ROV and Seafloor Data Processing and Analysis

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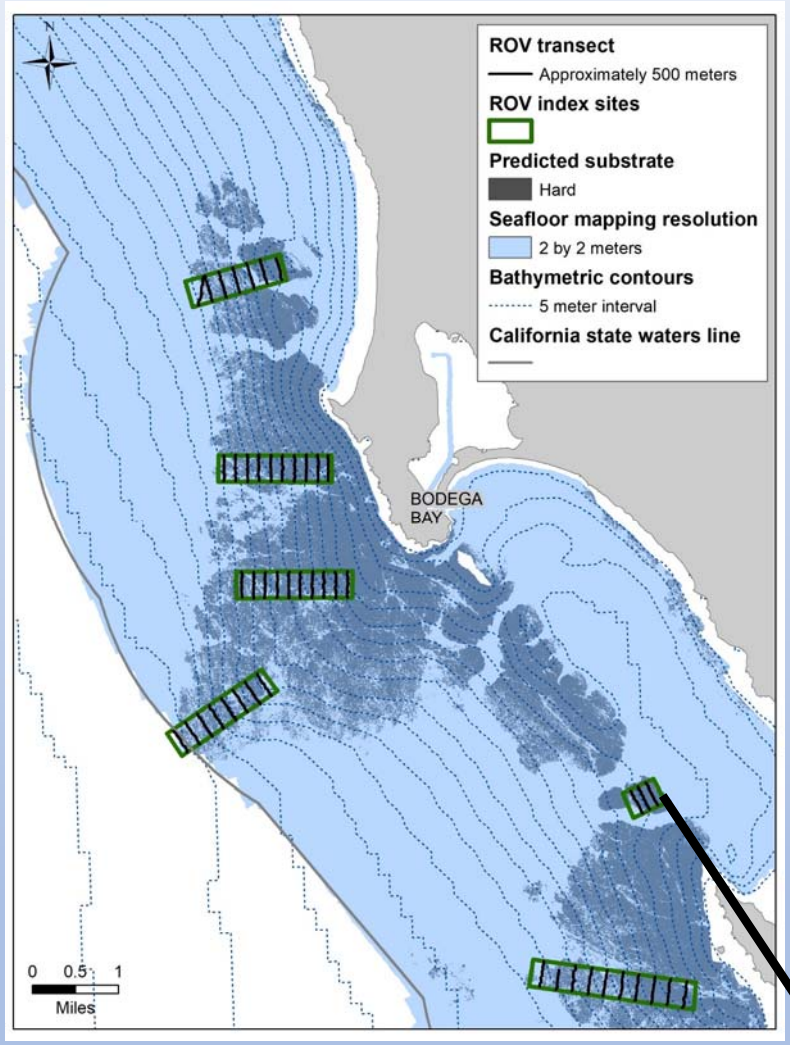
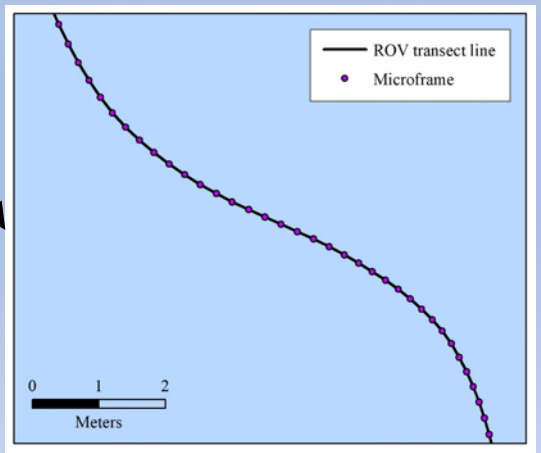
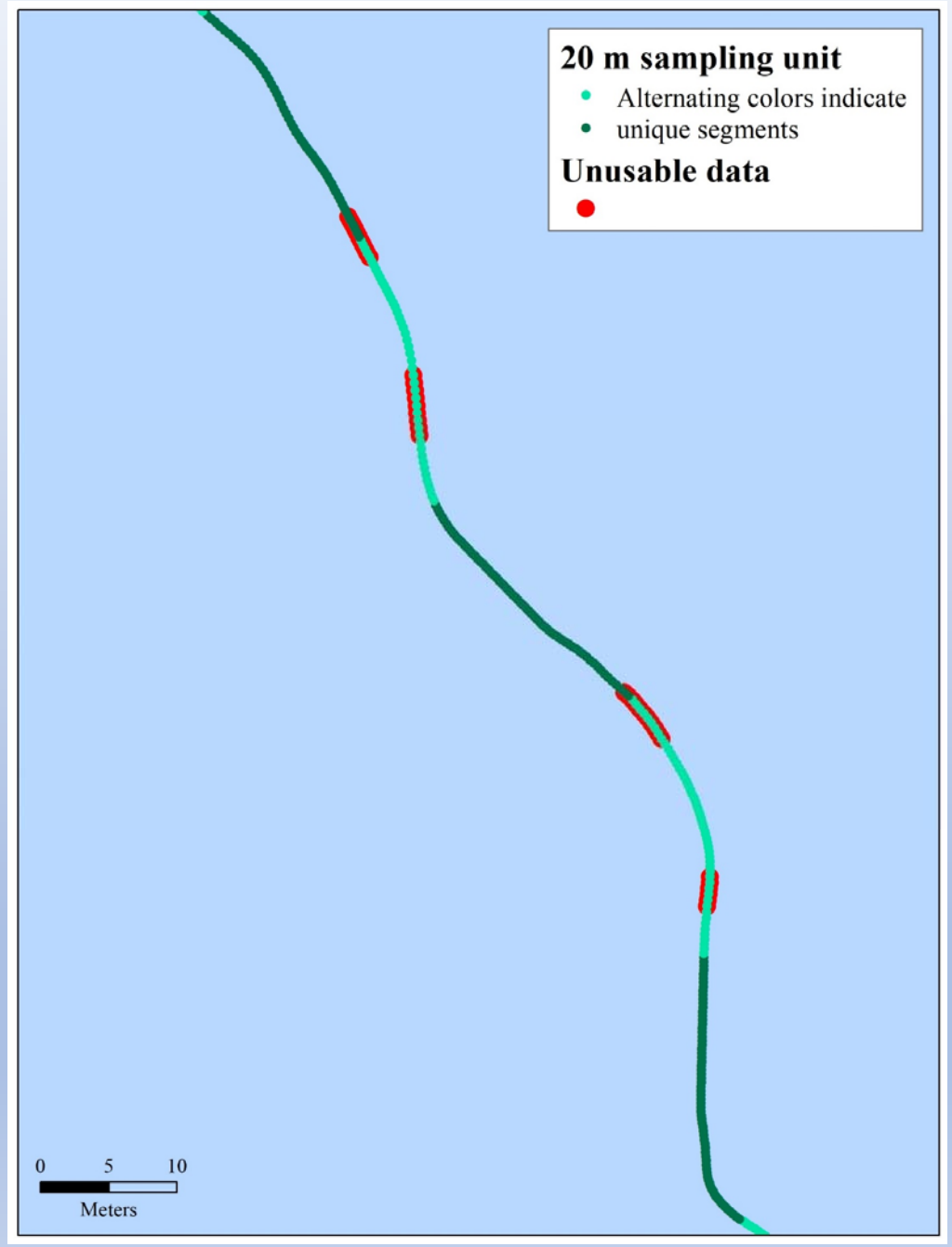
ROV Data Aggregation - Transects and Microframes



- ROV transects are typically 500 m
- Transects composed of individual data points collected at 1 s interval
- Microframes grouped in 10 m or 20 m segment lengths.
- Correlations between ROV density observations, observed variables and terrain attributes derived from seafloor mapping data.



20 Meter Segment Length Processing



- All microframes included when grouping into 20 m segments
- Some microframes flagged as unusable because of:
  - Backsides of high relief
  - Stop pulls
  - Other
- Data from unusable microframes removed after 20 m segments defined
- Entire segments removed if <60% usable data (12 m)
- Density estimates = fish counts/ usable seafloor area observed

Methodology Review Overview

- Density Estimates-Index of Abundance
  - Generalized linear model
  - Generalized additive model
  - Distributions and variables

- Abundance Estimates
  - Habitat area from seafloor habitat mapping
  - Design-based methods
    - Poststratification of data based on Generalized Linear Model
    - Validate results of model-based
  - Model-based methods
    - Analogous to Young and Carr 2015 and Dick 2019
    - Generalized additive models of density with variables
    - Marine Geospatial Ecology Tools (Duke) used to expand based on variables identified
- Length Composition and Average Weight Estimation
  - Visual Approximation with paired lasers – subject to error and bias
  - Validation with stereo camera data – more limited but higher accuracy
  - Use of recreational length data as a proxy

Species Considered

- Distribution vs. sampling effort
- Estimates of abundance vs index or exclude
- Detection Probability Concerns
  - Cryptic – i.e. Cabezon
  - Demersal vs. semi-pelagic i.e. blue and black rockfish
  - Avoidance/Attraction
- Identification issues
  - Similar species
  - Ambiguous species ID

Species	Index of Abundance	Abundance Estimate
Brown Rockfish	X	X
Quillback Rockfish	X	X
China Rockfish	X	X
Kelp Greenling	X	X
Copper Rockfish	X	X
Gopher Rockfish	X	X
Blue Deacon Rockfish Complex	X	
Black Rockfish	X	
Vermilion Rockfish	X	X
Canary Rockfish	X	
Yelloweye Rockfish	X	
Lingcod	X	

Seafloor Data Sets

- “White zone” interpolated rocky reef estimates shoreward of the CSMP coverage
- CSMP coverage with 2x2 m and 3x3 resolution
  - derived terrain attributes
- CSMP coverage with 5x5 m and 10x10 resolution rocky reef estimates
- NOAA EFH Mapping, 10-20 m BOEM and MBARI. From Joe Bizzaro.
- U.S Coastal Relief Model 84 m resolution data.
- All combined to provide estimates of rocky reef habitat.

Data by Seafloor Resolution

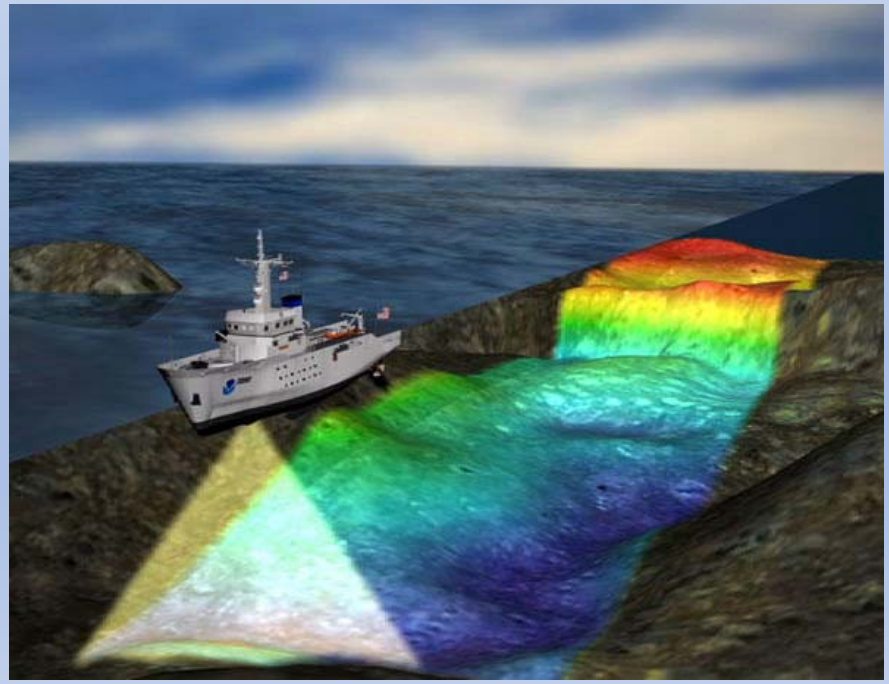
Table D. Area in square kilometer from the dataset that best represents depth and habitat between the California Oregon border and Point Conception by 10 m depth intervals.

	Area (km) from Each Resolution of Data			
	Depths defined by NOAA CRM	Depths defined by CSMP		Depths defined by NOAA CRM
Depth (m)	White zone (km)	2 meter (km)	5 meter (km)	84 meter (km)
0 - 10	407.551	147.539	2.119	0.413
10 - 20	29.052	936.584	1.143	5.431
20 - 30	4.268	1,112.596	1.038	123.660
30 - 40	3.180	1,018.159	1.275	283.376
40 - 50	0.590	745.098	2.113	512.509
50 - 60	0.235	583.114	11.898	862.793
60 - 70	0.299	565.900	17.485	798.643
70 - 80	0.299	450.771	15.777	999.902
80 - 90	0.043	288.837	81.484	1,125.865
90 - 100	0.078	72.239	162.696	1,316.198
100 - 110	0.050	14.486	139.386	1,314.431
110 - 120	0.007	7.954	86.204	1,115.110
Total 0 to 120 meters	**445.651**	**5,943.277**	**522.617**	**8,458.333**

Upshot: A generalized expansion on rock is preferable to limiting model for CSMP terrain attributes both in terms of data retention and spatial coverage

California Seafloor Mapping Program

- High resolution seafloor mapping data gathered in state waters between 2007 and 2010
- Data collected with multibeam sonar and available in raster format
- Resolution of data dependent on depth of collection:
  - 2 by 2 m in
    0 to 85 m depth range
  - 5 by 5 m in
    80 to 250 m depth range
  - 10 by 10 m in
    230 to 1500 m depth range



Terrain Attributes from Seafloor Mapping Data

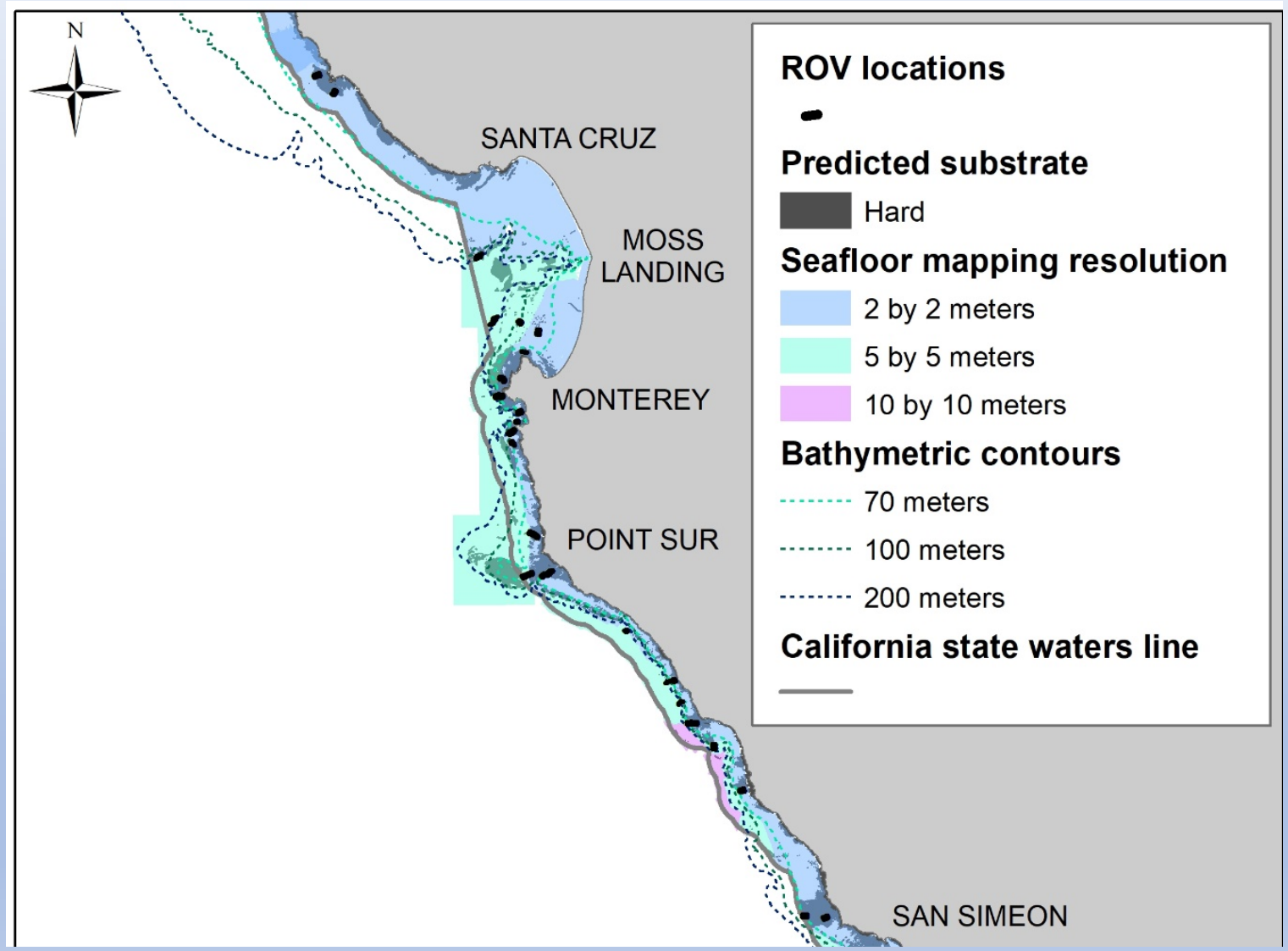
- Many rockfish inhabit rocky reef habitat
  - Terrain attributes derived from seafloor mapping provide measures of relief and rugosity/roughness

- Rockfish are found in specific depth ranges.
  - Seafloor mapping data provides high resolution characterizations of depth

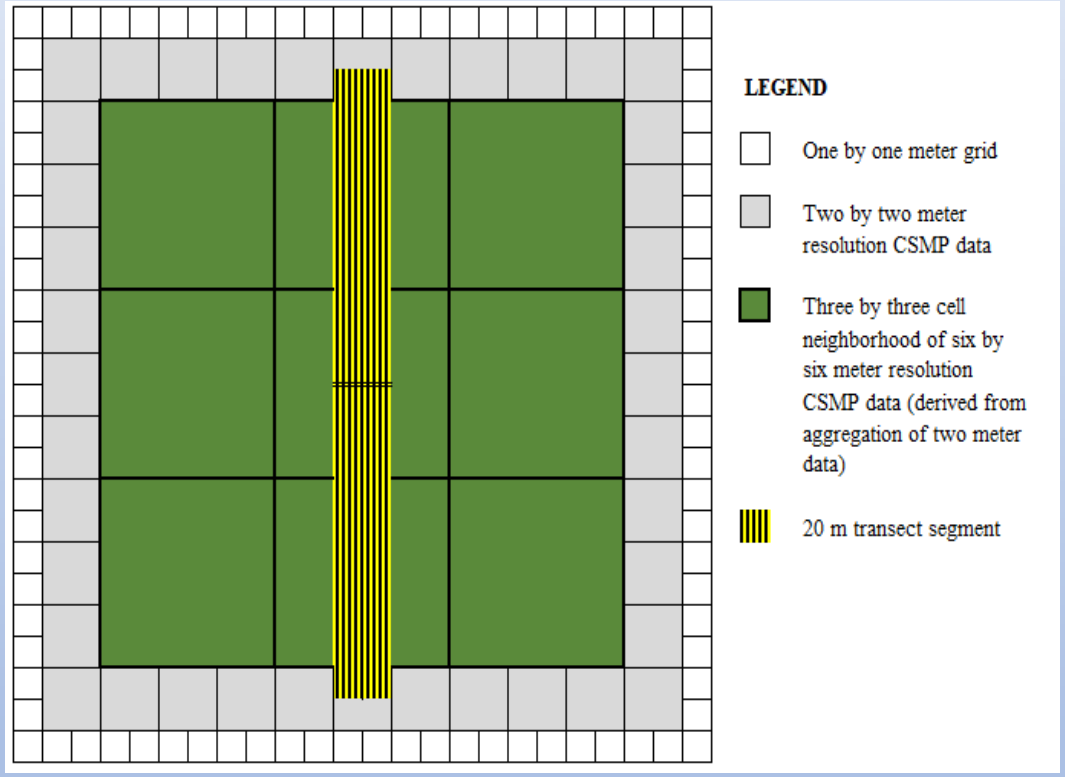
- Uses:
  - Categorize seafloor for correlation with observed fish density (fish/square meter)
  - Expansion of density estimates for design-based and model-based estimates of abundance

- Tested methods with 2 m resolution data from the California Seafloor Mapping Project

California Seafloor Mapping Program
Resolution in Central California

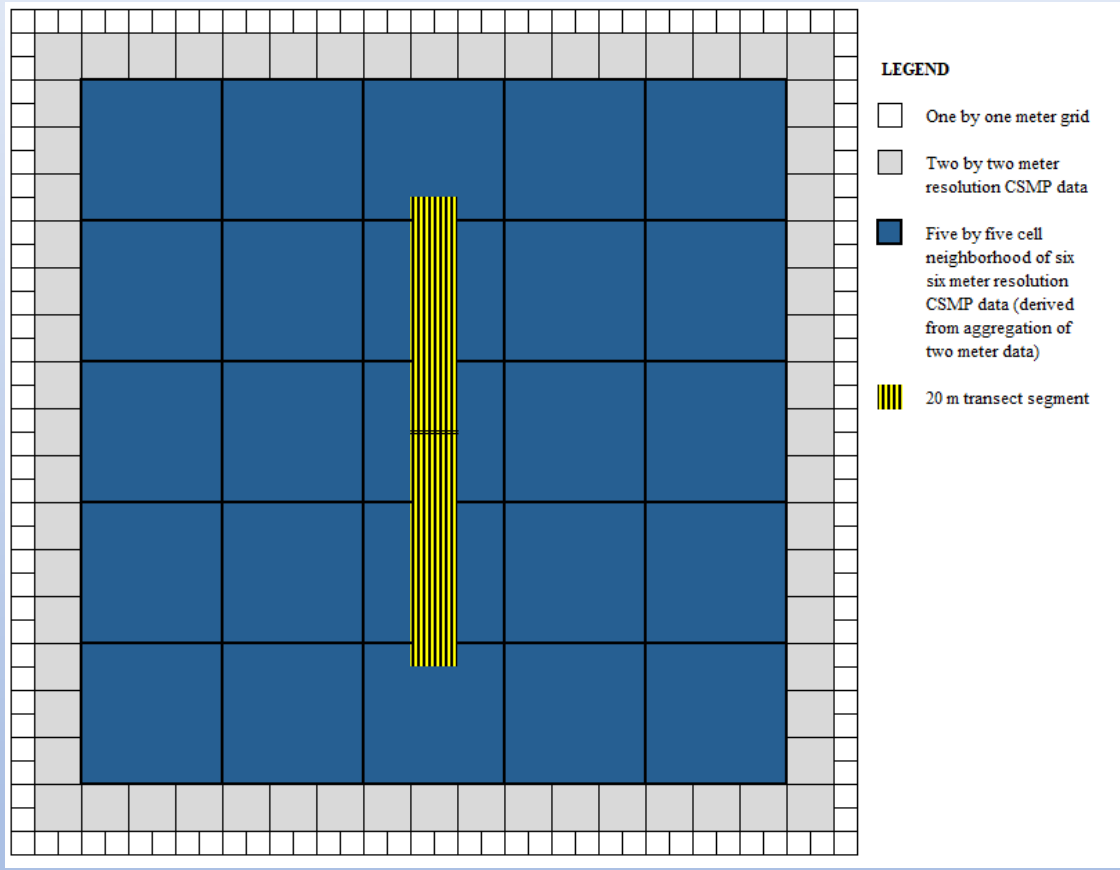


Neighborhood Size Compared to Sample Unit
3 by 3



- 20 m segment example
- 3 by 3 neighborhood required in some cases
- Results in an 18 by 18 m neighborhood size if based on a 6 by 6 m cell

Neighborhood Size Compared to Sample Unit
5 by 5



- 5 by 5 cell neighborhood of 6 by 6 m cells was used when possible
- Resulted in a neighborhood size of 30 by 30 m
- Reasonable neighborhood size for rockfish exhibiting high site fidelity

Terrain Attributes Generated for Analysis

Terrain Attribute	Description	Neighborhood Size	Tool
Depth range	Difference between the maximum and minimum cell depth	30 by 30 m: 5 by 5 cell neighborhood of 6 by 6 m cells	ArcGIS Spatial Analyst Focal Statistics, statistics type set to range
Standard deviation of depth	Standard deviation of depth values	30 by 30 m: 5 by 5 cell neighborhood of 6 by 6 m cells	ArcGIS Spatial Analyst Focal Statistics, statistics type set to STD
Slope	Maximum rate of change from the center cell to its neighbors	18 by 18 m: 3 by 3 cell neighborhood of 6 by 6 m cells	ArcGIS Spatial Analyst Slope
Standard deviation of slope	Standard deviation of slope values	30 by 30 m: 5 by 5 cell neighborhood of 6 by 6 m cells	ArcGIS Spatial Analyst Focal Statistics on slope raster, statistics type set to STD
Surface area to planar area	Ratio of surface area to planar area	18 by 18 m: 3 by 3 cell neighborhood of 6 by 6 m cells	Benthic Terrain Modeler for ArcGIS Surface Area to Planar Area tool

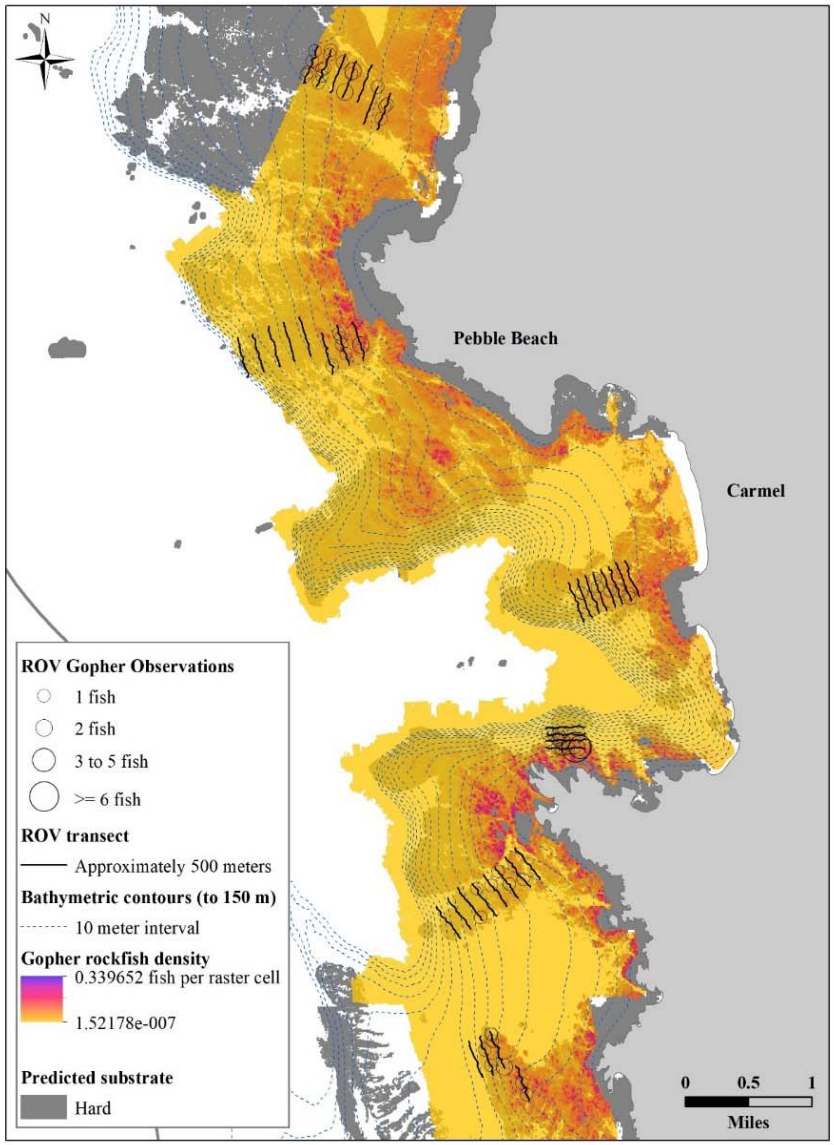
Segment and Seafloor Mapping Data Aggregation Scale Alternatives

- 10 m segments paired with 2x2 m resolution CSMP data
  - Highest possible resolution of terrain attributes
  - More subject to spatial error.
- 20 m segments paired with 6x6 m resolution CSMP data
  - Seafloor mapping data were aggregated from their original 2 by 2 m cell size to 6 by 6 m.
  - Sufficiently large neighborhood available to ArcGIS tools hard coded with a three by three cell neighborhood size.
  - 6 by 6 m aggregation was chosen, limited effects of spatial error in terrain characteristics derived from depth.
- Transect – Only application of seafloor is expansion to rock.

Habitat Mapping for Biomass Estimation

Expansion of density estimates to habitat for absolute abundance estimates:

- CSMP 2x2 m habitat expansion of terrain attributes/percent rock
- Design-based expansion across estimated rocky habitat for all resolutions and data sources
- Model-based expansion across estimated rocky habitat for all resolutions and data sources and CSMP.



Area From Each Resolution of Data

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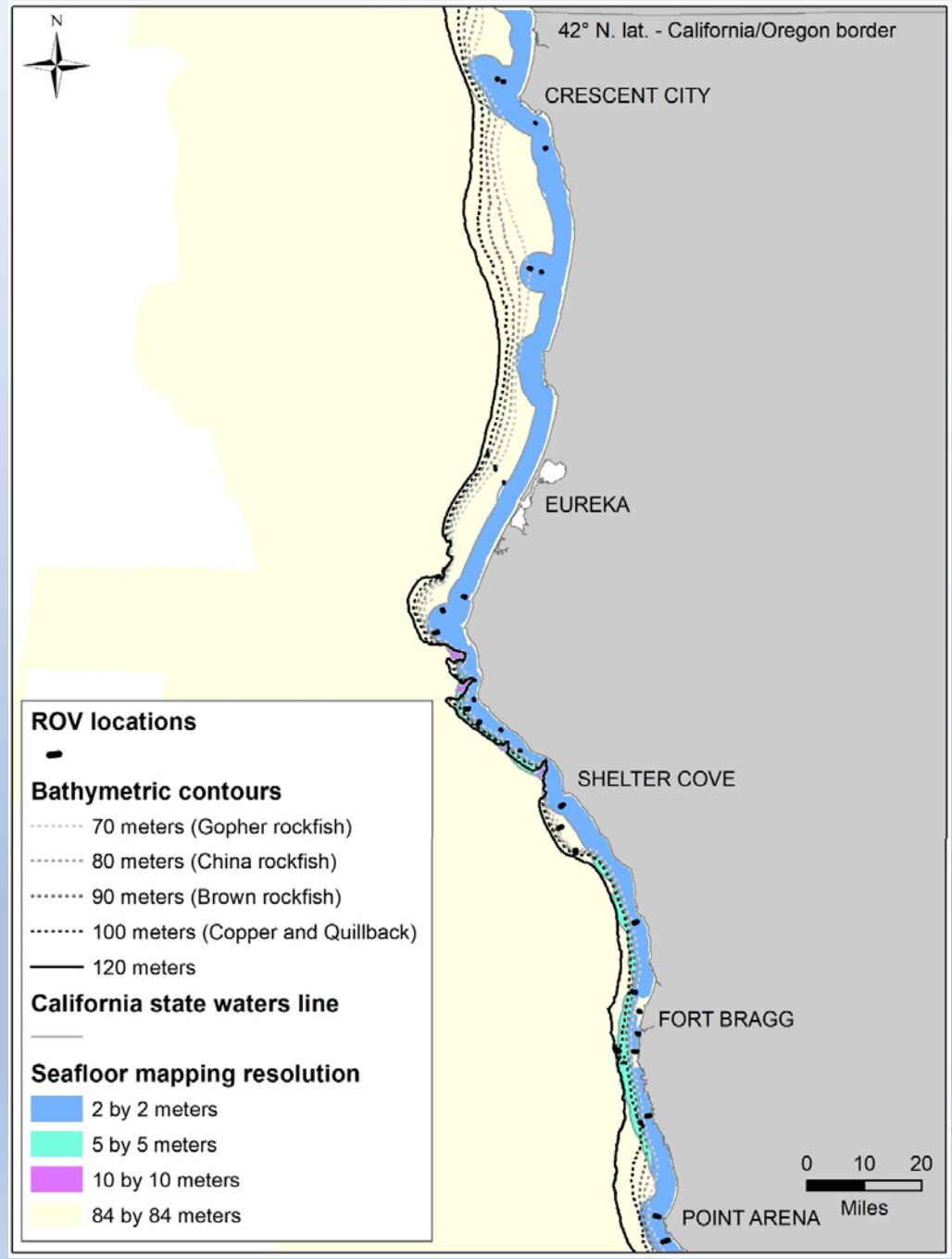
Predicted Substrate

Considerations

- Spatial Coverage
  - CSMP limited to state waters
  - White zone shoreward
  - Lower resolution NOAA Coastal Relief Model
- Information content
  - Terrain attributes vs. rock.
- Resolution
  - Spatial error



Data Sets

- ROV data sets available N and S of Point Conception:
  - 10 m segments, with terrain attributes (49260 Segments, 1104 Copper Rockfish)
  - 10 m segments, not limited to availability of terrain attributes. (86289 Segments, 4297 Copper Rockfish)
  - 20 m segments, terrain attributes
  - 20 m segments, not limited to terrain attributes
  - Transect level – combining segments or aggregated microframe data

Prior Variables from ROV and CSMP Data

- In situ ROV variables more consistently significant across distributions and species
- No consistent terrain attributes across species, few consistent across distributions
- Spatial error – location of observation vs. attribute location
- Aggregation of CSMP – loose microhabitat scale variation

Table 16. Results of GLM with various distributions for copper rockfish density with variables derived from the ROV and CSMP. The *** is significant at the 0.001 level, ** is significant at the 0.01 level and * is significant at the 0.05 level, . <0.1 is nearly significant. Values in brackets are the deviance for the variable in question. AIC values are indicated for each model and overdispersion test result provided. Estimates of overdispersion (>1 indicating overdispersion) and significance of overdispersion are indicated at the bottom of the table.

Variables / Factors	Poisson	Zero-Inflated Poisson	Quasi-Poisson	Zero-Inflated Quasi-Poisson	Binomial	Negative Binomial
Intercept		.		.		
Latitude	*	*	*	*	**	*
Proportion Hard/Mix ROV	***		***		***	***
Depth	.		.		.	.
Take		**		**		
DepthRange_3By3	.		.		.	.
DepthRange_5By5	.		.			.
DepthMean_3By3		*		*		.
DepthMean_5By5		.		.		
RDMV_3By3	*		*		*	*
RDMV_5By5	.		.			.
Slope_3By3		*		*		
STDofDepth_3By3	.	*	.	*	.	
STDofDepth_5By5						
STDofSlope_3By3						
STDofSlope_5By5	***		***		**	**
SurfaceAreaTo PlanarArea_3By3		*		*		
Proportion Hard CSMP	*	***	*	**		*
AIC	2019	1986	NA	1986	1913	2005
Dispersion	1.09 (0.09)					

New Data

- 2020 Super Year (2019-2021) - Second pass over the state.
- 10 m segments with 2 x 2 m resolution terrain attributes for comparison to 20 m and 6x6 m resolution terrain attributes to examine scale effects
- Percent hard in 2x2 m CSMP data for 15 x 15 cell area.
- CRFS district level assignment for regional analysis
- Cumulative recreational effort from 2005-2019 at district level
- Time since implementation of no-take MPAs
- Distance from port for each segment from Rebecca Miller SWFSC
- Length data for both paired laser approximations and stereo-cameras

Analytical Directions

1. Transects converted to segments to examine correlation of terrain attributes capturing relief/rugosity from the 2x2 m California Seafloor Mapping
    - 10 m segment analyzed with terrain attributes at a 2x2 m resolution
    - 20 m " " at 6 m x 6 m resolution
    - Index accounting for microhabitat variables capturing relief
    - Expansions limited to 2x2 m resolution CSMP grid area
    - Data loss due to limited underlying mapping from CSMP for areas observed by the ROV.

2. Transects or segments with variables from ROV observations and GIS derived variables
    - No measures of relief, only percent rocky reef from ROV observations or other habitat.
    - Index reflecting observations of the ROV and derived macro scale variables.
    - Expansions apply reflect rocky reef across scales of seafloor data.
    - Spatial autocorrelation between segments accounted for in INLA/SDM-TMB
    - Transects may contain variable depth despite aligning with bathy lines on paper
        - Bearing selected may cross bathylines in sampling

End

Data Sets

Sampling Locations/Number of Transects Over Time

Region	MPA Group	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total Transects	Total Series Replicates
North	Point St. George Reef Offshore SMCA										23	14					19	12	68	4
	Reading Rock SMR										19	19					20	14	72	4
	South Cape Mendocino SMR										14								14	1
	Mattole Canyon SMR										21	16							37	2
	Sea Lion Gulch SMR										15	6					18	20	59	4
	Big Flat SMCA										3								3	1
	Ten Mile SMR										19	20					20	18	77	4
	MacKerricher SMCA										12								12	1
	Point Arena SMR/SMCA							12				17					14	12	55	4
	Saunders Reef SMCA											8							8	1
	Stewarts Point SMR											3							3	1
	Bodega Bay SMR/SMCA							31				45				38	44		158	4
	Point Reyes SMR/SMCA					21													21	1
	North Farallon Islands SMR																10		10	1
	Southeast Farallon Islands SMR/SMCA							21				27				23	23		94	4
Central	Montara SMR											16					19	12.5	47.5	3
	Pillar Point SMCA											8					12	9	29	3
	Ano Nuevo SMR											9				10		10	29	3
	Soquel Canyon SMCA												3						3	1
	Portuguese Ledge SMCA												15			12		10	37	3
	Pacific Grove SMCA			12									8						20	2
	Asilomar SMR			13	26								15						54	3
	Carmel Bay SMCA			13							10		8						31	3
	Point Lobos SMR			12	31	23							24			23		34	147	5
	Point Sur SMCA				22				25				23			22		20.5	112.5	4
	Big Creek SMR/SMCA												28				13		41	2
	Piedras Blancas SMR/SMCA												8				15		23	2
	Point Buchon SMR				24	18			40				15			14		16	127	6
South	Naples SMCA										4								4	1
	Campus Point SMCA										19					18		16	53	3
	Harris Point SMR	30	24	21	21	19					23	23				24	33		218	9
	Carrington Point SMR	25	31	25	25	25					25	26				24	40		246	9
	South Point SMR	37	31	26	26	26					24	25				26	31		252	9
	Gull Island SMR	44	41	39	39	38					39	40				32	41		353	9
	Scorpion Point SMR										3	6							9	2
	Anacapa Island SMR/SMCA	39	29	30	28	25					59	29				28	37		304	9
	Point Dume SMR										18								18	1
	Santa Barbara Island SMR										19								19	1
	Farnsworth Offshore SMCA										25						27	18	70	3
	Swami's SMCA										25						13	14	52	3
	Point Conception SMR										17					16		13	46	3
	South La Jolla SMR/SMCA										24						27	20	71	3
	Total :	175	156	191	242	195		64	65		484	357	147			327	476	281.5	**3,161**	**142**

Data Loss to Filters for CSMP Terrain Attribute Variables

Filter	Segments	Segments Lost	Copper Lost
None	92966	0	0
Depth greater than 120 m	92946	20	0
No Depth	90499	2447	31
Lacking Terrain Attributes	70774	19725	1872
<6m	67709	3065	102
>50 m sq	67345	364	24
<14 m segment	66980	365	21
Remove percent hard blank	49260	17720	1412

Data Filters for Rock Expansion

Copper 10 m File Manipulations and Data Loss for Rock Expansion

Filter	Segments	Segments Lost	Copper Lost
None	92966	0	0
Depth greater than 120 m	92955	11	0
No Depth	90497	2457	75
<6m	86552	3945	189
>50 m sq	67345	263	49
<14 m segment	66980	1	0

Extracting depth where possible to save some segments and observations.
How concerned should we be about fragment length or area?

Copper Rockfish Sample Sizes

Sum of Copper Rockfish	Column Labels																				
	2014			2014 Total	2015			2015 Total	2016		2016 Total	2019			2019 Total	2020			2020 Total	2021		2021 Total	Grand Total
Row Labels	MPA	MPA/Outside	Reference		MPA	MPA/Outside	Reference		MPA	Reference		MPA	MPA/Outside	Reference		MPA	MPA/Outside	Reference		MPA	Reference		
Central					**2**			**2**	**77**	**72**	**149**	**120**		**43**	**163**	**24**		**42**	**66**	**126**	**20**	**146**	**526**
Ano Nuevo												1		1	2					6	2	8	10
Big Creek									4	54	58					6		35	41				99
Montara					1			1								3			3	5		5	9
Montara/Pillar Point																		2	2		1	1	3
Piedras Blancas									7		7					11		5	16				23
Pillar Point					1			1								4			4	3		3	8
Point Buchon									4	4	8	6		8	14					11	1	12	34
Point Lobos									13	2	15	39		8	47					72	5	77	139
Point Sur									21	3	24	53		16	69					26	3	29	122
Portuguese Ledge									28	9	37	21		10	31					3	8	11	79
North	**21**		**35**	**56**	**78**		**38**	**116**				**69**		**32**	**101**	**160**		**72**	**232**	**73**	**30**	**103**	**608**
Bodega Bay					11		3	14				29		25	54	62		23	85				153
N Farallon Islands																2		5	7				7
Point Arena					8		11	19								28		2	30	14	4	18	67
Point St. George	13		3	16	14		1	15								7		3	10	10		10	51
Reading Rock	3		11	14	2		10	12								5		18	23	11	8	19	68
SE Farallon Islands					18		1	19				40		7	47	24		3	27				93
Sea Lion Gulch			5	5												7		10	17	9	10	19	41
Ten Mile	5		16	21	25		12	37								25		8	33	29	8	37	128
South	**543**	**37**	**169**	**749**	**611**	**33**	**205**	**849**				**639**	**14**	**168**	**821**	**719**	**11**	**264**	**994**	**48**	**15**	**63**	**3476**
Anacapa Island	95	37		132	58	33		91				35	14		49	33	11	8	52				324
Campus Point	14			14								16		1	17					12	1	13	44
Carrington Point	60		100	160	53		100	153				65		84	149	148		85	233				695
Farnsworth	18		13	31												26		6	32	5	1	6	69
Gull Island	168		18	186	237		50	287				115		30	145	120		62	182				800
Harris Point	113		17	130	131		25	156				223		23	246	267		57	324				856
Point Conception	13			13								56		2	58					27	9	36	107
South La Jolla	1		1	2												3		1	4	1	3	4	10
South Point	61		20	81	132		30	162				129		28	157	113		45	158				558
Swami's																9			9	3	1	4	13
Grand Total	**564**	**37**	**204**	**805**	**691**	**33**	**243**	**967**	**77**	**72**	**149**	**828**	**14**	**243**	**1085**	**903**	**11**	**378**	**1292**	**247**	**65**	**312**	**4610**

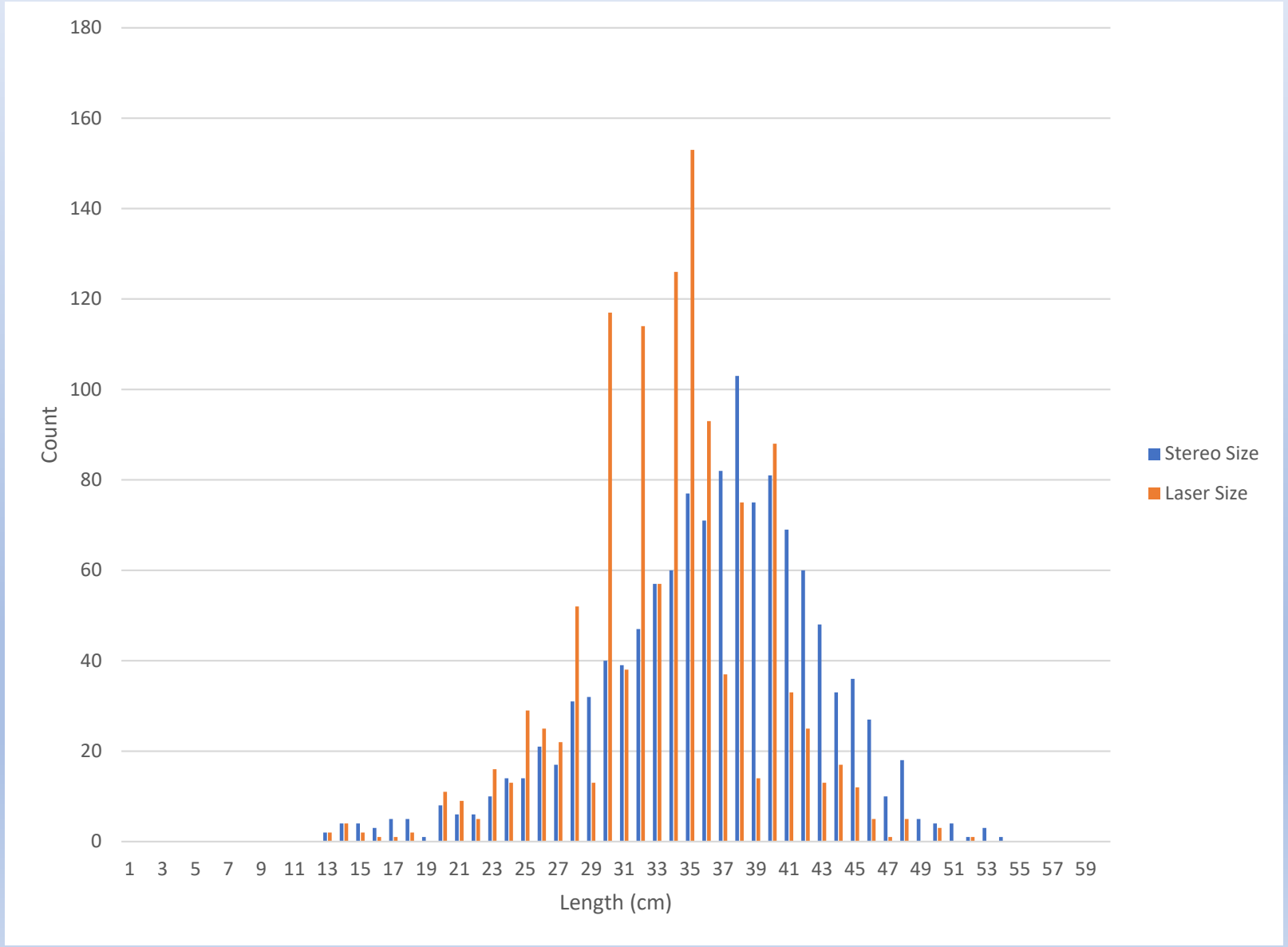
Black Rockfish Sample Sizes

Sum of Black Rockfish	Column Labels																					
	2014			2014 Total	2015			2015 Total	2016		2016 Total	2019			2019 Total	2020			2020 Total	2021		2021 Total	Grand Total
Row Labels	MPA	MPA/Outside	Reference		MPA	MPA/Outside	Reference		MPA	Reference		MPA	MPA/Outside	Reference		MPA	MPA/Outside	Reference		MPA	Reference		
Central					**68**		**29**	**97**	**1**	**48**	**49**					**22**		**1**	**23**	**63**	**8**	**71**	**240**
Ano Nuevo							3	3												2	1	3	6
Big Creek									1		1												1
Montara					41			41								14			14	36		36	91
Montara/Pillar Point							26	26										1	1		7	7	34
Piedras Blancas																3			3				3
Pillar Point					27			27								5			5	25		25	57
Point Buchon																							
Point Lobos										48	48												48
Point Sur																							
Portuguese Ledge																							
North	**32**		**130**	**162**	**61**		**18**	**79**				**8**		**38**	**46**	**151**		**94**	**245**	**72**	**67**	**139**	**671**
Bodega Bay					5		4	9				8		38	46	23		2	25				80
N Farallon Islands																							
Point Arena					1		7	8								38		16	54	10	15	25	87
Point St. George	1		22	23																			23
Reading Rock	12		45	57	44		7	51								85		46	131	55	12	67	306
SE Farallon Islands					8			8															8
Sea Lion Gulch			63	63												4		30	34	6	40	46	143
Ten Mile	19			19	3			3								1			1	1		1	24
South			**1**	**1**										**4**	**4**	**1**		**2**	**3**				**8**
Anacapa Island																							
Campus Point																							
Carrington Point																							
Farnsworth																							
Gull Island			1	1																			1
Harris Point																1			1				1
Point Conception														4	4								4
South La Jolla																		2	2				2
South Point																							
Swami's																							
Grand Total	**32**		**131**	**163**	**129**		**47**	**176**	**1**	**48**	**49**	**8**		**42**	**50**	**174**		**97**	**271**	**135**	**75**	**210**	**919**

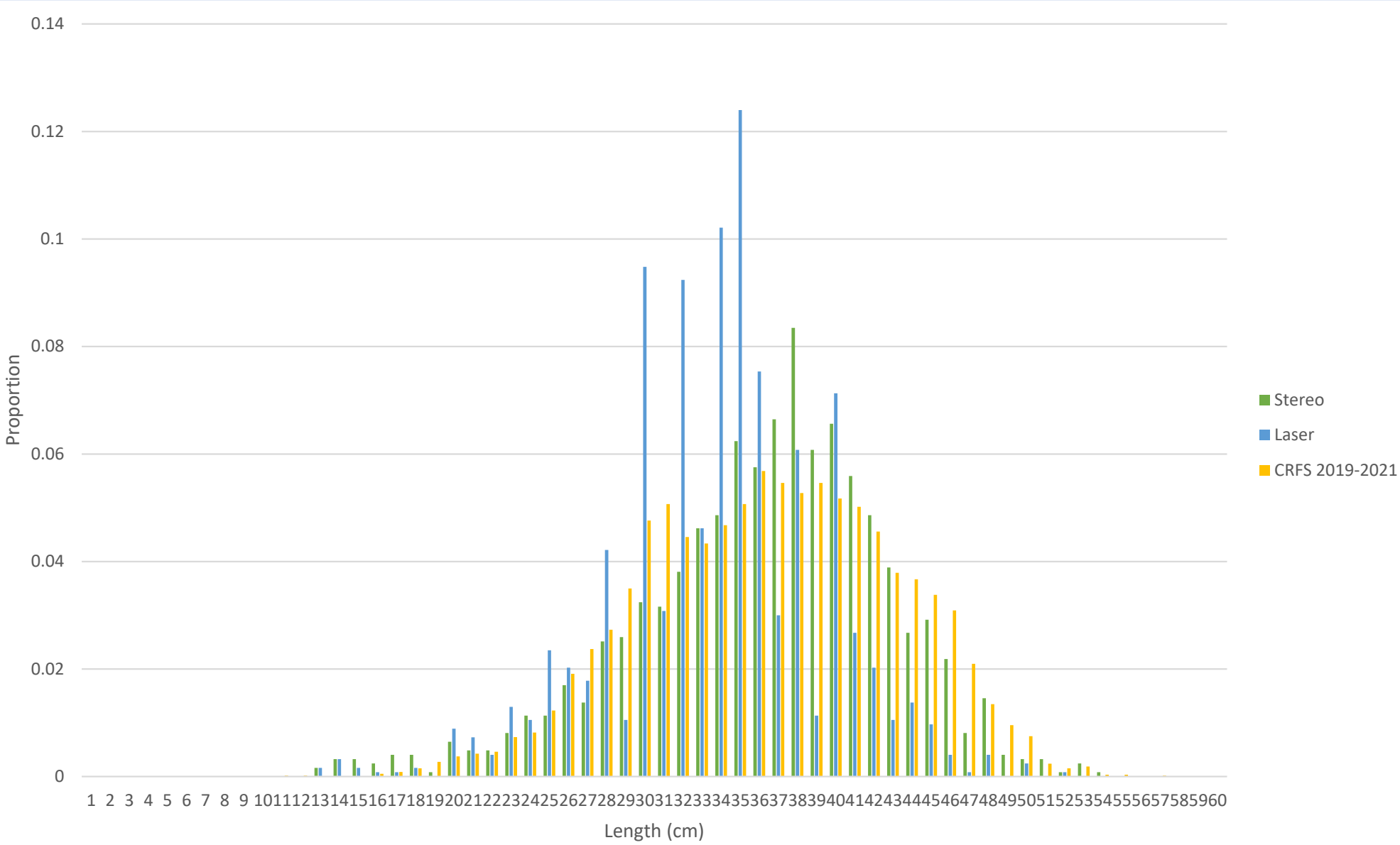
Canary Rockfish Sample Sizes

Sum of Canary Rockfish	Column Labels																					
	2014			2014 Total	2015			2015 Total	2016		2016 Total	2019			2019 Total	2020			2020 Total	2021		2021 Total	Grand Total
Row Labels	MPA	MPA/Outside	Reference		MPA	MPA/Outside	Reference		MPA	Reference		MPA	MPA/Outside	Reference		MPA	MPA/Outside	Reference		MPA	Reference		
Central					**233**		**78**	**311**	**103**	**99**	**202**	**44**		**83**	**127**	**39**		**44**	**83**	**190**	**77**	**267**	**990**
Ano Nuevo					11		32	43				8		30	38					18	21	39	120
Big Creek									1	52	53							13	13				66
Montara					201			201								23			23	130		130	354
Montara/Pillar Point							46	46										31	31		14	14	91
Piedras Blancas									8		8												8
Pillar Point					21			21								16			16	25		25	62
Point Buchon									4	7	11	1		2	3					2	1	3	17
Point Lobos									63	7	70	19		34	53					12	37	49	172
Point Sur									6	4	10	12		13	25					1		1	36
Portuguese Ledge									21	29	50	4		4	8					2	4	6	64
North	**320**		**276**	**596**	**684**		**408**	**1092**				**460**		**329**	**789**	**1114**		**732**	**1846**	**351**	**261**	**612**	**4935**
Bodega Bay					118		112	230				326		317	643	410		266	676				1549
N Farallon Islands																20		28	48				48
Point Arena					61		108	169								170		50	220	49	60	109	498
Point St. George	232		98	330	202		21	223								247		133	380	141	14	155	1088
Reading Rock	12		82	94	15		18	33								38		40	78	20	22	42	247
SE Farallon Islands					150		41	191				134		12	146	53		19	72				409
Sea Lion Gulch	18		25	43	13			13								29		17	46	21	82	103	205
Ten Mile	58		71	129	125		108	233								147		179	326	120	83	203	891
South	**5**	**1**	**3**	**9**	**9**		**5**	**14**				**4**		**10**	**14**	**14**		**11**	**25**	**3**		**3**	**65**
Anacapa Island																							
Campus Point																							
Carrington Point												1		2	3			4	4				7
Farnsworth																		3	3	3		3	6
Gull Island					2			2								2			2				4
Harris Point	5		2	7	7		2	9				1		2	3	12		2	14				33
Point Conception																							
South La Jolla																							
South Point			1	1			3	3				2		6	8			2	2				14
Swami's		1		1																			1
Grand Total	**325**	**1**	**279**	**605**	**926**		**491**	**1417**	**103**	**99**	**202**	**508**		**422**	**930**	**1167**		**787**	**1954**	**544**	**338**	**882**	**5990**

Comparison of Stereo and Laser Lengths for Same Individuals



Comparison of Laser, Stereo and CRFS



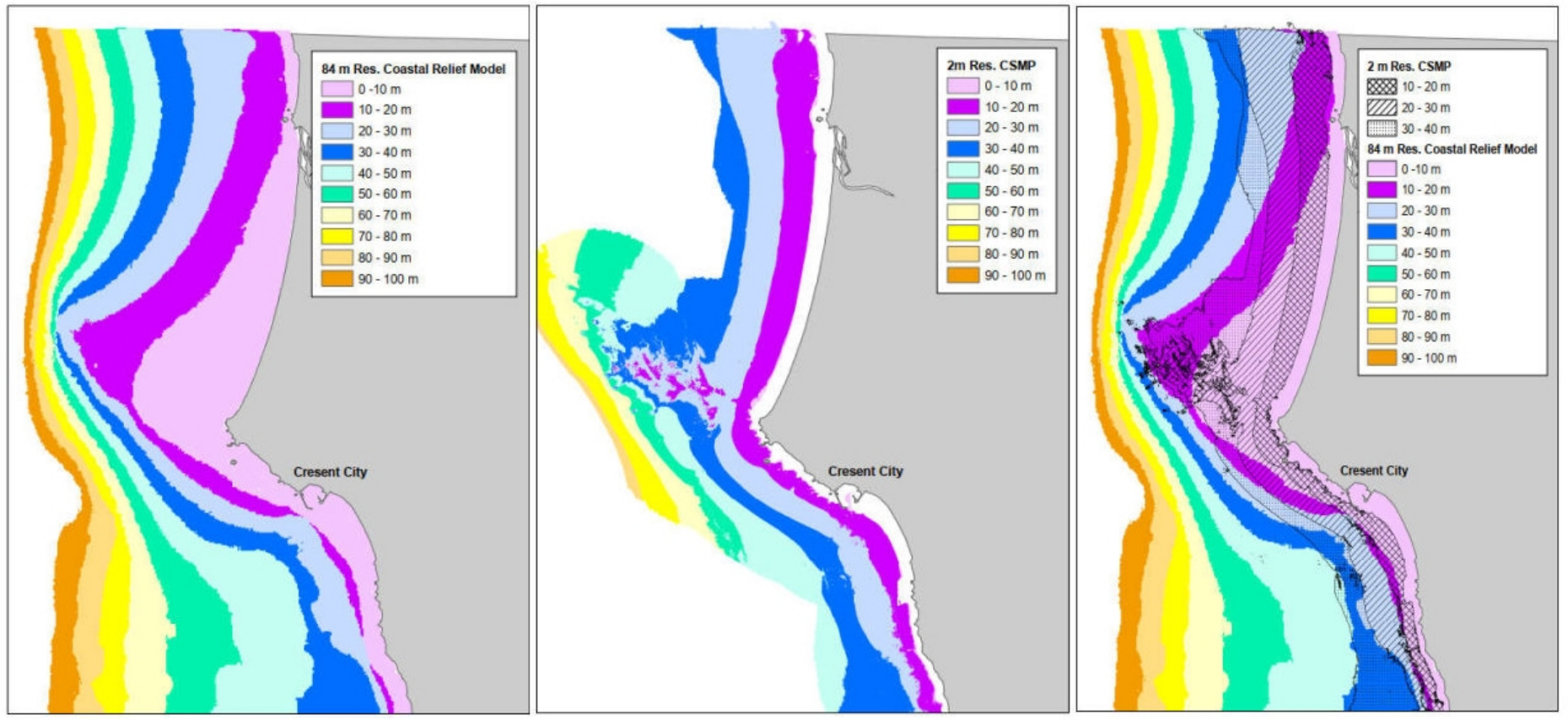
BACK POCKET SLIDES

Back Up: Seafloor Mapping Data Aggregation and Neighborhood Size

- Estimated ROV location spatial error is between 3 and 6 m
- This spatial error was considered when selecting resolution of the seafloor mapping data used to derive terrain attributes and when selecting the 20 m fixed length as the sample unit
- Terrain attributes are derived from seafloor depth raster files
- Focal statistics assigns a value to each raster cell based on calculations performed on neighborhood of cells around it

Depth Range Example

NOAA CRM vs. CSMP Depth Data



- Data quality differences highlighted above should be considered when deciding whether to use low resolution NOAA CRM data to apply the same methods applied to high resolution CSMP data to estimate rockfish abundance.

Sample Unit Considered But Rejected: 25 m^2 Fixed Area

- Reasons to reject 25 m^2 Fixed Area:
  - Inconsistency of segment length.

- Reasons why fixed area segments vary in length
  - Microframe area = swath width * distance travelled
  - Swath width varies depending on how far off the bottom the ROV is
  - Distance travelled in a second is dependent on the speed of the ROV

Sample Unit Considered But Rejected: Microframe

- Reasons to consider microframes:
  - Produces the largest possible sample size
  - Each fish observation paired with the high resolution raster cell that intersects the location of observation.

- Reasons to reject microframes:
  - Abundance of data points with no observations of fish.

Sample Unit Considered But Rejected: Full Transect

- Reasons to consider 500 m transects:
  - Data were already grouped into transects.
  - Very low number of units with zero observations.

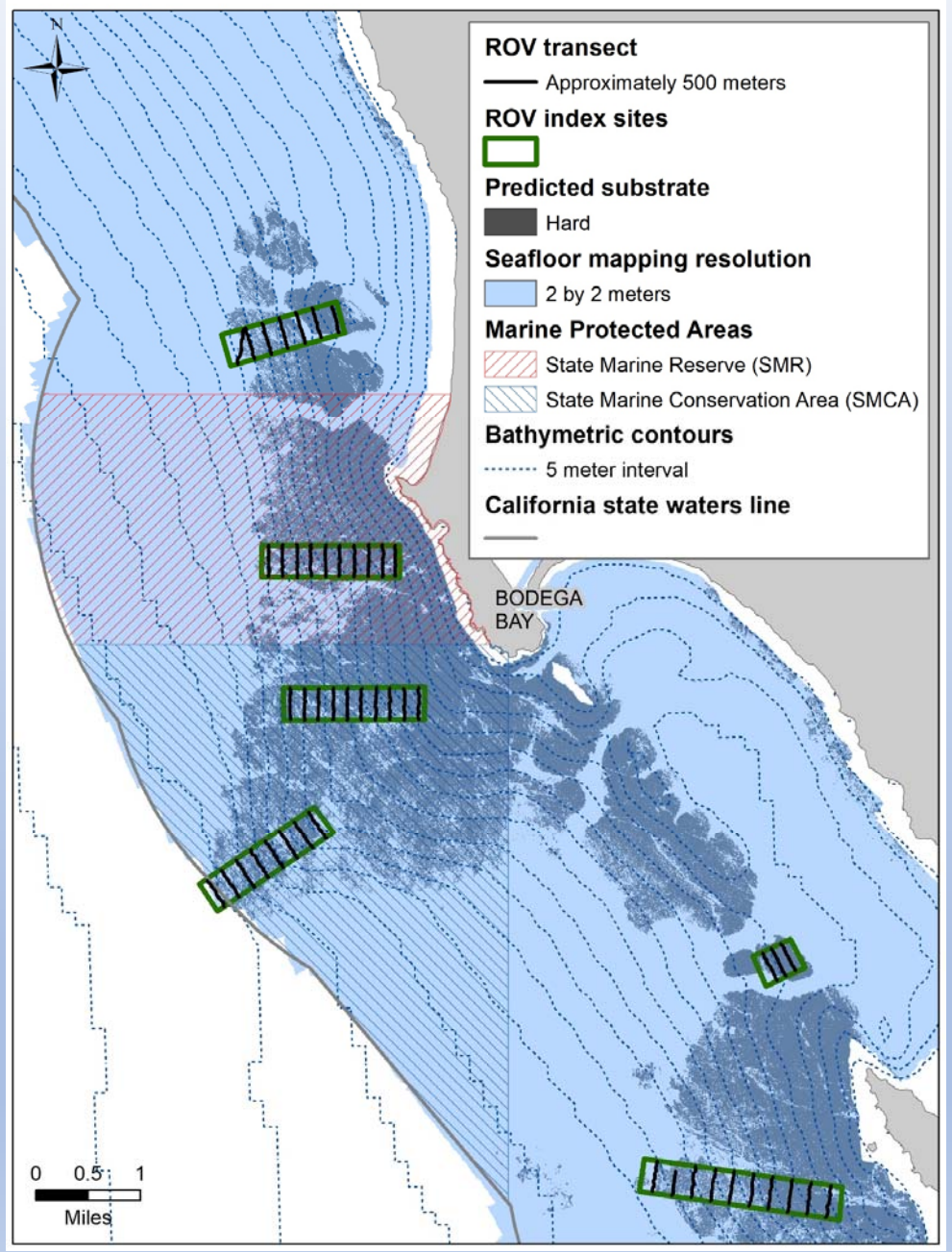
- Reasons to reject 500 m transects:
  - Habitat is variable over the full transect length making associations between observations and habitat impossible to evaluate effectively.

Pairing Terrain Attributes with ROV Observations

- Terrain attributes were paired with ROV data to facilitate analysis of correlations between fish observations and terrain attributes.
- The following steps were taken to accomplish this:
  - ROV data were summarized based on unique 20 m sample unit ID
  - 20 m segment lines created using the ArcGIS Points to Lines tool
  - Center points created for each line using the Feature to Point tool
  - Terrain attribute values added to center point attributes using the ArcGIS Extract Multi Values to Points tool
  - Summarized ROV observation data were added to center point attributes

Predicted Substrate and Depth in the White Zone

- 50 to 500 m wide band of seafloor shoreward of the 2 m resolution CSMP data
- Data collection was prevented due to navigation hazards and technical limitations that prevented ship-board mapping
- Need GIS data on predicted substrate as well as depth from the white zone for abundance estimates



Predicted Substrate and Depth in the White Zone

- Raster data of predicted substrate at 30 m resolution are available in the white zone from CSMP and NOAA environmental Sensitivity Index shoreline habitat categorizations to generate predictive maps of substrate characterizations.
- Interpolations were not meant to precisely predict the location of specific reef features, but rather to provide a general estimate of the amount of rock versus soft bottom.
- Best raster data of depth is the National Geophysical Data Center's Coastal Relief Model with a resolution of 90 m.

Predicted Substrate and Depth Offshore of State Waters

- Region wide vector habitat classification data for federal was waters created for the groundfish Essential Fish Habitat review.
- Important notes on data quality from habitat classification metadata:
  - Derived from mixed resolutions of heterogenous quality.
  - Data are not intended to replace local site mapping nor are all areas are equally well known.
- Best region wide raster data of depth found is the National Geophysical Data Center's Coastal Relief Model.
  - resolution of 90 m.