The relationship of environmental conditions on the catch rates of nearshore fish species along the Central California Coast

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Introduction

The California Collaborative Fisheries Research Program (CCFRP) has been monitoring marine protected areas (MPAs), and their nearby reference (REF) sites using standardized recreational hook and line methods since 2007[1]. One metric calculated from CCFRP data and used to assess fish stocks is catch per unit effort (CPUE). The impact of environmental conditions on the catch rates of nearshore fish species along the Central California Coast may contribute to variability in CPUE calculations. Additionally, angler expertise is often used in collaborative fishing studies to determine fishing location but there has been little examination of angler beliefs about the effect of environmental parameters on catch rates. Many members of the fishing community believe that certain environmental conditions can have a large impact on CPUE. **The purpose of this study is to elucidate contributing environmental factors to the variability in CPUE and test the use of angler expertise in collaborative fisheries projects.** Variation observed in CPUE may be a result of two conditions: fish availability to the gear, and vulnerability to the gear [2]. The CCFRP database was used to examine environmental factors that contribute to the variation in CPUE.

Figure 1a: Identifying, tagging, and measuring fish captured on a CCFRP trip.

Figure 1b: Copper rockfish (*Sebastes caurinus*) captured and released on a CCFRP trip.

Figure 1c: Volunteer anglers using standardized hook-and-line fishing methods.

Methods

Sampling: Data for this analysis were collected over a six year sampling period using standardized recreational hook and line fishing methods aboard commercial passenger fishing vessels in waters less than 120 feet deep (Fig 1). Fished waters included areas in San Mateo, Monterey, and San Luis Obispo Counties and are named: Año Nuevo, Point Lobos, Piedras Blancas, and Point Buchon. Each fishing area was divided into 500m x 500m grid cells. Four grid cells were randomly sampled on each fishing day. Each grid cell was fished for three 15-minute drifts, representing focused fishing in ideal habitat chosen by experienced boat captains (Fig 2). The number of fish caught during each drift was identified and recorded. CPUE was calculated using total fish caught divided by the angler fishing time. Along with CPUE, we also recorded swell height and direction, depth, wind speed and direction, sea surface temperature, cloud cover, relief, and secchi depth for each drift. Each of these factors was calculated as an average value over each drift.
Statistical Analysis: A multiple linear regression was performed using individual and nested (Trip ID[Area, Site]) terms, and tested for the following factors: swell height, swell direction, wind speed, wind direction, depth, sea surface temperature, secchi depth, time of day, month, area (Año Nuevo, Point Lobos, Piedras Blancas, and Point Buchon) and site (MPA/REF). Factors that were found not significant were omitted from the final model (Table 1).
Angler Survey: We created a survey directed towards the local fishing community containing a series of multiple-choice questions. Anglers were asked to provide the best choice for how wind and swell influence fish catch, relative to ideal conditions. Angler responses were calculated as an average for each category (Fig 4).

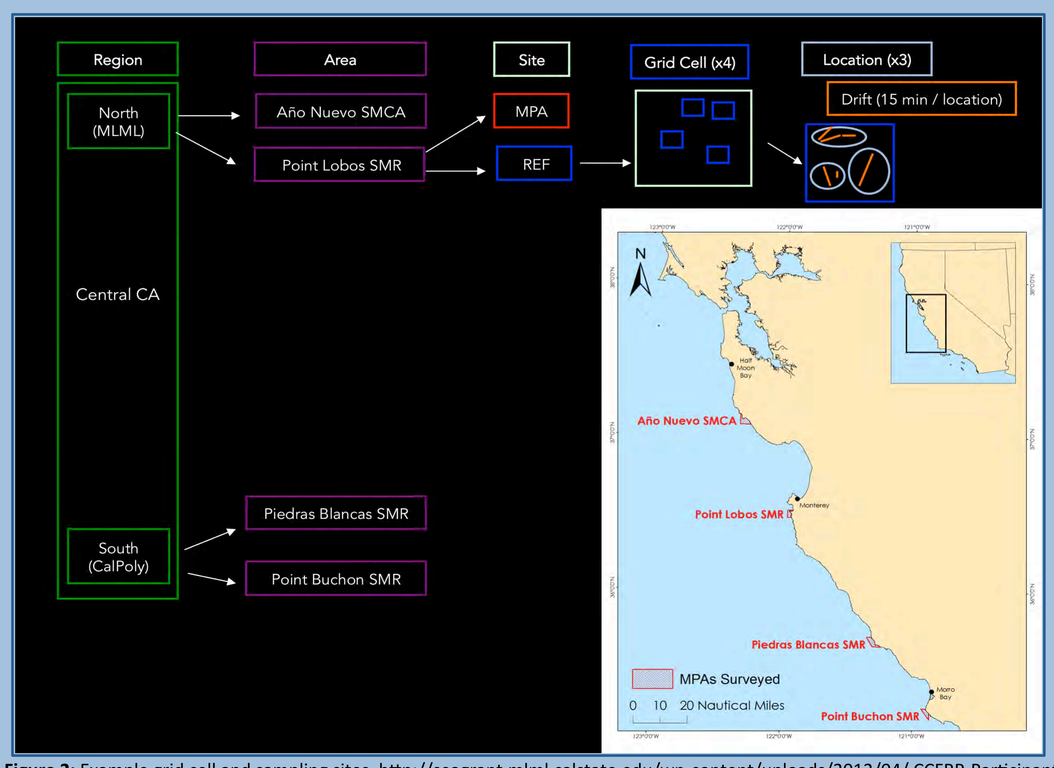

Figure 2: Example grid cell and sampling sites. http://seagrant.mlml.calstate.edu/wp-content/uploads/2012/04/ CCFRP-Participant-Handbook.pdf

Results

Swell height and wind speed were found to have a significant negative relationship with CPUE. The magnitude of effect was found to be different for each sampling location (Fig 5). Sampling month (Month) and fishing location (Area & Site) were also significantly related to CPUE (Table 1).

Table 1: Reduced multiple-regression model examining the effect of environmental variables on CPUE using independent (Area, Site, Month, Obs. Wind Speed, NOAA Wave Height) and nested (TripID[Area, Site]) terms.

Summary of Fit

RSquare	0.363248
RSquare Adj	0.308361
Root Mean Square Error	0.754931
Mean of Response	-2.44743
Observations (or Sum Wgts)	2181

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Area	3	3	23.36186	13.6638	<.0001*
Site (MPA/ REF)	1	1	3.84859	6.7529	0.0094*
Month	3	3	52.75634	30.8559	<.0001*
Obs Wind Speed (kt)	1	1	8.20786	14.4017	0.0002*
NOAA Wave Height (m)	1	1	3.41084	5.9848	0.0145*
Trip ID[Area,Site (MPA/ REF)]	164	164	416.37521	4.4548	<.0001*

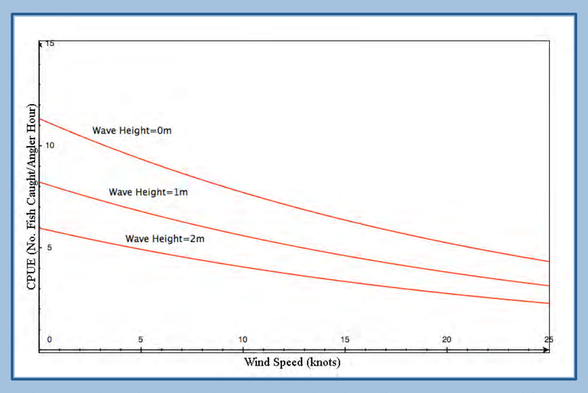

Figure 3: The relationship between wind and swell on CPUE averaged for all four areas. Each line represents the relationship between wind speed (knots) and CPUE for a given swell height (meters).

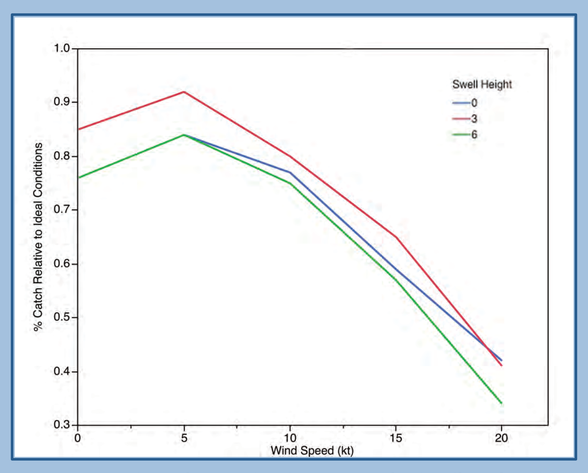

Figure 4: Mean lines of reported angler responses for the effect of wind speed (knots) and swell height (meters) on CPUE.

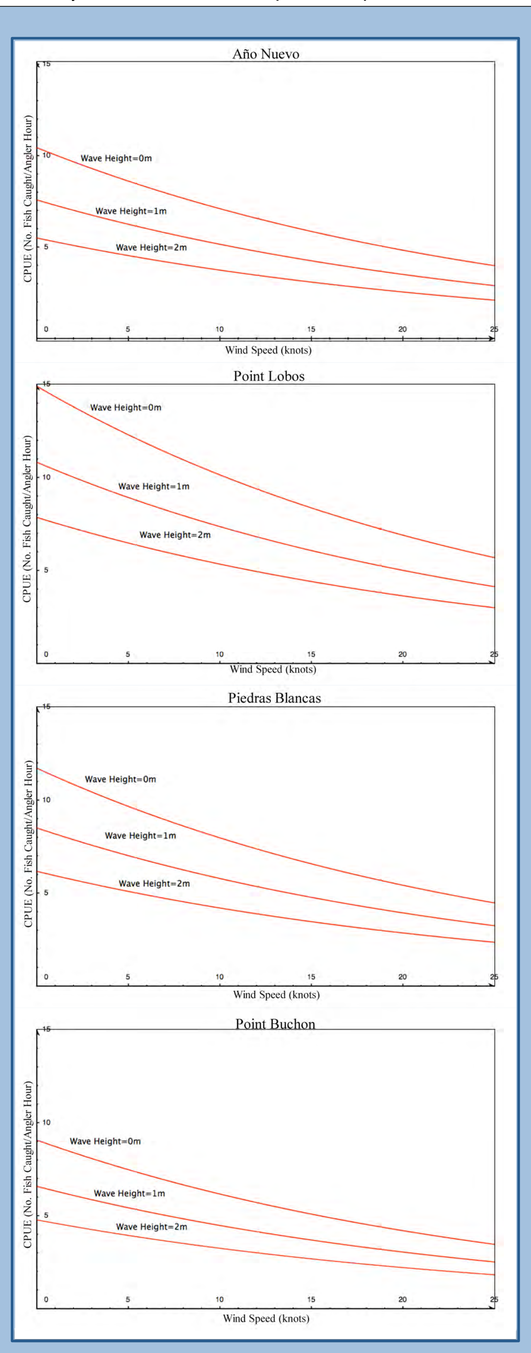

Figure 5: The relationship between wind and swell on CPUE for individual areas. Each line represents the relationship between wind speed (knots) and CPUE for a given swell height (meters).

Discussion

We found that wind speed and swell height have a significant negative relationship with CPUE (Table 1). This relationship supports the perception in the fishing community that certain environmental variables influence fishing catch rates. Angler survey responses reported that a wind speed of 5 knots is ideal for maximizing fish catch rates (Fig 4); however, our regression model (Fig 3) suggests that a wind speed of 0 knots is ideal. With a wind speed and swell height of 0, a fishing vessel is stationary, this limits the fish vulnerability to the gear; therefore, our regression model at 0 knots may not truly represent the actual effect associated with a wind speed and swell height of 0. Finally, the magnitude of effect for wind speed and swell height on CPUE was found to be different for each sampling location (Fig 5). This variation may be due to the differences of characteristics in bathymetry of the seafloor or other geographic or environmental factors not examined by this study across sampling areas.

Acknowledgements

I thank the DEW lab for research facilities; The Fisheries Conservation Lab at Moss Landing; and Dr. Steve Rein at Cal Poly for his help in statistical analysis. This research was funded through SeaGrant, CSU COAST, and the CSU Monterey Bay Undergraduate Research Opportunities Center.

Literature cited

1. Carr, Mark H., Raimondi, Pete., Starr, Rick., Wendt, Dean., Yoklavich, M. (2013). State of the California Central Coast: Results from Baseline Monitoring of Marine Protected Areas 2007-2012. *California Ocean Science Trust*, 44.
2. Stoner, A. W. (2004). Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. *Journal of Fish Biology*, (65), 1445–1471.