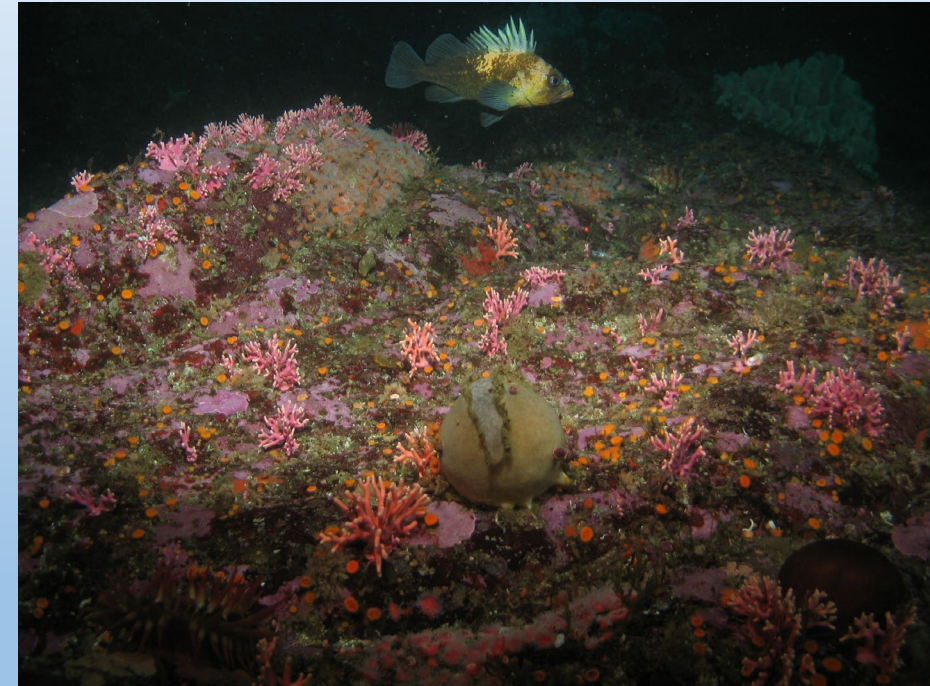


Transect Level ROV Index of Abundance for Quillback Rockfish

Dr. John Budrick, CDFW

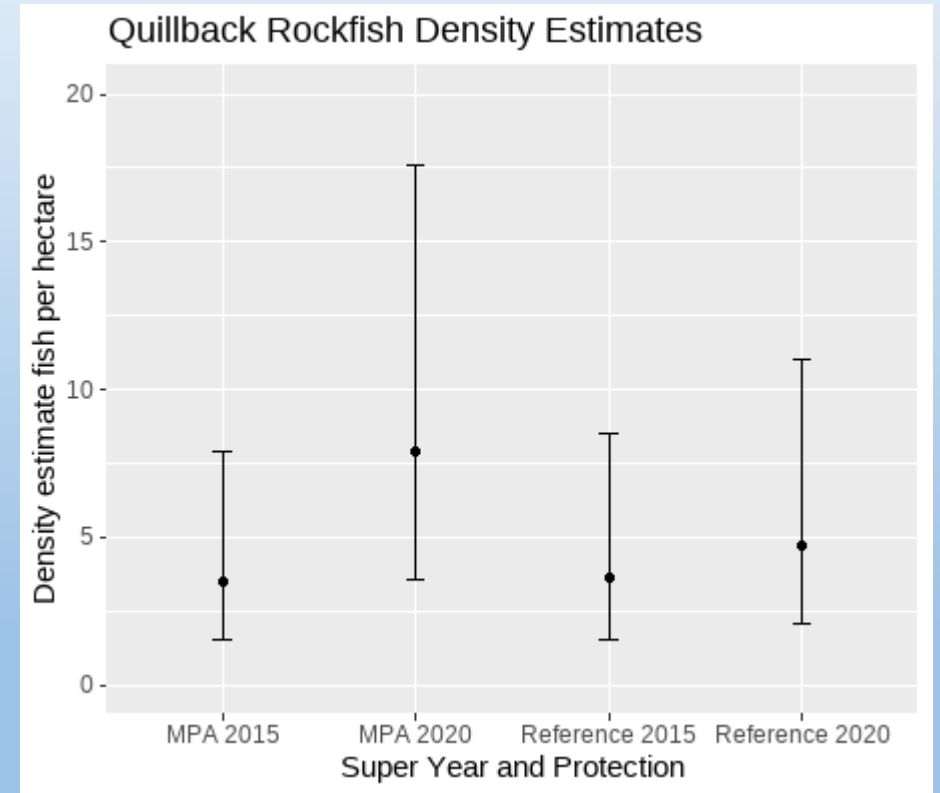
Overview

- Methodology review requested transect level index.
 - Random Site effect selected sites are among many potential sites and sampling proceeds on a randomized basis within a site.
 - Fixed effect might have less variance.
 - Appropriate scale given 8 to 12 km scale of autocorrelation.
- Evaluated methods accounting for MPAs, through an interaction term for super year and protection status since effect of closure varies with time.
- Evaluated alternative model error distributions Negative Binomial and Poisson with random site effect.
- Many error distributions evaluated with a simpler model with same variables.
- Comparison to 10 m segment data set results.



Transect Index for Quillback Rockfish

- New data set from MARE in SQL server can extract multiple resolutions 1 second microframes to full 500 m transect.
- Discussions with NMFS in 2022 for the Copper Rockfish Assessment, preference expressed for transect level data.
- Less resolution, but more independent than 10 m segments spatially.
- Incorporated random effect for Site variable and cross product of protection and super year in a GLMM.
- Evaluated alternative methods of accounting for closed areas.
- Habitat area weighted indices.
- Compared various distributions to the negative binomial.
- Comparison to 10 m results.



Data

- New SQL database produced by MARE
- Full 500 m transect level data set.
- Dependent Variable: Density (Fish per Square Meter)
- Independent variables: Depth, latitude, distance from port, protection status, years since protection, proportion rock, proportion soft, proportion hard, proportion mixed, proportion hard/mixed.
- Differences with protection status and Super Year examined in generating indices.

Super Year	Transects
2014-2016	390
2019-2021	545
Grand Total	935

Super Year	Quillback Rockfish
2014-2016	428
2019-2021	932
Grand Total	1360

Super Year	Usable Distance Observed (m)
2014-2016	198324
2019-2021	257079
Grand Total	455403

Data Filtering Steps

- Removed samples before 2013 to focus on 2015 (2014-2015) and 2020 (2019-2021) Super Years
- Removed sites without data to represent it in both super years
- Removed sites south of Point Conception
- Removed sites deeper than 110 m
- MARE pre filters outliers



Model Overview

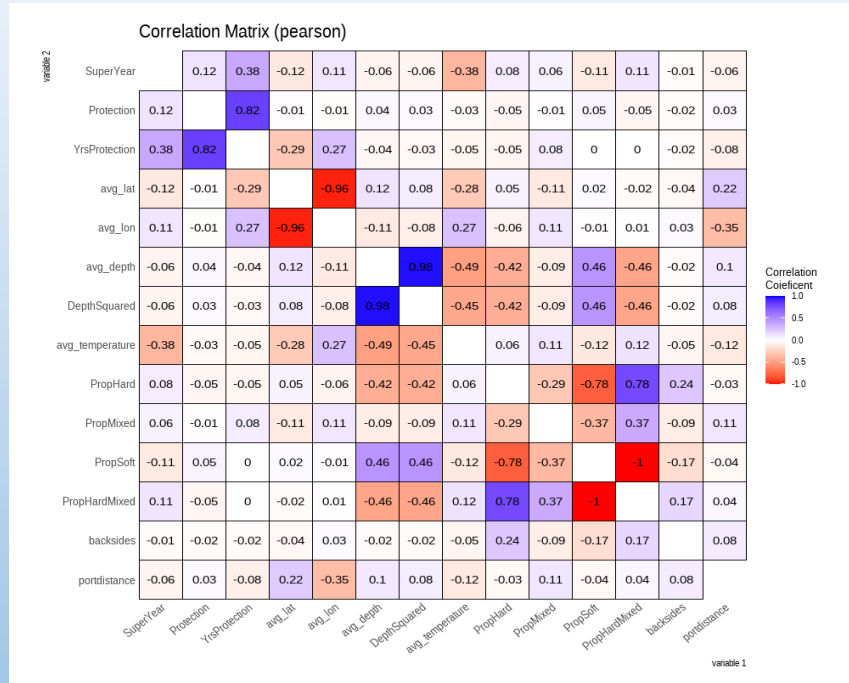
- The log of seafloor area observed included as an “offset” as the denominator of density in the dependent variable (fish/square meter)
- Site level variable random effect
- Generalized linear mixed model (GLMM) fit by maximum likelihood
- Negative binomial error distribution with log link
- Continuous variables were scaled prior to analysis by centering on the mean and dividing by the standard deviation
 - Different scales more comparable
 - Facilitates estimation of index values
- Means and confidence intervals back calculated assuming all other covariates are at the mean value

- Model Selection Criteria
 - Significance of Correlation
 - AIC
 - Deviance
 - QQ Plot
 - Dispersion

Quillback.Rockfish ~ (1 | site) + SuperYear * Protection + PropHardMixed + avg_lat + avg_depth + DepthSquared, data = sc.dat, offset = log(usable_area_fish)

	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	-7.73411	0.38969	-19.847	< 2e-16	***
SuperYear2020	0.29067	0.10672	2.724	0.006455	**
Protection1	-0.09709	0.51964	-0.187	0.851785	
PropHardMixed	0.19075	0.03692	5.166	2.39e-07	***
avg_lat	1.87562	0.29183	6.427	1.30e-10	***
DepthSquared	-0.67173	0.06284	-10.690	< 2e-16	***
SuperYear2020:Protection1	0.54935	0.14170	3.877	0.000106	***
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					

2022 Model: Negative Binomial Distribution



Model 1: Quillback.Rockfish ~ (1 | site) + SuperYear + Protection + PropHard + PropHardMixed + avg_lat + avg_depth + DepthSquared + portdistance + avg_temperature

AIC BIC logLik deviance df.resid
2222.0 2280.1 -1099.0 2198.0 923

Scaled residuals:

Min 1Q Median 3Q Max
-1.3735 -0.4989 -0.1625 -0.0315 11.9623

Random effects:

Groups Name Variance Std.Dev.

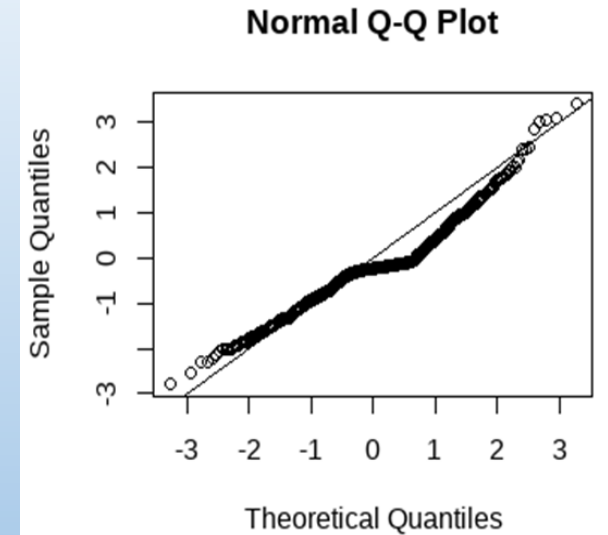
site (Intercept) 1.733 1.317

Number of obs: 935, groups: site, 60

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-8.159809	0.349199	-23.367	< 2e-16 ***
SuperYear2020	0.644395	0.138559	4.651	3.31e-06 ***
Protection1	0.285792	0.426389	0.670	0.5027
PropHard	0.003938	0.080703	0.049	0.9611
PropHardMixed	0.599710	0.100712	5.955	2.61e-09 ***
avg_lat	1.680492	0.243801	6.893	5.47e-12 ***
avg_depth	0.635008	0.110961	5.723	1.05e-08 ***
DepthSquared	-0.597317	0.078369	-7.622	2.50e-14 ***
portdistance	0.417703	0.193175	2.162	0.0306 *
avg_temperature	0.051038	0.085024	0.600	0.5483

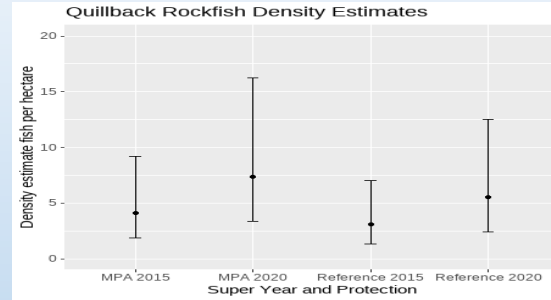
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Modeling Protection

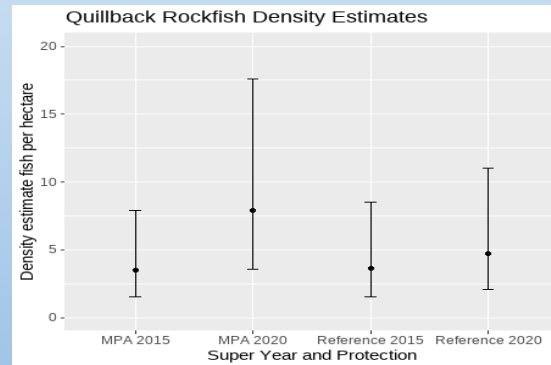
- **Variable:**

Model 2: Quillback.Rockfish ~ (1 | site) + SuperYear + Protection + PropHardMixed + avg_lat + avg_depth + DepthSquared, data = sc.dat, offset = log(usable_area_fish)



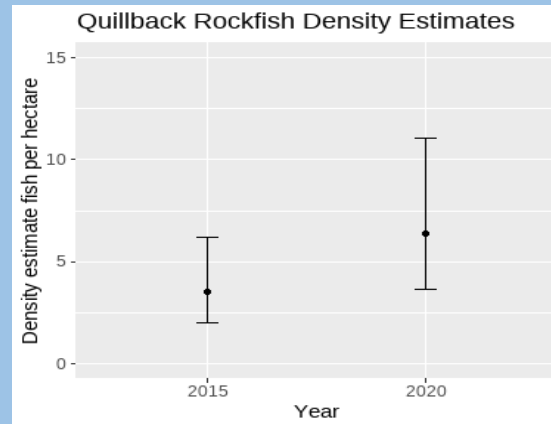
- **Interaction Term:**

Model 3: Quillback.Rockfish ~ (1 | site) + SuperYear * Protection + PropHardMixed + avg_lat + avg_depth + DepthSquared, data = sc.dat, offset = log(usable_area_fish)



- **No accounting:**

Quillback.Rockfish ~ (1 | site) + SuperYear + PropHardMixed + avg_lat + avg_depth + DepthSquared, data = sc.dat, offset = log(usable_area_fish)



Model	2015				2020				Percent Change
	Area	Index	Weight	Index* Weight	Area	Index	Weight	Index*Weight	
2	Open	3.08	0.8	2.46	Open	5.51	0.8	4.41	79.07%
	MPA	4.13	0.2	0.83	MPA	7.39	0.2	1.48	
			Sum	3.29			Sum	5.88	
3	Area	Index	Weight	Index* Weight	Area	Index	Weight	Index*Weight	48.91%
	Open	3.65	0.8	2.92	Open	4.75	0.8	3.80	
	MPA	3.47	0.2	0.69	MPA	7.90	0.2	1.58	
			Sum	3.61			Sum	5.38	
4	Total	3.55		3.55		6.37		6.37	79.34%

Area weighted combined index representing habitat inside (20%) and outside MPAs (80%).

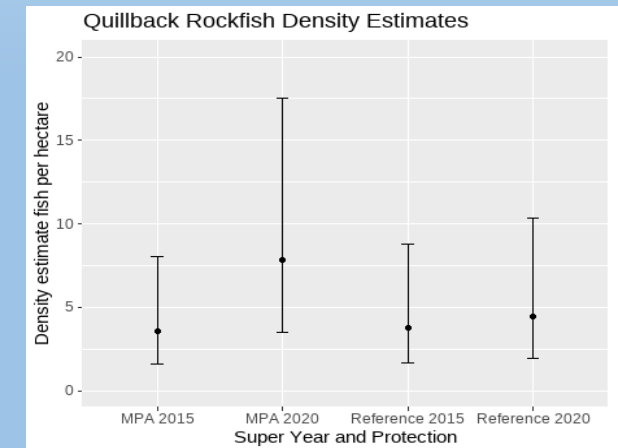
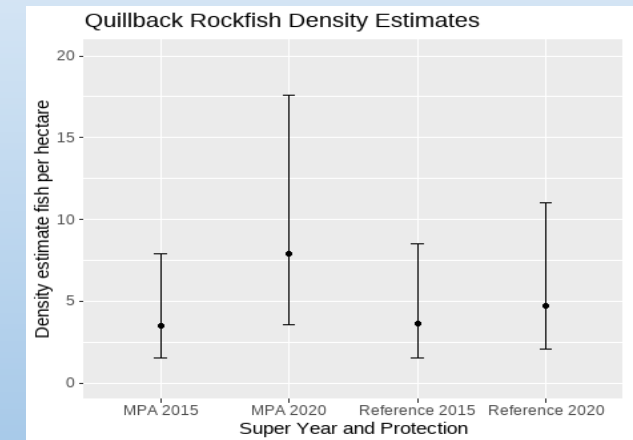
Evaluation of Error Distributions

- Site level random effect

- Negative Binomial
- Poisson

Quillback.Rockfish ~ (1 | site) + SuperYear * Protection + PropHardMixed + avg_lat + avg_depth + DepthSquared, Data: sc.dat, Family: poisson(log), Offset: log(usable_area_fish)

Model	AIC	BIC	Log Likelihood	Deviance	Dispersion
Negative Binomial	2214.1	2262.5	-1101.6	2203.3	0.927
Poisson	2341.1	2384.7	-1161.6	2323.1	1.498

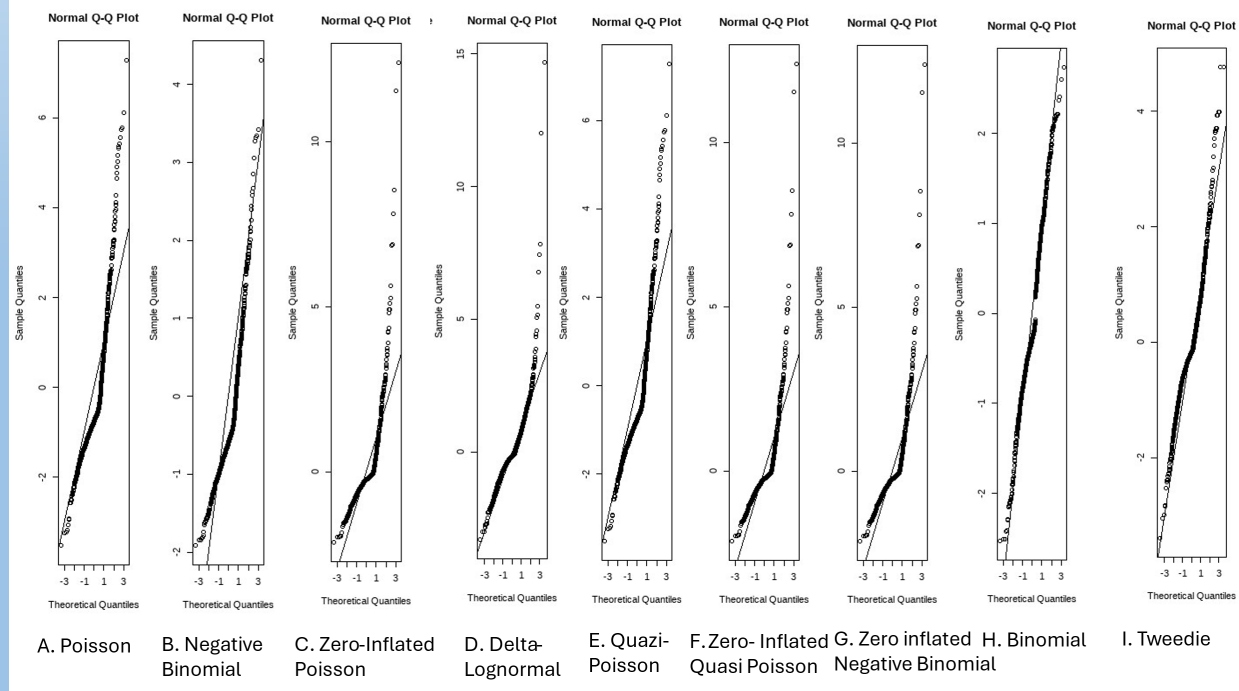


Model	2015				2020				Percent Change
Negative Binomial (Model 3)	Area	Index	Weight	Index* Weight	Area	Index	Weight	Index*Weight	48.91%
	Open	3.65	0.8	2.92	Open	4.75	0.8	3.80	
	MPA	3.47	0.2	0.69	MPA	7.90	0.2	1.58	
			Sum	3.61			Sum	5.38	
Poisson (Model 5)	Area	Index	Weight	Index* Weight	Area	Index	Weight	Index*Weight	37.19%
	Open	3.80	0.8	3.04	Open	4.48	0.8	3.58	
	MPA	3.57	0.2	0.71	MPA	7.85	0.2	1.57	
			Sum	3.76			Sum	5.15	

Evaluation of Distributions

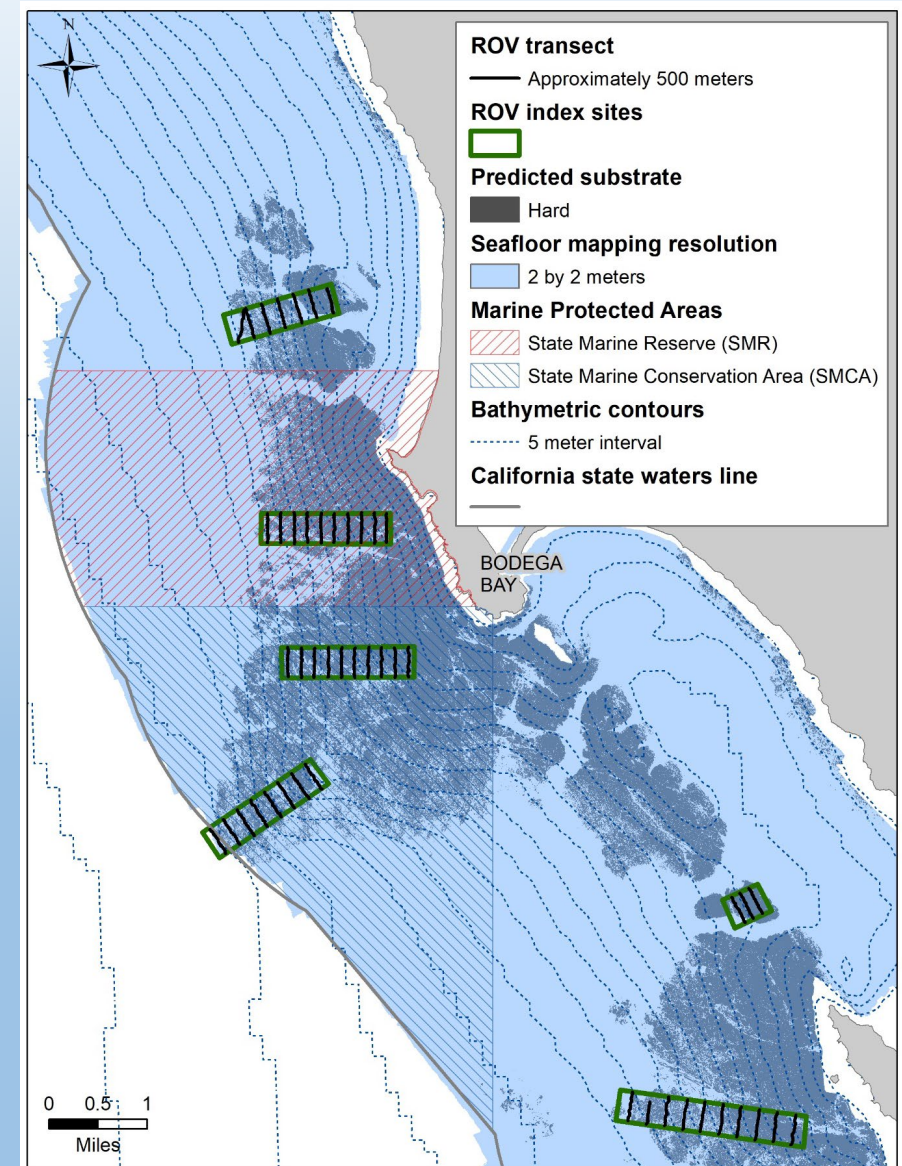
- Simplified Model
 - Quillback.Rockfish ~ SuperYear * Protection + PropHardMixed + avg_lat + avg_depth + DepthSquared, family = X, data = sc.dat, offset = log(sc.dat\$usable_area_fish))

Variable	Poisson	Quasi-Poisson	Zero - Inflated Poisson	Zero-Inflated Quasi-Poisson	Negative Binomial	Zero-Inflated Negative Binomial	Binomial
AIC	3455.6	NA	NA	NA	2869.4	NA	938.5
Dispersion	3.18	3.12	1.42	1.42	0.96	1.42	0.96
Intercept	***	***	***	***	***	***	***
Super Year	***	**	***	***	***	***	***
Protection							
Proportion Hard or Mixed	***	***	**	**	***	**	***
Average Latitude	***	***	**	**	***	**	***
Average Depth	***	***	*	*	***	*	***
Depth Squared	***	***	***	***	***	***	***
Super Year * Protection	***	*	.	.	.	.	



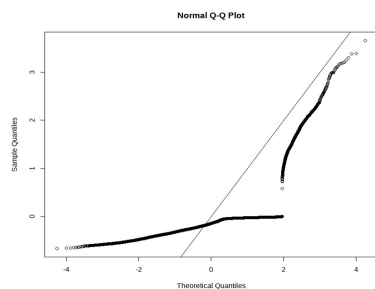
10 m Segment Index

- Finer resolution analysis-correlating density with seafloor characteristics from ROV and CSMP terrain attributes.
- 10 m resolution analysis conducted by Dr. Nick Perkins of University of Tasmania.
 - MPA effects over a longer time-period
 - Analyzed density over a suite of species evaluating MPA vs. Reference
 - Analysis of spatial autocorrelation
- 10 m analysis by CDFW for comparison to transect level analysis for quillback rockfish.

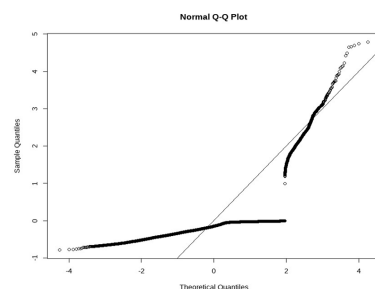


Comparison to 10 m Results

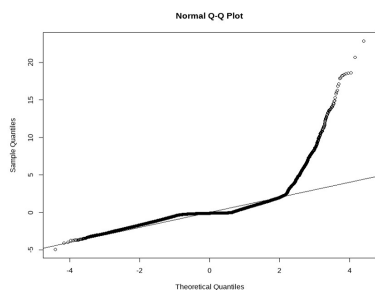
2015				2020				Percent Change
Area	Index	Weight	Index* Weight	Area	Index	Weight	Index*Weight	51.84%
Open	4.38	0.8	3.50	Open	5.85	0.8	4.68	
MPA	3.97	0.2	0.79	MPA	9.20	0.2	1.84	
Sum			4.30	Sum			6.52	



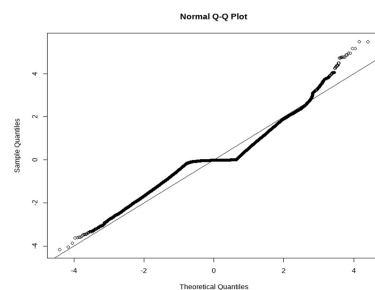
A. Negative Binomial



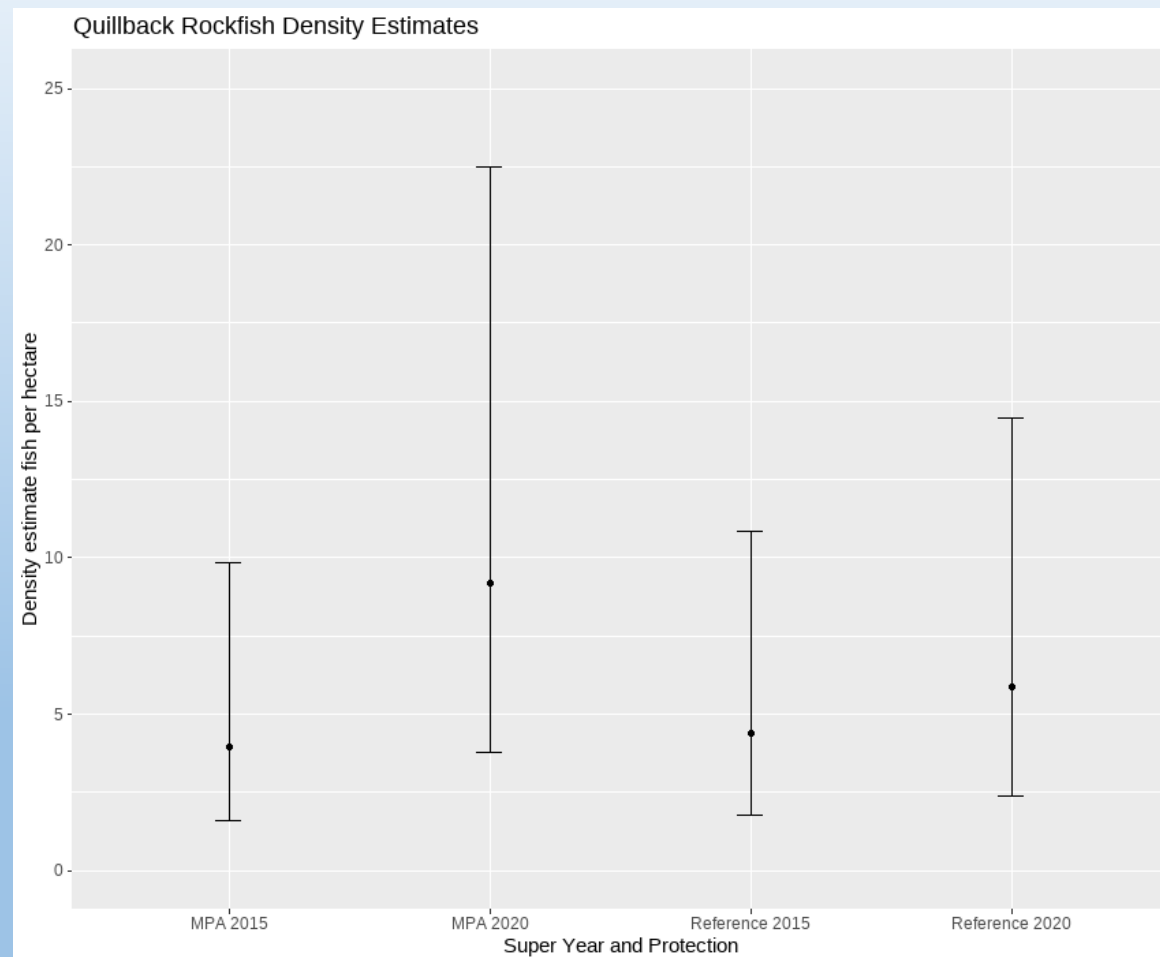
B. Poisson



C. Delta-Lognormal



D. Tweedie



Conclusions

- Negative binomial distribution still preferred
- Site level variable improves the model
- Interaction term for protection and super year
- Transect level preferred to segments for broad scale analysis
- Area weighting for final index
- Consistent results for 10 m and transect
- Recent recruitment apparent in length composition, concomitant increase in encounters

