18.0 ± 1.2	52.6 ± 6.8	-66%
NWHI	Kure	39.9 ± 4.9	45.2 ± 5.8	-12%
	Midway	73.5 ± 19.6	57.2 ± 10.9	29%
	Pearl & Hermes	31.0 ± 3.1	46.5 ± 6.2	-33%
	Lisianski	62.9 ± 22.1	43.5 ± 6.9	45%
	Laysan	35.6 ± 6.9	37.6 ± 4.6	-5%
	Maro	42.4 ± 7.5	59.9 ± 7.3	-29%
	French Frigate	33.5 ± 6.5	54.5 ± 7.0	-39%
MHI	Kauai	16.3 ± 1.9	45.3 ± 6.3	-64%
	Niihau	40.4 ± 7.3	50.2 ± 9.7	-20%
	Oahu	8.3 ± 0.7	37.8 ± 5.0	-78%
	Molokai	21.6 ± 2.5	64.9 ± 7.9	-67%
	Lanai	19.9 ± 1.8	65.7 ± 7.8	-70%
	Maui	18.6 ± 1.6	50.8 ± 5.5	-63%
	Hawaii	21.2 ± 1.7	62.0 ± 6.9	-66%
PRIA	Wake	35.1 ± 3.5	56.9 ± 7.0	-38%
	Johnston	50.6 ± 9.0	34.9 ± 4.2	45%
	Kingman	129.6 ± 18.3	72.6 ± 9.8	79%
	Palmyra	116.8 ± 17.3	84.1 ± 12.5	39%
	Howland	64.3 ± 5.9	74.5 ± 10.9	-14%
	Baker	55.7 ± 7.3	82.7 ± 12.6	-33%
	Jarvis	104.2 ± 8.8	99.0 ± 20.3	5%
Am. Samoa	Swains	27.1 ± 2.3	34.0 ± 6.8	-20%
	Ofu & Olosega	45.4 ± 4.5	57.5 ± 7.2	-21%
	Tau	31.1 ± 3.3	54.1 ± 6.5	-42%
	Tutuila	25.5 ± 1.5	57.5 ± 6.9	-56%
	Rose	30.1 ± 2.3	44.5 ± 5.0	-32%

Williams et al. 2015 Human, oceanographic and habitat drivers of Central and Western Pacific Coral Reef Fish Assemblages

==

This is the R code used to run the analysis in the paper.

```
rm(list=ls())   # clean workspace
library(MuMIn)  # needed for model averaging
library(mgcv)   # needed for GAM
load(file="WilliamsetalPLosSONE2015.rdata") # reads in dataset z
```

Explanation of dataframe variables

- REGION, ISLAND .. region and island names (e.g. "MHI" and"Oahu")
- PRIM Biomass (g/m2) of Primary Consumers
- SECO Biomass (g/m2) of Secondary Consumers
- PLNK Biomass (g/m2) of Planktivores
- PISC_noSJ Biomass (g/m2) of piscivores, excluding sharks and jacks
- ALLF_noSJ Biomass (g/m2) of all fishes, excluding sharks and jacks
- HC Visually estimated Hard Coral Cover (%)
- CX Visually estiamted mean substrate height within survey cylinders (m)
- CHL Oceanic productivity, i.e. long-term mean of satelitte derived Chl-a of waters surrounding the reef areas
- SSTL Climatological low sea surface temperature, satelitte derived
- HUM Square-root transformed human population density per reef area (ie humans rsident ont he island divided by area of forereef)
- HDIST Square-root transformed 'distant' human population per reef area (i.e. humans living within 200km of the site but not resident on the island, divided by the area of forereef)
- AT Atoll? (True/False)
- WV Long-term mean estimated island-scale wave energy

MuMIn routines to generate and rank all possible models, and to model average the selected models

```
MXPARAMS<-7  # maximum # of parameters in the model
BASE_K<-5    # limit to number of knots

##### Example code for ALLF_noSJ
z$BIO<-z$ALLF_noSJ

#define full model
M1<-gam(BIO ~ s(CX, k=BASE_K)
        + s(CHL, k=BASE_K)
        + s(HC, k=BASE_K)
        + s(HUM, k=BASE_K)
        + s(HDIST, k=BASE_K)
        + s(SSTL, k=BASE_K)
        + s(WV, k=BASE_K)
```

```
        + AT,
        data=z, family=Gamma(link=log))

# run all possible combinations, but do not include both SSTL and WV in
the same model
options(na.action="na.fail") # prevent fitting models to different data
sets

M.set<-dredge(M1,beta=FALSE, rank="AICc", subset=!(`s(SSTL, k = BASE_K)
`  &&  `s(WV, k = BASE_K)`), m.max=MXPARAMS, extra = alist(AIC, "R^2",
"adjR^2"))

#head(M.set,12) #view top models, and variable importance
#round(importance(M.set),3)

top.models <- get.models(M.set, weight > .05) #select all models with w
eight > 0.05

# use model averaging of all selected top models
M.avg<-model.avg(top.models) # get averaged coefficients
```

Code to generate predictions in absence of humans

A predictor data set is created from the full data set, and set the two human population density variables to 0

```
PD<-z # duplicate dataset
PD$HUM<-0 # set local human population to 0
PD$HDIST<-0 # set distance human population to 0

# run predict function on the averaged mdoel (generated above)
PRED<-predict(M.avg, newdata=PD, se.fit=TRUE, backtransform=FALSE, type
="response")

#generate prediction output data frame
PO<-z[,c("REGION", "ISLAND", "PRIM", "SECO", "PLNK", "PISC_noSJ", "ALLF
_noSJ")]
PO$REGION<-as.character(PO$REGION)
PO$fit<-PRED$fit
PO$se<-PRED$se.fit
```