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HUMAN INTERIM USE

of the

POINT REYES NATIONAL SEASHORE

ROCKY INTERTIDAL - SUBTIDAL SITES

by

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NPS Contract
CX-8000-3-0002

Second Draft

September 30, 1984

I. INTRODUCTION

The objective of this Interim-Use Report is to describe the activities of a sampling of the human visitors to the rocky intertidal and subtidal habitats of the Point Reyes National Seashore.

The method of sampling the use of the seashore boundaries is direct observation by staff technicians and colleagues who are professionally involved with the health status of these coastal habitats. Mr. Robert Stewart, Marin County naturalist at the Bolinas Headland system, contributed much of the information for the southern portions of the Marin seashores. Of primary concern is human use at the Duxbury Reef complex and the marine habitats of the Tomales Point sites, Figure 1.

II. DATA and OBSERVATIONS

A. Duxbury Reef - Agate Beach Complex

While over one-half million people utilize the Stinson Beach-Bolinas Lagoon area during a five-month period of 1984 (Table 1), only about

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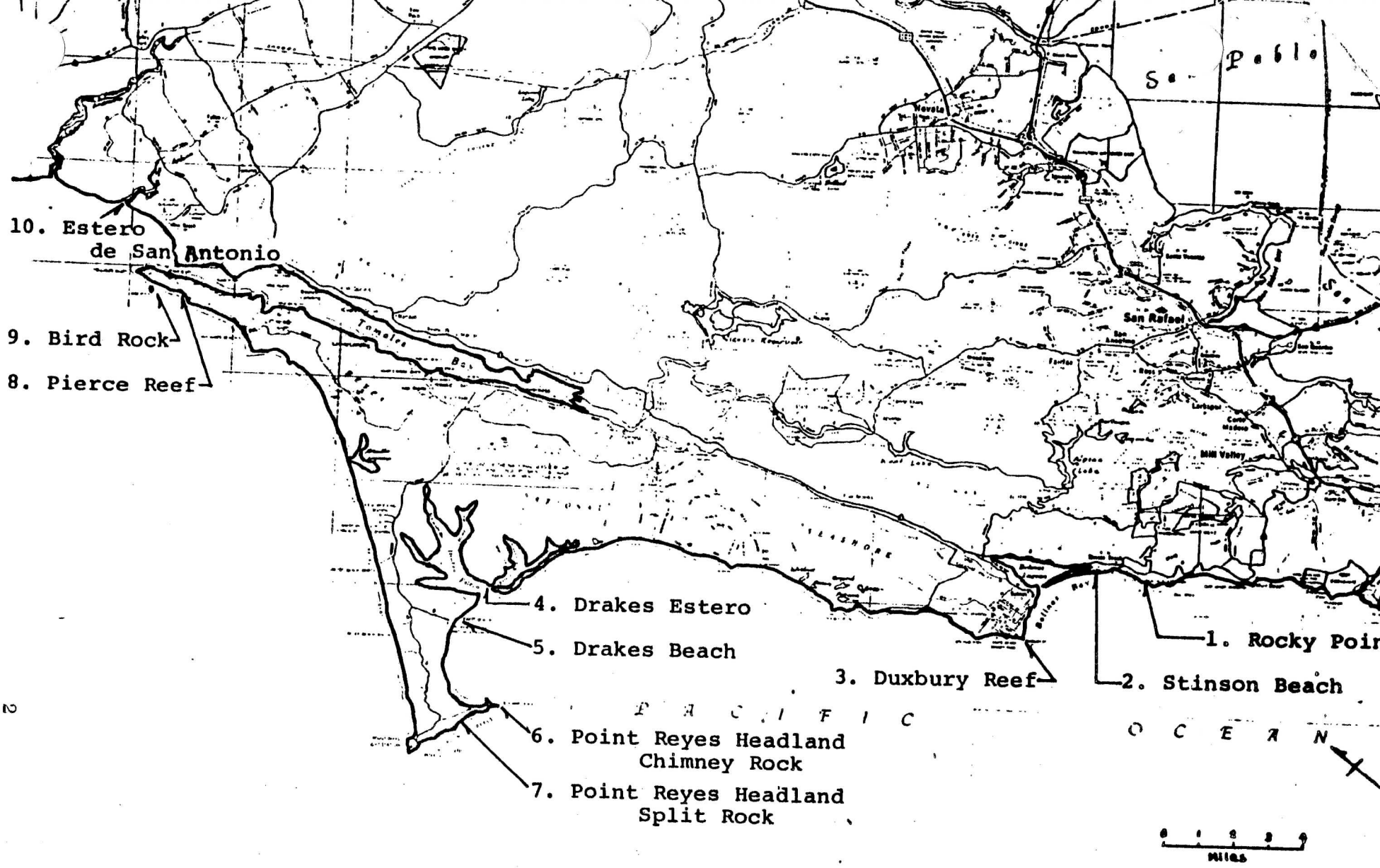


Figure 1. POINT REYES NATIONAL SEASHORE, MONITORING SAMPLING SITES

one percent visit the intertidal and subtidal regions of the Agate Beach - Duxbury Reef complex. From July 1983 to July 1984, at least 2,484 persons used the Duxbury Reef sites. In this one-year period, during 186 days of observations, Mr. Stewart compiled a record of the numbers and activities of the individuals on the reef and beaches; data and information in Tables 1 and 2 and Figure 2. By averaging about 2-3 hours per low-tide day, he calculated that his people counts during the minus tides were accurate in the 90th percentile as he directly noted the human activities on the reef ramparts. However, on plus-tide days, people would come and go during the 6-hour tidal period; he estimated the data accuracy to be about 50%. Thus, all the data provided represent conservative estimates.

1. Table 2 illustrates the intertidal users of the Agate Beach-Duxbury Reef complex. Some 2484 intertidal users were observed in one year, July 1983 to July 1984. By far, persons who were tidepool observers represented the largest percentage of users, 62%, Table 2 and Figure 2. Most of the tidepoolers were school children who took advantage of low tides in May, just before summer vacation time. May tidepoolers represented 40% of those involved in this intertidal activity. Summer month tidepoolers were second in frequency. Tidepoolers dominate the population curve of users at Agate Beach- Duxbury Reef, Figure 2.

INTERIM HUMAN USE (Stewart)

April–August, 1984

Other Bolinas Areas	April	May	June	July	Aug	TOTAL
Brighton Beach	160	18	61	322	15	576
Bolinas Beach	35	238	65	50	138	526
Stinson Beach (Spit)	745	142	500	516	601	2,504
Stinson Beach (GGNRA)	75,327	90,495	105,413	95,573	100,000	466,808
Bolinas Ridge (GGNRA)	—	7,186	8,225	7,513	7,500	30,424
Audubon Canyon Ranch	4,104	5,600	3,545	1,330	-0-	14,579
Bolinas Lagoon	203	208	206	206	292	1,115
	80,969	104,764	118,497	105,833	108.697	519,088
Bolinas-Palomarin Reefs	2	8	12			22
Point Reyes Headland						
Chimney Rock	8	29	6			43

TABLE 1. VISITORS to the BOLINAS-STINSON BEACH AREA, 1984 (Stewart, 1984)

TABLE 2 HUMAN USE OF THE AGATE BEACH-DUXBURY REEF COMPLEX (Stewart, 1984)

a. Activities, Individuals

	1983 July	Aug	Sept	Oct	Nov	Dec	1984 Jan	Feb	Mar	Apr	May	June	July	Total	%
Tidepooling	170	30	0	0	65	56	93	31	48	124	618	216	90	1540	62.0
Beachwalking	84	12	54	38	48	109	114	43	29	42	45	27	87	732	29.5
Fishing	16	2	0	0	2	24	24	10	8	17	6	31	15	159	6.4
Birding	0	1	0	0	0	0	1	0	0	0	0	0	1	3	0.1
Photography	0	1	0	0	0	2	1	1	1	0	0	0	4	10	0.4
Boating	0	0	0	0	0	2	10	0	0	0	0	0	0	10	0.4
Collecting (illegal)	0	0	0	0	0	6	4	6	0	9	0	2	0	27	1.1
TOTALS	270	46	54	38	115	203	247	91	86	172	669	276	197	2484	100.0

b. Activities, Proportions

	1983 July	Aug	Sept	Oct	Nov	Dec	1984 Jan	Feb	Mar	Apr	May	June	July	Activity Prop for the year
Tidepooling	.62	.65	0	0	.56	.27	.37	.34	.55	.72	.92	.78	.45	.620
Beachwalking	.31	.26	1.00	1.00	.41	.53	.46	.47	.33	.24	.06	.09	.44	.295
Fishing	.05	.04	0	0	.01	.11	.09	.10	.09	.09	0	.11	.07	.064
Birding	0	.02	0	0	0	0	0	0	0	0	0	0	0	.001
Photography	0	.02	0	0	0	0	0	0	.01	0	0	0	.02	.004
Boating	0	0	0	0	0	0	.04	0	0	0	0	0	0	.004
Collecting (illegal)	0	0	0	0	0	.02	.01	.06	0	.05	0	0	0	.011
Monthly Proportion:	.11	.02	.02	.02	.05	.08	.10	.04	.04	.07	.27	.11	.08	1.000

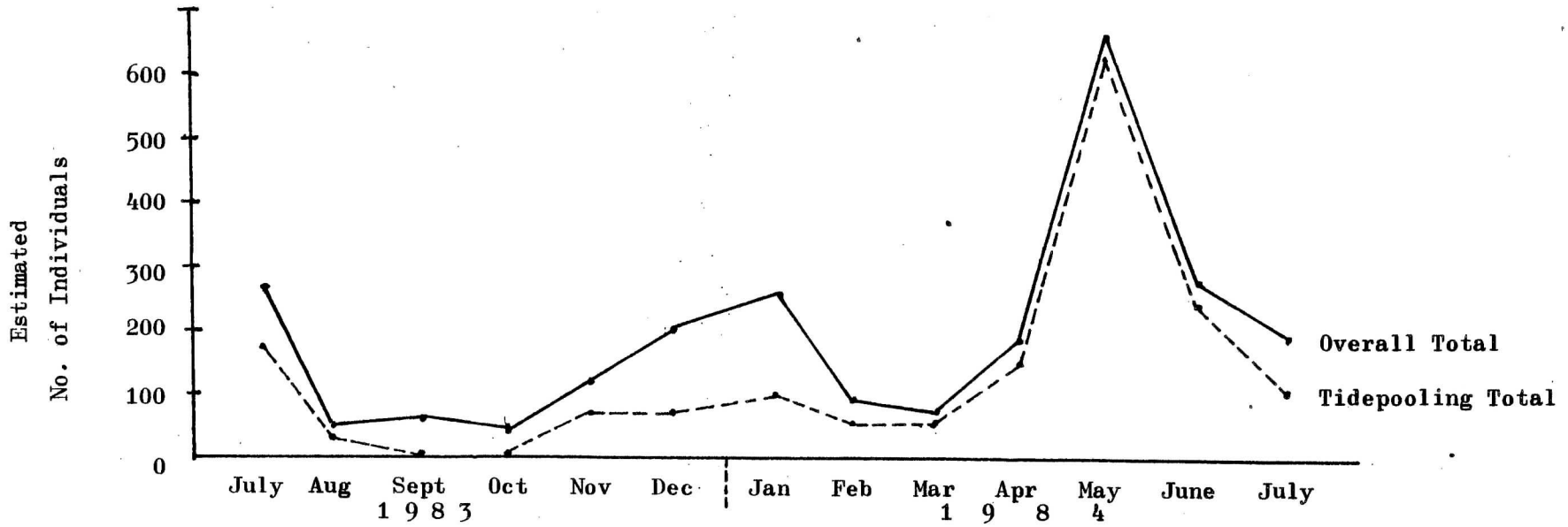


FIGURE 2. HUMAN USE OF THE AGATE BEACH-DUXBURY REEF COMPLEX (Stewart, 1984)

LOW TIDES PER MONTH July 1983 to July 30, 1984 = 186 Days of Observations

2. About 6% of the users are fishermen; nearly all reef fishermen illegally remove the sessile mussels as bait. Some of the mussel colonies on the reef ramparts have been severely depleted.

3. About 1% of the users were collectors, illegally taking mussels and black turban snails by the bucketfuls. According to ranger-naturalist Bob Stewart, this percentage would be lower if posted signs describing marine reserve status could withstand the constant vandalism.

4. Over the years, areas A and B of Duxbury Reef have been ravaged by intertidal visitors; thus, very few marine invertebrates can be observed in comparison to those seen in the large reef extensions at Area C, Figure 3. In recent years, some 75% of the visitors and fishermen to the Duxbury Reef complex have been hiking out to area C. Perhaps through the efforts of the ranger-naturalist at lowtides and enforcement of the Fish and Game Reserve laws, the depletion of marine life in area C might be dminished. It would be a disaster to this unique shale reef if Area C were to look like the ecological "desert" of areas A and B over a long period of human use.

B. Tomales Point Marine Sites

The only area that is practical for abalone sport fishing is the Tomales Point marine habitats. The granitic rocks afford good visibility for divers and sufficient legal-sized specimens are available for low tide rockpickers.

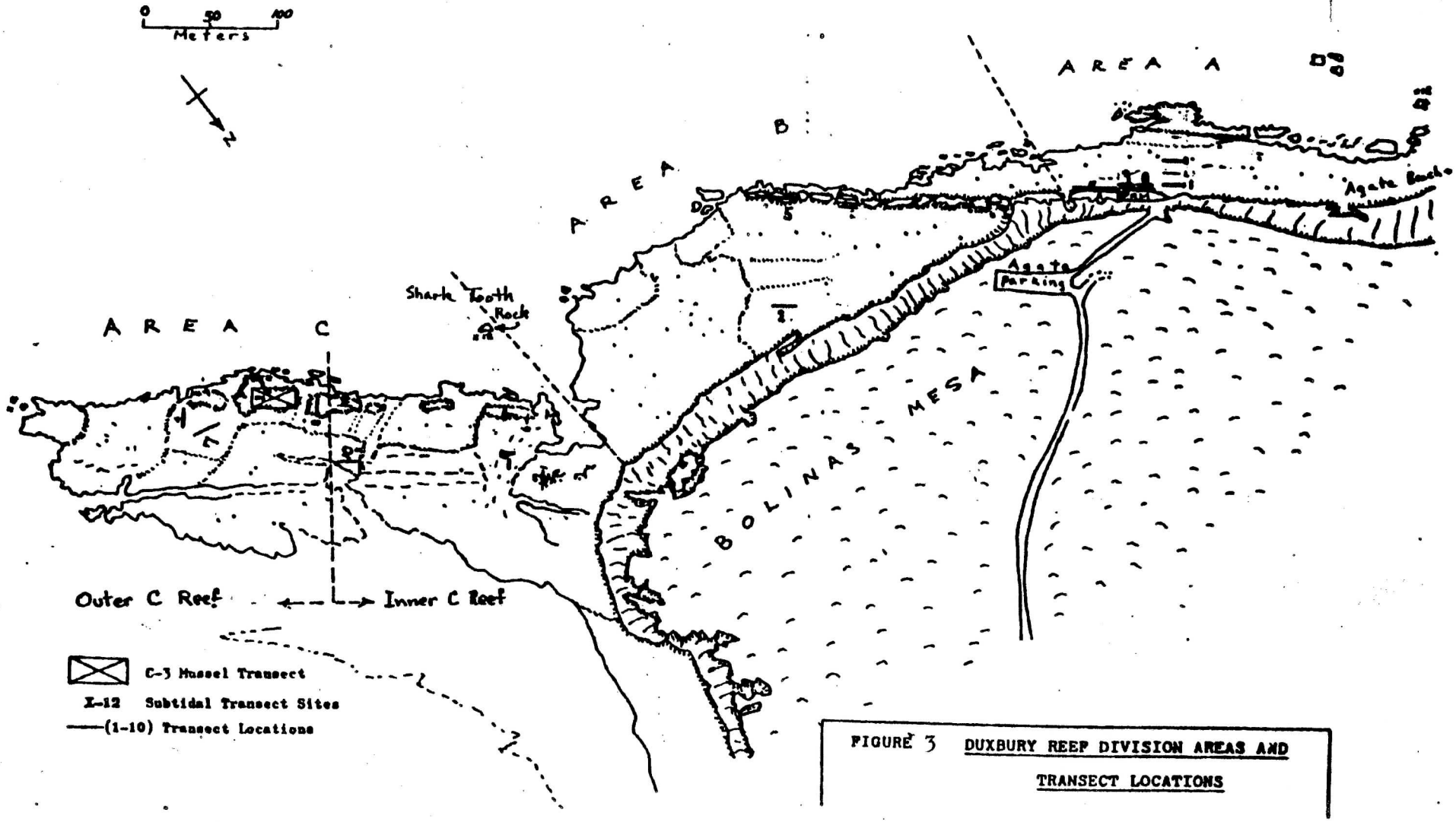


FIGURE 3 DUXBURY REEF DIVISION AREAS AND TRANSECT LOCATIONS

To evaluate a representative sample of the intensity of human use on this peninsula, observations of low tide weekends were selected: one set of three days in 1983, two sets of three days in 1984, and a single Saturday at close of abalone season in 1984, for a total of 10 days of observations. The marine sites most frequented by human users are noted in Figure 4 and Table 3.

(1) South McClure Beach area
Elephant Rock Site

(2) North McClure Reefs

— The users of both areas come by auto, parking in the South McClure Ranch parking lot of the park system.

(3) McDonald's Beach Reefs

(4) Bird Rock Cove Complex

(5) North Tomales Bluff

— Users come to these sites from the Lawson's Landing Trailer Park south of Dillon Beach.

The Tomales Point data (Table 3) reveals:

1. A total of 673 individuals were observed using this elongated marine peninsula during the ten days of low-tide, May-June, 1983 and 1984.
2. Of the 673 persons, only 27 or 4% of the total were hikers-sightseers. Some 646 persons or 95% of the total were involved in the quest for abalones.
3. In order of hunting preference, the following sites were frequented:
   a. Bird Rock Cove complex 35%
   b. North McClure Beach Reefs 29%
   c. McDonald Beach Reefs 24%
   d. South McClure Beach Reefs 10%
   e. North Tomales Bluff Reefs 2%

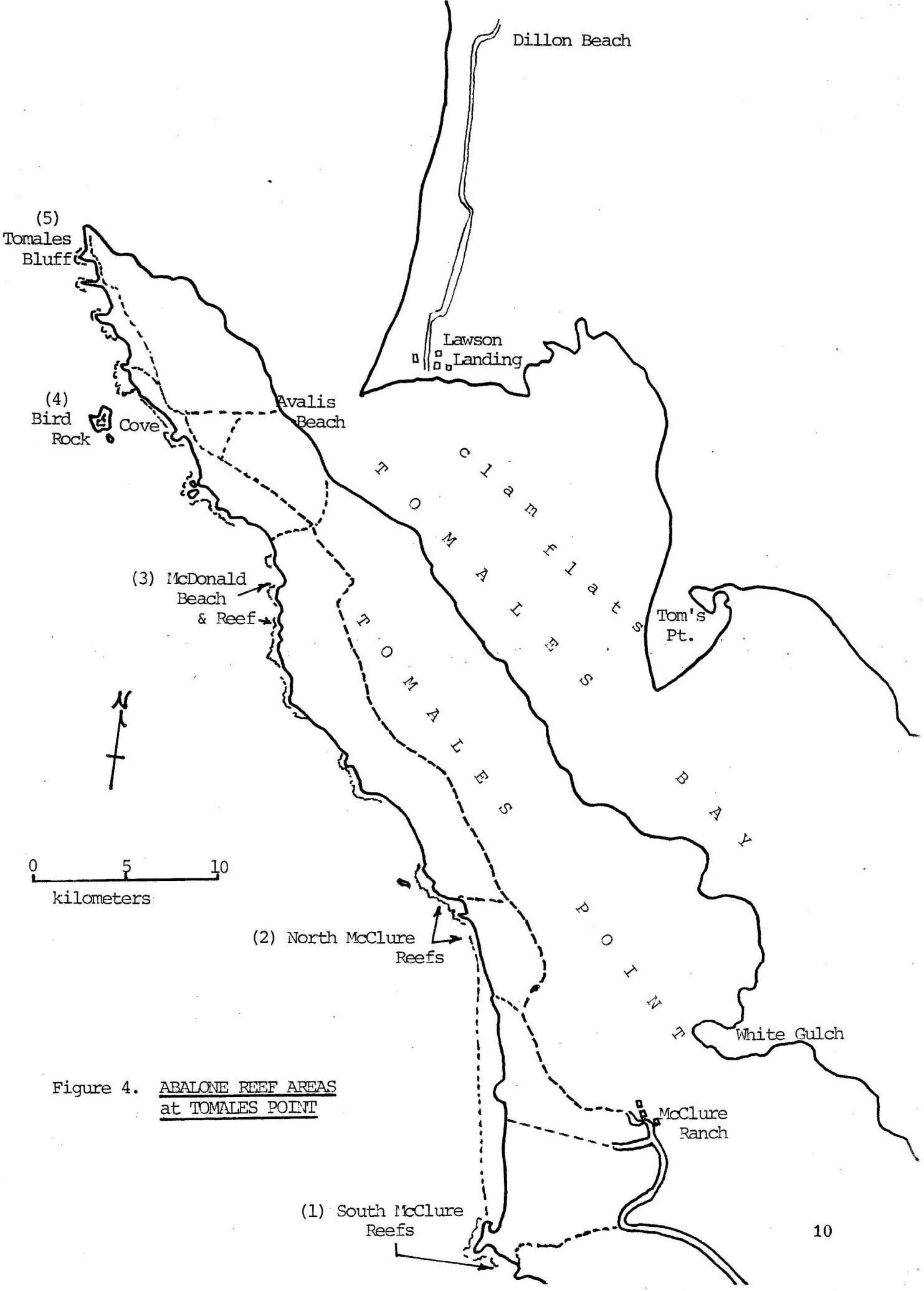


Figure 4. ABALONE REEF AREAS at TOMALES POINT

TOMALES POINT AREAS	JUNE, 1983			MAY, 1984			JUNE, 1984			JUNE 1984	two-yr sample
	10 Fri	11 Sat	12 Sun	18 Fri	19 Sat	20 Sun	1 Fri	2 Sat	3 Sun	~~30~~ Sat	
McClure-South Elephant Rock	2			4	10	8	3	10	10	12	67
McClure-North Reefs	6	5	4	6	30	22	18	36	23	43	193
McDonald's Beach	12	20	18	20	28	12	6	15	8	19	158
Bird Rock Cove	14	46	33	23	30	15	4	23	10	33	231
(boats)	(2)	(3)	(2)	(3)	(9)	(6)	(1)	(3)	(2)	(4)	(35)
Tomales Bluff	0	3			4			5		4	16
Total ABALONE HUNTERS	32	74	55	53	98	57	31	84	51	111	646
Weekend Totals		161			208			166		111	
HIKERS-VISITORS		11			7			9			27
Total for 10 days of observation:											673

96% of Tomales Point visitors were abalone hunters

4% of Tomales Point visitors were sightseeing hikers

TABLE 3, SAMPLING OF WEEKEND ABALONE HUNTING, TOMALES POINT, 1983 and 1984 (10 day sampling)

4. On the 3-day weekend observations, Saturday was the most popular day for abalone hunting, 256 persons or 48% of total count, almost equal to Fridays and Sundays combined, 279 persons (comparison for three sets of weekends). The largest record of weekend abalone hunting was May 18-20, 1984, with 208 persons.

5. The largest single-day count was 111 persons for Saturday, June 30, 1984, the last day of abalone hunting before the closing of hunting during the month of July only.

6. At the Bird Rock Cove complex, 35 boats from Lawson's Landing used this site to ferry hunters to this area. About 30% of the boat excursion hunters in this cove were rock pickers of abalones on the east side of Bird Rock Island.

7. No counts of actual abalones taken were recorded. From a small sampling of a total of 9 divers and rock pickers in the Bird Rock-McDonald's Beach area, it was estimated that hunters averaged two abalones each, a fair guess, in the opinion of local Fish and Game wardens. Thus, if there were 646 abalone hunters during the 10 days of boservations, then approximately 1200 legal-sized abalones may have been removed from the Tomales Point area during 4 weekends, based on half-limit catch estimates. Moreover, in the Bird Rock south cove reefs, three individuals were observed handling abalone limits of four abalones to persons who did not enter the water, but had fishing licenses for marine shores. Such illegal activities may be more common under high user weekends; a diver may bag more abalone limits for his family in such cases.

C. Other Areas

Visitors use the intertidal regions of other park areas in a lesser degree than at Bolinas and Tomales Point. These other marine habitats

stretch from Palomarin reefs to Chimney Rock, Point Reyes Headland.

1. Palomarine Reefs. About 30 divers per year hunt for abalones in this area. Poor water visilibity is a limiting factor to their success and also provides a natural protective cover for the abalone species.

2. Double Point. The posted protective signs regarding marine mammals at this area, plus steep cliffs, limit the intrusion of man at this habitat.

3. Bear Valley - Sculpture Beach. Few hikers to these sites disturb the marine life on these sea stack rocks. Flat rampart reefs do not exist in these areas.

4. Chimney Rock, Point Reyes Headland. In a three-month period, Table 2, some 43 persons visited the intertidal reefs at Chimney Rock. The lack of access prevents more users. However, college intertidal students are the highest number of users at this site in May. Summertime fishermen also use this area for rock fishing.

III. SUMMARY and CONCLUSIONS

While vast numbers of people visit the Bolinas Headland - Stinson Beach - Point Reyes National Seashore Park facilities, only a small percentage investigate the intertidal and subtidal marine habitats. However, these human visitors to reefs do impact the nearshore habitats, some very severely (Chan, 1970, 1973, 1974, 1977).

A. Impact at the Agate Beach - Duxbury Reef complex.

1. Marine life is lost as intertidal visitors impact the environment through constant picking up and removal of marine species. for example, a shore crab which is lifted from a tidepool and reviewed by a class of 30 grade school children will probably be dead after its return to a tidepool.

2. Fishermen rip mussels and limpets from their moorings to use as bait. Some mussel habitats in Duxbury Reef, area C, are severely impacted by these fishermen.

3. Collectors, though small in numbers, come onto the reef to collect buckets of mussels and black turban snails. Most of them claim innocence, an unawareness of the Fish and Game laws prohibiting such events. The posting of protection signs could assist in the lower frequency of such violations.

4. Finally, the importance of a ranger-naturalist on Duxbury Reef during low tide periods cannot be overstated. The presence of such a person is vital to the long-term welfare of this large reef with its unique shale marine life resources.

B. Impact at Tomales Point

While Duxbury Reef has many non-hunting visitors, the reverse is true at Tomales Point during advantageous tidal series. With favorable low tides during the spring and summer weekends, hundreds of visitors come to hunt abalones on rocky reefs and seek clams on mudflats.

1. The user-sampling on 10 days (3 low-tide weekends and final day before split in season) in this study revealed the following:

   a. Saturday is the highest day for abalone hunting visitors (48%), compared to either Friday or Sunday. The totals for Saturdays were almost half of all visitors counted for the three-day weekends.

   b. Lawson's Landing is a base operation for 35% of the weekend hunters and they seem to be more successful in bagging the four-abalone limit than their counterpart who drive to the McClure Beach area.

c. A survey at the McClure Beach site showed that the hunters had about two abalones each, on the average.

C. Impact on Abalones

The question of whether the abalone species can withstand the cropping pressure can be summarized thusly:

1. The species in northern California waters will not be threatened as in southern waters where the human pressure from commercial and sport fisheries is intense and the sea otter prevails.
2. The greatest user pressure occurs during spring and summer low tides. The fall and winter season low tides are not favorable and ocean conditions are hazardous, thus providing protection to the numbers of specimens.
3. The unanswered question is the long-term effect of human pressure. In the intertidal zone, rock pickers will have to go further down, towards minus tides, to obtain legal sizes. Whether seasonal replenishment is sufficient to withstand the divers' pressure remains a matter of evaluation under a long-term monitoring program.

D. Summary

In summary, the Point Reyes National Seashore affords much recreation to thousands of yearly visitors. Less than one percent of the visitors enter into the intertidal and subtidal environments for educational viewing and fish hunting. These human users of this near-shore environment do impact the abiotic and biotic resources, and it behooves the representative authorities of this marine habitat to govern these resources wisely. Otherwise, future generations may not have the same opportunities as the current populace.

Cited References

Chan, G. L. 1970. Analysis of the effects of field trips to Duxbury Reef, Marin County. College of Marin, Kentfield: 140 pp.

_____. 1973. A study of the effects of the San Francisco oil spill on marine life, Part I. Proc. of Joint Conferences on Prevention and Control of Oil Spills, Washington D.C., Amer. Petroleum Inst: 741-759.

_____. 1974. The marine resources and environmental alternatives for the Natural Resources Management Plan of the Golden Gate National Recreational Area. College of Marin, Kentfield: 92 pp.

_____. 1977. The five-year recruitment of marine life after the 1971 San Francisco oil spill. American Petroleum Institute Proceedings: 543-545.

Stewart, R. 1984. Annual report, Bolinas Lagoon- Duxbury Reef, July 1, 1983 to August 30, 1984. Memorandum to Bolinas Lagoon Technical Advisory Committee, Marin County Parks and Recreation, Sept. 7, 1984.

Addendum to the

INTERIM USE REPORT

of the

POINT REYES NATIONAL SEASHORE

ROCKY INTERTIDAL - SUBTIDAL SITES

by Gordon L. Chan
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Kentfield, CA 94904

NPS No. CX-8000-3-0002

March 22, 1985

The following additional data, Tables 1 and 2, are sample of human use of the intertidal-subtidal sites of the Point Reyes National Seashore. As stated in the Interim Report of September 30, 1984, there is a decrease of seashore use during fall and winter months in comparison to the heavier use of spring and summer periods. In the sample days at the areas of Point Reyes Headland and Tomales Point, only 8 abalone divers were observed. The abalone seasons close during the months of December through March of each year. The conclusion and summary of the September 30, 1984 report covers the major emphasis of the call to monitor the activities of human use to determine their impact on the marine resources.

During the months of December 1984 through March 1985 there was a heavy influx of whale watching individuals to the Point Reyes Headland sites. This data is not reported in my papers on Interim Human Use.

1984

DUXBURY REEF and AGATE BEACH	August	September	October	November	December	TOTAL
Tidepooling	0	0	24	0	46	70
Fishing	0	0	4	0	29	32
Photography	0	0	1	0	2	3
Bird Watching	0	0	0	0	0	0
Beach Walking	25	28	38	43	112	246
Totals	25	28	66	43	189	351

TABLE 1. Number of Visitors Involved in Activities at the Bolinas Headland Area, August - December, 1984*

*Data from the Quarterly Reports of Bob Stewart, Bolinas Lagoon Naturalist, based on 59 days of observations of human individuals visiting Bolinas Headland Area.

1984

POINT REYES SEASHORE Sites	Days Observed	AUG	SEPT	OCT	NOV	DEC	TOTAL
Drakes Estero	5	0	6	4	4	4	18
Chimney Rock	5	0	0	0	0	0	0
McClures Beach	10	22	10	18	8	31	89
Tomales Point	4	12	5	6	4	12	39
Totals		32	21	28	16	47	146
(Abalone hunting =		6	2	0	0	0	8)

TABLE 2. Number of Human Individuals and Activities at the Point Reyes Seashore, August - December 1984, based on 24 days of observations

FIRST-YEAR MONITORING DATA

POINT REYES SEASHORES

Twelve Months

December 1983 to
December 1984

Contract No. CX 8000-3-0002

Second Draft

March 20, 1985

by

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TRANSECT DATA for 12 months, December 1983 to December 1984

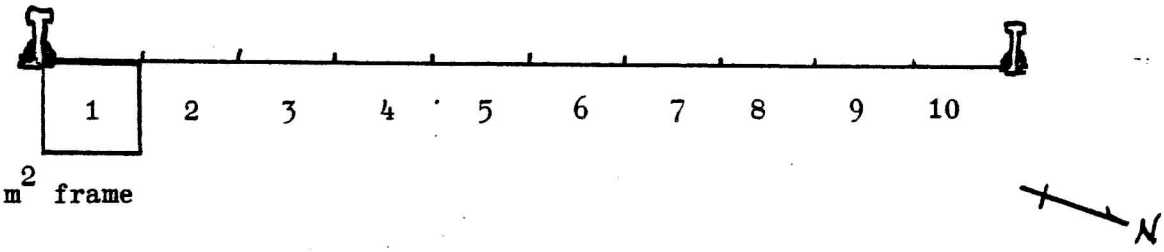
Duxbury Reef, Area A,	AT-1	May 5, 1984	1
	AB-8	May 5, 1984	3
	AB-9	May 5, 1984	5
Duxbury Reef, Area B,	BT-1	May 5, 1984	7
	BT-5	Apr 19, 1984	9
Duxbury Reef, Area C,	CT-9	Apr 19, 1984	11
	CT-11	Apr 19, 1984	11
	CT-10	Dec 28, 1983	13
	CT-8	May 5, 1984	15
	CT-3	Dec 27, 1983	17
	CT-7	May 5, 1984	19
	CT-4	Dec 27, 1983	21
Drakes Estero	DE-1	Jun 5, 1984	23
Chimney Rock	CR-1	Apr 15, 1984	25
	CR-2a	Apr 15, 1984 ($20m^2$)	27
	CR-2b	Apr 15, 1984 ($24m^2$)	27
	CR-2c	Apr 15, 1984 ($8m^2$)	27
	CR-Q1	Sep 14, 1984	29
Split Rock	SR-1	Jul 29, 1984	31
McDonald's Beach	MB-2	Dec 7, 1984	33
Bird Rock	BR-Q1	May 19, 1984	35
	BR-Q2	May 19, 1984	35
Estero de San Antonio	ESA-1	Jul 14, 1984	37

APPENDIX A: The Sessile and Mobile Group Codes 39

WORKSHEET DUXBURY AREA A, AT-1

AT-1

Stake 1 — ten meter marked polypropolene line — Stake 2



m^2 frame

1 sample: spring to fall

Investigator Chan Date May 5, 1984 Season Spring '84

Weather Clear Tide -0.7 @ 9 : 11 (A.M.) / P.M.

Temperature: AIR 68 °F WATER 55 °F SALINITY 33 PPT

____ °C ____ °C

SPECIES COUNTS

Sq. Meter	Tegula funebralis (black turban snail)	Anthopleura elegantissima (aggregating anemone)			Other Species
#1	33				
#2	21				
#3	11	3			
#4	11				
#5	12	1			
#6	10				
#7	4				
#8	6				
#9	17				
#10	13				
TOTAL	138	4			

Special Notes: (5)

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT AT-1

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr SPR / 84 Date MAY 5, 1984 Field Investigator G CHAN

Tide/Time -0.7 @ 9:11 AM Salinity 33 PPT Stats Tech

Species Codes	SESSILE AEL	MOBILE TE6	ALL SPECIES IN SAMPLE
1. Σx_i	4	138	142
2. $\Sigma (x_i)^2$	10	2526	2626
3. s.d.	0.9	8.3	8.2
4. $\bar{X}$	0.4 /m²	13.8 /m²	14.2 /m²
5. 95% C.I. for population mean	-0.3 to 1.1	7.8 to 19.7	8.3 to 20.1

Comments from field worksheet

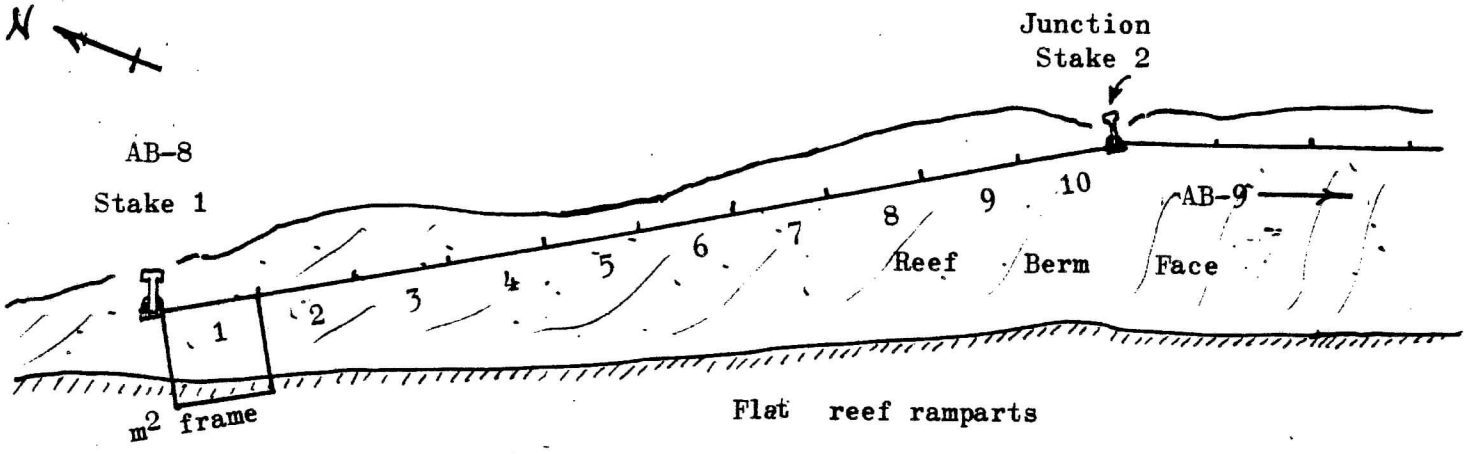
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY Area A, AB-8



← To Agate Beach Trail

1 sample: spring to fall

Investigator Chan Date May 5, 1984 Season Spring '84

Weather Clear Tide -0.7 @ 9:11 (A.M) / P.M.

Temperature: AIR 68 °F WATER 55 °F SALINITY 33 PPT

_____ °C _____ °C

SPECIES COUNTS

Sq. Meter	Littorina planaxis (large periwinkle)	Collisella spp. (limpets)	Pachygrapsus crassipes (striped shore crab)			Other Species
#1		3				
#2		8				
#3		10				
#4		3				
#5		10				
#6		10				
#7		3				
#8		10				
#9		15				
#10	1	20				
TOTAL	1	92	0			

Special Notes:

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT AB-8

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr SPR / 84 Date MAY 5, 1984 Field Investigator G. CHAN

Tide/Time -0.7 @ 9:11 AM Salinity 33 PPT Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes	NA	1 LITx 92 COL & crabs	
1. Σx_i		93	93
2. $\Sigma (x_i)^2$		1157	1157
3. s.d.		6.0	6.0
4. $\bar{X}$		9.3/m²	9.3/m²
5. 95% C.I. for population mean	to	5.2 to 13.4	5.2 to 13.4

Comments from field worksheet

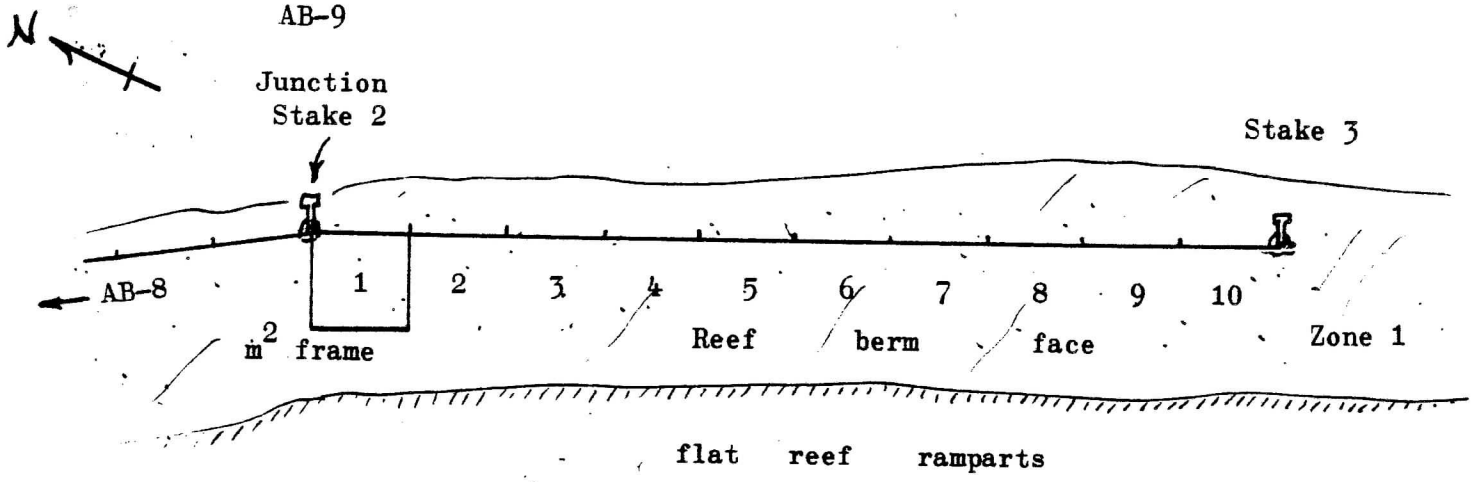
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes			
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY Area A, AB-9



1 sample: spring to fall

Investigator Chan Date May 5, 1984 Season Spring '84

Weather Clear Tide -0.7 @ 9 : 11 (A.M.) / P.M.

Temperature: AIR 68 °F WATER 55 °F SALINITY 33 PPT

_____ °C _____ °C

SPECIES COUNTS

Sq. Meter	Littorina planaxis (large periwinkle)	Collisella spp. (limpets)	Pachygrapsus crassipes (striped shore crab)			Other Species
#1		15				
#2	14	3				
#3		2				
#4		36	1			
#5		54				
#6		67				
#7		25				
#8		123				
#9		53				
#10		56				
TOTAL	14	434	1			

Special Notes:

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT AB-9

Sample Size 10m² Transect Page 1

File Record for SEASON/yr SPR/84 Date MAY 5, 1984 Field Investigator J. CHAN

Tide/Time -0.7 @ 9:11 AM Salinity 33 PPT Stats Tech

Species Codes	SESSILE	MOBILE 14 LITx 434 COL 1 crab	ALL SPECIES IN SAMPLE
1. Σx_i		449	449
2. $\Sigma (x_i)^2$		30991	30991
3. s.d.		34.7	34.7
4. $\bar{X}$		44.9/m²	44.9/m²
5. 95% C.I. for population mean	to	20.1 to 69.7	20.1 to 69.7

Comments from field worksheet

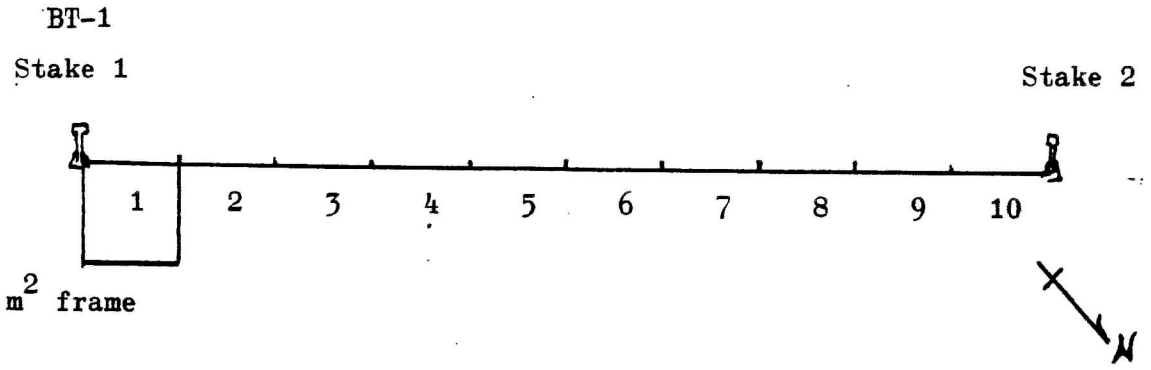
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY Area B, BT-1



1 sample: spring to fall

Investigator Chan Date May 5, 1984 Season Spring '84

Weather Clear Tide -0.7 @ 9 : 11 (A.M.) / P.M.

Temperature: AIR 68 °F WATER 55 °F SALINITY 33 PPT

_____ °C _____ °C

SPECIES COUNTS

Sq. Meter	Tegula funebralis (black turban snail	Collisella spp. (limpets)	Anthopleura elegantissima (aggre. sea an)			Other Species
#1	38		14			
#2	18		40			2 Searlesia
#3	16		10			
#4	23		20			
#5	16		30			
#6	7		35			1 Mopalia muscosa
#7	3		15			
#8	19		45			
#9	15		20			1 Searlesia
#10	28		25			
TOTAL	183		254 (5)			

Special Notes:

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT BT-1

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr SPR / 84 Date MAY 5, 1984 Field Investigator J. CHAN

Tide/Time -0.7 @ 9:11 AM Salinity 33 PPT Stats Tech

Species Codes	SESSILE AEL	MOBILE TEG	ALL SPECIES IN SAMPLE
1. Σx_i	254	183	437
2. $\Sigma (x_i)^2$	7696	4237	20927
3. s.d.	11.7	9.9	14.2
4. $\bar{X}$	25.4 /m²	18.3 /m²	43.7 /m²
5. 95% C.I. for population mean	17.0 to 33.8	11.2 to 25.4	33.5 to 53.9

Comments from field worksheet total other species: 3 Dendrasia
1 Mopalia muscosa

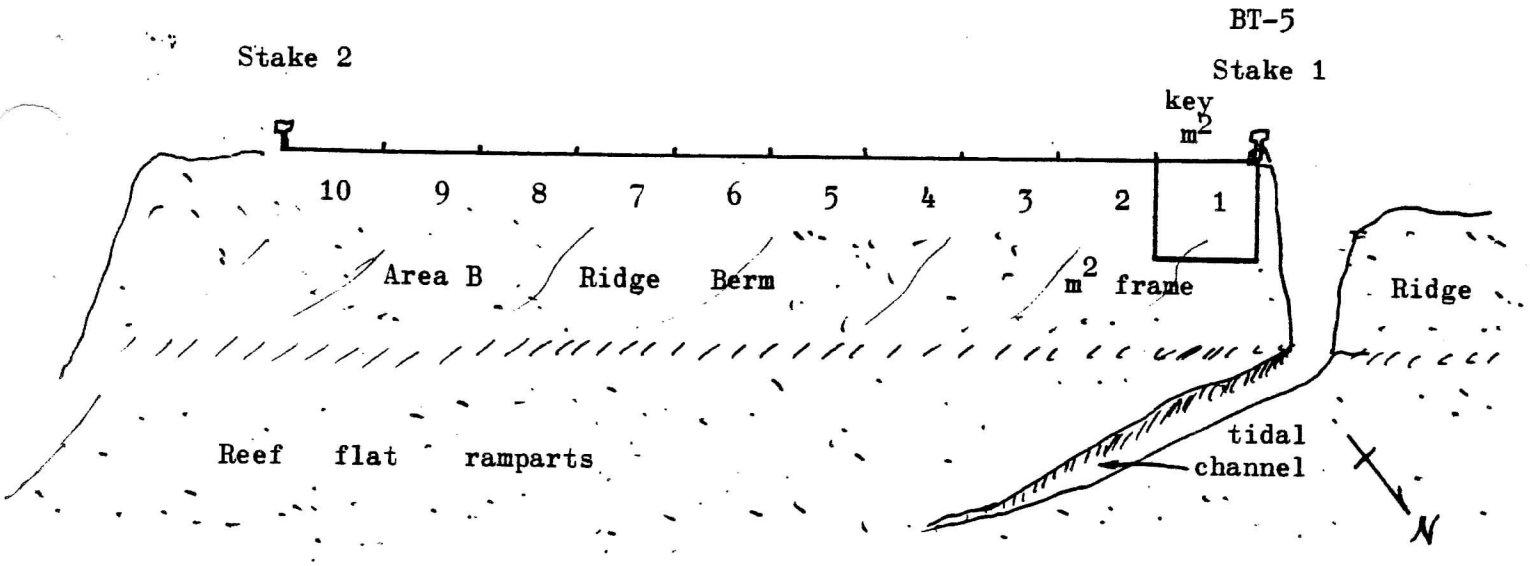
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY, Area B, BT-5



1 sample: spring to fall

Investigator Chan Date April 19, 1984 Season Spring '84

Weather Clear Tide -0.8 @ 7:55 (A.M.) / P.M.

Temperature: AIR 66 °F WATER 55 °F SALINITY 33 PPT

_____ °C _____ °C

SPECIES COUNTS

key m² Sq. Meter	Mytilus californianus (sea mussel)	Pollicipes polymerus (goose barnacle)	Mopalia spp. (chiton)	Strongylo. purpuratus (purple urchin)		Lottia gigantea (owl limpet)		Other Species
#1	228	58	1	12		1		
#2								
#3								
#4								
#5								
#6								
#7								
#8								
#9								
#10								
TOTAL	228 (S)	58 (S)	1.	12		1		

Special Notes:

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT BT-5

Sample Size #1, key one m^2 Transect Page 1

File Record for SEASON/yr SPR 184 Date APRIL 19, 1984 Field Investigator G. CHAN

Tide/Time -0.8 @ 7:55 AM Salinity 33 PPT Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes	228 MYT, 58 POL	12 STR, 1 MOP, 1 LOT	
1. Σx_i	286	14	300
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

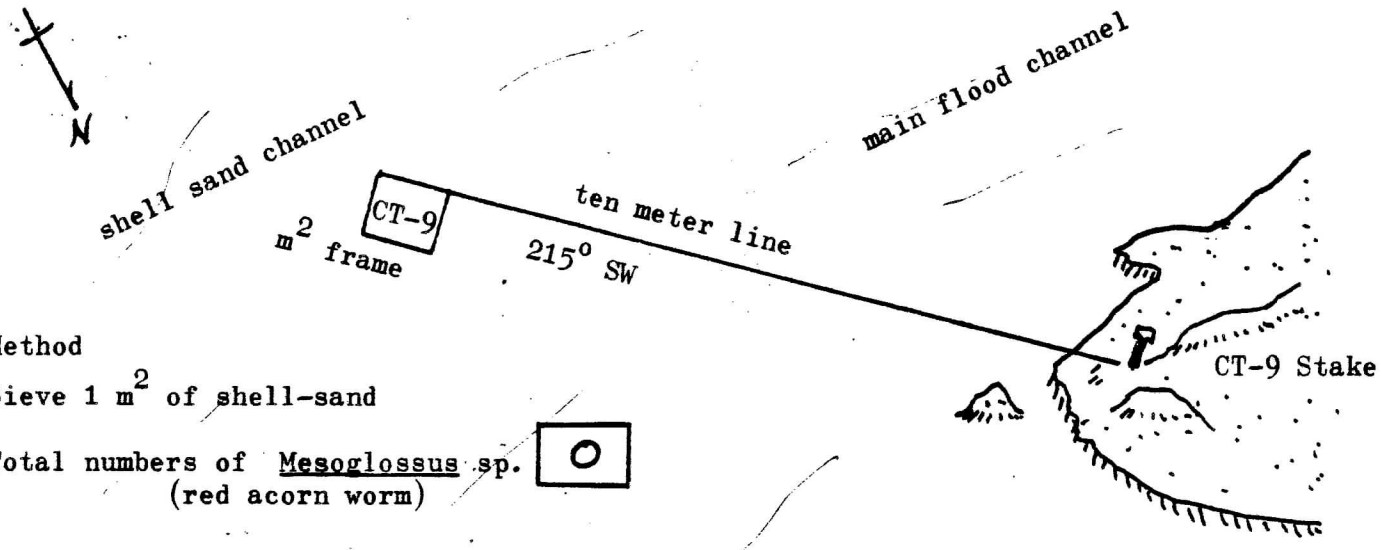
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes			
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY, Area C, CT-9 and CT-11



Method

Sieve 1 m^2 of shell-sand

Total numbers of Mesoglossus sp. (red acorn worm) [0]

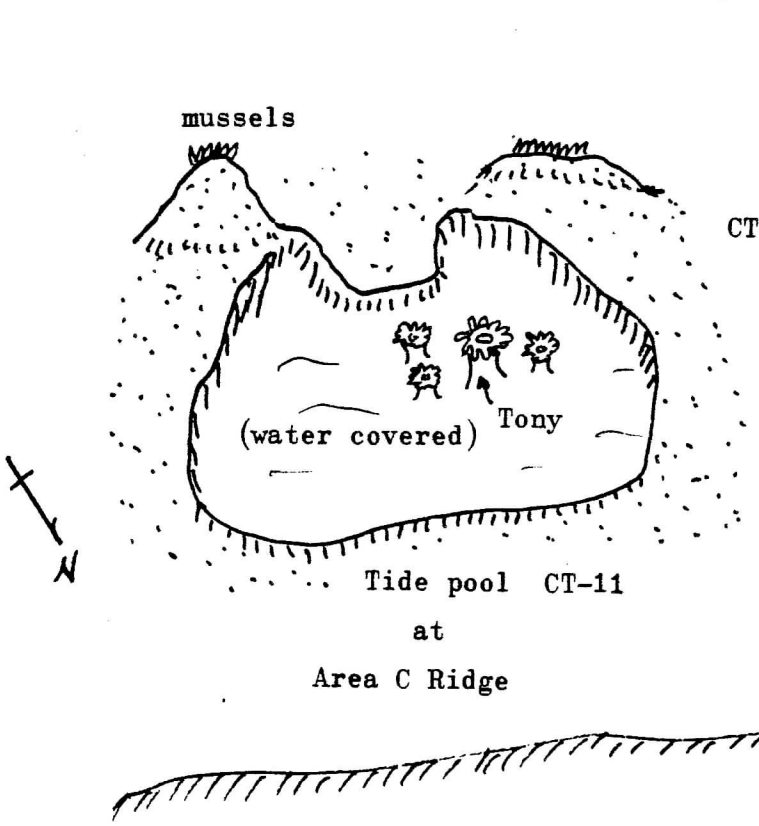
1 sample: spring to fall

Investigator Chan Date April 19, 1984 Season Spr. '84

Weather Clear Tide -0.8 @ 7:55 (A.M.)/ P.M.

Temperature: AIR 68 °F WATER 55 °F SALINITY 33 PPT

_____ °C _____ °C



1 sample: spring to fall

CT-11 Anthopleura xanthogrammica

Total numbers of Tony and other sea anemones = [4] (5)

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT CT-9, CT-11

Sample Size see below

Transect Page 1

File Record for SEASON/yr SPR/84 Date APRIL 19, 1984 Field Investigator G. CHAN

Tide/Time -0.8 @ 7:55 AM Salinity 33 PPT Stats Tech

Species Codes	SESSILE AXA (Tony) TIDEPOOL	MOBILE Mesoglossus m² sieve	ALL SPECIES IN SAMPLE
1. Σx_i	4	0	NA
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

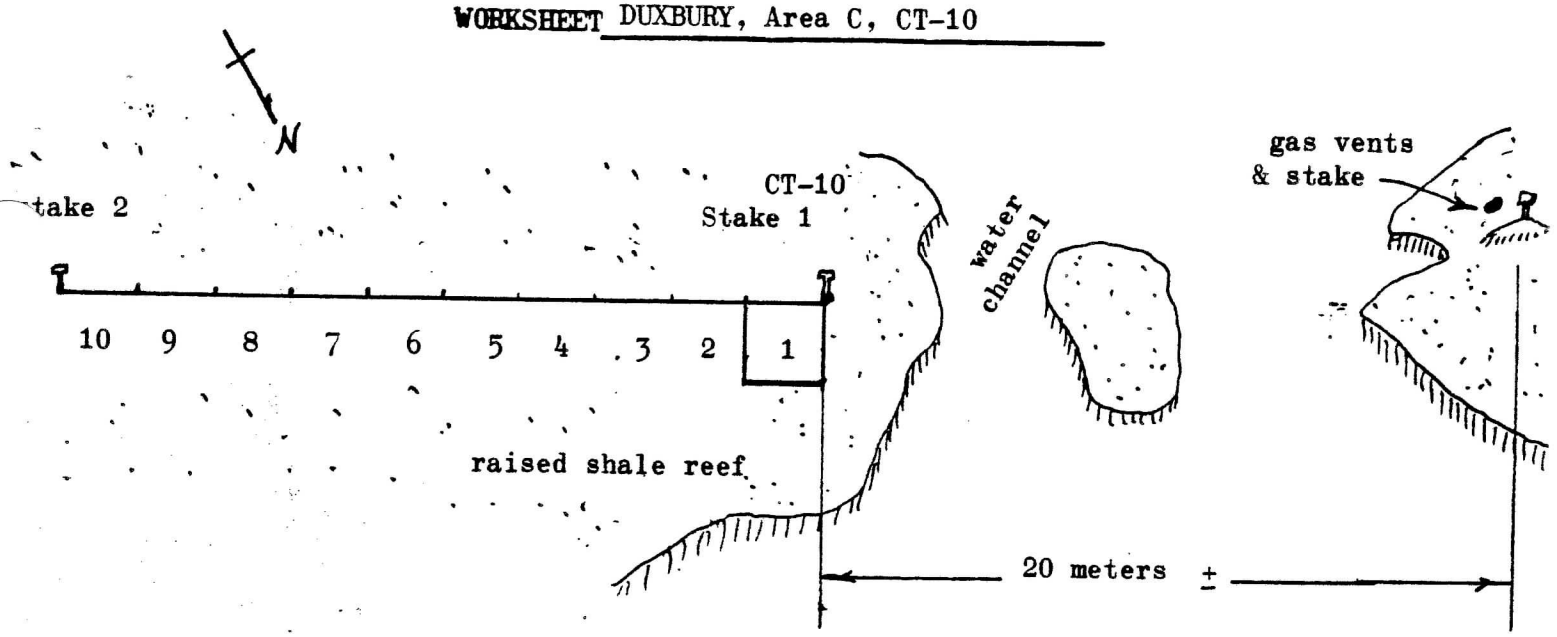
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY, Area C, CT-10



1 sample: spring to fall

Investigator Chan Date Dec. 28, 1983 Season Winter '83

Weather Clear Tide -1.1 @ 3:51 A.M. / (P.M.)

Temperature: AIR 56 °F WATER 54 °F SALINITY 32 PPT

_____ °C _____ °C

SPECIES COUNTS

Sq. Meter	Tegula funebralis (black turban snail)	Mopalia spp. (chiton)			Other Species
#1	6	7			
#2	0	5			
#3	15	2			
#4	10	1			
#5	3	7			
#6	2	9			
#7	8	8			
#8	2	0			2 Nucella
#9	2	6			1 Searlesia
#10	6	2			
TOTAL	54	47			

Special Notes:

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT CT-10

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr WIN/83 Date Dec 28, 1983 Field Investigator S. CHAN

Tide/Time -1.1 @ 3:51 PM Salinity 32 PPT Stats Tech

Species Codes	SESSILE NA	MOBILE 54TEG, 47 MOP	ALL SPECIES IN SAMPLE
1. Σx_i		101	101
2. $\Sigma (x_i)^2$		1213	1213
3. s.d.		4.6	4.6
4. $\bar{X}$		10.1	10.1
5. 95% C.I. for population mean	to	6.8 to 13.4	6.8 to 13.4

Comments from field worksheet 2 NOCELLA and 1 Dendrasia

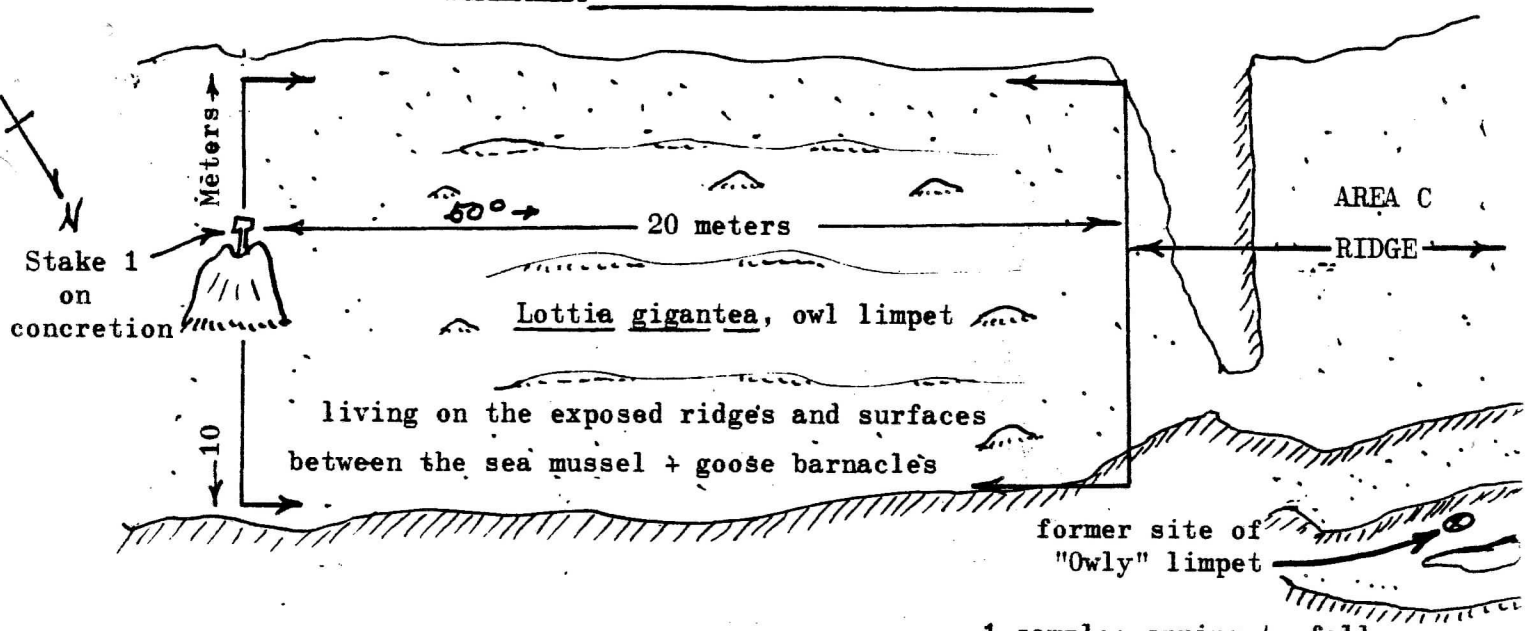
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY REEF, AREA C, CT-8



1 sample: spring to fall

Investigator Chan Date May 5, 1984 Season Spring '84

Weather Clear Tide -0.7 @ 9:11 (A.M.) / P.M.

Temperature: AIR 66 °F WATER 55 °F SALINITY 32 PPT

_____ °C _____ °C

CT-8

_____

20 meters, total count of the owl limpet, Lottia gigantea in transect = 15

Other species and observations:

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT CT-8

Sample Size 20 m ridge (200 m²) Transect Page 1

File Record for SEASON/yr SPR / 84 Date MAY 5, 1984 Field Investigator J. CHAN

Tide/Time -0.7 @ 9:11 AM Salinity 32 PPT Stats Tech

Species Codes	SESSILE	MOBILE LOT	ALL SPECIES IN SAMPLE
1. Σx_i		15 total	NA
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

File Record for SEASON/yr / Date Field Investigator

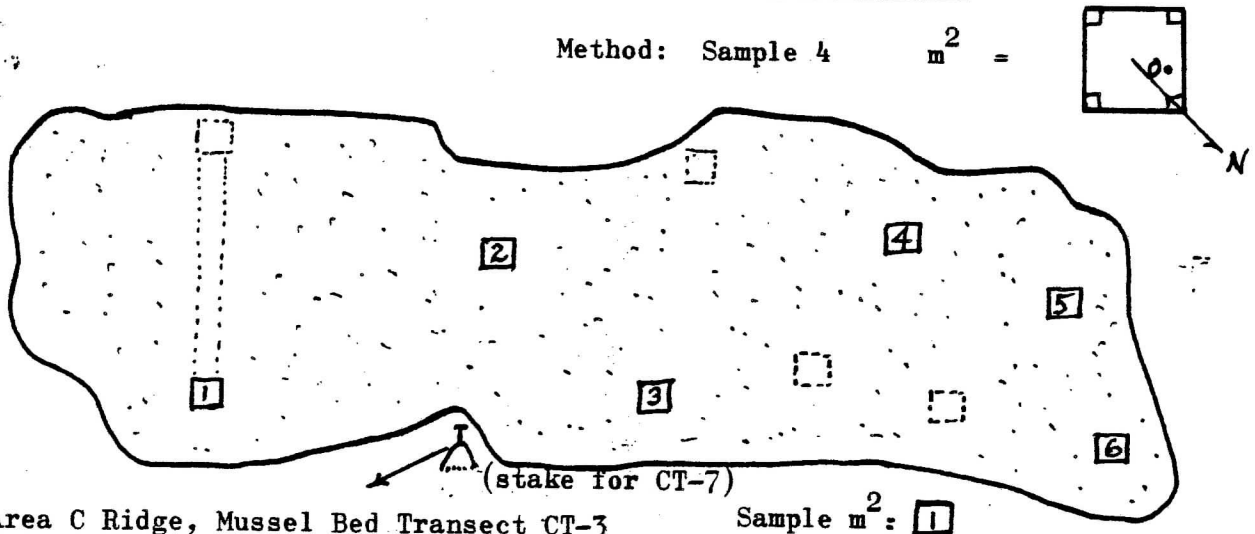
Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY, Area C, CT-3

Method: Sample 4 m^2 =



Area C Ridge, Mussel Bed Transect CT-3

Sample m^2: 1

former m^2:

Investigator Chan Date Dec. 27, 1983 Season Winter '83

1 sample: spring to winter

Weather Clear Tide -0.5 @ 3:06 A.M. / (P.M.)

Temperature: AIR 58 °F WATER 54 °F SALINITY 33 PPT

_____ °C _____ °C

SPECIES COUNTS		Mytilus californianus (sea mussel) LIVE count				Pollicipes polymerus (goose barnacle) LIVE count						
Sq. Meter	Total Dead m^2	dm^2	dm^2	dm^2	dm^2	dm^2	dm^2	dm^2	dm^2			Other Species
#1		20	20	22	20							
#2		20	19	20	24							
#3		15	17	20	20							
#4		15	17	20	20							
#5		22	23	20	19							
#6		22	20	18	19							
#7												
#8												
#9												
#10												
TOTAL		472 for 24 dm^2				, for 24 dm^2						

Special Notes: (S) (S)

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT CT-3

Sample Size 24 dm² in 6m² Transect Page 1

File Record for SEASON/yr WIN / 83 Date Dec 27, 1983 Field Investigator S. CHAN

Tide/Time −0.5 @ 3:06 PM Salinity 33 PPT Stats Tech

Species Codes	SESSILE: MYT	MOBILE: NA	ALL SPECIES IN SAMPLE
1. Σx_i	472		472
2. $\Sigma (x_i)^2$	9392		9392
3. s.d.	2.2		2.2
4. $\bar{X}$	19.6 /dm²		19.6 /dm²
5. 95% C.I. for population mean	18.7 to 20.6	to	18.7 to 20.6

Comments from field worksheet

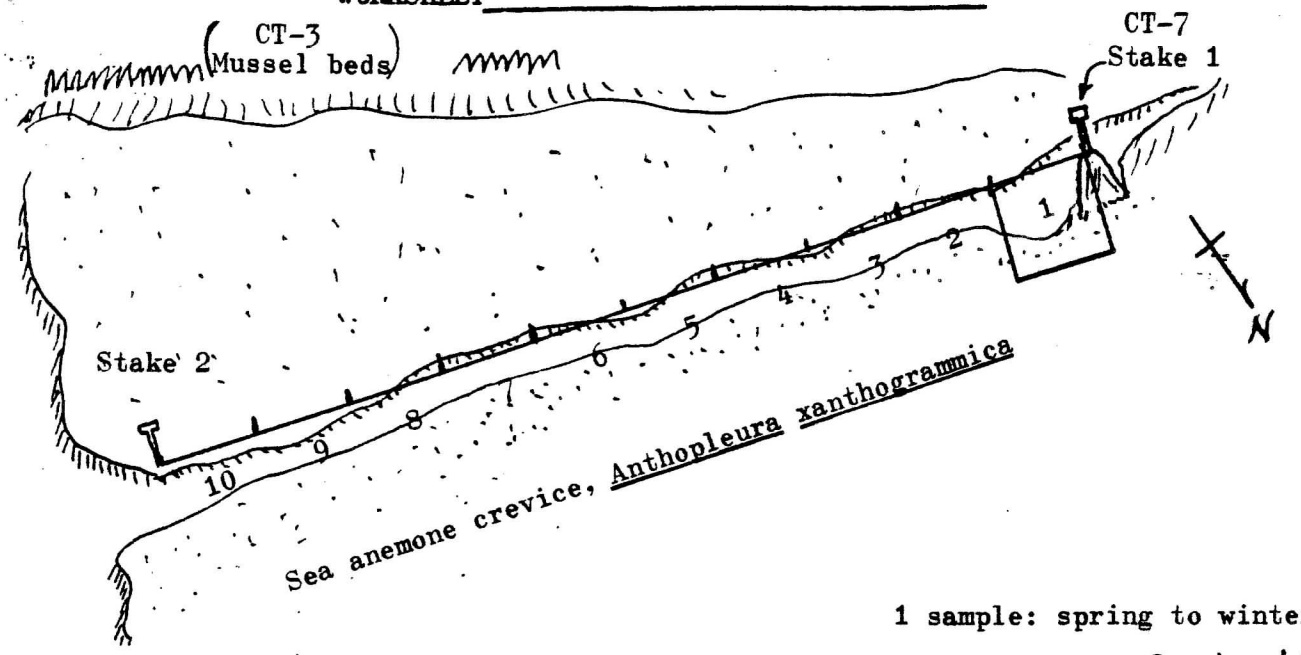
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY, Area C, CT-7



1 sample: spring to winter

Investigator Chan Date May 5, 1984 Season Spring '84

Weather Clear Tide -0.7 @ 9:11 (A.M.) / P.M.

Temperature: AIR 66 °F WATER 55 °F SALINITY 33 PPT

CT-7 _____ °C _____ °C

m^2	Anthopleura xanthogrammica (giant green sea anemone)	Others
1	14	
2	13	
3	8	
4	20	
5	55	
6	50	
7	82	
8	27	
9	82	
10	30	
Total	381	

(S)

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT CT-7

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr SPR / 84 Date MAY 5, 1984 Field Investigator G CHAN

Tide/Time -0.7 @ 9:11 AM Salinity 33 PPT Stats Tech

Species Codes	SESSILE: AXA	MOBILE: NA	ALL SPECIES IN SAMPLE
1. Σx_i	381		381
2. $\Sigma (x_i)^2$	21431		21431
3. s.d.	38.1		38.1
4. $\bar{X}$	27.7/m²		27.7/m²
5. 95% C.I. for population mean	18.3 to 57.9	to	18.3 to 57.9

Comments from field worksheet

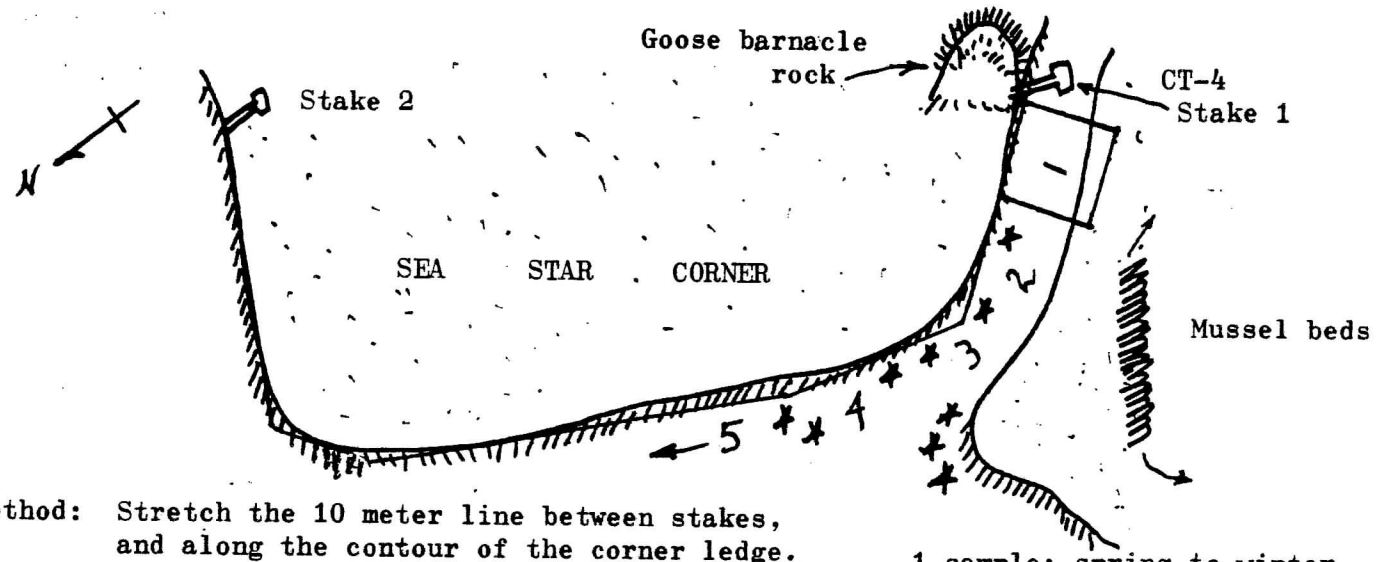
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DUXBURY, Area C, CT-4



Method: Stretch the 10 meter line between stakes, and along the contour of the corner ledge.

1 sample: spring to winter

Investigator Chan Date Dec. 27, 1983 Season Winter 83

Weather Clear Tide -0.5 @ 3 :06 A.M / (P.M.)

Temperature: AIR 58 °F WATER 55 °F SALINITY 33 PPT

_____ °C _____ °C

CT-4 m^2	Pisaster ochraceous (purple sea star)	Others
1	1	
2	5	
3	7	
4	8	
5	5	
6	1	
7	2	
8	1	
9	1	
10	2	
Totals	33	

STATISTICS RECORD for DUXBURY REEF (Location) TRANSECT CT-4

Sample Size 10m² Transect Page 1

File Record for SEASON/yr WIN / 83 Date DEC 27, 1983 Field Investigator G. CHAN

Tide/Time -0.5 @ 3:06 PM Salinity 33 PPT Stats Tech

Species Codes	SESSILE NA	MOBILE AST Pisaster ochraceus	ALL SPECIES IN SAMPLE
1. Σx_i		33	33
2. $\Sigma (x_i)^2$		175	175
3. s.d.		2.7	2.7
4. $\bar{X}$		3.3/m²	3.3/m²
5. 95% C.I. for population mean	to	1.4 to 5.2	1.4 to 5.2

Comments from field worksheet

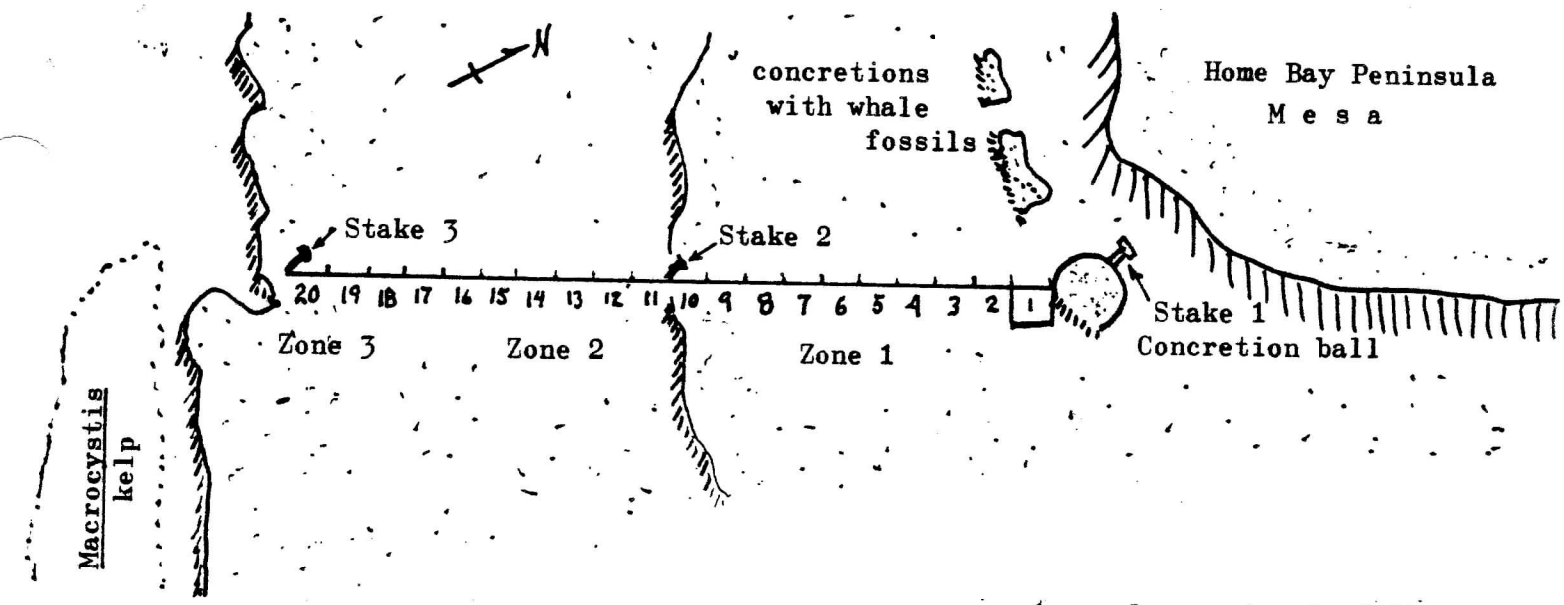
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET DRAKES ESTERO, Rocky Intertidal, DE,T-1



1 sample: spring to fall

Investigator Chan **Date** June 5, 1984 **Season** Summer '84

Weather Clear **Tide** -0.7 @ 10:45 (A.M.) / P.M.

Temperature: AIR 62 °F. WATER 54 °F SALINITY 31 PPT

°C °C

SPECIES COUNTS

Sq. Meter	✓=present	Balanus-barn.	Littorn-peri.	Tegula-turban	Collisella spp. (limpet)	Notoacmeae sp. (flat limpet)	Pachygrapsus (striped crab)	Hemigrapsus (purple crab)	Petrolisthes (porcelain crab)	A. elegantis (sea anemone)	A. xanthogr. (green sea anem.)	P. brevispinus (pink seastar)	P. ochraceous (purple star)			Other Species
#1 / #11	✓	✓			11	1	1	✓					1			
#2 / #12	✓	✓	✓				4									
#3 / #13	✓	✓	✓			2	9						1			8 Pagurus
#4 / #14	✓	✓	✓				2/7									
#5 / #15	✓		✓	3			17									
#6 / #16	✓		✓	1												
#7 / #17	✓			1	1		2									
#8 / #18	✓		✓				8			18						
#9 / #19	✓		✓				1		20							6 Thais.
#10 / #20							3		3	100			1			
TOTAL				17	3	44	0	23	118 (S)	0 (S)	0	0	3			

Special Notes:

STATISTICS RECORD for DRAKES ESTERO (Location) TRANSECT DE-1

Sample Size 20 m² Transect Page 1

File Record for SEASON/yr SUM / 84 Date JUNE 5, 1984 Field Investigator S. CHAN

Tide/Time -0.7 @ 10:45AM Salinity 31 PPT Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes	118 AEL, 0 AXA	20 COL spp, 67 crabs, 3 AST	
1. Σx_i	118	90	208
2. $\Sigma (x_i)^2$	10324	980	11792
3. s.d.	22.5	5.5	22.5
4. $\bar{X}$	5.9/m²	4.5/m²	10.4/m²
5. 95% C.I. for population mean	-4.6 to 16.4	1.9 to 7.1	-0.1 to 20.9

Comments from field worksheet 8 Pagurus and 6 Thais
BAL, HT, TEG present

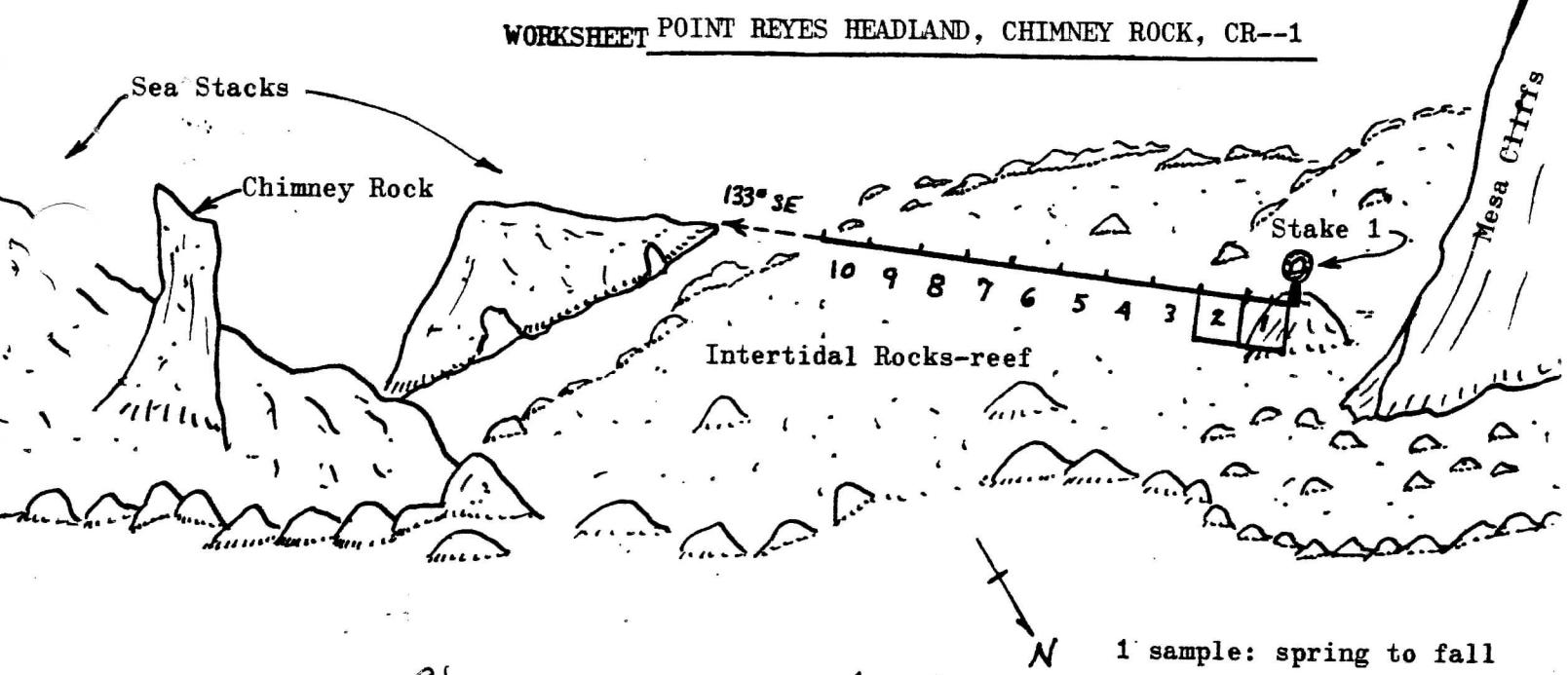
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes			
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET POINT REYES HEADLAND, CHIMNEY ROCK, CR--1



1 sample: spring to fall

Investigator Chan Date April 15, 1984 Season Spring '84

Weather Clear Tide -0.5 @ 4:43 (A.M.) / P.M.

Temperature: AIR 60 °F WATER 52 °F SALINITY 30 PPT

°C °C

SPECIES COUNTS

CR-1

Sq. Meter	Tegula funeb. (Bl. turban sn)	Anthop. xantho. (gr. sea anem)	A. elegantis. (aggreg. anem.)	Cancer anten. (cancer crab)	Hemigrap. nudus (pur. sh. crab)	Pagurus spp. (hermit crabs)	Patiria miniata (bat star)	Pisaster och. (pur. seastar)	Haliotis rufescens (red abalone)			Other Species
#1	15											
#2	18											
#3	13											
#4	13											
#5	11											
#6	16	2										2 Pugettia
#7	12	1				4	3					
#8	13	2		1		2	10					4 Leptasterias
#9				1		10		1				2 Leptasterias
#10		1				12		1	2			
TOTAL	111	6 (5)	(5)	2		28	13	2	2			

Special Notes:

STATISTICS RECORD for CHIMNEY ROCK (Location) TRANSECT CR-1

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr SPR / 84 Date APRIL 15, 1984 Field Investigator J. CHAN

Tide/Time -0.5 @ 4:43 AM Salinity 30 PPT Stats Tech

Species Codes	SESSILE 6 AXA, 0 AEL	MOBILE 111 TEG 15 ASTapp 30 crabs 2 HALnuf	ALL SPECIES IN SAMPLE
1. Σx_i	6	158	164
2. $\Sigma (x_i)^2$	10	2670	2916
3. s.d.	0.8	4.4	5.0
4. $\bar{X}$	0.6/m²	15.8/m²	16.4/m²
5. 95% C.I. for population mean	-0.0 to 1.2	12.6 to 18.9	12.8 to 20.0

Comments from field worksheet 2 Pugettia, 6 Leptasterias

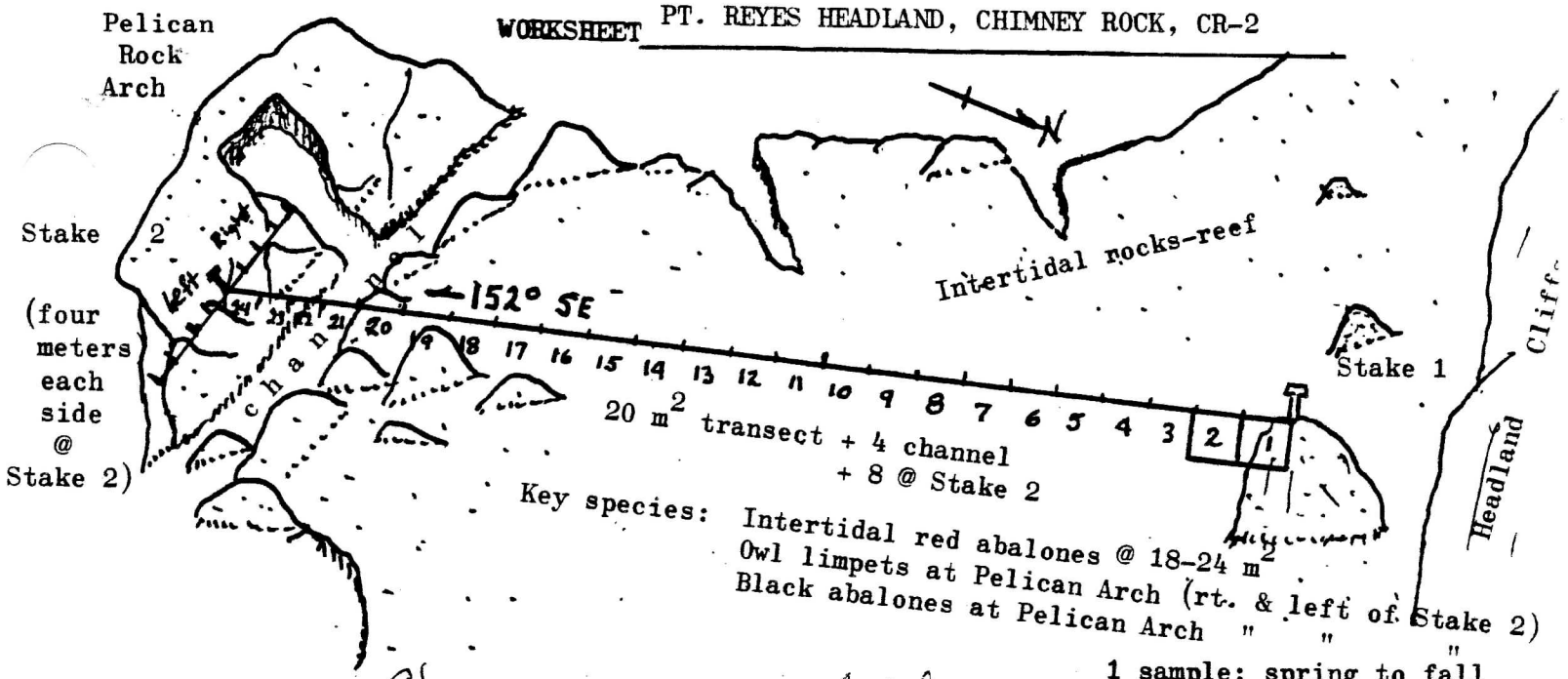
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET PT. REYES HEADLAND, CHIMNEY ROCK, CR-2



1 sample: spring to fall

Investigator Chan Date April 15, 1984 Season Spring 84

Weather Clear Tide -0.5 @ 4:43 (A.M.) / P.M.

Temperature: AIR 60 °F. WATER 52 °F SALINITY 30 PPT

°C °C

SPECIES COUNTS

CR-2

Sq. Meter	✓ = present	Pachy. + Hemigp. (shore crabs)	Cancer antennar. (rock crab)	Collisella spp. (limpets)	Antho. elegantis. (aggreg. sea an)	A. xanthogramm. (green sea anem)	Patiria miniata (bat star)	Pisaster ochrac. (purple sea star)	Strongyl. purpur. (purple sea urch.)	Haliotis rufescens (red abalone)
1 11	✓									
2 12			✓			1				
3 13						1		1		
4 14		✓								
5 15								2		
6 16										
7 17										
8 18						2				
9 19			✓		1		1			
10 20			✓		1		2			1
TOTAL-Sq (note presence only)					1				21. 3	
TOTALS					7	2	5	3	22. 23. 24.	
					(5)				Ab. Total	6

Other Species		Lottia gigantea (owl limpet)	H. cracherodii (black abalone)
R-4		1	1
R-3		1	2
R-2		1	
R-1		2	
Stake			
L-1			
L-2		1	
L-3			1 Tonicella
L-4		1	2 Leptasterias
Totals		6	3

STATISTICS RECORD for CHIMNEY ROCK (Location) TRANSECT CR-2

Sample Size 20m² Transect Page 1

File Record for SEASON/yr SPR / 84 Date APRIL 15, 1984 Field Investigator G. CHAN

Tide/Time -0.5 @ 4:43 AM Salinity 30 PPT Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
	AXA	4 ASTspp 3 STR 1 HALmuf	
1. Σx_i	2	11	13
2. $\Sigma (x_i)^2$	2	21	23
3. s.d.	0.3	0.9	0.9
4. $\bar{X}$	0.1/m²	0.5/m²	0.6/m²
5. 95% C.I. for population mean	-0.0 to 0.2	0.1 to 0.9	0.2 to 1.0

Comments from field worksheet 6 HAL muf for 24m²
6 LOT, 3 HAL era. for 8m²

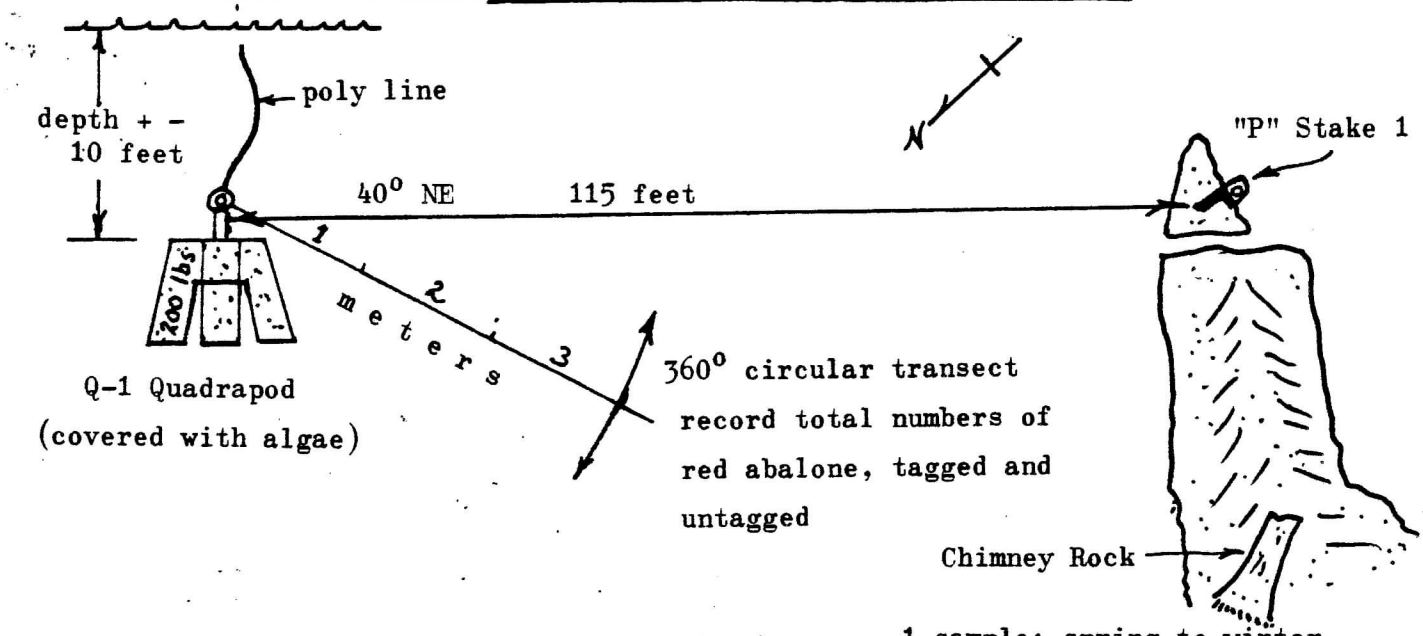
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET PT. REYES, CHIMNEY ROCK, SUBTIDAL Q-1



1 sample: spring to winter

Investigator Chan Date Sept. 14, 1984 Season Fall '84

Weather Clear Tide +1.0 @ 8:00 A.M. / P.M.

Temperature: AIR 60 °F WATER 52 °F SALINITY 33 PPT

_____ °C _____ °C

Circular Q-1	numbers of *Haliotis rufescens*	Tagged abs + their numbers	Others
Meter 1 (+abs under the quadrapod)	4		
Meter 2	7		
Meter 3	26		
Total	37		

Other Notes:

STATISTICS RECORD for POINT REYES CHIMNEY ROCK (Location)

TRANSECT Subtidal Q-1

Transect Page 1

Sample Size Quadrapod, 3m radius

File Record for SEASON/yr FALL / 84 Date Sept 14, 1984 Field Investigator G Chan

Tide/Time +1.0 @ 8:00 AM Salinity 33 PPT Stats Tech

Species Codes	SESSILE NA	MOBILE HALrud	ALL SPECIES IN SAMPLE
1. Σx_i		4, 7, 26 (meter #1, #2, #3)	37 total
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

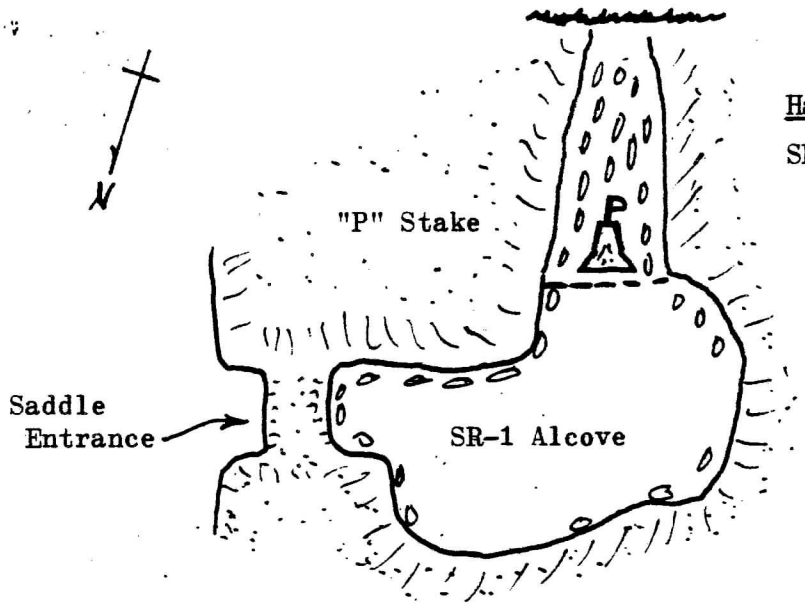
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET PT. REYES, SPLIT ROCK, SUBTIDAL SR-1



Haliotis rufescens, red abalone
SR-1 Wall Transect

1 sample: spring to winter

Investigator Chan Date July 29, 1984 Season Summer '84

Weather Clear Tide -1.3 @ 7:31 (A.M.) / P.M.

Temperature: AIR 58 °F WATER 54 °F SALINITY 34 PPT

_____ °C _____ °C

SR-1 Haliotis rufescens (red abalone)	Total counts within SR-1 Sections	Tagged abalones with their numbered tags	Other Species
Wall Transect	88		
Alcove	75		
Total	163		

Other observations:

STATISTICS RECORD for Point Reyes SPLIT ROCK (Location) Subtidal TRANSECT SR-1

Sample Size wall transect Transect Page 1

File Record for SEASON/yr SUM / 84 Date July 29, 1984 Field Investigator G. CHAN

Tide/Time -1.3 @ 7:31 AM Salinity 34 PPT Stats Tech

Species Codes	SESSILE NA	MOBILE HAL ruf	ALL SPECIES IN SAMPLE
1. Σx_i		88, 75 (wall, above)	163 total
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

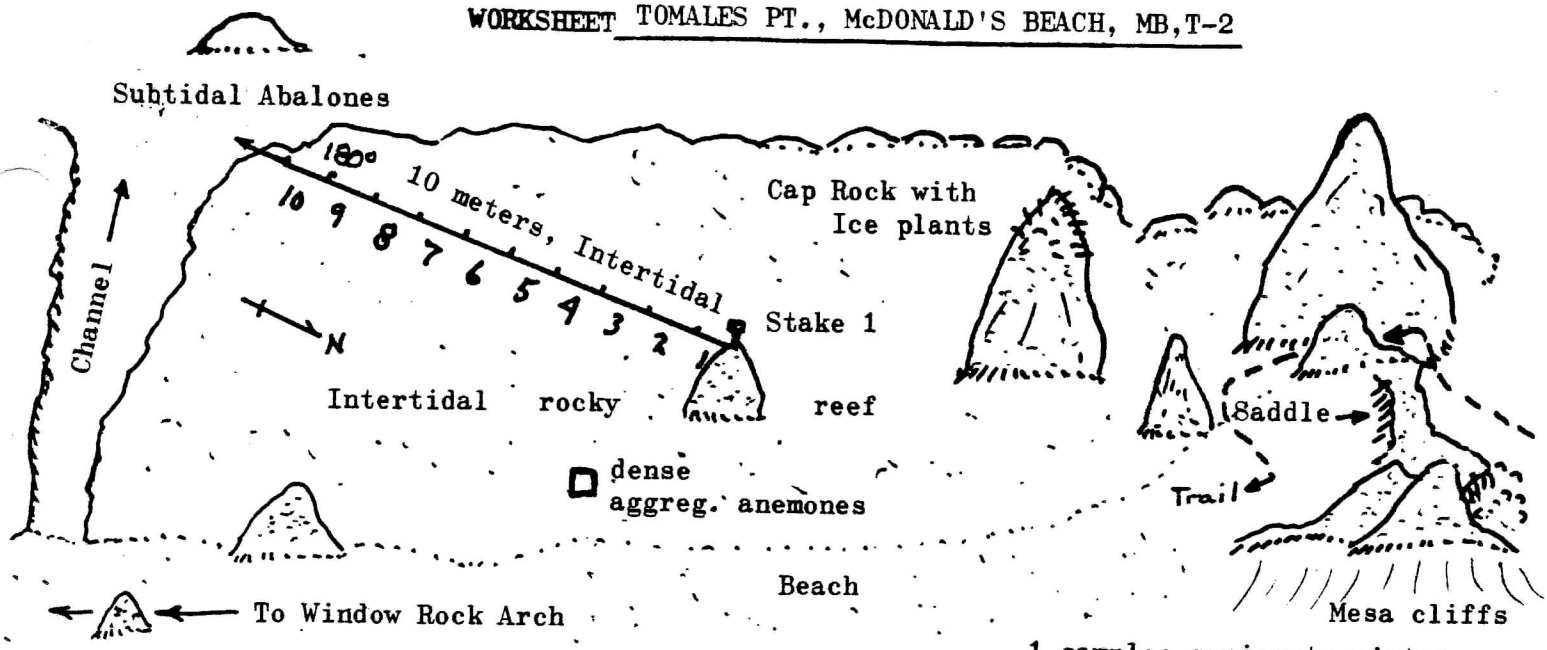
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

WORKSHEET TOMALES PT., McDONALD'S BEACH, MB,T-2



1 sample: spring to winter

Investigator Chan Date December 7, 1984 Season Winter '84

Weather Clear Tide -0.6 @ 4:51 A.M. / (P.M.)

Temperature: AIR 70 °F WATER 56 °F SALINITY 30 PPT

°C °C

SPECIES COUNTS

MB,T-2

Sq. Meter	Mytilus calif. (sea mussel)	Pollicipes poly. (goose barnac.)	Monadia musc. (chiton)	Anthopleura ele. (aggreg. sea anem)	A. xanthogrammica (green sea anem)	Pachyg. + Hemi. (shore crabs) ✓=present	Pisaster och. (seastar)	Haliotis rufesc. (red abalone)			Other Species
						Pach Hemi					
#1	700	230				✓ ✓					
#2	440	130									3 Nuttalina
#3			1		2		4				
#4			2	33							
#5				6		✓	3				
#6				10							4 Pagurus 1 Eupentacta
#7				6	2		1				8 Epiactis
#8					1						9 Pagurus
#9											2 Pagurus
#10				4	1						2 Pugettia 20 Pagurus
TOTAL	1140 (S)	360 (S)	3	59 (S)	6 (S)		8				

Special Notes:

STATISTICS RECORD for TOMALES PT. McDONALDS BEACH (Location) TRANSECT MB-2

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr WIN / 84 Date Dec 7, 1984 Field Investigator G. CHAN

Tide/Time -0.6 @ 4:51 AM Salinity 30 PPT Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes	1140 MYT 59 AEL 360 PDL 6 AXA	8 AST, 3 MOP	
1. Σx_i	1565	11	1576
2. $\Sigma (x_i)^2$	1191119	39	1191362
3. s.d.	324.2	1.7	323.7
4. $\bar{X}$	156.5	1.1	157.6
5. 95% C.I. for population mean	-75.4 to 388.4	-0.1 to 2.3	-74.0 to 389.1

Comments from field worksheet Parhyographers and Hemigrapsus present
35 Pagurus, 2 Pugettia, 3 Kuttalina, 8 Epiactus, 1 Eupentacta

File Record for SEASON/yr / Date Field Investigator

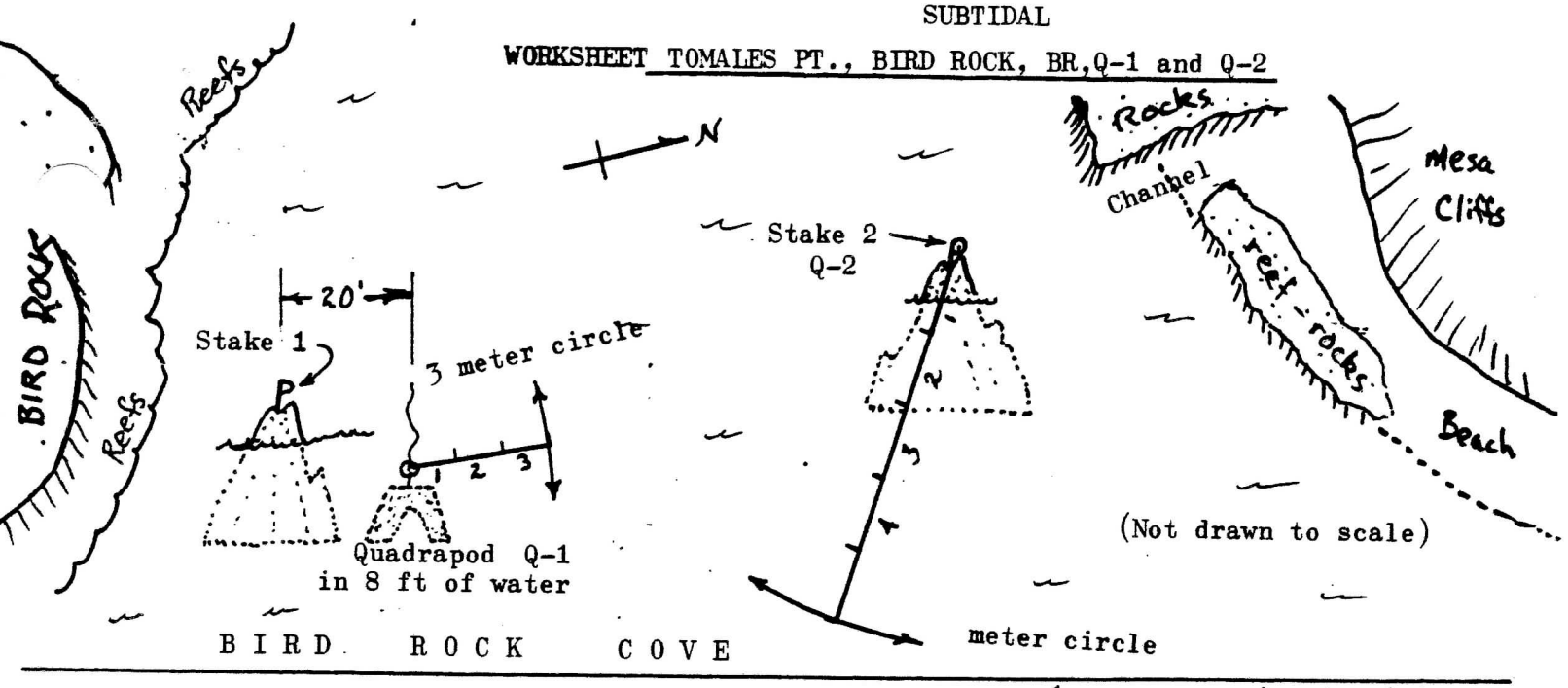
Tide/Time Salinity Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes			
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

SUBTIDAL

WORKSHEET TOMALES PT., BIRD ROCK, BR, Q-1 and Q-2



BIRD ROCK COVE

1 season: spring to winter

Investigator Chan Date May 19, 1984 Season Spring 84

Weather Clear Tide -0.7 @ 9:22 (A.M.) / P.M.

Temperature: AIR 62 °F WATER 49 °F SALINITY 34 PPT

SUBTIDAL _____ °C _____ °C

BR, Q-1 Circular Meter	Haliotis rufescens number of abs	Tagged abs observ.	Other species
1	2		
2	10		
3	10		
Total	22		

BR, Q-2 Circular Meter	Haliotis rufescens number of abs	Tagged abs obser.	other species
1	1		
2	2		
3	4		15 Strongylocentrotus franciscanus
4	2		23 Strongylocentrotus franciscanus
Total	9		

STATISTICS RECORD for TOMALES PT. BIRD ROCK (Location) TRANSECT BR, Q1 + Q2

Sample Size Quadrapods #1 + #2 Transect Page 1

File Record for SEASON/yr SPR / 84 Date May 19, 1984 Field Investigator G. Chen

Tide/Time -0.7 @ 9:22 AM Salinity 34 PPT Stats Tech

	Species Codes Q1 HALIOTIS rufescens Q2		ALL SPECIES IN SAMPLE
1. Σx_i	2, 10, 10	1, 2, 4, 2	22 + 9 = 31
2. $\Sigma (x_i)^2$	(meter # 1, 2, 3)	(meter # 1, 2, 3, 4)	total
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet also in Q2 was, 38 STRONGYLOCENTROTUS franciscanus

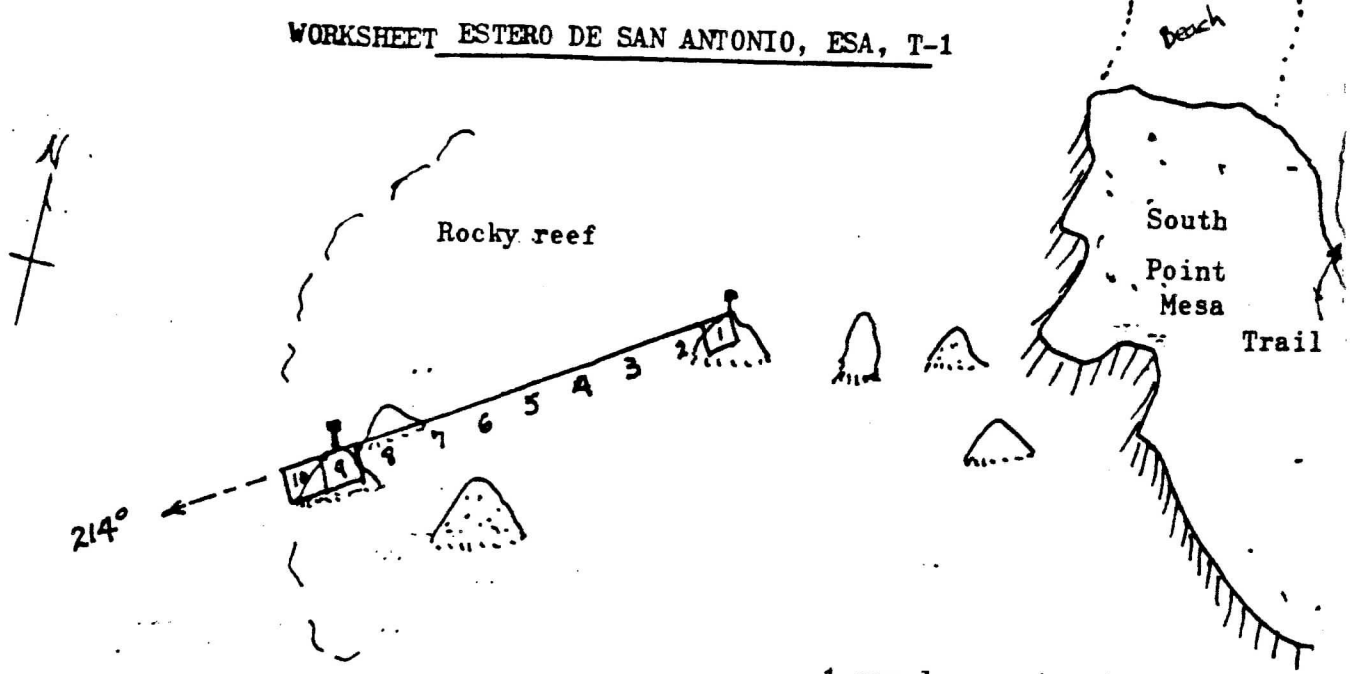
File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

	Species Codes	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
1. Σx_i				
2. $\Sigma (x_i)^2$				
3. s.d.				
4. $\bar{X}$				
5. 95% C.I. for population mean		to	to	to

Comments from field worksheet

WORKSHEET ESTERO DE SAN ANTONIO, ESA, T-1



1 sample: spring to winter

Investigator Chan Date Dec. 20, 1984 Season Winter '84

Weather Clear, occasional calm Tide -1.2 @ 3:59 A.M. / (P.M.)

Temperature: AIR 62 °F WATER 52 °F SALINITY 32 PPT

°C °C

SPECIES COUNTS

ESA, T-1

Sq. Meter	Anthop. xantho. (green sea anem)	A. elegantis. (aggreg. anem)	Mytilus calif. (sea mussel)	Pollicipes poly. (goose barnacle)	Katharina tunicata (black chiton)	Pisaster och. (pur. sea star)			Other Species
#1	9	20	600	500					1 Nuella
#2	7	14	200	100		2			
#3	9	250				24			
#4	2	30				18			
#5	1	40				4			
#6	2	40							
#7	3					1			
#8					1	6			
#9	8				5	15			
#10	6				7	10			
TOTAL	47 (5)	394 (5)	800 (5)	600 (5)	13	80			

Special Notes:

STATISTICS RECORD for ESTERO de SAN ANTONIO (Location) TRANSECT ESA-1

Sample Size 10 m² Transect Page 1

File Record for SEASON/yr WIN/84 Date Dec 20, 1984 Field Investigator G. CHAN

Tide/Time -1.2 @ 3:59 PM Salinity 32 PPT Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes	800 MYT 394 AEL 600 POL 47 AXA	13 KAT 80 AST	
1. Σx_i	1841	93	1934
2. $\Sigma (x_i)^2$	1449341	1659	1466726
3. s.d.	357.	9.4	348.4
4. $\bar{X}$	184.1 /m²	9.3 /m²	193.4 /m²
5. 95% C.I. for population mean	-67.1 to 435.3	2.6 to 16.0	-55.8 to 442.6

Comments from field worksheet 1 NUCELLA

File Record for SEASON/yr / Date Field Investigator

Tide/Time Salinity Stats Tech

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes			
1. Σx_i			
2. $\Sigma (x_i)^2$			
3. s.d.			
4. $\bar{X}$			
5. 95% C.I. for population mean	to	to	to

Comments from field worksheet

SESSILE and MOBILE group CODES *APPENDIX A*

Species to combine for descriptive statistics

codes	SESSILE
AXA	A. xanthogrammica green sea anemone
AEL	A. elegantissima aggregating anemone (AXE for both)
MYT	Mytilus californianus sea mussel
POL	Pollicipes polymerus goose barnacle
BAL	Balanus glandula acorn barnacle

codes	MOBILE
crabs	Cancer antennarius Pagurus spp. Pugettia spp. Pachygrapsus crassipes Hemigrapsus nudus Petrolithes cinctipes
TEG	Tegula funebralis black turban snail
MOPspp	Mopalia muscosa Hairy chiton Cryptochiton stelleri gumboot chiton
(KAT)	Katharina tunicata black chiton
STR	Strongylocentrotus purpuratus purple sea urchin
ASTspp	Patiria miniata bat star Pisaster orchraceous purple seastar Pisaster brevispinus pink star Pycnopodia helianthoides sunstar Leptasterias spp. small seastar
HALruf	Haliotis rufescens red abalone
HALcra	Haliotis cracherodii black abalone
COLspp	Collisella spp., limpet Notoacmaea sp., limpet
LOT	Lottia gigantea owl limpet
LIT LITx	Littorina scutulata Littorina planaxis perwinkle snails

Other Species (no statistics involved)

Nucella emarginiata
whelk snail

Nuttalina californica
chiton

Epiactus prolifera
sea anemone

Eupentacta quinquesemita
sea cucumber

MONITORING HANDBOOK

INTERTIDAL AND SUBTIDAL COMMUNITIES

POINT REYES NATIONAL SEASHORE

Contract No. CX 8000-3-0002

Second Draft

March, 1985

by

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I. INTRODUCTION

The Point Reyes National Seashore Peninsula and Farallon National Marine Sactuary encompass some of the most diverse intertidal and subtidal marine species found anywhere along the entire Pacific Coast. The marine habitats range from the soft shale mudstone of Duxbury Reef to the hard granitic rocks of the Point Reyes Headland and Tomales Point areas. This handbook is structured for the biological staff of the National Park Service, with the major objective of providing methodologies for the techniques to monitor these intertidal and subtidal marine resources.

The subject outline of this handbook will be, as follows:

- A review of the statistics used for the intertidal and subtidal transect data, Appendix A.
- Methodologies and maps of the key sampling localities. Other less important sampling sites are also listed in Figure 1.

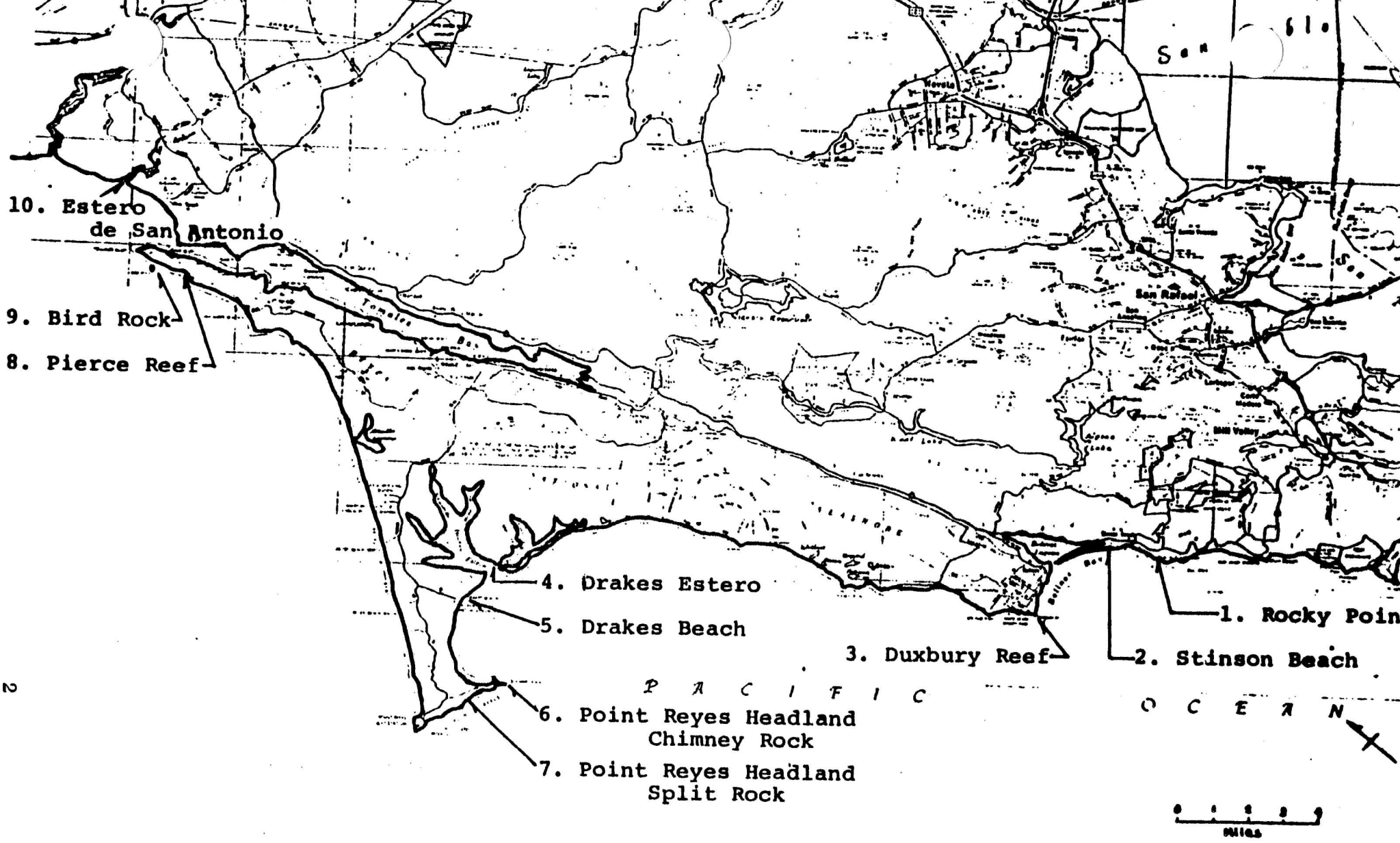


Figure 1. POINT REYES NATIONAL SEASHORE, MONITORING SAMPLING SITES

A. THE APPLICATION OF STATISTICS

1. Establish the prescribed field quadrats on the sampling sites.
2. Schedule the sampling dates for minus low tide days only.

Make the sample counts: at least once a year, favoring spring to fall months for most of the transects:

Winter - December, January, February

Spring - March, April, May

Summer - June, July, August

Fall - September, October, November

3. Record the data for each sampling at each site on the record sheets.
4. Determine the sample mean, sample variance, and sample standard deviation for each transect site.
5. Compute the 95% confidence interval for population mean for each sampling.
6. Comparison of seasonal sampling, e.g., spring of one year vs. spring of previous years, can then be charted in graphs showing the sample mean and confidence interval for population mean for each sampling.
7. Samples of each statistical method will be described in this handbook.
8. Some transects will record the absence or presence of organisms. This data will be useful for future comparative references on ecological changes.
9. Measure salinity at each site, recording the total dissolved solids (TDS). If salinities drop below 26 PPT, abalones will be stressed.

A. THE APPLICATION OF STATISTICS

The key component in the comparison study of population densities in marine organisms is the monitoring of sessile species. Mobile marine invertebrates are vital to a particular niche, but are not as reliably observed as the sessile species. Procedures for sampling statistics are:

1. Schedule field sampling in prescribed quadrat sites. Make sample counts at least once per year, favoring spring to fall seasons. Winter season is a difficult time for sampling; field work is often cancelled due to inclement weather, particularly for subtidal sampling. Repeat sampling each year during the same month as previous year, or within two or three weeks of the date.
2. Sessile species are marked with a (S) on the sample worksheets:

   Balanus spp., the acorn barnacle
   Pollicipes polymerus, goose barnacle
   Mytilus californianus, sea mussel
   Anthopleura elegantissima, aggregating anemone
   A. xanthogrammica, green sea anemone

   All other marine species to be sampled are mobile organisms. All species have an individual or group code name; see Appendix D.
3. Group the individual species into two main categories, sessile and mobile, excluding those in "other species" section of worksheet (see explanation under item 6). Determine the sample mean and sample standard deviation for each category and for all species sampled.
4. Compute the 95% confidence interval for population mean for each category and for all species sampled as the total transect group.
5. Comparisons of the same season from year to year can be illustrated by graphs which show the sample mean and the confidence interval for population mean for each sampling.
6. Some sites will record the absence or presence of organisms. This data will be useful for future consideration if ecological changes take place. There is work space to include counts of other species, also for useful reference in future evaluations.
7. Finally, abiotic measurements of temperature and salinity are useful if sudden changes occur. For example, abalone populations will be stressed if salinities fall below 26 PPT.

II. SAMPLING SITES AND DATA WORKSHEETS

This section of the handbook will describe sampling of high priority sites.

DUXBURY REEF COMPLEX Areas A, B, and C. Figures 2 through 7

Location 122°41'W; 37°53'N to 122°44'W; 37°56'N

The large platform soft shale rocks at Duxbury Reef encompass one of the most species diverse intertidal reefs in California. This reef is heavily impacted by human visitors--reef fishermen and tidepoolers. The Marin County Parks and Recreation Department provides a naturalist to patrol the activities of human visitors on a year around basis.

Key indigenous and endemic species on this reef are:

Mytilus californianus, large flat beds of the sea mussel, Figure 3.

Tegula funebralis, endemic giant-size variation of this black turban snail

Mesoglossus sp., endemic acorn worm

Background Information on Duxbury Reef

The Bolinas headland is an uplifted marine terrace, with large eroded marine intertidal reefs. The general geology of the Bolinas headland and reefs is classified as late Miocene in age, called the Santa Cruz Formation about 5 to 7 million years old (Clark, et al, 1984).

Historically, the reef was named after the 1849 shipwreck of the DUXBURY. In 1968, Gordon Chan of the College of Marin divided the reef ramparts into three sections for study (Fig. 2). The rationale for these divisions:

Area A = Agate Beach reef is very close to the Agate Beach trail and should have the highest human impact.

Area B = Mesa reef is also close in to human visitation and should be the second highest in impacted effect.

Area C = Outer reef is the long extended reef, least impacted by humans and should have the greatest species diversities.

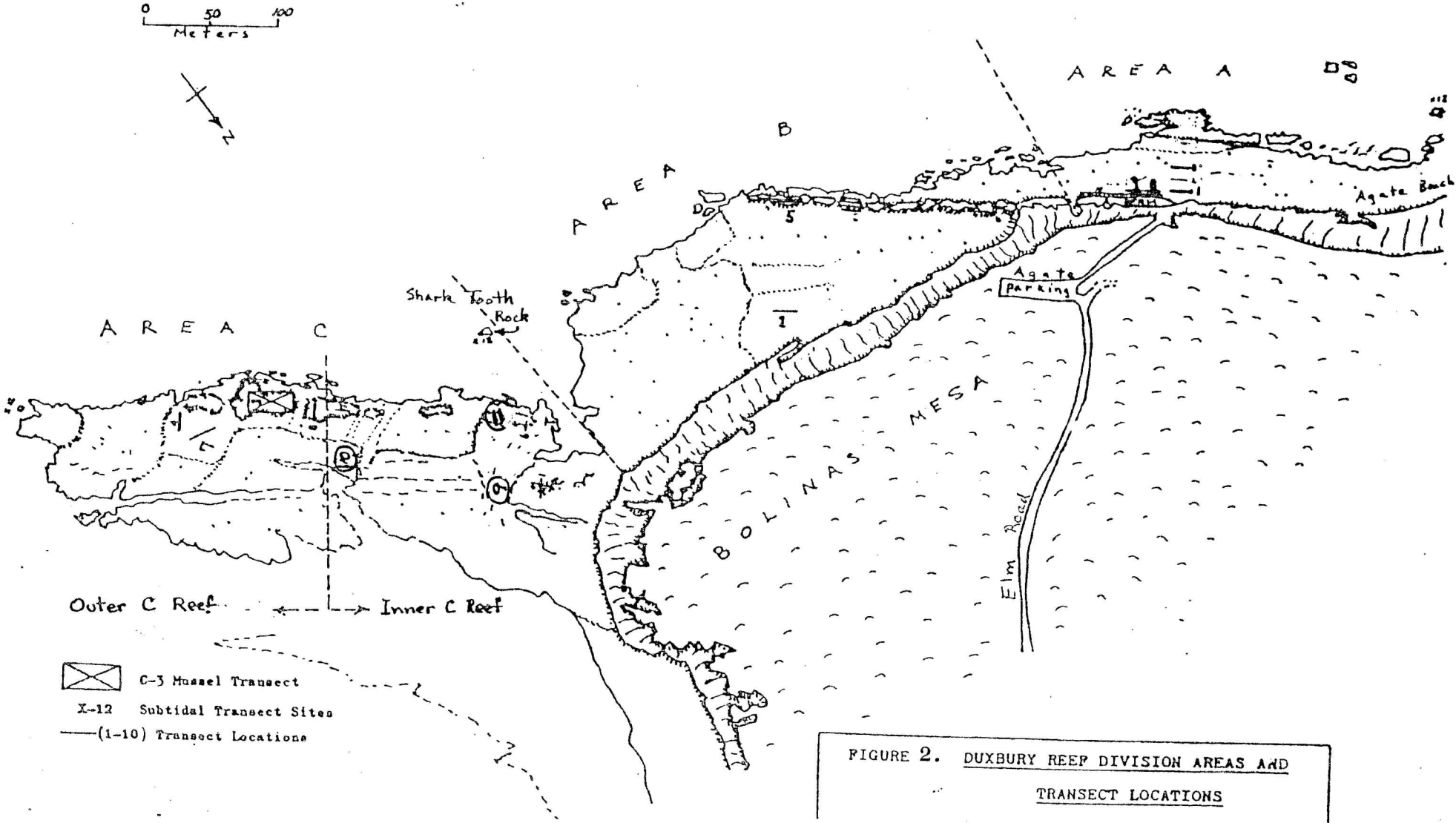


FIGURE 2. DUXBURY REEF DIVISION AREAS AND TRANSECT LOCATIONS

In 1971, the California Department of Fish and Game declared Duxbury Reef a marine reserve. The Fish and Game code protects most marine life on the reef except those designated as fish species. Among those excluded from fishing are the vast beds of the sea mussel Mytilus californianus.

Furthermore, because of the unique marine life, the reef was designated as a California marine waters Area of Special Biological Significance (ASBS) in 1974 by the California State Water Resources Control Board.

Low Tide Sampling

Two consecutive low-tide sampling days are required to complete a single sampling for study of Duxbury Reef. Areas A and B required one minus low tide day. Area C sites require one low tide day.

Intertidal sampling should begin at Zone 4 and progress back to Zone 1 as the tidal height increases with time, Figure 3.

Note: All worksheets have sketches of the transects; these are not drawn to scale but serve as aids in locating the site.

Frequence of sampling

Sampling should be done once per year or as noted on the worksheet.

Equipment for Intertidal Work

10-meter polypro line with each meter marked with electrician tape looped between the braided line

square meter frame with square decimeter marking at each corner

salinometer - refractometer

thermometer, centigrade

compass

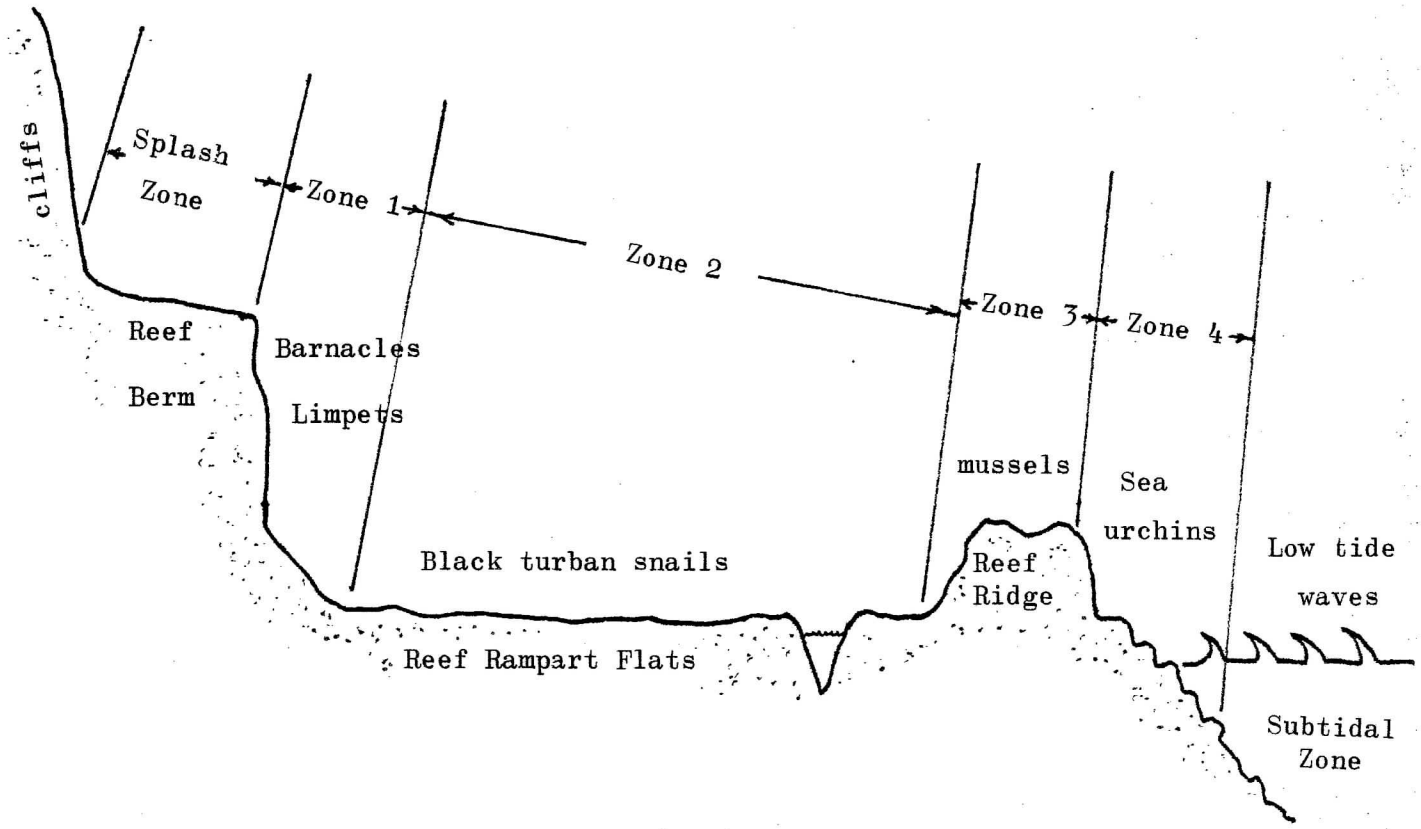


Figure 3. INTERTIDAL ZONATION AT DUXBURY REEF - VERTICAL PROFILE

DUXBURY REEF, AREA A 122°42'40"W; 37°53'50"N (Figure 4)

The parking lot at the Bolinas Mesa, Figure 2, provides quick access to Area A. The major objective of the Area A transects is to obtain data on marine organisms which are impacted by frequent visitors on low tide days. Three ten-meter transects are utilized. Populations to be counted will have cyclical fluctuations throughout the four seasonal counts.

AT-1 (Area A, Transect 1, 10 square meters)

Introduction: A flat transect on top of the reef rampart, close to the Agate Beach trail head.

Location: From the north point of the Agate Beach trail, mesa cliff, move 30 meters west to the steel marker stake which is embedded in the substrate.

Method: Lay out a marked 10-meter, polypropolene line between the two steel stakes. Place a square meter frame at the left (or south) stake, as the first square meter sample, and move to the right, making counts for each consecutive square meter, for the full ten meters. Record the total number of individuals for each species observed in each square meter frame area.

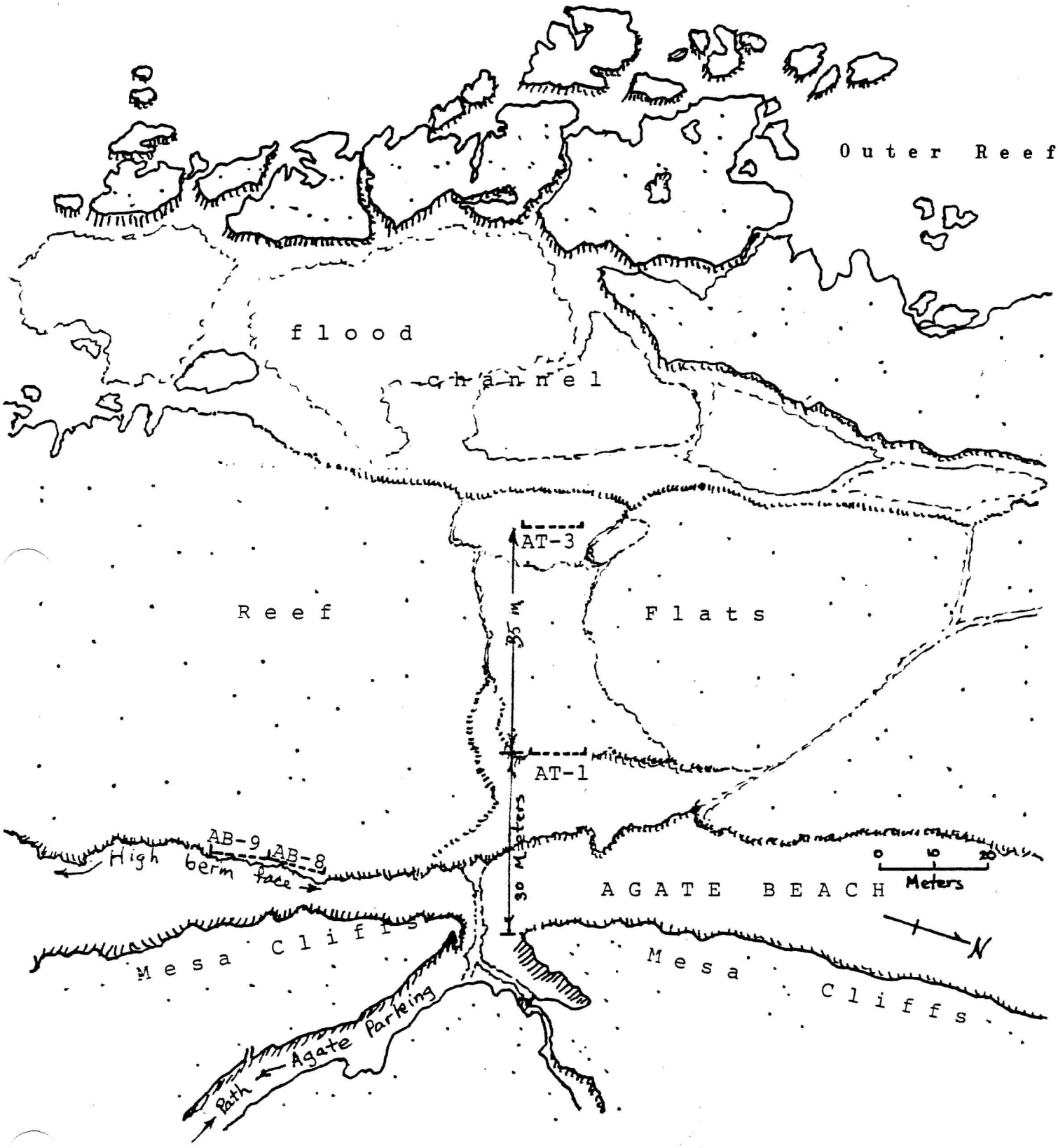
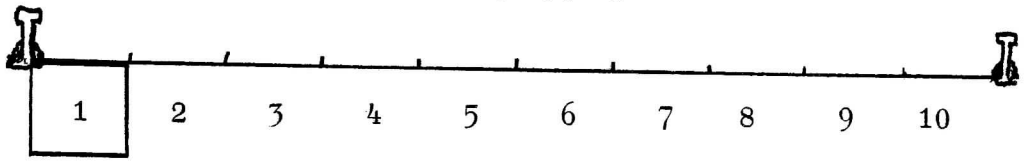


Figure 4. DUXBURY REEF, AREA A

WORKSHEET DUXBURY AREA A, AT-1

AT-1

Stake 1 — ten meter marked polypropolene line — Stake 2



m^2 frame

N

1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS

Sq. Meter	Tegula funebralis (black turban snail)	Anthopleura elegantissima (aggregating anemone)			Other Species
#1					
#2					
#3					
#4					
#5					
#6					
#7					
#8					
#9					
#10					
TOTAL		(S)			

Special Notes:

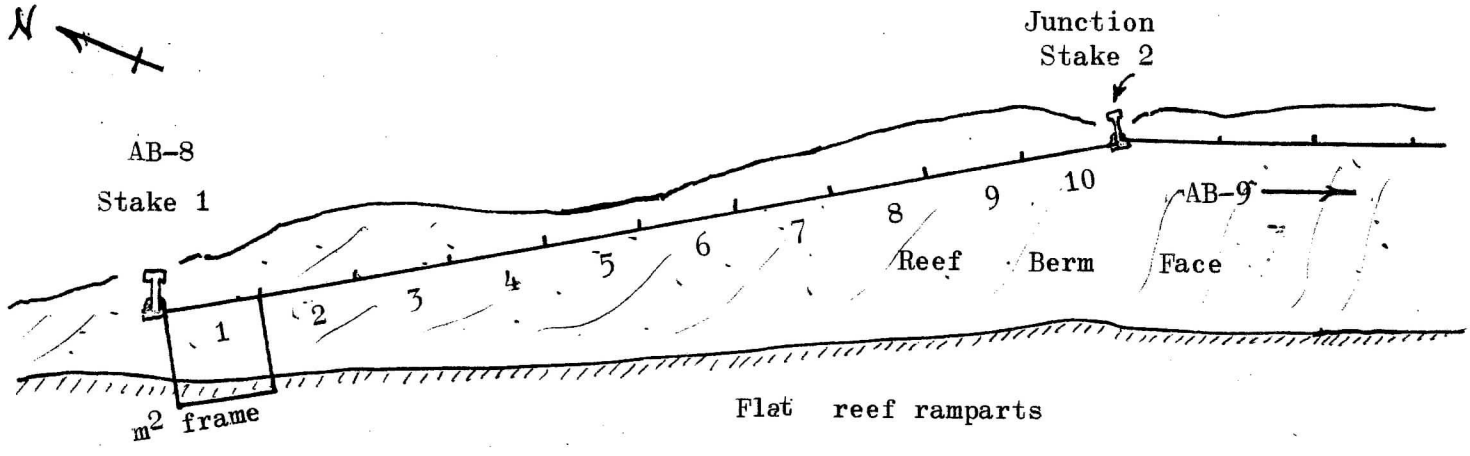
AB-8 and AB-9 (Area A, Transects 8 and 9, 20 square meters)

Introduction: The two berm face transects, AB-8 and AB-9, are nearly vertical transects, recording Zone 1 organisms of limpets, periwinkle snails, and crabs. In previous years, the acorn barnacles were counted, but are now omitted because of their continuous abundance year after year.

Location: At the Agate trail head, walk about 22 meters to the south to find the large steel stake embedded in the berm face at the junction of AB-8 and AB-9.

Method: Place the 10-meter marked line at this junction stake of AB-8 and 9. Stretch the 10-meter line north to reach the stake at square meter #1 of AB-8. Afterwards, stretch it 10 meters to the south to obtain AB-9's transect. On each transect, square meter #1 is at the north end of the 10-meter line; sampling continues in the next square meter to the south.

WORKSHEET DUXBURY Area A, AB-8



← To Agate Beach Trail

1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

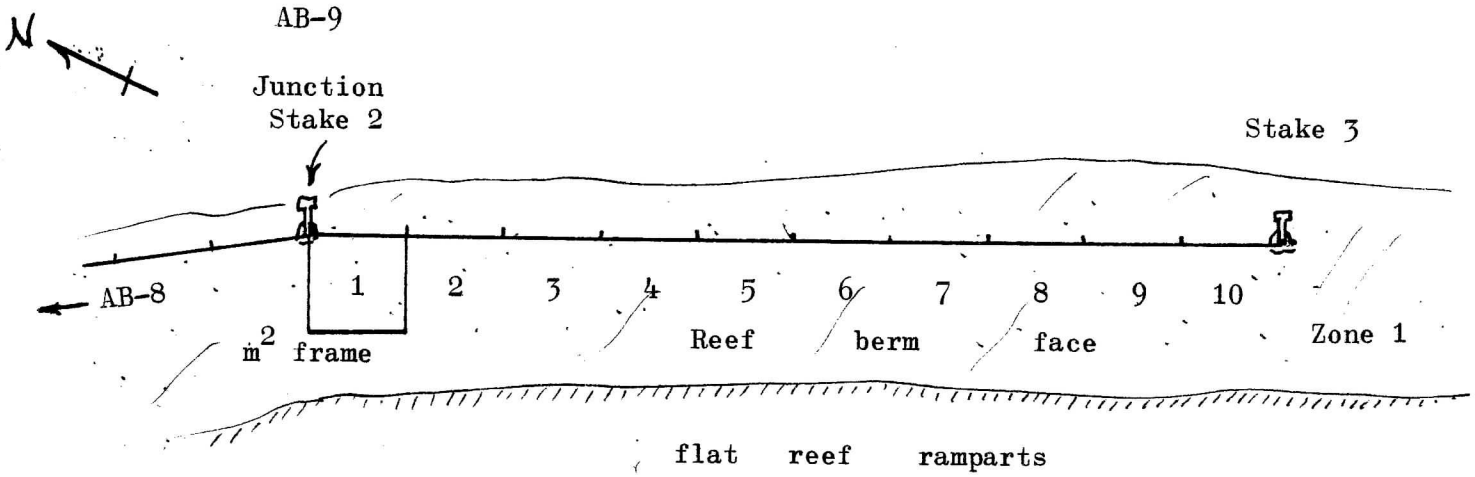
_____°C _____°C

SPECIES COUNTS

Sq. Meter	Littorina planaxis (large periwinkle)	Collisella spp. (limpets)	Pachygrapsus crassipes (striped shore crab)			Other Species
#1						
#2						
#3						
#4						
#5						
#6						
#7						
#8						
#9						
#10						
TOTAL						

Special Notes:

WORKSHEET DUXBURY Area A, AB-9



1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS

Sq. Meter	Littorina planaxis (large periwinkle)	Collisella spp. (limpets)	Pachygrapsus crassipes (striped shore crab)			Other Species
#1						
#2						
#3						
#4						
#5						
#6						
#7						
#8						
#9						
#10						
TOTAL						

Special Notes:

DUXBURY REEF, AREA B 122°42'50"W; 37°53'22"N (Figure 5)

Introduction

Area B of Duxbury Reef, Figure 2, is also heavily visited by man. Of the original five intertidal transects established in 1968, only two will now be utilized, BT-1 and BT-5. The close-in transect of BT-1 should illustrate impacted species while BT-5 species should show greater stability year after year. It is expected that populations at Area B would be more stable than those at Area A.

One low-tide sampling sequence should be used for Areas A and B, taking data first at Area B at the lowest tide time, then moving back to sample at Area A.

BT-1 Location — From Area A, move south along the high berm reefs to Area B. Continue to walk east along the Area B beach to "Hump Rock", a large isolated rock close to the mesa cliffs, Figure 5. A steel stake is embedded in Hump Rock. From this stake, go 80 meters at a compass heading of 191° (magnetic north) to the steel marker for BT-1, a 10 square meter transect.

BT-5 Location — From BT-1, move approximately 100 meters at a compass heading of 210° (magnetic north) to the Area B Ridge, Figure 5. The mid-ridge rock is the 8th pinnacle in a series, from south to north. On the top north edge of the rock is a steel stake. Lay the line south of the stake to obtain a 10 square meter transect.

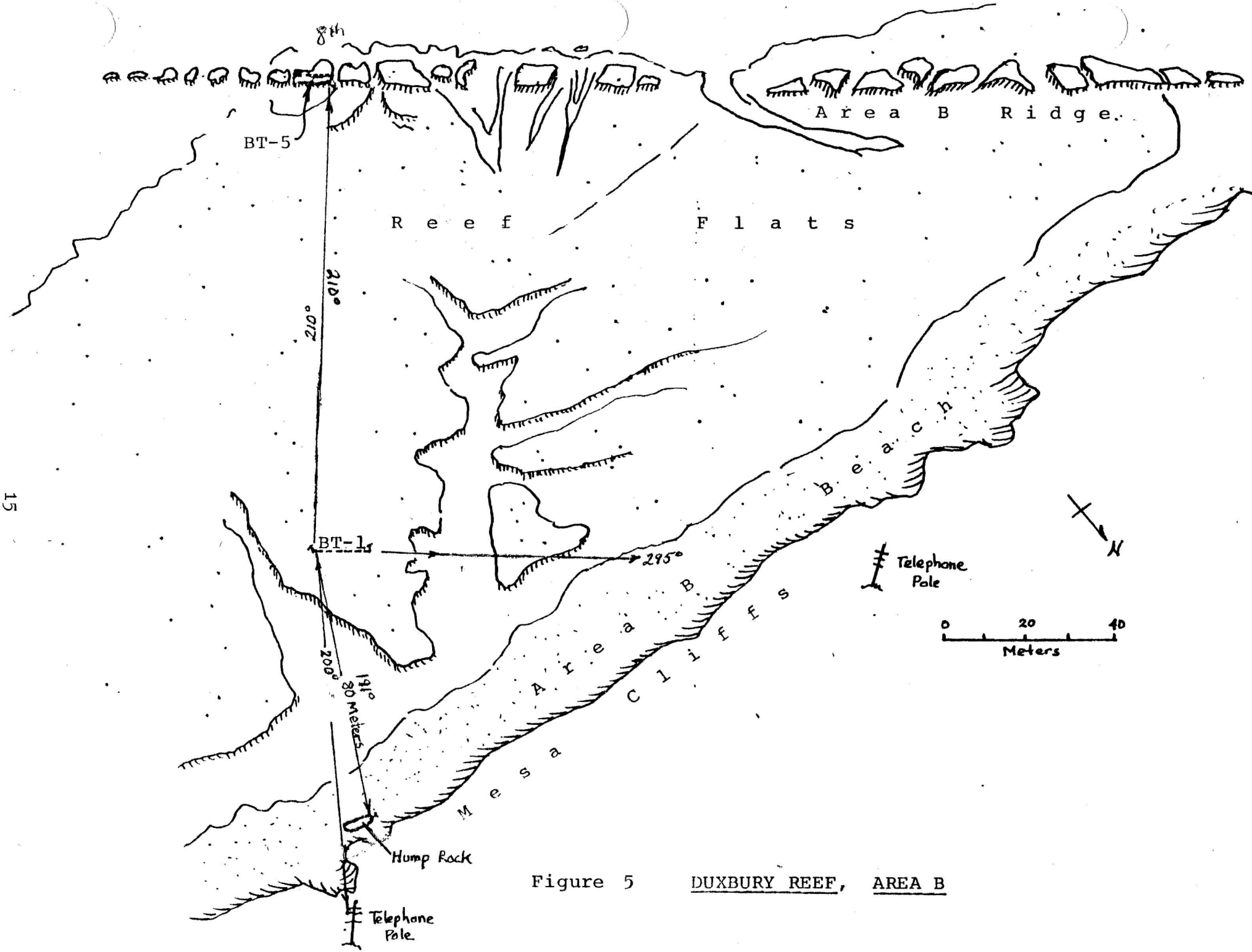
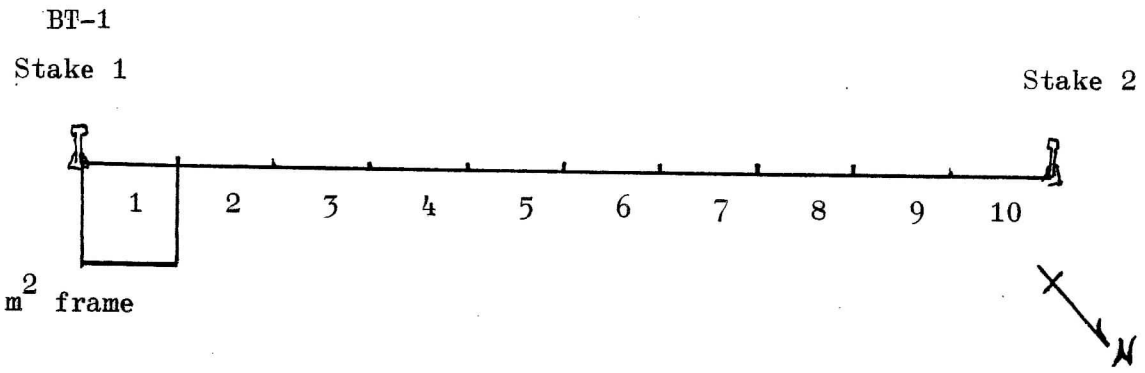


Figure 5 DUXBURY REEF, AREA B

WORKSHEET DUXBURY Area B, BT-1



1 sample: spring to fall

Investigator_____ **Date**_____ **Season**_____

Weather_____ **Tide**_____@_____:_____**A.M. / P.M.**

Temperature: AIR_____°F WATER_____°F **SALINITY**_____**PPT**

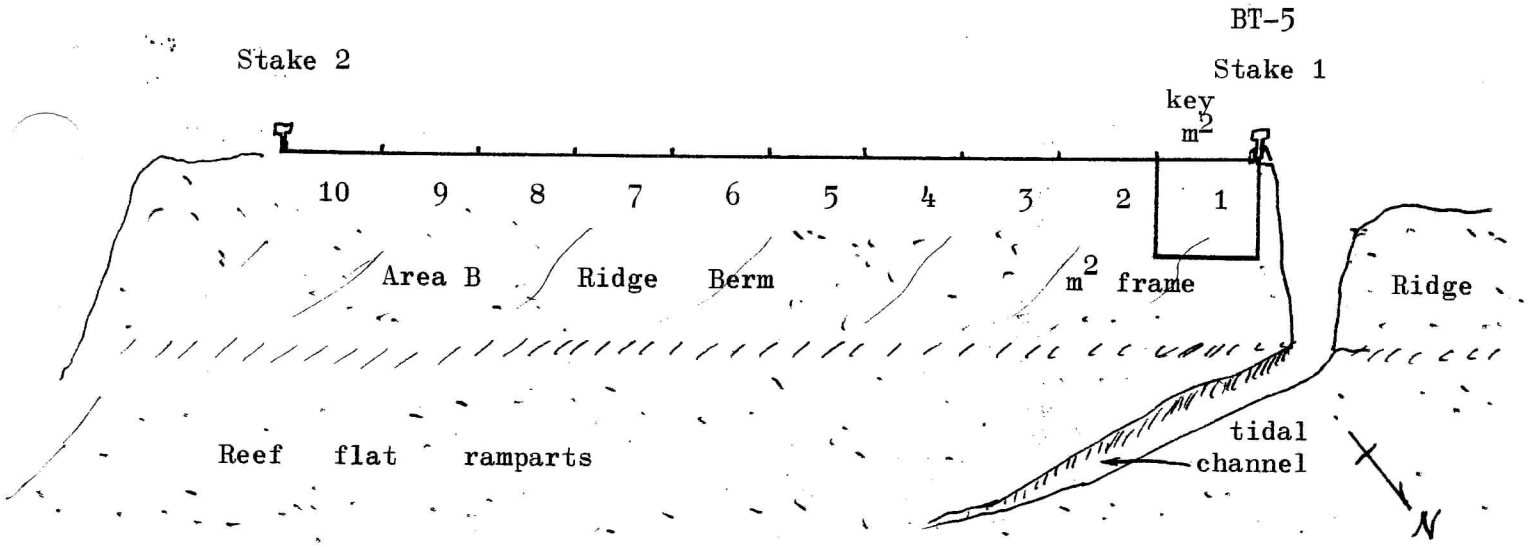
_____°C _____°C

SPECIES COUNTS

Sq. Meter	Tegula funebralis (black turban snail	Collisella spp. (limpets)	Anthopleura elegantissima (aggre. sea an)			Other Species
#1						
#2						
#3						
#4						
#5						
#6						
#7						
#8						
#9						
#10						
TOTAL						

Special Notes: (S)

WORKSHEET DUXBURY, Area B, BT-5



1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS

key m^2

Sq. Meter	Mytilus californianus (sea mussel)	Pollicipes polymerus (goose barnacle)	Mopalia spp. (chiton)	Strongylo. purpuratus (purple urchin)	Lottia gigantea (owl limpet)	Other Species
#1						
#2						
#3						
#4						
#5						
#6						
#7						
#8						
#9						
#10						
TOTAL	(5)	(5)				

Special Notes:

DUXBURY REEF, AREA C 122°41'55"W; 37°53'0"-15"N

Introduction

The Area C of Duxbury Reef is the largest in acreage, extending over 900 meters in a southeasterly direction. Area C has two major sections, the Inner Reef section and the Outer Reef section.

The Outer Reef section should have a greater species diversity because of its remoteness from human traffic and the better circulation of nutrient waters. Each of these two reef sections has unique marine species which are of particular interest. These special organisms are described below:

Inner Reef, Figure 6

Transect CT-9 Mesoglossus sp., endemic acorn worm

CT-11 Anthopleura xanthogrammica, sea anemone

Tony, a special specimen, has been observed over a period of 34 years by G. Chan.

CT-10 Tegula funebralis, the giant spire black turban snail, the largest on the Pacific Coast, and the chiton, Mopalia muscosa.

Outer Reef, Figure 9

Transect CT-8 Lottia gigantea, the owl limpet

CT-3 Mytilus californianus, vast beds of approximately 3 million sea mussels

CT-7 Anthopleura xanthogrammica, numerous giant-size sea anemones in crevices

Area C's INNER REEF SECTION

CT-9 Location — The transect stake is at the end of a long outcropping of shale rocks, Figure 6. A large steel stake marks this transect at the end of these rocks. Place the ten-meter line at this stake and align the rope to 215°SW to Shark Tooth Rock. The tenth meter from the stake marks the location of the one square meter sampling in the inner flood channel for this rare acorn worm.

Method — Sieve one square meter of shell-sand through a one-millimeter sieve. The sample must be at least 15 cm. deep; it can be dug with a small shovel. Mesoglossus sp. are the red-colored worms; these should all be counted.

CT-11 Location — Anthopleura xanthogrammica, the solitary "Tony" sea anemone, is located 50 meters on the upper south ridge within a deep tidepool or 200° from stake CT-9. There are three other anemones in this long-standing tidepool.

Method — Count all the anemones and note whether "Tony" is present.

CT-10 Location — From CT-9, follow a compass bearing of 150°SE for approximately 200 meters and you will arrive at the steel staked natural gas vent. Another 20 meters to an uplifted shale berm will locate CT-10. This is the ten square meter transect of the giant turban snail and the hairy chiton, Figure 6.

Method — Count all the black turban snails, Tegula funebralis, and the chitons, Mopalia muscosa, in the 10 square meter transect.

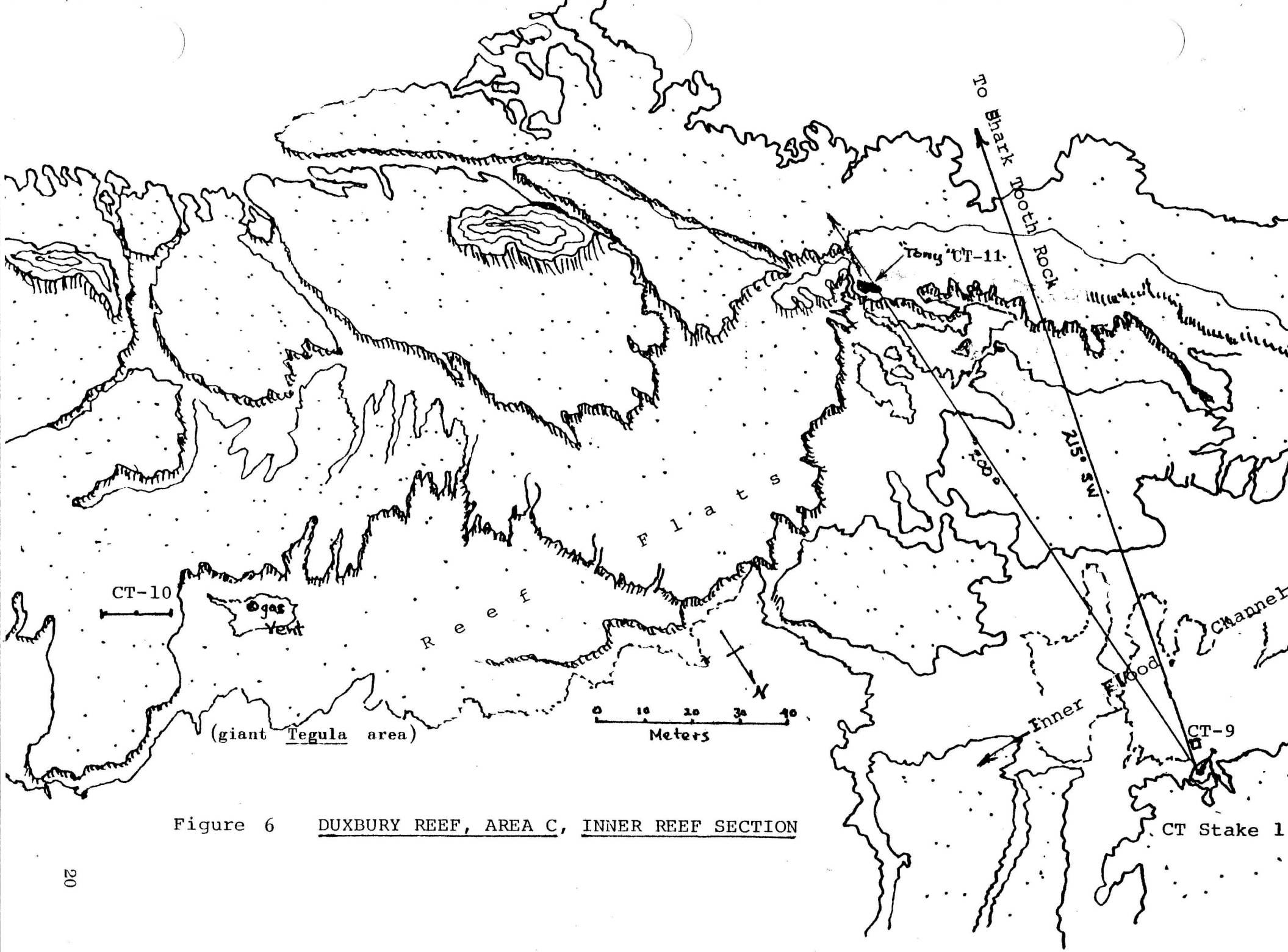
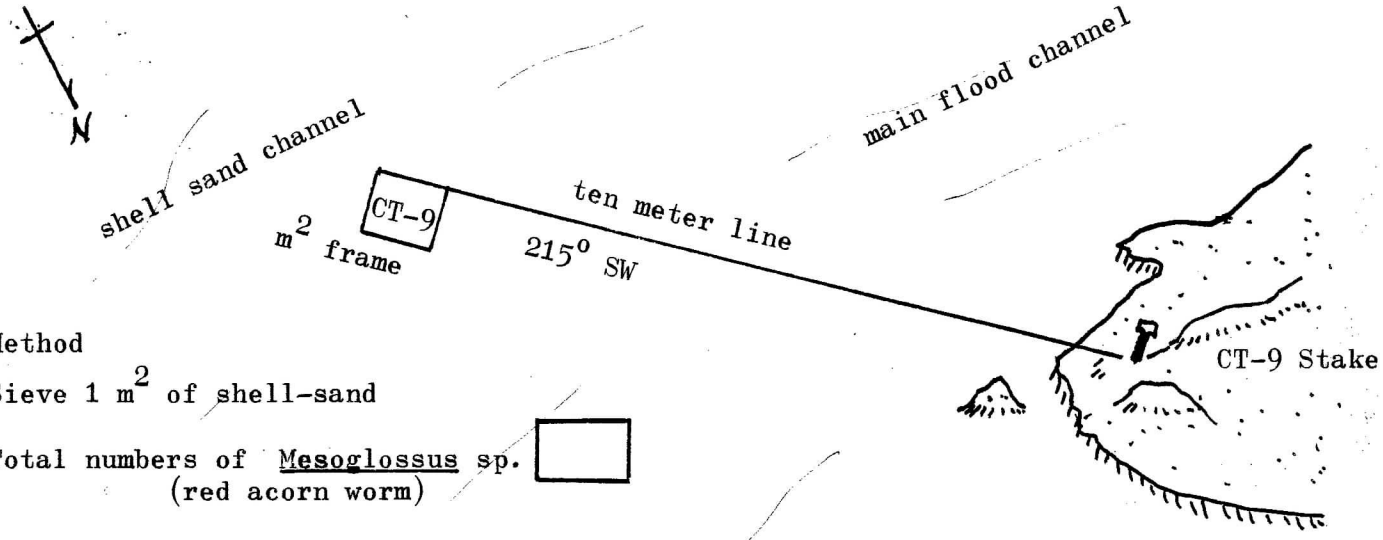


Figure 6 DUXBURY REEF, AREA C, INNER REEF SECTION

WORKSHEET DUXBURY, Area C, CT-9 and CT-11



Method

Sieve 1 m^2 of shell-sand

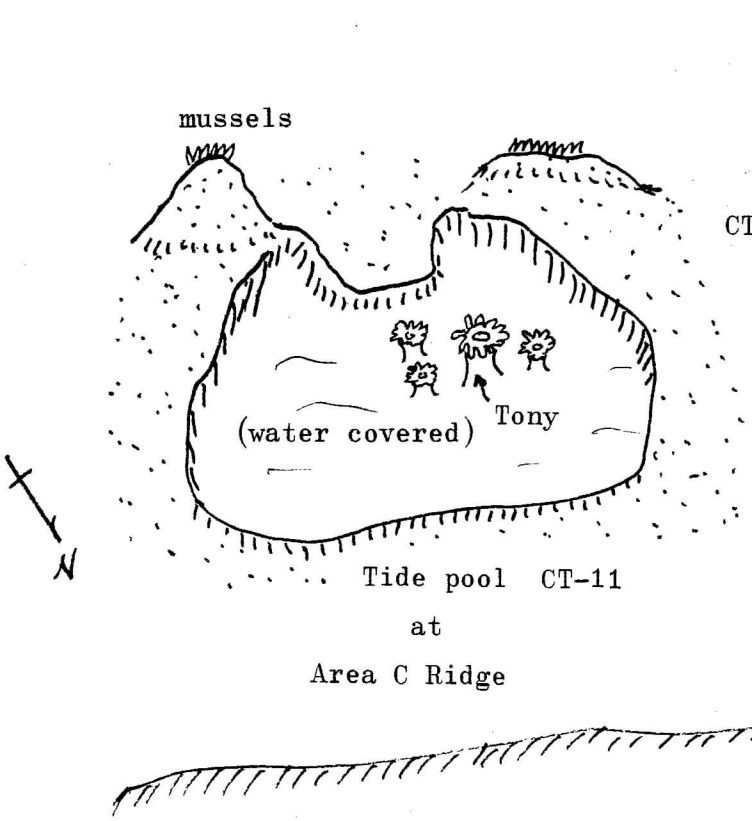
Total numbers of Mesoglossus sp. ☐
(red acorn worm)

1 sample: spring to fall

Investigator_____ **Date**_____ **Season**_____

Weather_____ **Tide**_____@_____:_____**A.M. / P.M.**

Temperature: AIR_____°F WATER_____°F **SALINITY**_____**PPT**
_____°C _____°C



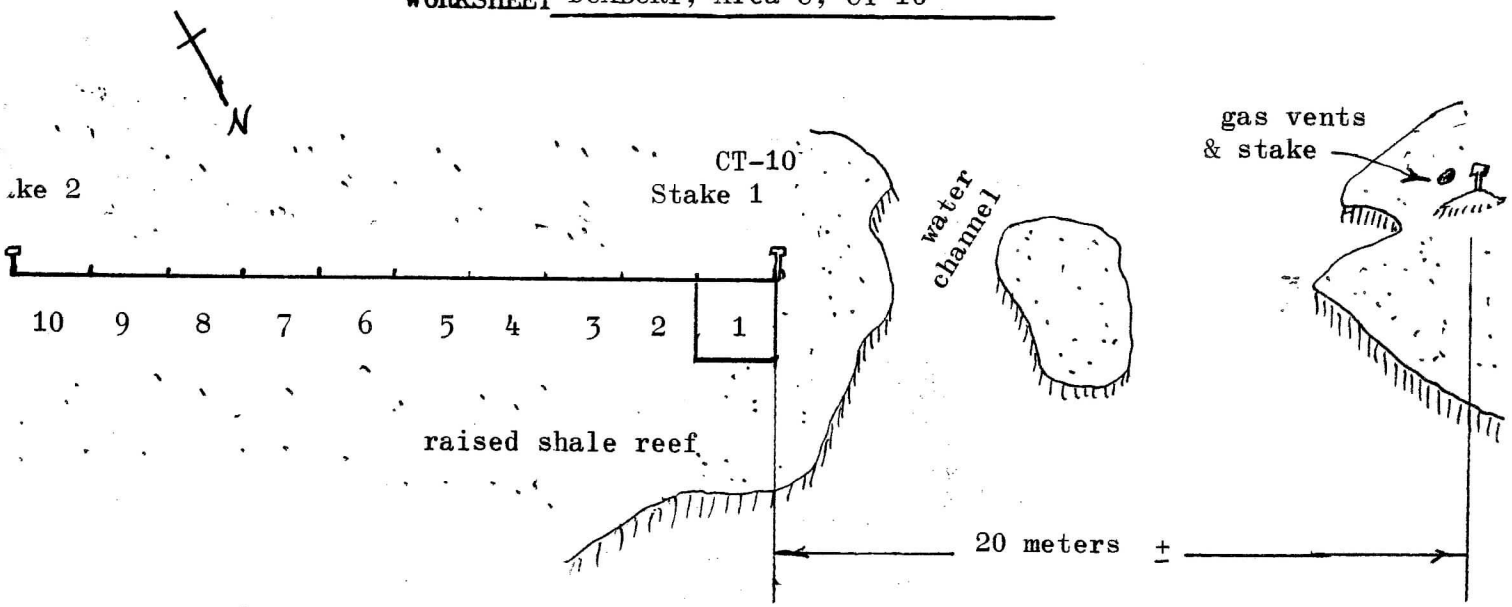
Tide pool CT-11
at
Area C Ridge

1 sample: spring to fall

CT-11 Anthopleura xanthogrammica (5)

Total numbers of Tony and
other sea anemones = ☐

WORKSHEET DUXBURY, Area C, CT-10



1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS

Sq. Meter	Tegula funebralis (black turban snail)	Mopalia spp. (chiton)			Other Species
#1					
#2					
#3					
#4					
#5					
#6					
#7					
#8					
#9					
#10					
TOTAL					

Special Notes:

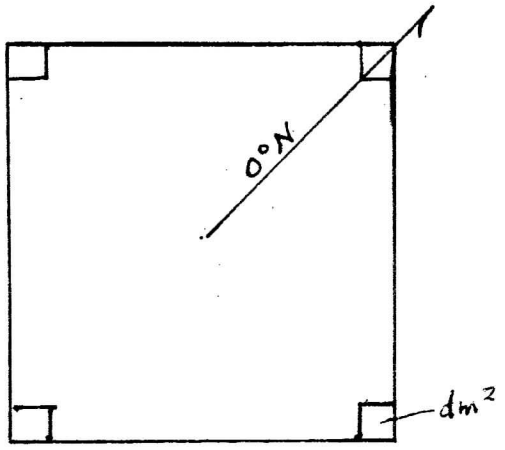
Area C's OUTER REEF SECTION

CT-8 Location — CT-8 is located about 100 meters from CT-10 on a 230° compass bearing, to the south ridge berm of mussels beds. The steel stake is driven on top of a concretion, Figure 7.

Method — Move the 10 meter line on a 50° northwesterly direction to mark 20 meters total. The transect area to be covered extends 5 meters on both sides of the 20-meter line, a 200 square meter area encompassing the grazing territories of the owl limpet, Lottia gigantea. Count all the owl limpets observed on the rock surfaces.

CT-3 Location — The giant "chennile" beds of the sea mussel Mytilus californianus are easily viewed when one continues on a 300° compass bearing along the south mussel ridge for approximately 100 meters from CT-8. Extensive square meter transect sampling was performed here over a period of 17 years to determine the succession of these mussel beds. In previous years ten square meter quadrats had been used, but now only six square meters are employed.

Method — The square meter transect frame has four square decimeter sections. Count the number of mussels and goose barnacles in each of the square decimeter quadrants at each corner of the square meter frame; use this sampling method for each of the six square meters located by steel stakes within the mussel bed.



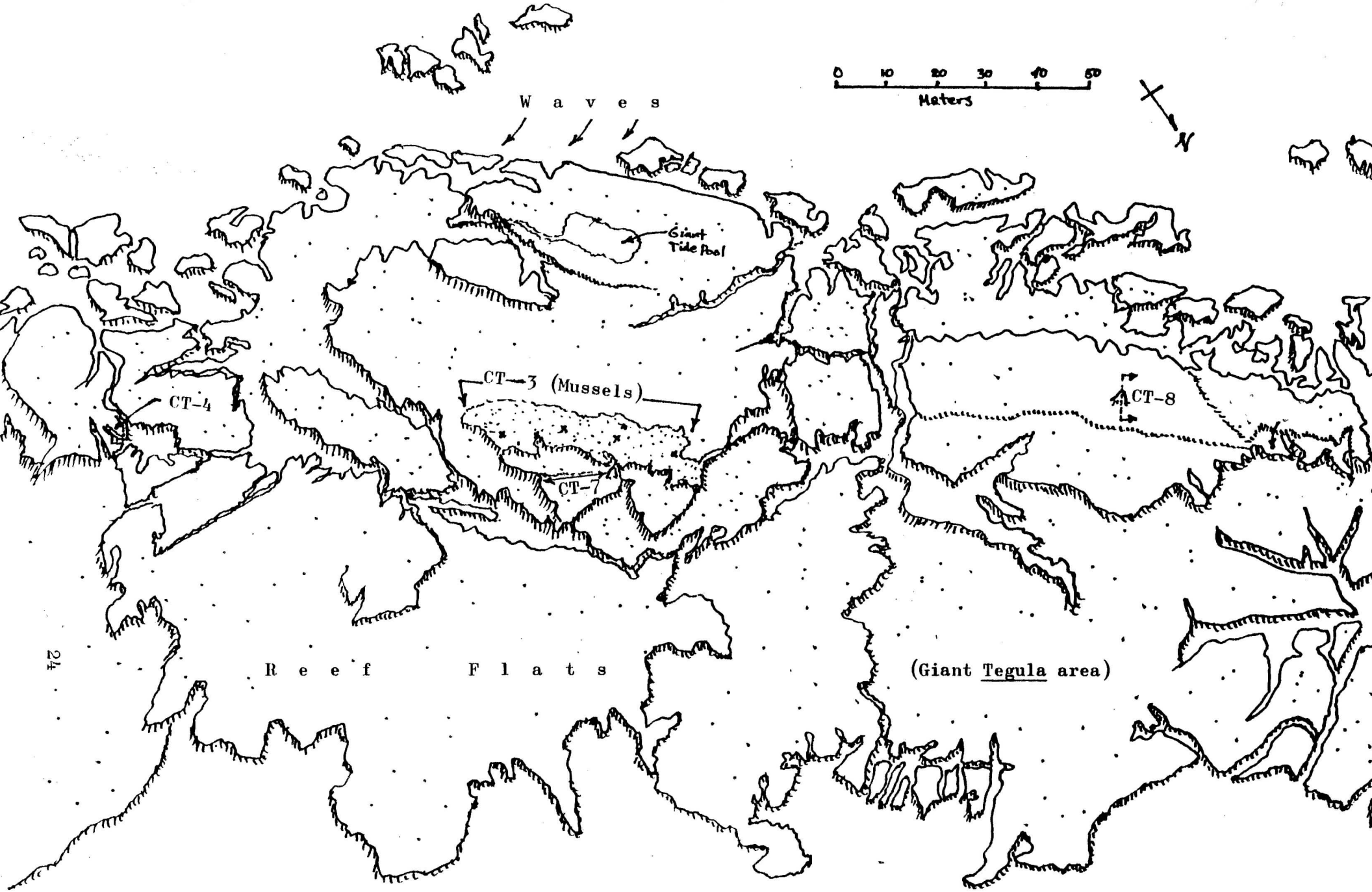
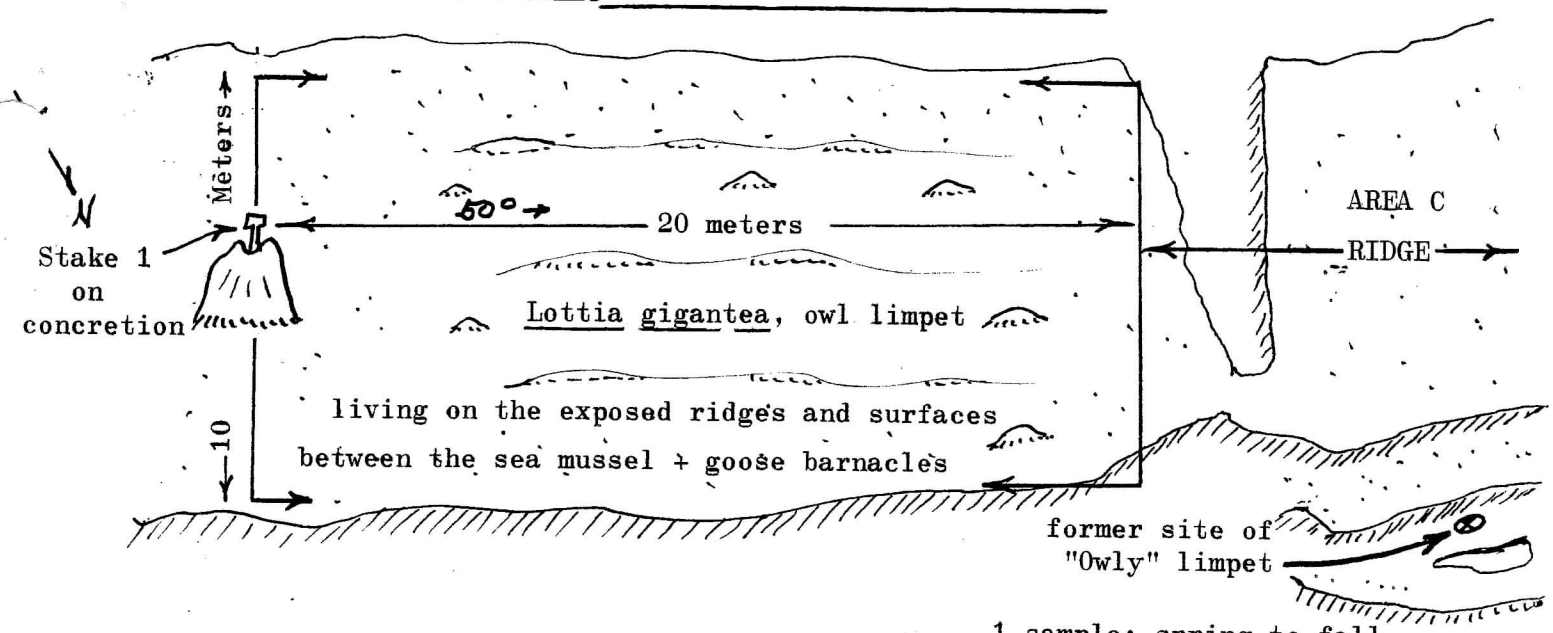


Figure 7 DUXBURY REEF, AREA C, OUTER REEF SECTION

WORKSHEET DUXBURY REEF, AREA C, CT-8



1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

CT-8

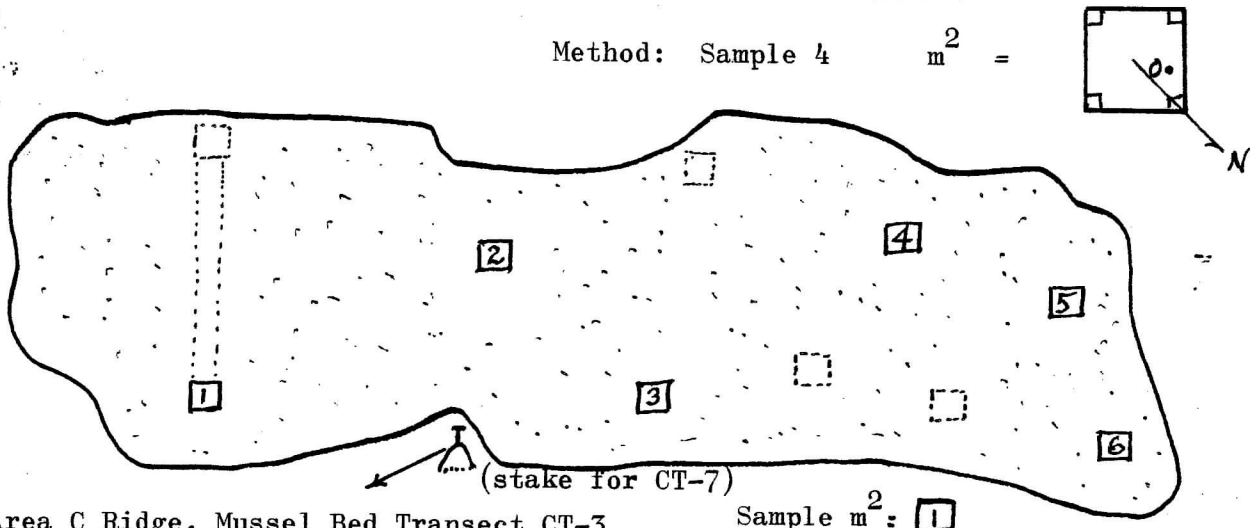
_____

20 meters, total count of the owl limpet, Lottia gigantea in transect = ☐

Other species and observations:

WORKSHEET DUXBURY, Area C, CT-3

Method: Sample 4 m^2 =



Area C Ridge, Mussel Bed Transect CT-3

Sample m^2: 1

former m^2: ☐

1 sample: spring to winter

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS		Mytilus californianus (sea mussel)				Pollicipes polymerus (goose barnacle)						
Sq. Meter	Total Dead m^2	LIVE count dm^2	dm^2	dm^2	dm^2	LIVE count dm^2	dm^2	dm^2	dm^2			Other Species
#1												
#2												
#3												
#4												
#5												
#6												
#7												
#8												
#9												
#10												
TOTAL		for 24 dm^2				for 24 dm^2						

Special Notes: (5) (5)

Area C's OUTER REEF SECTION (continued)

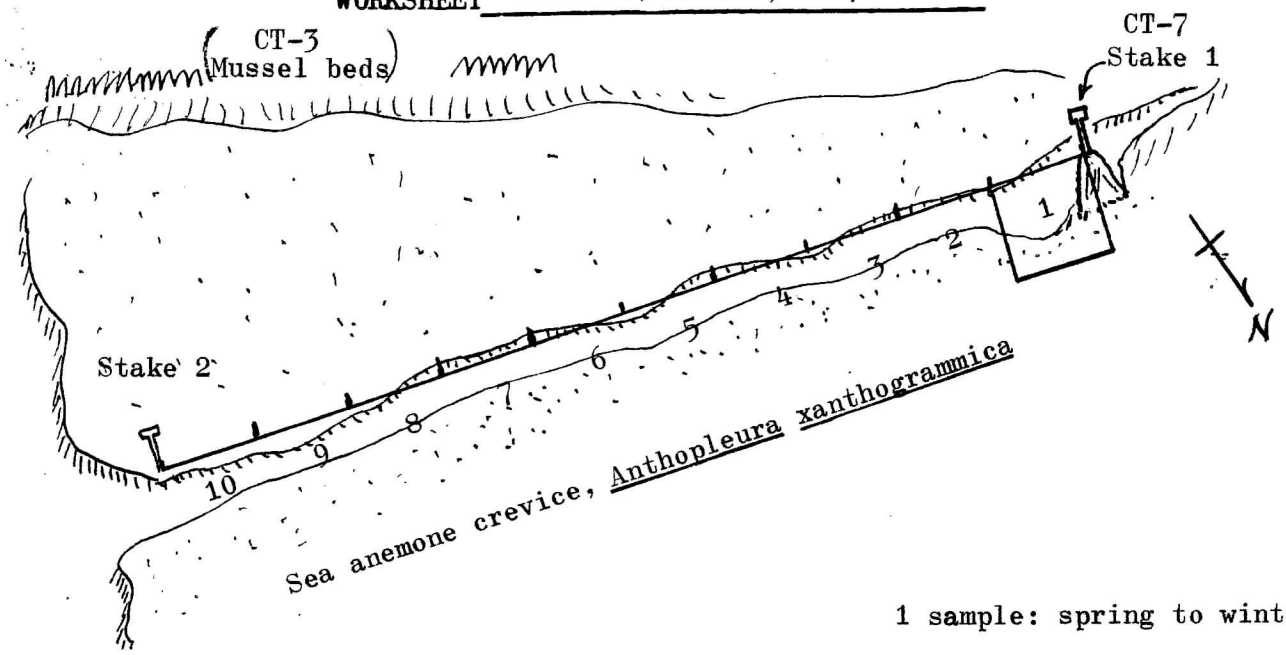
CT-7 Location — Just north of the CT-3 mussel bed transect is the CT-7 sea anemone crevice, Figure 7. The transect is a 10-meter line along a shale crevice that is lined with the large green sea anemone, Anthopleura xanthogrammica. These sea anemones are well fed with mussels which have been loosened by wave action from the mussel beds just adjacent to the crevice.

Method — Count all the green sea anemones in the ten square meters indicated along the line which is stretched from stake #1 to #2.

CT-4 Location — About 100 meters south of CT-7 anemone crevice is CT-4, Seastar corner of Pisaster ochraceous, Figure 7. The purple seastars gather in this 10-meter crevice during low tides and feed on the adjacent mussel beds at high tide.

Method — Count all the seastars along the ten-meter plots.

WORKSHEET DUXBURY, Area C, CT-7



1 sample: spring to winter

Investigator_____ **Date**_____ **Season**_____

Weather_____ **Tide**_____ @ _____ : _____ A.M. / P.M.

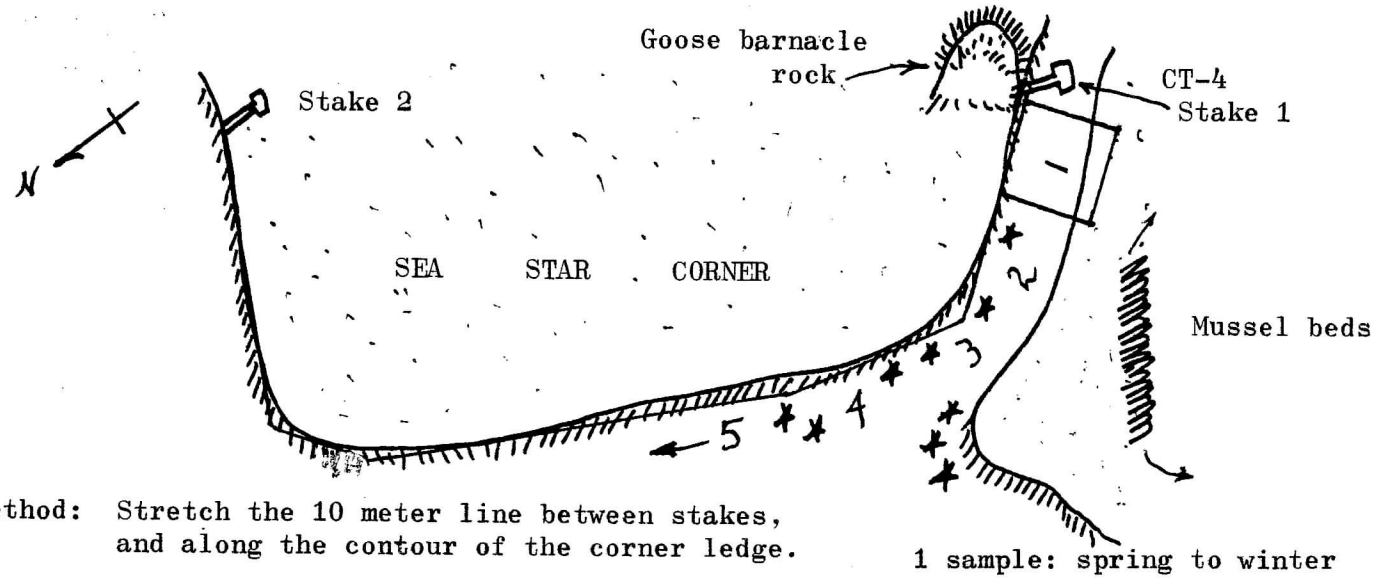
Temperature: AIR_____ °F **WATER**_____ °F **SALINITY**_____ PPT

CT-7 _____ °C _____ °C

m^2	Anthopleura xanthogrammica (giant green sea anemone)	Others
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total		

(5)

WORKSHEET DUXBURY, Area C, CT-4



Method: Stretch the 10 meter line between stakes, and along the contour of the corner ledge.

1 sample: spring to winter

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

CT-4 m^2	Pisaster ochraceous (purple sea star)	Others
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Totals		

DUXBURY REEF SUMMARY WORKSHEET

Range of Dates, from _____

to _____

Season _____

AREA	Transect	Sample Size	Total Number	$\bar{X}$ Avg.	Major Species
A	AT-1	10 m^2	_____	____	Tegula funebralis, black turban snail
			_____	____	Anthopleura elegantissima, aggreg. sea anemone (S)
	AT-8	10 m^2	_____	____	Littorina planaxis, large periwinkle
			_____	____	Collisella spp., limpets
			_____	____	Pachygrapsus crassipes, striped shore crab
	AB-9	10 m^2	_____	____	Littorina planaxis, large periwinkle
			_____	____	Collisella spp., limpets
			_____	____	Pachygrapsus crassipes, striped shore crab
B	BT-1	10 m^2	_____	____	Tegula funebralis, black turban snail
			_____	____	Collisella spp., limpets
			_____	____	Anthopleura elegantissima, aggreg. sea anemone (S)
	BT-5	10 m^2	_____	____	Mytilus californianus, sea mussel (S)
			_____	____	Pollicipes polymerus, goose barnacle (S)
			_____	____	Mopalia spp., chiton
			_____	____	Strongylocentrotus purpuratus, purple urchin
			_____	____	Lottia gigantea, owl limpet
C	CT-9	1 m^2	_____	NA	Mesoglossus sp., acorn worm
	CT-11	1 m^2	_____	NA	Anthopleura xanthogrammica, Tony in tidepool (S)
	CT-10	10 m^2	_____	____	Tegula funebralis, black turban snail
			_____	____	Mopalia muscosa, chiton
	CT-8	200 m^2	_____	____	Lottia gigantea, owl limpet
	CT-3	24 dm^2	_____	____	Mytilus californianus, mussel bed (S)
			_____	____	Pollicipes polymerus, goose barnacle (S)
	CT-7	10 m line	_____	NA	Anthopleura xanthogrammica, green sea anemone (S)
	CT-4	10 m^2	_____	____	Pisaster ochraceous, purple seastar

DRAKES ESTERO Rocky Intertidal 122°55'30"W; 38°02'30"N

Introduction The Drakes Estero rocky intertidal transect at the mouth of Drakes Estero was established in 1968 for the study of oceanic species. The sampling consists of 20 square meters; at the end of the transect is the giant kelp, Macrocystis spp. in thick abundance off the lower reef ramparts. Another rich resource at the Drakes Estero transect is the large number of whale bone fossils scattered throughout the upper reefs. In fact, the large concretion where transect stake 1 is located has whale bone fossils embedded in the matrix.

Location The rocky intertidal transect is just inside the mouth of Drakes Estero, Figure 8. Access is either by small boat or by hiking via the Estero Trail. The end of the Estero Trail is at the west side marsh flats. Walk south along the beach for about 800 meters; the transect site is located at the most southern tip of the headland's reef.

Method Place the 10-meter line at stake #1 and stretch it out to stake #2. Count the key species on the Drakes Estero worksheet.

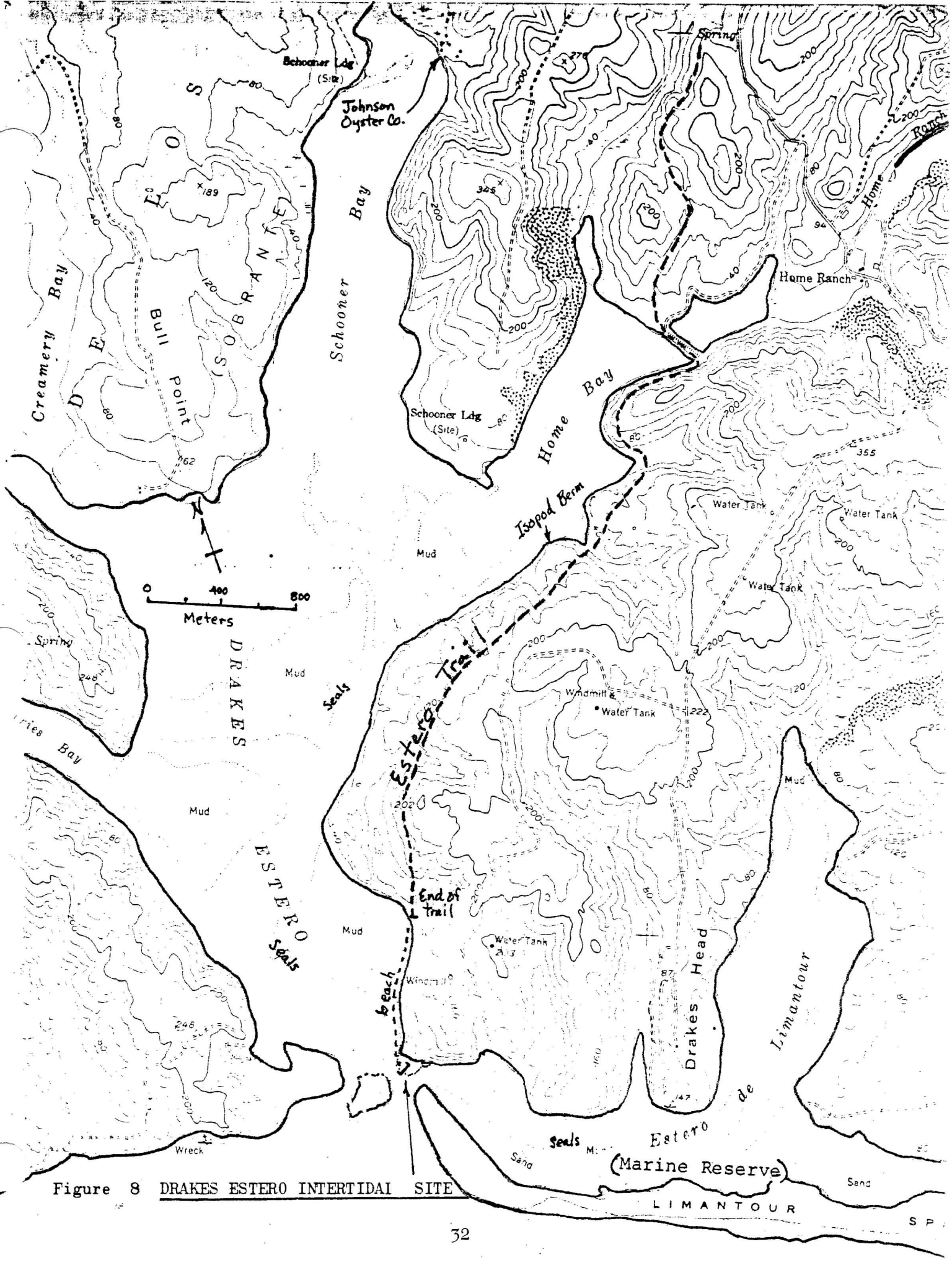
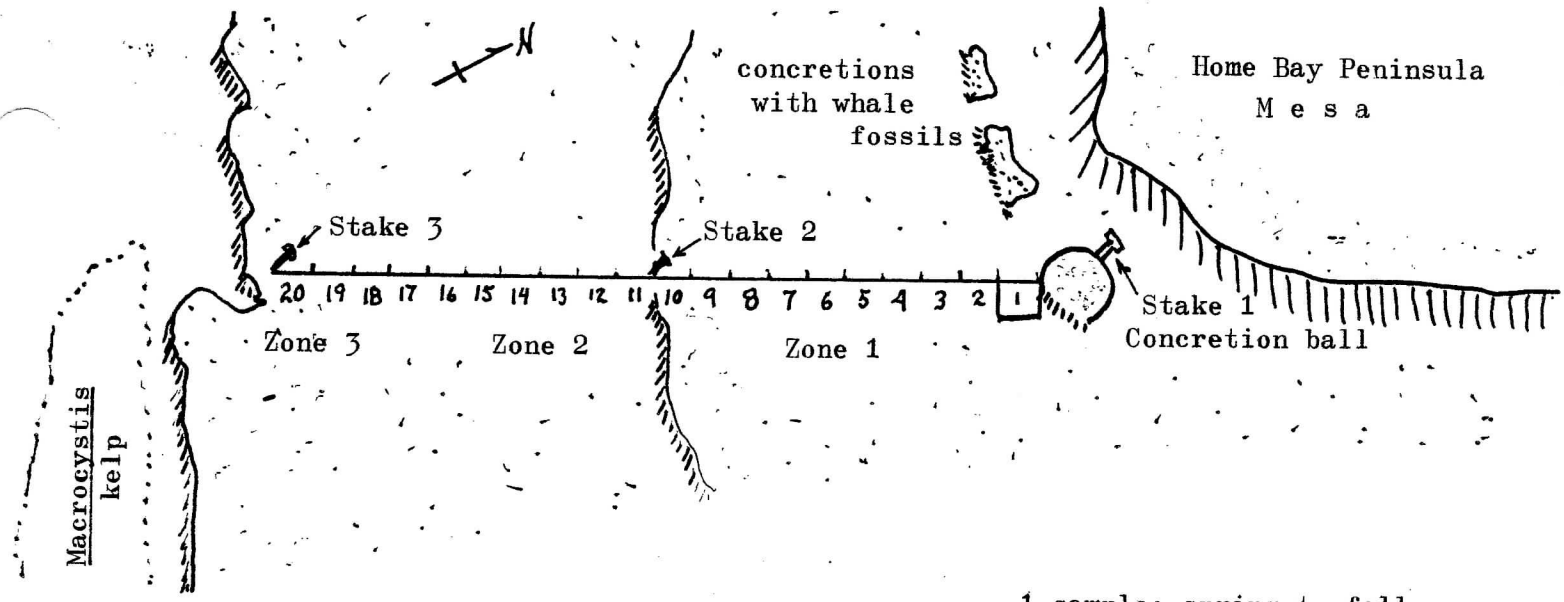


Figure 8 DRAKES ESTERO INTERTIDAL SITE

WORKSHEET DRAKES ESTERO, Rocky Intertidal, DE,T-1



1 sample: spring to fall

Investigator_____ **Date**_____ **Season**_____

Weather_____ **Tide**_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS

Sq. Meter	✓=present	Balanus-barn.	Littorn-peri.	Tegula-turban	Collisella spp. (limpet)	Notoacmeae sp. (flat limpet)	Pachygrapsus (striped crab)	Hemigrapsus (purple crab)	Petrolisthes (porcelain crab)	A. elegantis (sea anemone)	A. xanthogr. (green sea anem.)	P. brevispinus (pink seastar)	P. ochraceous (purple star)	Other Species
#1 / #11														
#2 / #12														
#3 / #13														
#4 / #14														
#5 / #15														
#6 / #16														
#7 / #17														
#8 / #18														
#9 / #19														
#10 / #20														
TOTAL														

Special Notes: (S) (S)

POINT REYES HEADLAND

CHIMNEY ROCK 122°57'22"W; 37°59'22"N (Two intertidal, one subtidal; total of three transects)

Introduction

The Point Reyes Headland Marine Reserve was established in 1972, extending from high tide out to 1000 feet. The Headland was also declared a California marine waters Area of Special Biological Significance (ASBS) in 1975, Figure 9. The key invertebrate resource here is the red abalone, Haliotis rufescens. Since all invertebrate and vertebrate organisms are protected within this reserve, all species are considered to be "control study organisms".

Location of Chimney Rock Transects

Two intertidal transects are located within the boundry of the State Headland Reserve. Access to the intertidal zone is made by walking down the north slope trail and then tranversing along the beach to the reefs which face south. Steel stake markers are clearly embedded for the location of the first intertidal transect at CR-1; about 75 meters to the southwest is transect CR-2, Figure 10.

The subtidal transect is located at the southeast toe of the Chimney Rock sea stack where a large steel stake marks the subtidal quadrapod site. From this stake, at a compass bearing of 40°NE and approximately thirty-five meters from the steel "P" stake is the location of the subtidal quadrapod in about ten feet of water, Figure 10. This quadrapod is outside the marine reserve and is therefore subject to fishing pressure by man, even though very few persons visit this habitat during the open seasons.

Method for CR-1: Attach the ten-meter line to stake #1 bolt and stretch out the line to 133° compass bearing. Count the number of each species for each square meter on worksheet CR-1.

Method for CR-2: Attach the ten-meter line to stake #1 bolt and stretch out the line to 152° compass bearing. Mark presence of the first four species, as shown on worksheet CR-2. For each of the remaining species on the worksheet, count the total in each square meter. For the red abalone, Haliotis rufescens, continue the square meter sampling through #24.

At stake #2, stretch a line perpendicular to the CR-2 transect, and begin square meter sampling to the right of the stake for four quadrats (R-1 through R-4). Record counts for Lottia gigantea, the owl limpet and Haliotis cracherodii, the black abalone. Use the same method for 4 square meters to the left of the stake (L-1 through L-4).

Method for Subtidal Q-1: Attach 130-foot line to P stake bolt at Chimney Rock. The line should have a red flag at the 115-foot mark, and at 40°, the quadrapod should be located. Tie off line to the quadrapod bolt. Stretch out a 3-meter line (marked at every meter) from the bolt. Station three divers at each meter. As you swim in a 360° circular route around the Q-1 marker, count total number of abalones for each circular meter area. Also record the number of tagged abalones per circled meter-area along with the tag numbers.

Equipment for Subtidal Work

5-meter polypro line with each meter marked with electrician tape

125-foot line with a marker on the 115th foot.

4 underwater writing slates with attached pencils

underwater compass

complete diving gear

16-foot Zodiac boat with 25 HP motor

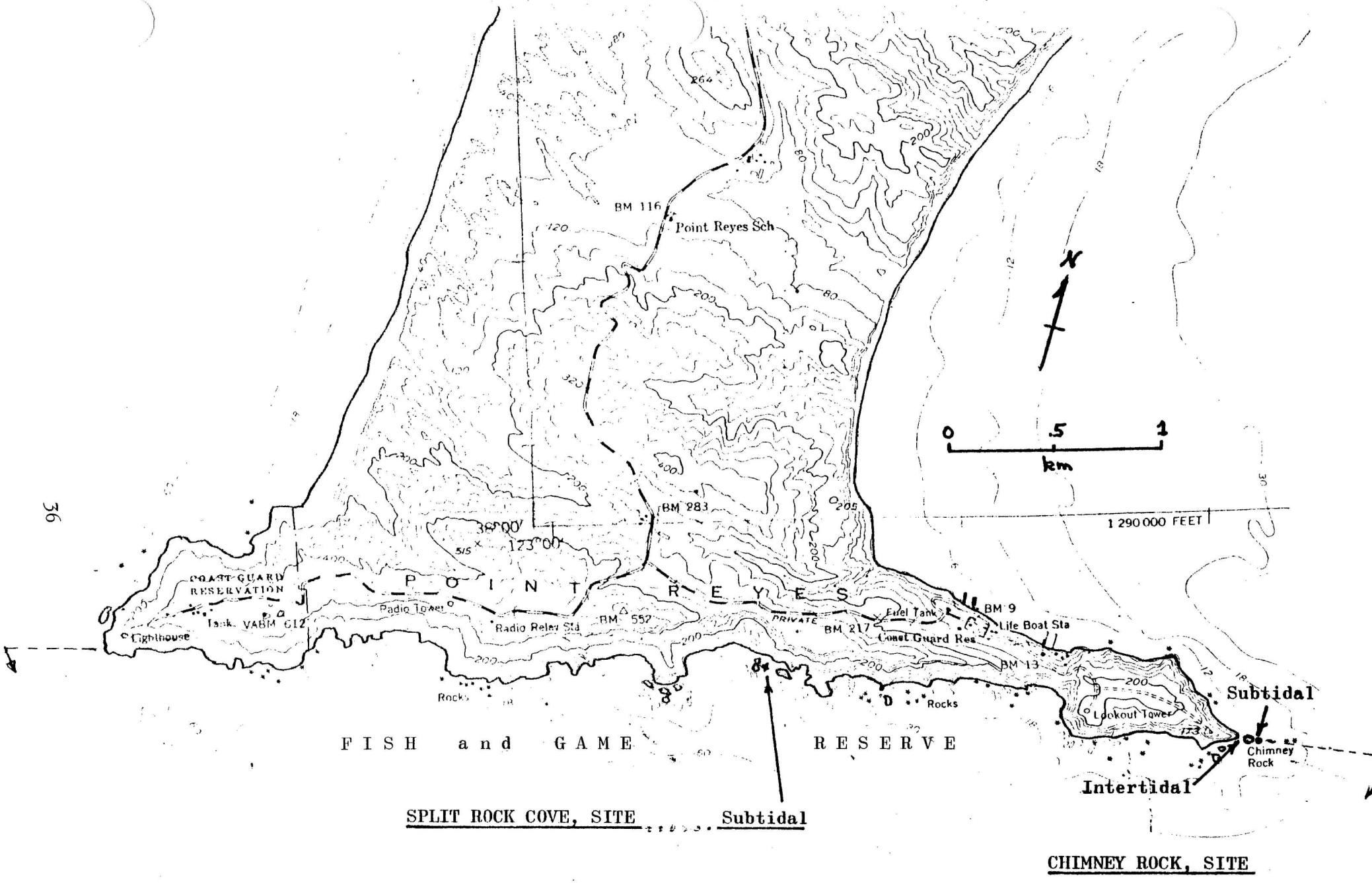


Figure 9 POINT REYES HEADLAND

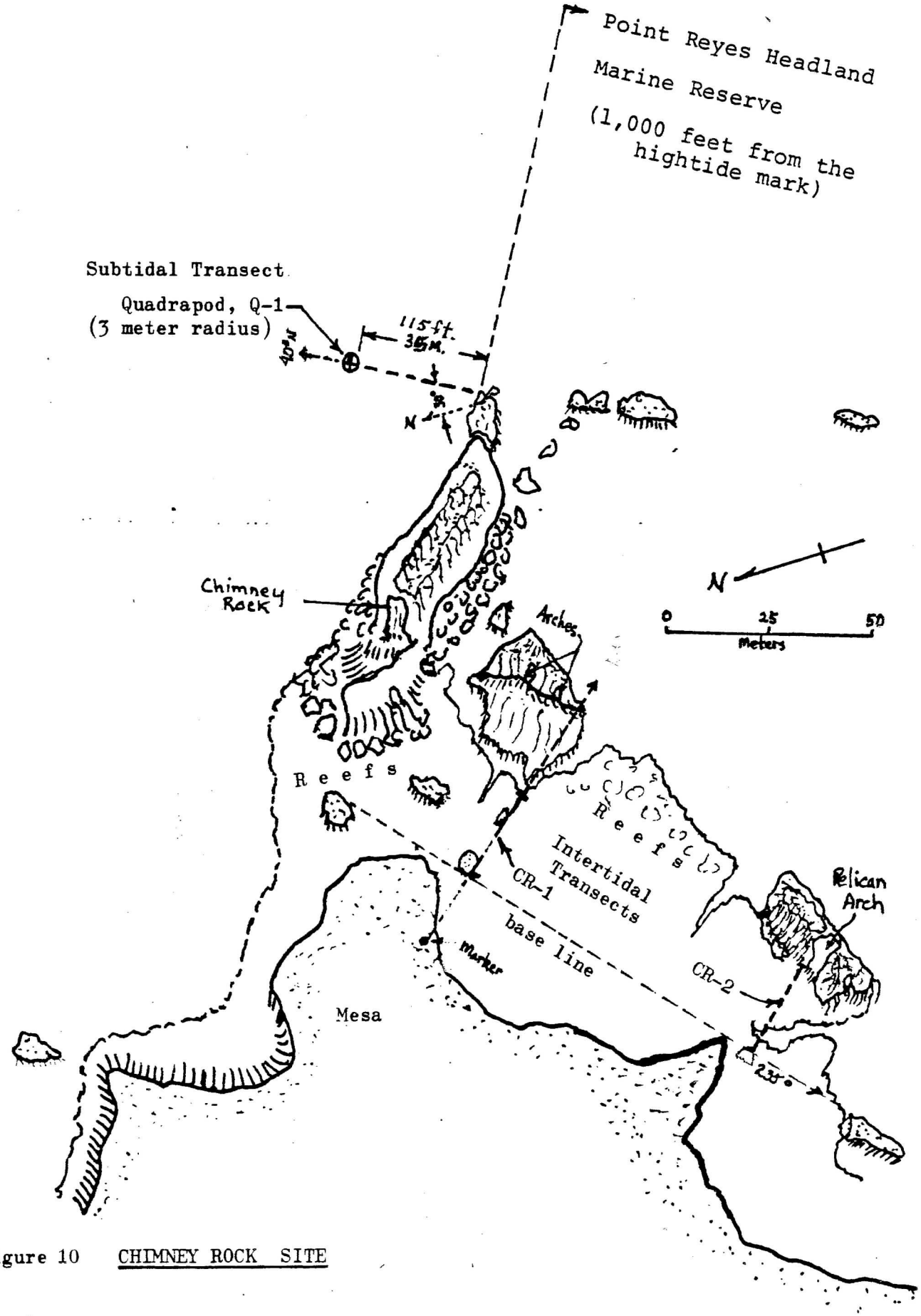
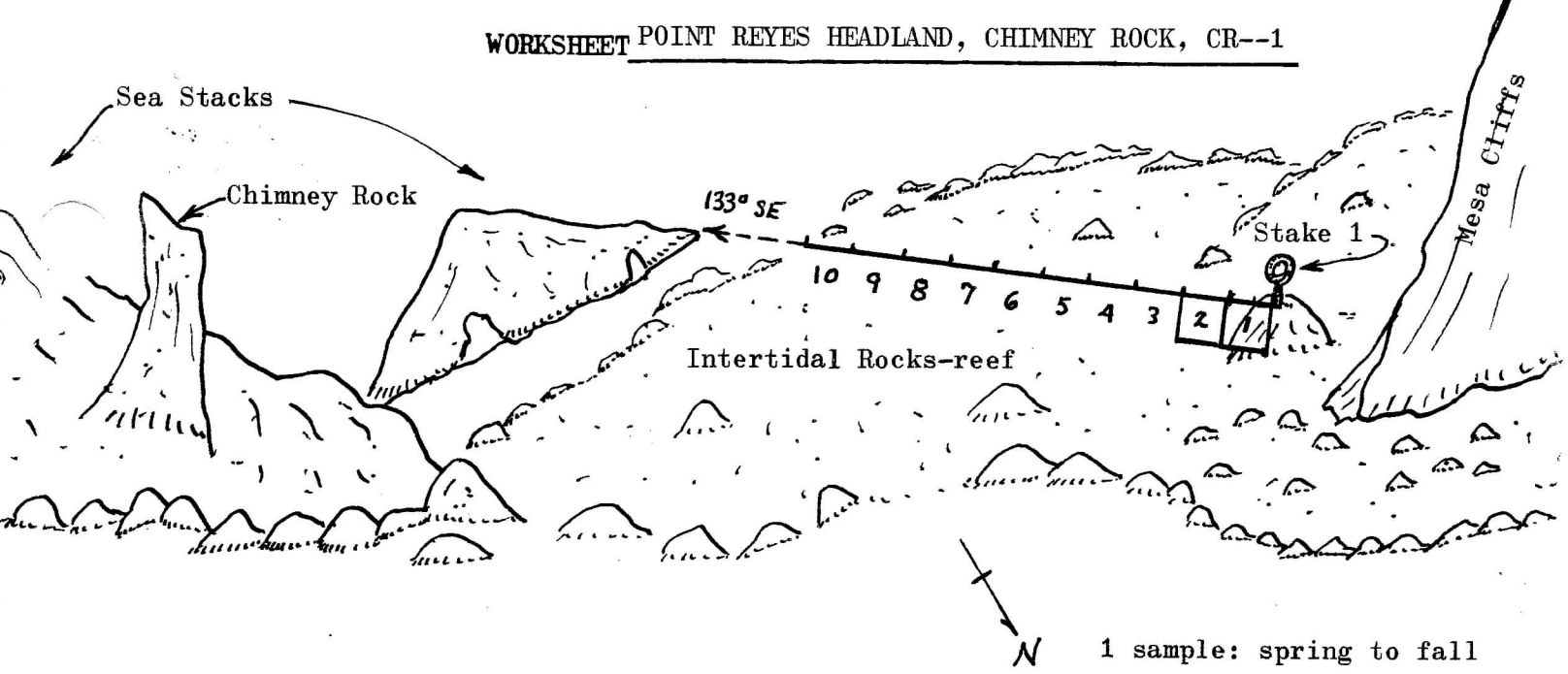


Figure 10 CHIMNEY ROCK SITE

WORKSHEET POINT REYES HEADLAND, CHIMNEY ROCK, CR--1



1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

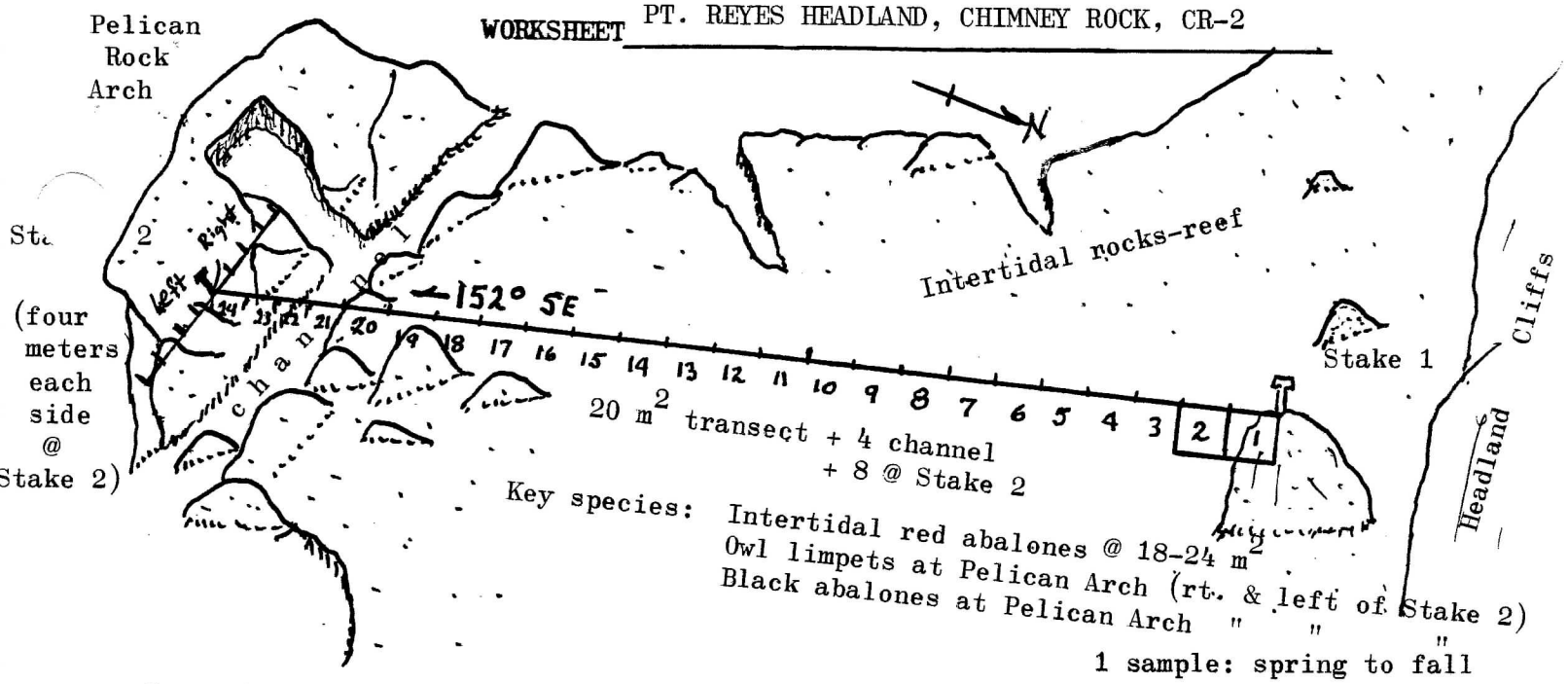
SPECIES COUNTS

CR-1

Sq. Meter	Tegula funeb. (Bl. turban sn)	Anthop. xantho. (gr. sea anem)	A. elegantis. (aggreg. anem.)	Cancer anten. (cancer crab)	Hemigrap. nudus (pur. sh. crab)	Pagurus spp. (hermit crabs)	Patiria miniata (bat star)	Pisaster och. (pur. seastar)	Haliotis rufescens (red abalone)	Other Species
#1										
#2										
#3										
#4										
#5										
#6										
#7										
#8										
#9										
#10										
TOTAL		(5)	(5)							

Special Notes:

WORKSHEET PT. REYES HEADLAND, CHIMNEY ROCK, CR-2



Key species: Intertidal red abalones @ 18-24 m²
Owl limpets at Pelican Arch (rt. & left of Stake 2)
Black abalones at Pelican Arch " " "
1 sample: spring to fall

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT
_____°C _____°C

SPECIES COUNTS

CR-2

Sq. Meter	✓ = present	Pachy. + Hemigr. (shore crabs)	Cancer antennar. (rock crab)	Collisella spp. (limpets)	Antho. elegantis. (aggreg. sea an)	A. xanthogramm. (green sea anem)	Patiria miniata (bat star)	Pisaster ochrac. (purple sea star)	Strongyl. purpur. (purple sea urch.)	Haliotis rufescens (red abalone)	Lottia gigantea (owl limpet)	H. cracherodii (black abalone)
1	11											
2	12											
3	13											
4	14											
5	15											
6	16											
7	17											
8	18											
9	19											
10	20											
TOTAL-Sp	(note presence only)											
TOTALS												

Other Species

R-4, R-3, R-2, R-1, L-1, L-2, L-3, L-4

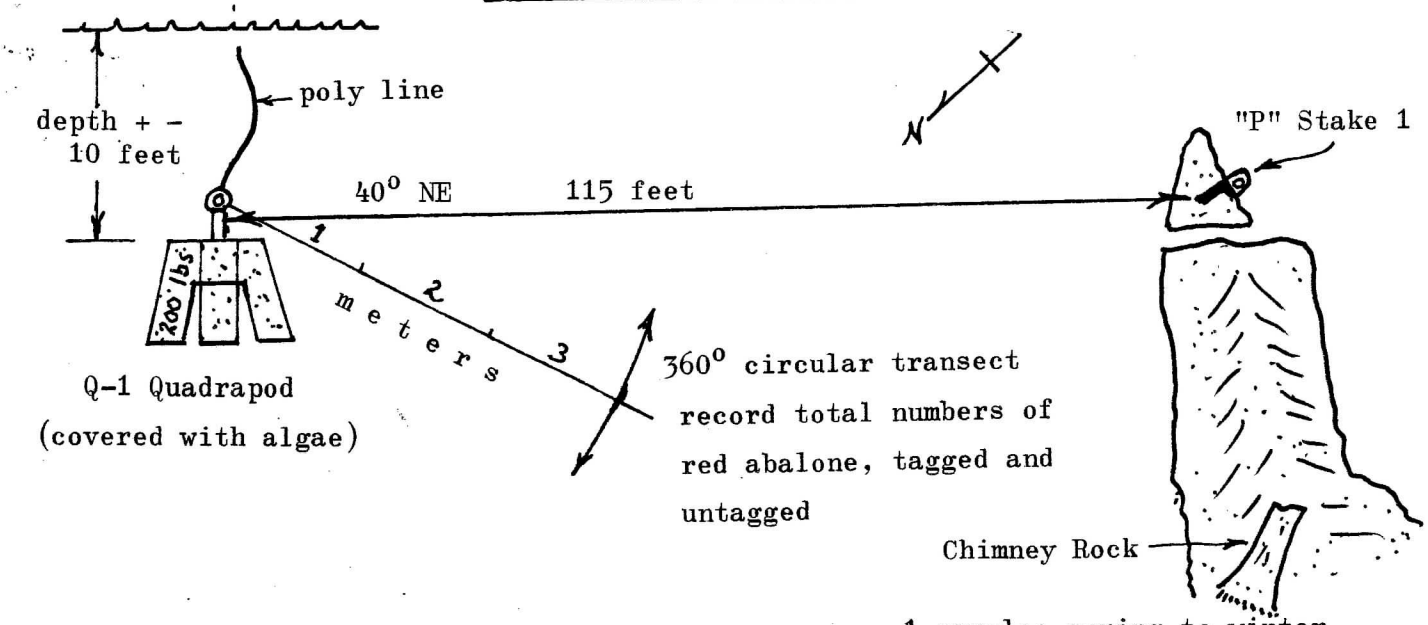
Stake 2

21. 22. 23. 24.

(5) Ab. Total

Totals

water surface **WORKSHEET** PT. REYES, CHIMNEY ROCK, SUBTIDAL Q-1



1 sample: spring to winter

Investigator_____ **Date**_____ **Season**_____

Weather_____ **Tide**_____@_____:_____**A.M. / P.M.**

Temperature: AIR_____°F WATER_____°F **SALINITY**_____**PPT**

_____°C _____°C

Circular Q-1	numbers of Haliotis rufescens	Tagged abs + their numbers	Others
Meter 1 (+abs under the quadrapod)			
Meter 2			
Meter 3			
Total			

Other Notes:

POINT REYES HEADLAND

SPLIT ROCK 122°58'55"W; 37°59'30"N

Introduction

The Split Rock transect is a subtidal site located nearly in the southerly face of the Point Reyes Headland Reserve, Figure 9. Since the marine reserve protects all marine life, the organisms are considered to be "control study animals". The principal organisms in the subtidal transect is the red abalone, Haliotis rufescens.

Location

From the top of the Headland cliffs, Split Rock can be observed at the left, with Ship Rock at the right, thus forming Split Rock Cove, Figure 11. Access should be made by small boat to this area. Anchorage of the boat should be made at the location indicated in Figure 12. The depth of the sand bottom is 30 feet, and as one swims west, the saddle will appear. Swim over the saddle and enter the alcove sand channel. The alcove is completely surrounded by a wall of granitic rocks. At the south end of the alcove, there is a large steel "P" stake embedded in a funnel, cemented to the base of the abalone transect, Figure 12. The entire south wall is the study site for the red abalone.

Method for Subtidal, Q-2

With the aid of College of Marin's biology department divers, locate the dive spot for the subtidal site by spotting the sea stack rocks during minus low tides. Count total number of abalones on the wall transect and in the alcove sites. Record the number of tagged abalones observed per site.

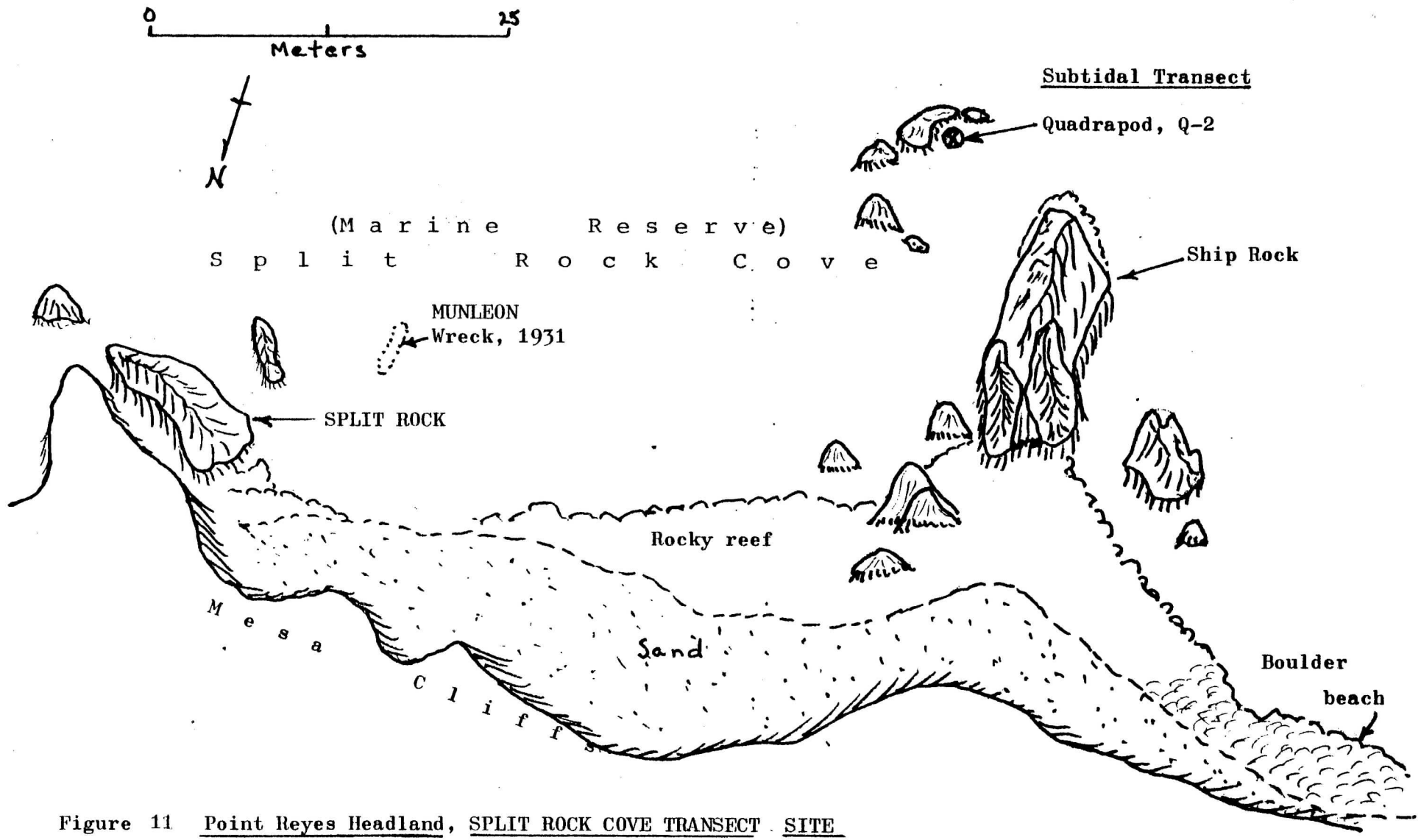


Figure 11 Point Reyes Headland, SPLIT ROCK COVE TRANSECT SITE

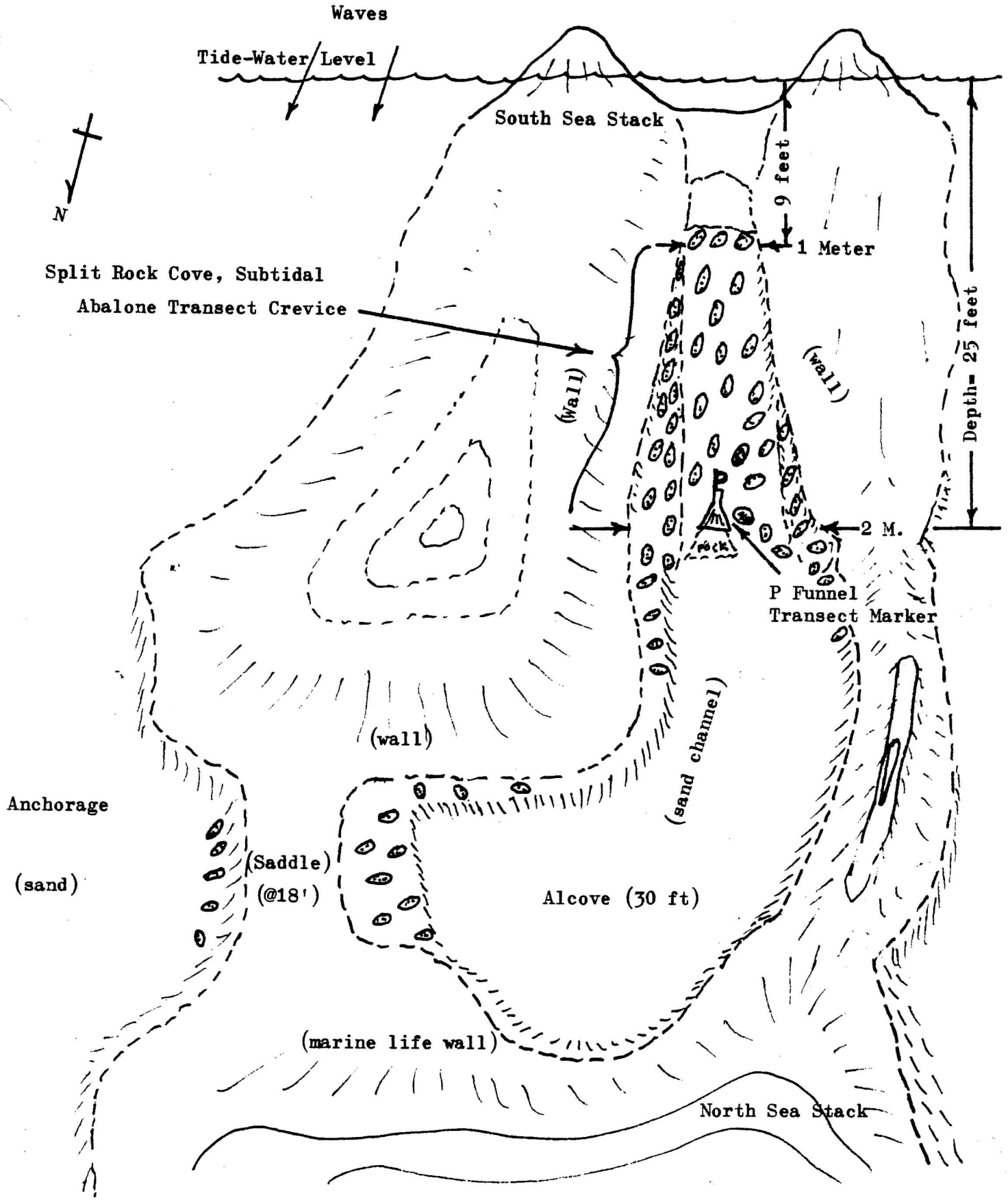
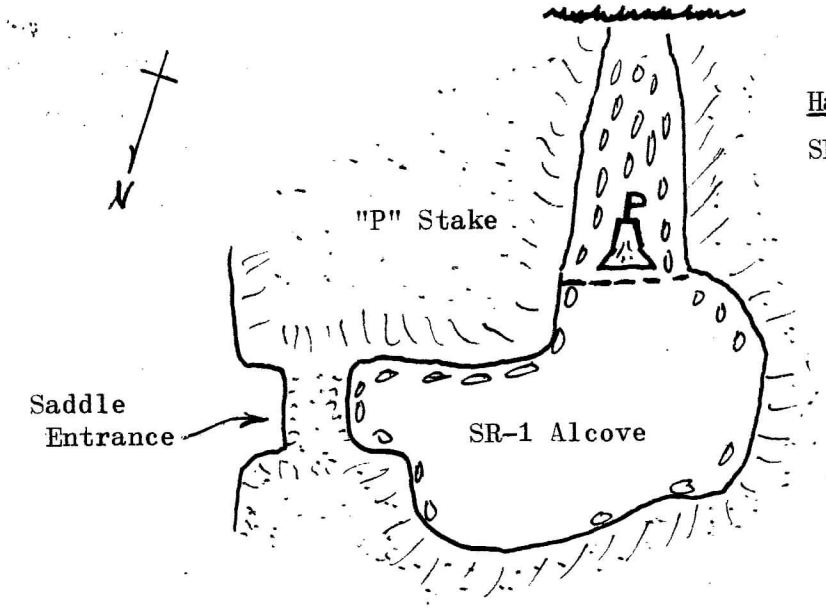


Figure 12 SPLIT ROCK TRANSECT (Subtidal) (Not drawn to scale)

WORKSHEET PT. REYES, SPLIT ROCK, SUBTIDAL SR-1



Haliotis rufescens, red abalone

SR-1 Wall Transect

1 sample:spring to winter

Investigator_____ **Date**_____ **Season**_____

Weather_____ **Tide**_____@_____:_____**A.M. / P.M.**

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SR-1 Haliotis rufescens (red abalone)	Total counts within SR-1 Sections	Tagged abalones with their numbered tags	Other Species
Wall Transect			
Alcove			
Total			

Other observations:

TOMALES POINT

McDONALD'S BEACH 122°58'40"W; 38°13'22"N

Introduction

On Tomales Point, Figure 13, the McDonald's Beach intertidal transect site is located just west of the former Lower Pierce Point Ranch and approximately 5 miles north of McClures Beach parking lot. Two intertidal transects were formerly studied in this McDonald's Beach area. The long, 5-mile walk, from the parking lot at McClure's Ranch and Beach, makes it very difficult to fully evaluate both intertidal transects, at T-1 and T-2. Transect T-2, with the greater species diversity, was selected as more typical of the intertidal habitats at Tomales Point.

Method at MB, T-2

Place the ten-meter line over stake #1 and stretch it to 180° compass bearing. Record the number for each species indicated on the MB, T-2 worksheet, square meter #1 through #10. For the shore crabs, Pachygrapsus crassipes and Hemigrapsus nudus, only note their presence, by placing check mark in applicable square meters.

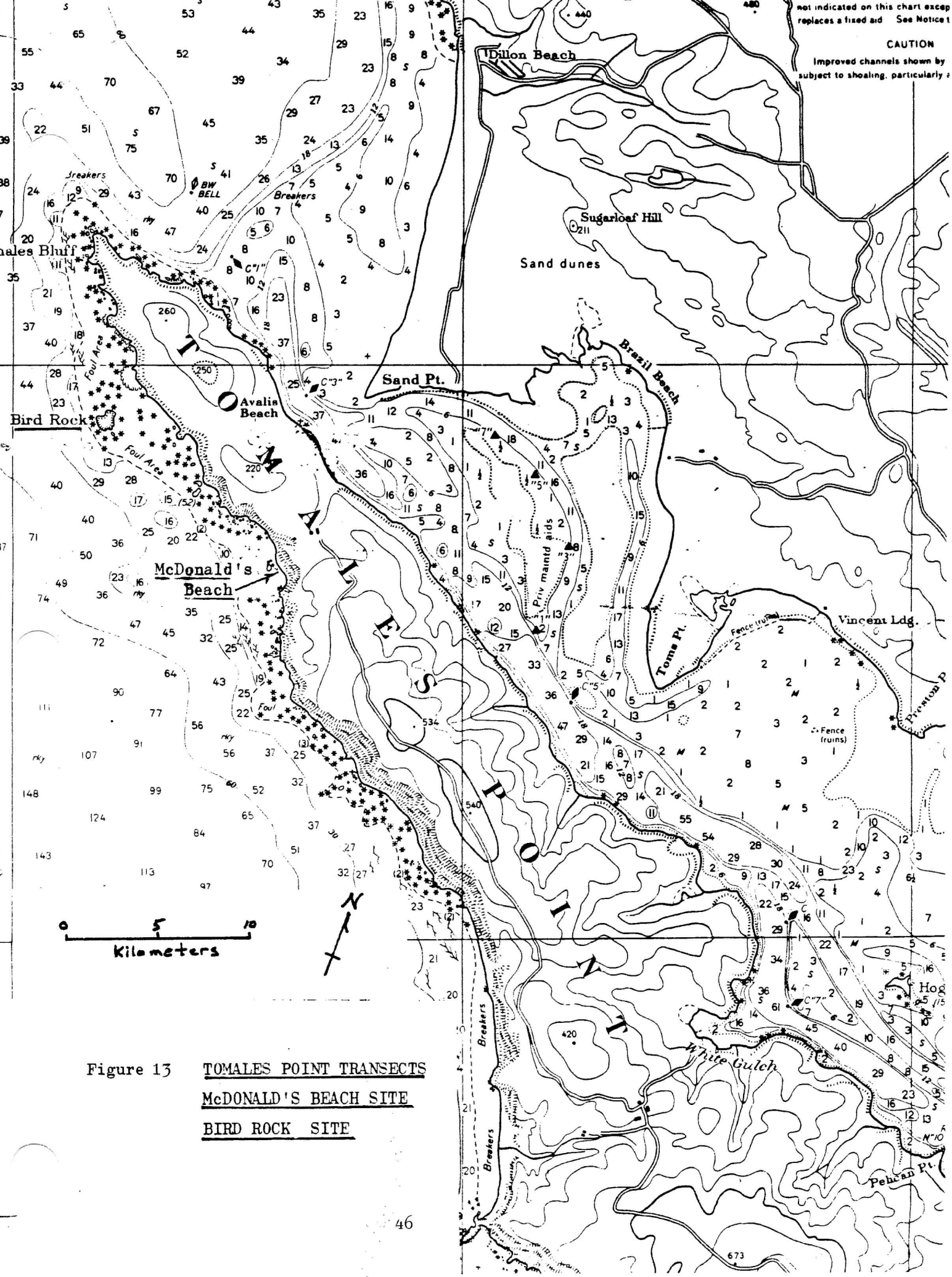


Figure 13 TOMALES POINT TRANSECTS
McDONALD'S BEACH SITE
BIRD ROCK SITE

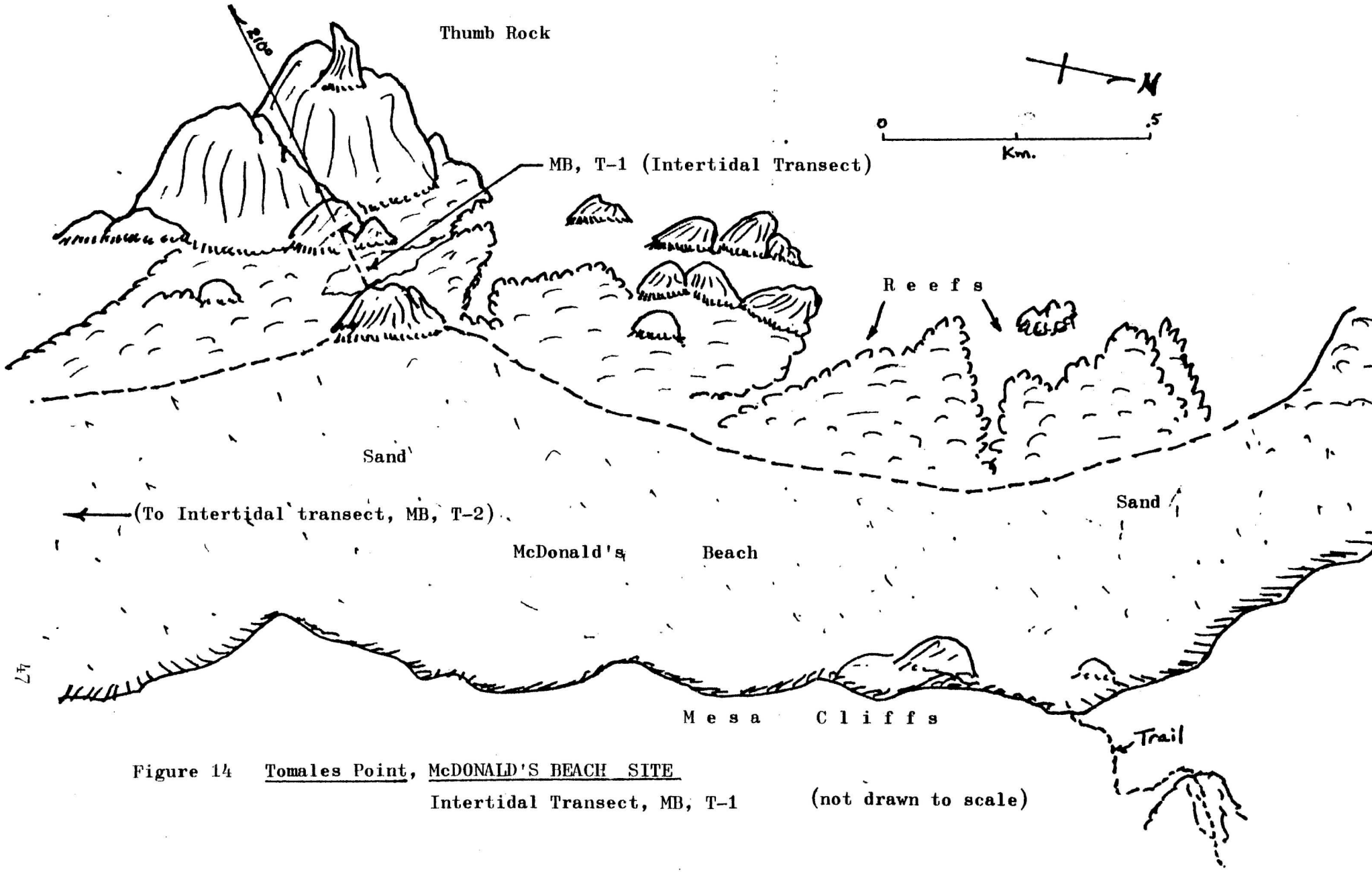


Figure 14 Tomales Point, McDONALD'S BEACH SITE
Intertidal Transect, MB, T-1 (not drawn to scale)

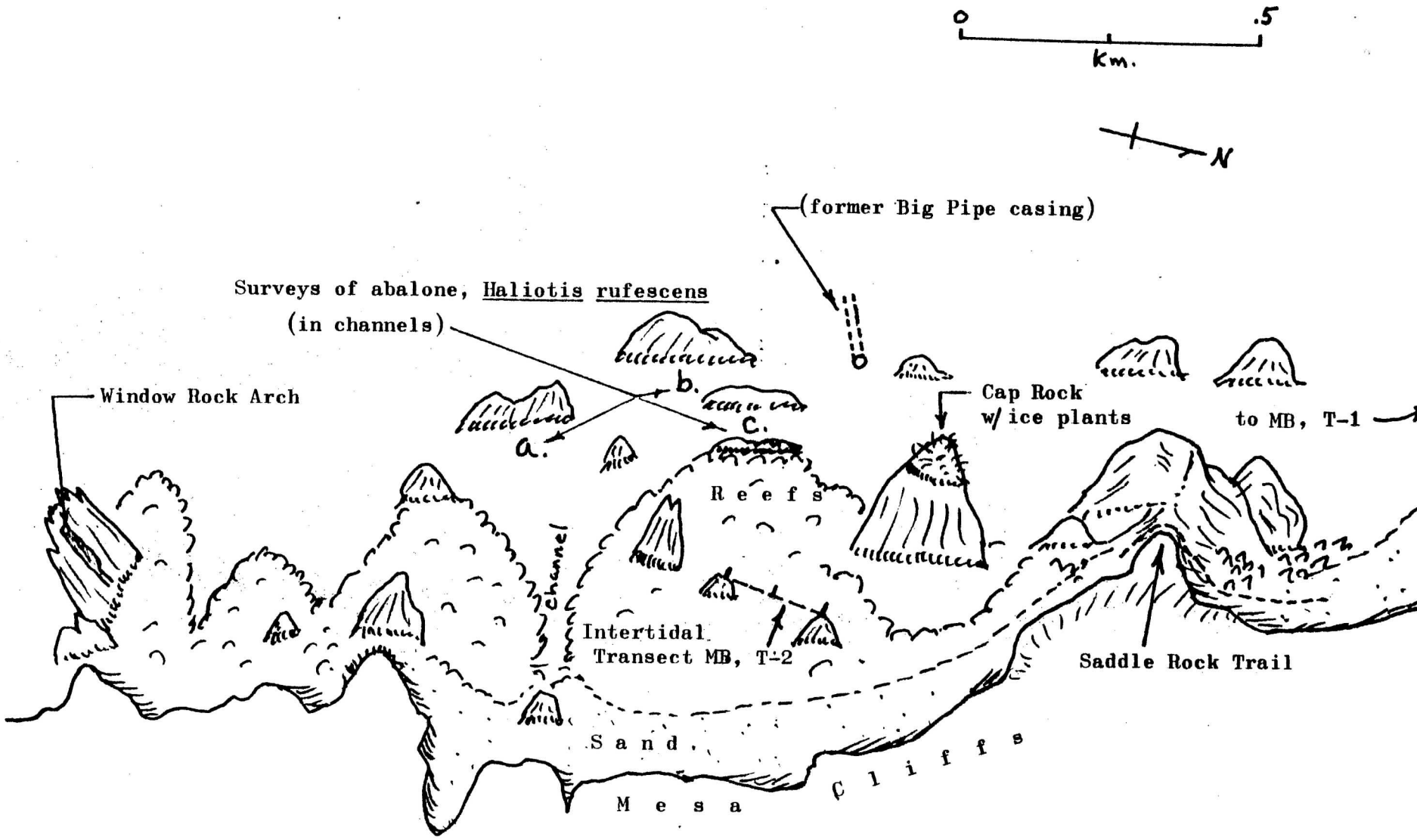
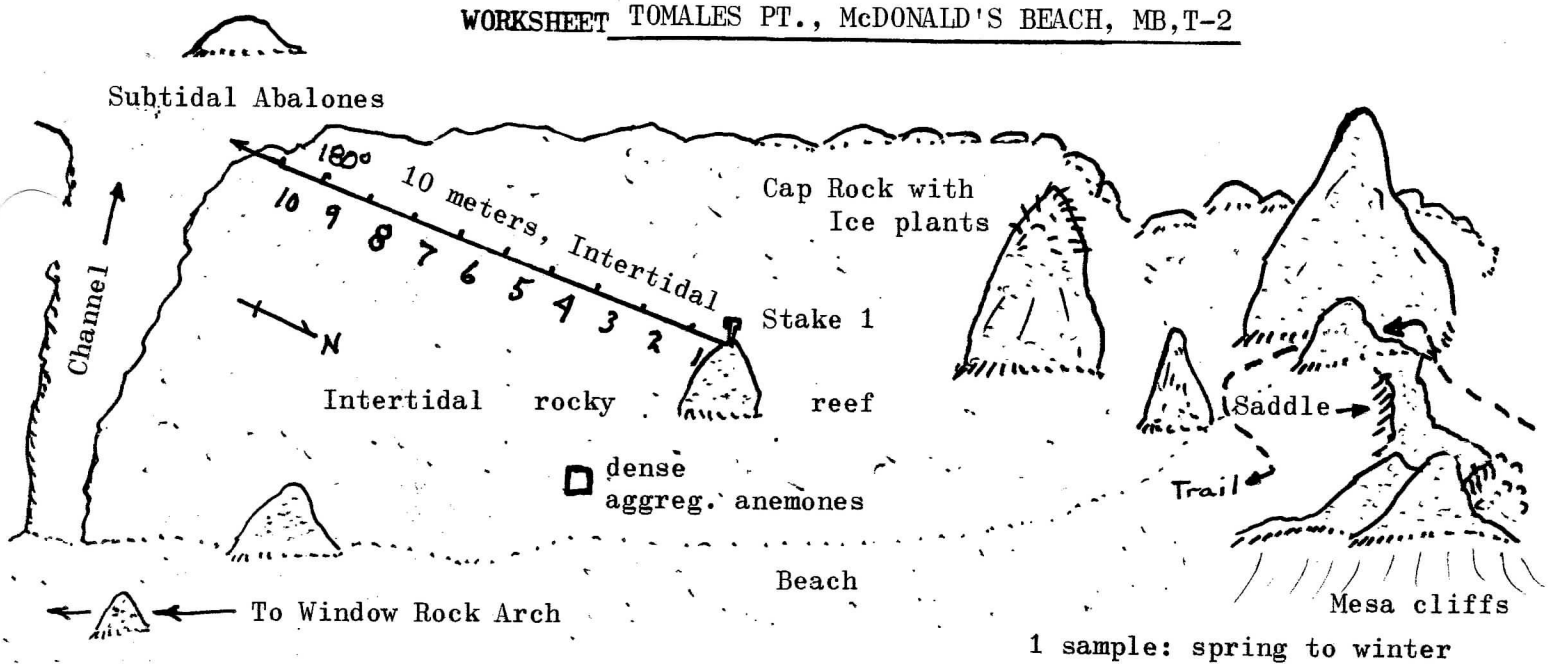


Figure 15 Tomales Point, McDONALD'S BEACH SITE (not drawn to scale)

Intertidal Transect, MB, T-2

Surveys of Haliotis rufescens in channels

WORKSHEET TOMALES PT., McDONALD'S BEACH, MB,T-2



1 sample: spring to winter

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS

MB,T-2

Sq. Meter	Mytilus califor. (sea mussel)	Pollicipes poly. (goose barnac.)	Mopalia musc. (chiton)	Anthopleura ele. (aggreg. sea anem)	A. xanthogrammica (green sea anem)	Pachyg. + Hemigr. (shore crabs)	Pisaster och. (seastar)	Haliotis rufesc. (red abalone)	Other Species
					Pachi Hemi	=present			
#1									
#2									
#3									
#4									
#5									
#6									
#7									
#8									
#9									
#10									
TOTAL	(S)	(S)		(S)	(S)				

Special Notes:

TOMALES POINT

BIRD ROCK 122°59'29"W; 38°14'48"N

Introduction

Near the north end of Tomales Point is the guano-capped island called Bird Rock, Figure 16. In 1975, the site was designated an Area of Special Biological Significance (ANBS) by the State Water Quality Control Board. Subtidal transects are placed within the Bird Rock Cove to record the red abalone, Haliotis rufescens. Furthermore, extreme care must be given to diving safety because of the high potential of white shark attacks in the area.

Location

Access to Bird Rock Cove may be accomplished by walking, but it is more efficient to launch a boat from Lawson's Landing in Tomales Bay. Selectin the proper low tide and traversing the sand bars at the mouth of Tomales Bay must be done with the utmost care. For example, minus tides during morning hours are preferred because of the lack of afternoon winds. Boating across the sand bars at the mouth of the bay should take place at or near slack tide; the crossing should not be attempted if the breakers are greater than three feet in height.

The three abalone subtidal transects are (Figure 16):

BR,Q-1, a quadrapod near a small sea stack, west side of Bird Rock Cove

BR,Q-2, a sea stack at the eastern side of the cove

BR,Q-3, a quadrapod next to Blow Hole Rock. This site is optional and not a prerequisite transect.

Method at Q-1

About 20 feet north of stake #1 is quadrapod Q-1 in about 8 feet of water during minus low tides. Place a 3-meter marked line in the eye bolt of Q-1. It is best to have four divers make the 360° survey count. Each of three divers is positioned at the 1st, 2nd, and 3rd marked meters of the line. The fourth diver assists as a support member of the team. As the line is pulled in circular fashion to mark off the 360° turn, each diver counts the total number of abalones in his circled ring; the tagged abalone specimens are also recorded at the same time.

Method at Q-2

Place a 5-meter marked line through the eye bolt of Q-2 on top of the rock pinnacle. With 4 divers, make a 360° sweep of the area, recording total numbers of abalones observed and the tagged specimens.

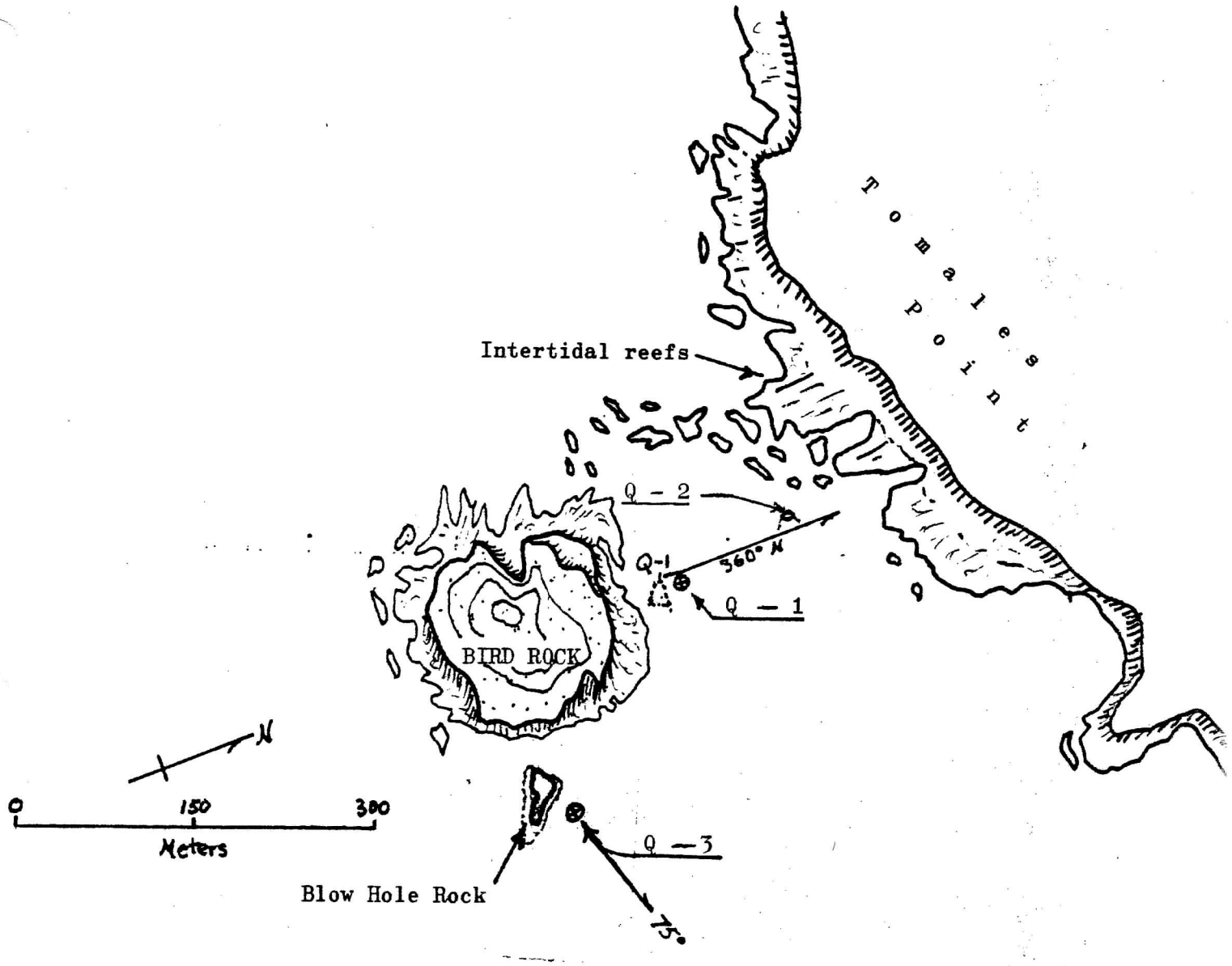


Figure 16 Tomales Point, BIRD ROCK

Subtidal transect, Quadrapod, Q-1, Q-2, Q-3

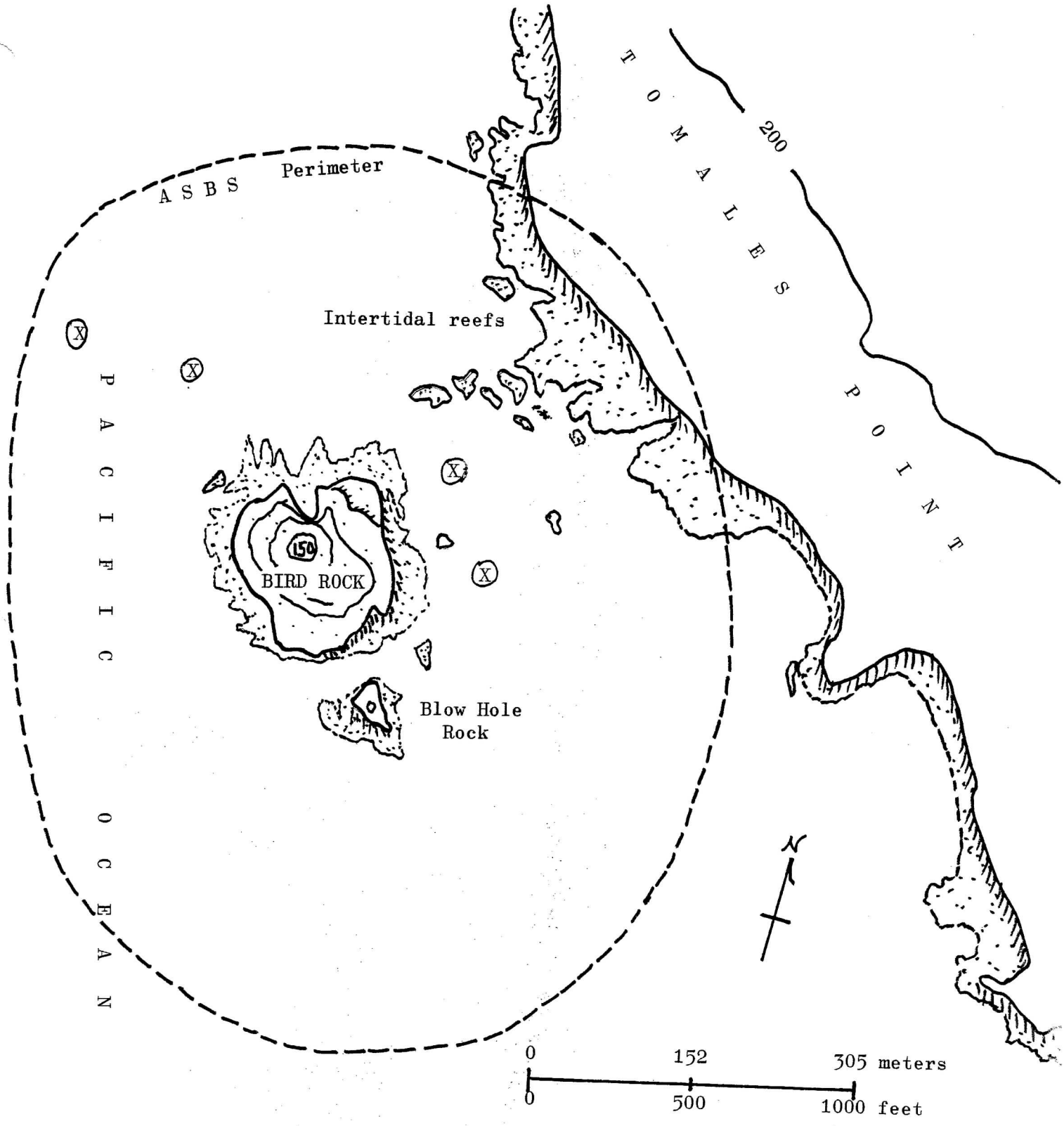
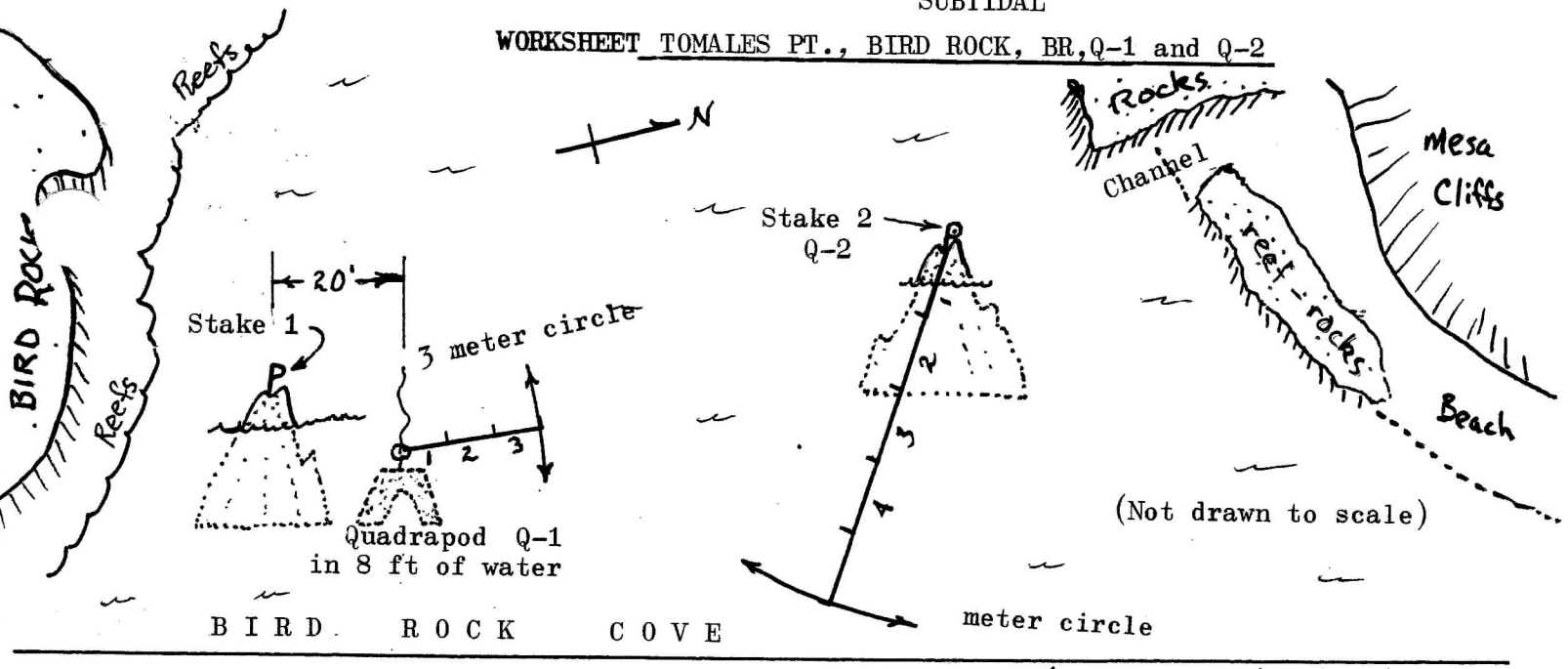


Figure 17. BIRD ROCK SITE OF SHARK ATTACKS

(X) = Shark attack sites

WORKSHEET TOMALES PT., BIRD ROCK, BR,Q-1 and Q-2



B I R D R O C K C O V E

1 season: spring to winter

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

SUBTIDAL _____°C _____°C

BR, Q-1 Circular Meter	Haliotis rufescens number of abs	Tagged abs observ.	Other species
1			
2			
3			
Total			

BR, Q-2 Circular Meter	Haliotis rufescens number of abs	Tagged abs obser.	other species
1			
2			
3			
4			
Total			

ESTERO DE SAN ANTONIO 122°58'36"W; 38°16'02"N

Introduction At the western shores bordering Bodega Bay are two esteros, Estero Americano to the north and Estero de San Antonio to the south (Figure 18). Estero Americano has a large ongoing salmon farming project, while Estero de San Antonio is fairly pristine. Thus, an intertidal transect was set up at the south reefs of Estero de San Antonio.

Location From the Dillon Beach homes estates, a dirt road leads into the Estero de San Antonio marsh and sandy beach (Figure 19). After arriving at the San Antonio sand spit, hike south about 200 meters to the staked rock indicating the intertidal transect of 10 square meters.

Method Place a ten-meter line around stake #1, stretch it out 214° to the second stake. Mark on the worksheet the presence of species indicated and record the total number of organisms for species listed for data counts on the worksheet.

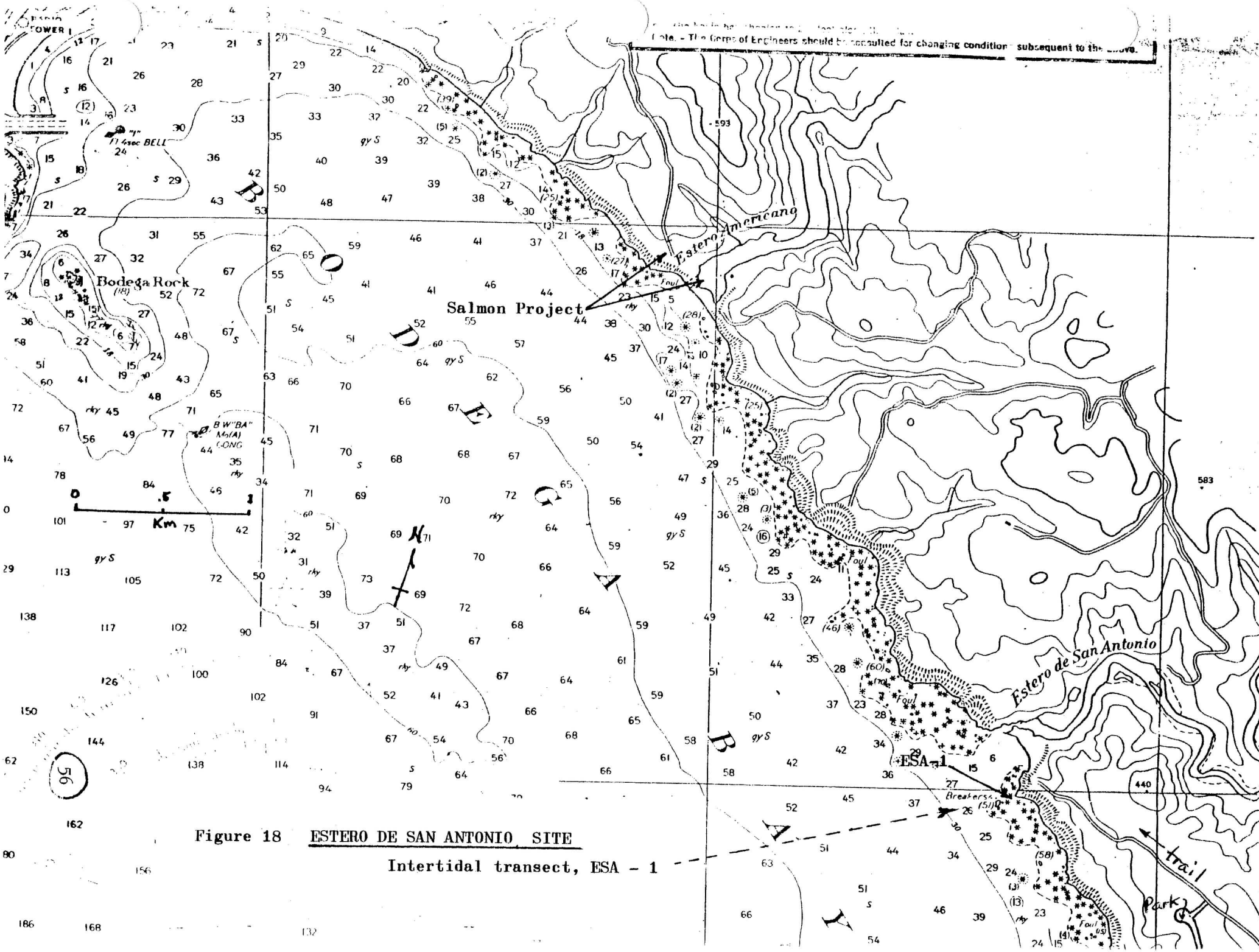


Figure 18 ESTERO DE SAN ANTONIO SITE

Intertidal transect, ESA - 1

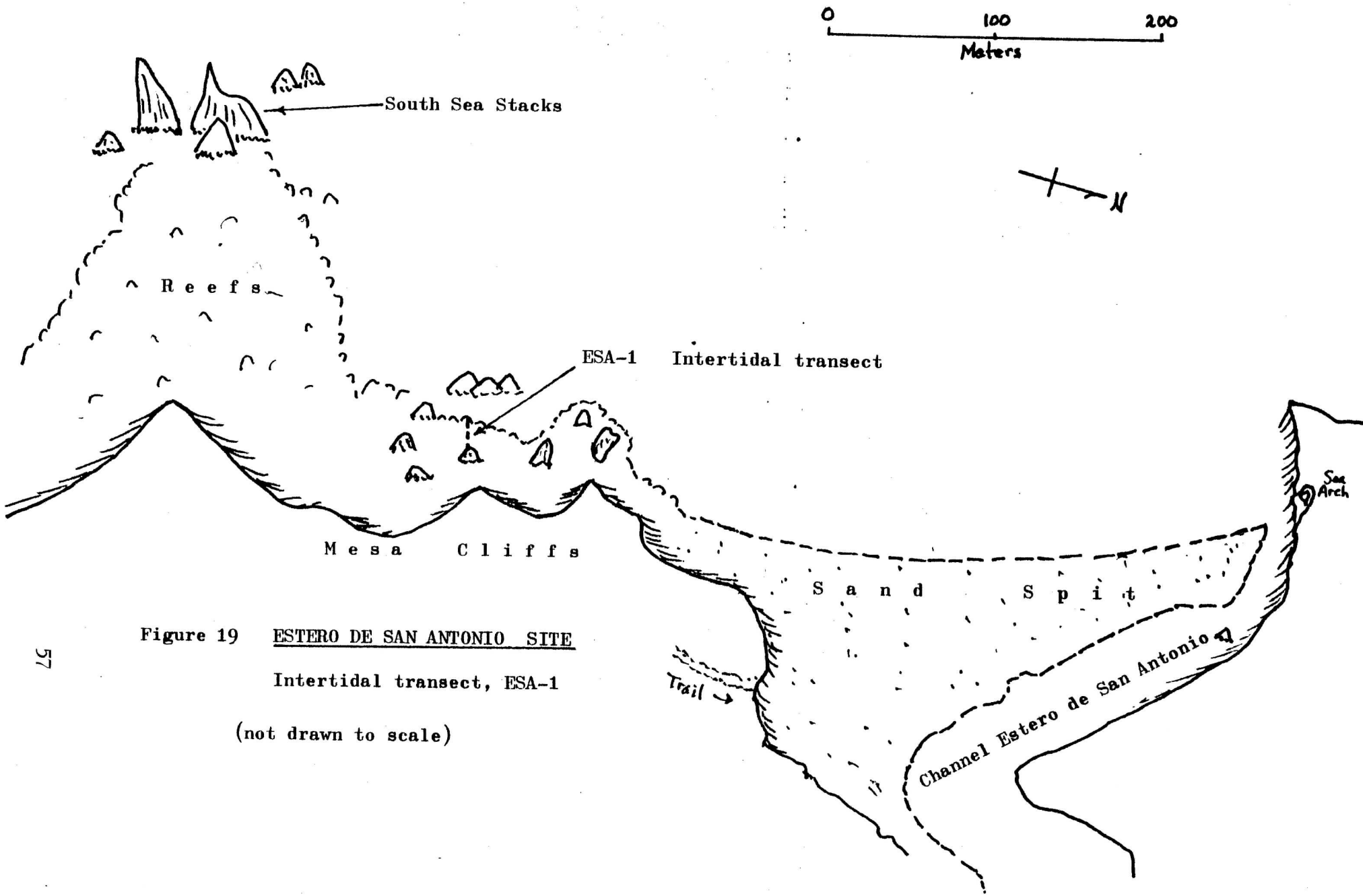
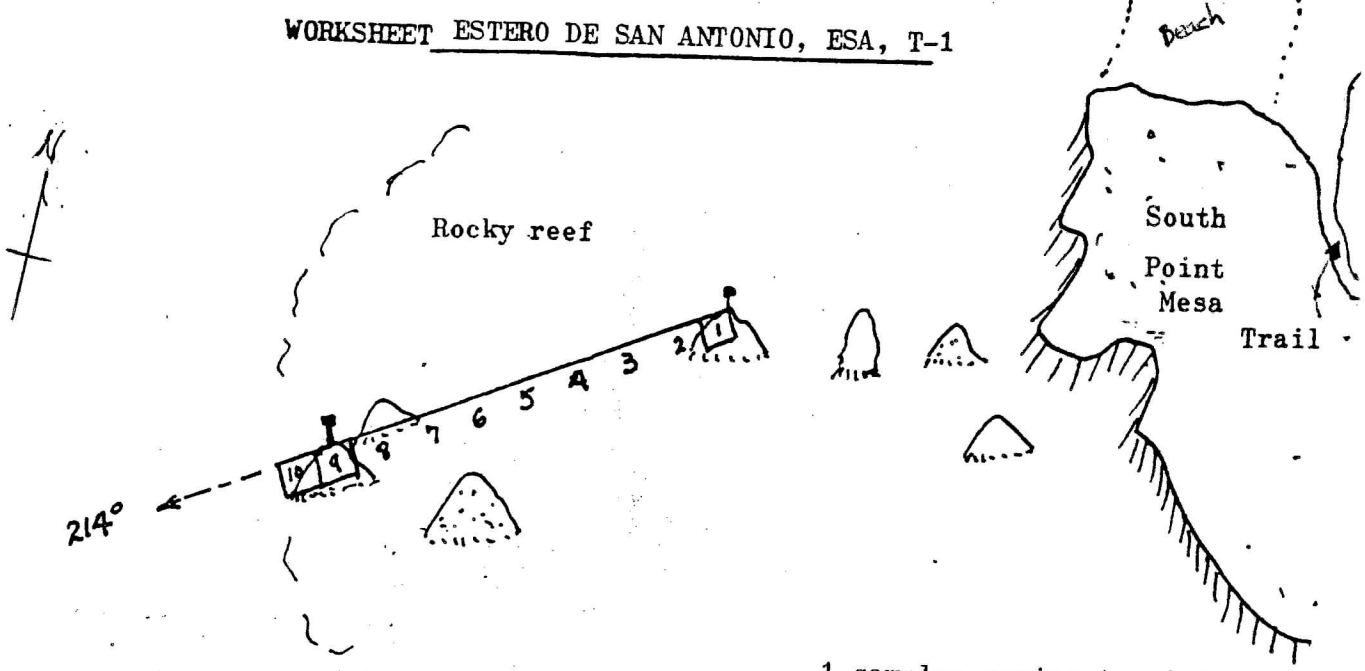


Figure 19 ESTERO DE SAN ANTONIO SITE

Intertidal transect, ESA-1

(not drawn to scale)

WORKSHEET ESTERO DE SAN ANTONIO, ESA, T-1



1 sample: spring to winter

Investigator_____ Date_____ Season_____

Weather_____ Tide_____@_____:_____A.M. / P.M.

Temperature: AIR_____°F WATER_____°F SALINITY_____PPT

_____°C _____°C

SPECIES COUNTS

ESA, T-1

Sq. Meter	Anthop. xantho. (green sea anem)	A. elegantis. (aggreg. anem)	Mytilus calif. (sea mussel)	Pollicipes poly. (goose barnacle)	Katharina tunicata (black chiton)	Pisaster och. (pur. sea star)	Other Species	
#1								
#2								
#3								
#4								
#5								
#6								
#7								
#8								
#9								
#10								
TOTAL	(S)	(S)	(S)	(S)				

Special Notes:

III. OTHER TRANSECTS

Other intertidal and subtidal transects are available for data review and information for these are stored at the College of Marin Biology Department. Some of the observations and data date back to the 1950's and some are more complete than others on an annual-seasonal basis. These intertidal and subtidal sites have lower priority and are listed here in order of southerly to northerly site location:

South Muir Beach Reefs
Slide Ranch Reefs
Rocky Point Headland and Steep Ravine Beach
Stinson Beach at Calle de Sierra inlet
Bolinas Lagoon mudflats
Duxbury Sand Flat Reefs
Bolinas Point Reefs
Palomarin - Abalone Point Reef
Double Point Reefs, north and south point
Double Point South Reef, subtidal, two transects
Sculpture Beach Reef, intertidal and subtidal
Drakes Estero inner bay mudflats and rocky intertidal
Abbotts Lagoon
McClure's Beach, south reef
Bird Rock, interitdal reefs, five transects
Tomales Bluff, two intertidal transects
Tomales Bay, three rocky intertidal transects
two subtidal transects
four mudflat transects

Appendix A

STATISTICAL FORMULAE

Terminology

Sample — the group of individuals directly studied; the sample is a representative portion of a larger group called the "population".

Population — the total of a species in an area; the population statistics are based on data collected from samples.

Mean — the average of all measurements

Symbols for the Sample Statistics

Mean $$\bar{X} = \frac{\sum x_i}{n} = \frac{\text{sum of all measurements } (x_1 + x_2 , \ldots + x_n)}{\text{number in the sample } (n)}$$

Variance $$s^2 = \frac{\sum x_i^2 - \frac{(\sum x_i)^2}{n}}{n - 1}$$

Standard deviation $$s = \sqrt{\text{variance}}$$

Formula for Population Mean

The 95% confidence interval is used in this handbook to determine the interval within which we expect the population mean to be. If, on the basis of repeated sampling, many 95% confidence intervals for μ are set up, then approximately 95% of these confidence intervals will actually contain the true mean, μ. The probability that the true mean μ falls between two specified values is either 1.0 or 0.0. The population mean μ is a parameter, not a random variable, therefore it does not have a probability distribution.

For sample size less than 30: $\alpha = .05$

$$P\left(\bar{X} - t_{\frac{\alpha}{2}, n-1} \frac{s}{\sqrt{n}} \leq \mu \leq \bar{X} + t_{\frac{\alpha}{2}, n-1} \frac{s}{\sqrt{n}}\right) = 1 - \alpha$$

For sample size equal to or greater than 30: $\alpha = .05$

$$P\left(\bar{X} - Z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}} \leq \mu \leq \bar{X} + Z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}}\right) = 1 - \alpha$$

Comparison of Population Means of Two Samples

To compare the population means of two samples, e.g., the spring sample of one year with the spring sample of a previous year, the data obtained from the two representative samples is used to test the null hypothesis, H_o.

The null hypothesis states that there is no difference between the two population means:

$$H_o: \quad \mu_1 = \mu_2 = \mu_o$$

The alternate hypothesis states that there is a significant difference between the two population means:

$$H_1: \quad \mu_1 \neq \mu_2$$

Test statistics utilize the sample data to test the null hypothesis: Z test statistic for sample size 30 or more; t test statistic for sample size less than 30.

Test Statistic Z for sample size ≥ 30:

$$Z = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}}$$

Decision Rule: At the level of significance, $\alpha = .05$ (two-tailed test), reject H_o if $Z \geq 1.96$ or $Z \leq -1.96$.

If H_o is rejected, calculate the interval estimate of difference:

$$\mu_1 - \mu_2 = \bar{X}_1 - \bar{X}_2 \pm Z_{\frac{\alpha}{2}} \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

Test Statistic t for sample size < 30:

$$t = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where s_p^2 is the pooled variance

$$s_p^2 = \frac{(n_1 - 1)\, s_1^2 + (n_2 - 1)\, s_2^2}{n_1 + n_2 - 2}$$

Decision Rule: At the level of significance, $\alpha = .05$ (two-tailed test), compare test statistic t against the critical value of $t_{n_1 + n_2 - 1,\, \alpha/2}$ for your two samples, Appendix C.

For example, if $n_1 = 10$, $n_2 = 10$, locate 19 under df column, and value will be 2.093 for $\alpha = .05$ ($\alpha/2 = .025$)

Then, reject H_o if test statistic $t \geq 2.093$ or $t \leq -2.093$.

If H_o is rejected, calculate the interval estimate of difference:

$$\mu_1 - \mu_2 = \bar{X}_1 - \bar{X}_2 \pm t_{n_1+n_2-2,\,(.025)} \sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

$$= \bar{X}_1 - \bar{X}_2 \pm 2.101 \sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

APPENDIX B COMPARISON OF POPULATION MEANS

WITH TWO-SAMPLE TESTING OF NULL HYPOTHESIS

Descriptive Statistics

		Sample 1	Sample 2
Season =		Spring 79	Spring 84
Transect =		AB-8	AB-8
number,	n	10	10
average,	$\bar{X}$	20.8	9.3
variance,	s^2	445.21	32.59

Test Statistic t

$$t = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$t = \frac{20.8 - 9.3 - (\emptyset)}{\sqrt{238.85\ (0.1 + 0.1)}}$$

$$= \frac{11.5}{\sqrt{47.77}}$$

$$= 1.664$$

Pooled Variance

$$s_p^2 = \frac{(n_1 - 1)\, s_1^2 + (n_2 - 1)\, s_2^2}{n_1 + n_2 - 2}$$

$$s_p^2 = \frac{(10-1)445.21 + (10-1)32.49}{18}$$

$$= \frac{4006.89 + 292.41}{18}$$

$$= 238.85$$

Decision Rule: Reject H_o if test statistic $t \geq 2.093$ or $t \leq -2.093$.

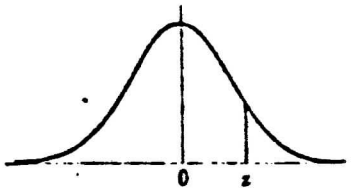
Decision: Do not reject H_o.

H_o: $\mu_1 = \mu_2 = \mu_o$ is true.

Therefore, there is no significant difference between the two population means.

Appendix C

AREAS under the STANDARD NORMAL CURVE from 0 to z



z	0	1	2	3	4	5	6	7	8	9
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0754
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2258	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2612	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2996	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3113	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998
3.6	.4998	.4998	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.7	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.8	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.9	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000

APPENDIX C (continued)

TABLE B. TABLE OF CRITICAL VALUES OF t*

df	Level of significance for one-tailed test: .10	.05	.025	.01	.005	.0005
	Level of significance for two-tailed test:					
α	.20	.10	.05	.02	.01	.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

* Table B is abridged from Table III of Fisher and Yates: *Statistical tables for biological, agricultural, and medical research*, published by Oliver and Boyd Ltd., Edinburgh, by permission of the authors and publishers.

APPENDIX D STATISTICS RECORD for _____ (Location) TRANSECT _____

Sample Size _____ Transect Page _____

File Record for SEASON/yr _____ / _____ Date _____ Field Investigator _____

Tide/Time _____ Salinity _____ Stats Tech _____

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes	_____	_____	
1. Σx_i	_____	_____	_____
2. $\Sigma (x_i)^2$	_____	_____	_____
3. s.d.	_____	_____	_____
4. $\bar{X}$	_____	_____	_____
5. 95% C.I. for population mean	_____ to _____	_____ to _____	_____ to _____

Comments from field worksheet _____

_____

File Record for SEASON/yr _____ / _____ Date _____ Field Investigator _____

Tide/Time _____ Salinity _____ Stats Tech _____

	SESSILE	MOBILE	ALL SPECIES IN SAMPLE
Species Codes	_____	_____	
1. Σx_i	_____	_____	_____
2. $\Sigma (x_i)^2$	_____	_____	_____
3. s.d.	_____	_____	_____
4. $\bar{X}$	_____	_____	_____
5. 95% C.I. for population mean	_____ to _____	_____ to _____	_____ to _____

Comments from field worksheet _____

_____

SESSILE and MOBILE group CODES *APPENDIX*

Species to combine for descriptive statistics

codes	SESSILE	codes	MOBILE
AXA	A. xanthogrammica green sea anemone	crabs	Cancer antennarius Pagurus spp. Pugettia spp. Pachygrapsus crassipes Hemigrapsus nudus Petrolithes cinctipes
AEL	A. elegantissima aggregating anemone (AXE for both)		
MYT	Mytilus californianus sea mussel	TEG	Tegula funebralis black turban snail
POL	Pollicipes polymerus goose barnacle	MOPspp	Mopalia muscosa Hairy chiton Cryptochiton stelleri gumboot chiton
BAL	Balanus glandula acorn barnacle	(KAT)	Katharina tunicata black chiton
		STR	Strongylocentrotus purpuratus purple sea urchin
	Other Species (no statistics involved)	ASTspp	Patiria miniata bat star Pisaster orchraceous purple seastar Pisaster brevispinus pink star Pycnopodia helianthoides sunstar Leptasterias spp. small seastar
	Nucella emarginiata whelk snail		
	Nuttalina californica chiton		
	Epiactus prolifera sea anemone	HALruf	Haliotis rufescens red abalone
	Eupentacta quinquesemita sea cucumber	HALcra	Haliotis cracherodii black abalone
		COLspp	Collisella spp., limpet Notoacmaea sp., limpet
		LOT	Lottia gigantea owl limpet
		LIT LITx	Littorina scutulata Littorina planaxis perwinkle snails