Palos Verdes Kelp Forest Restoration Project

Annual Report Appendices

Appendix A: Map Images

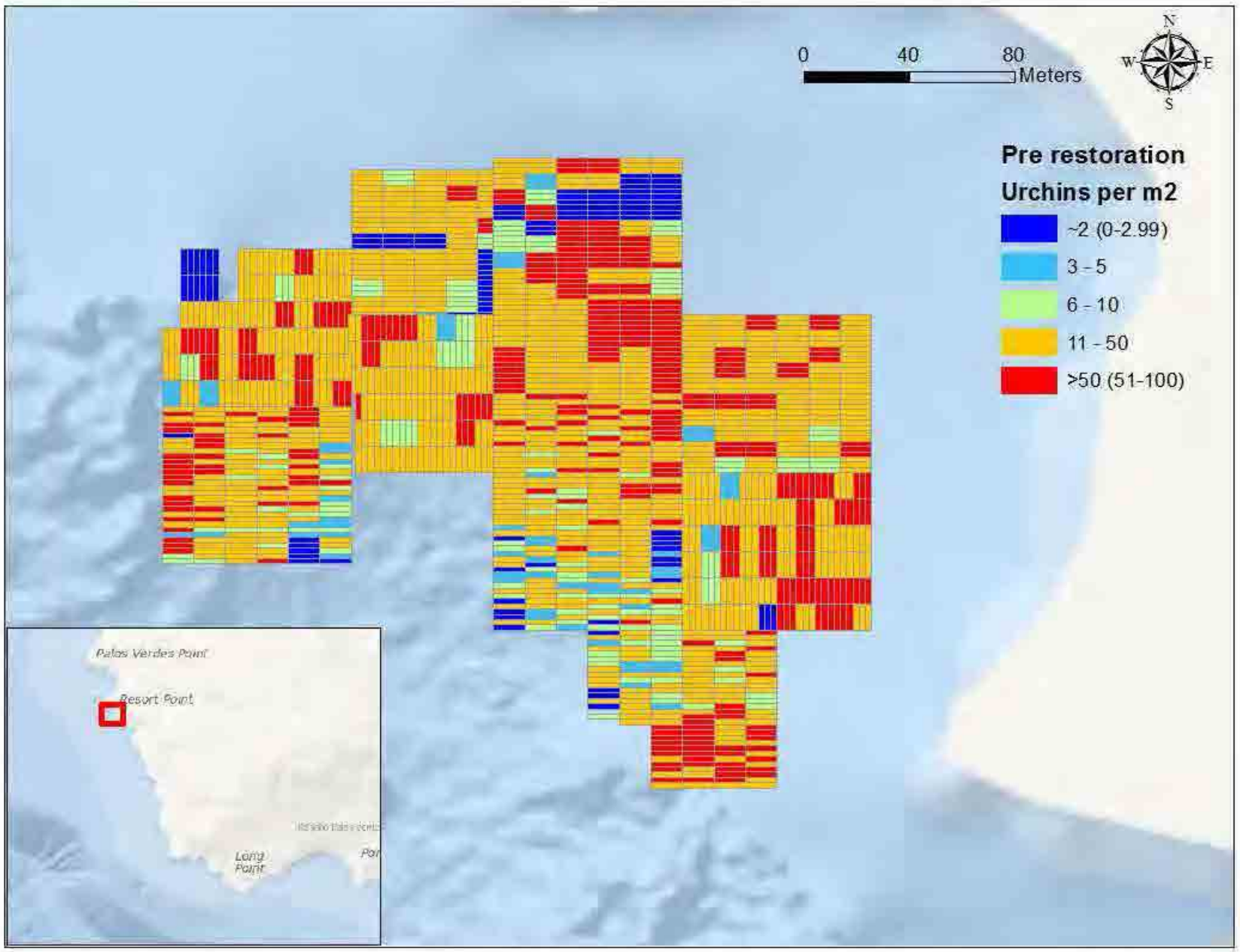
Appendix B: CRANE Data Tables 2011 – 2016

Appendix C: Gonad Indices Results 2014

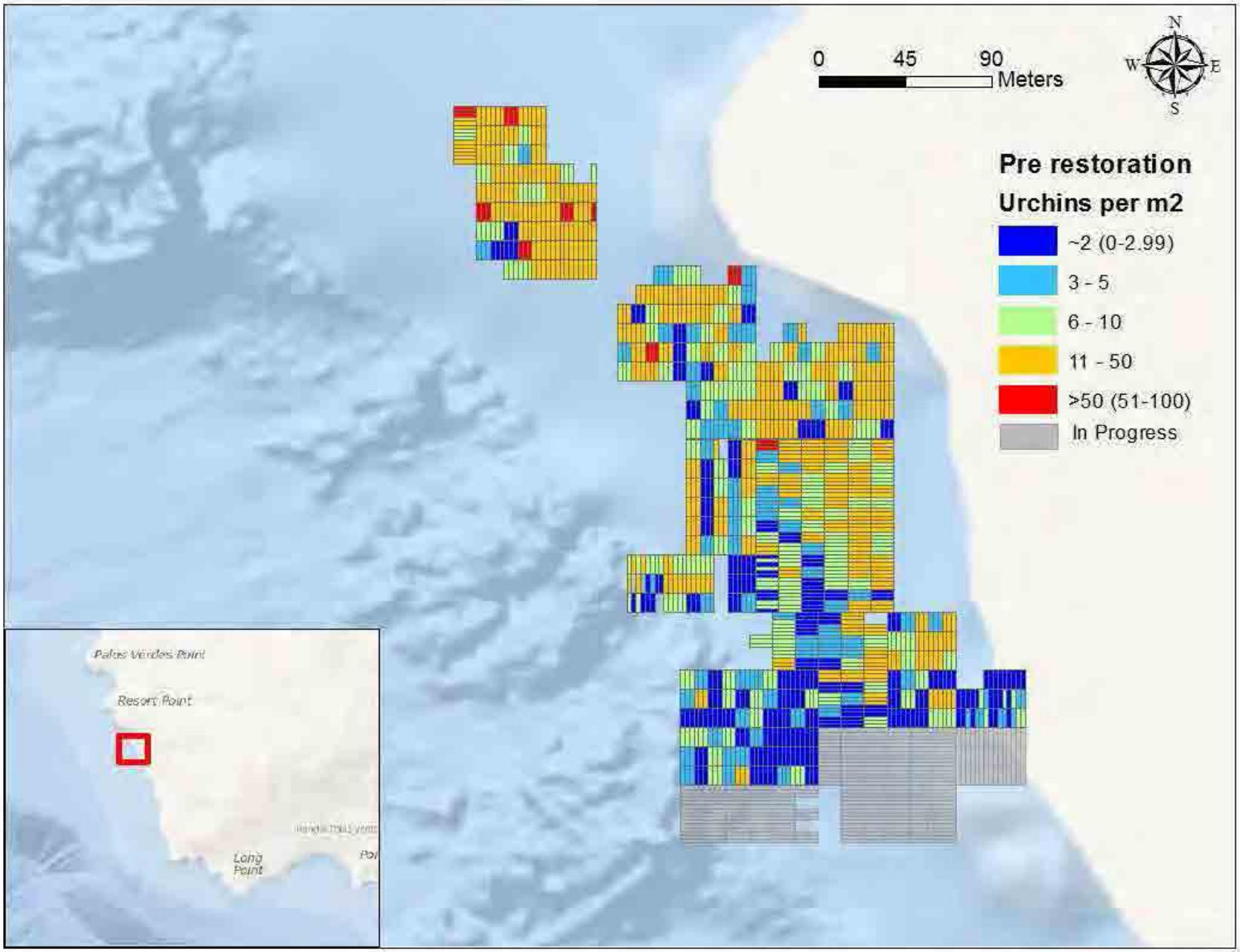
Appendix D: Restoration Photos

Appendix E: Aerial Photos

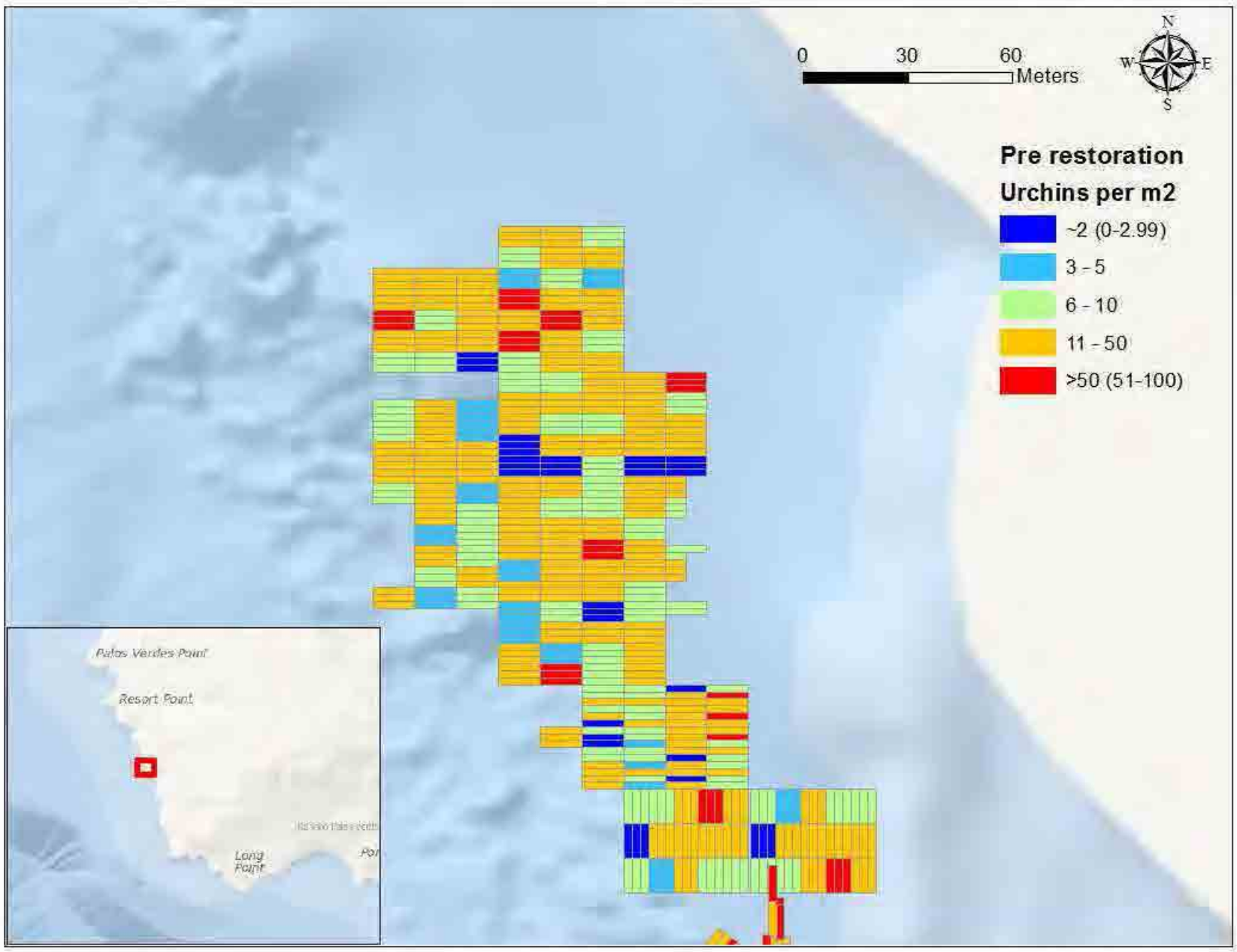
Appendix A: Pre and Post Restoration Urchin Density Maps –July 1, 2013 through June 30, 2016



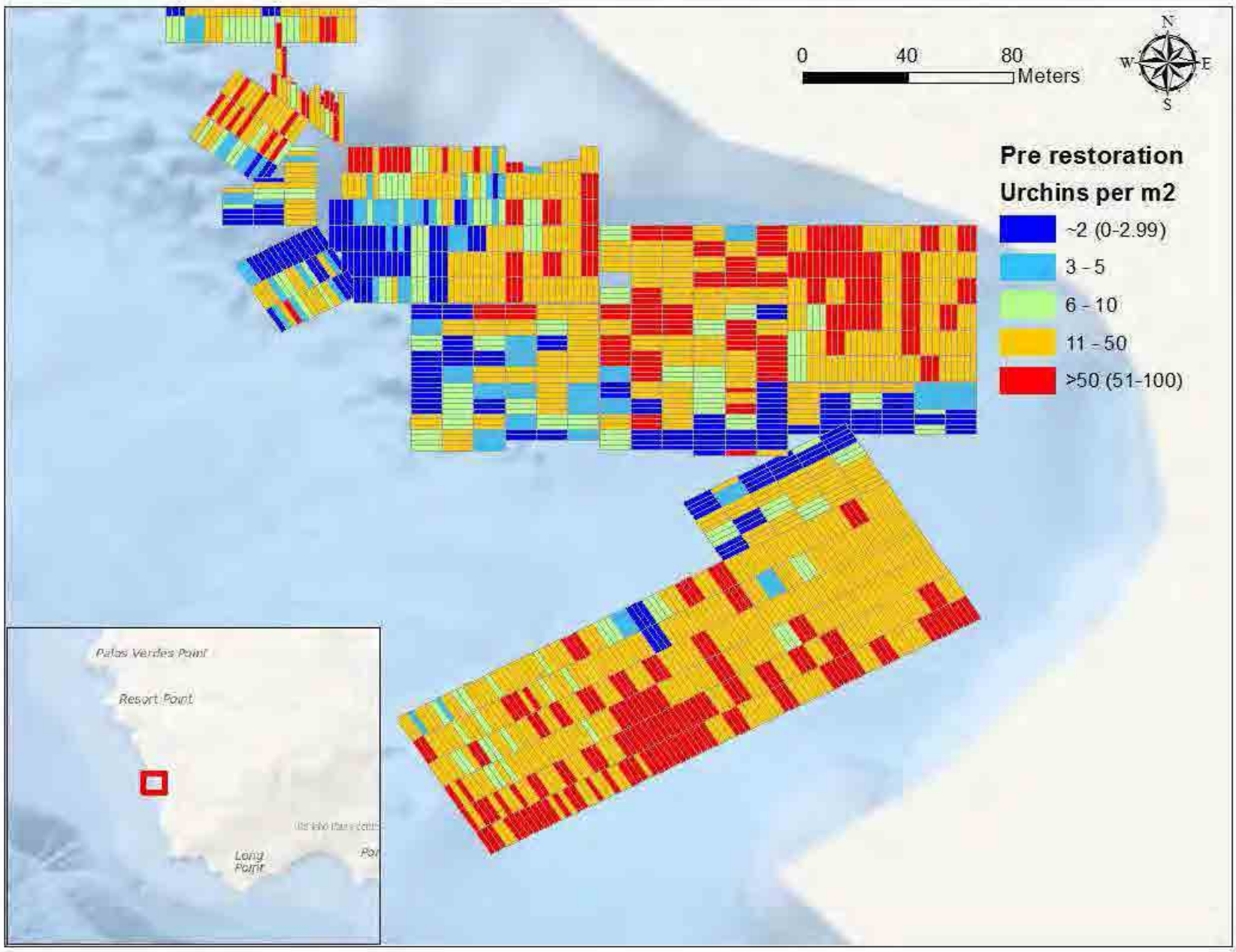
Map A1. Density of *S. purpuratus* (individuals per square meter) pre-restoration in Honeymoon Cove, Palos Verdes, California.



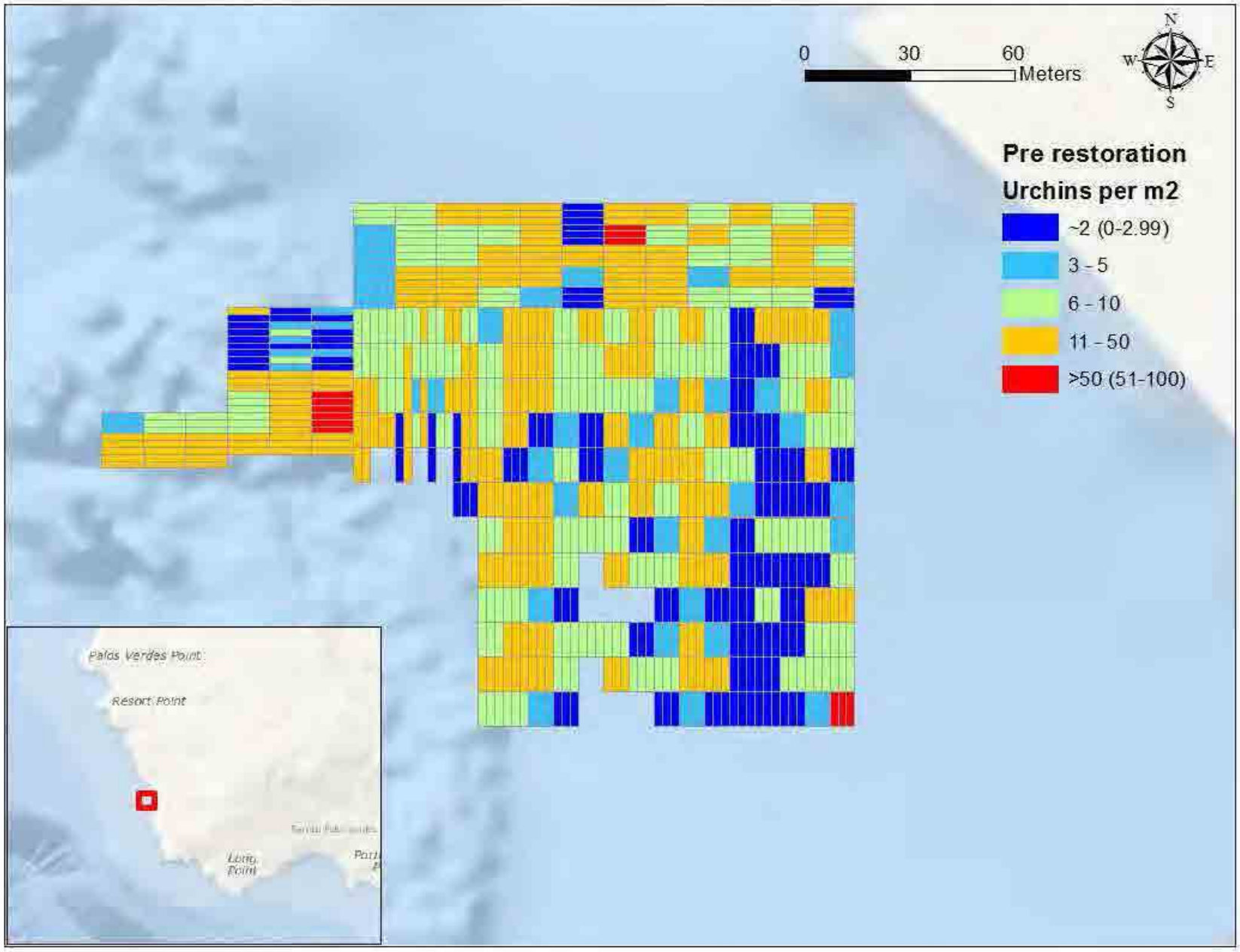
Map A2. Density of *S. purpuratus* (individuals per square meter) pre-restoration in Marguerite (north), Palos Verdes, California.



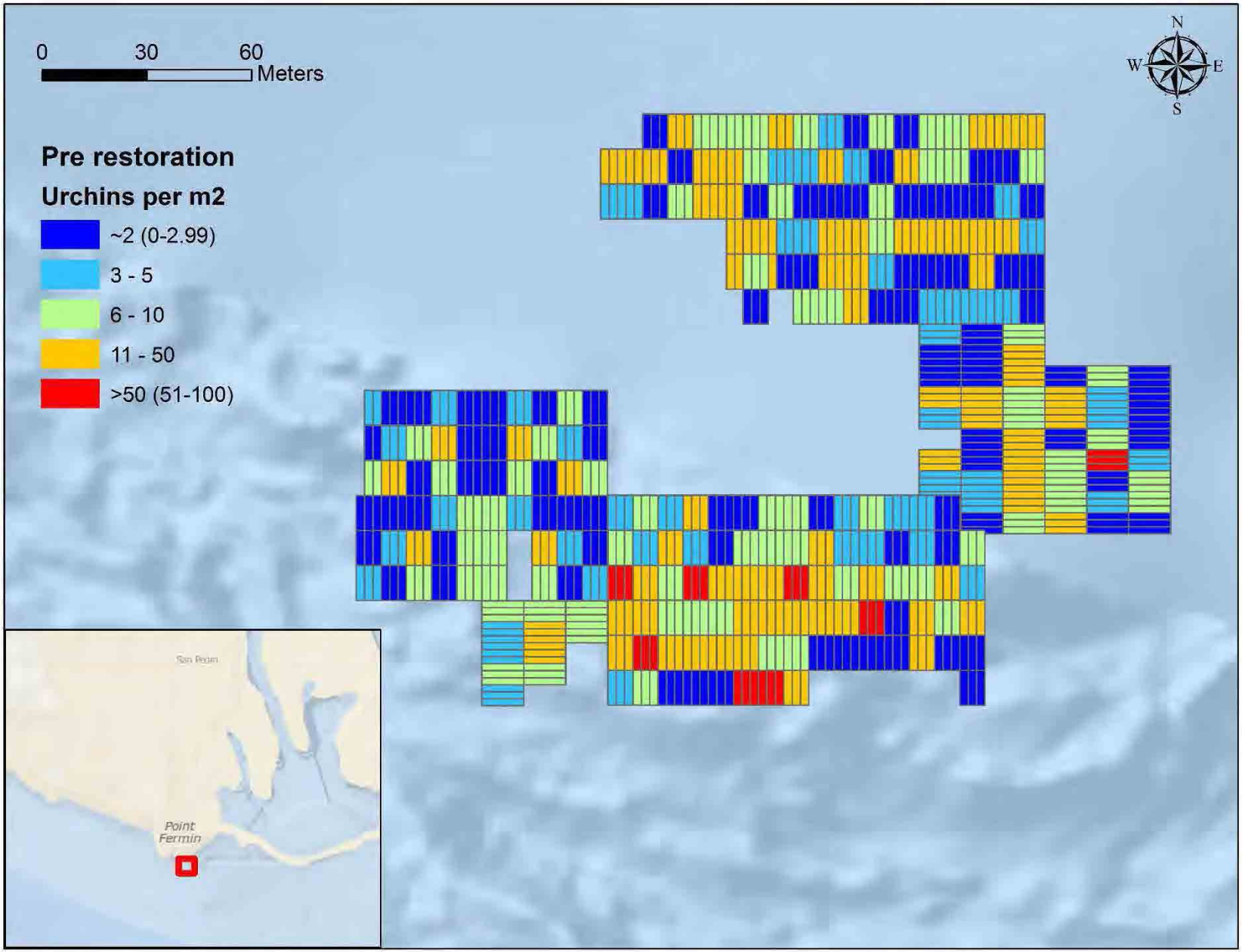
Map A3. Density of *S. purpuratus* (individuals per square meter) pre-restoration in Marguerite (south), Palos Verdes, California.



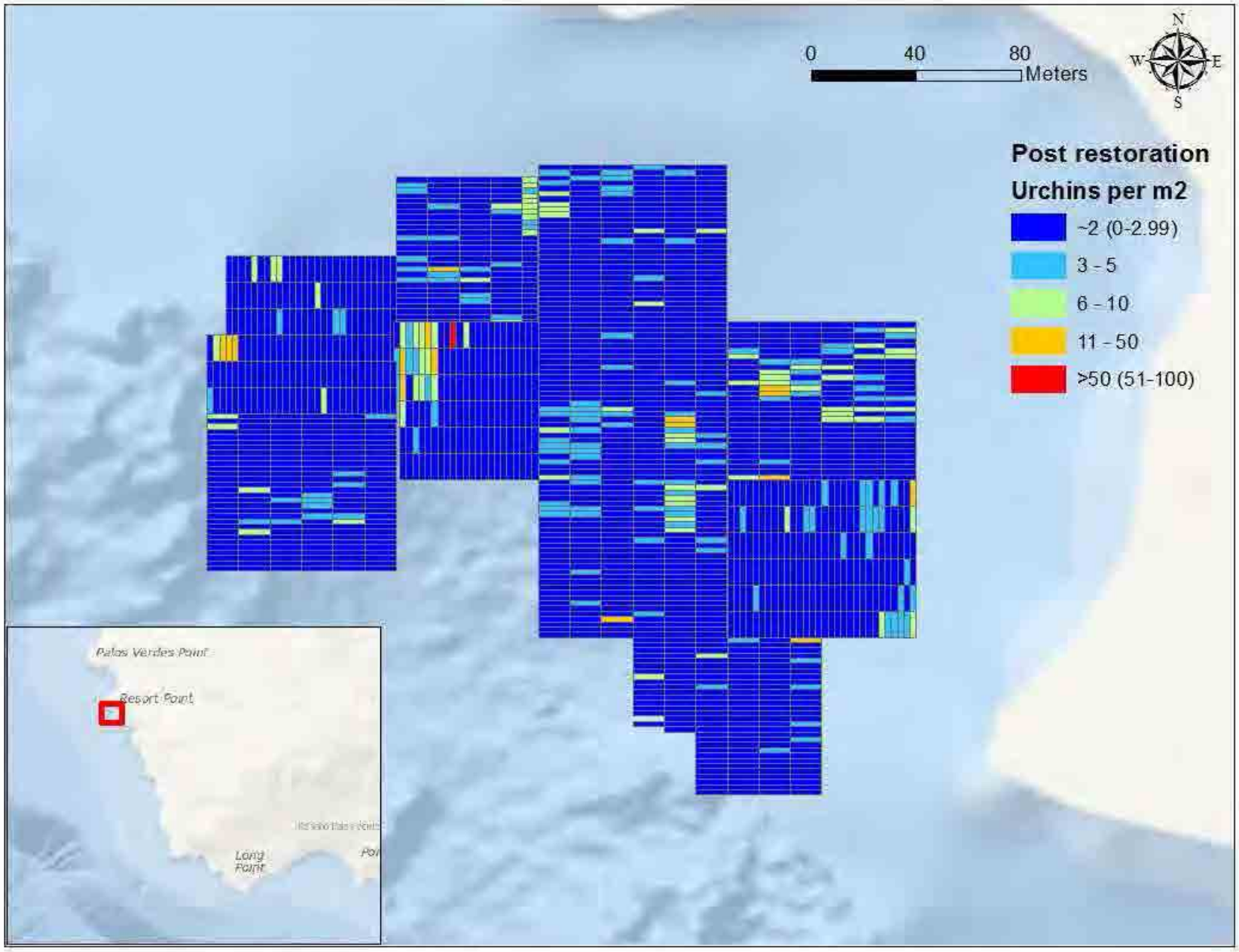
Map A4. Density of *S. purpuratus* (individuals per square meter) pre-restoration in Underwater Arch Cove, Palos Verdes, California.



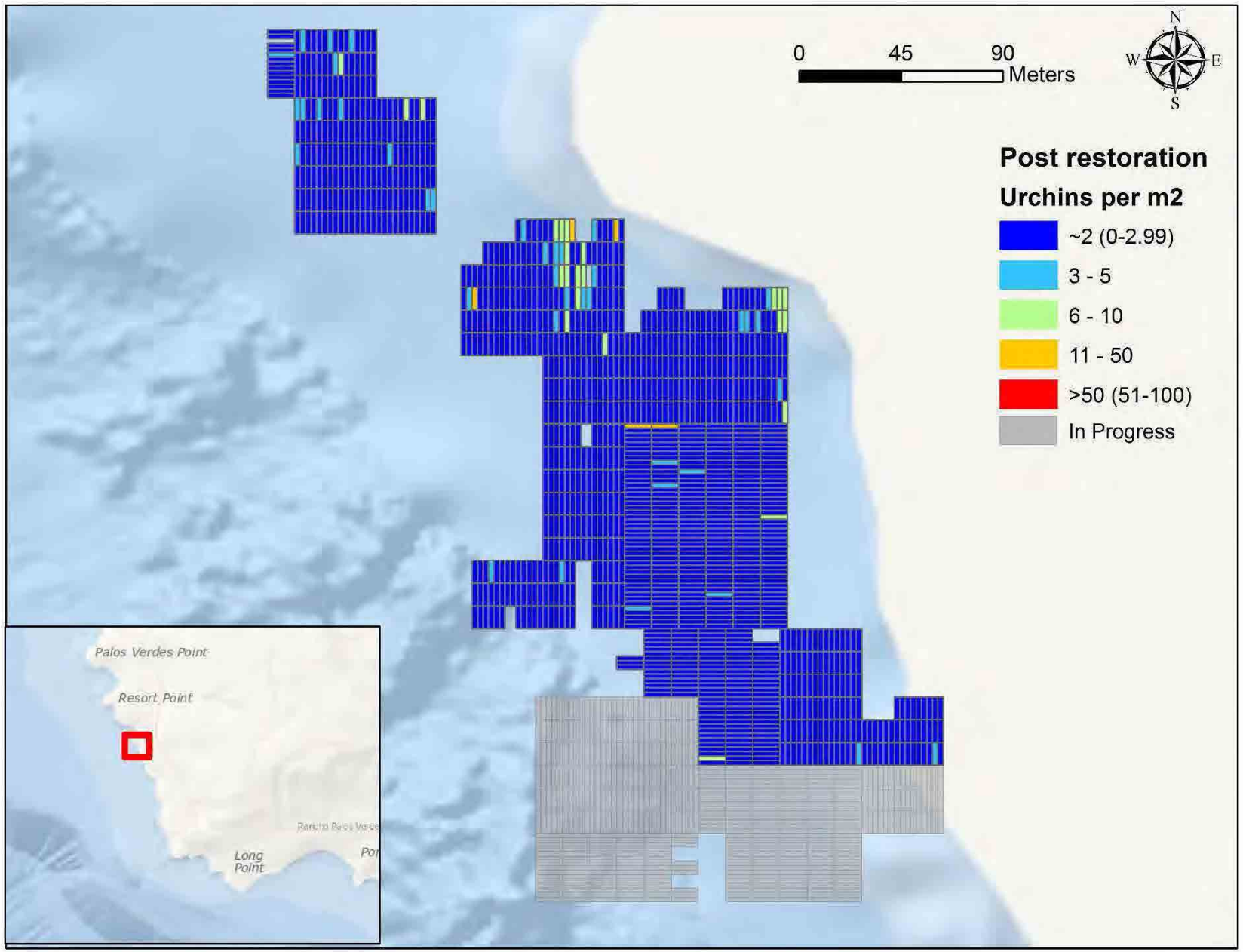
Map A5. Density of *S. purpuratus* (individuals per square meter) pre-restoration in Hawthorne, Palos Verdes, California.



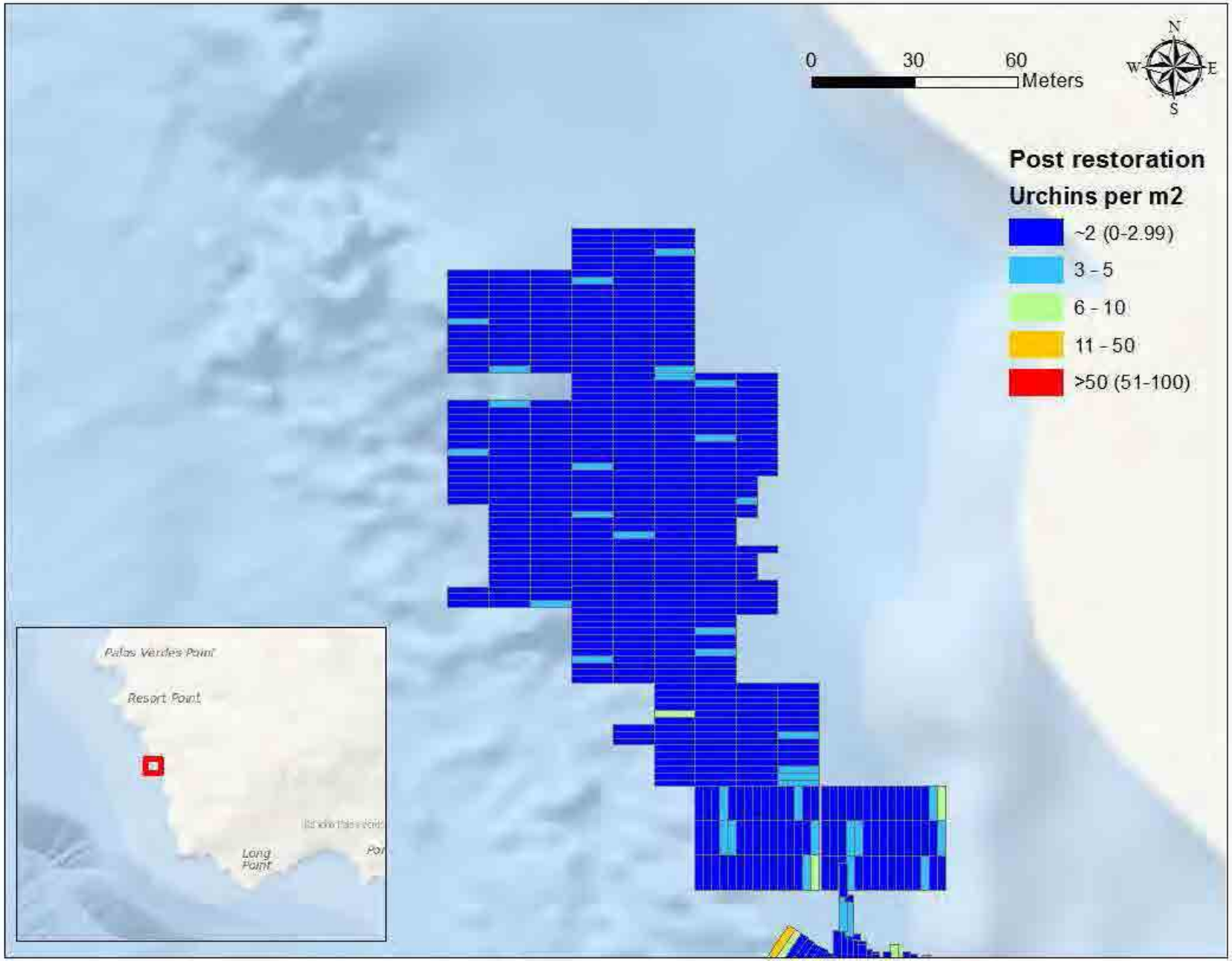
Map A6. Density of *S. purpuratus* (individuals per square meter) pre-restoration in Point Fermin, Palos Verdes, California.



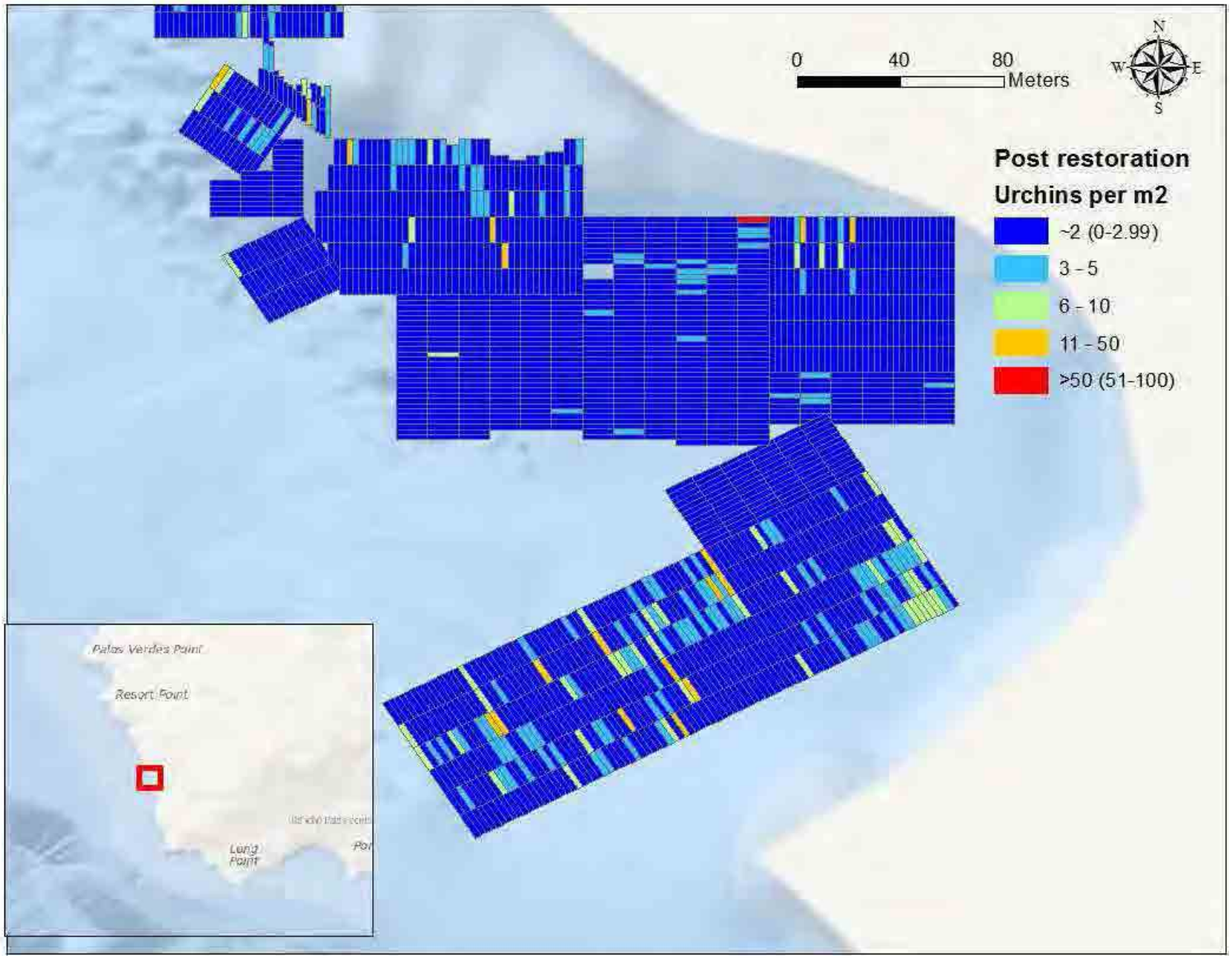
Map A7. Density of *S. purpuratus* (individuals per square meter) post-restoration in Honeymoon Cove, Palos Verdes, California.



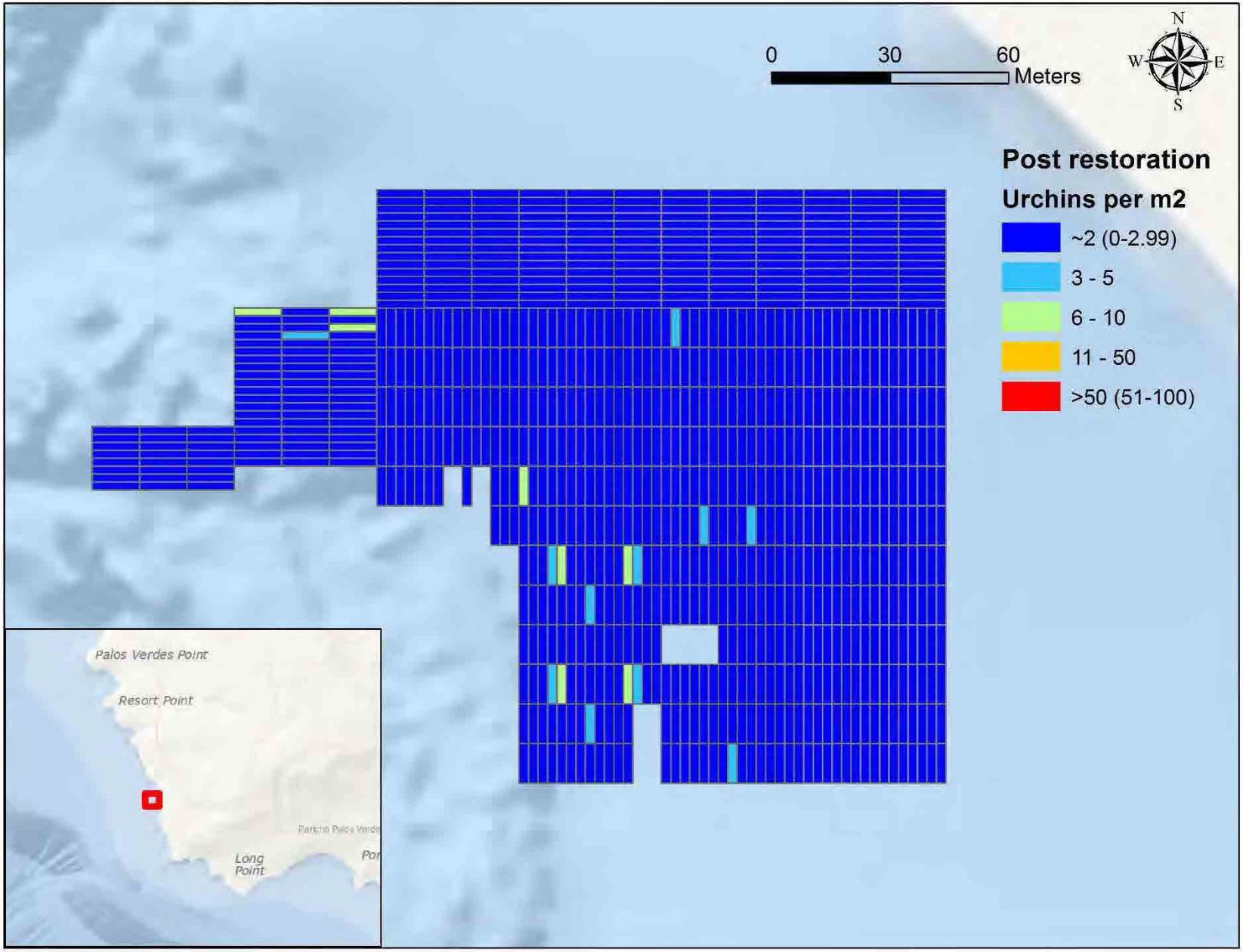
Map A8. Density of *S. purpuratus* (individuals per square meter) post-restoration in Marguerite (north), Palos Verdes, California.



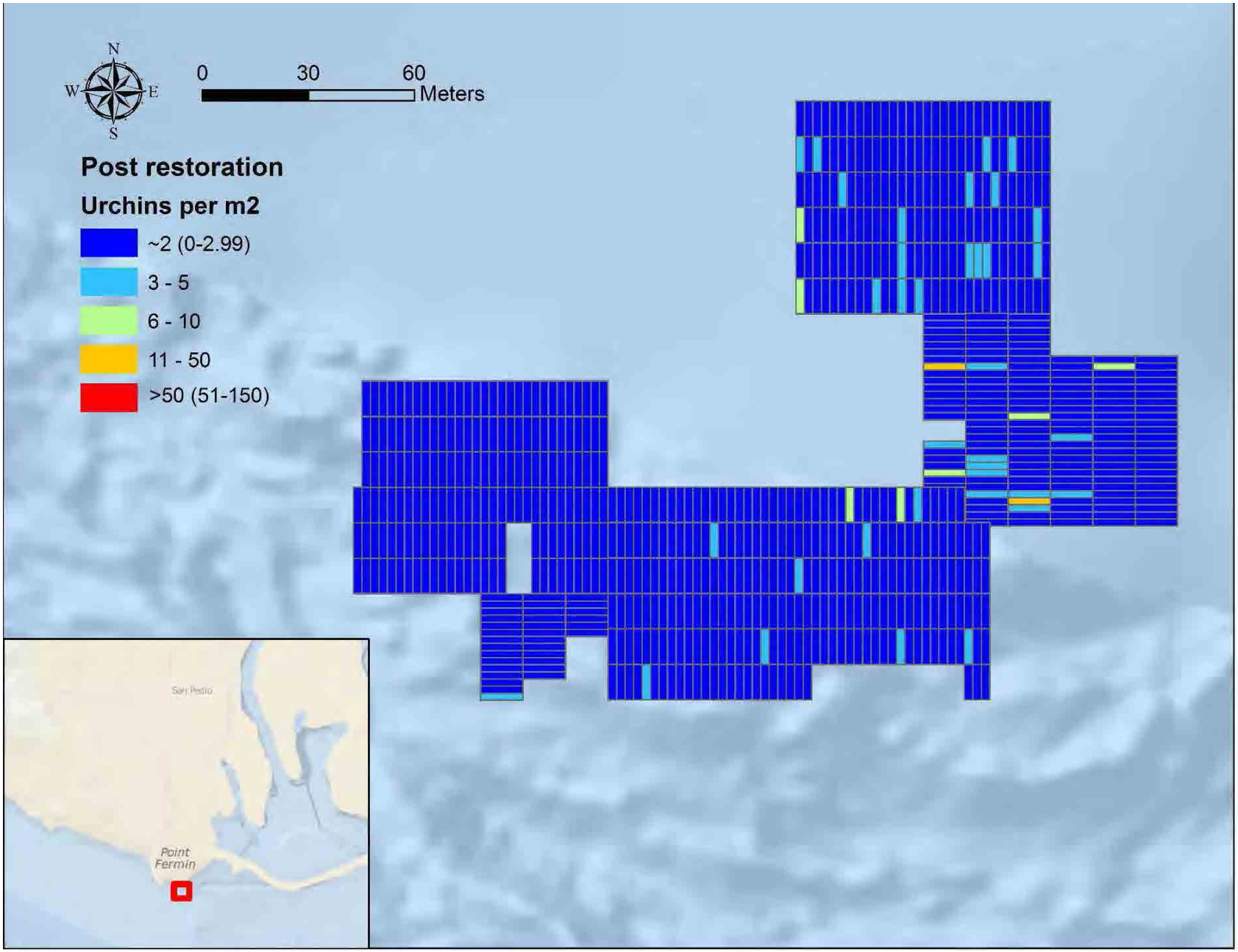
Map A9. Density of *S. purpuratus* (individuals per square meter) post-restoration in Marguerite (south), Palos Verdes, California.



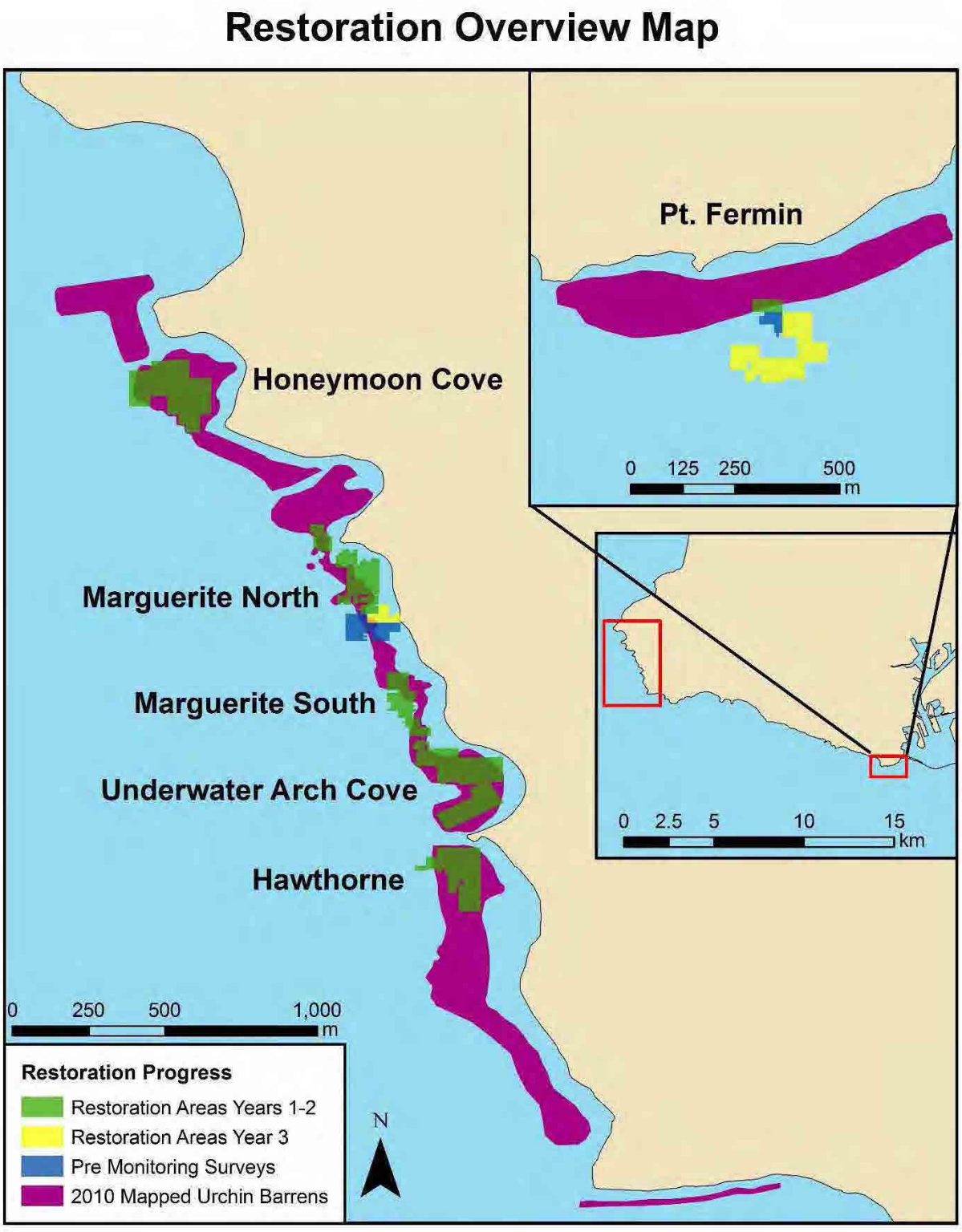
Map A10. Density of *S. purpuratus* (individuals per square meter) post-restoration in Underwater Arch Cove, Palos Verdes, California.



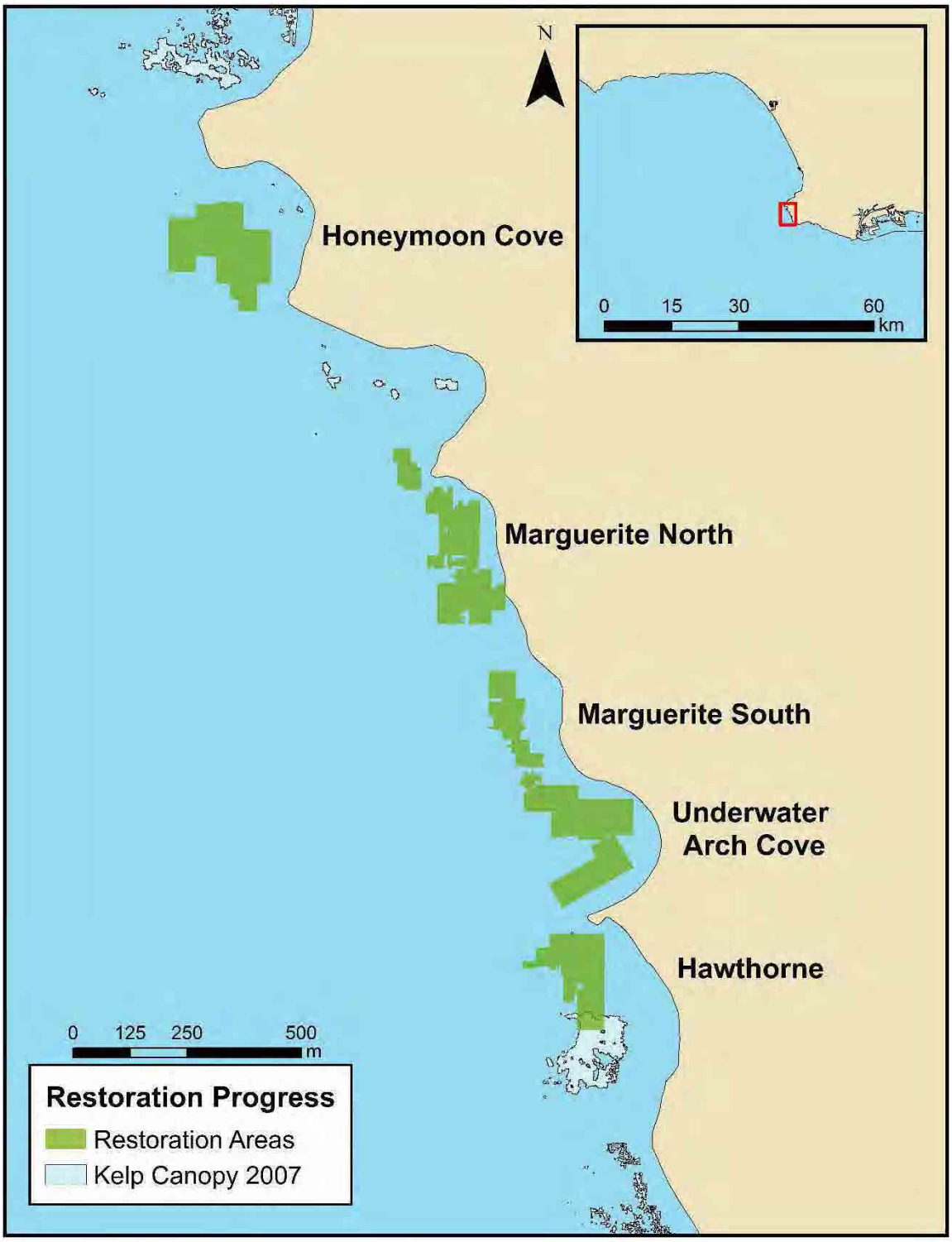
Map A11. Density of *S. purpuratus* (individuals per square meter) post-restoration in Hawthorne, Palos Verdes, California



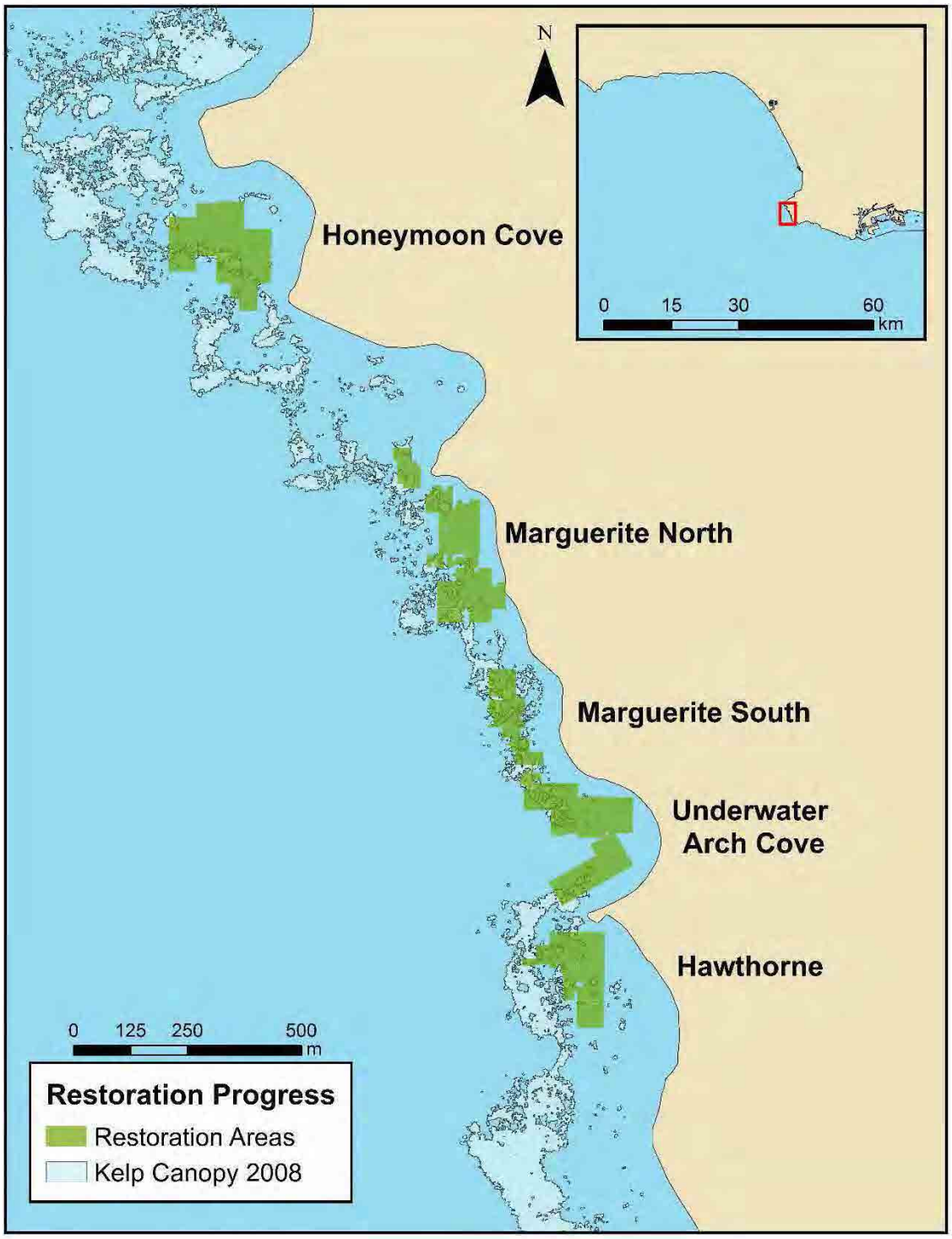
Map A12. Density of *S. purpuratus* (individuals per square meter) post-restoration in Point Fermin, Palos Verdes, California



Map A13. Urchin barrens as mapped in 2010 and observed in 2013, representing a possible expansion and/or shift of urchin barrens. Overview of the project area along the Palos Verdes Peninsula showing the urchin barren extent mapped in 2010 and the observed expansion of the urchin barrens in Honeymoon and Underwater Arch Coves from a series of surveys conducted in summer and fall of 2012. The locations of restoration areas completed in years 1 and 2 are in green, areas restored in year 3 are yellow, and areas currently in progress are blue.

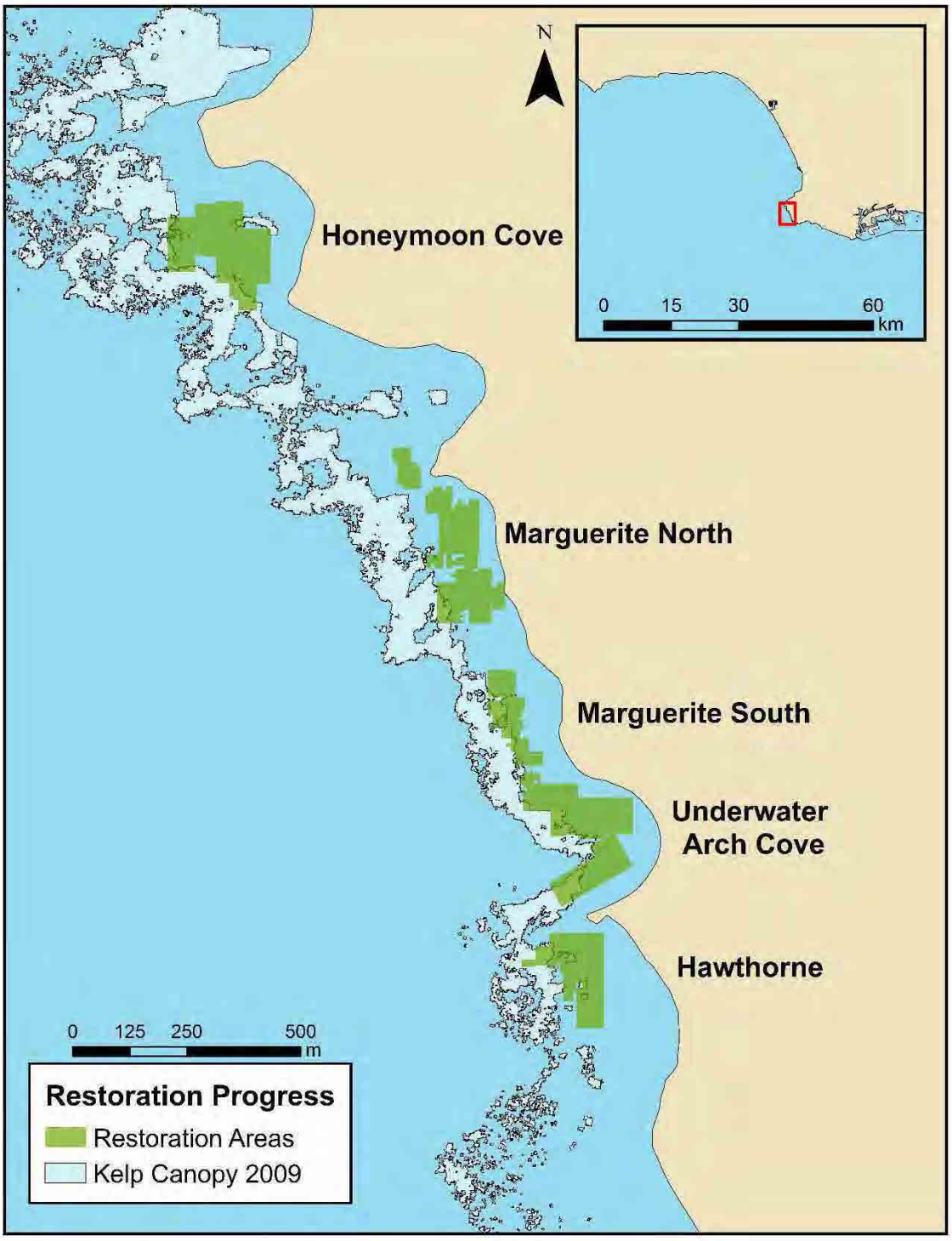


Map A14. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2007. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.

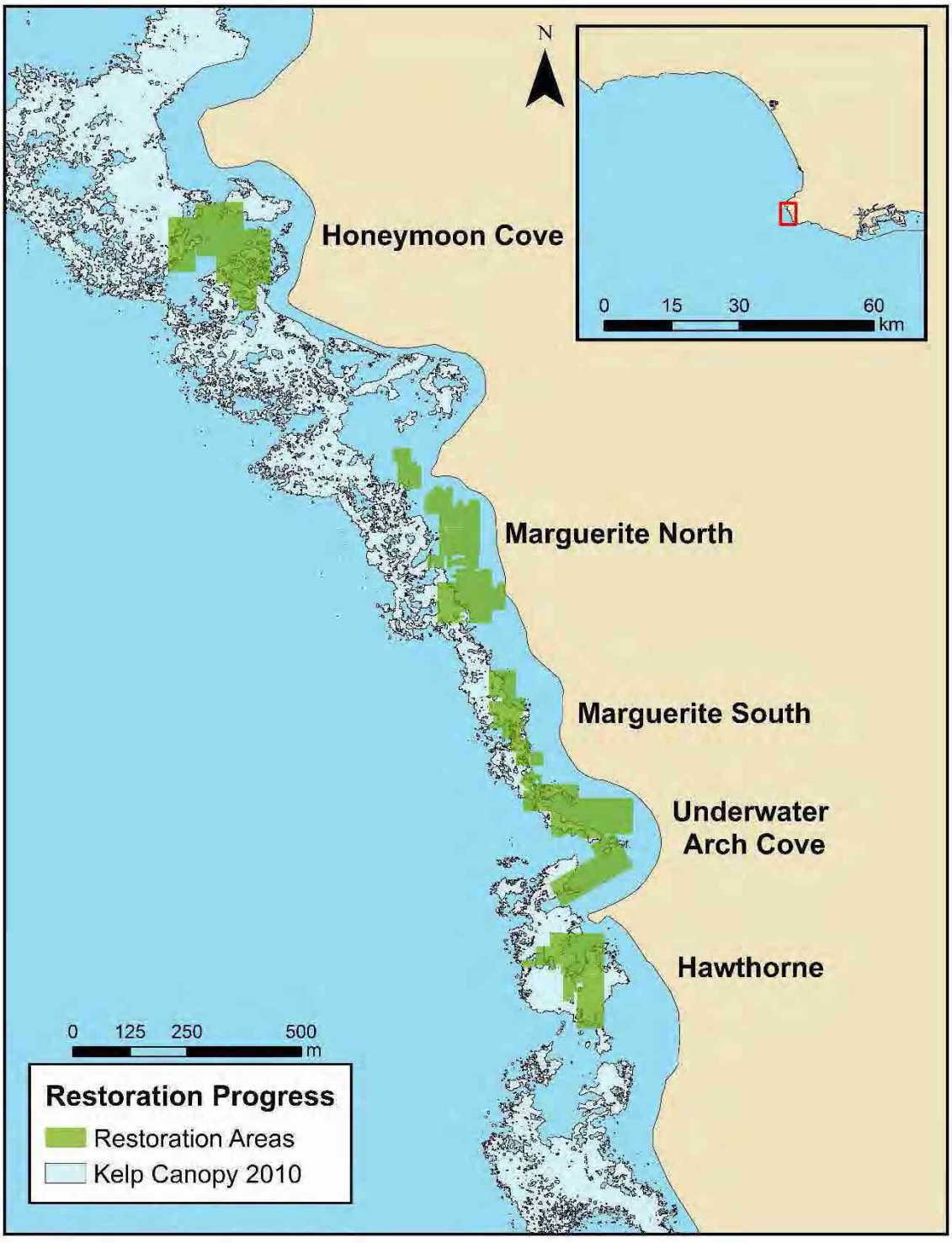


Map A15. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2008. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.

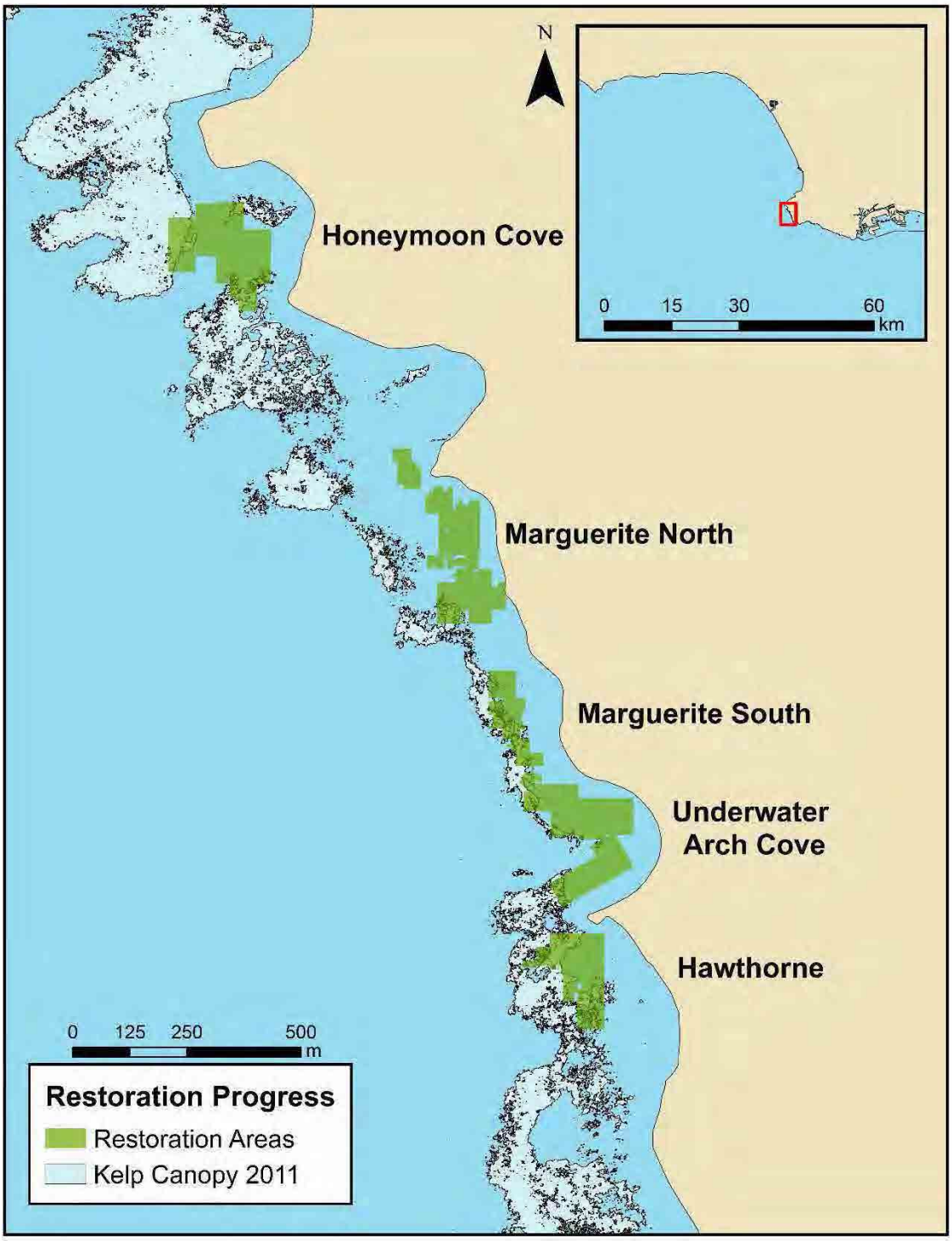
in green.



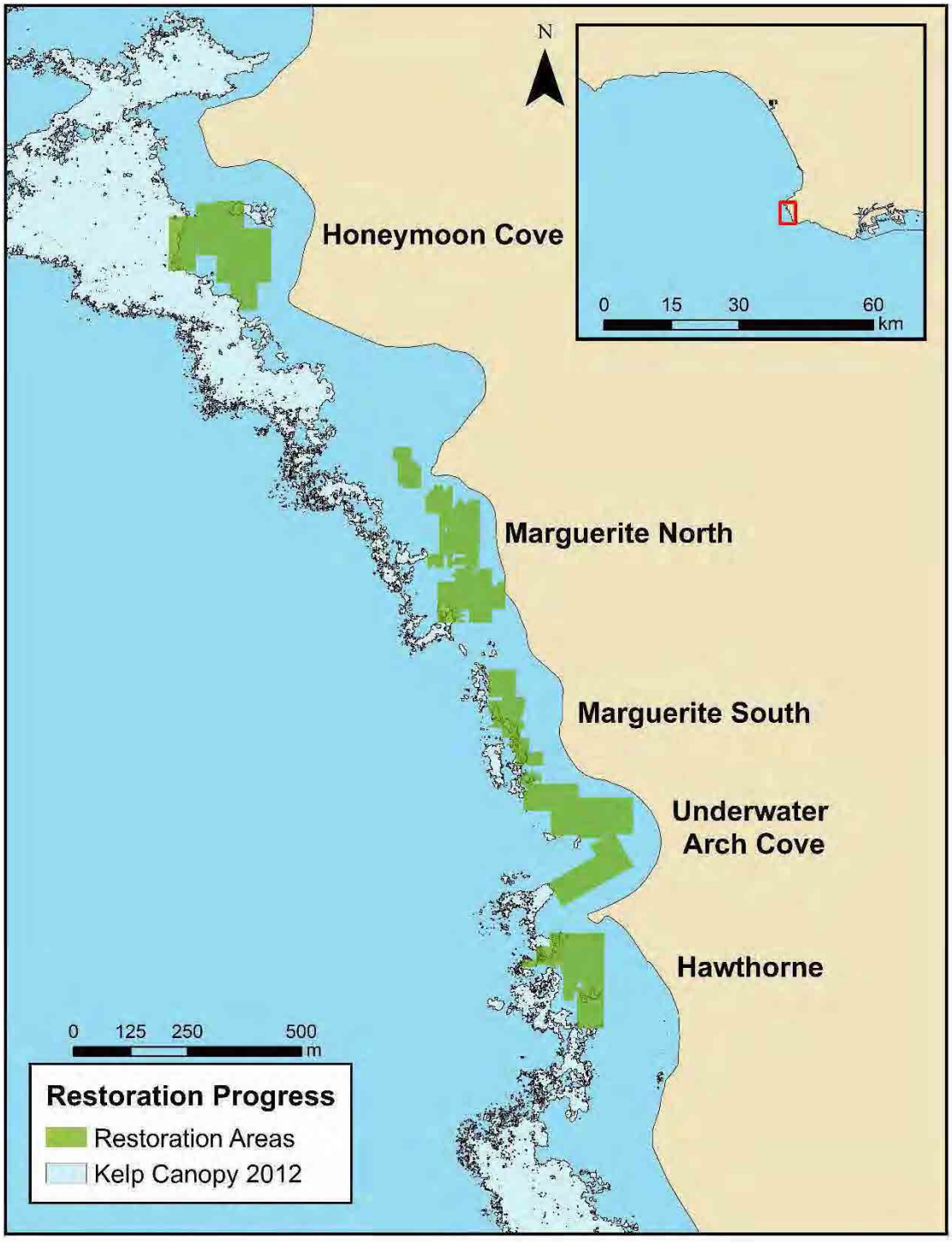
Map A16. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2009. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.



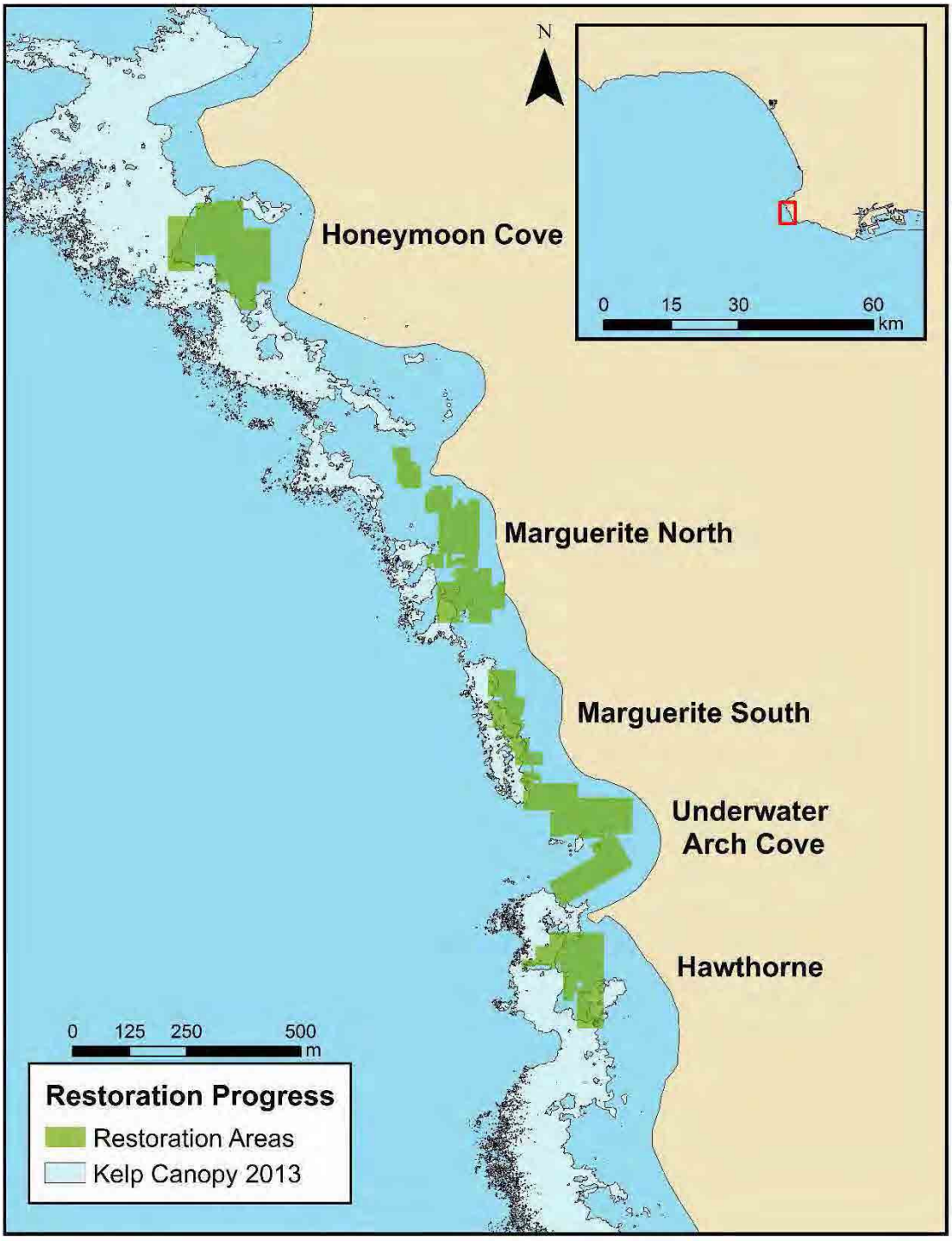
Map A17. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2010. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.



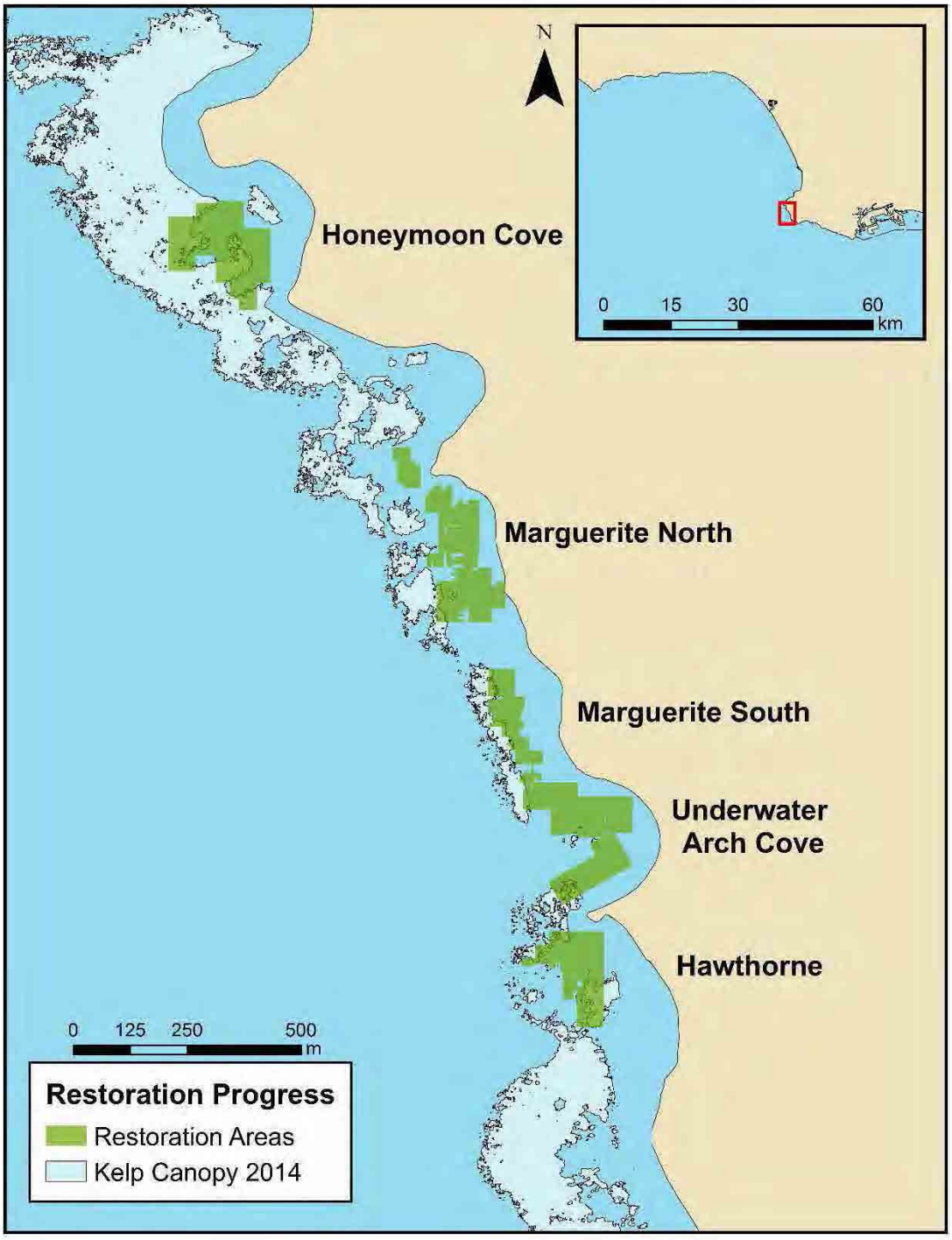
Map A18. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2011. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.



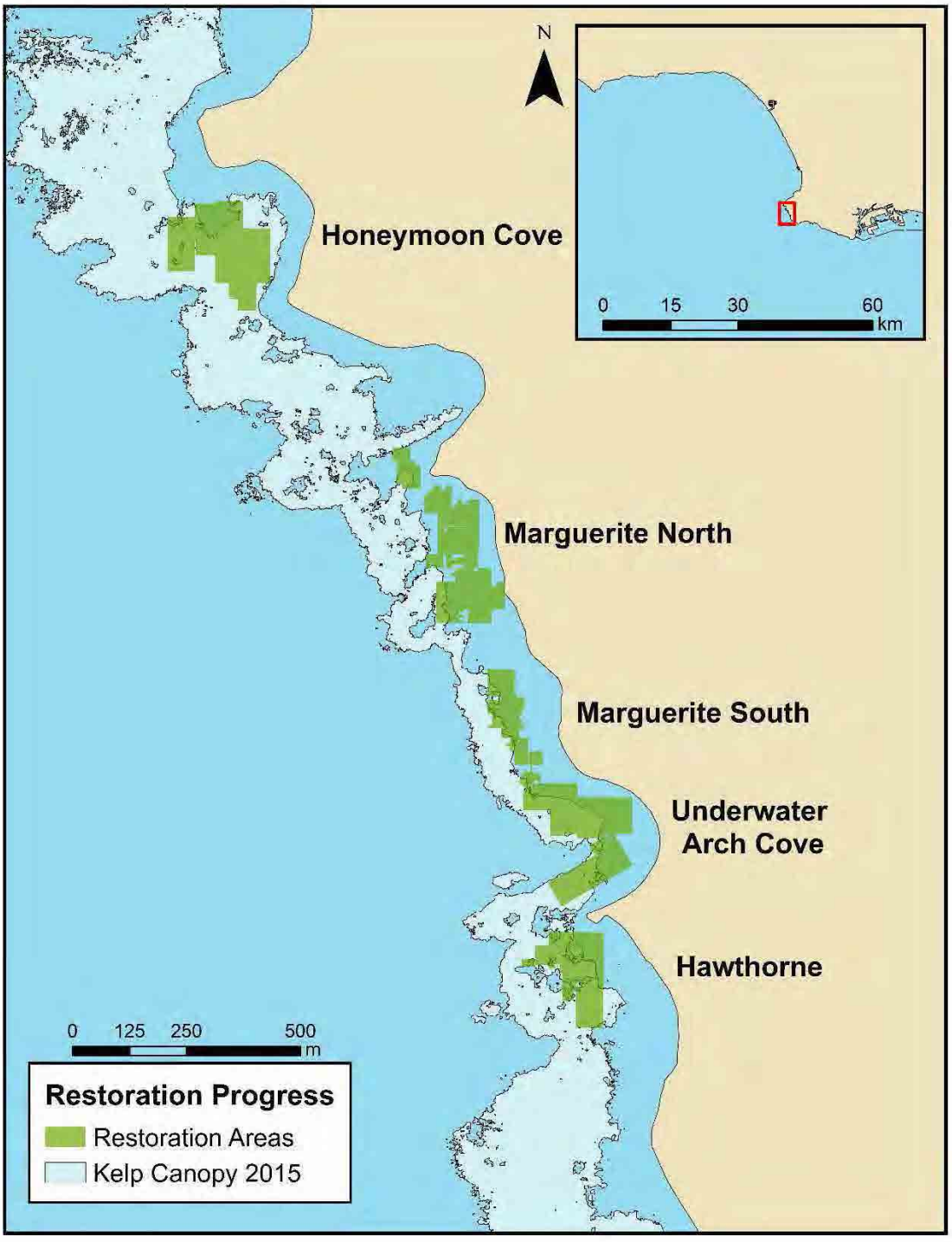
Map A19. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2012. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.



Map A20. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2013. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.



Map A21. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2014. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.



Map A22. Aerial kelp canopy coverage (*Macrocystis pyrifera*) from 2015. Data provided by MBC Applied Environmental. Canopy coverage is represented in light blue while restoration areas are in green.

Appendix B: CRANE Data Tables 2011 – 2016.

Table B1. CRANE Survey Metadata.

CRANE Survey Date							
						Spring	Summer
Site	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2016**
Abalone Cove Kelp West	5/27/2011	6/22/2012	6/21/2013	7/25/2014	9/2/2015	2/10/2016	6/29/2016
Marguerite Central	5/3/2011	6/8/2012	7/3/2013	6/20/2014	9/23/2015	2/10/2016	7/26/2016
Underwater Arch Cove	2/7/2011	6/12/2012	6/12/2013	7/11/2014	9/23/2015	2/10/2016	6/22/2016
Honeymoon Cove	1/28/2011	3/13/2012	5/31/2013	7/2/2014	8/19/2015	2/10/2016	6/22/2016
Point Vicente West	10/12/2011	8/10/2012	4/24/2013	4/18/2014	9/23/2015	2/10/2016	6/22/2016
Rocky Point North	6/24/2011	6/29/2012	7/2/2013	7/11/2014	9/25/2015	2/10/2016	6/10/2016
Bottom Temperature (ºC)							
Site	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2016**
Abalone Cove Kelp West	16	13	18	17	20	14	14
Marguerite Central	15	17	17	20	22	14	14
Underwater Arch Cove	15	19	15	15	22	14	14
Honeymoon Cove	15	12	18	16	21	14	14
Point Vicente West	11	19	15	14	21	14	14
Rocky Point North	18	15	18	21	21	15	15
Coordinates							
Site	**Latitude**	**Longitude**					
Abalone Cove Kelp West	33.73942	-118.38828					
Marguerite Central	33.75694	-118.41772					
Underwater Arch Cove	33.75300	-118.41507					
Honeymoon Cove	33.76490	-118.42339					
Point Vicente West	33.74093	-118.41257					
Rocky Point North	33.77942	-118.42731					

Table B2. Fish Species Richness (total number of species)

							Spring	Summer
Designation	*Site*	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2016**
Control	Abalone Cove Kelp West	7	7	10	9	8	13	13
	Marguerite Central	6	10	10	9	11	8	11
Restoration	Underwater Arch Cove	6	9	6	12	8	7	6
	Honeymoon Cove	—	2	4	8	5	5	12
Reference	Point Vicente West	8	6	10	11	12	11	12
	Rocky Point North	8	8	8	9	6	7	5

Table B3. Density of kelp and related understory algal species (individuals per 100 meters squared).

				2011		***2012***		***2013***		***2014***		***2015***		*Spring* ***2016***		*Spring* ***2016***	
	Species	*Designation*	*Site*	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE
Algae	*Cystoseira osmundacea*	Control	Abalone Cove Kelp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			Marguerite Central	—	—	0.8	0.8	—	—	—	—	—	—	150.8	151	10.8	9
		Restoration	Underwater Arch Cove	—	—	—	—	11.7	1.7	10.8	4.2	22.5	22.5	—	—	0.8	0.8
			Honeymoon Cove	2.5	2.5	—	—	—	—	—	—	0.8	0.8	—	—	—	—
		Reference	Point Vicente West	0.8	0.8	—	—	—	—	—	—	1.7	1.7	—	—	—	—
			Rocky Point North	—	—	—	—	—	—	2.5	0.8	17.5	17.5	1.7	—	41.7	13.3
	Egregia menziesii	Control	Abalone Cove Kelp West	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—	—
			Marguerite Central	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	—	—	0.8	0.8	—	—	—	—
			Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Reference	Point Vicente West	19.2	12.5	13.3	8.3	10.0	10.0	3.3	1.7	30.0	5.0	10.8	5.8	19.2	5.8
			Rocky Point North	—	—	—	—	5.0	—	12.5	5.8	29.2	20.8	5.0	5.0	3.3	3.3
	Eisenia arborea	Control	Abalone Cove Kelp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			Marguerite Central	11.7	11.7	3.3	3.3	12.5	5.8	—	—	—	—	4.2	2.5	—	—
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	0.8	0.8	—	—
		Reference	Point Vicente West	226.7	80.0	253.3	25.0	291.7	8.3	39.2	17.5	97.5	15.8	95.0	10.0	95.8	47.5
			Rocky Point North	—	—	2.5	2.5	18.3	11.7	28.3	6.7	21.7	13.3	14.2	5.8	25.8	7.5
	Macrocystis pyrifera	Control	Abalone Cove Kelp West	4.2	4.2	—	—	—	—	—	—	56.7	11.7	43.3	11.7	62.5	0.8
			Marguerite Central	—	—	—	—	—	—	10.0	10.0	9.2	4.2	3.3	1.7	46.7	35.0
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	25.0	—	45.8	4.2	—	—	—	—
			Honeymoon Cove	1.7	1.7	—	—	—	—	7.5	7.5	118.3	—	25.0	1.7	152.5	40.8
		Reference	Point Vicente West	28.3	6.7	27.5	10.8	12.5	0.8	5.8	2.5	13.3	8.3	—	—	59.2	24.2
			Rocky Point North	110.0	15.0	20.0	3.3	76.7	15.0	319.2	169.2	27.5	0.8	—	—	114.2	29.2
	Sargassum horneri	Control	Abalone Cove Kelp West	—	—	—	—	—	—	—	—	—	—	404.2	172.5	—	—
			Marguerite Central	—	—	—	—	—	—	—	—	118.3	38.3	11.7	10.0	24.2	24.2
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	—	—	—	—	28.3	28.3	—	—
			Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	90.0	51.7	—	—
		Reference	Point Vicente West	—	—	—	—	—	—	—	—	—	—	2.5	0.8	—	—
			Rocky Point North	—	—	—	—	—	—	—	—	5.0	1.7	77.5	40.8	15.8	9.2
	Sargassum muticum	Control	Abalone Cove Kelp West	—	—	—	—	—	—	—	—	2.5	2.5	318.3	318.3	—	—
			Marguerite Central	—	—	—	—	—	—	—	—	—	—	1.7	1.7	5.8	5.8
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	—	—	—	—	12.5	12.5	—	—
			Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Reference	Point Vicente West	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			Rocky Point North	—	—	—	—	—	—	—	—	—	—	7.5	4.2	2.5	2.5

Table B4. Density of kelp forest invertebrate species (individuals per 100 meters squared).

	Species	Designation	Site	2011 Mean Density (#/100m²)	2011 SE	2012 Mean Density (#/100m²)	2012 SE	2013 Mean Density (#/100m²)	2013 SE	2014 Mean Density (#/100m²)	2014 SE	2015 Mean Density (#/100m²)	2015 SE	Spring 2016 Mean Density (#/100m²)	Spring 2016 SE	Spring 2016 Mean Density (#/100m²)	Spring 2016 SE
Invertebrates	*Anthopleura elegantissima*	Control	Abalone Cove Kelp West	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			Marguerite Central	272.5	207.5	3.3	3.3	—	—	—	—	—	—	—	—	—	—
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Reference	Point Vicente West	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			Rocky Point North	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Anthopleura sola	Control	Abalone Cove Kelp West	42.5	26	3.3	—	10.0	3.3	90.0	58	—	—	1.7	—	4.2	4.2
			Marguerite Central	79.2	53	34.2	21	85.8	9.2	33.3	10	16.7	—	63.3	10.0	10.0	1.7
		Restoration	Underwater Arch Cove	52.5	6	115.0	52	24.2	11	18.3	5.0	4.2	2.5	40.8	7.5	18.3	5.0
			Honeymoon Cove	—	—	5.0	2	—	—	1.7	2	—	—	3.3	3.3	1.7	1.7
		Reference	Point Vicente West	85.8	4.2	155.8	78	144.2	44.2	198.3	6.7	0.8	0.8	8.3	1.7	3.3	1.7
			Rocky Point North	0.8	0.8	—	—	—	—	—	—	—	—	—	—	—	—
	Aplysia vaccaria	Control	Abalone Cove Kelp West	—	—	—	—	—	—	—	—	7.5	7.5	—	—	—	—
			Marguerite Central	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	—	—	—	—	—	—	12.5	4.2
			Honeymoon Cove	—	—	—	—	—	—	0.8	0.8	—	—	3.3	1.7	3.3	1.7
		Reference	Point Vicente West	—	—	—	—	—	—	—	—	—	—	—	—	2.5	2.5
			Rocky Point North	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Megastraea undosa	Control	Abalone Cove Kelp West	—	—	—	—	—	—	—	—	4.2	0.8	14.2	5.8	25.8	15.8
			Marguerite Central	—	—	—	—	—	—	—	—	0.8	0.8	73.3	63.3	75.0	50.0
		Restoration	Underwater Arch Cove	—	—	—	—	—	—	0.8	0.8	5.0	5.0	33.3	5.0	29.2	12.5
			Honeymoon Cove	2.5	1	—	—	0.8	1	0.8	1	9.2	0.8	9.2	7.5	0.8	0.8
		Reference	Point Vicente West	—	—	—	—	0.8	0.8	—	—	1.7	—	1.7	1.7	—	—
			Rocky Point North	27.5	9.2	25.8	4.2	4.2	0.8	0.8	0.8	3.3	—	2.5	2.5	—	—
	Panulirus interruptus	Control	Abalone Cove Kelp West	0.8	1	—	—	—	—	—	—	—	—	6.7	6.7	0.8	0.8
			Marguerite Central	—	—	—	—	—	—	—	—	4.2	4.2	—	—	—	—
		Restoration	Underwater Arch Cove	—	—	—	—	0.8	0.8	—	—	—	—	—	—	0.8	0.8
			Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	—	—	1.7	—
		Reference	Point Vicente West	2.5	0.8	0.8	0.8	1.7	1.7	0.8	0.8	5.0	5.0	1.7	1.7	—	—
			Rocky Point North	—	—	—	—	1.7	1.7	2.5	2.5	1.7	—	—	—	—	—
	Patiria miniata	Control	Abalone Cove Kelp West	20.8	6	11.7	2	5.0	1.7	2.5	3	—	—	—	—	—	—
			Marguerite Central	1.7	2	13.3	7	0.8	0.8	—	—	—	—	—	—	—	—
		Restoration	Underwater Arch Cove	10.8	3	21.7	2	—	—	—	—	—	—	—	—	0.8	0.8
			Honeymoon Cove	35.0	10	8.3	—	20.0	5	—	—	—	—	—	—	—	—
		Reference	Point Vicente West	—	—	—	—	0.8	0.8	0.8	0.8	—	—	—	—	—	—
			Rocky Point North	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Pisaster giganteus	Control	Abalone Cove Kelp West	25.0	2	33.3	10	23.3	5.0	0.8	0.8	—	—	—	—	0.8	0.8
			Marguerite Central	29.2	14.2	20.0	1.7	26.7	10.0	—	—	—	—	—	—	—	—
		Restoration	Underwater Arch Cove	6.7	1.7	15.8	2.5	—	—	—	—	—	—	—	—	—	—
			Honeymoon Cove	6.7	1.7	3.3	—	1.7	—	—	—	—	—	—	—	—	—
		Reference	Point Vicente West	21.7	8.3	8.3	3.3	10.0	—	—	—	—	—	—	—	—	—
			Rocky Point North	1.7	1.7	—	—	1.7	1.7	—	—	—	—	—	—	—	—
	Pisaster ochraceus	Control	Abalone Cove Kelp West	30.0	5	3.3	—	5.0	3.3	—	—	—	—	0.8	0.8	0.8	0.8
			Marguerite Central	23.3	7	8.3	—	10.8	5.8	0.8	1	—	—	—	—	—	—
		Restoration	Underwater Arch Cove	20.8	6	12.5	3	1.7	—	—	—	—	—	—	—	—	—
			Honeymoon Cove	9.2	4	3.3	2	1.7	2	—	—	—	—	—	—	—	—
		Reference	Point Vicente West	23.3	6.7	8.3	3	5.0	1.7	—	—	—	—	—	—	—	—
			Rocky Point North	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Strongylocentrotus franciscanus	Control	Abalone Cove Kelp West	464.2	221	165.8	129	110.0	10.0	50.0	11.7	0.8	0.8	2.5	2.5	10.0	3.3
			Marguerite Central	45.0	16.7	58.3	30.0	12.5	0.8	8.3	3.3	2.5	2.5	1.7	1.7	0.8	0.8
		Restoration	Underwater Arch Cove	54.2	17.5	33.3	13.3	23.3	18.3	42.5	7.5	2.5	0.8	1.7	—	0.8	0.8
			Honeymoon Cove	63.3	1.7	44.2	0.8	34.2	4.2	11.7	1.7	7.5	2.5	2.5	0.8	—	—
		Reference	Point Vicente West	31.7	10.0	55.8	27.5	32.5	4.2	26.7	10.0	2.5	0.8	0.8	0.8	3.3	—
			Rocky Point North	5.0	5.0	9.2	9.2	1.7	1.7	0.8	0.8	—	—	—	—	—	—
	Strongylocentrotus purpuratus	Control	Abalone Cove Kelp West	1250.0	250	902.5	268	462.5	87.5	1567.5	318	11.7	1.7	50.0	18.3	21.7	5.0
			Marguerite Central	2450.0	900	5765.0	1527	1499.2	80.8	1705.8	303	193.3	50.0	182.5	25.8	43.3	3.3
		Restoration	Underwater Arch Cove	2195.8	471	939.2	349	1008.3	465	24.2	10.8	1.7	—	3.3	3.3	0.8	0.8
			Honeymoon Cove	1541.7	142	1222.5	216	1223.3	303	325.0	298	9.2	0.8	6.7	5.0	16.7	16.7
		Reference	Point Vicente West	247.5	75.8	490.8	369	535.8	47.5	185.8	5.8	16.7	5.0	19.2	12.5	12.5	0.8
			Rocky Point North	15.8	7.5	30.8	12.5	10.0	8.3	3.3	—	5.8	5.8	0.8	0.8	—	—

Table B5. Fish Density (individuals per 100 meters squared).

			2011		2012		2013		2014		2015		Spring 2016		Summer 2016	
Species	*Designation*	*Site*	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE	Mean Density (#/100m^2)	SE
Chromis punctipinnis	Control	Abalone Cove Kelp West	14.6	7.6	—	—	4.2	4.2	4.6	2.7	—	—	11.7	11.7	—	—
		Marguerite Central	0.8	0.8	—	—	6.3	5.2	—	—	—	—	—	—	—	—
	Restoration	Underwater Arch Cove	1.3	1.3	1.3	1.3	0.4	0.4	2.1	0.8	—	—	—	—	21.3	8.5
		Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	—	—	2.5	2.5
	Reference	Point Vicente West	—	—	—	—	—	—	8.3	5.5	—	—	22.5	21.4	2.9	1.3
		Rocky Point North	0.4	0.4	—	—	—	—	—	—	—	—	—	—	—	—
Girella nigricans	Control	Abalone Cove Kelp West	1.3	0.8	0.4	0.4	1.3	1.3	0.8	0.5	—	—	—	—	2.1	1.0
		Marguerite Central	—	—	1.7	1.7	—	—	0.4	0.4	20.0	13.1	5.4	3.1	31.7	13.4
	Restoration	Underwater Arch Cove	4.2	3.6	0.4	0.4	—	—	0.4	0.4	—	—	0.4	0.4	—	—
		Honeymoon Cove	—	—	—	—	—	—	—	—	0.8	0.8	—	—	1.3	0.8
	Reference	Point Vicente West	—	—	—	—	1.3	0.8	1.7	1.2	0.4	0.4	0.8	0.5	0.8	0.5
		Rocky Point North	—	—	0.8	0.8	—	—	1.7	1.0	1.3	0.8	3.8	2.2	0.4	0.4
Paralabrax clathratus	Control	Abalone Cove Kelp West	0.4	0.4	—	—	0.8	0.5	0.4	0.4	1.3	0.4	2.1	1.0	2.1	1.6
		Marguerite Central	—	—	1.3	1.3	1.7	1.2	3.3	0.7	5.0	3.0	1.7	0.7	7.1	3.8
	Restoration	Underwater Arch Cove	—	—	0.4	0.4	0.4	0.4	6.7	4.5	4.2	2.2	2.9	0.8	4.6	1.3
		Honeymoon Cove	—	—	—	—	0.8	0.5	1.3	0.4	0.8	0.8	0.4	0.4	2.1	0.4
	Reference	Point Vicente West	—	—	—	—	0.8	0.5	—	—	2.9	0.4	1.3	0.4	4.6	1.8
		Rocky Point North	1.7	0.7	2.5	1.4	6.7	1.9	2.1	0.8	4.2	1.6	2.5	1.4	0.4	0.4
Semicossyphus pulcher	Control	Abalone Cove Kelp West	—	—	0.4	0.4	0.4	0.4	—	—	0.8	0.5	0.8	0.8	—	—
		Marguerite Central	0.4	0.4	0.4	0.4	—	—	0.8	0.5	—	—	1.3	0.8	2.9	1.8
	Restoration	Underwater Arch Cove	0.4	0.4	1.3	0.4	—	—	0.4	0.4	—	—	0.8	0.5	2.9	1.8
		Honeymoon Cove	—	—	—	—	—	—	—	—	0.4	0.4	0.4	0.4	0.8	0.8
	Reference	Point Vicente West	0.4	0.4	—	—	—	—	1.3	0.8	0.8	0.5	1.3	0.4	2.5	1.6
		Rocky Point North	0.8	0.8	1.7	0.7	3.8	0.4	0.4	0.4	0.4	0.4	0.8	0.8	0.4	0.4

Table B6. Fish Biomass (individuals per 100 meters squared).

			2011		2012		2013		2014		2015		Spring 2016		Summer 2016	
Species	*Designation*	*Site*	Mean Density (g/100m^2)	SE	Mean Density (g/100m^2)	SE	Mean Density (g/100m^2)	SE	Mean Density (g/100m^2)	SE	Mean Density (g/100m^2)	SE	Mean Density (g/100m^2)	SE	Mean Density (g/100m^2)	SE
Chromis punctipinnis	Control	Abalone Cove Kelp West	254.2	144	—	—	145.1	86.6	254.3	113.2	—	—	262.9	175.0	15.8	11.7
		Marguerite Central	20.5	20.5	3.0	3	194.9	154	—	—	—	—	—	—	—	—
	Restoration	Underwater Arch Cove	60.3	60.3	39.1	39.1	13.0	13.0	79.7	40	8.6	9	—	—	491.2	210
		Honeymoon Cove	—	—	—	—	—	—	—	—	—	—	—	—	98.8	98.8
	Reference	Point Vicente West	—	—	—	—	75.4	75	290.4	195.3	9.4	7.4	694.5	637	47.3	21
		Rocky Point North	10.2	10	—	—	—	—	—	—	—	—	—	—	—	—
Girella nigricans	Control	Abalone Cove Kelp West	41.2	32.0	216.0	216	647.9	647.9	278.7	203.8	—	—	—	—	711.8	396
		Marguerite Central	—	—	238.8	238.8	—	—	62.7	62.7	1161.6	966.6	312.6	204.2	9073.8	3122.2
	Restoration	Underwater Arch Cove	284.7	251.1	16.9	17	—	—	26.1	26	—	—	123.9	123.9	—	—
		Honeymoon Cove	—	—	—	—	—	—	—	—	186.6	186.6	—	—	55.5	40
	Reference	Point Vicente West	—	—	—	—	463.7	269.0	771.8	525	62.7	63	83.9	59	278.7	204
		Rocky Point North	—	—	125.5	125	—	—	434.3	256	463.7	269.0	645.2	313	35.6	18
Paralabrax clathratus	Control	Abalone Cove Kelp West	230.0	230	—	—	24.6	16.7	21.4	16.8	102.3	41.2	237.7	80.0	389.7	289.7
		Marguerite Central	—	—	310.6	311	373.1	319	459.7	182	515.5	285	185.4	70.3	1207.7	472.9
	Restoration	Underwater Arch Cove	—	—	17.7	17.7	42.3	42.3	652.8	466	382.9	319	259.7	142	197.4	81
		Honeymoon Cove	—	—	—	—	22.8	16.7	232.6	138	62.8	59.1	17.7	17.7	109.7	24.0
	Reference	Point Vicente West	—	—	—	—	227.5	141	—	—	324.2	93.4	388.7	220	1847.4	1163
		Rocky Point North	160.8	115	555.8	356	634.4	317	103.3	47.5	209.5	57.8	183.2	135	11.7	11
Semicossyphus pulcher	Control	Abalone Cove Kelp West	—	—	173.3	173	56.6	56.6	—	—	122.1	100	116.5	112	3.0	2
		Marguerite Central	56.6	56.6	56.6	56.6	—	—	28.5	17.2	—	—	139.0	82.9	412.7	237.9
	Restoration	Underwater Arch Cove	25.7	25.7	235.1	108	—	—	104.7	105	—	—	82.3	53.8	434.0	288.0
		Honeymoon Cove	—	—	—	—	—	—	—	—	56.6	56.6	104.7	105	39.0	33
	Reference	Point Vicente West	25.7	25.7	—	—	—	—	880.1	531	209.4	121	343.5	244	128.0	88
		Rocky Point North	130.4	130	312.2	144	866.5	95.8	173.3	173	56.6	56.6	229.9	230	59.9	60

Appendix C: Gonad Indices Results 2014

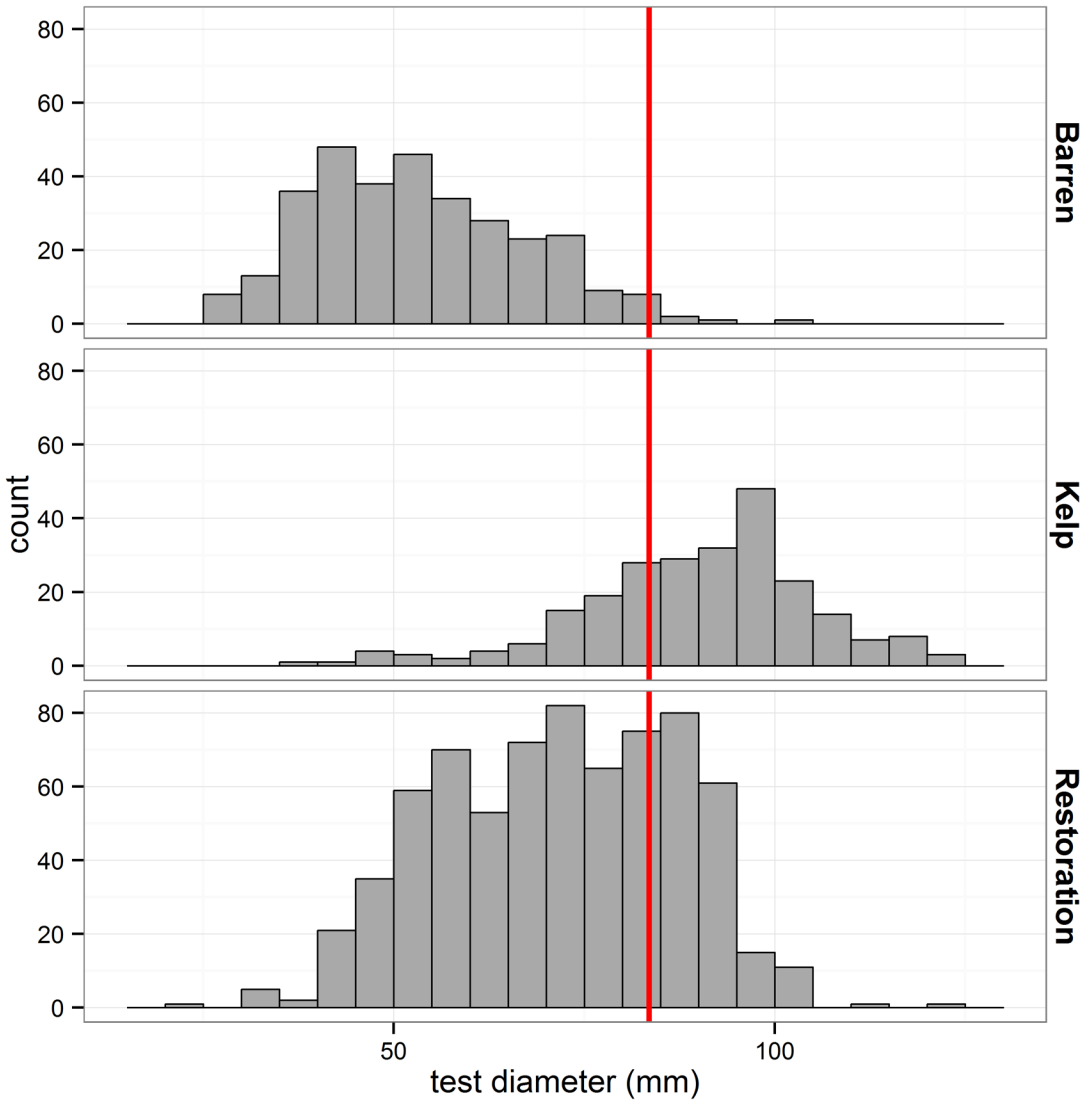


Figure C1. Histogram of Red Urchin (*Strongylocentrotus franciscanus*) test diameter for urchins collected in Barren, Kelp Forest Reference and Restoration Sites **pooling data from all 2014 collections**. The red line indicates the minimum size limit (84 mm) for the red urchin fishery. There was a significant difference among urchins collected in the three habitat types (one-way ANOVA: $p < 0.001$; mean ± SE: Barren 52 ± 1 mm, Kelp 89 ± 1 mm, Restoration 71 ± 1 mm).

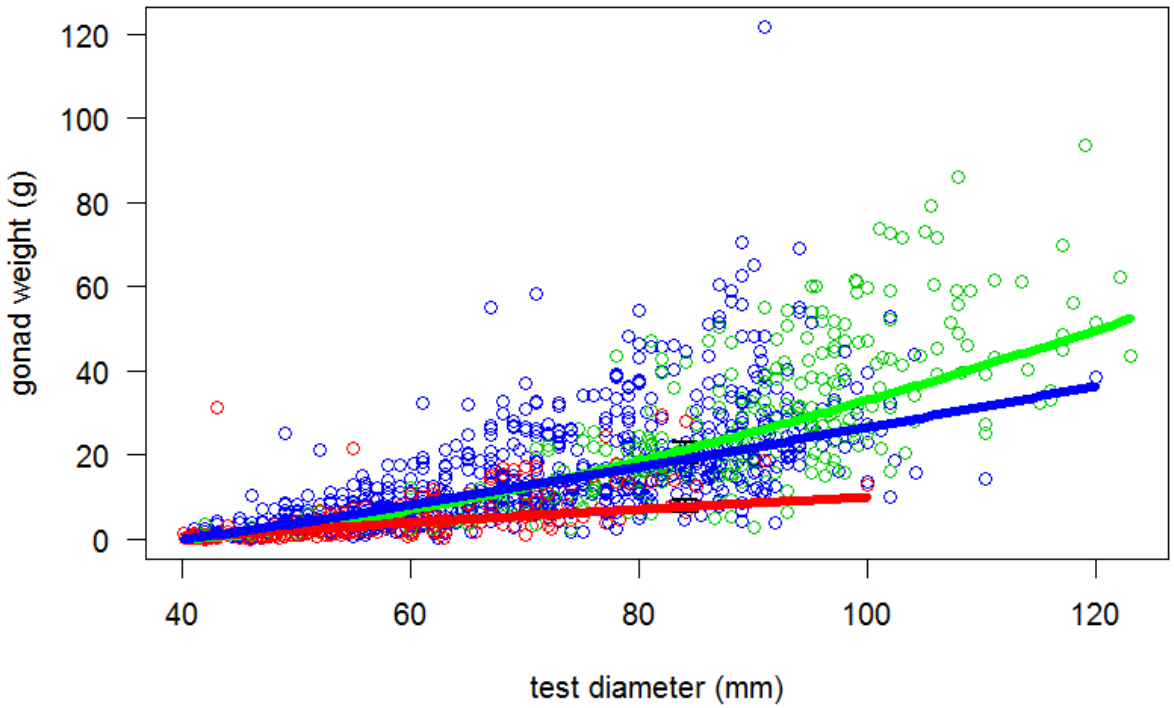


Figure C2. Relationship between Red Urchin (*Strongylocentrotus franciscanus*) gonad weight and urchin test diameter in the three site types: Barren (red), Kelp Forest Reference (green) and Restoration (blue) **pooling data from all 2014 collections**.

Following the methods in Claisse et al. (2013) and **pooling data from all 2014 collections** we estimated the Red Urchin (*Strongylocentrotus franciscanus*) mean gonad weight at 84 mm test diameter (the minimum size limit in the fishery) and estimated 95% confidence intervals for each mean: Barren 7.5 g (95% CI: 6.2 to 9.1), Kelp 21.3 g (95% CI: 19.7 to 22.9), Restoration 19.0 g (95% CI: 17.9 to 20.0). Gonad size at 84 mm test diameter in the restoration sites was 152% higher than in barrens (95% CI: 104% to 208%).

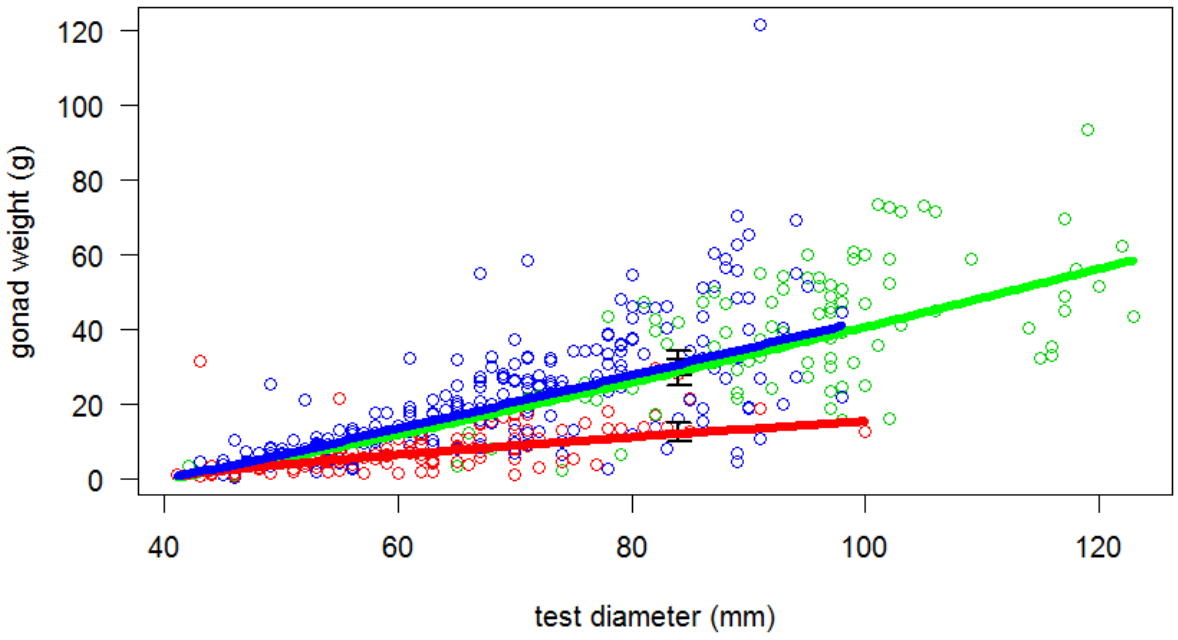


Figure C3. Relationship between Red Urchin (*Strongylocentrotus franciscanus*) gonad weight and urchin test diameter in the three site types: Barren (red), Kelp Forest Reference (green) and Restoration (blue) **with data from collections during Fall 2014 (30 Oct and 18 Nov)**.

Following the methods in Claisse et al. (2013) **with data from collections during Fall 2014 (30 Oct and 18 Nov)** we estimated the Red Urchin (*Strongylocentrotus franciscanus*) mean gonad weight at 84 mm test diameter (the minimum size limit in the fishery) and estimated 95% confidence intervals for each mean: Barren 11.9 g (95% CI: 9.8 to 14.8), Kelp 28.7 g (95% CI: 25.0 to 31.9), Restoration 30.7 g (95% CI: 27.5 to 34.3). Gonad size at 84 mm test diameter in the restoration sites was 158% higher than in barrens (95% CI: 102% to 229%).

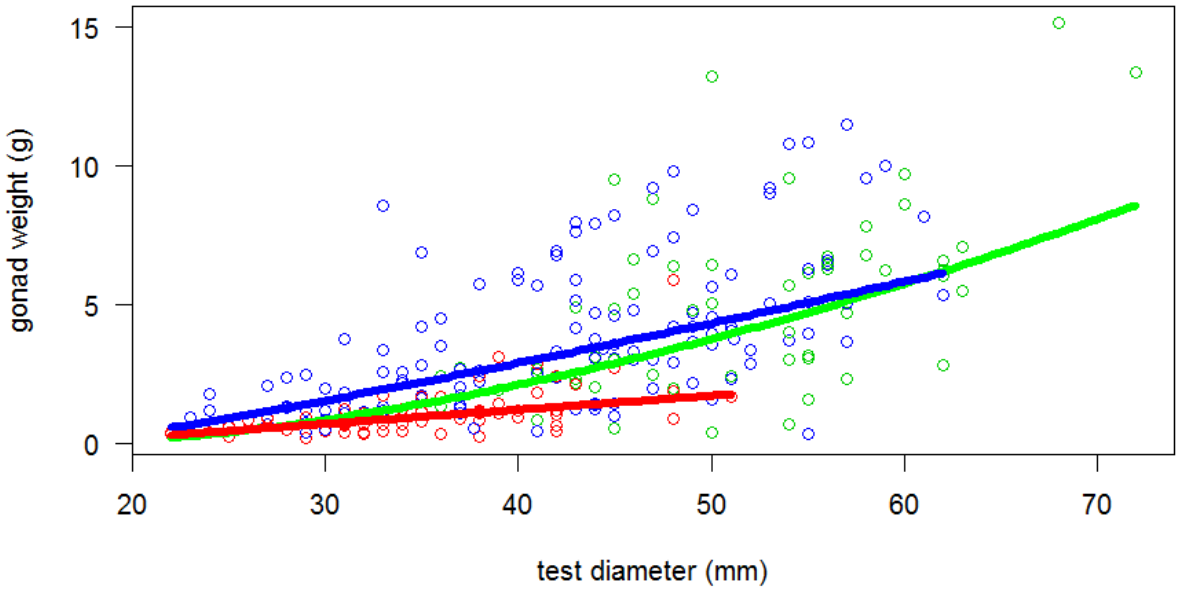


Figure C4. Relationship between Purple Urchin (*Strongylocentrotus purpuratus*) gonad weight and urchin test diameter in the three site types: Barren (red), Kelp Forest Reference (green) and Restoration (blue) **pooling data from 2014 collections (purple urchins collected on 22 July, 30 Oct, 18 Nov)**.

Claisse JT, Williams JP, Ford T, Pondella DJ, Meux B, Protopapadakis L (2013) Kelp forest habitat restoration has the potential to increase sea urchin gonad biomass. Ecosphere 4: art38 doi 10.1890/ES12-00408.1

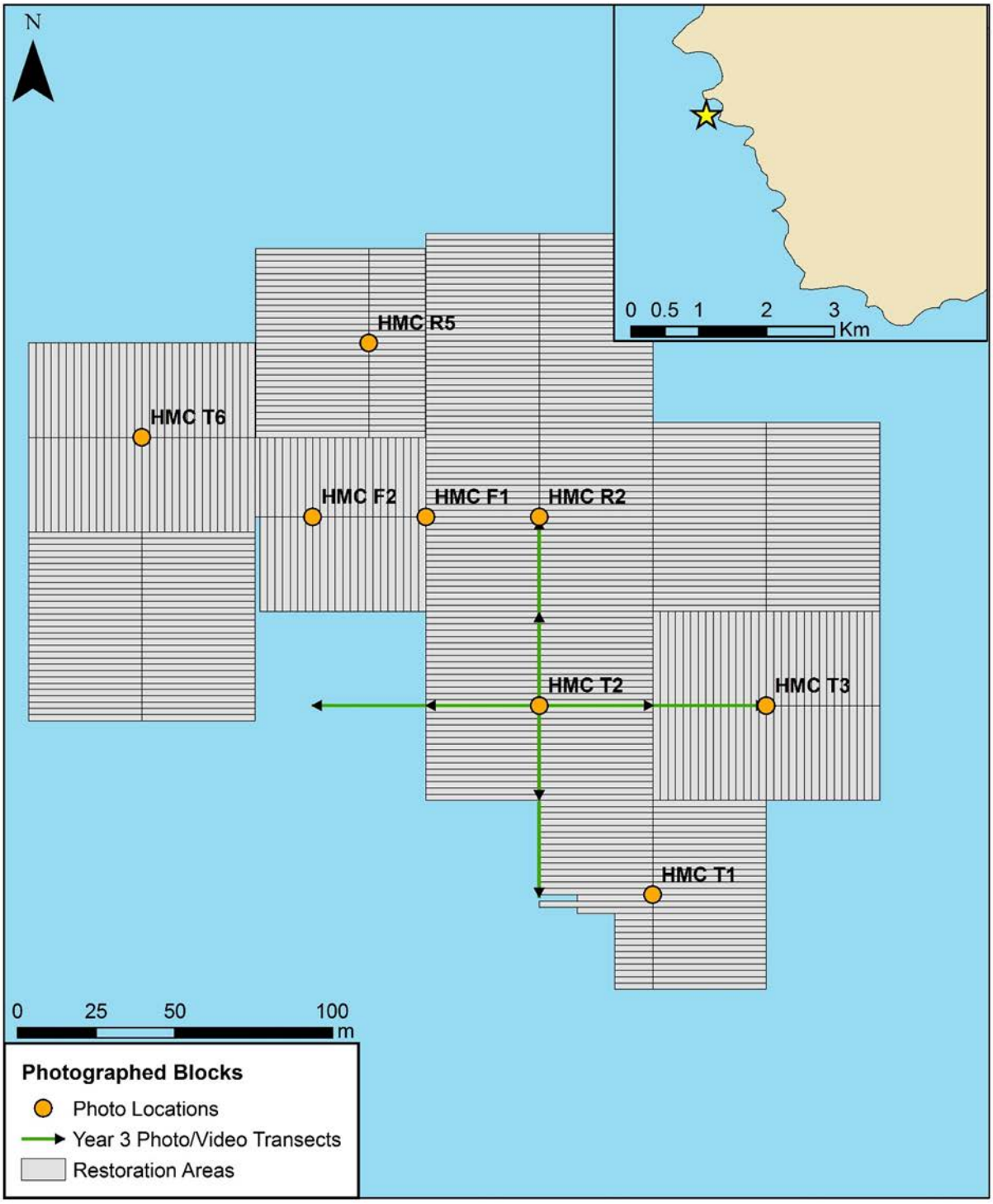
Appendix D: Appendix D: Photos of Restoration Blocks Pre and Post Restoration by Site
Link to high resolution photos and video:
Available upon request

All report photo and video files are titled according to the following format: “Figure/Video Number”_”Site Code”_”Block Code”_”Date (year-month-day)” ”Restoration Status (Pre/Post)”

Coordinates for photographed restoration blocks are listed in the table below and geospatially displayed on site maps included in this appendix.

Site	Block	Lat	Long
Fermin	J7	33.703028	-118.290167
Fermin	J8	33.702758	-118.289519
Fermin	W9	33.702758	-118.289195
Fermin	C1	33.70374	-118.289688
Fermin	T13	33.7032	-118.288717
Fermin	T14	33.70374	-118.289041
Hawthorne	2	33.75064	-118.416097
Hawthorne	3	33.75064	-118.415772
Hawthorne	4	33.75064	-118.415448
Hawthorne	5	33.75064	-118.415124
Hawthorne	J5	33.75091	-118.415772
Honeymoon	F1	33.764800	-118.424058
Honeymoon	F2	33.764800	-118.424381
Honeymoon	R5	33.765297	-118.424221
Honeymoon	T2	33.764260	-118.423734
Honeymoon	T6	33.765027	-118.424869
Honeymoon	T1	33.76372	-118.42341
Honeymoon	R2	33.7648	-118.423734
Honeymoon	T3	33.76426	-118.423086
Marguerite	T11	33.758916	-118.418114
Marguerite	T12	33.758646	-118.418147
Marguerite	W8	33.758374	-118.418144
Marguerite	R8	33.759458	-118.418113
Marguerite	T15	33.758104	-118.418144
Marguerite	T9	33.75556	-118.41692
Marguerite	T10	33.7561	-118.41692
Marguerite	T8	33.75502	-118.41692
Marguerite	T16	33.757561	-118.41782
Underwater Arch	J1	33.752060	-118.415686
Underwater Arch	J2	33.752330	-118.415125
Underwater Arch	T7	33.752600	-118.414563
Underwater Arch	W1	33.753855	-118.415756
Underwater Arch	002	33.75398	-118.41659
Underwater Arch	003	33.754124	-118.416310
Underwater Arch	006	33.753855	-118.416404
Underwater Arch	W2	33.753584	-118.415108

Honeymoon Cove Photo and Video Transects



Honeymoon Cove - Pre Restoration

Figure 1. (Site: Honeymoon, Block: T2, Date: 02/21/2014, Pre Restoration, GPS: 33.76426047, -118.423734)

Figure 2 (Site: Honeymoon, Block: F1, Date: 02/05/2014, Pre Restoration, GPS: 33.7648, -118.4240578)

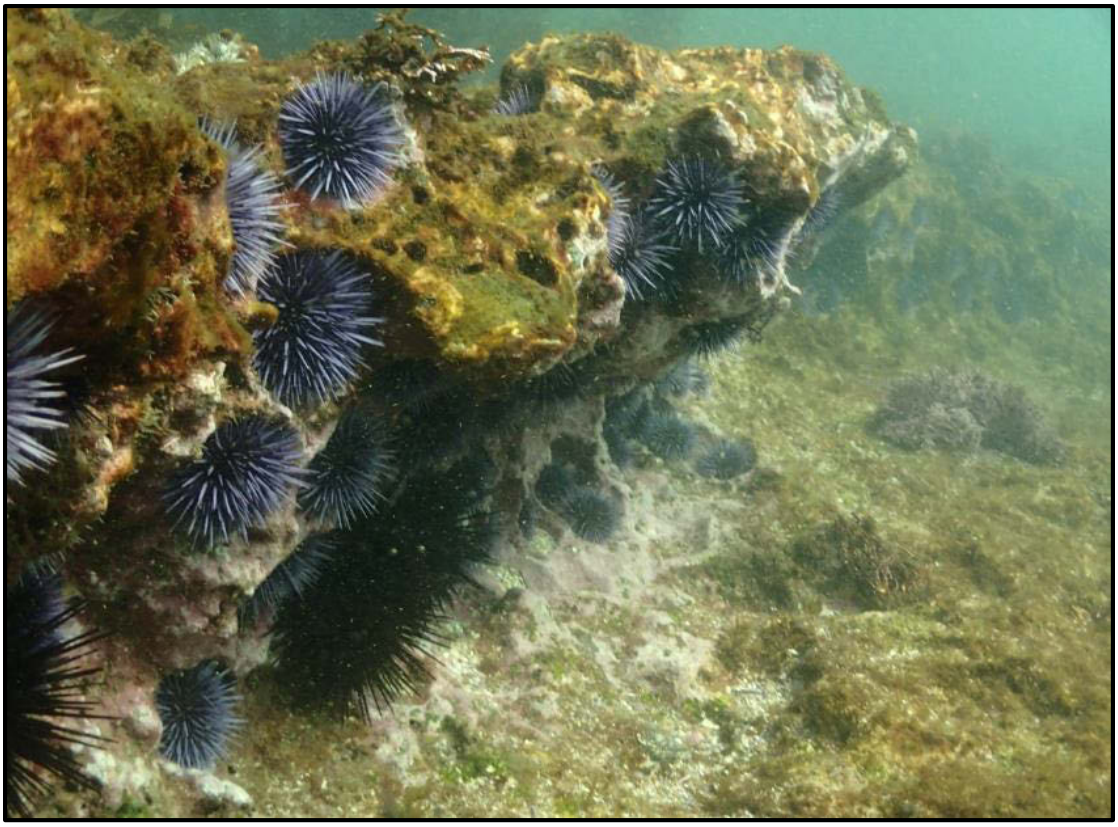


Figure 3 (Site: Honeymoon, Block: F2, Date: 07/12/2014, Pre Restoration, GPS: 33.7648, -118.424381)

Figure 4 (Site: Honeymoon, Block: F2, Date: 07/12/2014, Pre Restoration, GPS: 33.7648, -118.424381)

Figure 5 (Site: Honeymoon, Block: T6, Date: 05/02/2014, Pre Restoration, GPS: 33.765027, -118.424869)

Figure 6 (Site: Honeymoon, Block: T6, Date: 05/02/2014, Pre Restoration, GPS: 33.765027, -118.424869)

Honeymoon Cove – Post Restoration

Figure 7 (Site: Honeymoon, Block: T2, Date: 03/21/2014, Post Restoration, GPS: 33.76426047, -118.423734)

Figure 8 (Site: Honeymoon, Block: T2, Date: 05/02/2014, Post Restoration, GPS: 33.76426047, -118.423734)

Figure 9 (Site: Honeymoon, Block: T2, Date: 05/02/2014, Post Restoration, GPS: 33.76426047, -118.423734)

Figure 10 (Site: Honeymoon Cove, Block: T2, Date: 07/29/2016, Post Restoration, GPS: 33.764260, -118.423734)

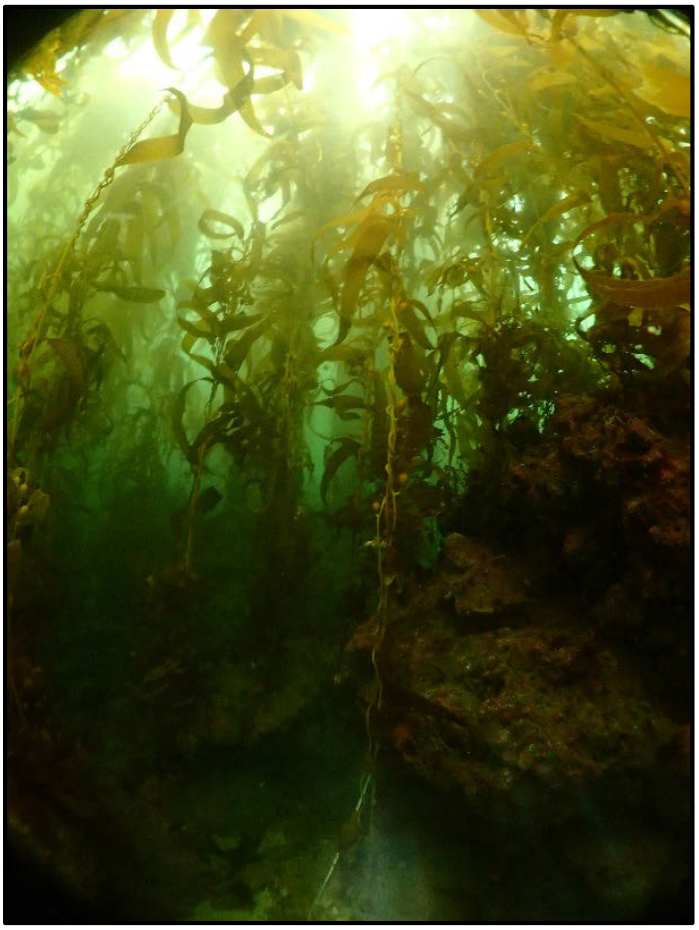


Figure 11 (Site: Honeymoon Cove, Block: T2, Date: 07/29/2016, Post Restoration, GPS: 33.764260, -118.423734)

Figure 12(Site: Honeymoon Cove, Block: T2, Date: 07/29/2016, Post Restoration, GPS: 33.764260, -118.423734)

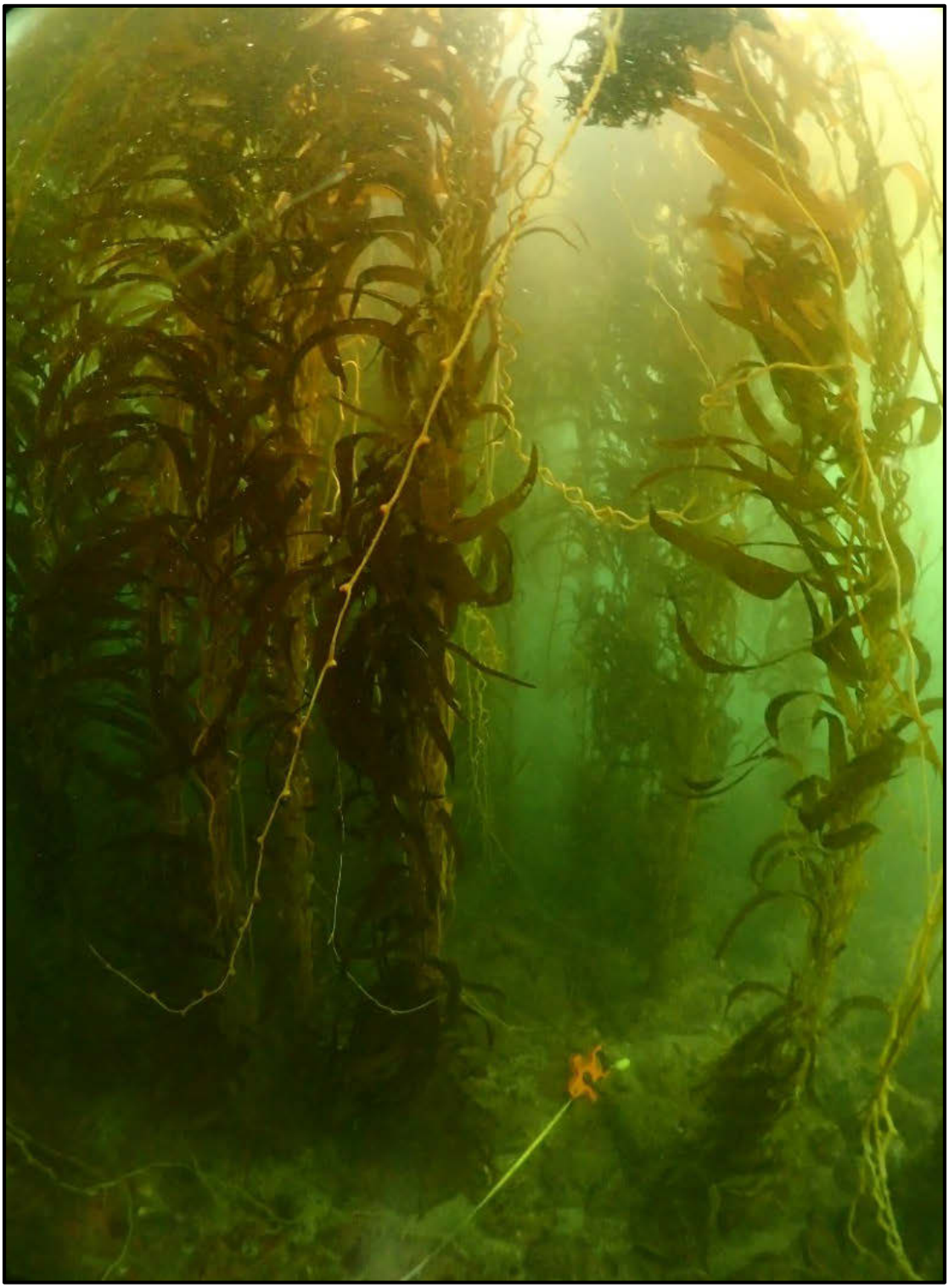


Figure 13 (Site: Honeymoon Cove, Block: R2, Date: 07/29/2016, Post Restoration, GPS: 33.7648, -118.423734)

Figure 14 (Site: Honeymoon Cove, Block: T1, Date: 10/22/2015, Post Restoration, GPS: 33.76372, -118.42341)

Figure 15 (Site: Honeymoon Cove, Block: T1, Date: 07/29/16, Post Restoration, GPS: 33.76372, -118.42341)

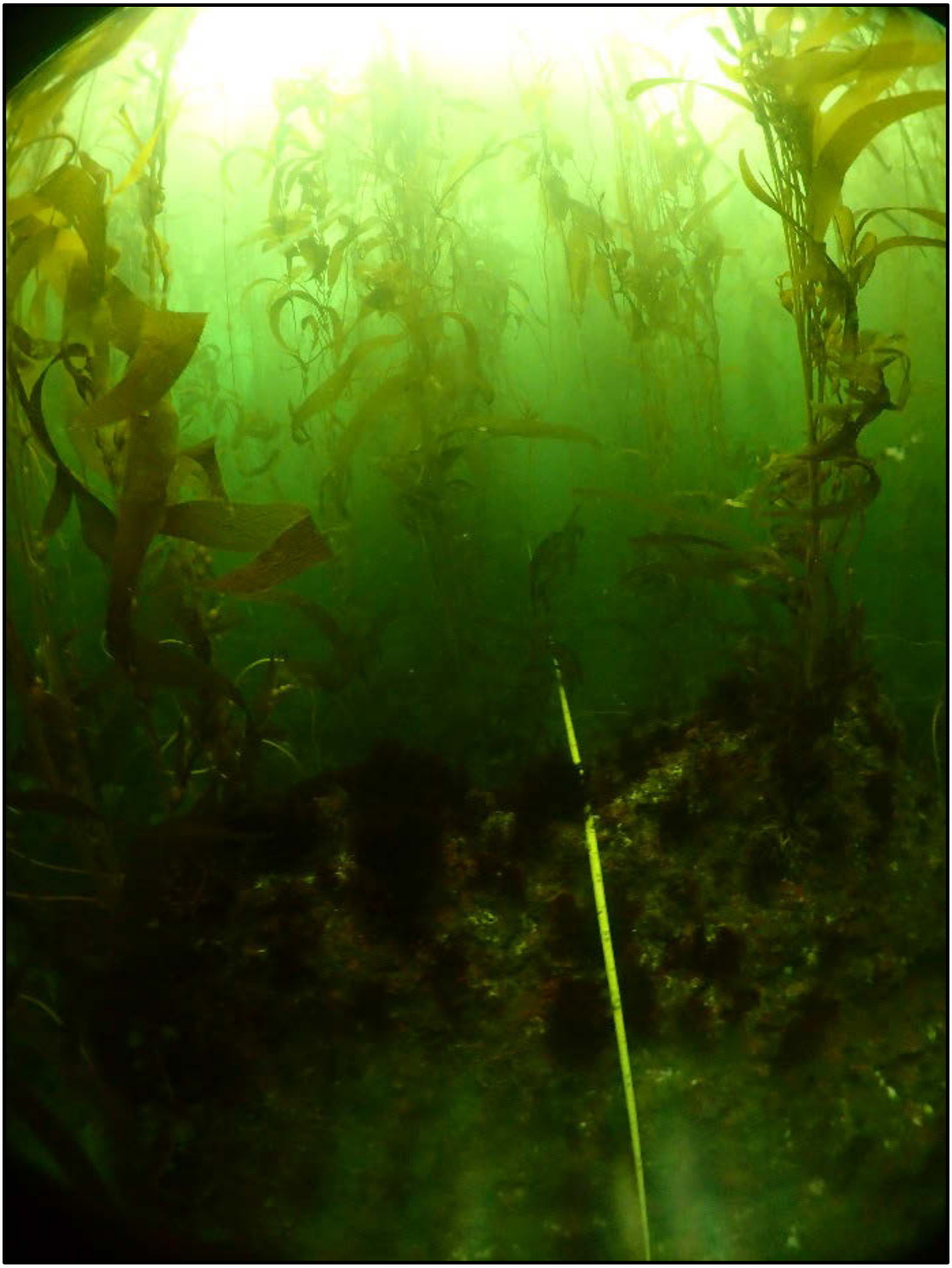


Figure 16 (Site: Honeymoon Cove, Block: T3, Date: 07/29/2016, Post Restoration, GPS: 33.76426, -118.423086)

Figure 17 (Site: Honeymoon, Block: R5, Date: 09/24/2015, Post Restoration, GPS: 33.765297, -118.424221)

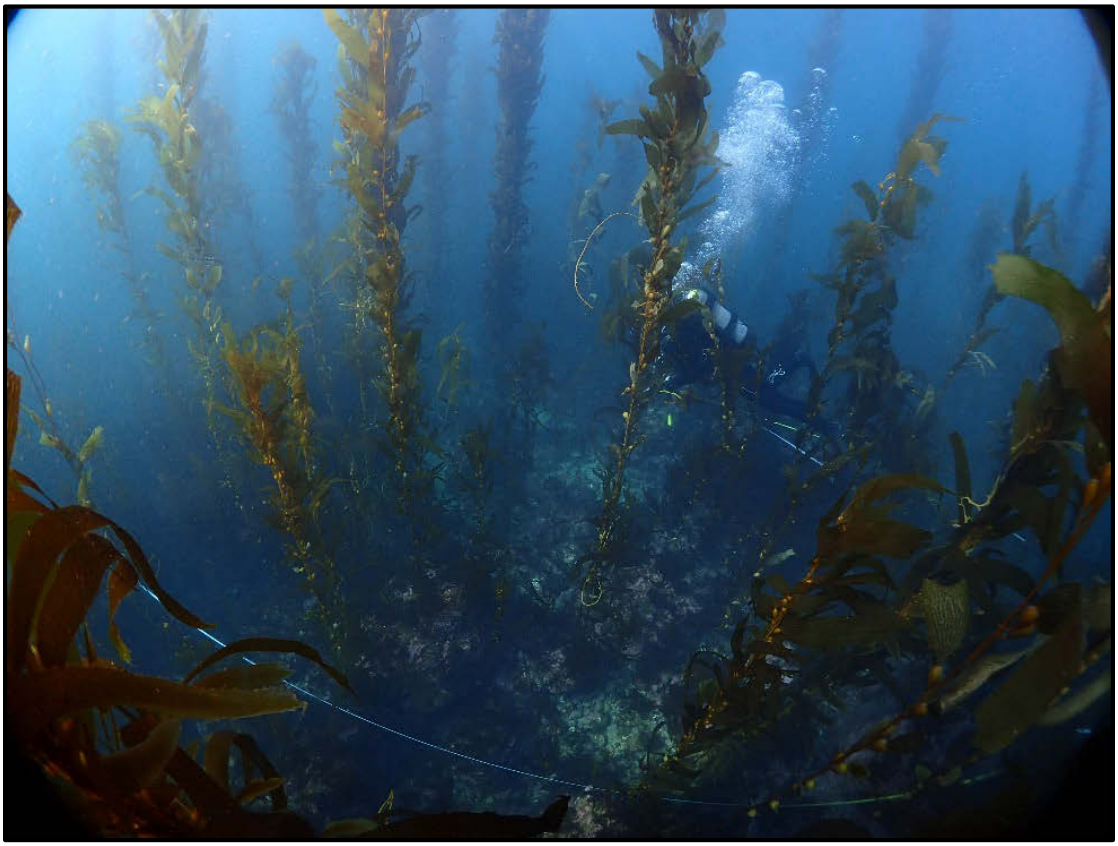
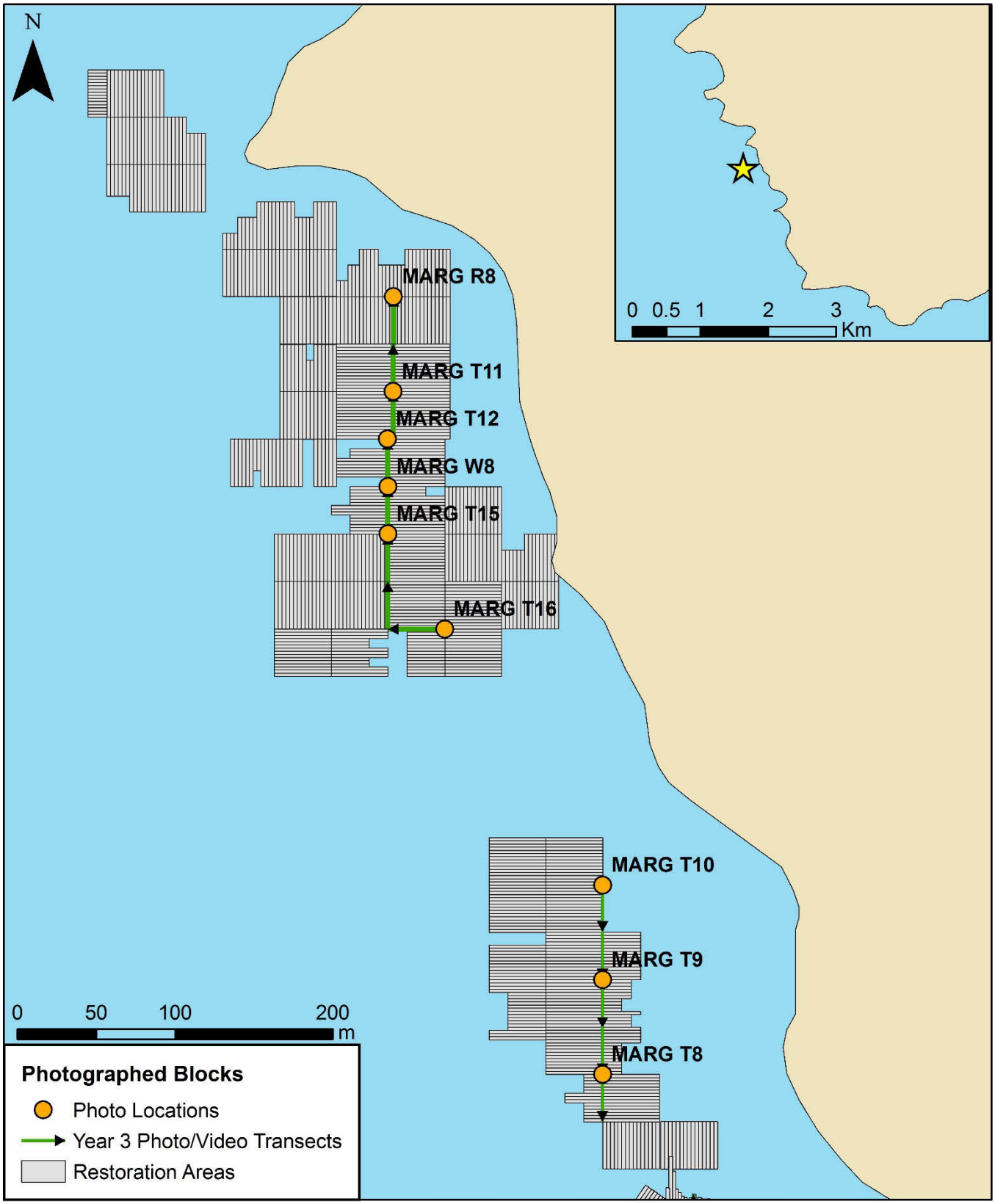


Figure 18 (Site: Honeymoon Cove, Block: R5, Date: 02/10/2016, Post Restoration, GPS: 33.765297, -118.424221)

Marguerite Photo and Video Transects



Marguerite Pre Restoration

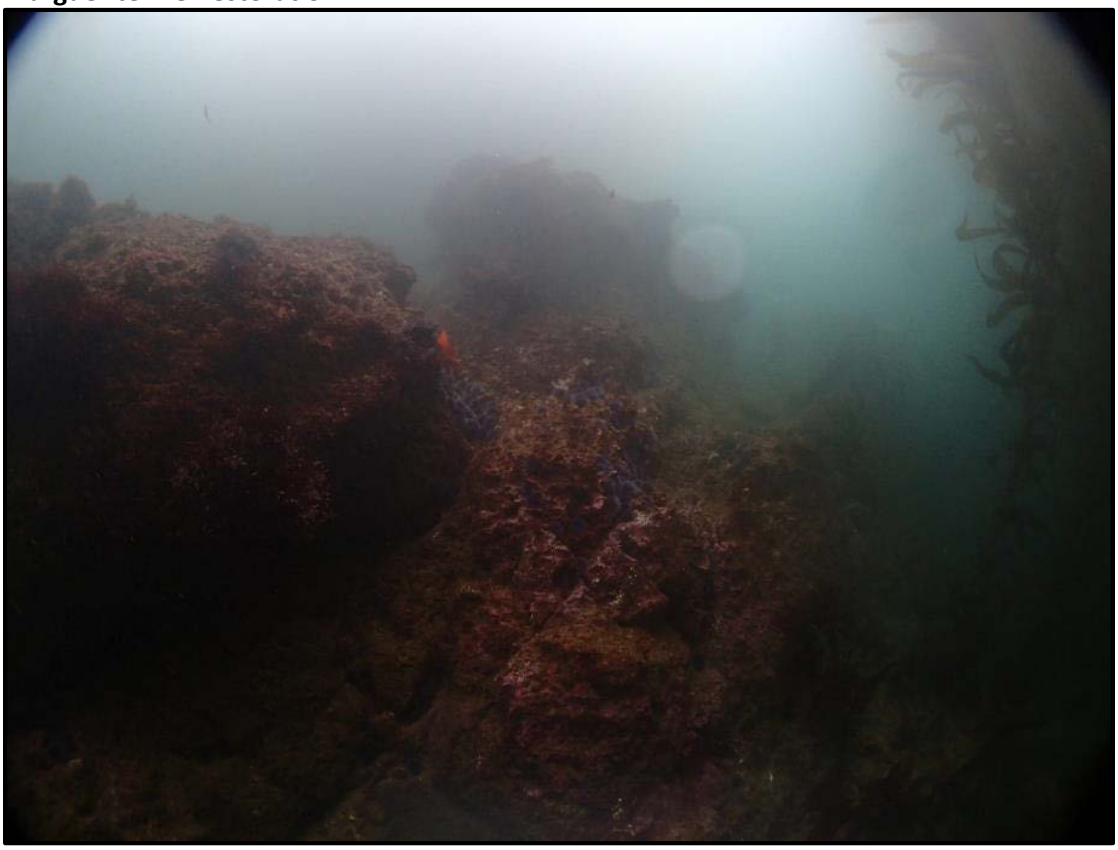


Figure 19 (Site: Marguerite, Block T12, Date: 03/12/2015, Pre Restoration, GPS: 33.758374, -118.418144)

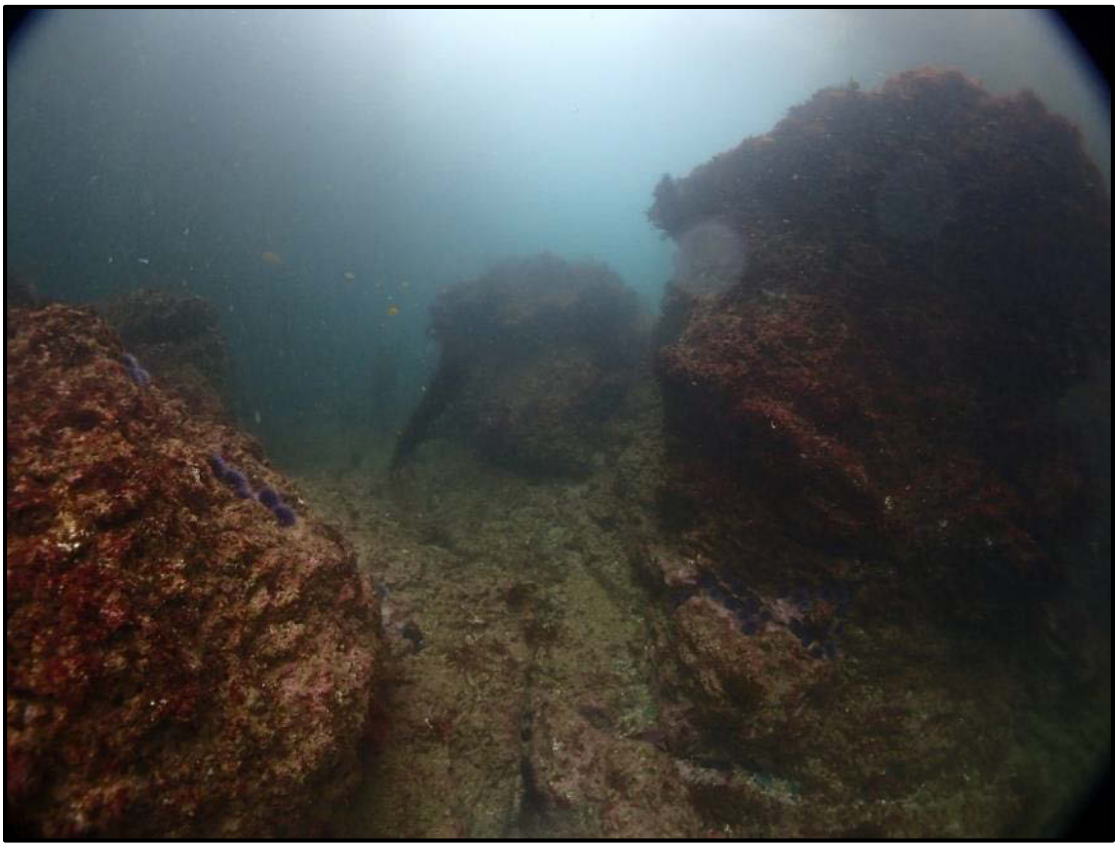


Figure 20 (Site: Marguerite, Block T12, Date: 06/12/2015, Pre Restoration, GPS: 33.758374, -118.418144)

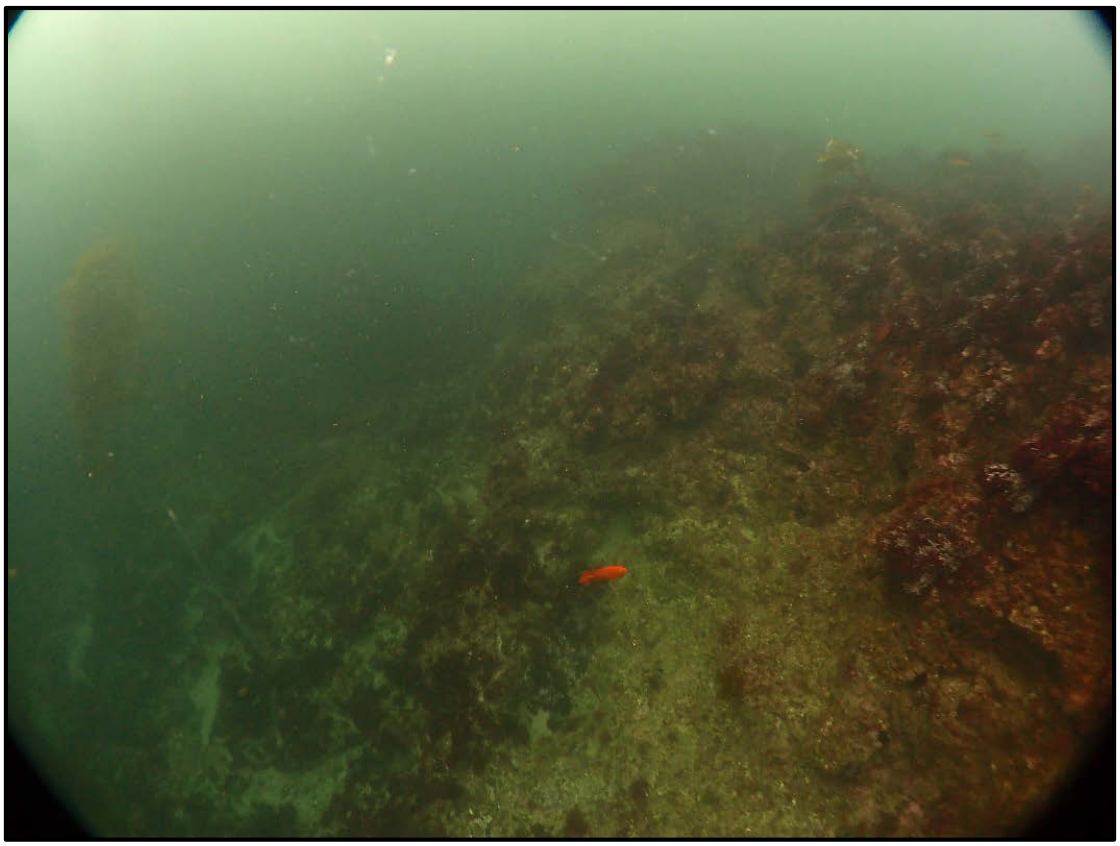


Figure 21 (Site: Marguerite, Block: T16, Date: 08/10/2016, Pre Restoration, GPS: 33.757561, -118.41782)

Marguerite Post Restoration

Figure 22 (Site: Marguerite, Block: R8, Date: 08/02/2016, Post Restoration, GPS: 33.759458, -118.418113)

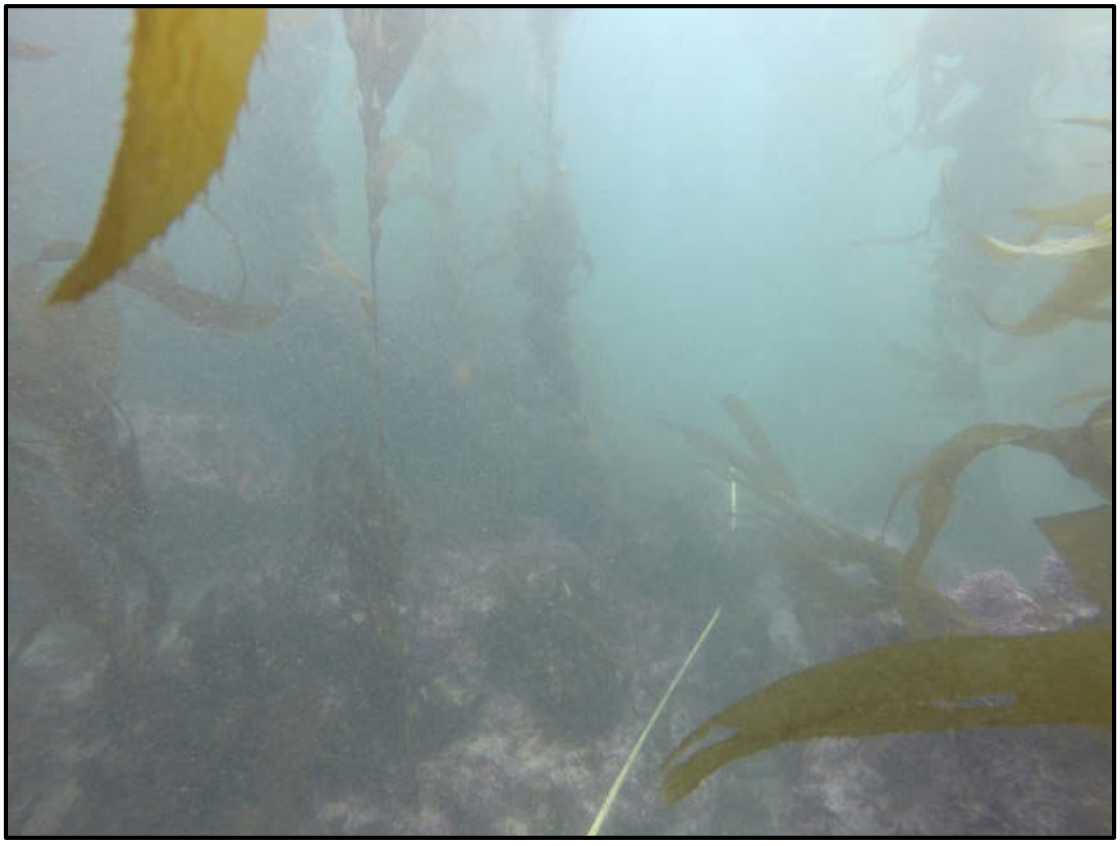


Figure 23 (Site: Marguerite, Block: T11, Date: 07/16/2015, Post Restoration, GPS: 33.75892, -118.41811)

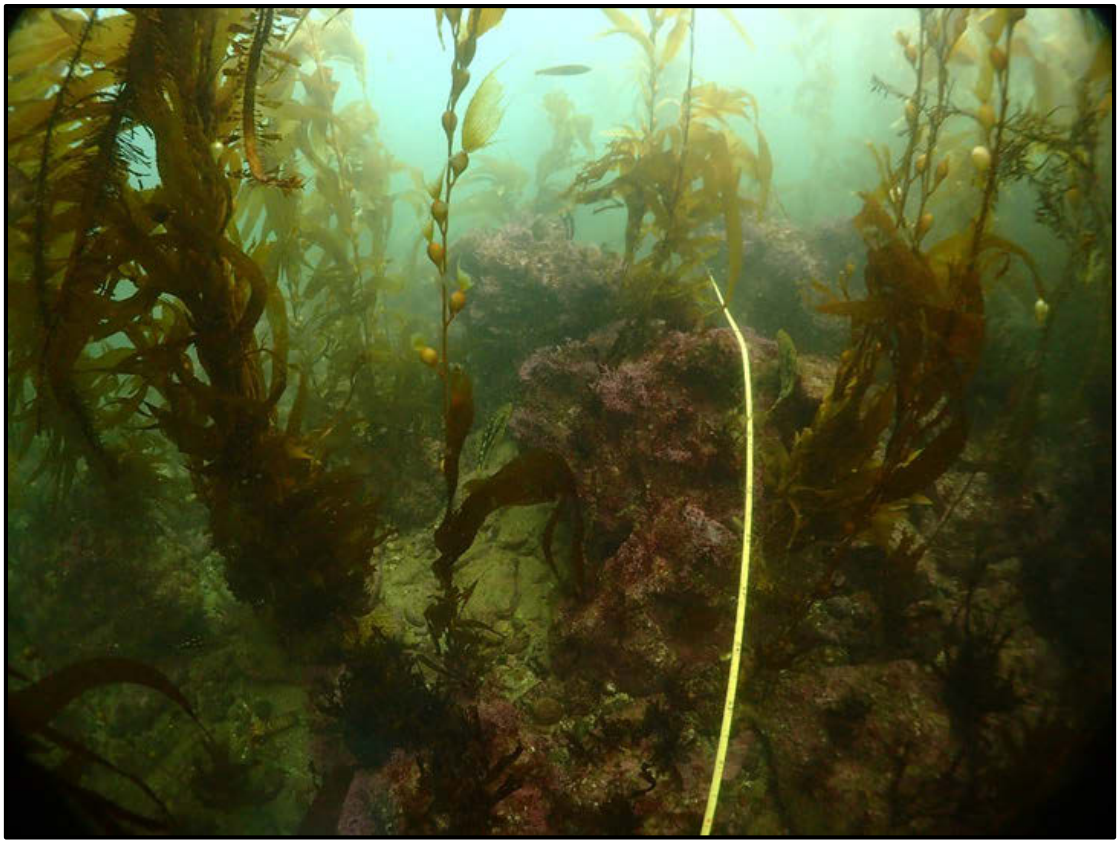


Figure 24 (Site: Marguerite, Block: T11, Date: 08/10/2016, Post Restoration, GPS: 33.75892, -118.41811)

Figure 25 (Site: Marguerite, Block: T12, Date: 08/10/2016, Post Restoration, GPS: 33.758646, -118.41814)

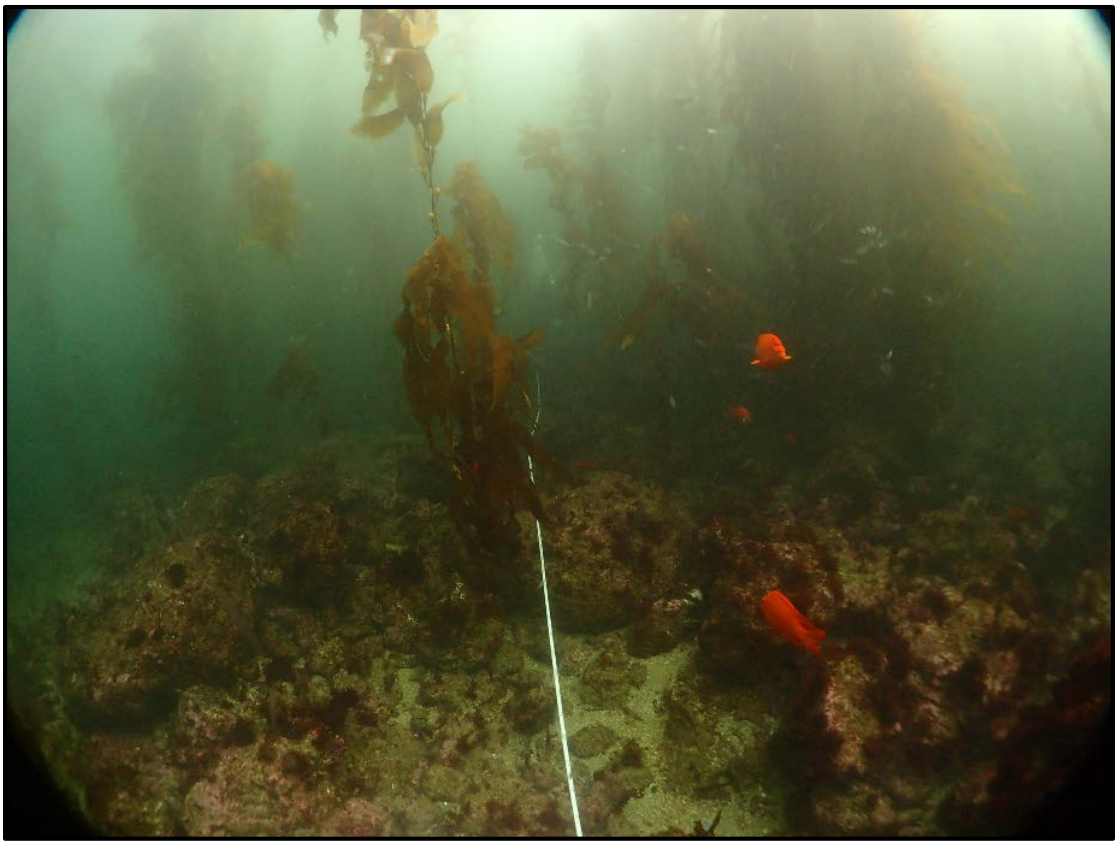


Figure 26 (Site: Marguerite, Block: W8, Date: 08/10/2016, Post Restoration, GPS: 33.75837, -118.41814)

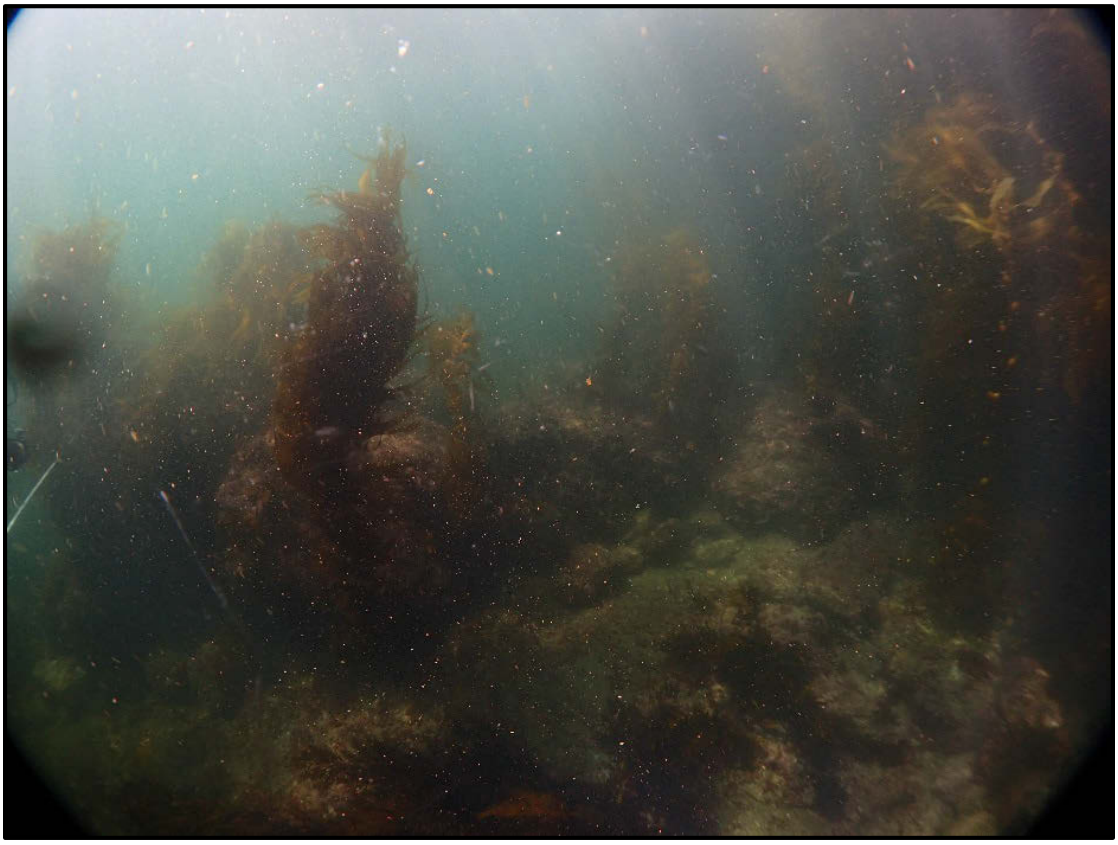


Figure 27 (Site: Marguerite, Block: T10, Date: 08/02/2016, Post Restoration, GPS: 33.7561, -118.41692)

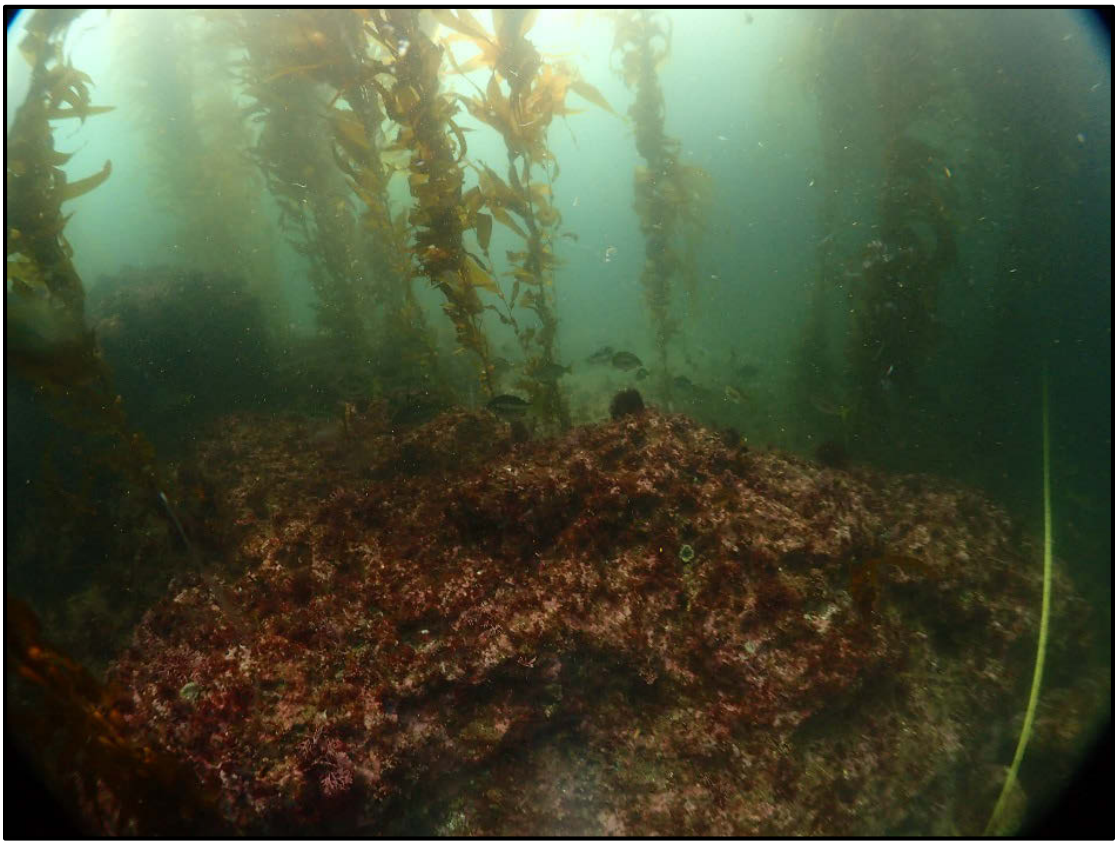


Figure 28 (Site: Marguerite, Block: T9, Date: 08/02/2016, Post Restoration, GPS: 33.75556, -118.41692)

Figure 29 (Site: Marguerite, Block: T8, Date: 08/10/2016, Post Restoration, GPS: 33.75502, -118.41692)

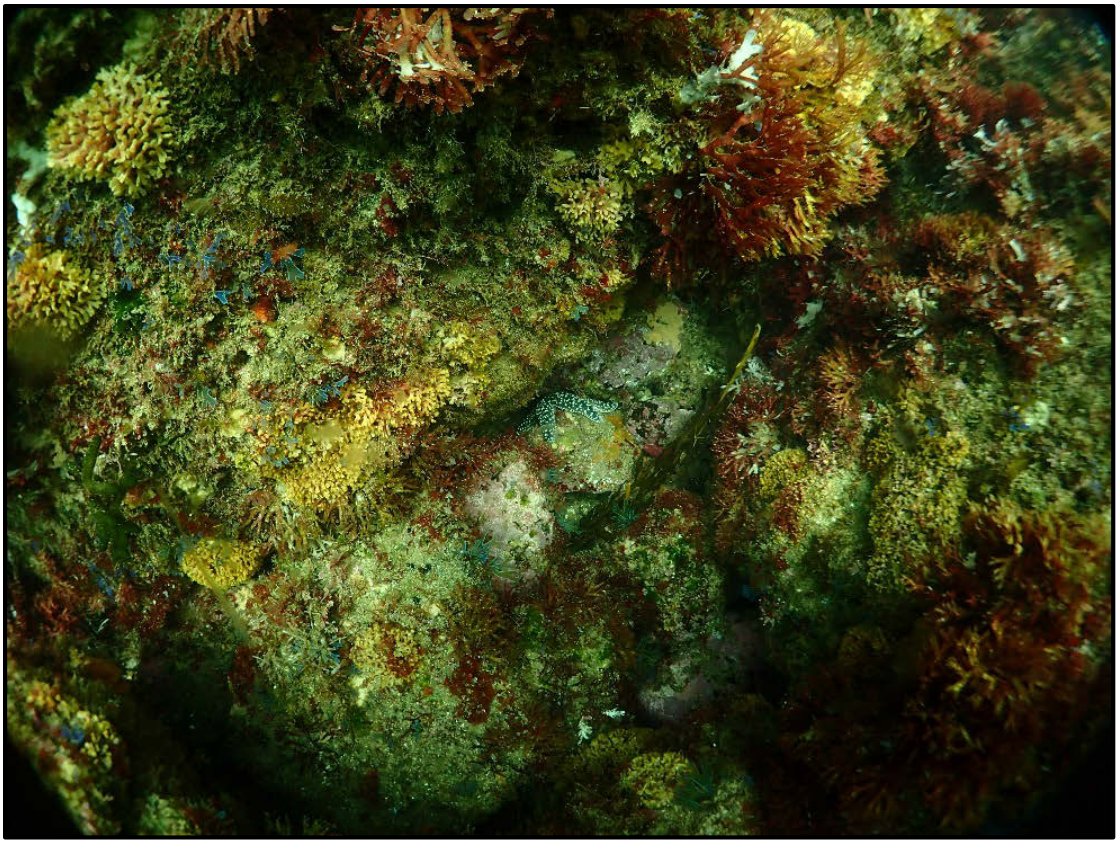
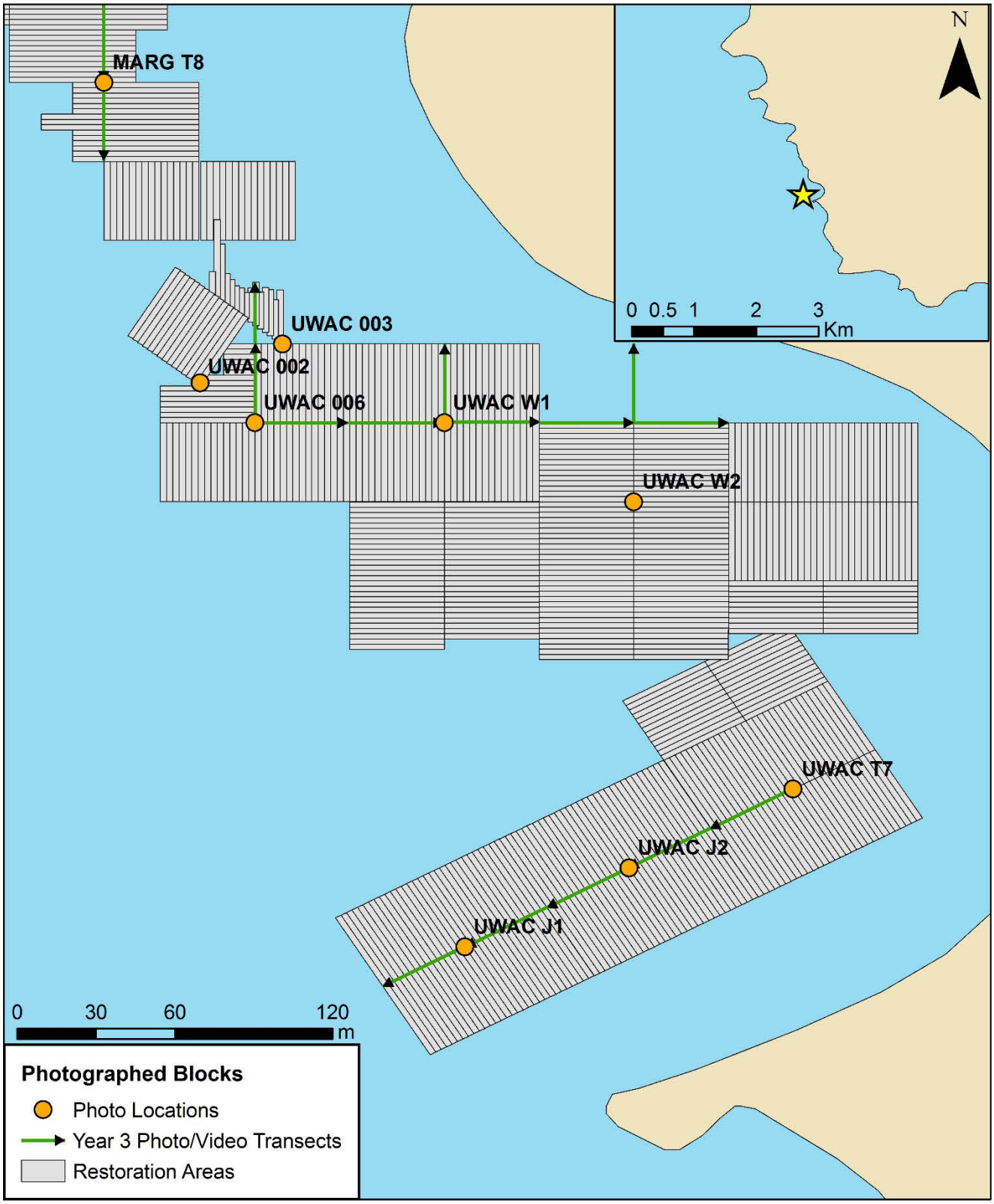


Figure 30 (Site: Marguerite, Block: T8, Date: 08/02/2016, Post Restoration, GPS: 33.75502, -118.41692)

Underwater Arch Cove Photo and Video Transects



Note: The coordinate for UWAC 006 (Heading 90) is the same starting coordinate for UWAC 001(Heading 270).

Underwater Arch Cove - Pre Restoration

Figure 31 (Site: Underwater Arch Cove, Block 001, Date: 07/17/2013, Pre Rest, GPS: 33.753855.-118.416404)

Figure 32 (Site: Underwater Arch Cove, Block 001, Date: 08/09/2013, Pre Rest, GPS: 33.753855.-118.416404)

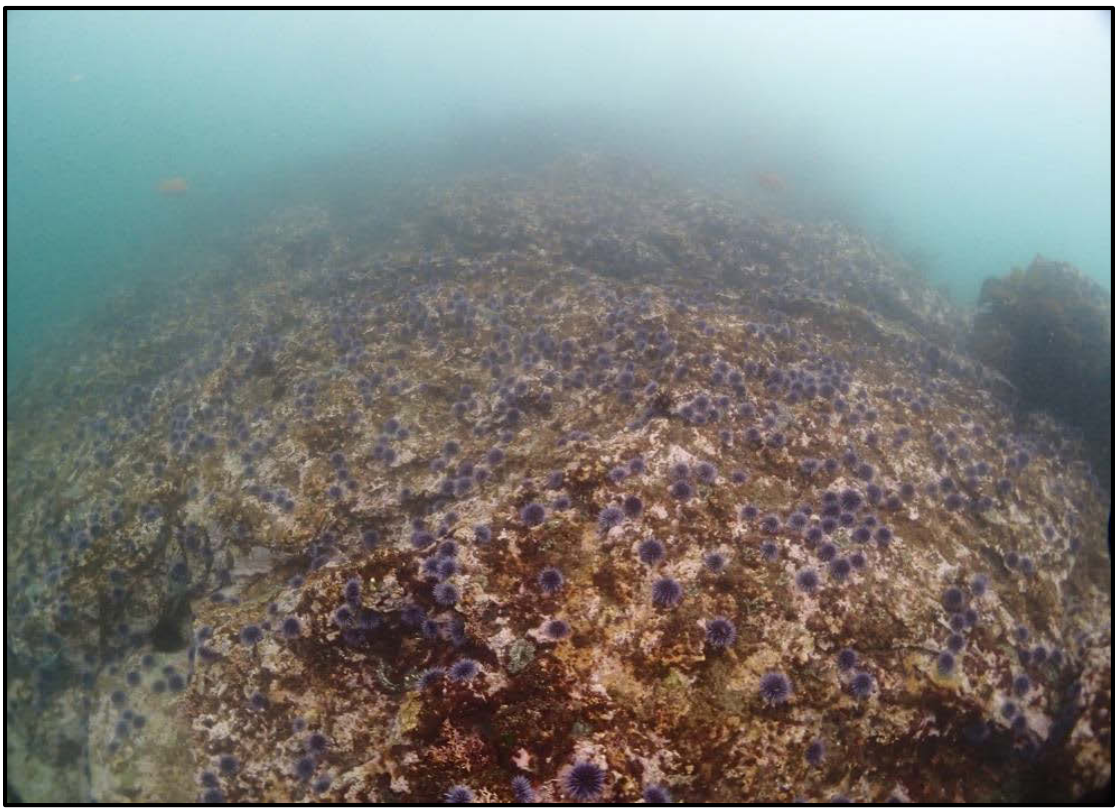


Figure 33 (Site: Underwater Arch Cove, Block 001, Date: 08/09/2013, Pre Rest, GPS: 33.753855.-118.416404)

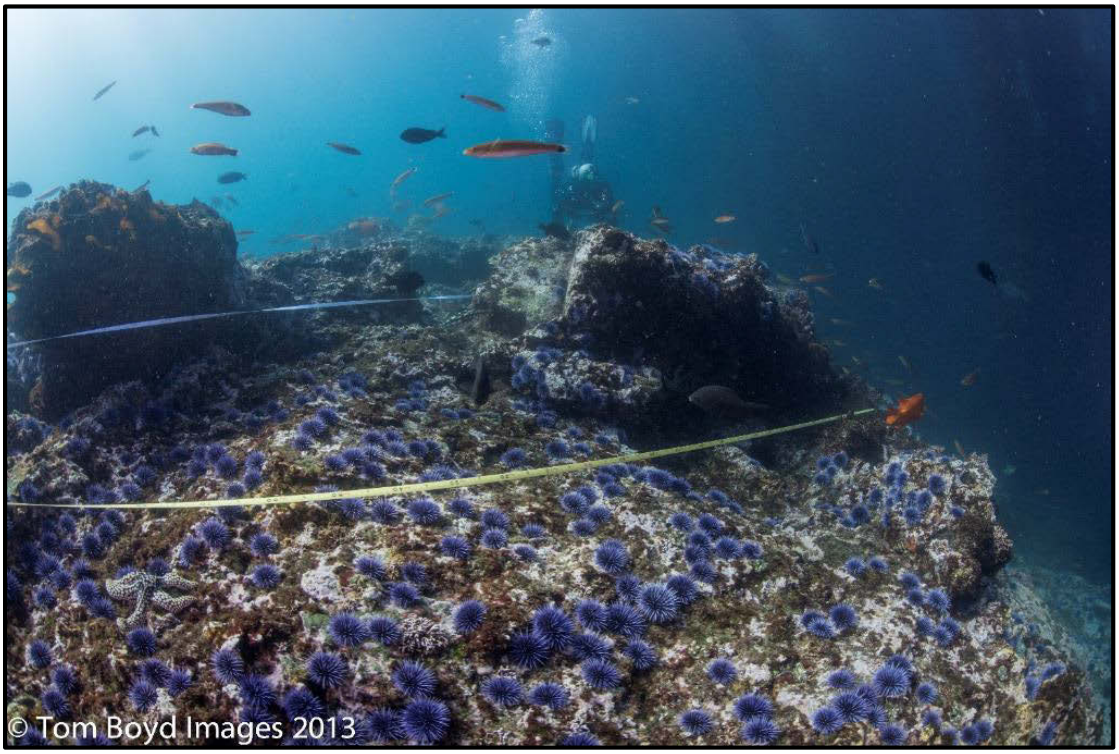


Figure 34 (Site: Underwater Arch Cove, Block 002, Date: 09/07/2013, Pre Rest, GPS: 33.75398, -118.41659)

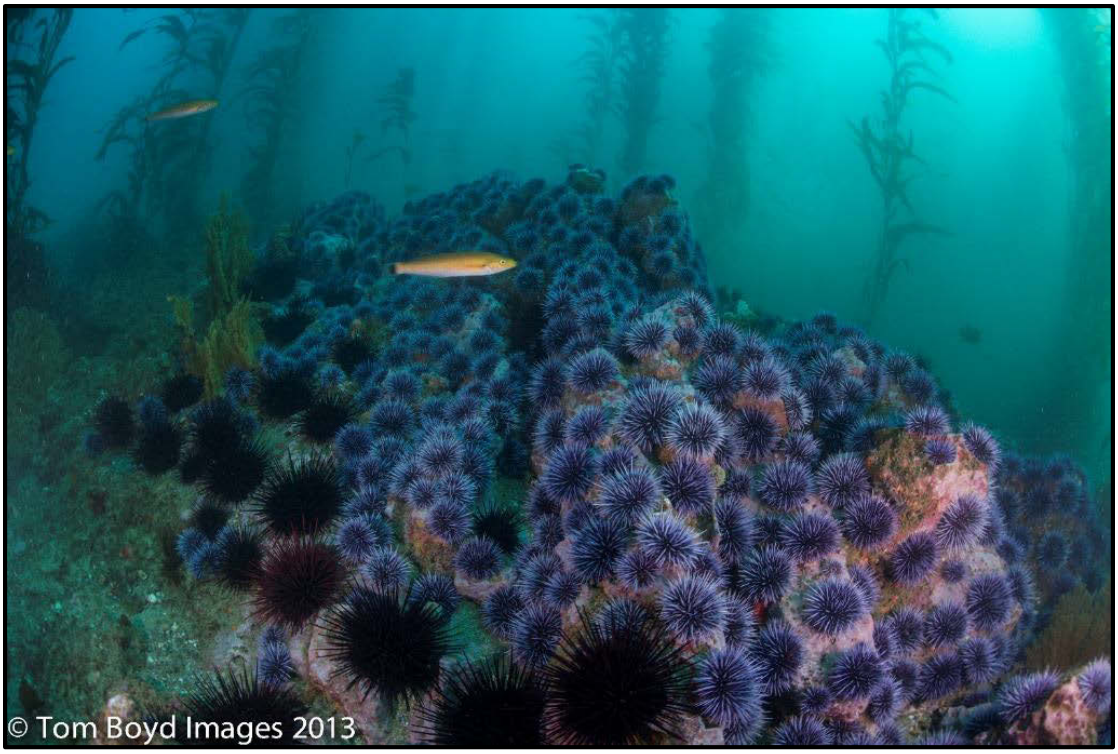


Figure 35 (Site: Underwater Arch Cove, Block 002, Date: 09/07/2013, Pre Rest, GPS: 33.75398, -118.41659)

Figure 36 (Site: Underwater Arch Cove, Block 003, Date: 11/25/2013, Pre Rest, GPS: 33.754124, -118.41631)

Figure 37 (Site: Underwater Arch Cove, Block J2, Date: 06/17/2014, Pre Rest, GPS 33.7523302, -118.4151245)

Figure 38 (Site: Underwater Arch Cove, Block J2, Date: 07/12/2014, Pre Rest, GPS 33.7523302, -118.4151245)

Figure 39 (Site: Underwater Arch Cove, Block T7, Date: 08/14/2014, Pre Rest, GPS 33.7526, -118.414563)

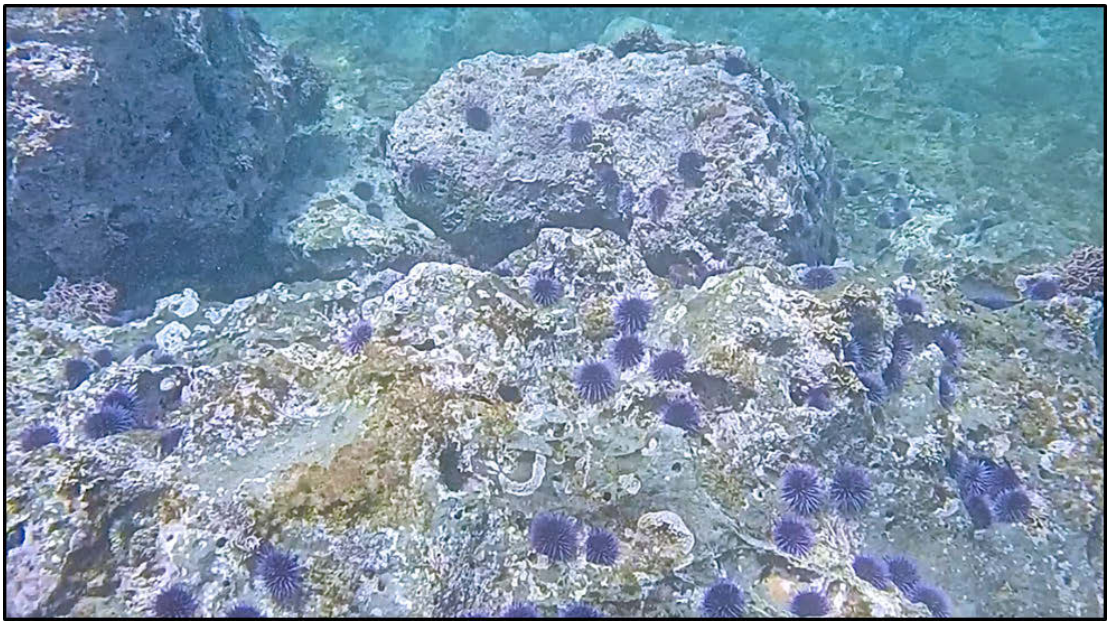


Figure 40 (Site: Underwater Arch Cove, Block T7, Date: 07/29/2014, Pre Rest, GPS 33.7526, -118.414563)

Underwater Arch Cove - Post Restoration

Figure 41 (Site: Underwater Arch Cove, Block 002, Date: 10/16/2013, Post Rest, GPS: 33.75398, -118.41659)

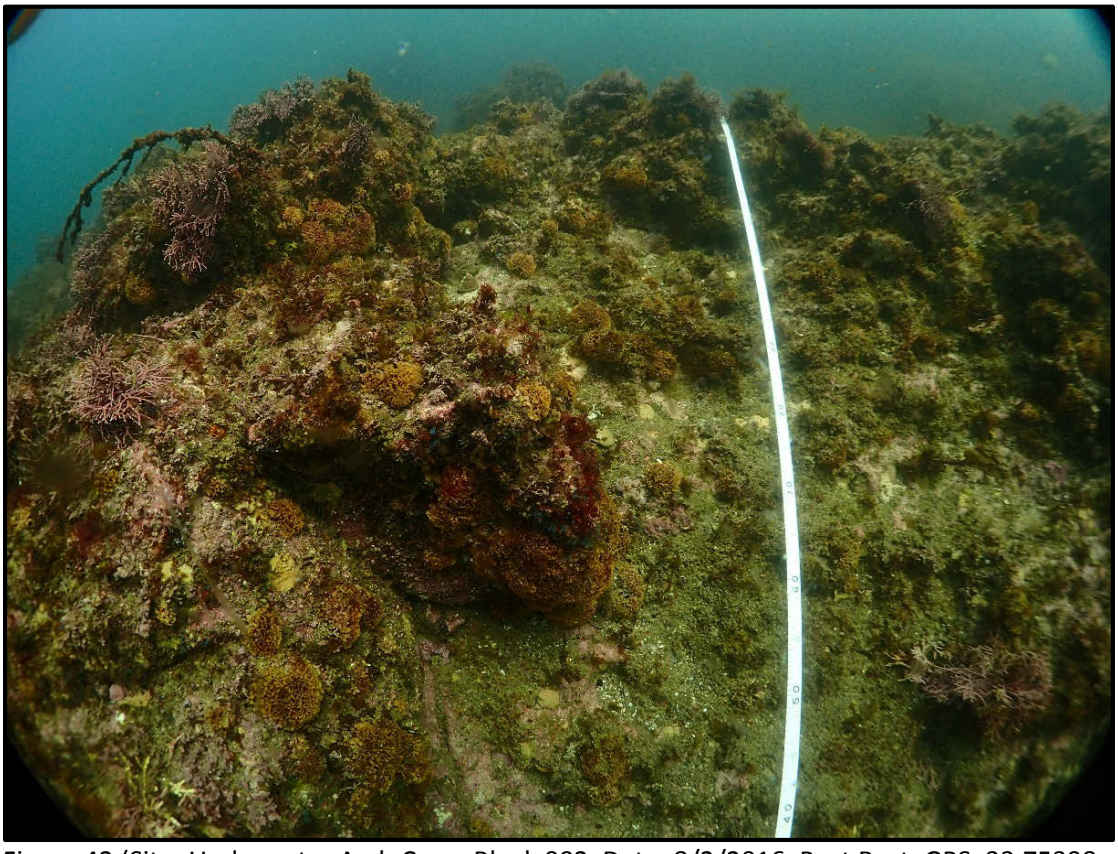


Figure 42 (Site: Underwater Arch Cove, Block 002, Date: 8/2/2016, Post Rest, GPS: 33.75398, -118.41659)

Figure 43 (Site: Underwater Arch Cove, Block 006, Date: 11/13/2013, Post Rest, GPS: 33.753655, -118.416404)

Figure 44 (Site: Underwater Arch Cove, Block 006, Date: 08/6/2016, Post Rest, GPS: 33.753655, -118.416404)

Figure 45 (Site: Underwater Arch Cove, Block J1, Date: 08/14/2014, Post Rest, GPS: 33.75205979 , -118.4156861)

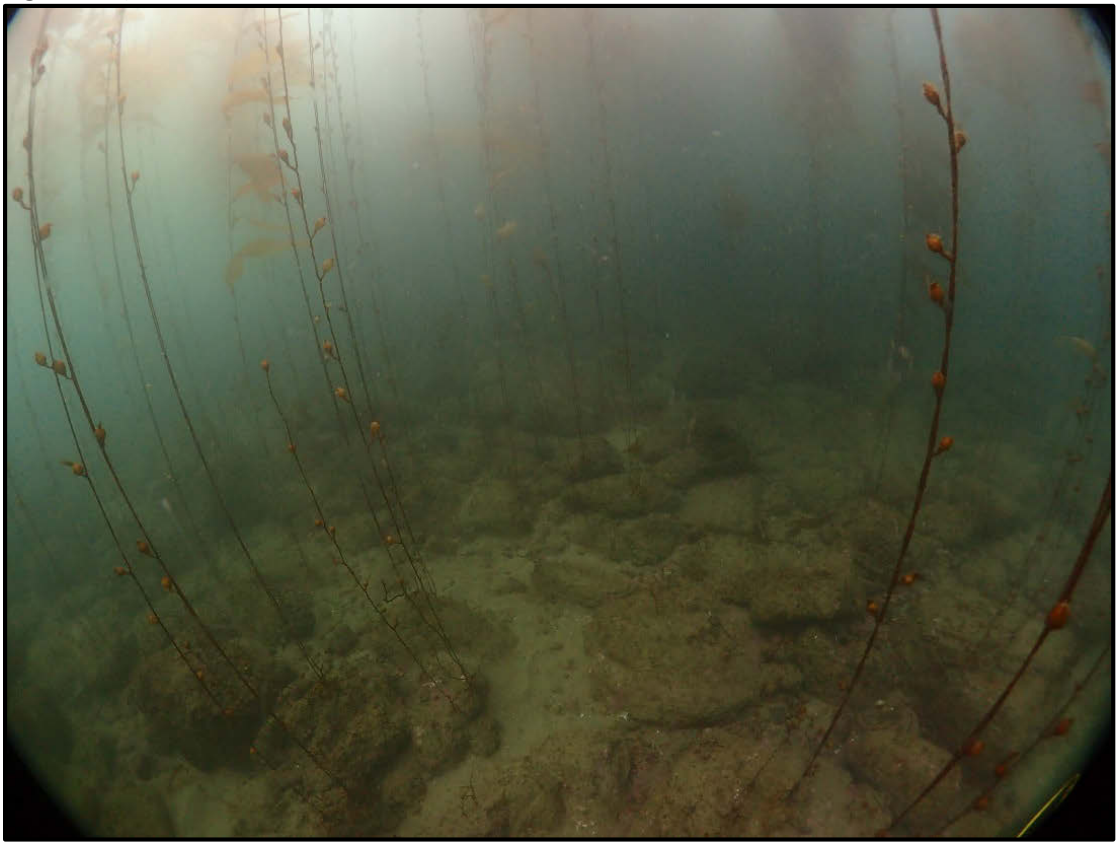


Figure 46 (Site: Underwater Arch Cove, Block J1, Date: 07/7/2016, Post Rest, GPS: 33.75205979 , -118.4156861)

Figure 47 (Site: Underwater Arch Cove, Block J2, Date: 08/14/2014, Post Rest, GPS 33.7523302, -118.4151245)

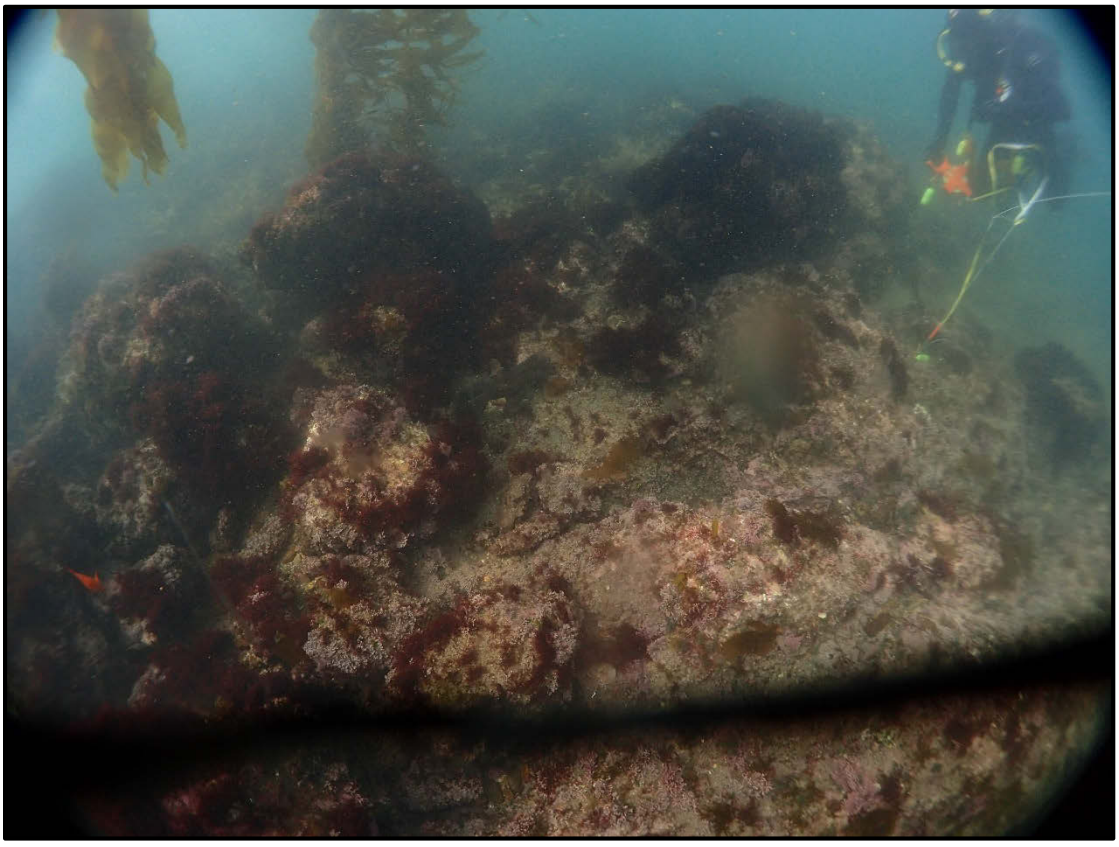
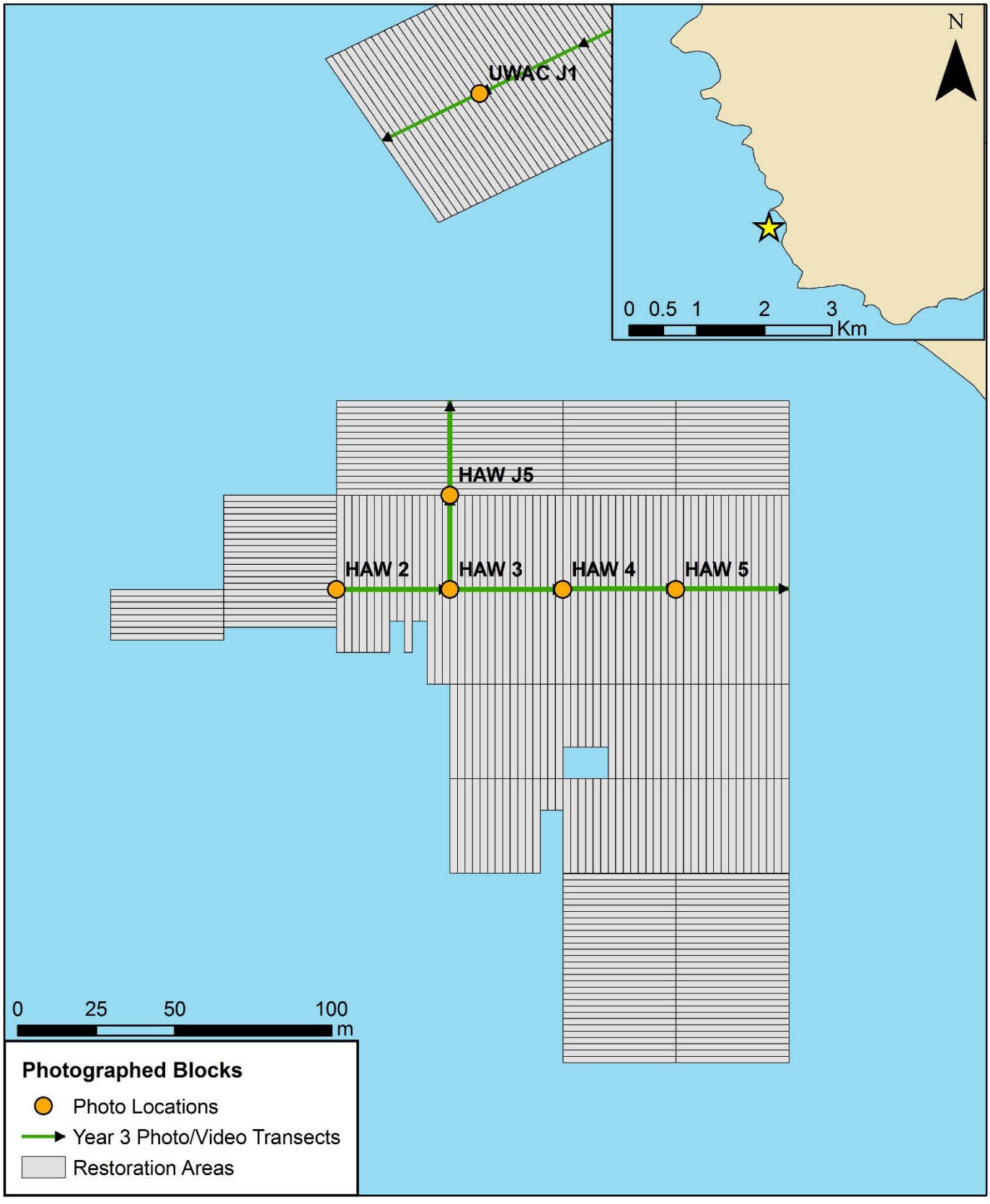


Figure 48 (Site: Underwater Arch Cove, Block T7, Date: 07/07/2016, Post Rest, GPS 33.7526, -118.414563)

Figure 49 (Site: Underwater Arch Cove, Block W1, Date: 08/05/2014, Post Rest, GPS 33.753855, -118.4157562)

Figure 50 (Site: Underwater Arch Cove, Block W1, Date: 08/02/2016, Post Rest, GPS 33.753855, -118.4157562)

Hawthorne Photo and Video Transects



Hawthorne – Post Restoration

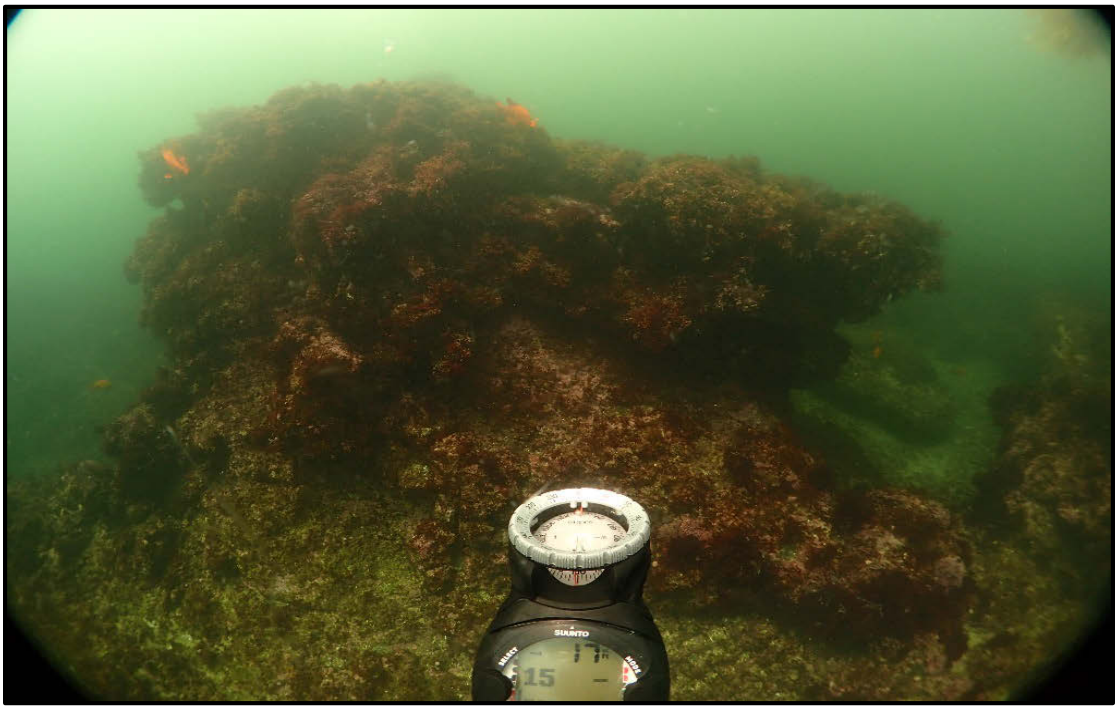


Figure 51 (Site: Hawthorne, Block: 2, Date: 08/10/2016, Post Restoration, GPS: 33.75064, -118.416097)

Figure 52 (Site: Hawthorne, Block: 2, Date: 08/10/2016, Post Restoration, GPS: 33.75064, -118.416097)

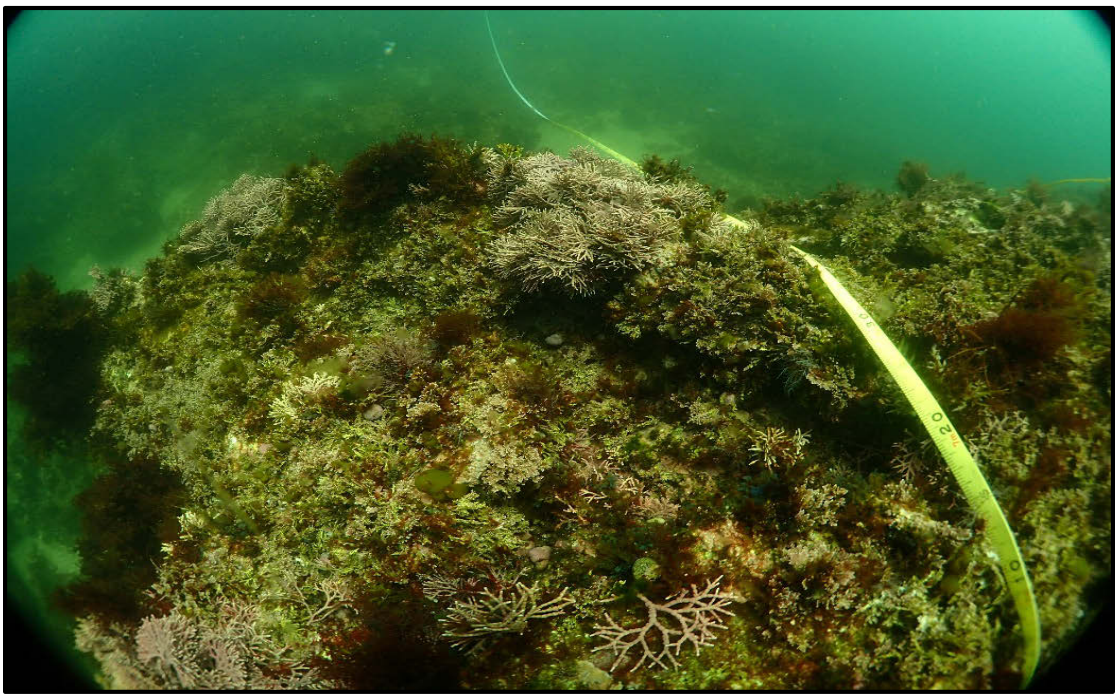


Figure 53 (Site: Hawthorne, Block: 3, Date: 08/10/2016, Post Restoration, GPS: 33.75064, -118.415772)

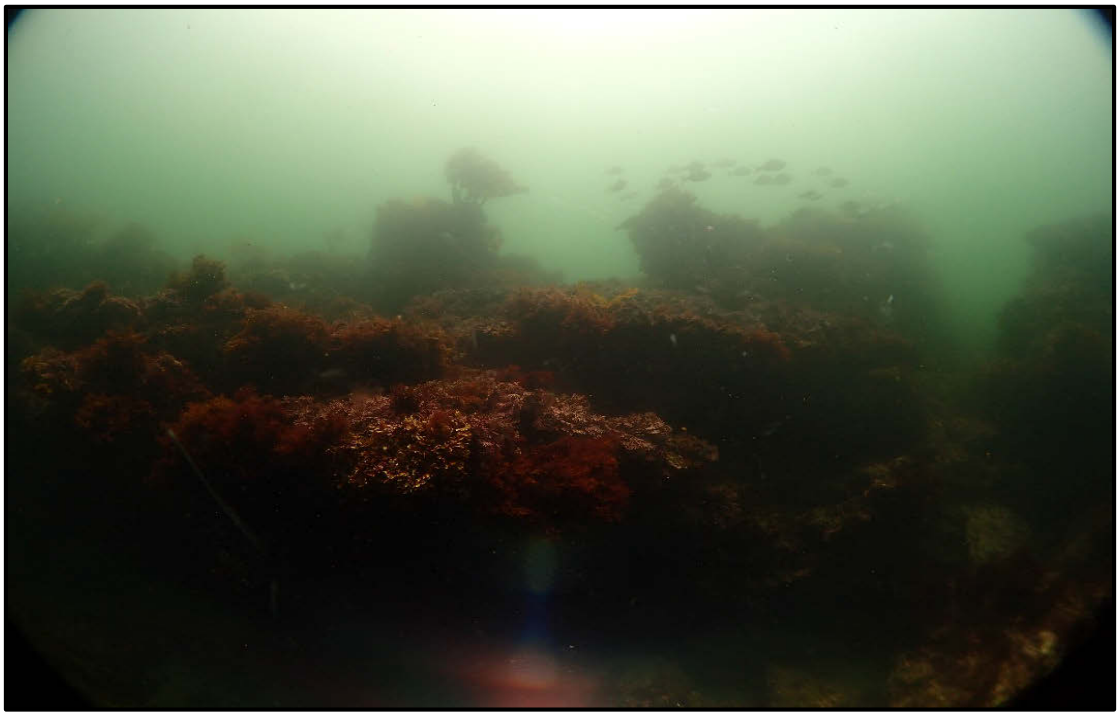


Figure 54 (Site: Hawthorne, Block: 3, Date: 08/10/2016, Post Restoration, GPS: 33.75064, -118.415772)

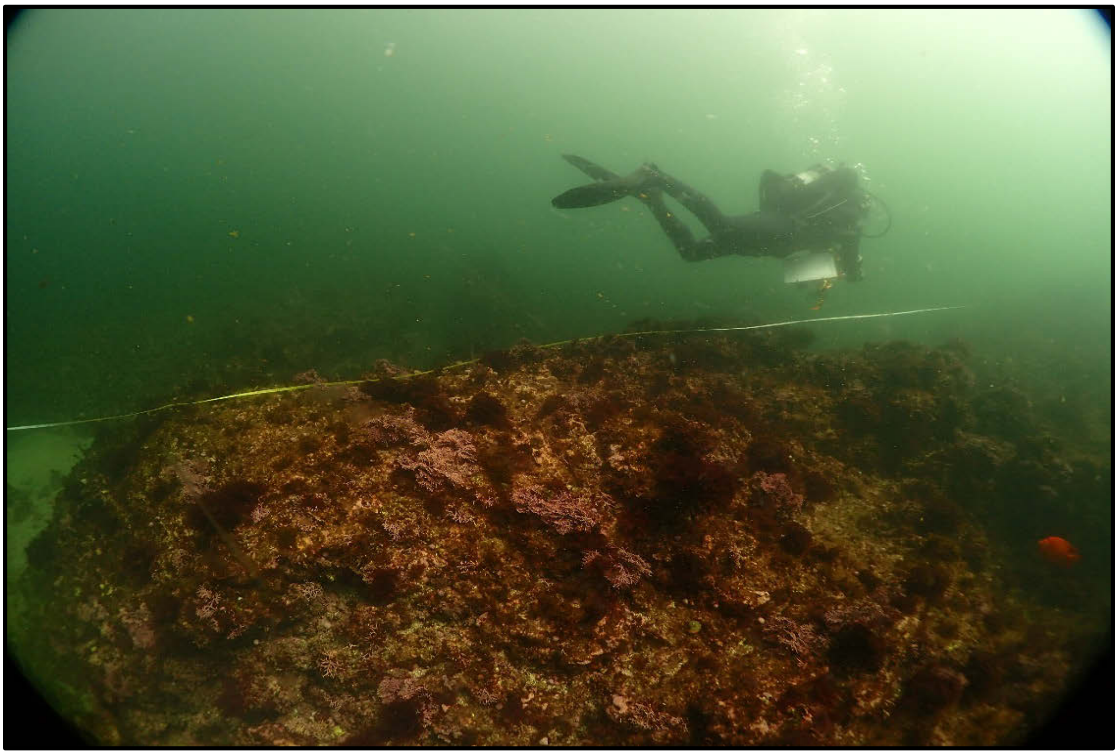
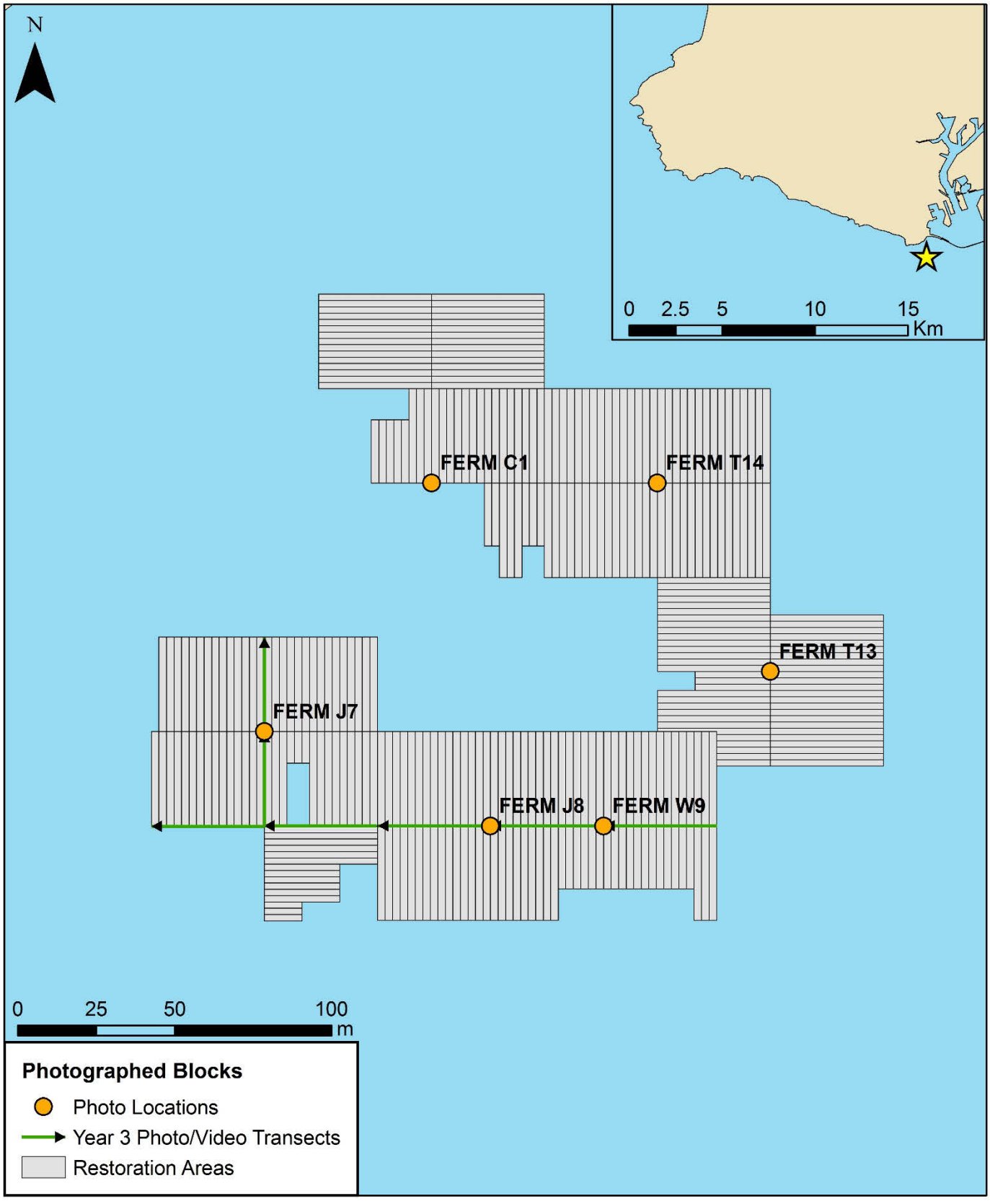


Figure 55 (Site: Hawthorne, Block: J5, Date: 08/10/2016, Post Restoration, GPS: 33.75091, -118.415772)

Point Fermin Photo and Video Transects



Point Fermin – Pre Restoration

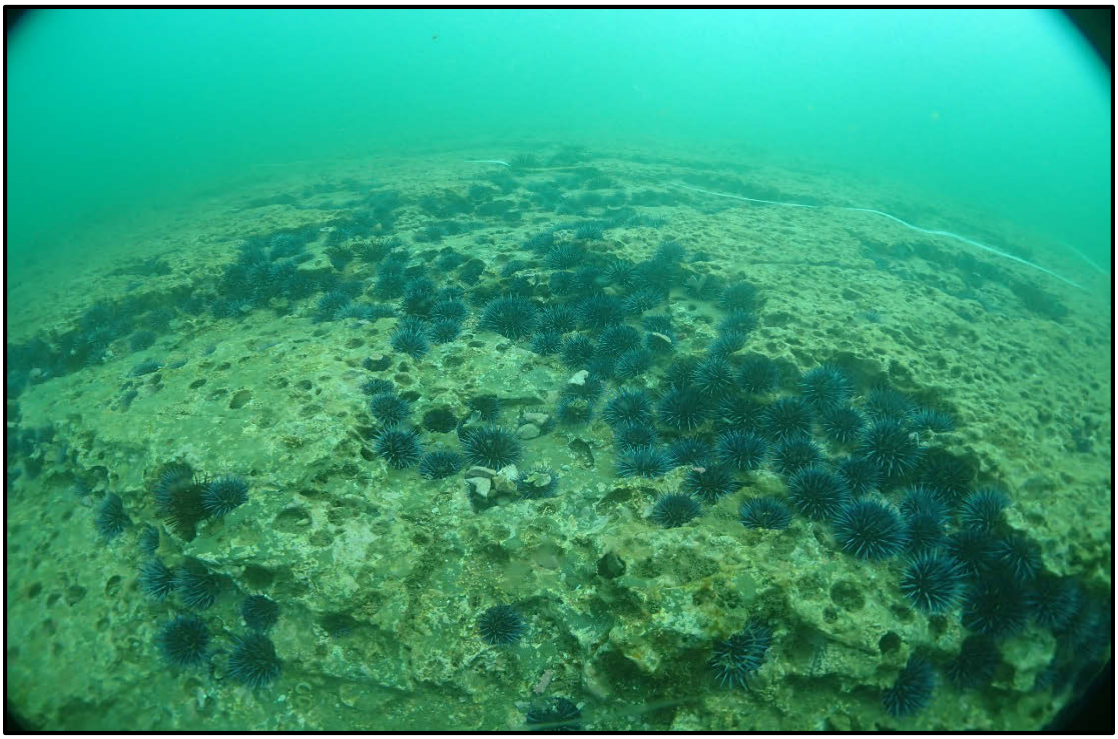


Figure 56 (Site: Pt. Fermin, Block: T14, Date: 07/17/2015, Pre Restoration, GPS: 33.70374, -118.289041)

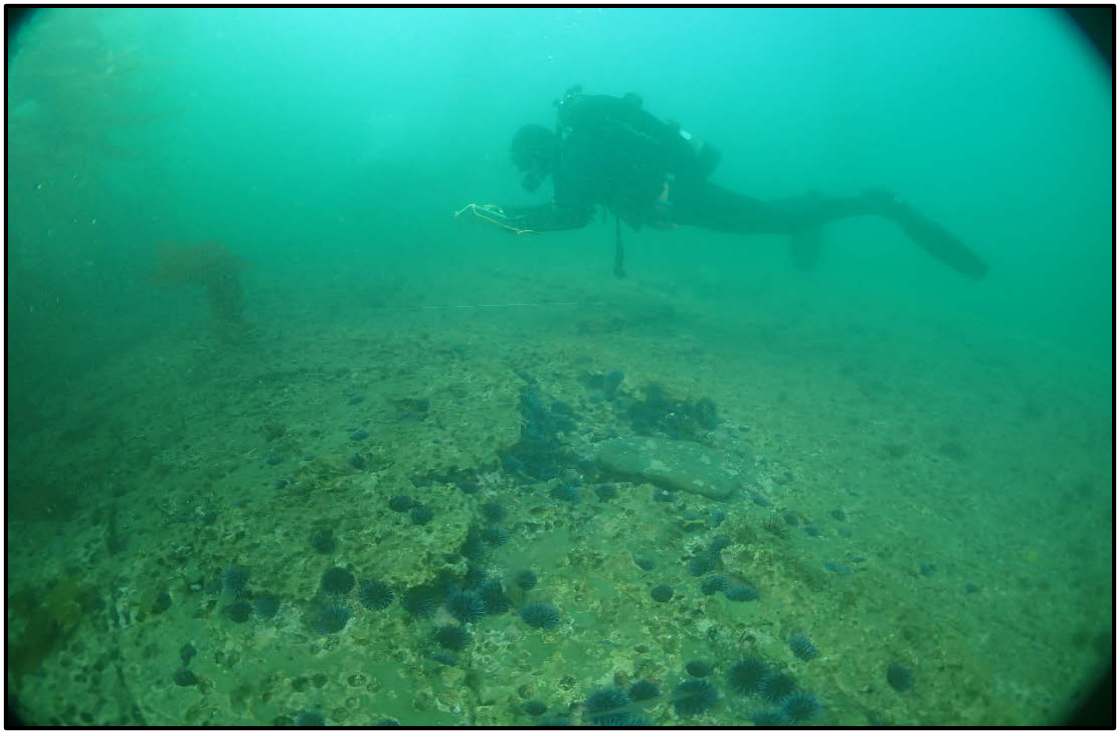


Figure 57 (Site: Pt. Fermin, Block: T14, Date: 07/17/2015, Pre Restoration, GPS: 33.70374, -118.289041)

Figure 58 (Site: Pt. Fermin, Block: C1, Date: 09/25/2015, Pre Restoration, GPS: 33.70374, -118.289688)

Figure 59 (Site: Pt. Fermin, Block: J7, Date: 06/26/2015, Pre Restoration, GPS: 33.703028, -118.290167)

Figure 60 (Site: Pt. Fermin, Block: J7, Date: 06/26/2015, Pre Restoration, GPS: 33.703028, -118.290167)

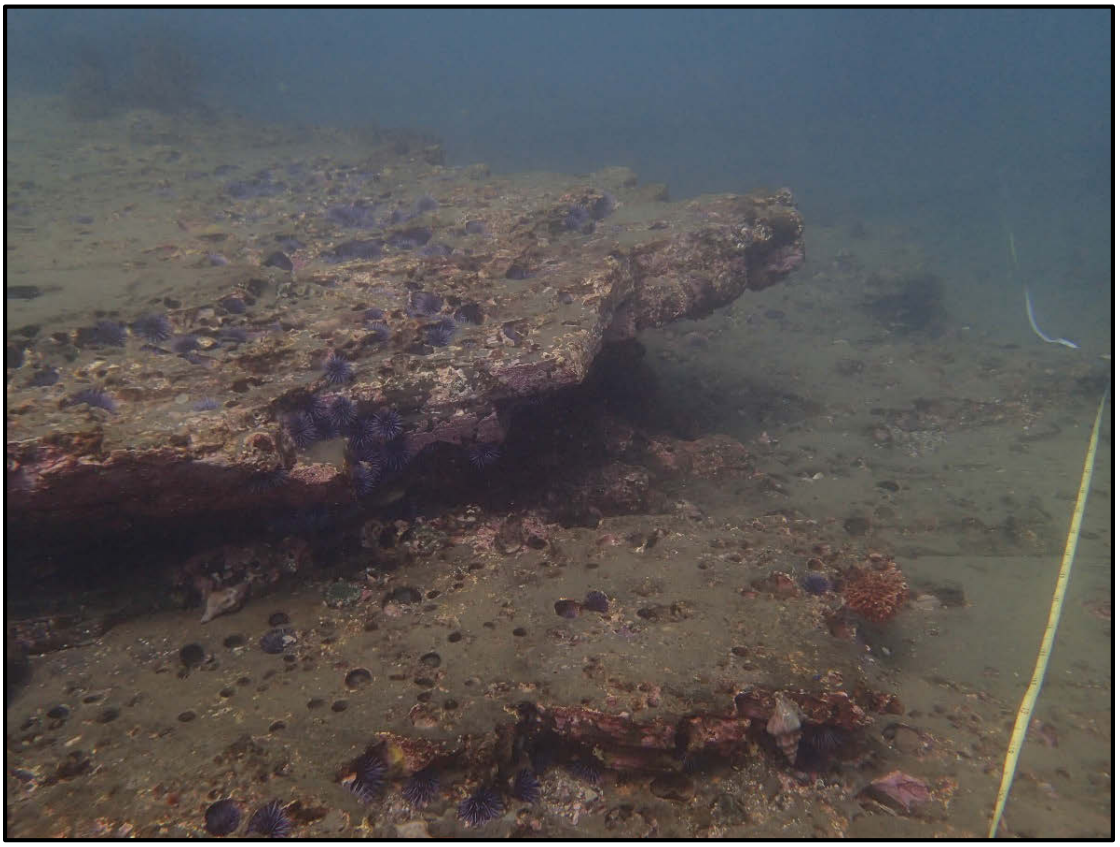


Figure 61 (Site: Pt. Fermin, Block: J8, Date: 08/12/2015, Pre Restoration, GPS: 33.702758, -118.289519)

Point Fermin – Post Restoration

Figure 62 (Site: Pt. Fermin, Block: J7, Date: 08/10/2016, Post Restoration, GPS: 33.703028, -118.290167)

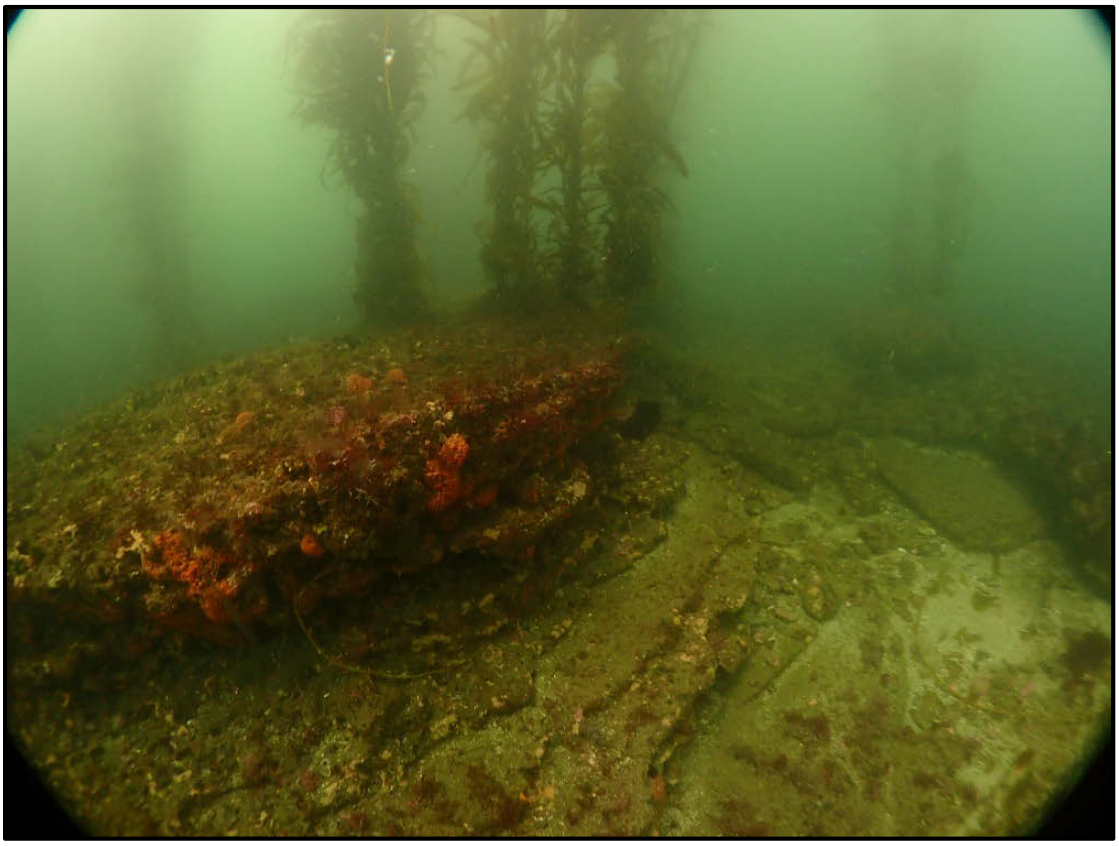


Figure 63 (Site: Pt. Fermin, Block: J7, Date: 08/10/2016, Post Restoration, GPS: 33.703028, -118.290167)

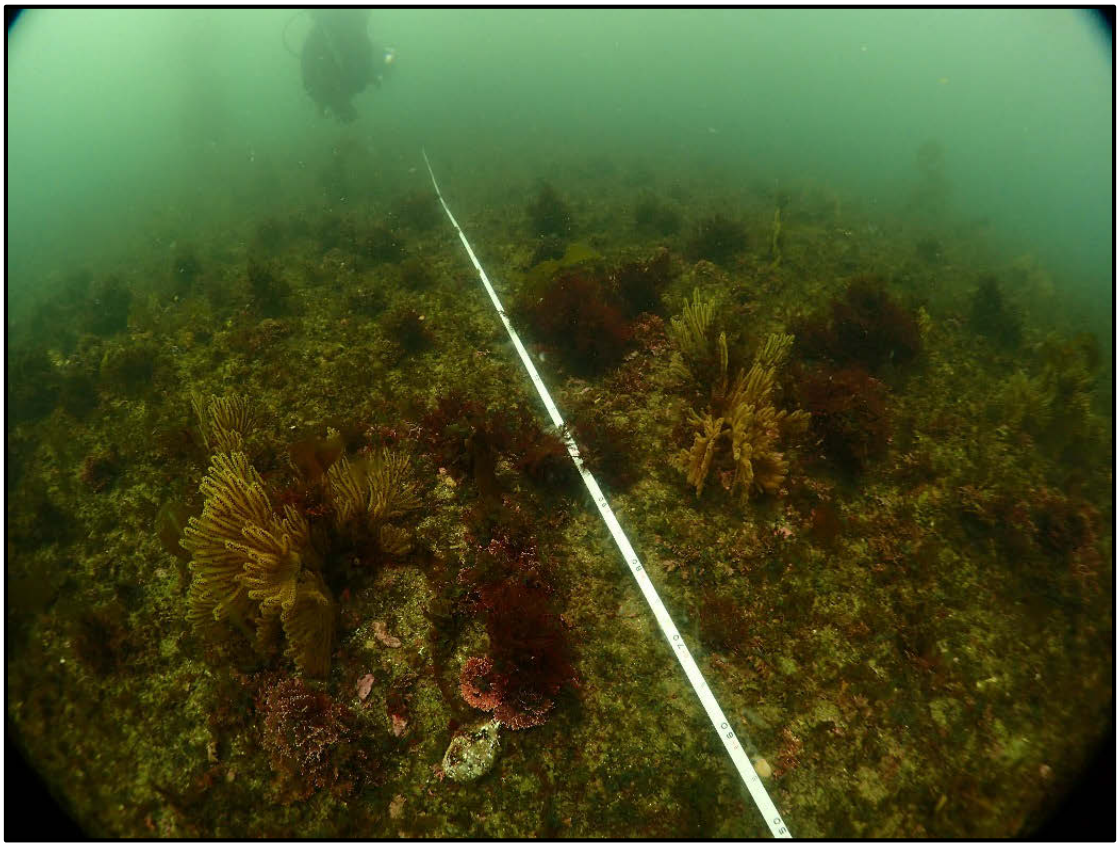
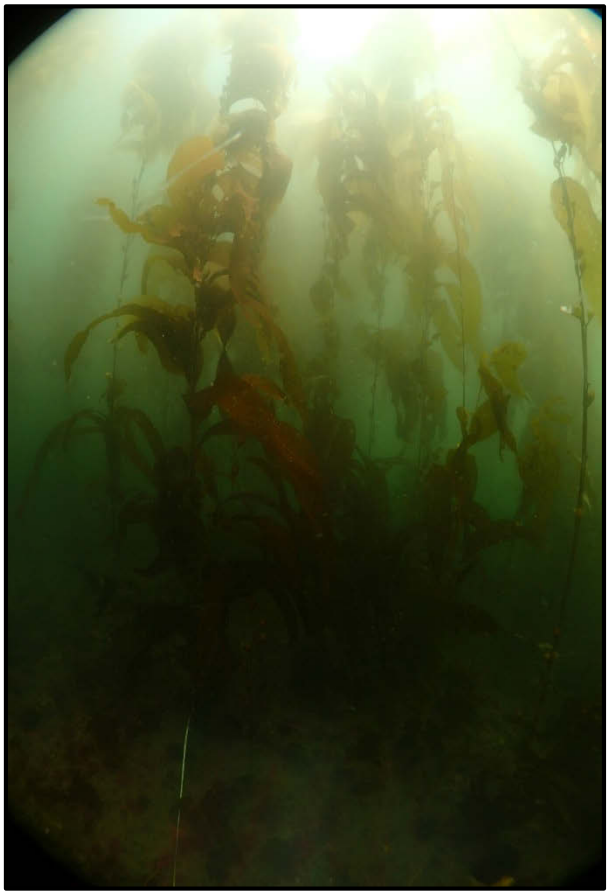


Figure 64 (Site: Pt. Fermin, Block: J8, Date: 08/10/2016, Post Restoration, GPS: 33.702758, -118.289519)



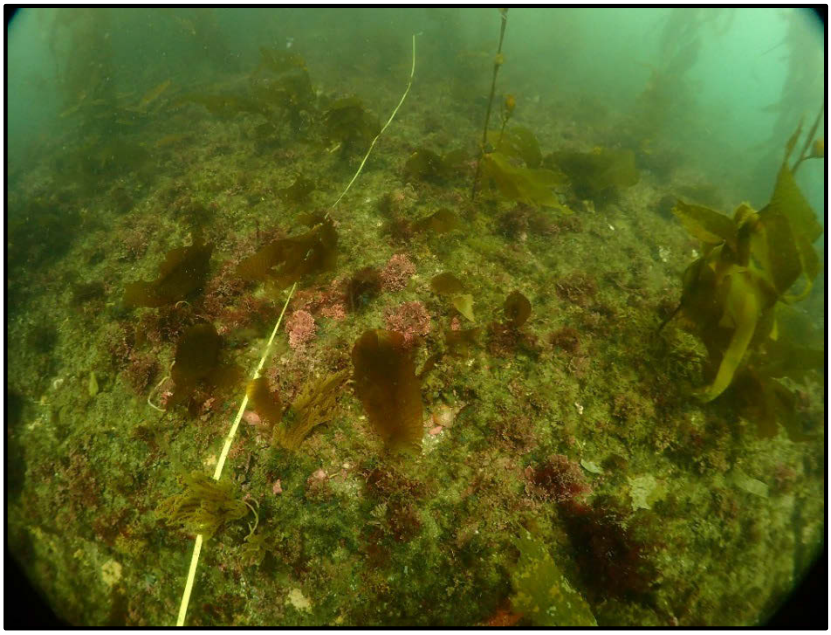


Figure 65 - 66 (Site: Pt. Fermin, Block: W9, Date: 08/10/2016, Post Restoration, GPS: 33.702758, -118.289195)

Restoration Sites - Permanent Photo/Video Points

This east-west running ridge located within **Honeymoon Cove**, Block T2 was chosen as a permanent photo point because it is large enough to be identified with dense kelp growth and relatively easy for divers to relocate.

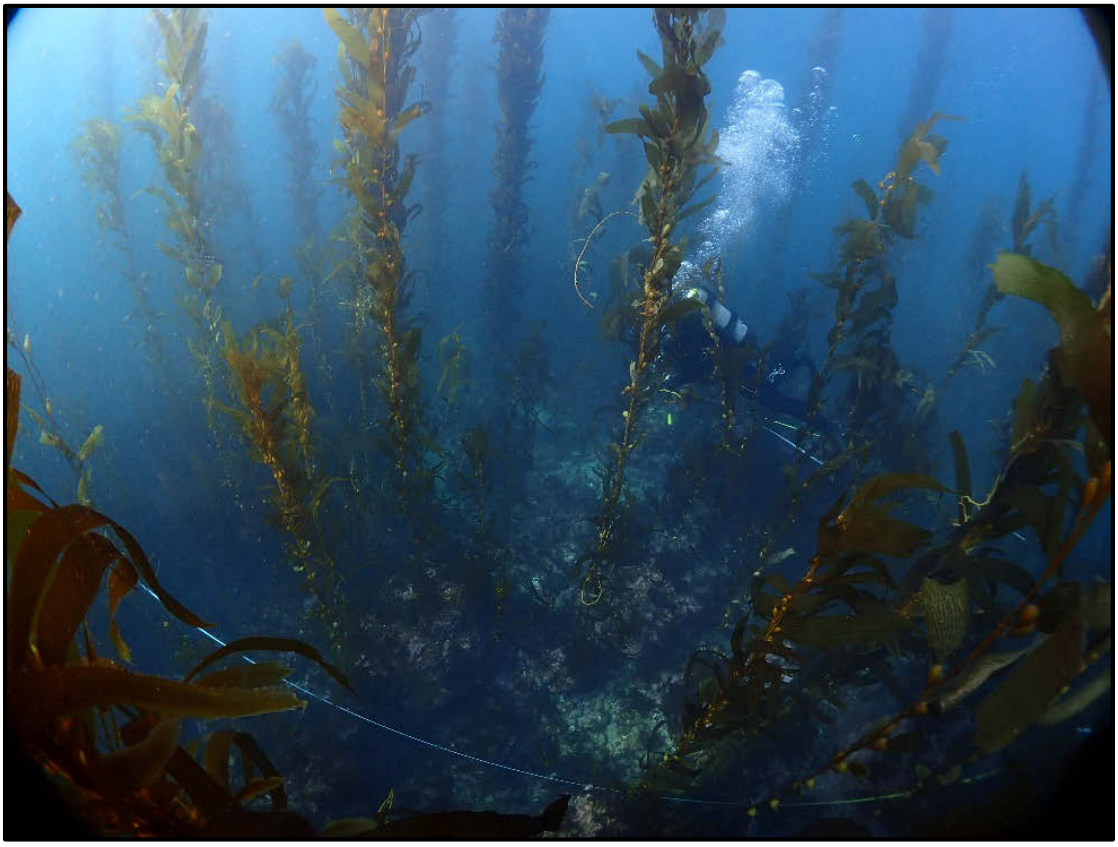
(Site: Honeymoon Cove, Block: T2, Date: 07/29/2016, Post Restoration, GPS: 33.764260, -118.423734).

Honeymoon Cove, Block R5 is the site of another TBF project with ongoing monitoring. Divers visit this area quarterly to conduct subtidal surveys allowing the opportunity to collect photos over time.

(Site: Honeymoon, Block: R5, Date: 06/22/2015, Post Restoration, GPS: 33.765297, -118.424221)

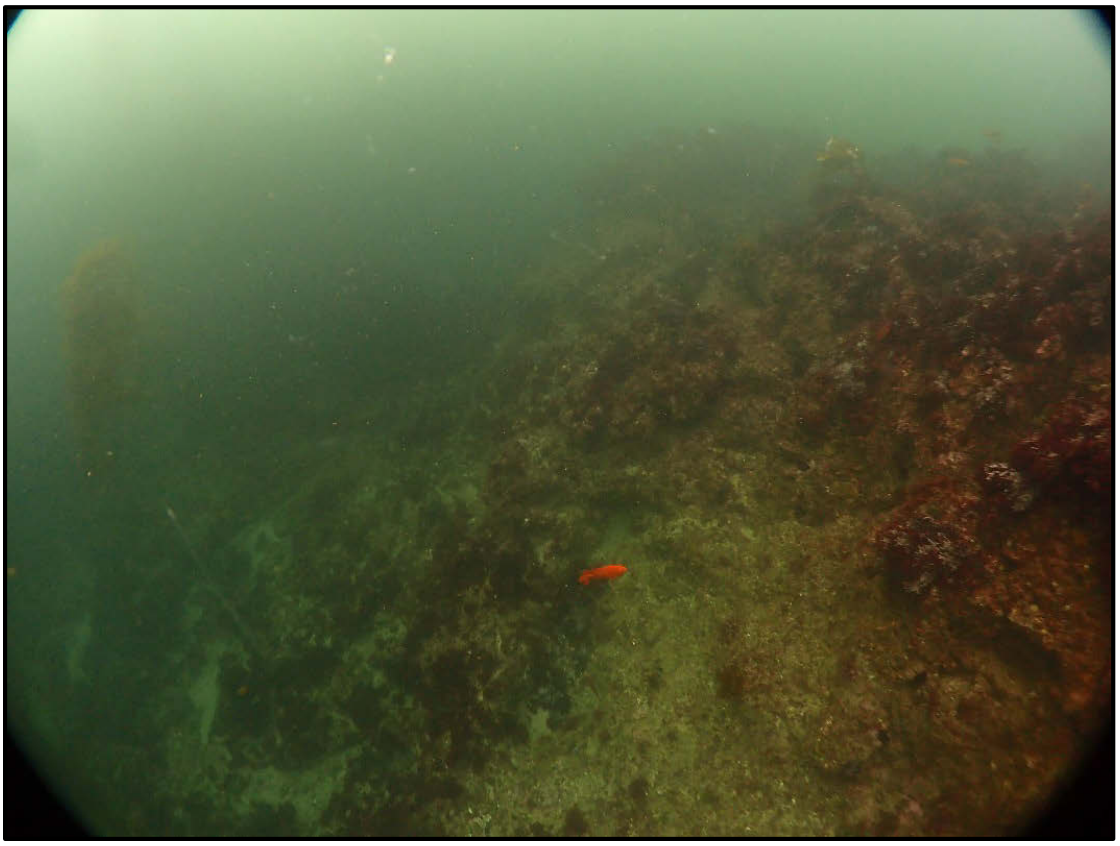
(Site: Honeymoon, Block: R5, Date: 09/24/2015, Post Restoration, GPS: 33.765297, -118.424221)

(Site: Honeymoon, Block: R5, Date: 11/12/2015, Post Restoration, GPS: 33.765297, -118.424221)



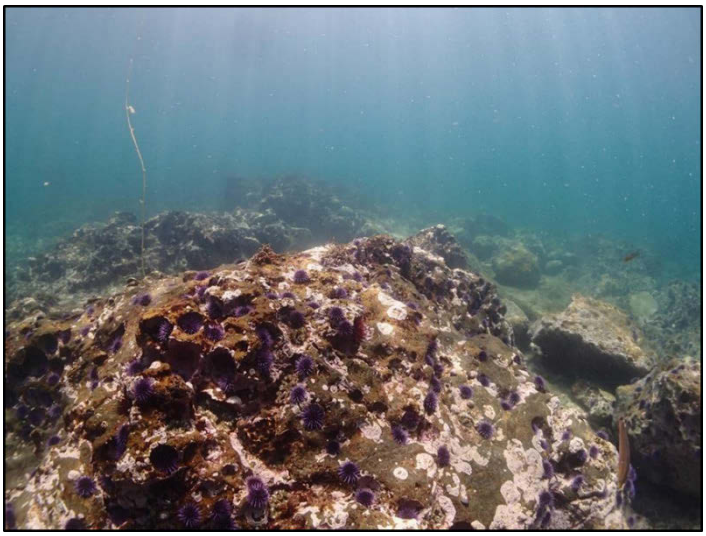
(Site: Honeymoon Cove, Block: R5, Date: 02/10/2016, Post Restoration, GPS: 33.765297, -118.424221)

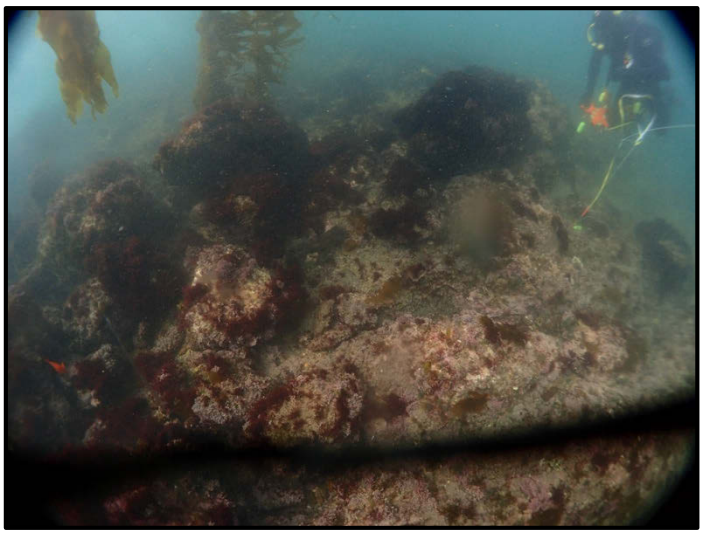
Marguerite, Block T16 will be monitored monthly by TBF divers for a hydrodynamic study over the next 2 years. Photos and video will be taken during these surveys.



(Site: Marguerite, Block: T16, Date: 08/10/2016, Pre Restoration, GPS: 33.757561, -118.41782)

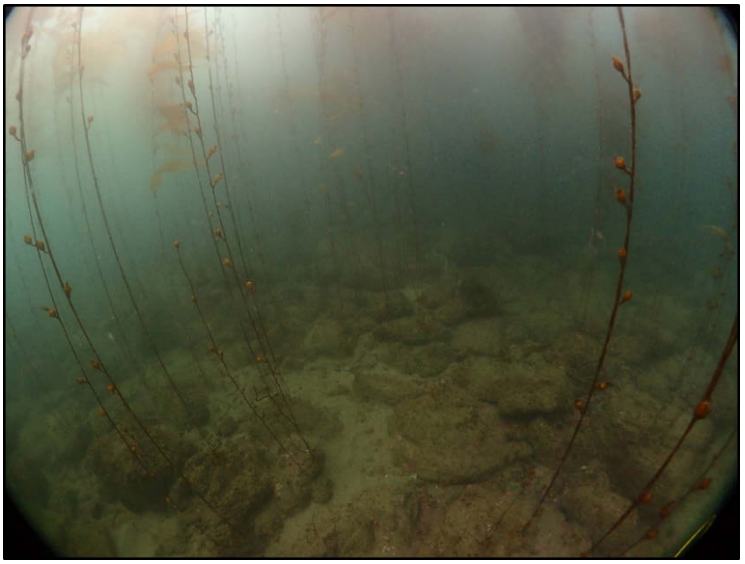
Underwater Arch Cove, Blocks T7, J2, and J1 were the locations of our first transect video shot in 2014. In 2016, this video transect was recorded again and photos from both dates have been archived. Divers will continue to revisit this area at least annually for video and photography.





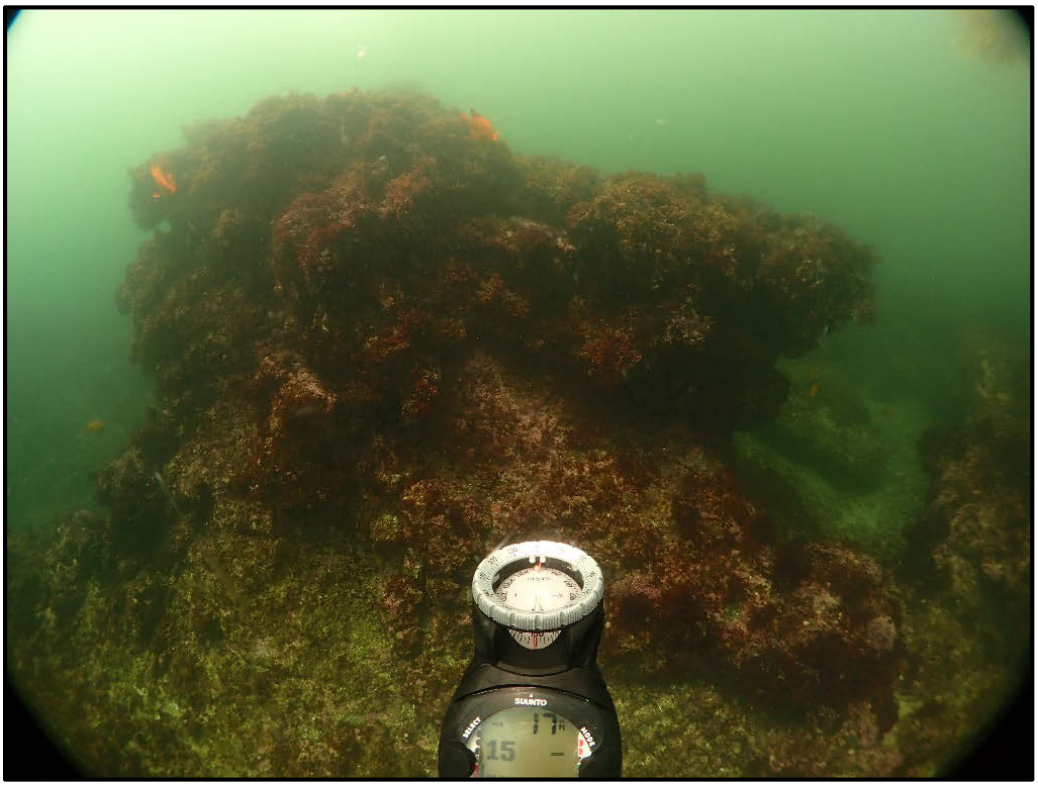
(Site: Underwater Arch Cove, Block T7, Pre restoration in 2014 and Post restoration in 2016, GPS 33.7526, -118.414563)

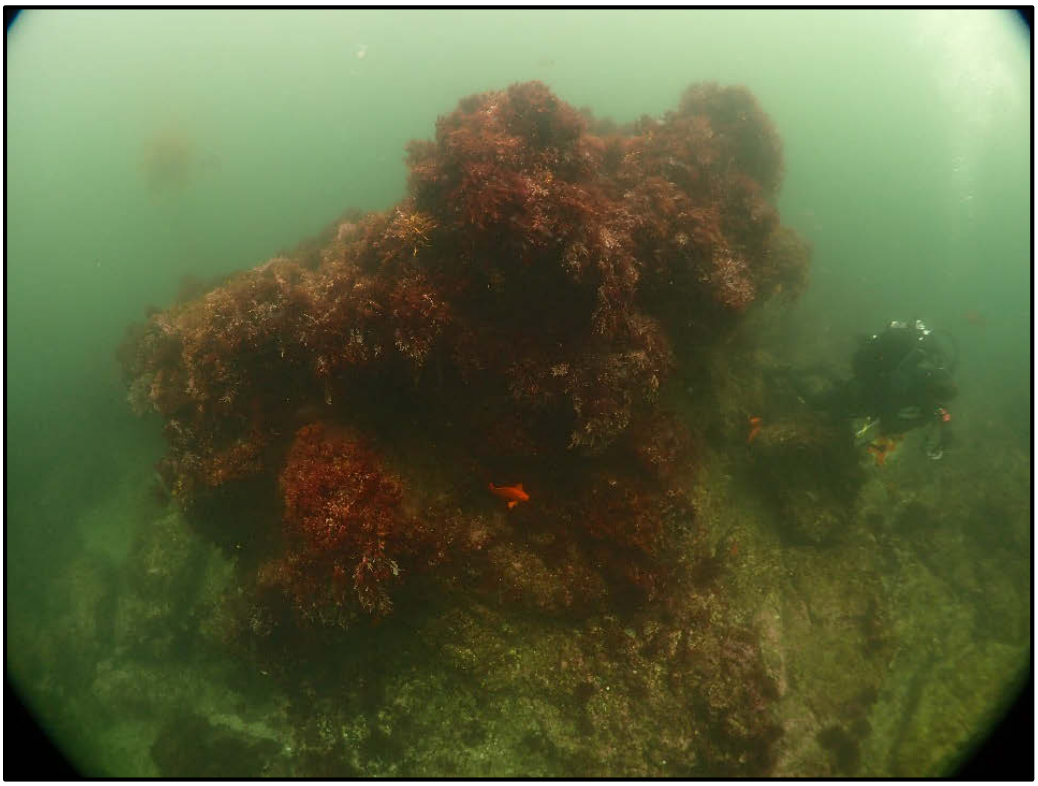
Site: Underwater Arch Cove, Block J2, Date: 06/17/2014, Pre Rest, GPS 33.7523302, -118.4151245)



(Site: Underwater Arch Cove, Block J1, Pre restoration in 2014 and Post restoration in 2016, GPS: 33.75205979, -118.4156861)

Hawthorne, this large pinnacle within Block 2 is easily found by divers and will serve as the starting point for video transects and photos of the site.





(Site: Hawthorne, Block: 2, Date: 08/10/2016, Post Restoration, GPS: 33.75064, -118.416097)

Point Fermin, Block J7 north-south running ridge has been well documented with video footage pre and post restoration. Below are screen shots of the ridge, full videos have been uploaded to Dropbox (Videos 63 and 64).

(Site: Pt. Fermin, Block: J7 Ridge, Pre Restoration 6/26/15 and Post Restoration 9/25/15, GPS: 33.703028, -118.290167)

(Site: Pt. Fermin, Block: J7 Ridge, Post Restoration 8/10/16 GPS: 33.703028, -118.290167)

Appendix E: Aerial Photos of Restoration Sites by Restoration Stage

Figure F1. (Site: Honeymoon Cove, Date: 11/07/2013, Pre Restoration, GPS: 33.794, -118.376)

Figure F2. (Site: Honeymoon Cove, Date: 11/07/2013, Pre Restoration, GPS: 33.794, -118.376)

Figure F3. (Site: Honeymoon Cove, Date: 04/28/2015, Post Restoration, GPS: 33.794, -118.376)

Figure F4. (Site: Honeymoon Cove, Date: 04/28/2015, Post Restoration, GPS: 33.794, -118.376)

Figure F5. (Site: Marguerite, Date: 04/28/2015, Restoration In Progress, GPS: 33.757, -118.418)

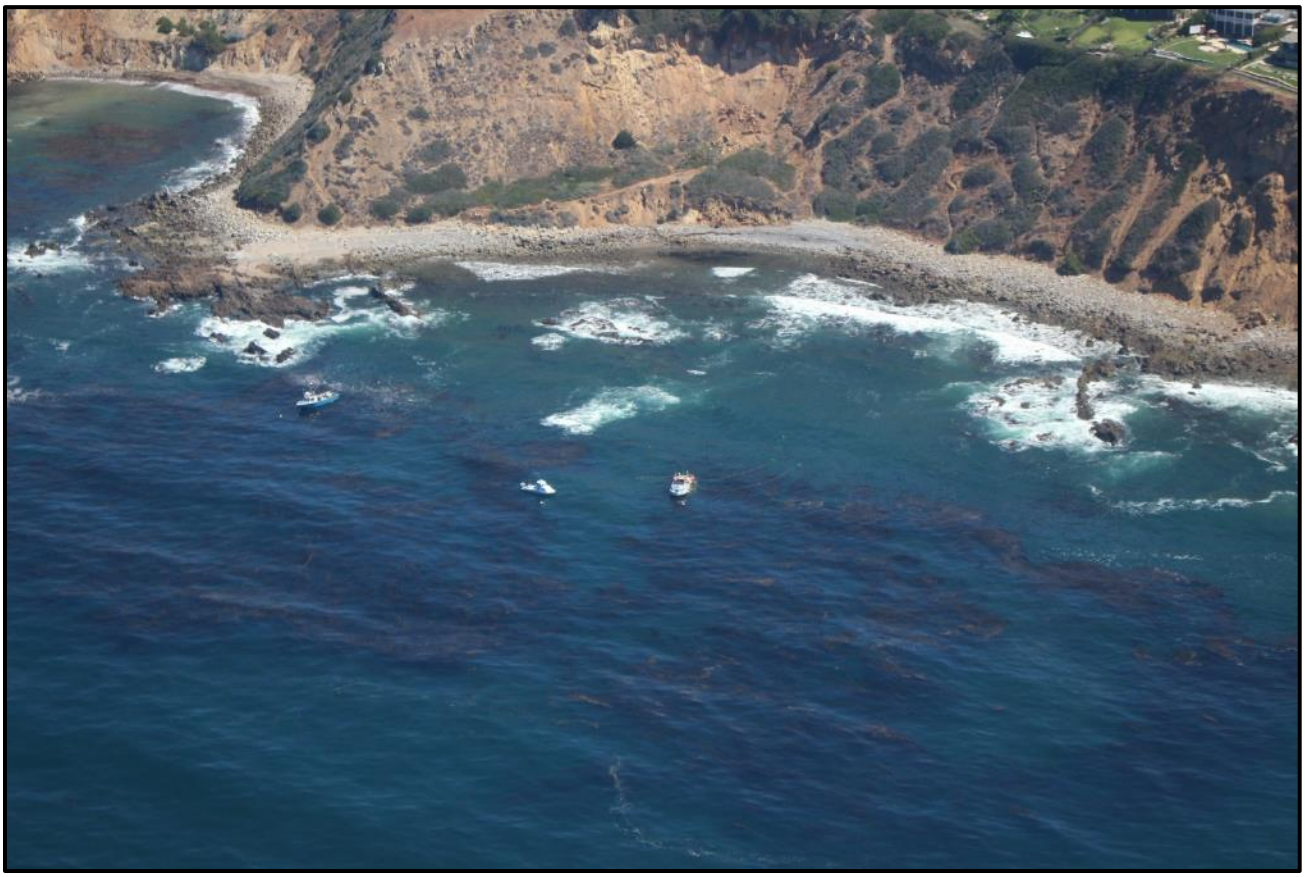


Figure F6. (Site: Marguerite, Date: 04/28/2015, Restoration In Progress, GPS: 33.757, -118.418)

Figure F7. (Site: Marguerite, Date: 04/28/2015, Restoration In Progress, GPS: 33.757, -118.418)

Figure F8. (Site: Underwater Arch Cove, Date: 11/07/2013, Pre Restoration, GPS: 33.752, -118.415)

Figure F9. (Site: Underwater Arch Cove, Date: 04/28/2015, Post Restoration, GPS: 33.752, -118.415)

Figure F10. (Site: Hawthorne, Date: 04/28/2015, Restoration In Progress, GPS: 33.747, -118.414)