

PISCO Kelp Forest Fish Surveys



Restrooms



Introductions



“Team MPA-PISCO UCSC”:

- Dan Malone
- Luke Murrell
- Rae Mancuso
- Honorary Team Lead: Steve Lonhart



PISCO Kelp Forest Fish Training

2026 Agenda

Monday

- 9:00 - 3:00 Fish training lecture @ OHB 118
3:30 – 4:30 Load tanks and gear into trucks

Tuesday - Wednesday

- 7:00 PISCO people meet at LML
8:00 Everyone meet at Hopkins Marine Station
8:15 Site and facility orientation and briefing
9:00 - 2:00 Point ID/ Sizing/ Fish transect practice
4:00 - 6:00 LML unload gear/fill tanks/load gear

Thursday

- 7:00 PISCO people meet at LML
8:00 Everyone meet at Hopkins Marine Station
9:00 - 2:00 Survey Practice (3 dives)
4:00 - 6:00 LML unload gear/fill tanks/load gear

Friday - off - Juneteenth Observed



PISCO Kelp Forest Fish Surveys

Today's Agenda

Today

9:00 - 11:00

- Introductions
- Survey program overview: history and purpose
- sampling design
- sampling protocols

11:00 – 12:00 lunch break

12:00-2:30

- Fish test
- Fish ID's



PISCO Kelp Forest Surveys

Three purposes of kelp forest surveys:

- I. Characterize geographic patterns of community structure and dynamics (since 1998)
- II. California MPA Network monitoring, evaluation and adaptive management
- III. California state-wide coastal ocean monitoring program (multiple purposes including climate change)



PISCO Kelp Forest Surveys

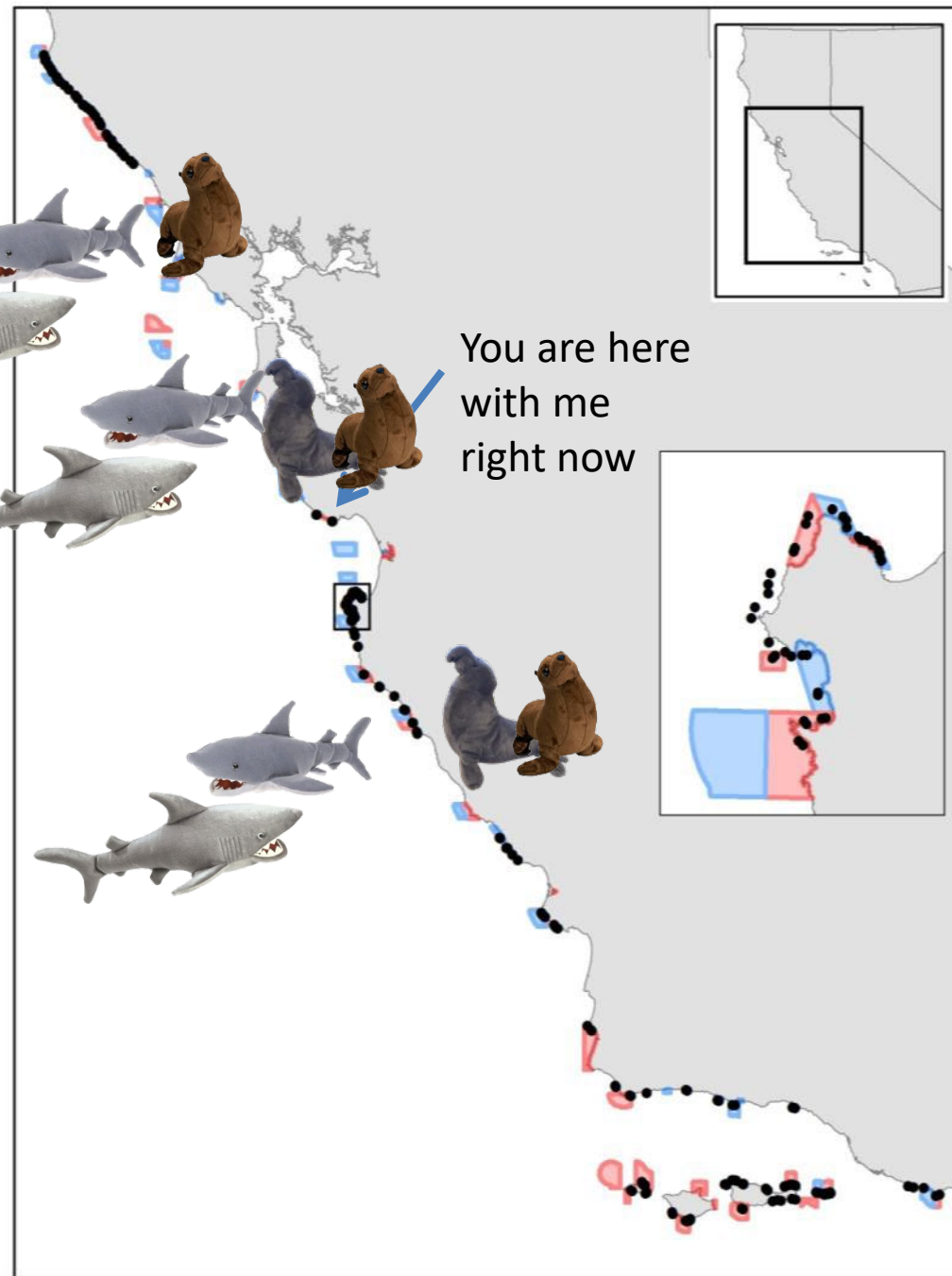
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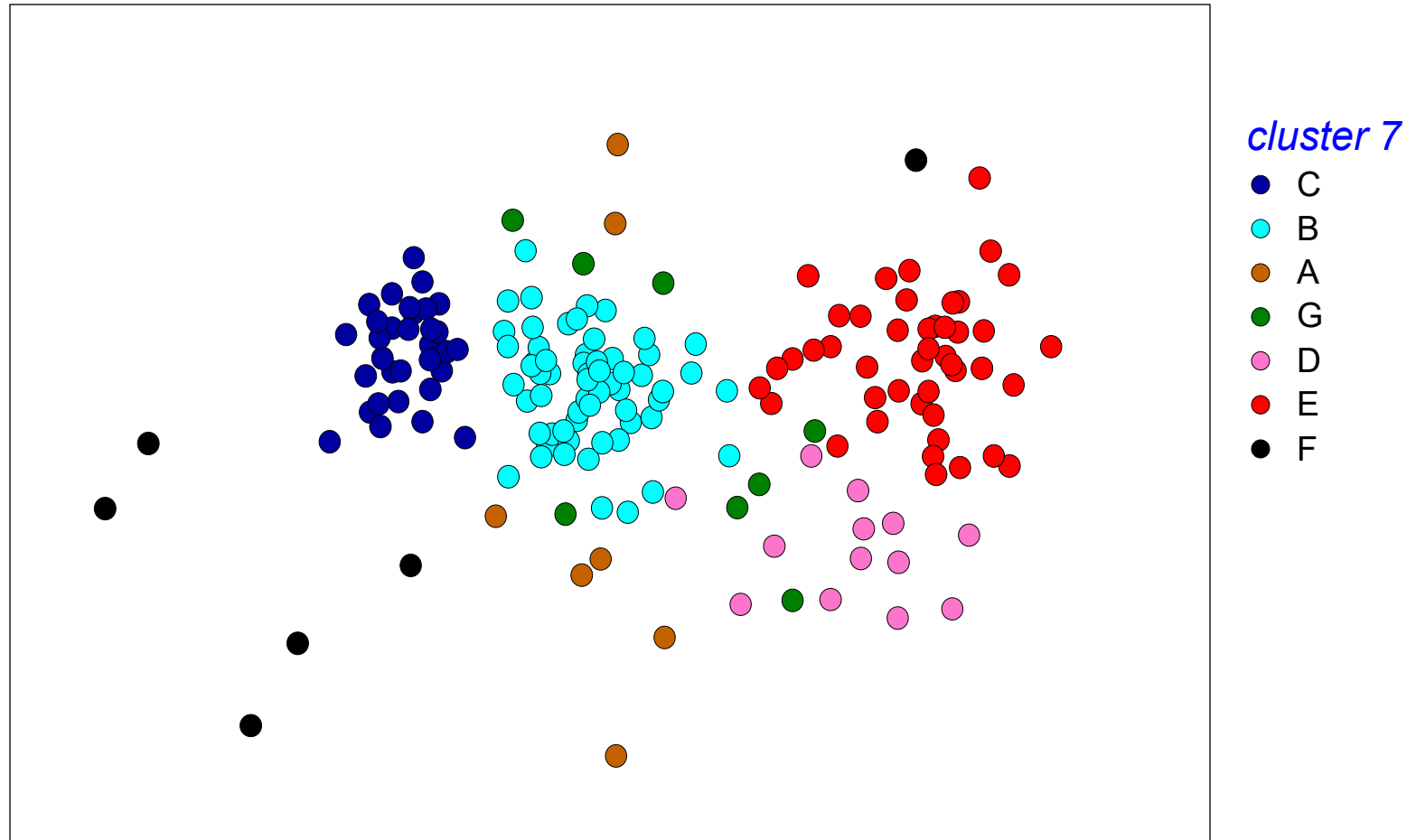


Spatial Sampling Design: Geographic Scale

2010-2011: 170 sites

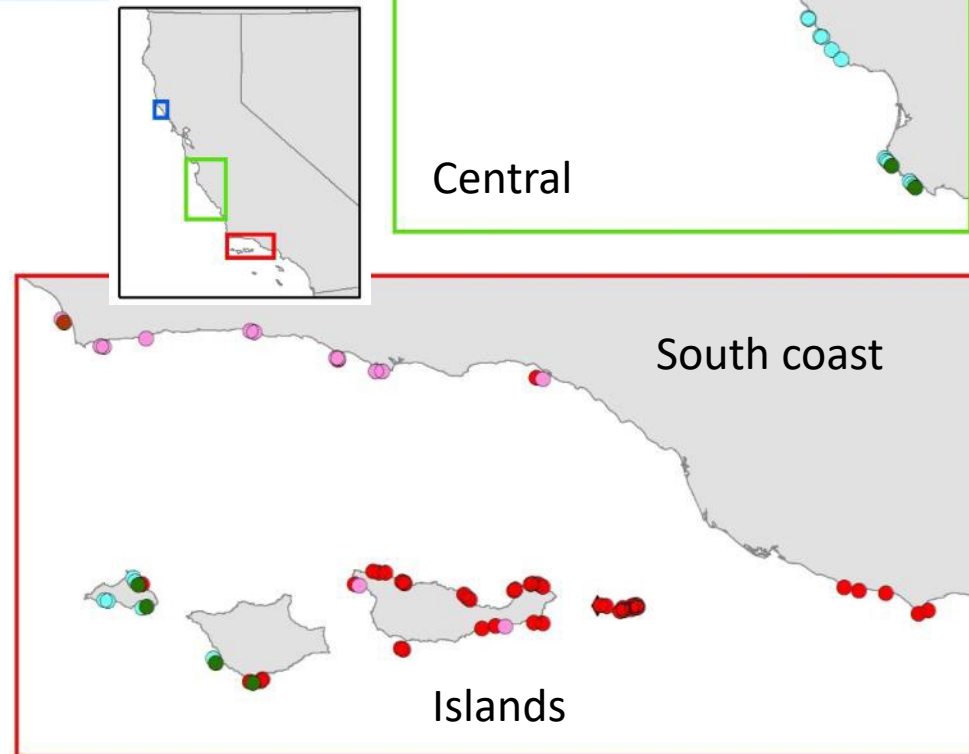
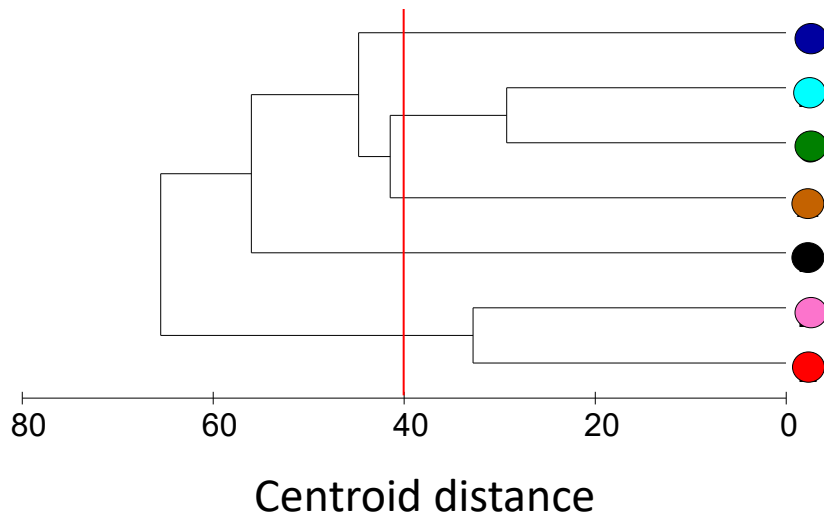
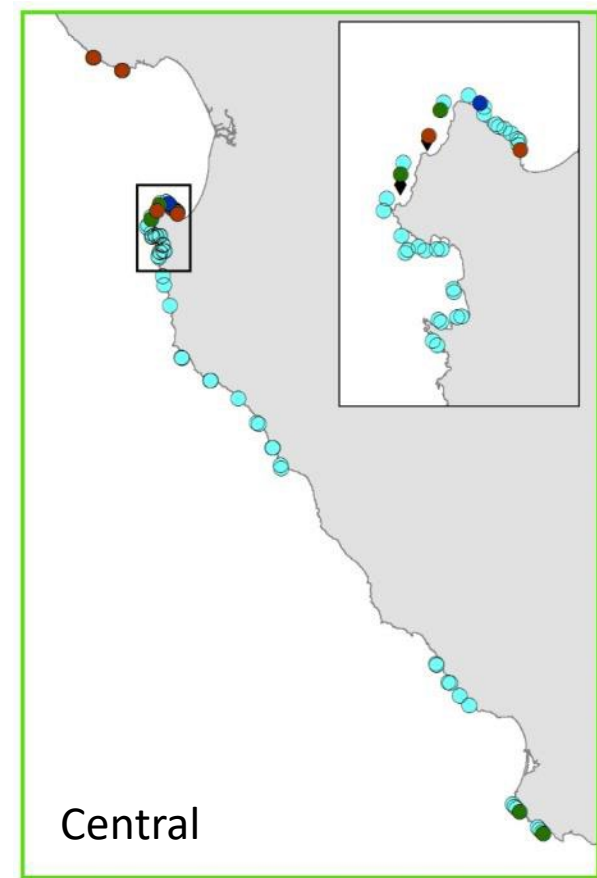
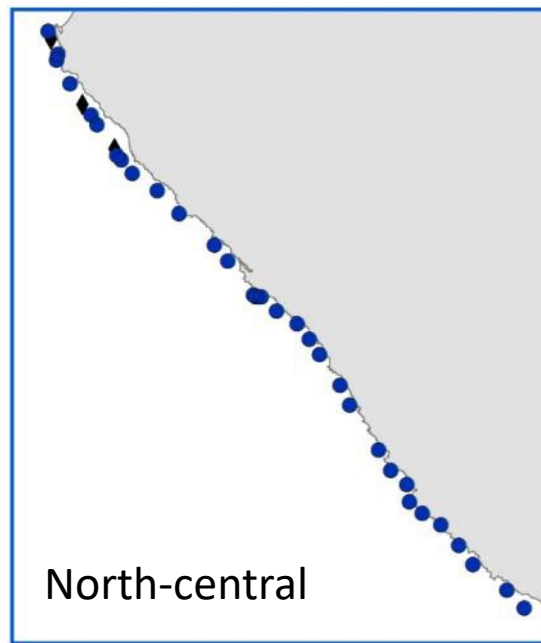


Geographic patterns of taxonomic structure fish assemblages (152 taxa)

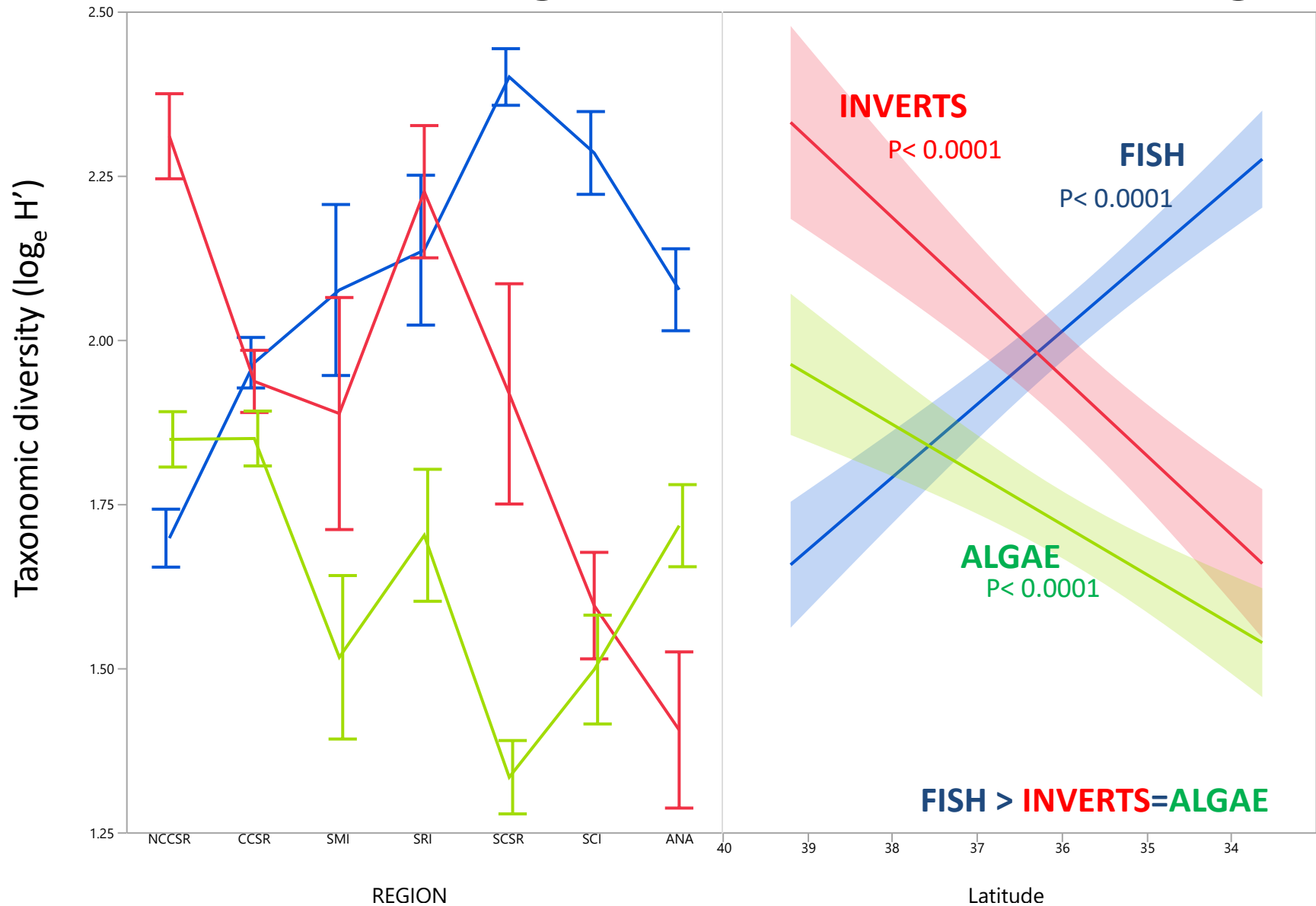


Non-metric MDS: Bray-Curtis similarity; Square root transform (2D Stress = 0.13)

Geographic patterns of taxonomic structure: fish assemblages



Are geographic patterns of taxonomic **diversity** concordant among fish, invertebrates and algae?



PISCO Kelp Forest Surveys

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PISCO Kelp Forest Surveys

II. MLPA-MPA purposes of kelp forest surveys:



- Quantify ecological responses to establishment of MPAs (SMRs, SMCAs)
 - populations
 - communities
 - ecosystems



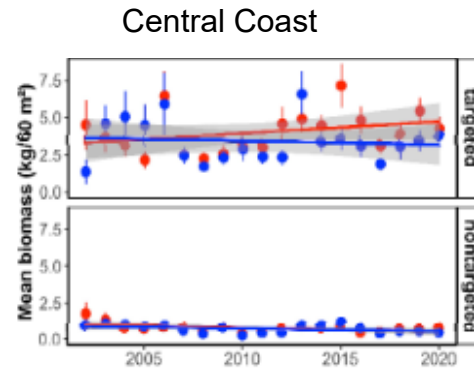
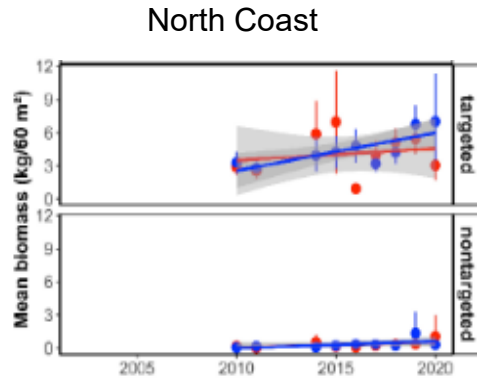
- Apply these responses to evaluation of MPA performance as conservation tools



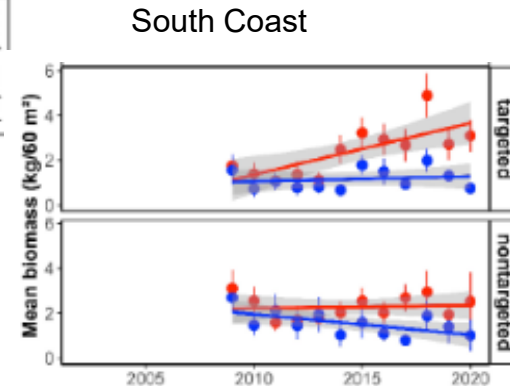
- Coast-wide MPA surveys:
Cal Poly HSU, UCSC, UCSB, Occidental



Does the Biomass of Targeted Fishes Increase Within MPAs?



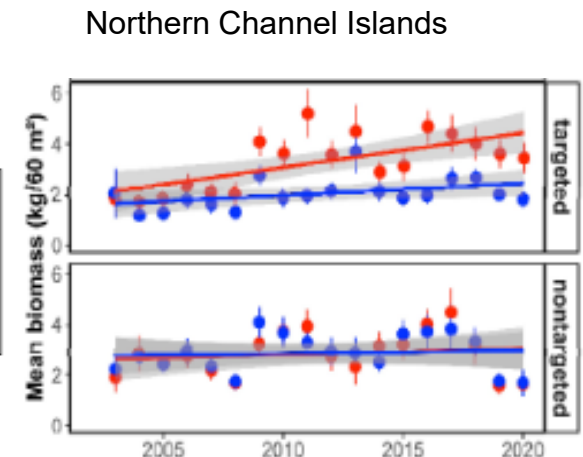
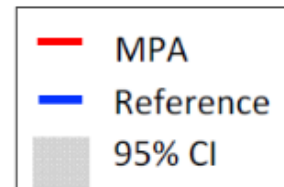
- **Inside MPA**
- **Outside MPA**
- **Non-targeted = control group**



Targeted

Non-targeted

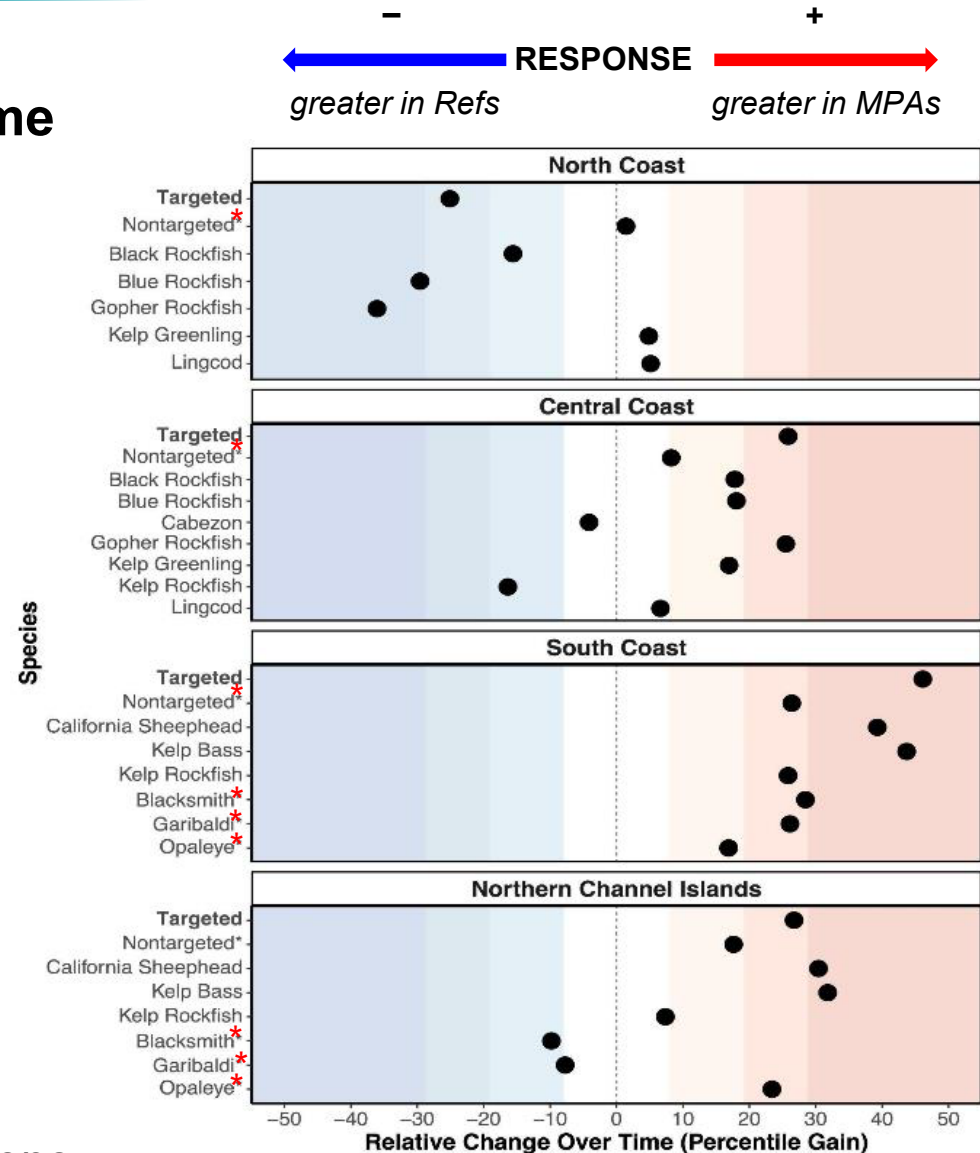
- **South Coast and Northern Channel Islands** showed a significant **increase in biomass** of Targeted species within these MPAs than outside MPAs
- But... **Northern Channel Islands** is the only region where Targeted species within the MPAs **diverge significantly** from Non-targeted species



Do Targeted Fishes Differ in Their Response?

Change in Fish Biomass Over Time

- Targeted vs. Non-targeted *
- Focal Species



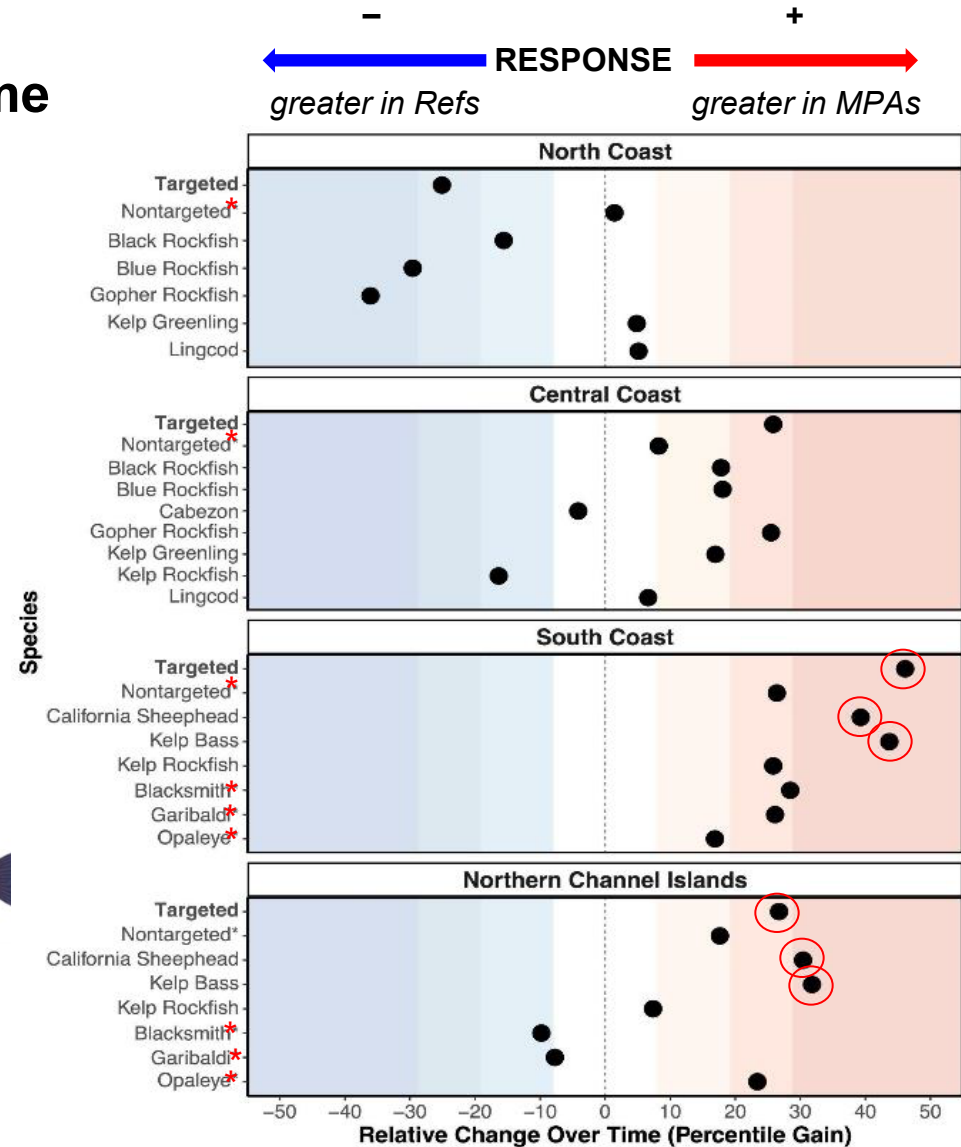
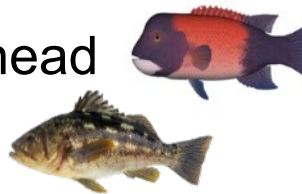
Do Targeted Fishes Differ in Their Response?

Change in Fish Biomass Over Time

- Targeted vs. Non-targeted *
- Focal Species

Stronger MPA responses in the
South Coast and Northern
Channel Islands:

- Fished species
- California Sheephead
- Kelp Bass

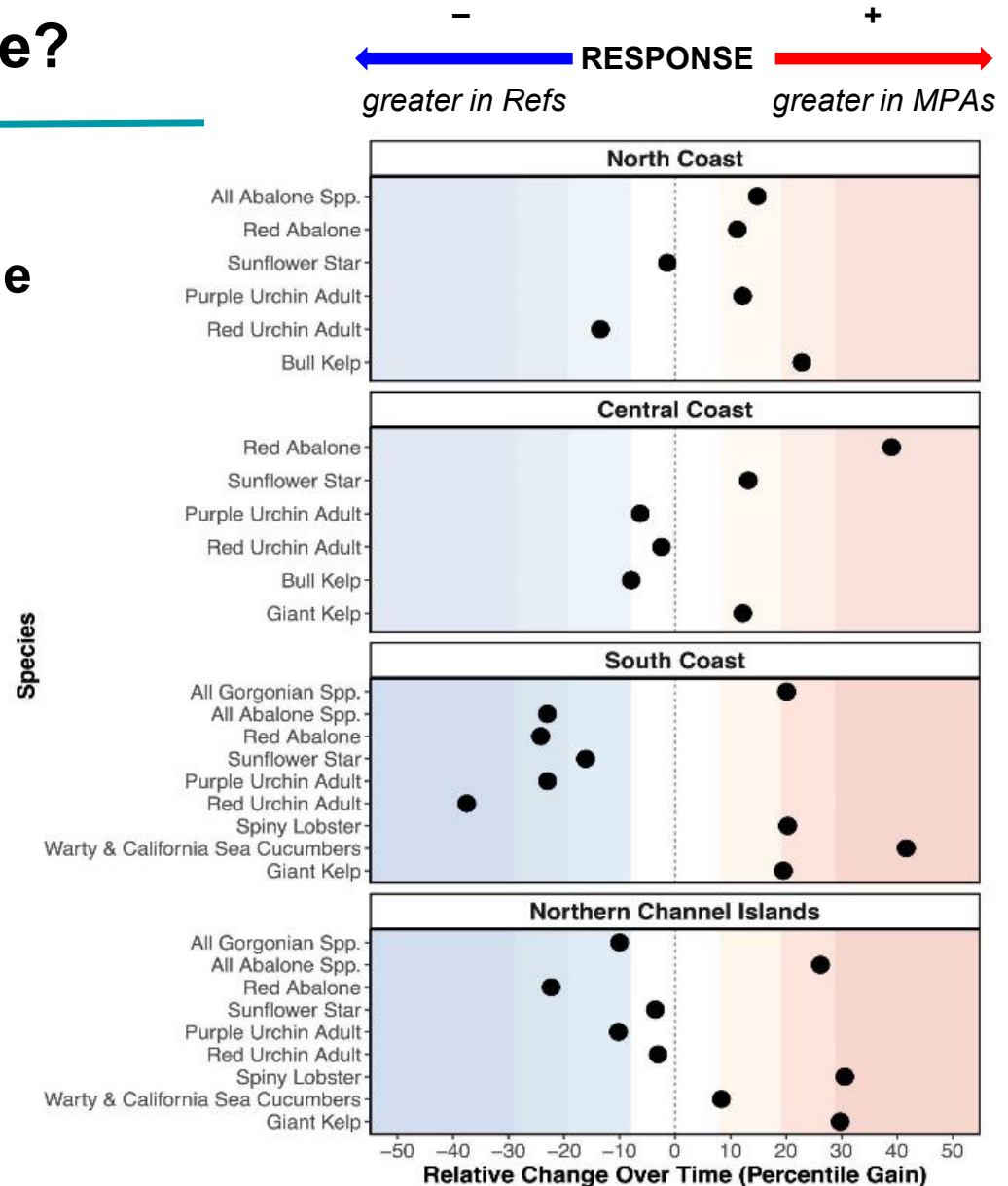


Do Targeted Invertebrates and Algae

Differ in Their Response?

Change in Density Over Time

→ *Focal Species*



Do Targeted Invertebrates and Algae

Differ in Their Response?

Change in Density Over Time

→ Invertebrates and algae

Stronger MPA responses:

- **Central Coast:** Red abalone
- **South Coast/NCI:**

Spiny lobster

sea cucumbers

giant kelp

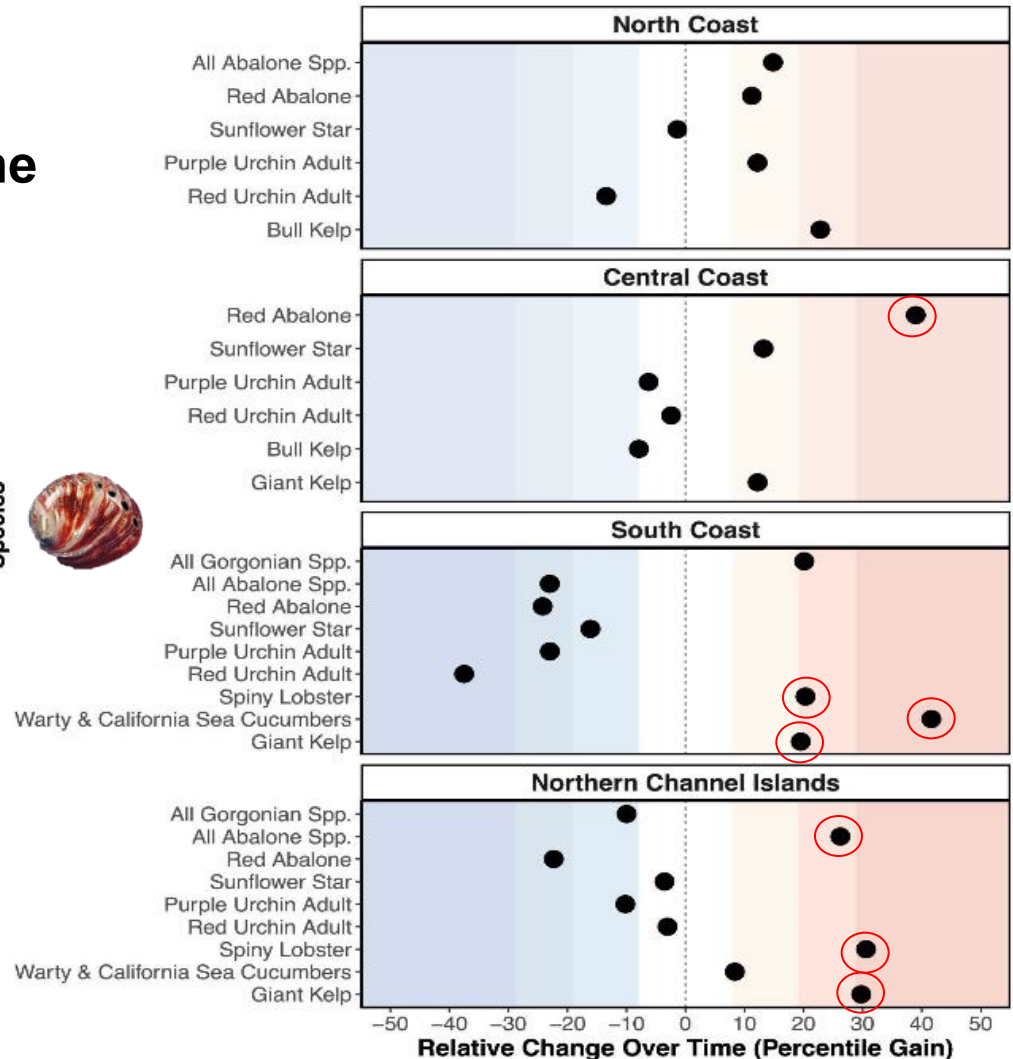


Species



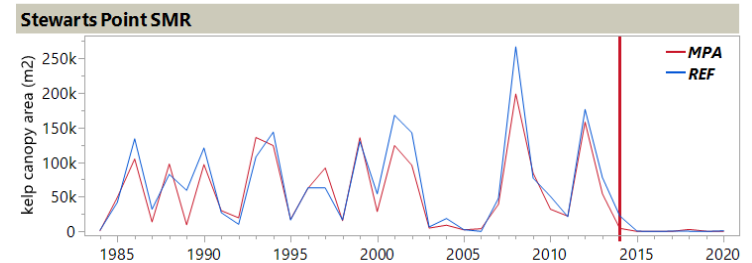
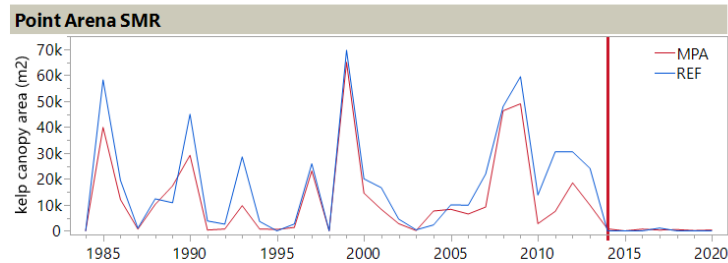
Warty & California Sea Cucumbers

← - RESPONSE + →
greater in Refs greater in MPAs

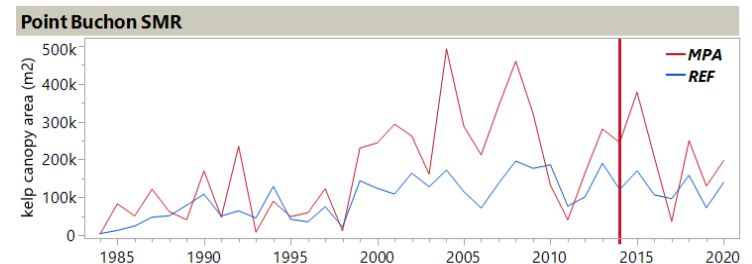
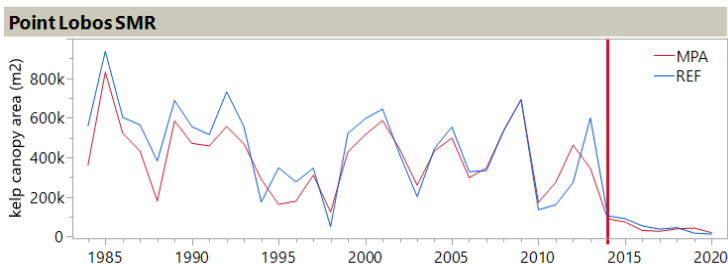


Effect of the Marine Heatwave (2014-2016) on Kelp (Bull and Giant)

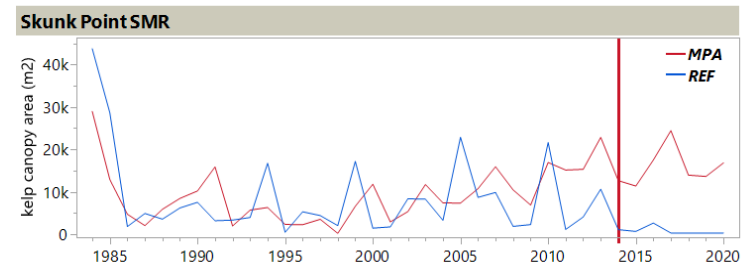
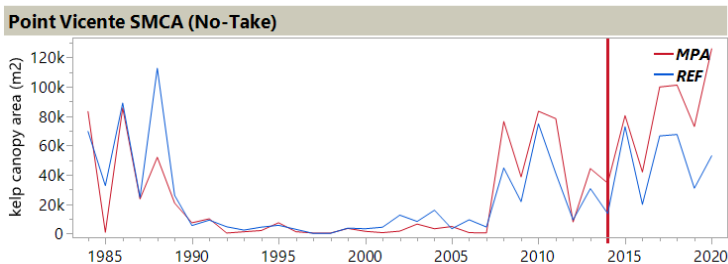
North Coast
(bull kelp)



Central Coast
(bull and giant)



South Coast &
No. Channel
Islands
(giant kelp)



Cascading Effects Created by MPAs

decline in density of urchin predator
(**sunflower star**)



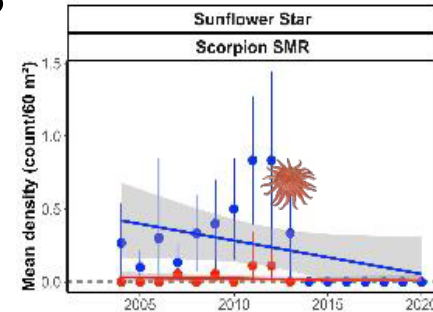
increase in density of 2 urchin predators
(**CA spiny lobster and CA Sheephead**)



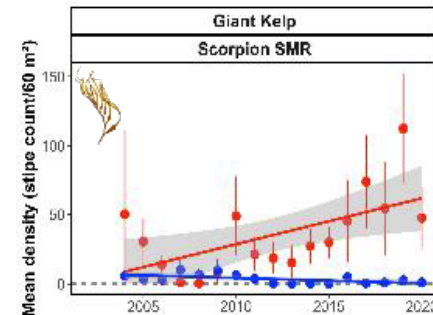
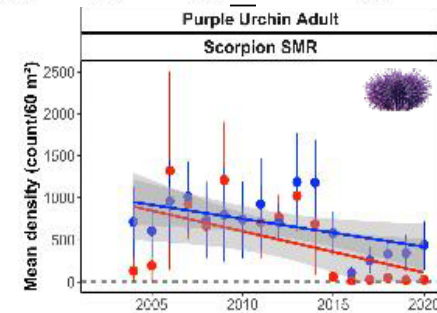
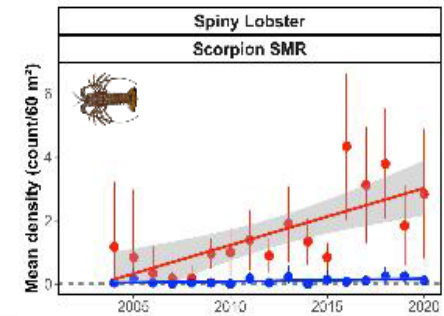
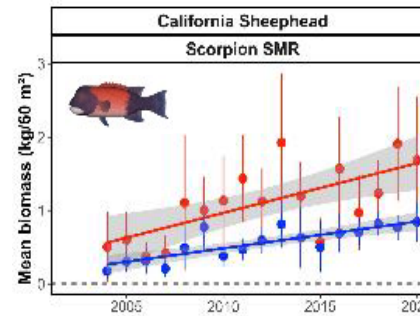
decline in density of **purple urchins**



increase in density of **giant kelp**



Inside MPA
Outside MPA

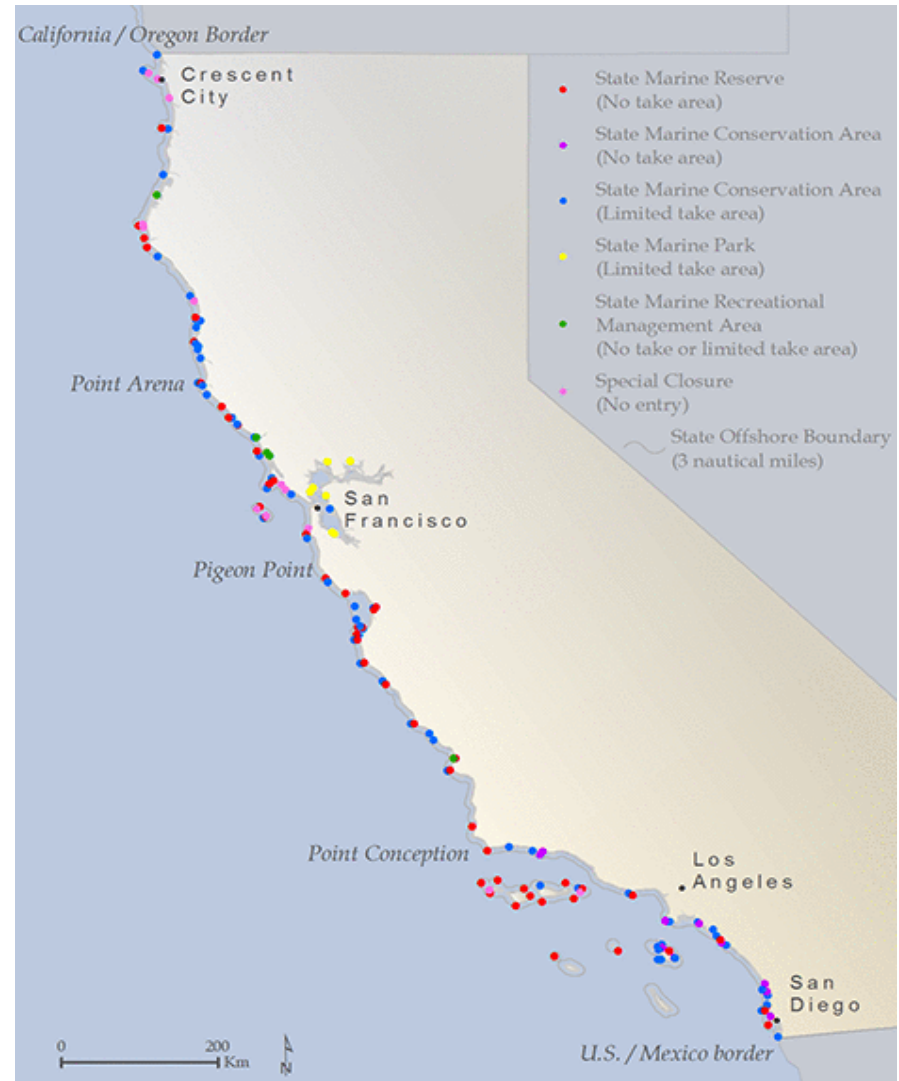


SUMMARY

- MPA effects **vary** across species, MPAs, biogeographic regions and time periods.
 - Regional scales proved more insightful than combined state-wide analyses.



Photo: Kate Vylet



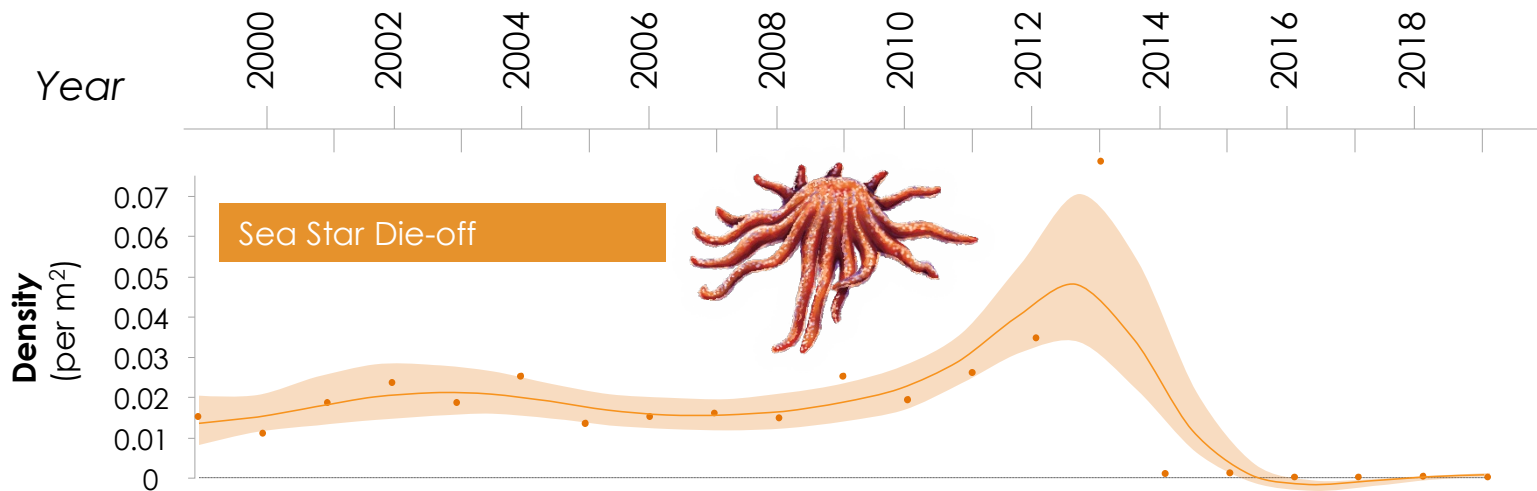
PISCO Kelp Forest Surveys

Three purposes of kelp forest surveys:

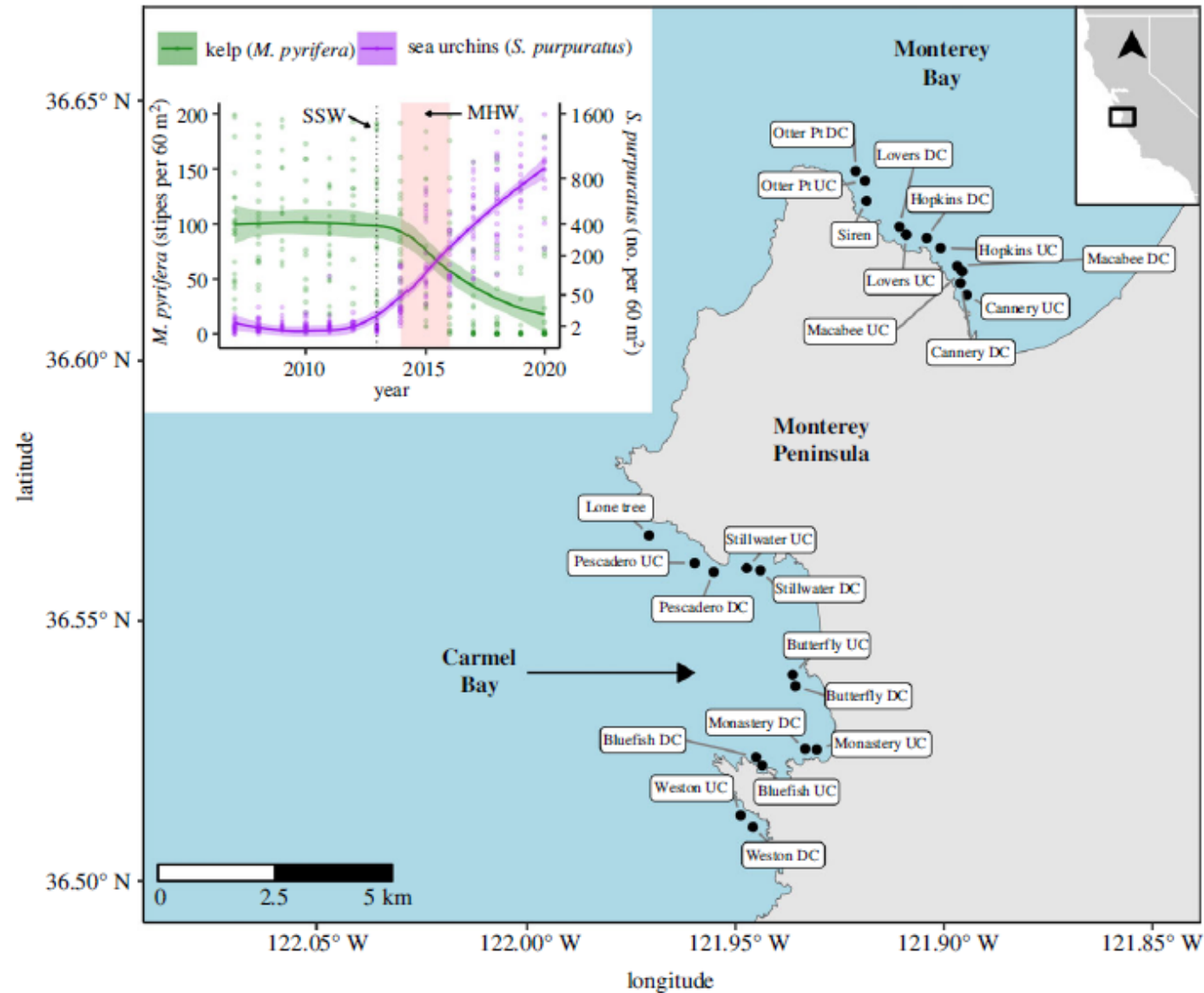
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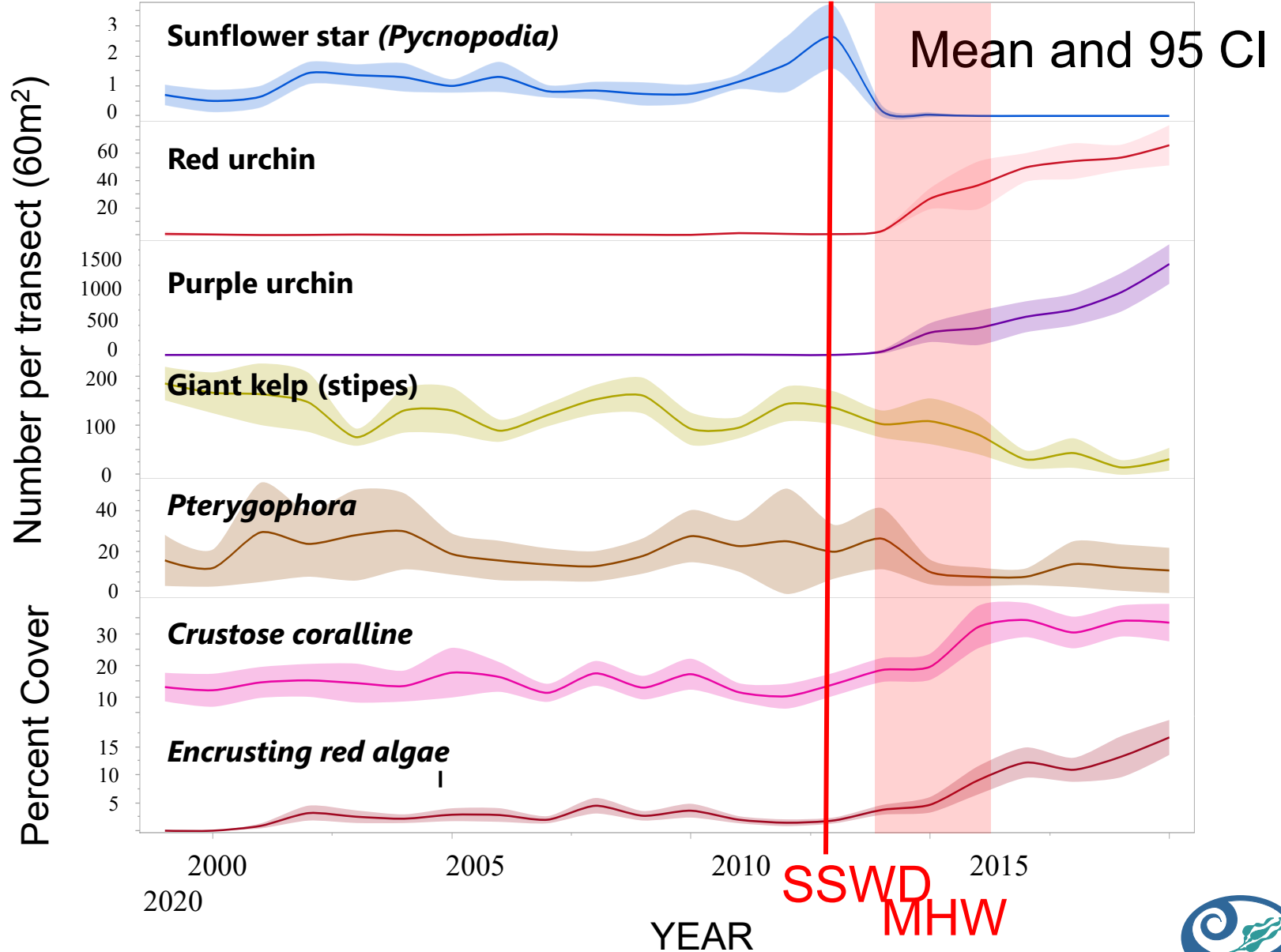
Sea Star Wasting Disease - 2013

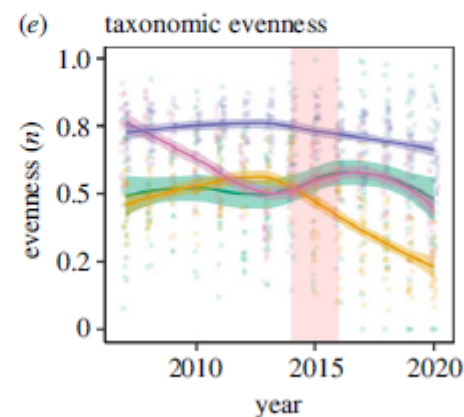
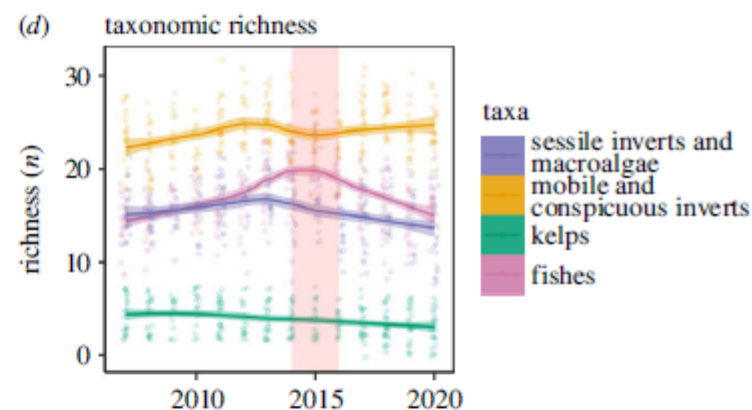
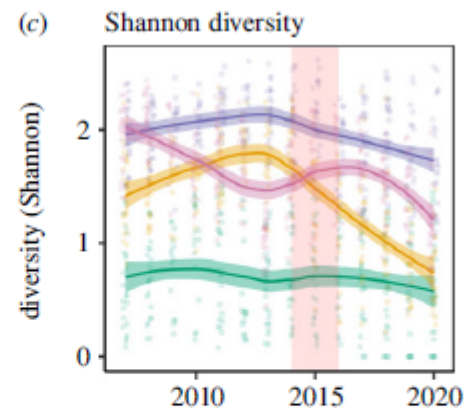
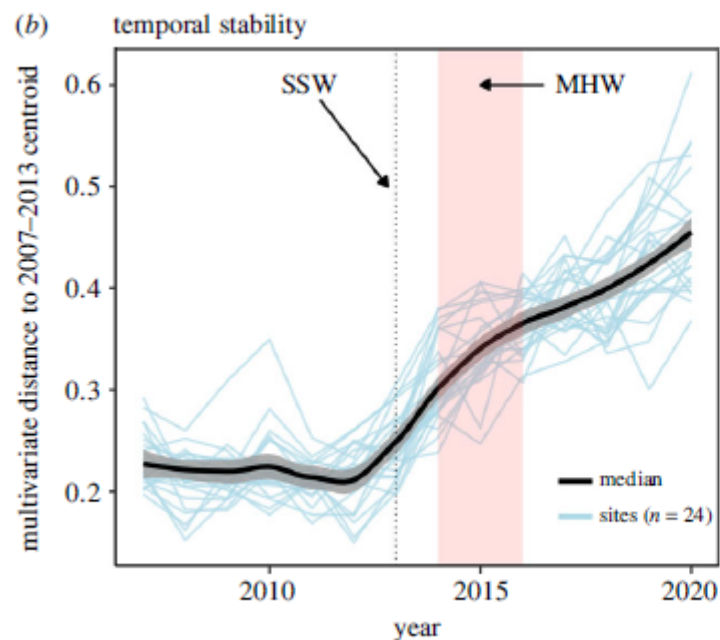
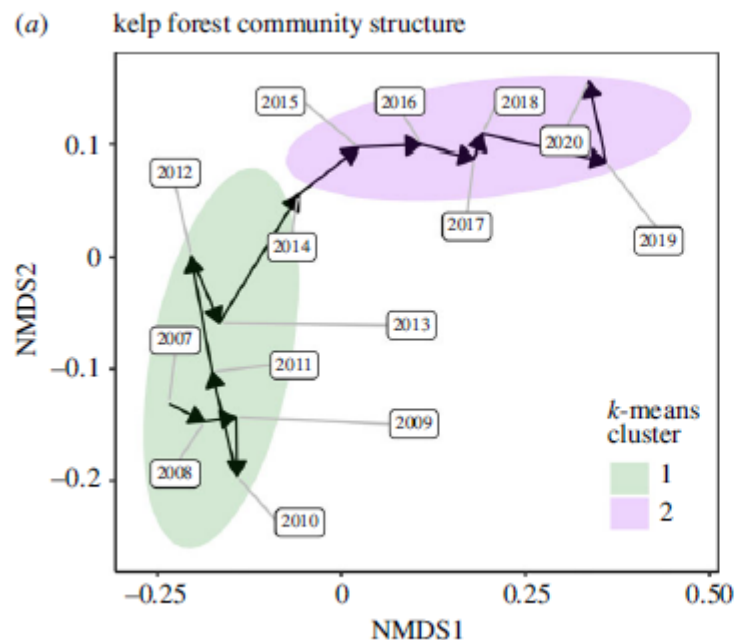


Study sites along Monterey Peninsula



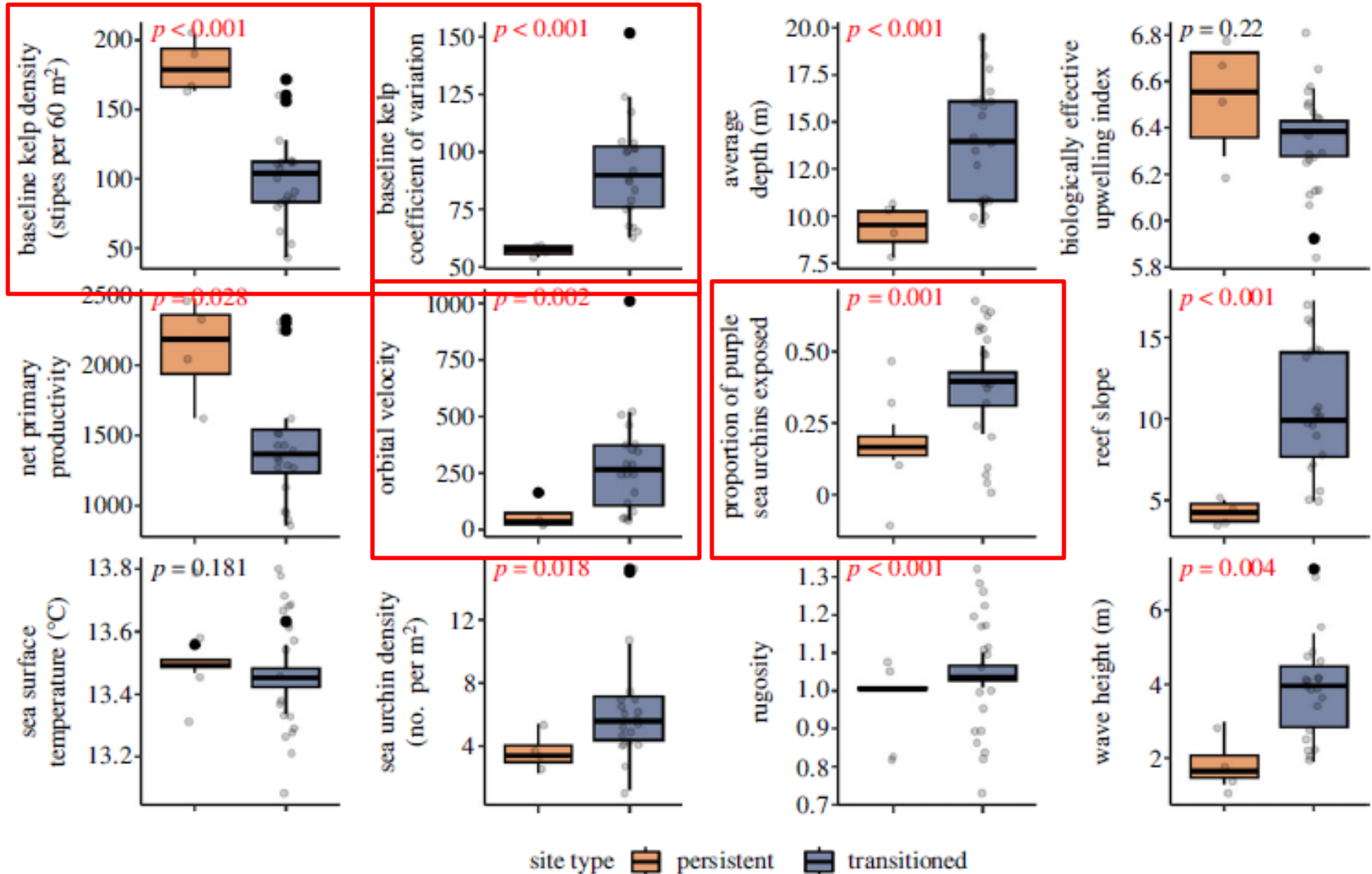
Spp. dynamics along Monterey Peninsula, Central California



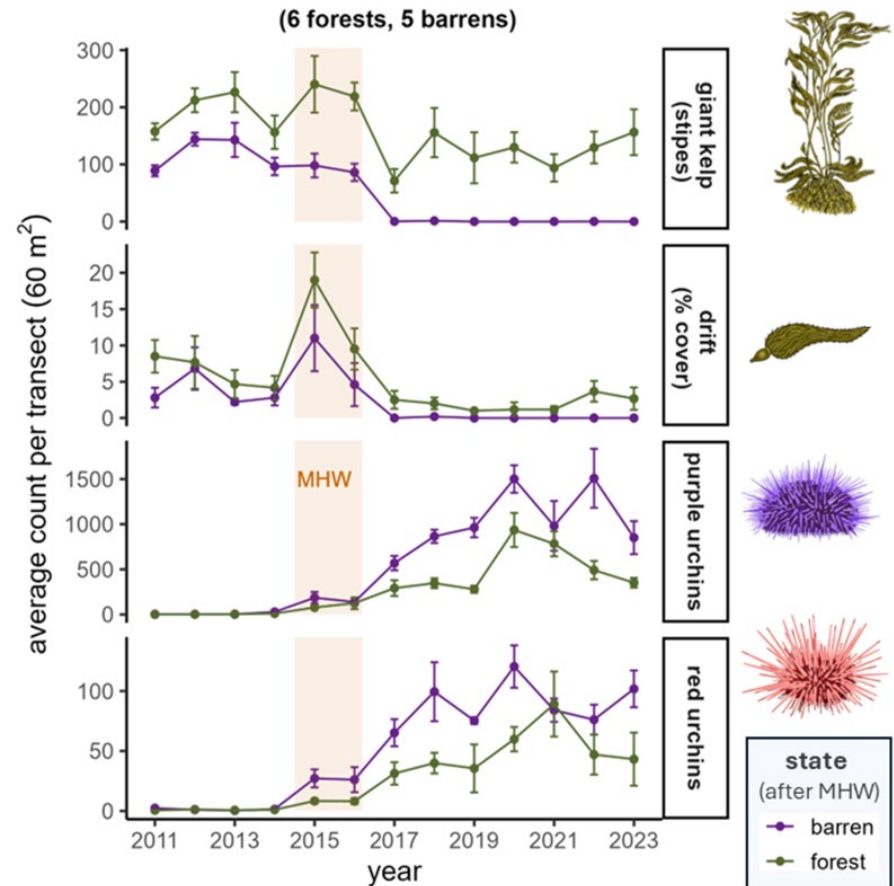
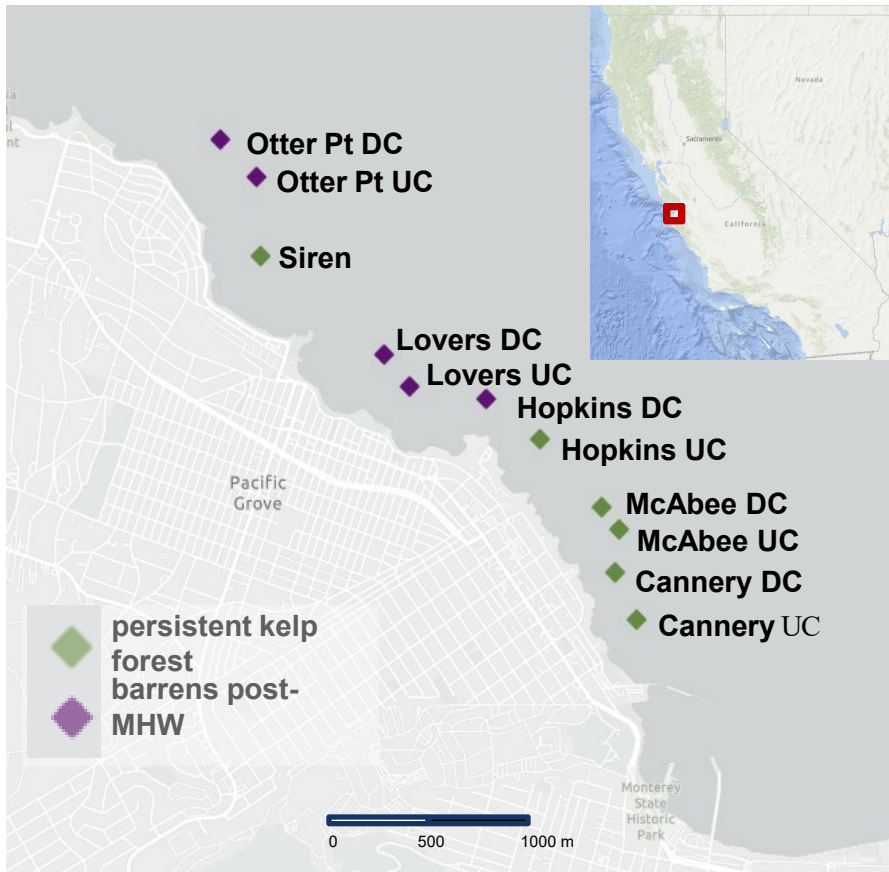


Predictors of persistent and transitioned forests

(b) features of persistent and transitioned forests

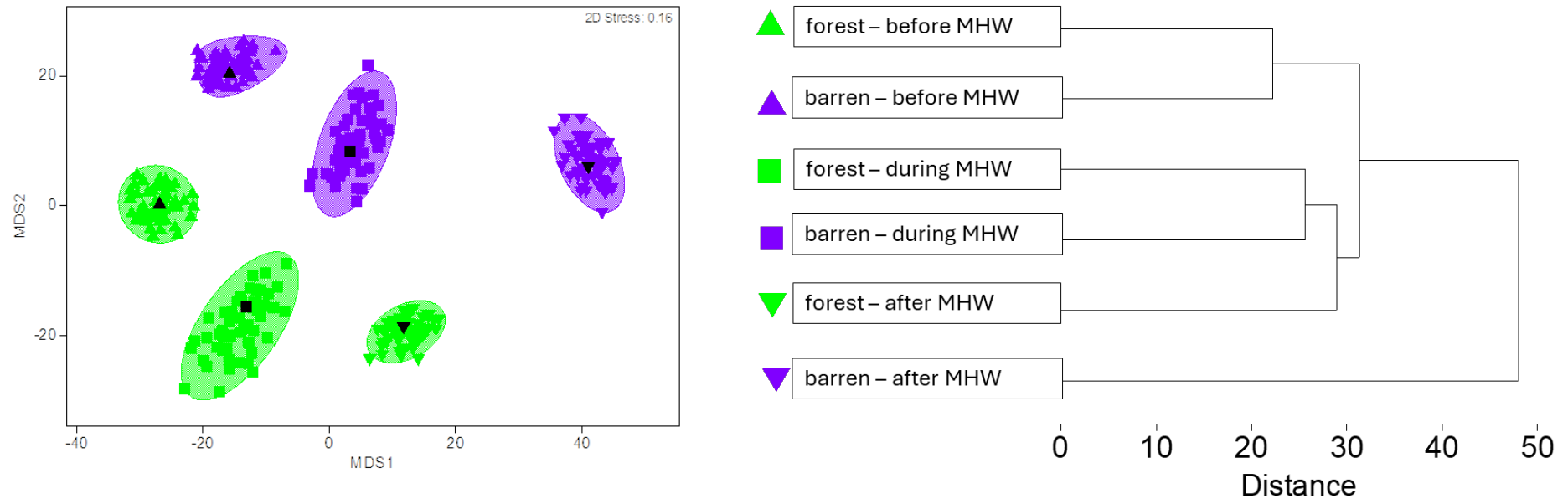


More comparison between persistent and transitioned forests



Relative effects of MHW and urchin-driven state shift

Combined benthic algae and invertebrate assemblages



- Persistent forests and forests that transitioned to barrens differed before MHW
- Both persistent and transitioning forests change through the MHW
- Most distinct configuration due to both the MHW and the state shift

2. Survey Design

When

Annually: July through mid-September

Where



Different oceanographic regimes

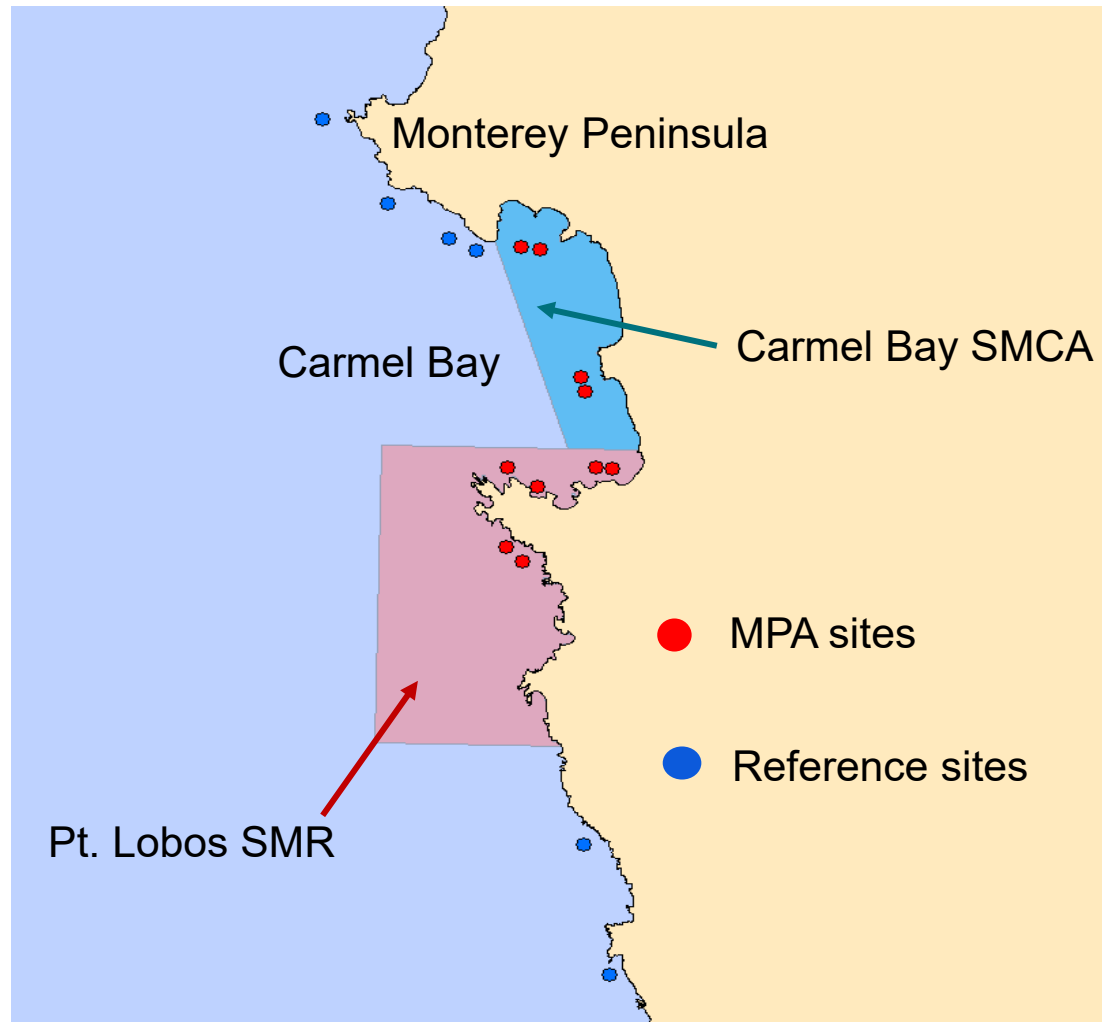
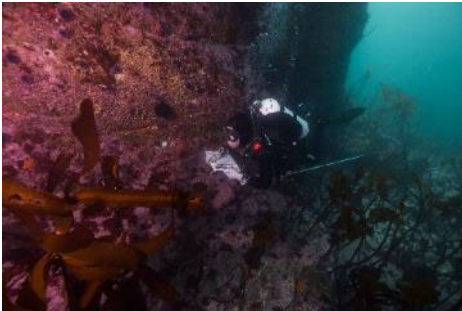
- a) Lower upwelling – Southern Monterey Bay
- b) Higher upwelling – Point Lobos, Carmel Bay



Marine protected areas and “paired” comparison sites

- a) Ed Ricketts SMCA, Lover’s Point – Julia Platt SMR, Pacific Grove Marine Gardens SMCA
- b) Point Lobos SMR, Carmel Bay SMCA, Pescadero Point, Soberanes

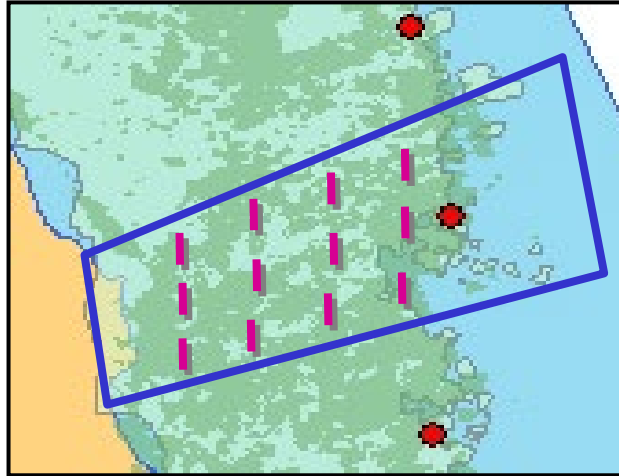
Spatial Design of Monitoring Program



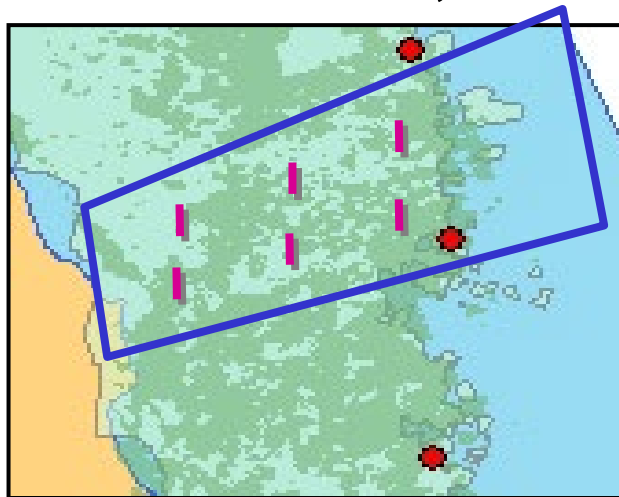
Cross-reef, depth-stratified sampling

Fish transects at 5, 10, 15 and 20m

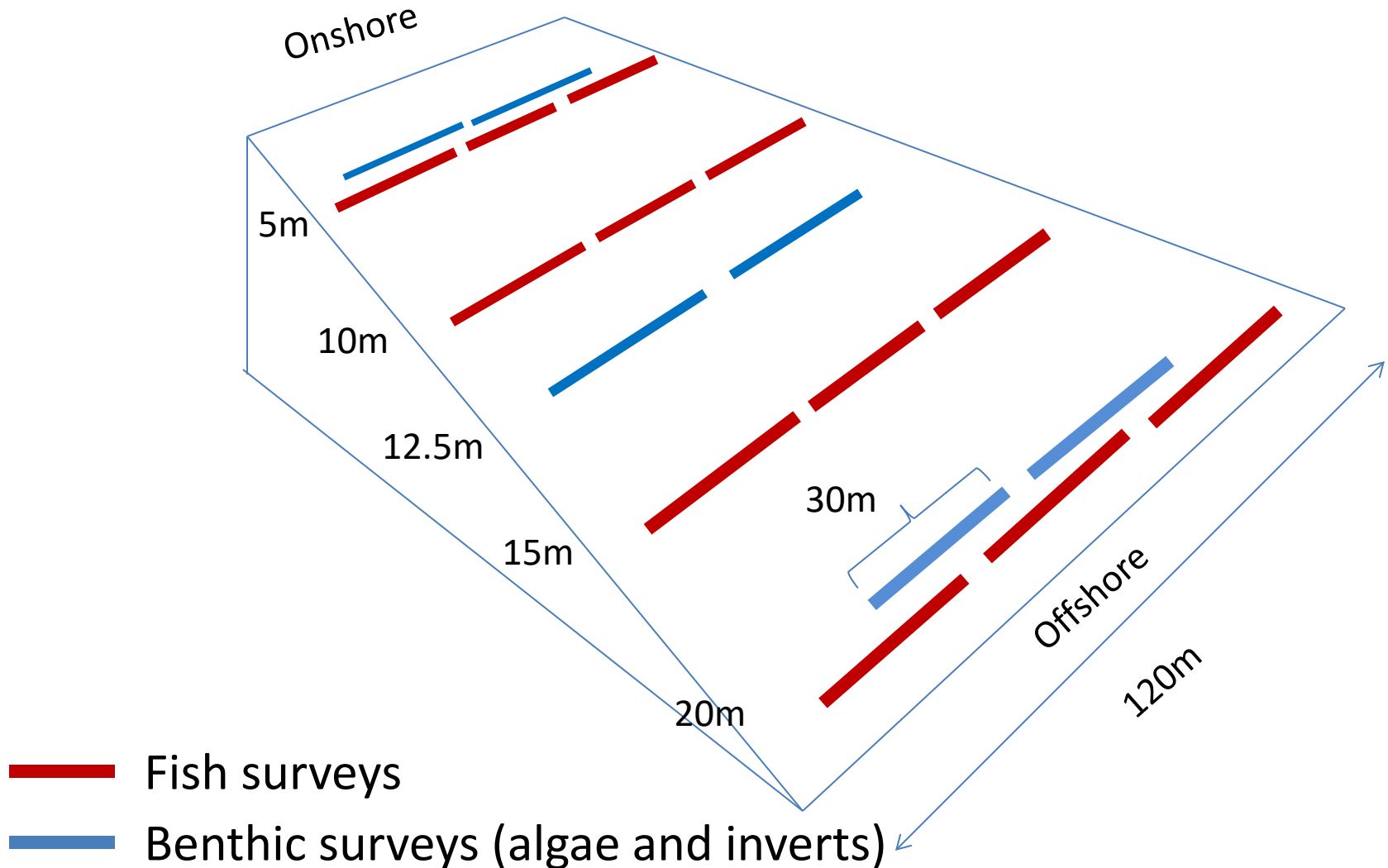
“Site”:



Benthic transects at 5, 12.5 and 20m



Spatial Sampling Design: Site Scale



Analytical Design

Source of variation

Levels

Time

Year 1

...

Year N

Regulatory treatment

SMR

SMCA

SMP

Reference¹

MPA

E. F. Ricketts

Pacific Grove

Carmel Bay

Site

1

2

3

4

Depth zone

20 m

15 m

10 m

5 m

Transects

1

2

3

¹ Reference refers to sites outside any marine protected area.

3. Sampling Protocols

What



All identifiable non-cryptic fishes
- e.g., rockfishes, surfperches, greenlings



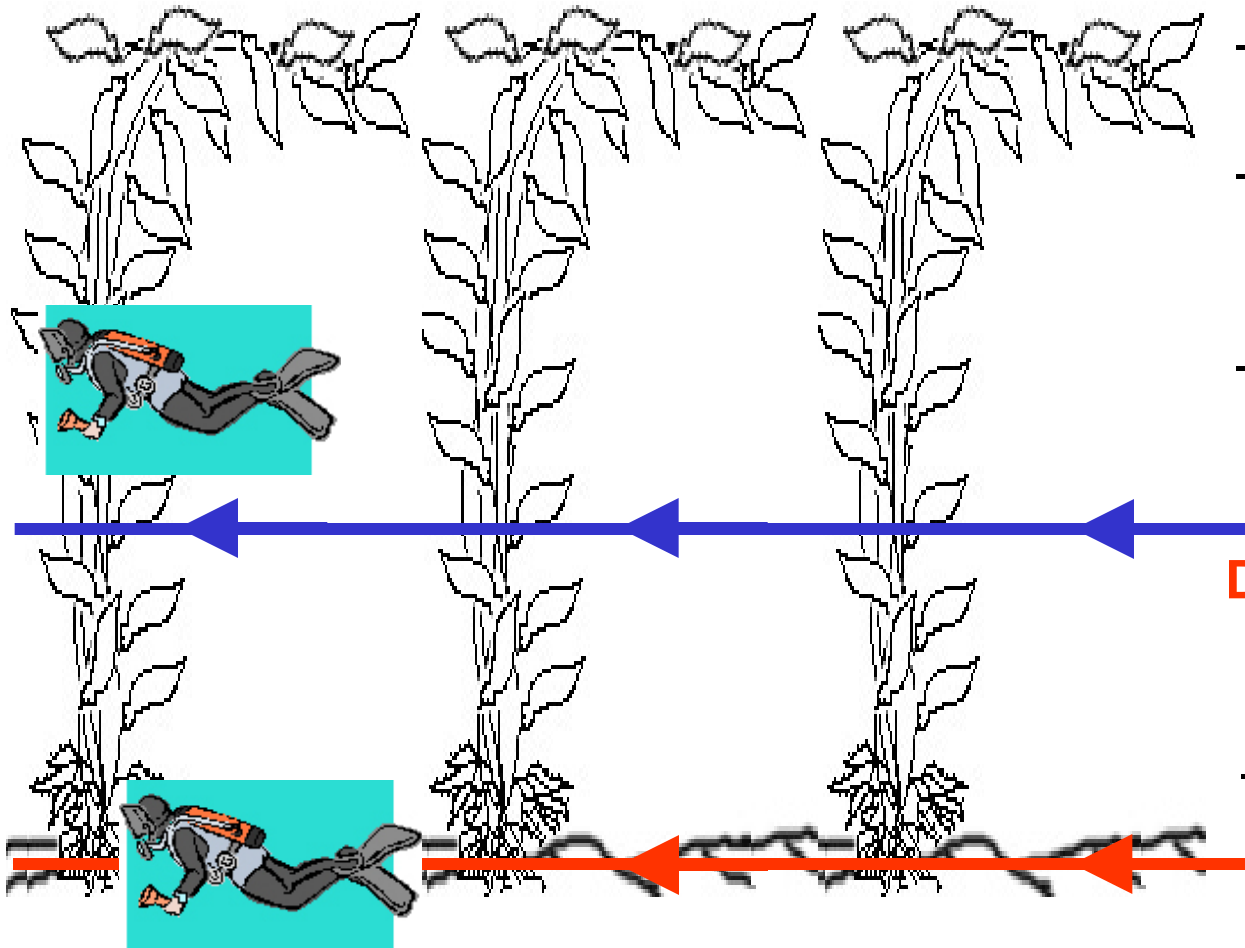
Estimate sizes
- total length (TL) to nearest centimeter



Three levels in water column
- bottom
- mid-water
- surface canopy

Fish Surveys

mid-water, bottom



Diver 1 (mid-water)

- runs tape while swimming transect
- stays just ahead of bottom diver
- records identity, number and size of fishes **AND kelp stipes**
- in 2m wide by 2 m tall by 30m long transect

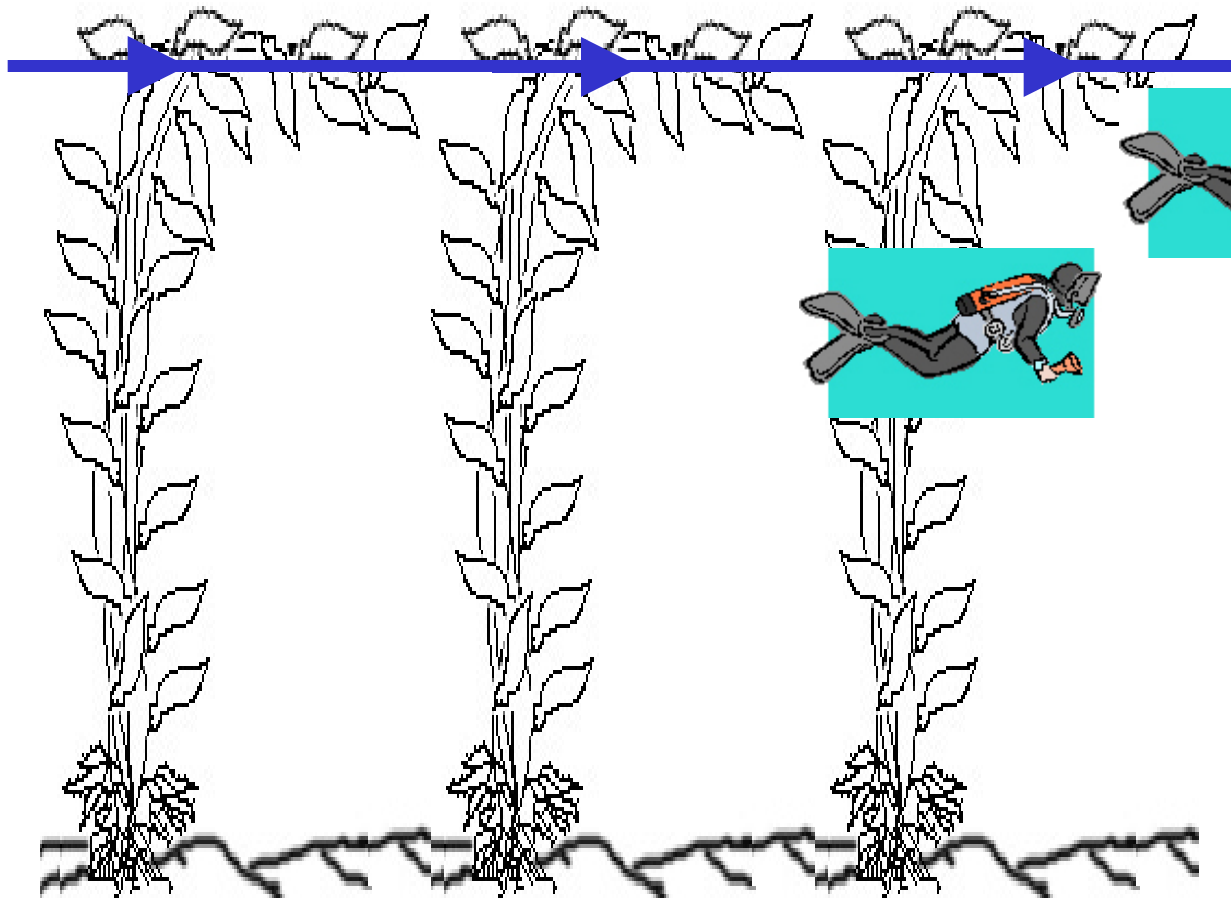
Diver 2 (bottom)

- lays tape while swimming transect
- records identity, number and size of fishes
- in 2m wide by 2 m tall by 30m long transect

30m transect duration: 8-10 min

Fish Surveys

canopy



ape
Is identity,
number and size of
fishes
- in 2m wide by 2 m
tall by 30m long
transect

Diver 2

- Stays behind Diver 1
- Estimates canopy cover
- counts kelp stipes

30 m transect duration: 6-10 min

Surface / Canopy Survey Datasheet

[illegible]

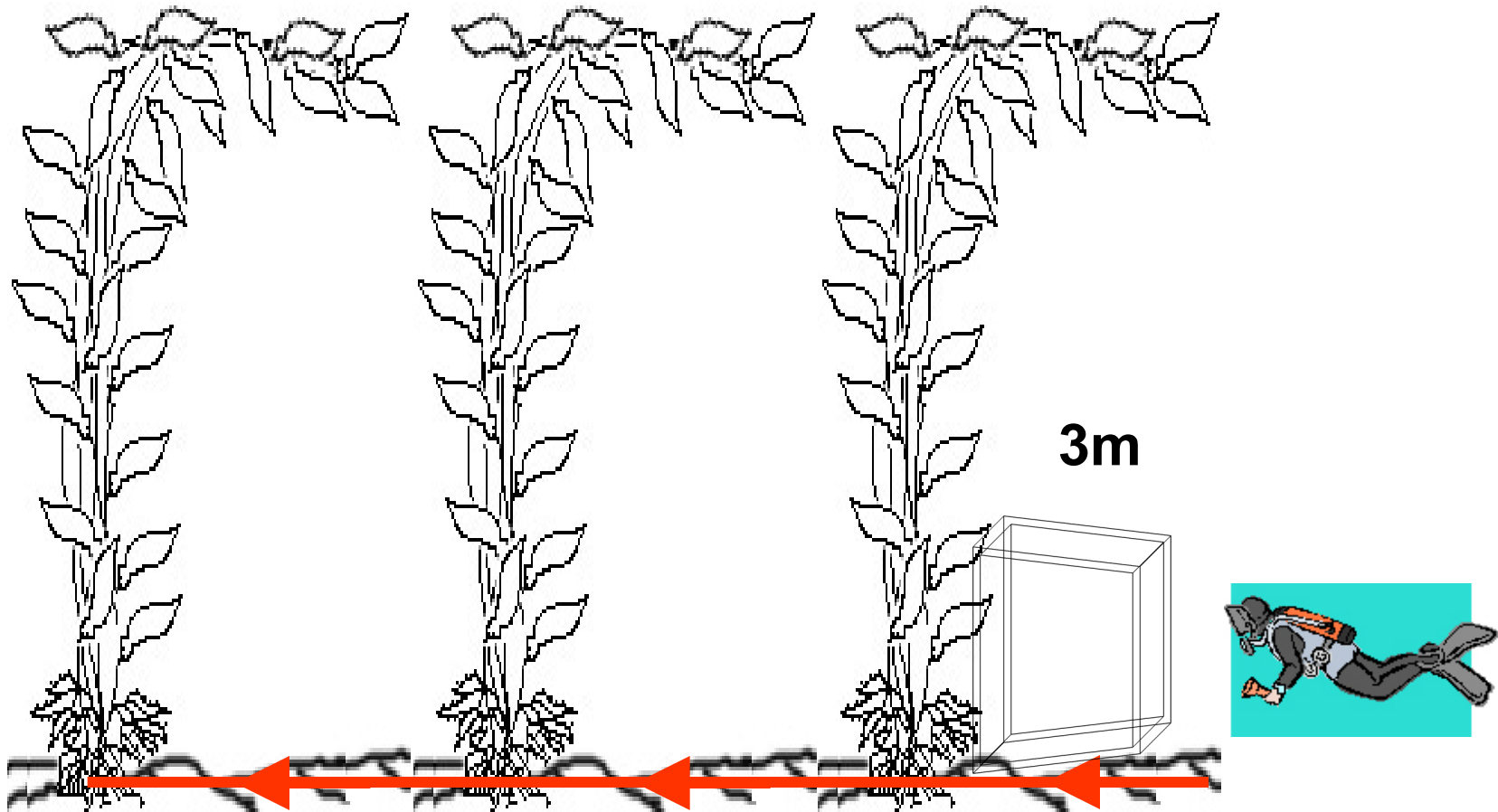
Survey Methods and Counting Rules

1. Transect location: depth and distance from shore supersedes outer edge of forest !!!
2. Drop to bottom (together) at pre-determined depth
3. Identify start and direction
4. Secure transect tape to kelp or rock
5. Mid-water diver begins, stays ahead, and maintains visual contact with btm diver (constrained by depth)
6. Only count ahead, never look back to count behind you
7. Maintain reasonable speed (can bias counts)

Survey Methods and Counting Rules

1. Sequential windows of 2-3 m (use habitat markers)
2. First: count large mobile exposed fishes -- SNAPSHOT
3. Second: search and count unexposed fishes
4. Repeat next window
5. End of transect:
 - “pop” and rewind transect tape
 - regroup
 - random number of kicks to start of next transect
6. High relief -- contour rock and maintain depth
7. Sand -- if headed off reef > 4 m, redirect transect

Moving Windows

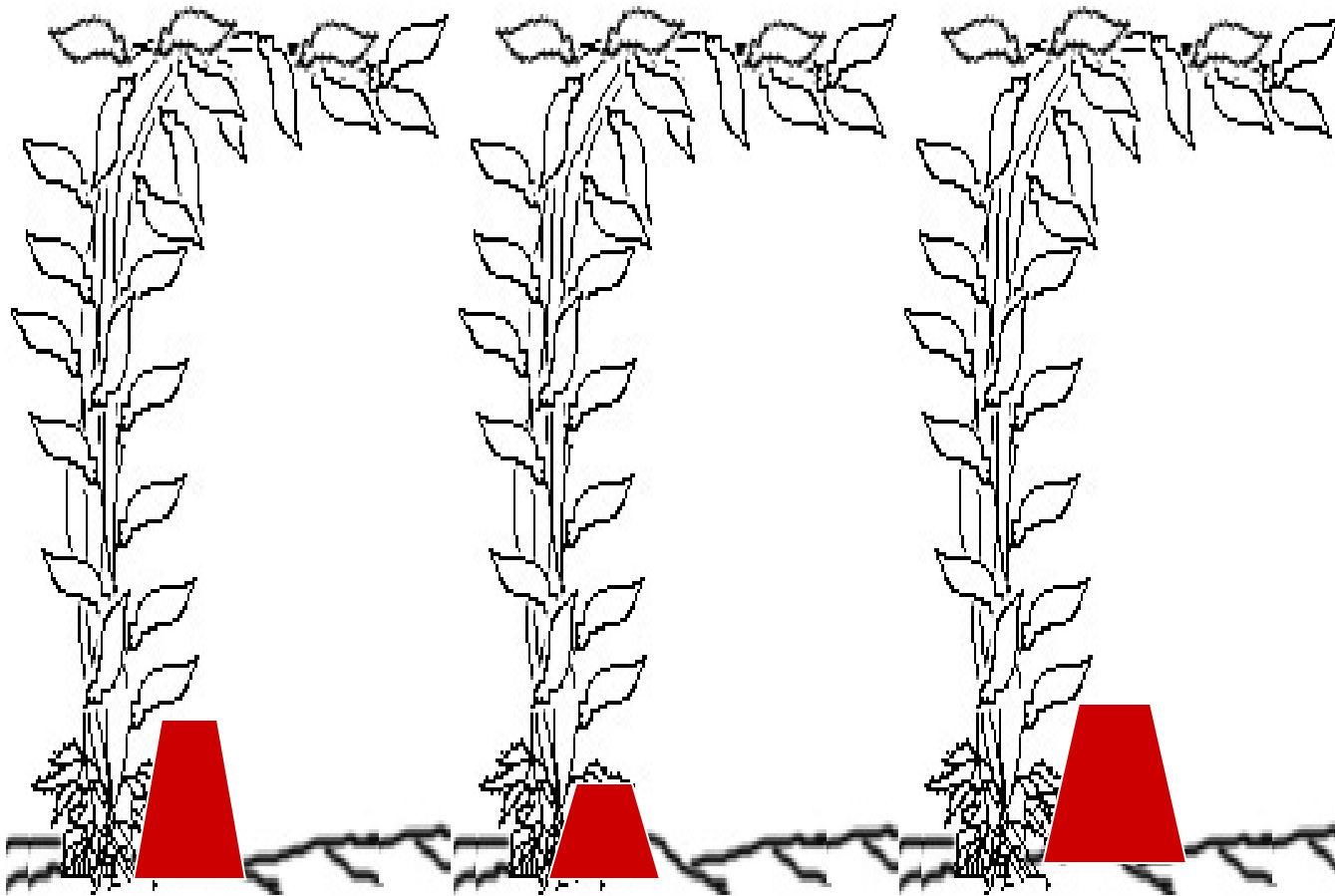


Moving Windows

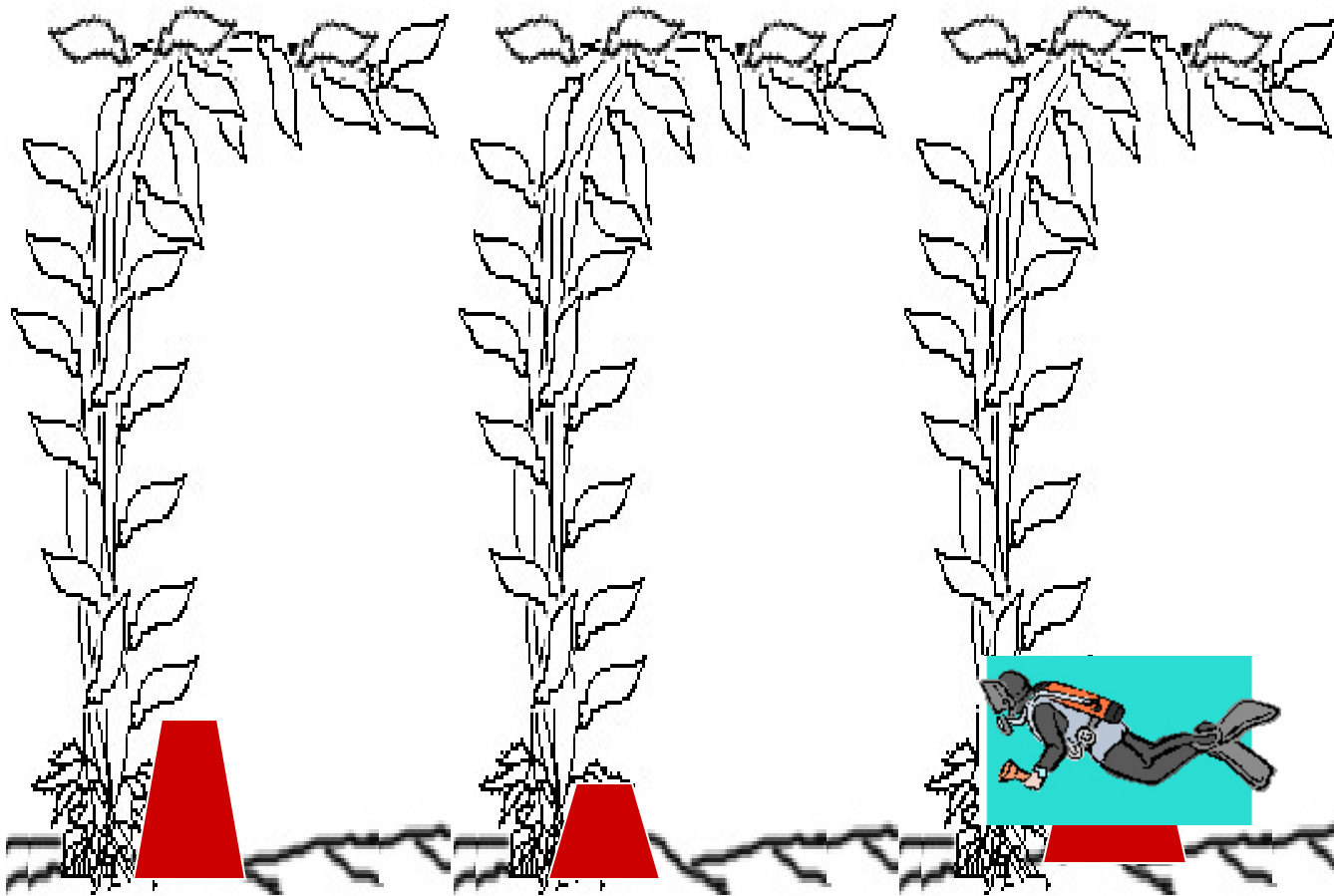


Look ahead, but not too far ahead

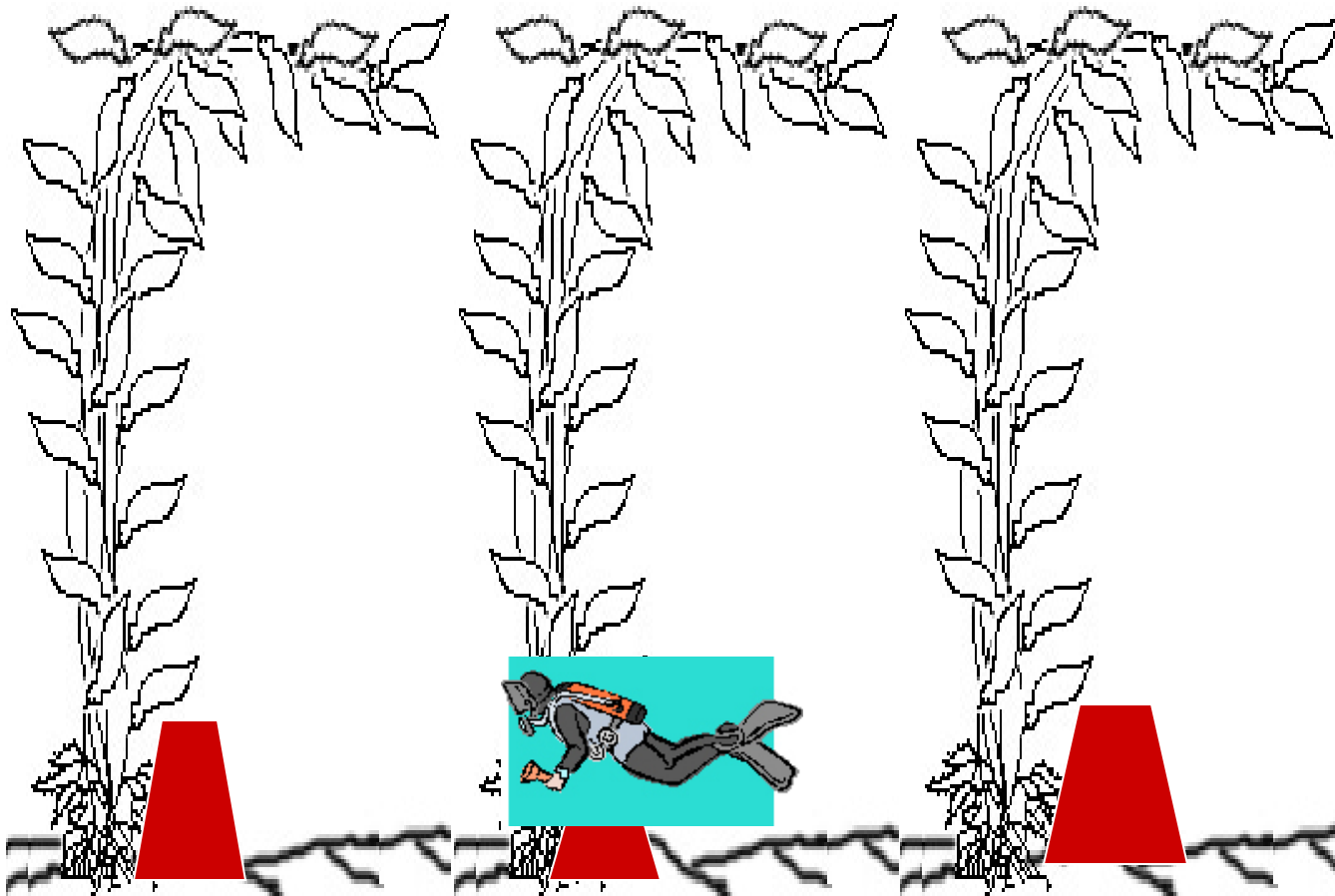
Moving In Bounds



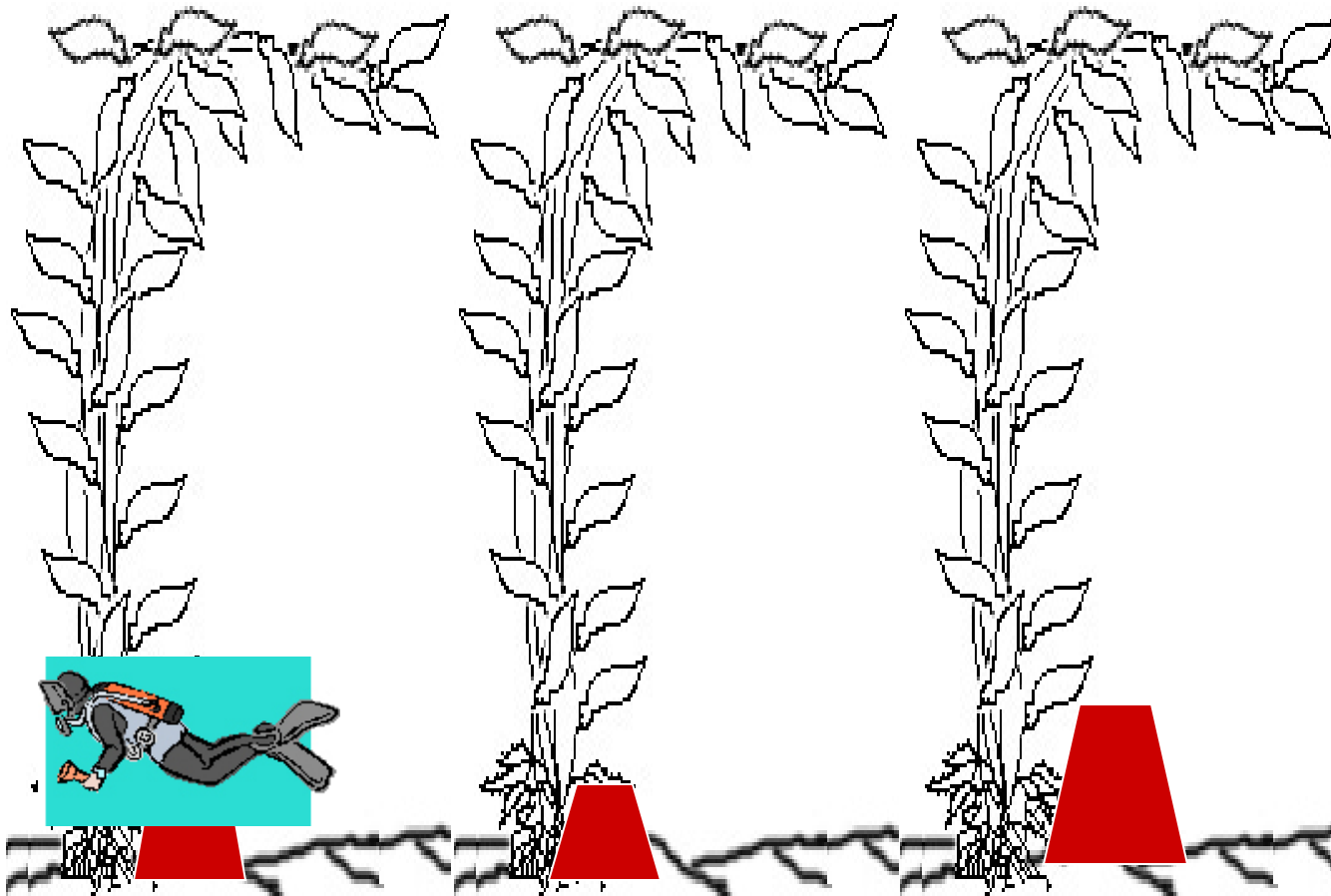
Moving In Bounds



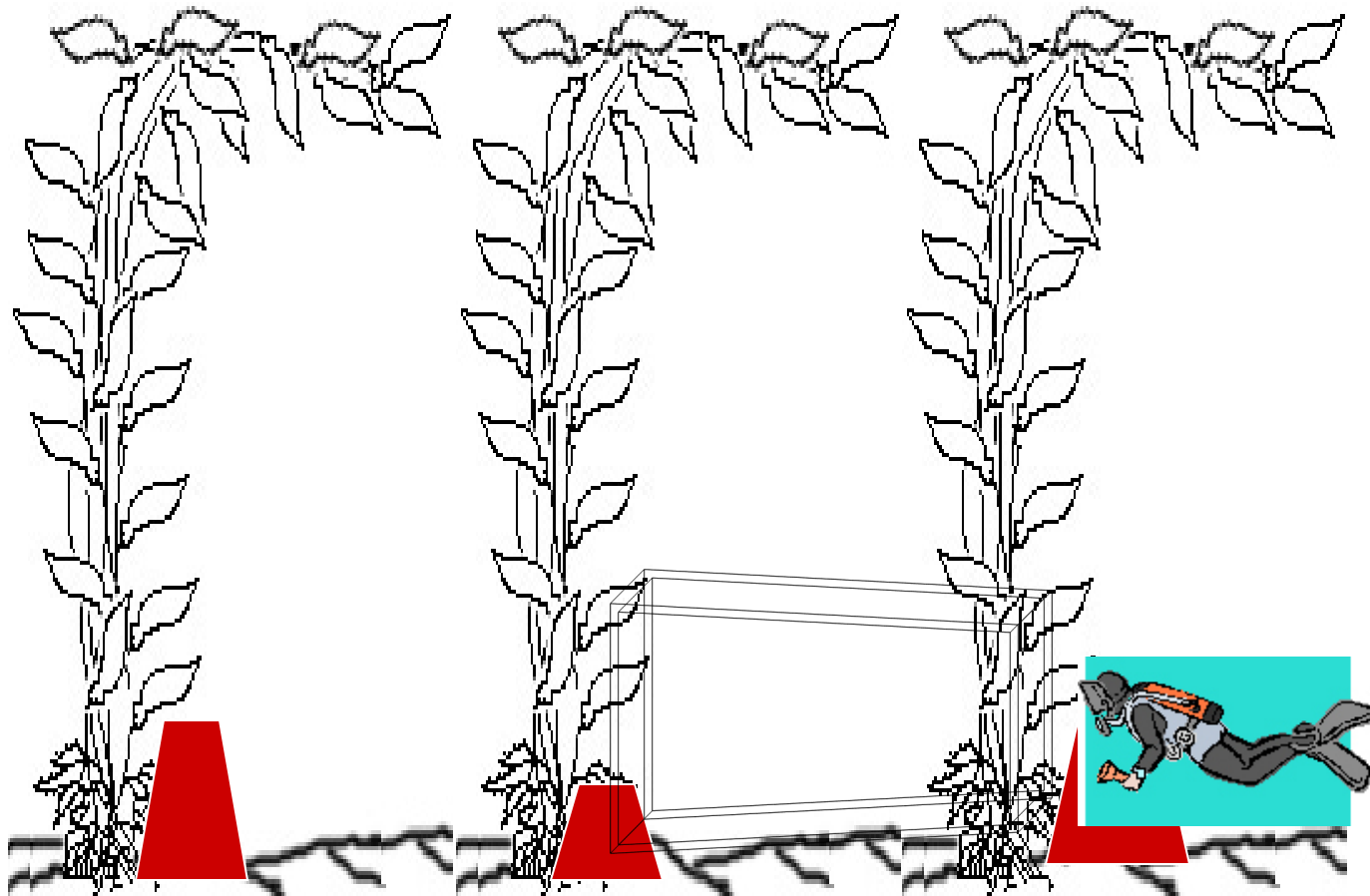
Moving In Bounds



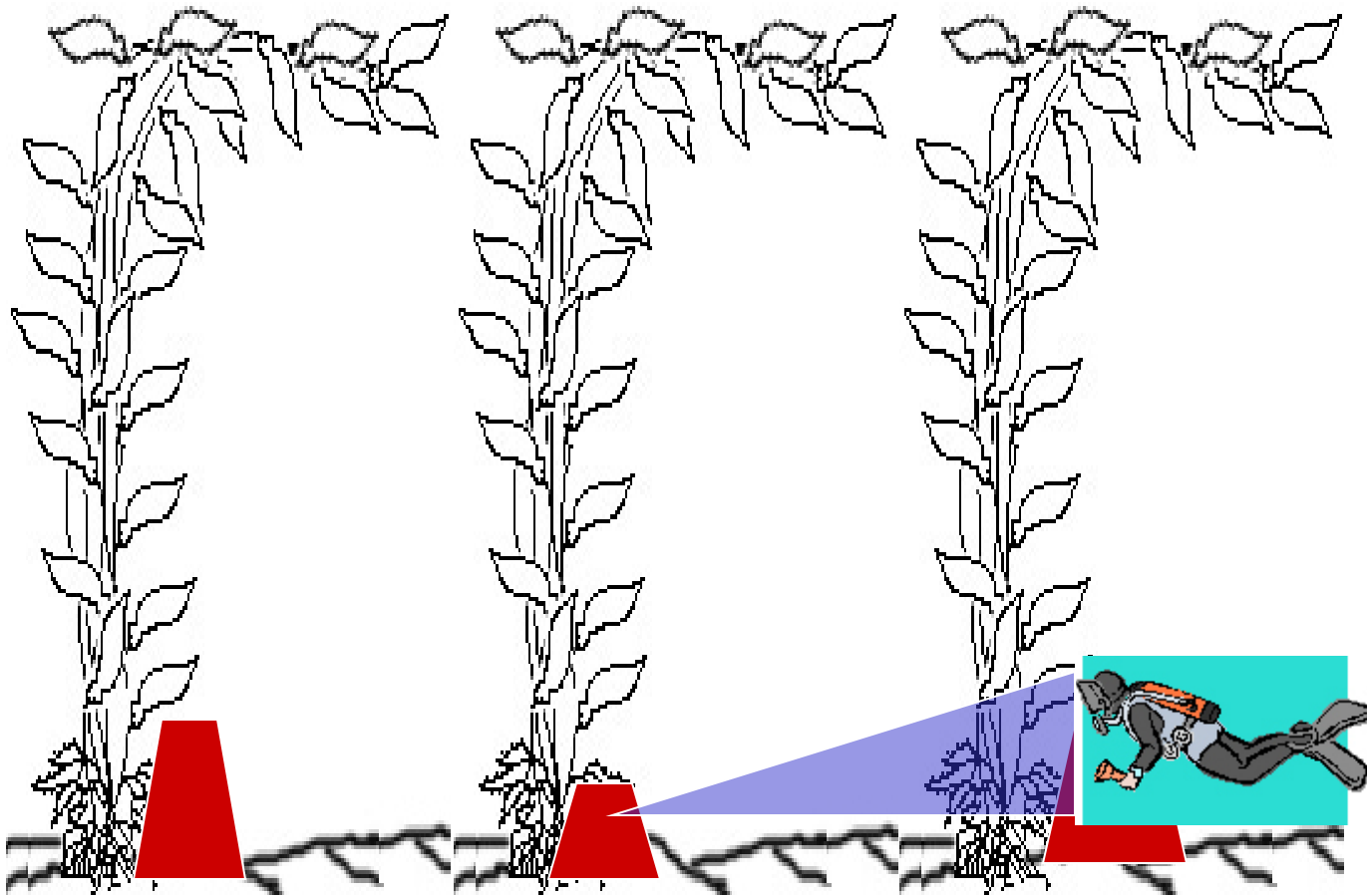
Moving In Bounds



Use landmarks to help divide the transect

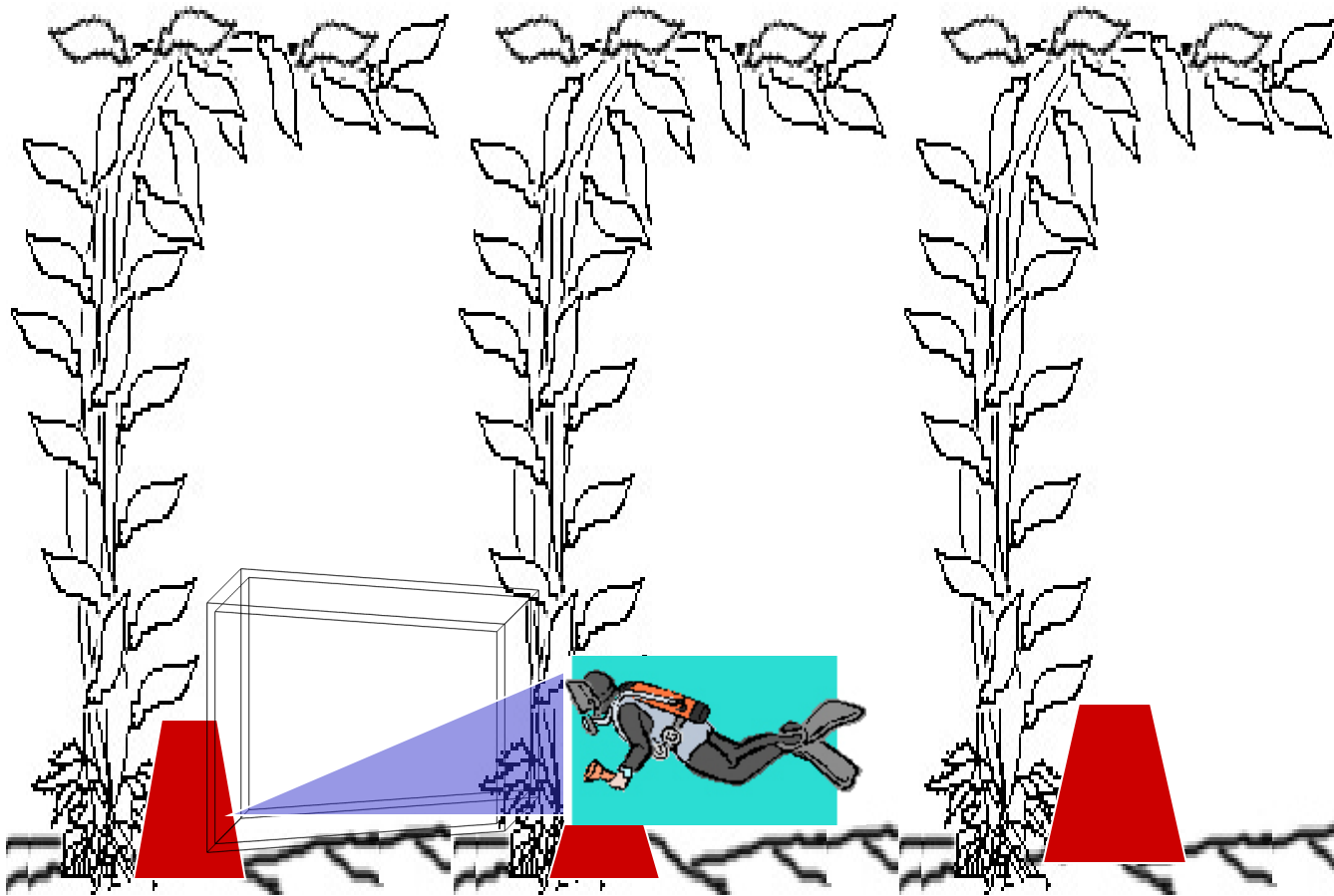


Stop, Scan, Search

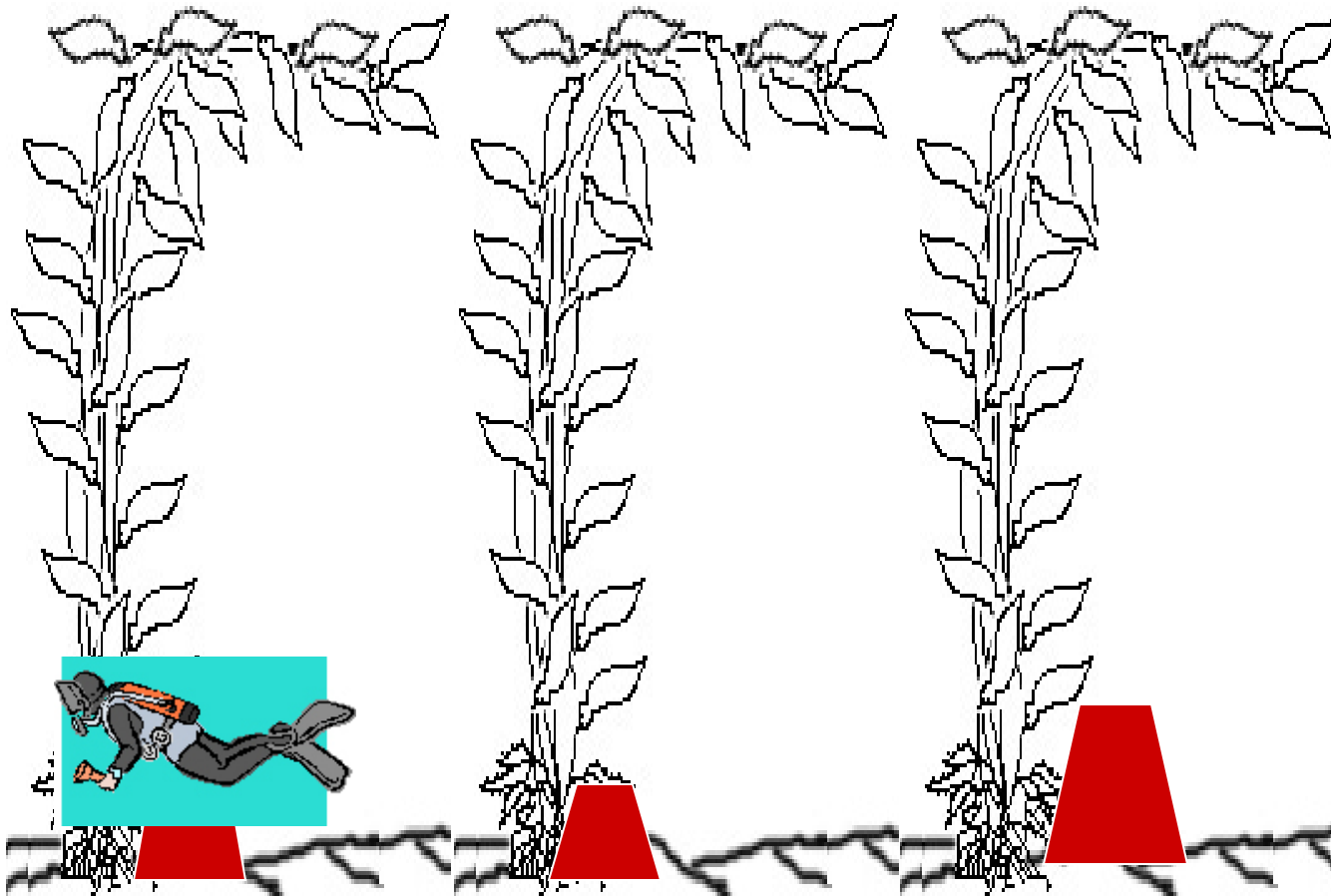


Sedentary, solitary, cryptic species

Stop, Scan, Search



Stop, Scan, Search



Structure your counts, develop routine

When do I write all this stuff down?

1. After scan at beginning of bound, record mobile exposed species
2. At end of bound, record unexposed species
3. When you have more than 3 tallies to remember
4. Whenever you need to!

Golden rule: Rarely lower your slate!

SITE	UPCOAST / DOWNCOAST				DIVERS		DATE		TIME IN		OUT
ZONE (m)	5	10	15	20	SURGE: (L)ight - no significant surge (M)oderate - noticeable lateral movement, diver must compensate (H)igh - significant surge, diver moved out of transect bounds when not holding on						
FISH >	Blue rf	Black rf	OYT	KGB	Kelp rf	Gopher	Black /Yellow	Copper rf	Canary rf	Senorita	
LEVEL											
TRANSECT											
DEPTH (M)											
VISIBILITY (M)											
SURGE											
HEADING											
TEMP (C.)											
			Pntd grnlg	Blkeye gobie	Kelp grnlg	Striped prch	Rnbw perch	Black perch	Pile perch		
FISH >	Blue rf	Black rf	OYT	KGB	Kelp rf	Gopher	Black /Yellow	Copper rf	Canary rf	Senorita	
LEVEL											
TRANSECT											
DEPTH (M)											
VISIBILITY (M)											
SURGE											
HEADING											
TEMP (C.)											
			Pntd grnlg	Blkeye gobie	Kelp grnlg	Striped prch	Rnbw perch	Black perch	Pile perch		
FISH >	Blue rf	Black rf	OYT	KGB	Kelp rf	Gopher	Black /Yellow	Copper rf	Canary rf	Senorita	
LEVEL											
TRANSECT											
DEPTH (M)											
VISIBILITY (M)											
SURGE											
HEADING											
TEMP (C.)											
			Pntd grnlg	Blkeye gobie	Kelp grnlg	Striped prch	Rnbw perch	Black perch	Pile perch		

Data Recording Protocols

Data should be placed on data sheets in the following manner:

Size of fish should be in centimeters on **left side** of box not set off by any other marks (parentheses, dashes, quotes, etc.)

If a size is by itself within a box anywhere other than on the left hand side of the box, it should be circled for clarity.

Number of fish counted should be placed to the **right of the size of the fish inside parentheses** with numbers separated by commas as follows:

12 (9, 15, 1)

(i.e. nine 12 cm long fish, then fifteen 12 cm long fish, then one 12 cm long fish)

The number 11 is denoted with a capital **E** for any size or frequency.

E (9, 15, E)

Any two vertical lines that could otherwise be interpreted as the number 11, will be interpreted as hatch marks indicating a quantity of 2 or a size of 2.

Size Ranges (i.e. 1-4, 5-9, 10-14 cm) are acceptable when a diver feels that he/she is unable to reasonably estimate the actual size of each individual fish (i.e. schools of blues, aggregations of YOY's).

Ranges should be kept within a 5 cm bin (for example 25-29 or 30-34), but if possible, smaller bins should be made.

When denoting Male vs. Female Fish (Kelp Greenling and Sheephead), make symbols clear (♀ and ♂). It is acceptable to use (F and M) for the same purpose, but symbols are preferred.

All Black-eyed Gobies should be larger than 8 cm to be recorded on data sheet.

All small, cryptic sculpins will **NOT** be recorded except for juvenile cabezon

Olive and Yellowtail Rockfish are to be grouped in an OYT category.

Fish that are unknown should be classified **to the best specific possibilities** (such as “smelt” (jack or top), or “white perch” or “silver perch”), or into the nearest taxonomic grouping possible (i.e. genus or family).

If neither the specific possibilities, nor a genus or family can be discerned, fish should be recorded as **“unknown”** with a description for immediate topside investigation. No unknown beyond the above parameters shall be left as such without consent with others upon review.

Sampling Protocols:

Btm fish divers must use flashlights AT ALL TIMES to look in cracks, holes, and to help in the identification of YOY's.

Mid fish divers must always have a flashlight to use yourself or to give the Btm diver if they lose theirs.

Data Sheets must be checked by the individual diver AND by one person in charge of collecting data sheets for the day.

**All information must be filled out, including:
(transect, depth, temperature, surge, etc.)**

SITE		UPCOAST / DOWNCOAST				DIVERS		DATE		TIME IN		OUT	
ZONE (m)		5	10	15	20	SURGE (H)igh - significant surge, diver moved out of transect bounds when not holding on; (M)oderate - noticeable lateral movement, diver must compensate.							
FISH	Blue rf	Black rf	OYT	KGB	Kelp rf	Gopher	Black /Yellow	Copper rf	Canary rf	Senorita			
LEVEL	B	M											
TRANSECT	1	2	3										
DEPTH (M)													
VISIBILITY (M)													
SURGE					Pntd grnling	Blkeye gobie (> 8 cm)	Kelp grnling	Striped prch	Rnbw perch	Black perch	Pile perch		
HEADING													
TEMP (C.)													

* write **D** after observations of Rockfish YOY seen over drift algae:

Looked for? ☐

UPCOAST/DOWNCOAST: These are legacy terms to distinguish two nearby sites in the same area (e.g., Hopkins UC and DC). UC is toward the pole and DC toward the equator as you traverse the coastline.

Zone (5, 10, 15, 20): A division of the side into 4 categories representing onshore (5m)-offshore (20m) stratification or targeted bottom depths (m) for transects.

Level (B M): Letter code for the position of the transect in the water column (Bottom or Midwater)

Transect (1, 2, 3): A number representing one of the three transects sampled within the same zone. With the heading and zone, this describes the location of each transect relative to all others.

Depth: Average actual depth of the transect estimated by the diver.

Visibility: The diver estimation of horizontal visibility on each transect. Measured by reeling in the tape and noting the distance at which the end of the tape can first be seen.

SITE		UPCOAST / DOWNCAST				DIVERS		DATE		TIME IN		OUT	
ZONE (m)		5	10	15	20	SURGE: (L)ight - no significant surge (M)oderate - noticeable lateral movement, diver must compensate. (H)igh - significant surge, diver moved out of transect bounds when not holding on							
FISH >		Blue rf	Black rf	Gtn	KCD	Kelp rf	Copher	Black/Yellow	Copper rr	Canary rf	Senorita		
LEVEL													
B M													
TRANSECT													
1 2 3													
DEPTH (M)													
VISIBILITY (M)													
						Pntd grnling	Blkeye gobie (> 8 cm)	Kelp grnling	Striped prch	Rnbw perch	Black perch	Pile perch	
SURGE													
HEADING													
TEMP (C.)													

* write **D** after observations of Rockfish YOY seen over drift algae: Looked for? ☐

Surge: Diver estimation of magnitude of horizontal displacement on each transect, recorded at depth

- (L)ight - no significant surge
- (M)oderate - noticeable lateral movement, diver must compensate.
- (H)igh - significant surge, diver moved out of transect bounds when not holding on

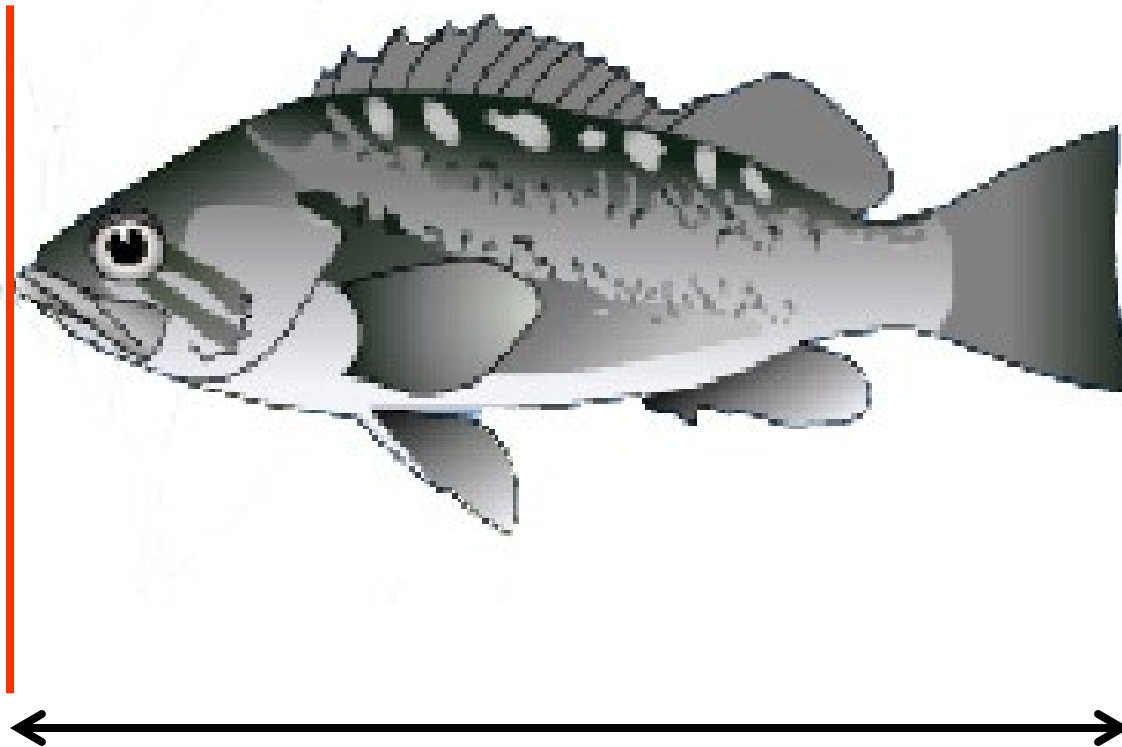
Heading: Compass direction of transect along isobath

Temp: The temperature on each transect measured by the diver's computer.

Sizing Fish Underwater

1. Total length
2. Aids to sizing fish
3. Factors that contribute to over- or under-estimation

1. Total length



Total length
Target accuracy $\pm 10\%$

2. Aids to sizing fish

1. Slate marks
2. Hand measurements (measure your hand)
3. Bracketing (with habitat features)
4. Comparative approach (with habitat features)
5. Recalibration during dive (check yourself)

3. Factors that contribute to under and overestimation of size

	Underestimate	Overestimate
1. ambient light	low	bright
2. body color	dull	bright
3. visibility	poor	good
4. objects	in foreground	in background
5. body shape	deep-bodied	elongate

Safety Considerations

1. Dive profiles

- approved by DSO
- well within no-decompression limits
- maximum depth 20m
- 3-5 min safety stops mandatory on dives below 10m

2. Air consumption

- **safety over data collection** (300 – 500 psi minimum)

3. Buddy system

- members of a dive team are always in visual contact
- follow buddy when retrieving meter tape

4. Sea conditions

- diving will only be conducted in good conditions

5. Live boating

- be careful surfacing

Dive Safety Brief

1. Dive log - sign out and in
2. Dive procedures
 - ascent rate 10m / min
 - deep-shallow
 - maintain dive team
3. Communications: cell phone, VHF Ch 16, SPOT
4. First Aid & Oxygen - shore and vessel
5. Evacuation plan: develop for each section of the coast... **everyone** needs to be thinking of this

Dive Safety Brief

6. Communication is a team effort (everyone's responsibility):

- Emergency personnel (911, Coast Guard)
- DAN
- DSO (Dave Benet) and BSO (Ian Moffitt)
- Dive supervisor
- PI (me)

Evaluation During Training

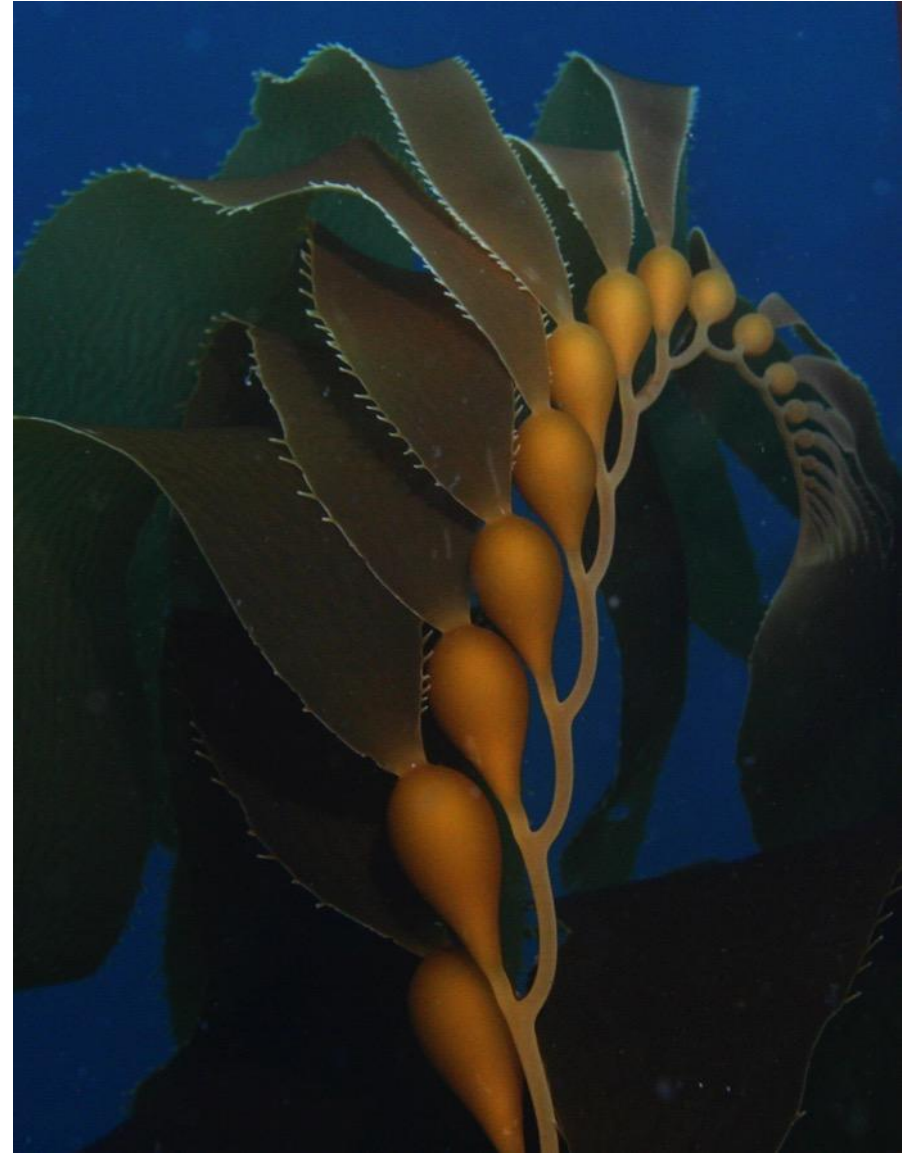
1. Ongoing
2. Some self-evaluation required
3. End of day - submit data sheets
4. Species ID quizzes
5. Feedback



2026 PISCO UCSC Invertebrate and Algae Sampling Methods

Overview of today's training

- **PISCO Annual Survey Design**
- **Swath survey method**
- **UPC method**
- **Benthic transect protocol**
- **Organism ID slides**



Annual Survey Design

When:

June – September

1999 – present

Where:

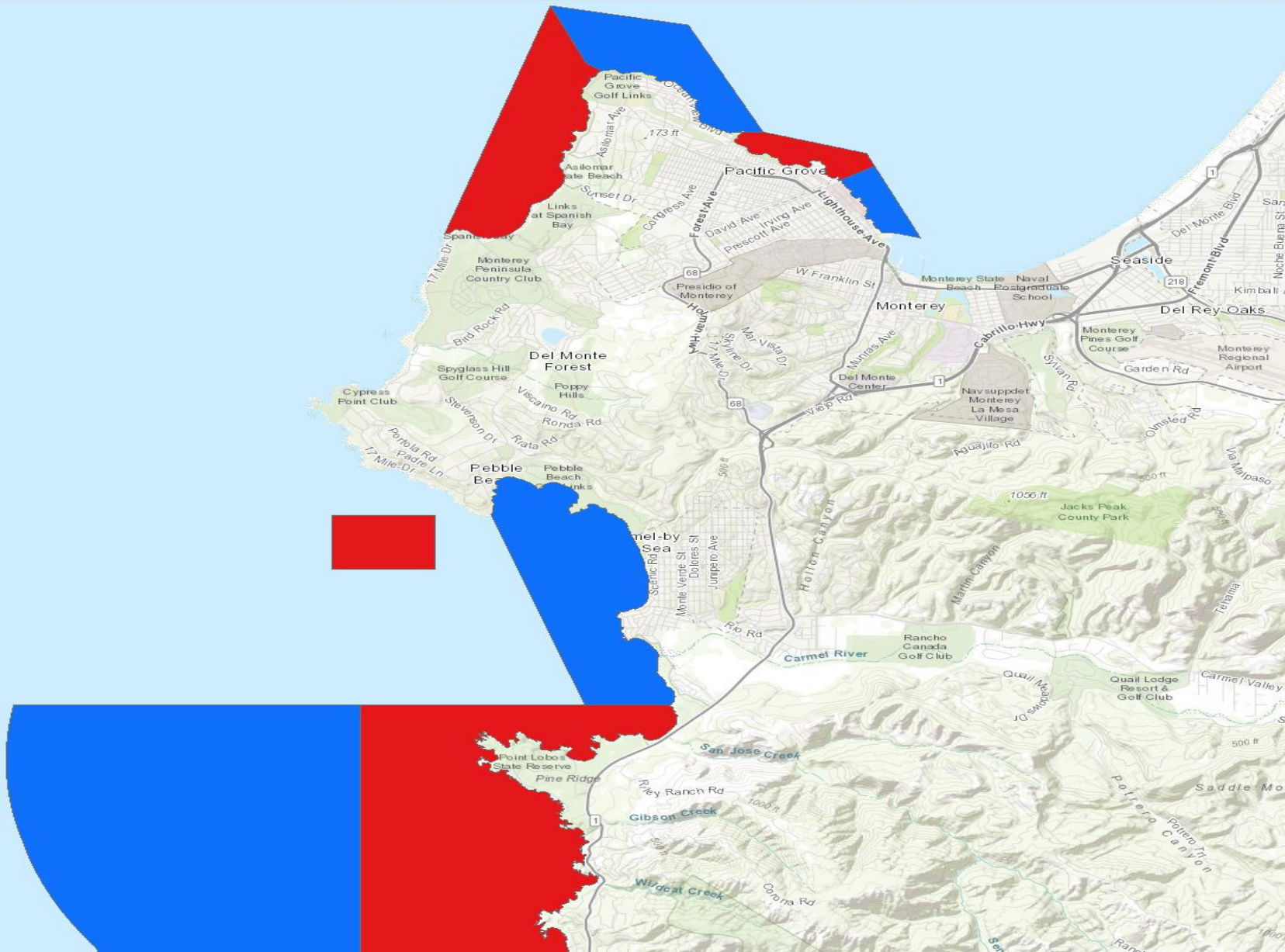
1. Different oceanographic regimes

- a) Lower upwelling – southern Monterey Bay
- b) Higher upwelling – Carmel Bay & Point Lobos

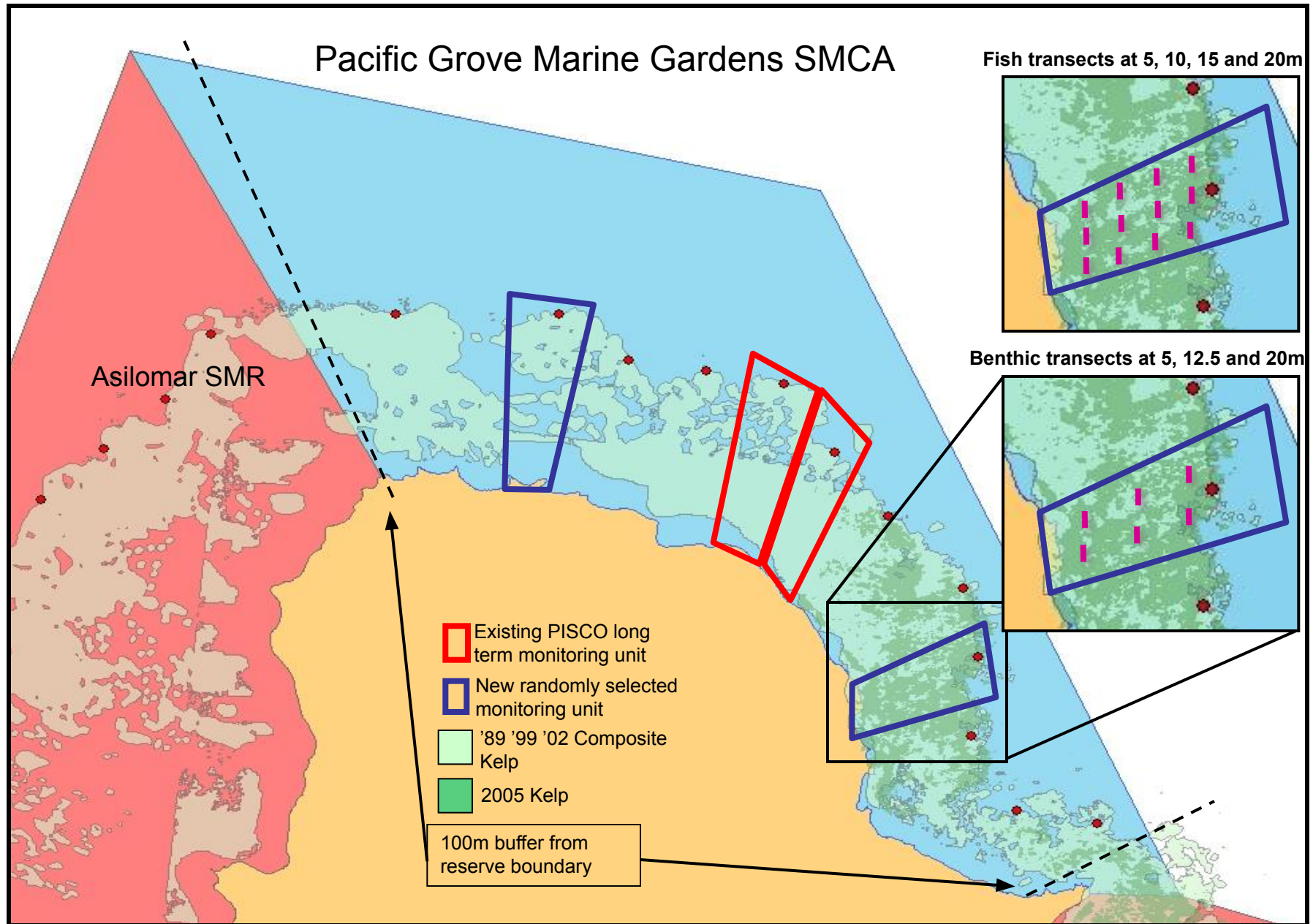
2. Marine Protected Areas and paired comparison sites

- c) Lover's Point SMR, Ed Ricketts SMCA, Pacific Grove Marine Gardens SMCA
- d) Point Lobos SMR, Pescadero Point, Soberanes

State Marine Protected Areas



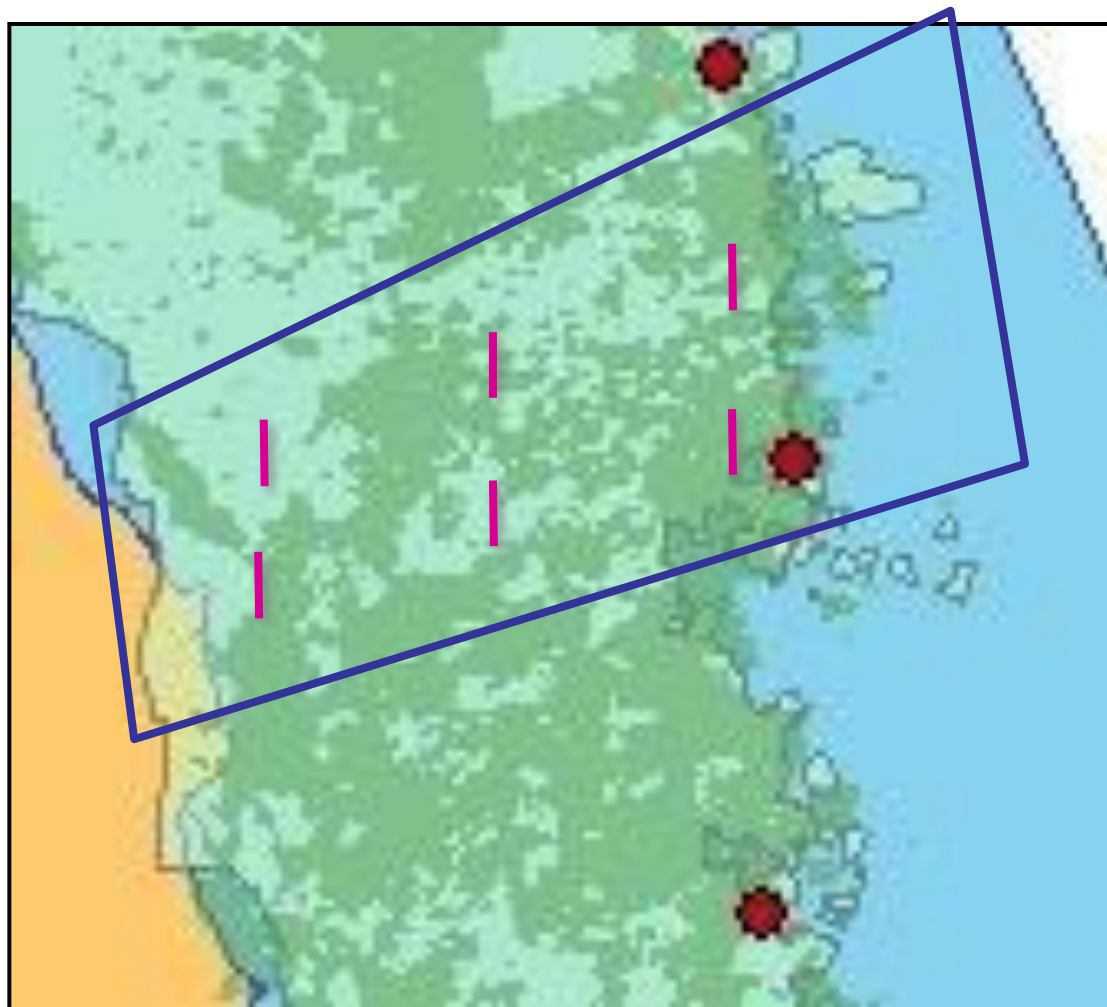
Example of permanent, stratified random sampling design



Depth-stratified sampling design: inverts & algae

Benthic transects: 30 m (n=2 per depth)

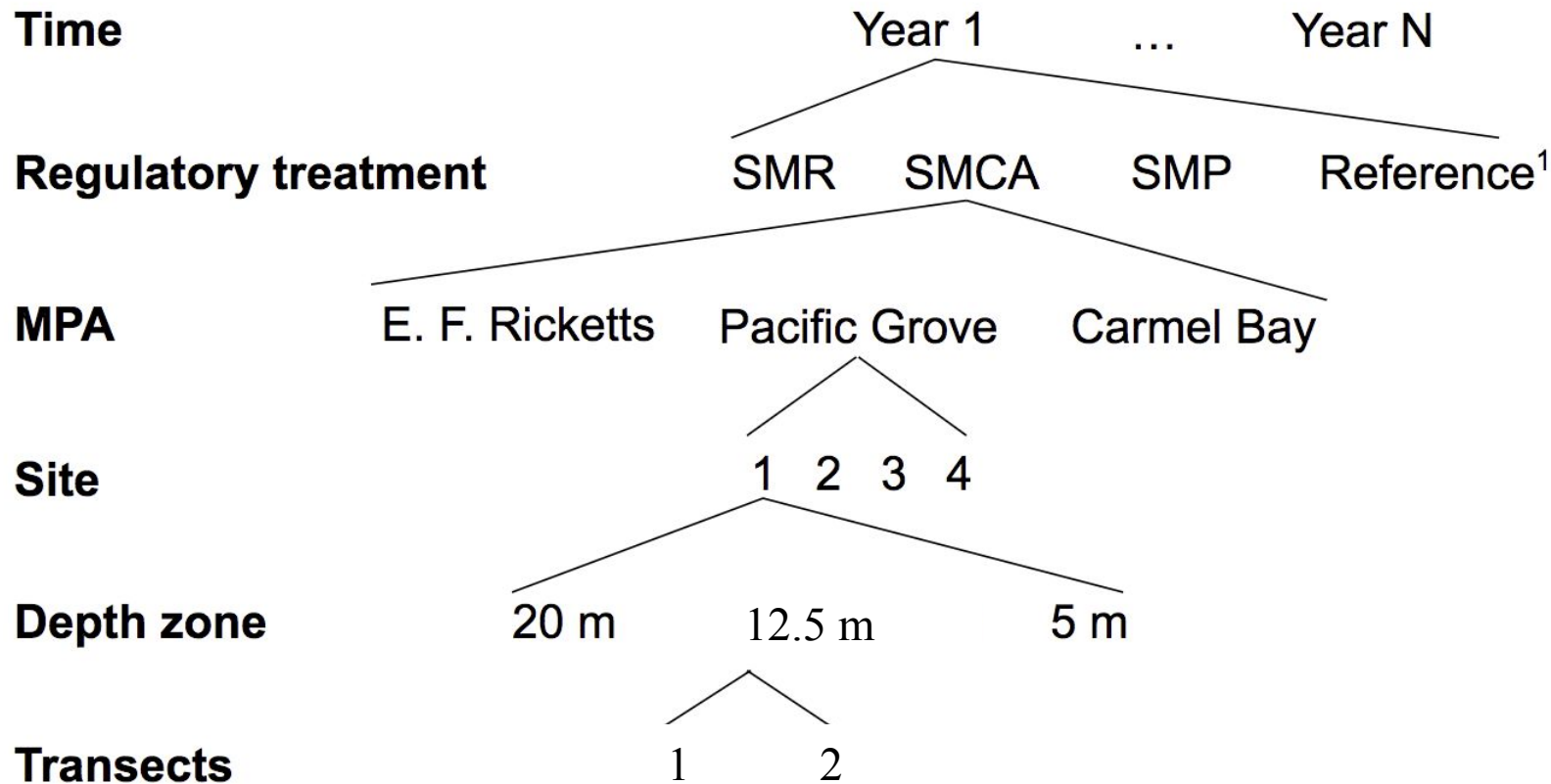
Transect depths: 5, 12.5 & 20 m



Annual Benthic Surveys – Nested Hierarchy

Source of variation

Levels



¹ Reference refers to sites outside any marine protected area.

Annual Benthic Surveys: Depth Stratification

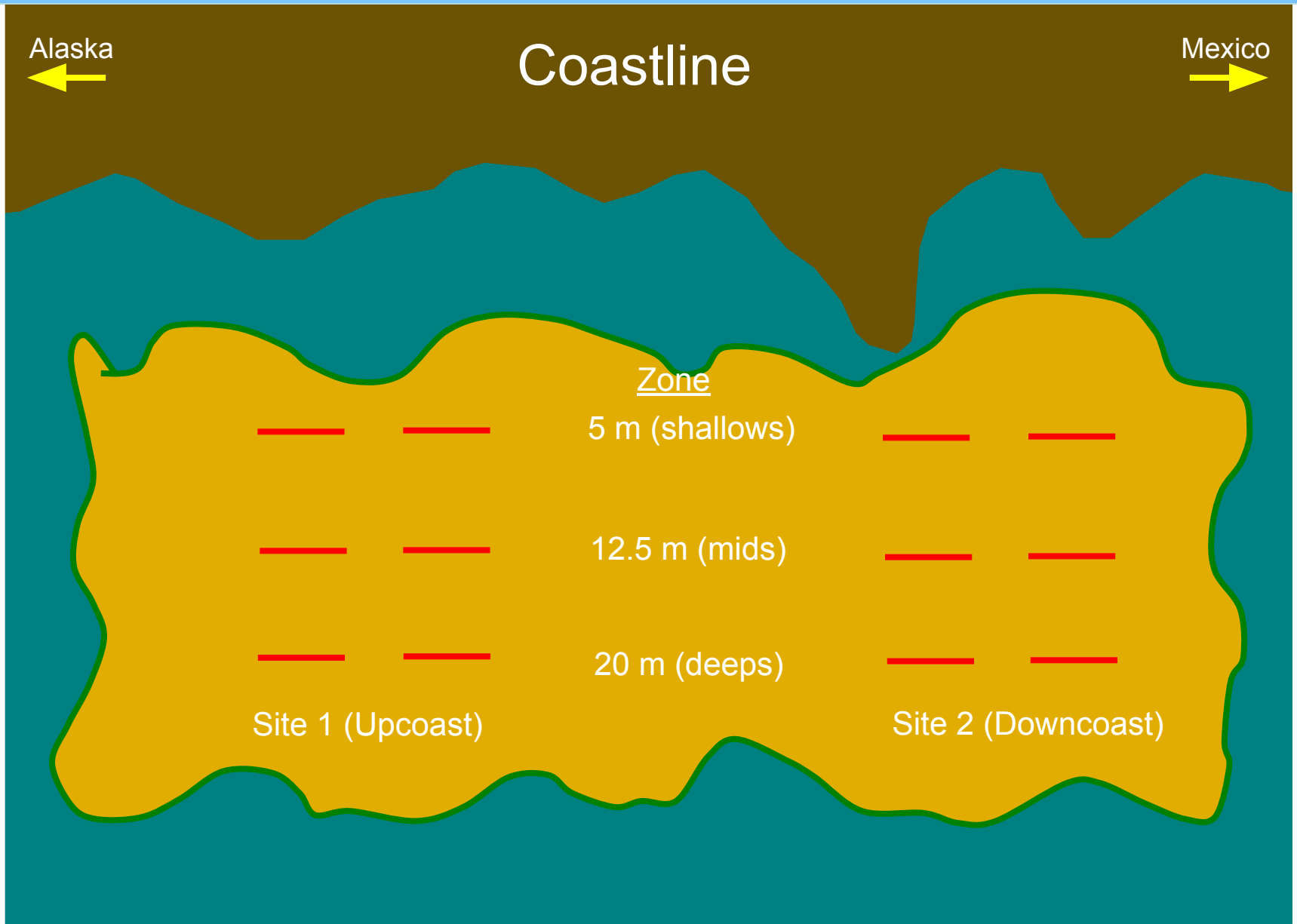
1. Depth zones:

Shallow (S) = 5 m, Mid (M) = 12.5 m, Deep (D) = 20 m

designed to assure that all depth zones are representatively sampled for description of invert and algae assemblages.

2. Allows representative sampling from outer to inner edges of the reef.
3. If reef depths are constrained (e.g., 5-10 m), then sampling is distributed from outer to inner edges of reef including comparable depths (when possible) to those above (e.g., 5 and 10 m), plus additional depth strata to assure coverage from inner to outer edges of the reef.
4. Note that divers descend at known GPS locations, not where kelp is present or not. In some years, the kelp is very thick, and in others it can be absent. We have GPS points to tell us where to go for each depth zone and we return to them year after year.

Annual Benthic Surveys: Depth Stratification



Annual Benthic Surveys: 3 Methods

PISCO-UCSC divers use three methods:

- (1) Uniform point contact (**UPC**) to estimate percent cover of benthic organisms and to characterize the substrate
- (2) **Swath** transects to estimate the density of kelps and targeted macroinvertebrates
- (3) Size frequencies of kelp recruits and urchins (**KelpUR**)

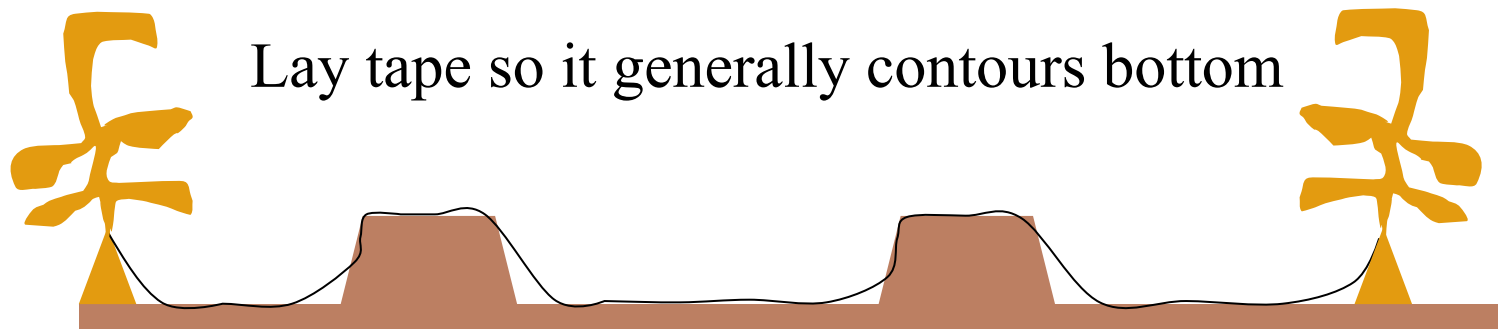
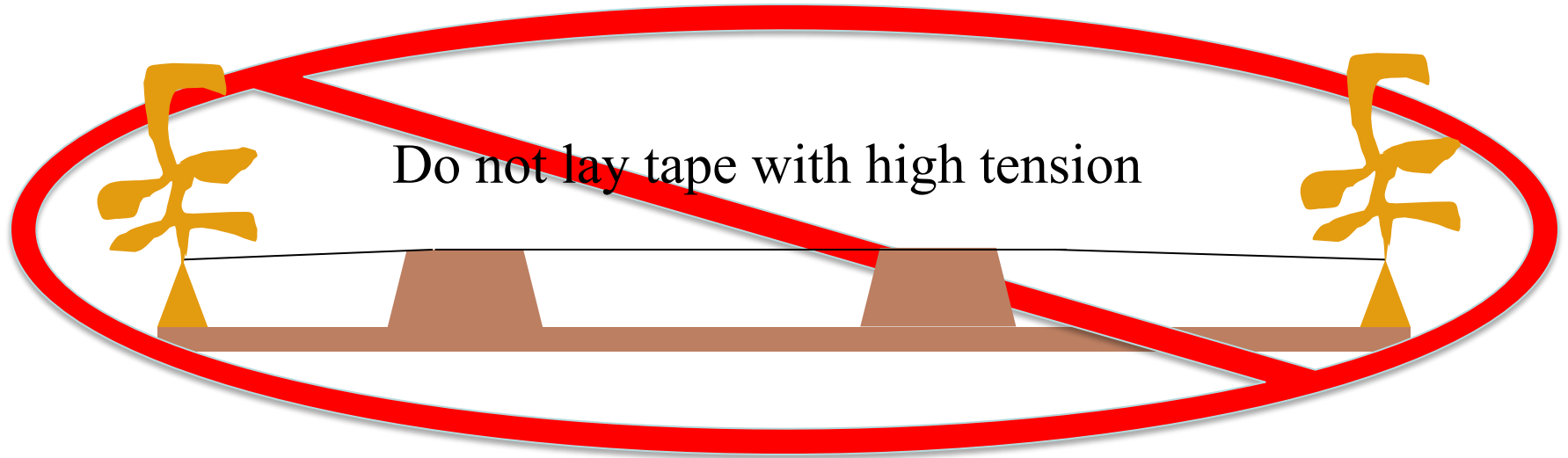
Annual Benthic Surveys: reeling tape out

Priorities: reef > depth > heading

- If your pre-designated compass heading will take you off reef, make a systematic deviation and maintain the new heading for the remainder of the transect, and record the new heading.
- Maintain constant depth (**continuously watching depth gauge**) by contouring around large rocks and avoid stringing the transect tape over very large crevices. ≤ 2 m total change along tape.
- Use kelp, rocks, etc. to wrap/anchor the transect tape along the bottom if there is high surge or the terrain warrants it.

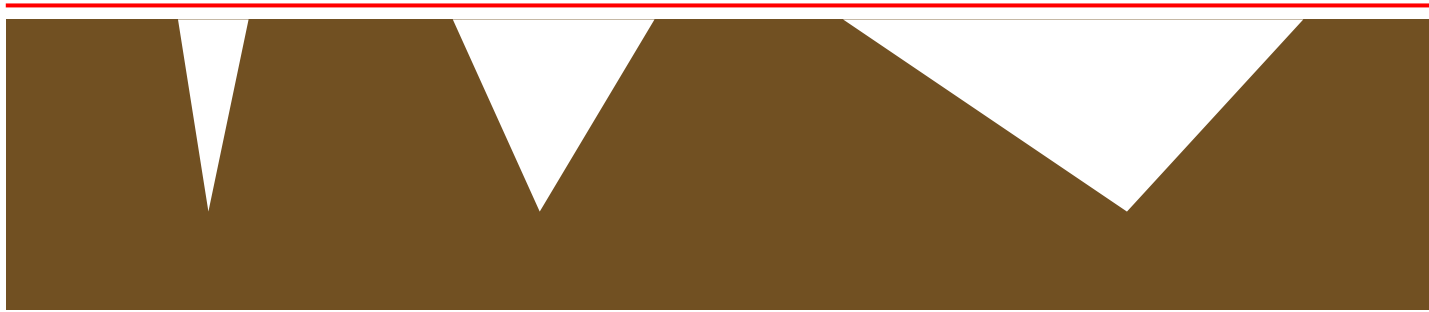
****If you ever complete a transect and feel that something was “off”, speak up. We can always re-do transects.****

Annual Benthic Surveys: tape tension

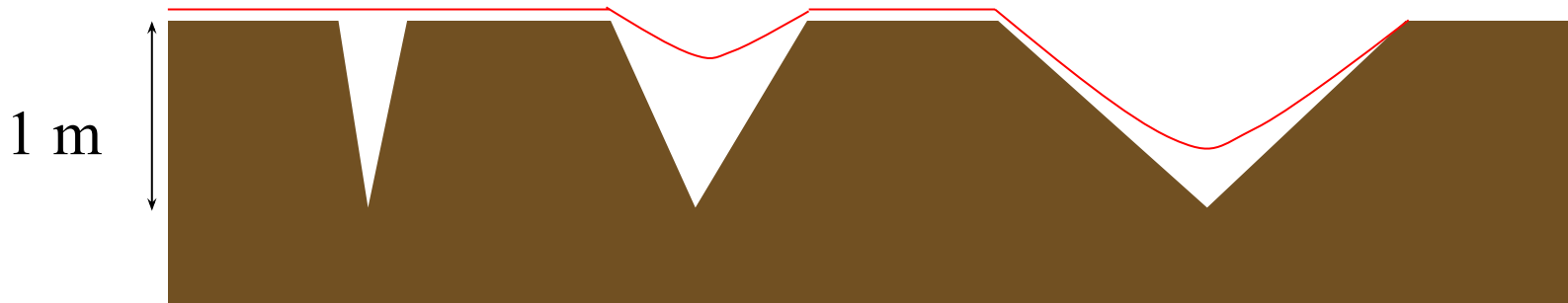


Annual Benthic Surveys: tape and crevices

Side view of reef with red tape: too taut



Less tension on red tape



Swath Surveys: mandatory flashlights

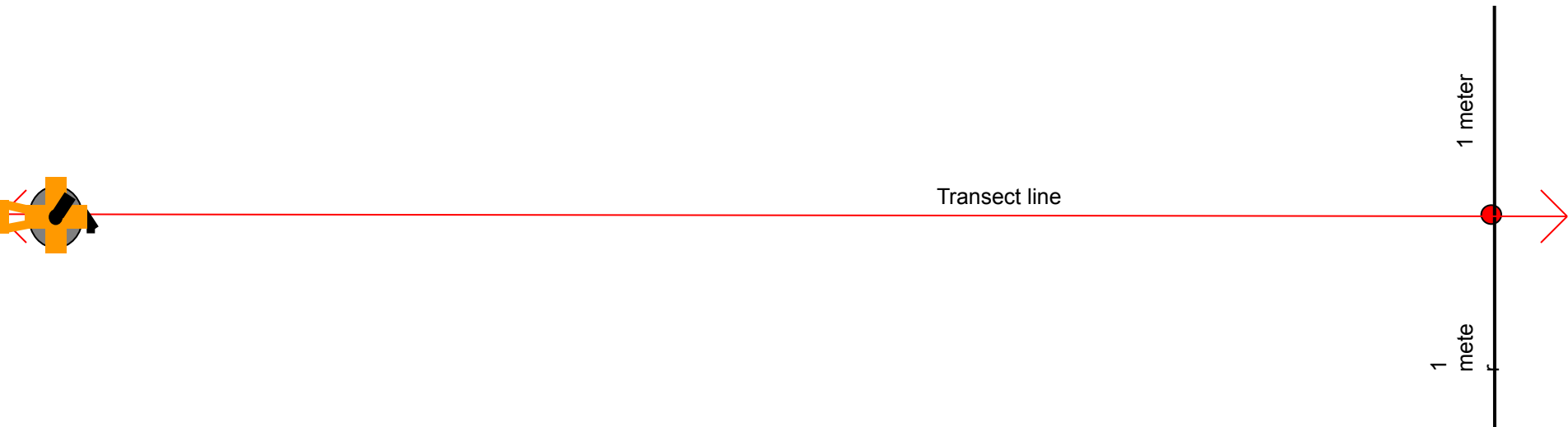


Use a flashlight at all times when surveying for swath invertebrates to make sure organisms in cracks and crevices are counted and identified

Swath Surveys: 2 m wide

Swaths should extend ***one meter on either side*** of the transect line.

Top view of transect

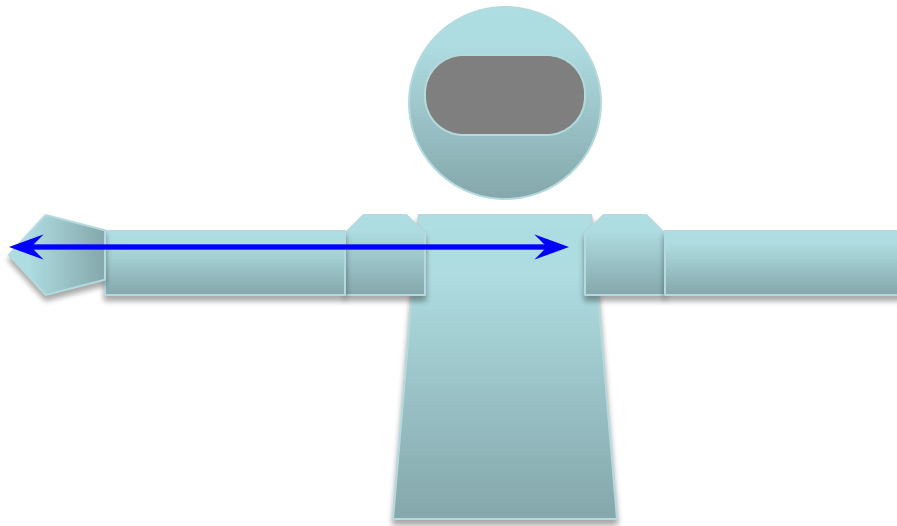


Maintain reasonable speed (~20 minutes per transect) and only count invertebrates 2.5 cm or larger in diameter (except urchins, abalone, and certain sea stars) & $\geq 50\%$ of body inside swath

Swath Surveys: 1 m body measurement

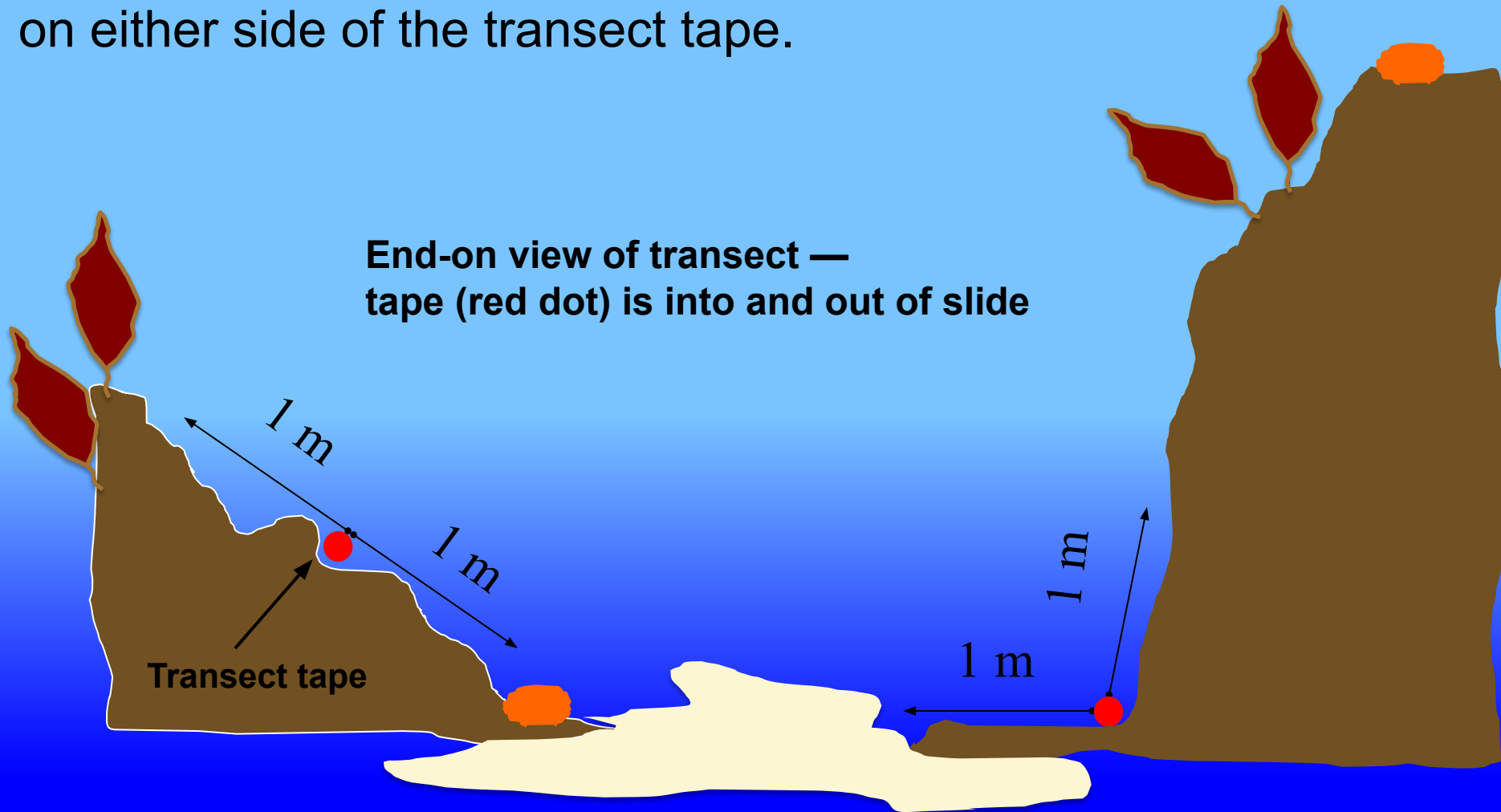
1 m is measured by diver extending arm and moving body over line to the point on chest where 1 m ends.

Each diver must know where on their body 1 meter from the tip of their fingers stops (endpoint). This is often near armpit, but it varies.

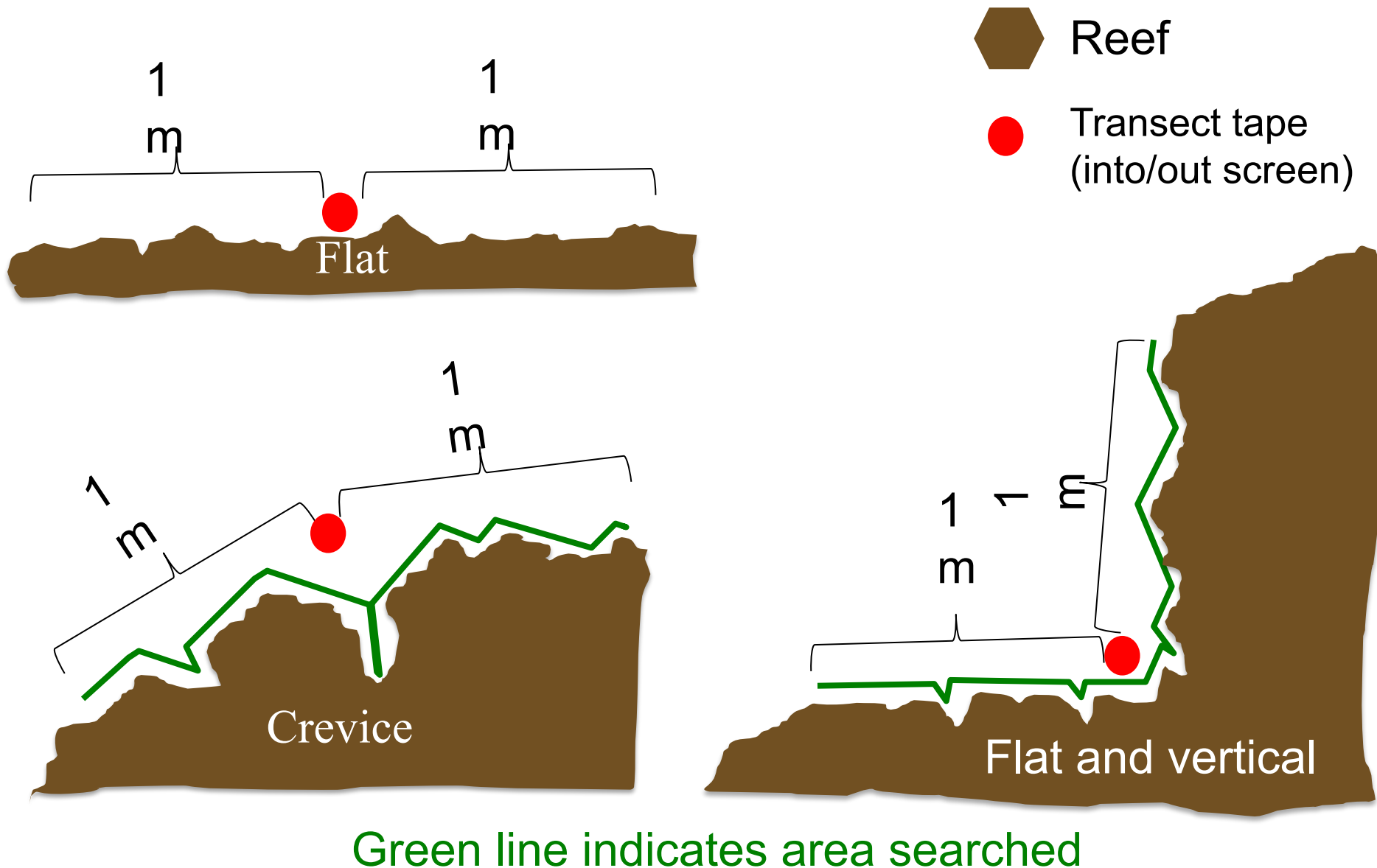


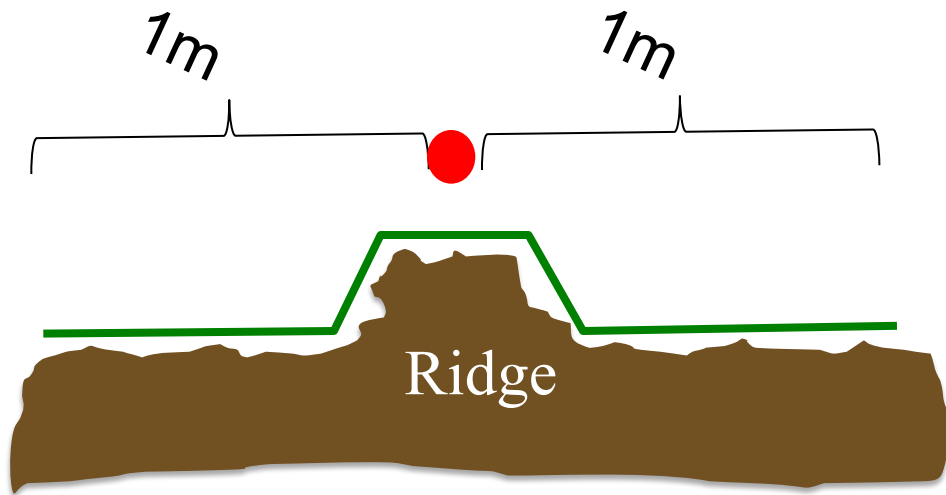
Swath Surveys: swath width

Diver uses “arm to endpoint” to measure 1 m on either side of the transect tape.

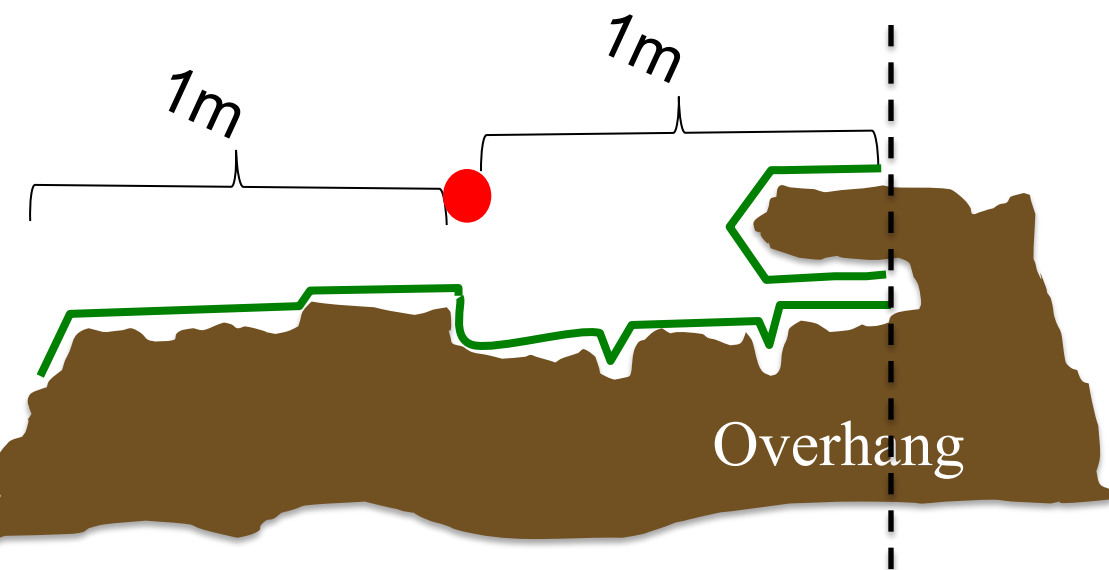


Swath Surveys: search area

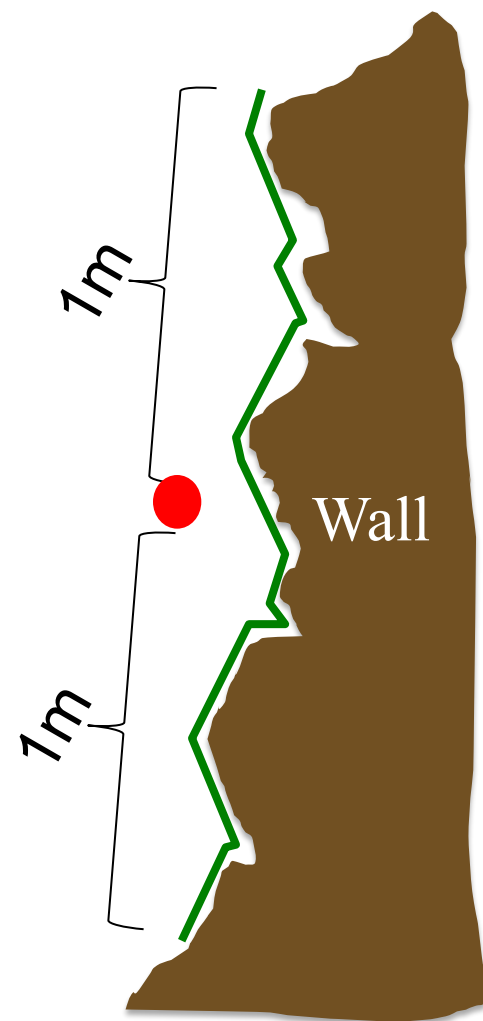




Green line indicates area searched

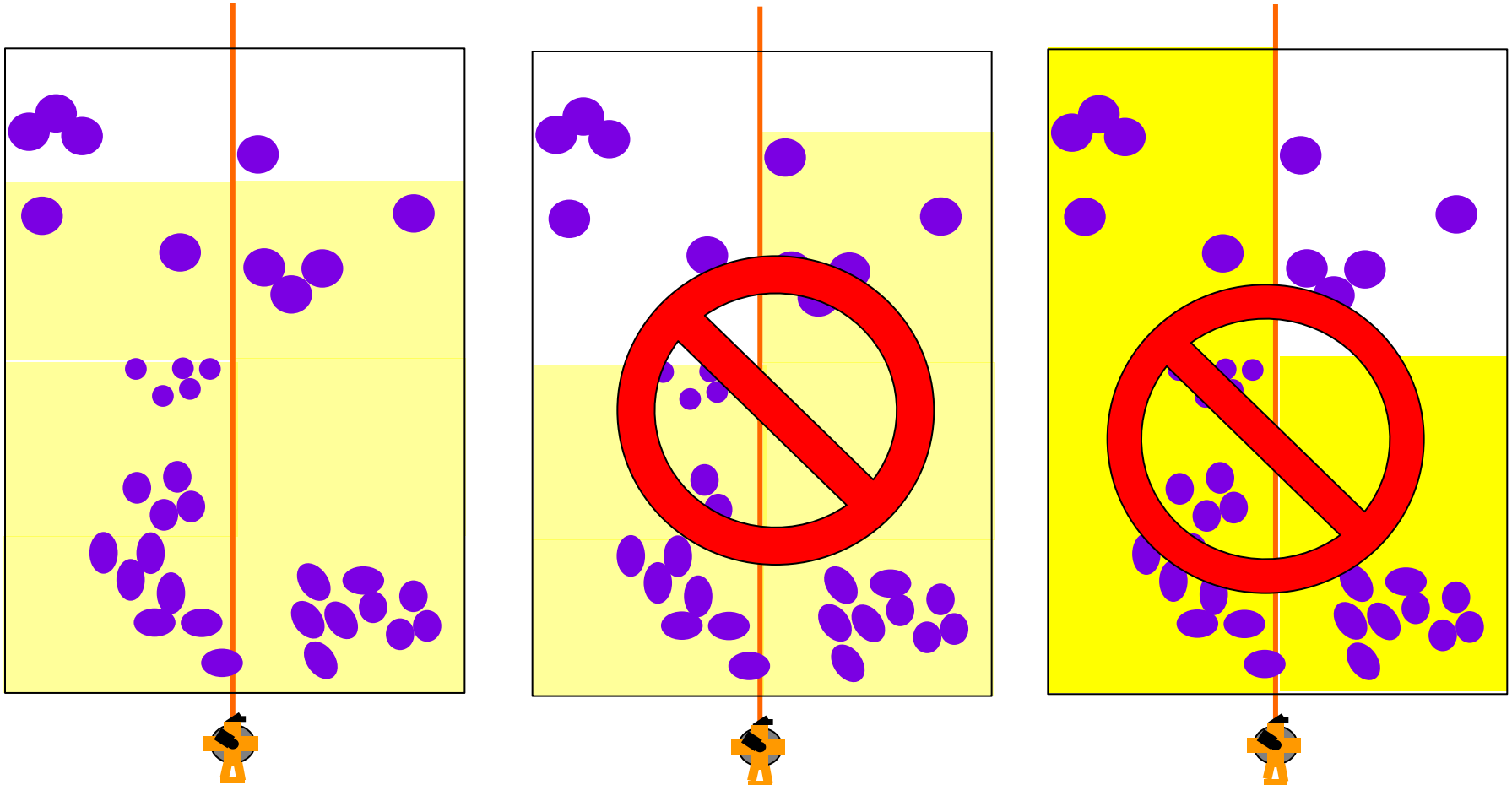


-  Reef
-  Transect tape (into/out screen)



Sub-sampling protocol: proper counting

When subsampling the area search must have four, not six, sides! Evenly sample both sides of the tape.

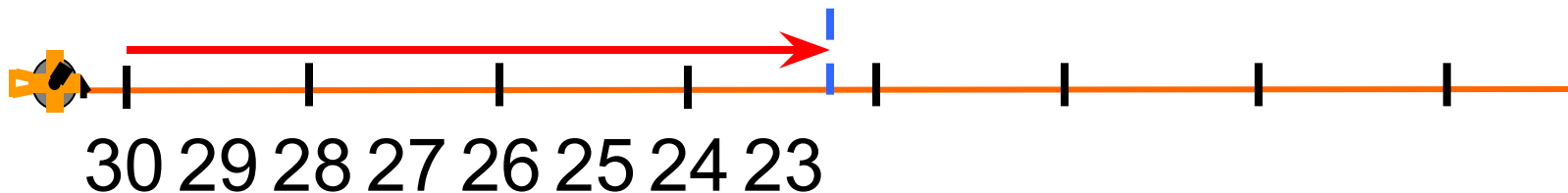


Distance covered, not meter mark

For a sub-sample, record the distance sampled within the 10 m segment to the nearest 0.1 m.

Example: this diver started at 30 m and counted 33 *Pterygophora* by the 26.2 m mark, thereby sampling a rectangle 3.8 m long.

Record this as: 33 @ 3.8 m.



Swath Surveys: invert data sheet

SITE: Siren		DATE: 7-23-26		HEADING OUT: 330		OBSERVER: Lonhart	
UPCOAST TOWNCOAST		TRANSECT #: 1 2		ACT. DEPTH: 36'-34'		BUDDY: Malone	
TARG. DEPTH: S M D							
All non-star spp. must be ≥ 2.5 cm dia		0-10 m		10-20 m		20-30 m	
S e a S t a r s	Patiria miniata (bat star)						
	Dermasterias imbricata (leather star)						
	Henricia spp. (elongate rays)						
	Mediaster aequalis (vermillion, red with large marginal plates)						
	Size - measure radius of longest ray	PYCHEL (Pycnopodia)					
PISGIG (Pisaster giganteus)							
PIS spp. (juvenile Pisaster)							
write-in							

Disease * = mild ** = severe Record disease as: *(III, 2, I), which indicates 6 mildly diseased. **(2,II, E) indicates 15 severely diseased. WRITE-INS: PISOCH, PISBRE, ORTKOE

Four genera are counted and three genera are measured:

Count = *Patiria*, *Dermasterias*, *Henricia*, & *Mediaster*

Measure = *Pisaster*, *Pycnopodia* and *Orthasterias*.

Sea star measurement

Measure length (nearest cm) for TARGET sea stars encountered in the 2 m wide swath.

(Target = *Pisaster* spp., *Pycnopodia* and *Orthasterias*).

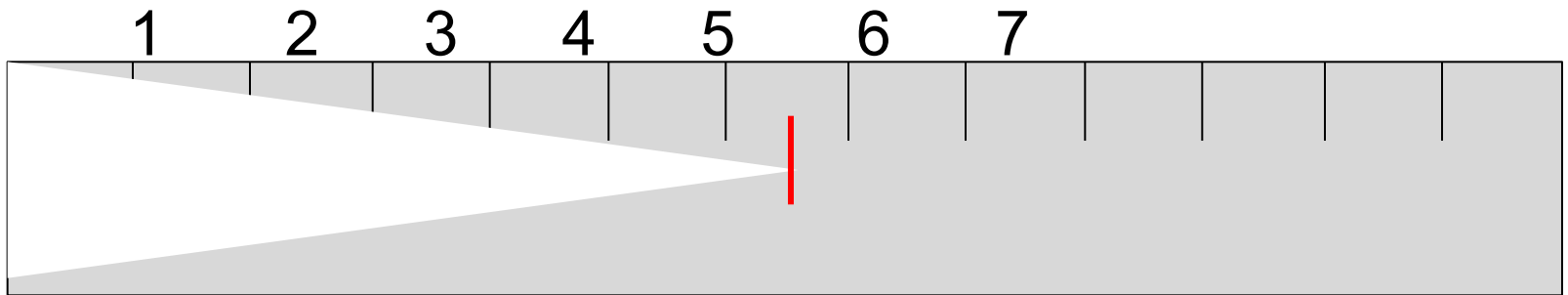
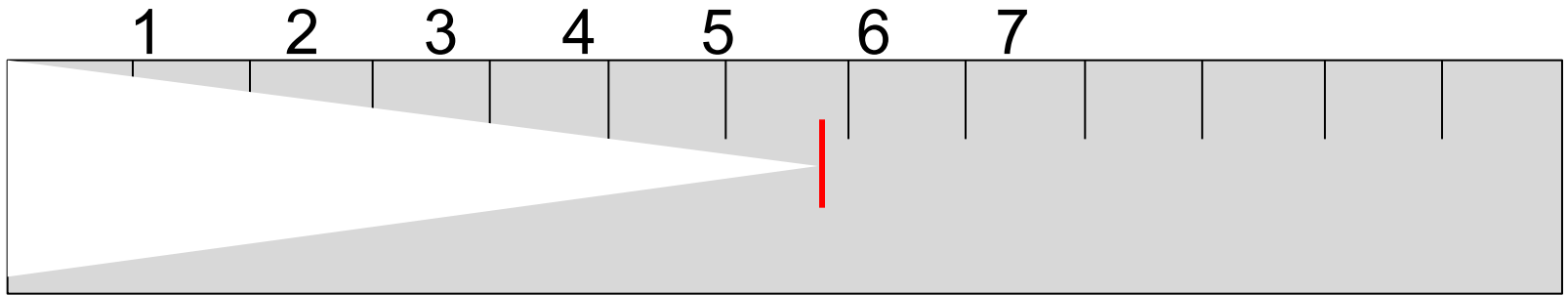
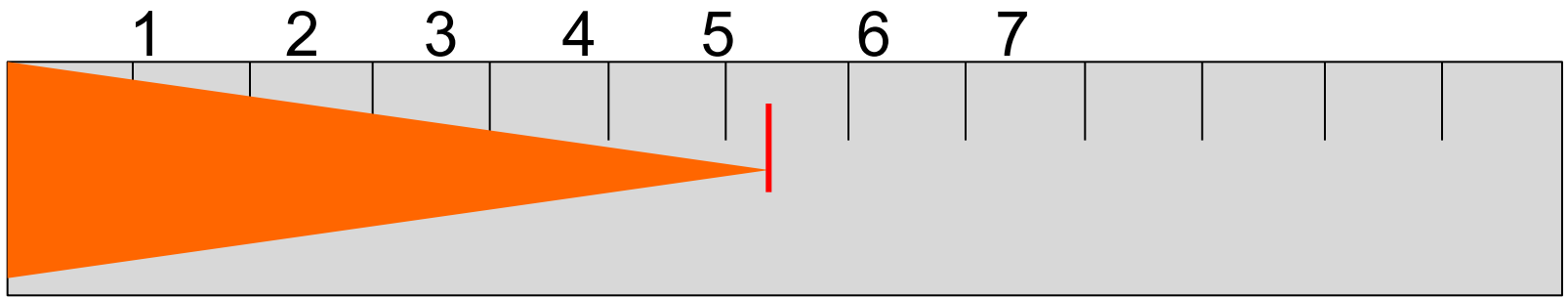
Measure along the aboral surface, from the center of the medial disc to the tip of the single longest ray.

Remove the star if unable to measure in place.
Do not handle any *Pycnopodia*.

Note disease status (* = mild, ** = dissolving)



When measuring, follow the curve of the longest ray



Measure to the nearest cm (without bias)

Sea star disease and recording

Note health status for sea stars: * = mild disease ** = severe

Example: *(II, 3, E), 4 = 16 stars had mild disease, 4 were healthy.

Swath diver measures sea star ray length for certain species.

SITE: Siren		DATE: 7-23-26		HEADING OUT: 330		OBSERVER: Lonhart		
UPCOAST DOWNCOAST		TRANSECT #: 1 2		ACT. DEPTH: 36'-34'		BUDDY: Malone		
TARG. DEPTH: S M D								
All non-star spp. must be ≥ 2.5 cm dia		0-10 m		10-20 m		20-30 m		
S e a S t a r s	Patiria miniata (bat star)	III, 7, 5, *(2,I)		*(II, 3, E), 4				
	Dermasterias imbricata (leather star)							
	Henricia spp. (elongate rays)							
	Mediaster aequalis (vermillion, red with large marginal plates)							
	Size - measure radius of longest ray	PYCHEL (Pycnopodia)			3, 7, E, 5*			
		PISGIG (Pisaster giganteus)	7, 12, E, 8*, 10, 14**		8(III, 3) 8*			
		PIS spp. (juvenile Pisaster)						
		Ortkoe	5, 9,					
write-in								

Disease * = mild ** = severe Record disease as: *(III, 2, I), which indicates 6 mildly diseased. **(2,II, E) indicates 15 severely diseased. WRITE-INS: PISOCH, PISBRE, ORTKOE

Swath Surveys: invert data sheet

Anemones	Urticina lofotensis white spots in distinct columns			
	Urticina piscivora solid red column, smooth			
	Anthopleura sola radial bands on oral disc			
Cucumbers	Cucumaria miniata bright orange tentacles			
	Apostichopus californicus large, triangular papillae; 'thorn-like'			
	Apostichopus parvimensis black stubble, small papillae			
Crustaceans	"Cancer" spp. classic crab shape			
	Pugettia producta smooth carapace; red, brown, or golden			
	Pugettia richii/gracilis spiked carapace, striped red-white legs			
	L. crispatus/ Scyra acutifrons cryptic decorator, tan or gray coloring			
	Pugettia foliata (was Mimulus) broad rectangular carapace, various colors			
	Balanus nubilus giant acorn barnacle			
Mollusks	Cryptochiton stelleri Gumboot chiton			
	Crassadoma gigantea Giant Pacific rock scallop			
	Megathura crenulata Giant keyhole limpet			
	Pomaulax gibberosus Red turban snail			
	Kelletia kelletii Kellet's whelk			
	Ceratosstoma foliatum Leafy hornmouth			
Other	Tethya californiana Orange puffball			
	Styela montereyensis Stalked tunicate			
	Stylaster californicus California hydrocoral			
	Abalone (Size) Haliotis spp.			

Write-Ins: Other *Urticina*, *Anthopleura xanthogrammica* (Large Green Anemone), *Metridium* spp. (all white, long column), *Lytechinus pictus* (White Sea Urchin), *Aplysia californica* and *A. vaccaria* (Sea Hares), *Megastrea undosa* (wavy turban snail), *Loxorhynchus grandis* (sheep crab), *Neobernaya spadicea* (chestnut cowry)

These species must be
≥2.5 cm diameter/length

Abalone size to nearest cm

Swath Surveys: invert data sheet

Do not forget the write-ins:

Other *Urticina*

Anthopleura xanthogrammica = giant green anemone, no lines on oral disc

Metridium spp. = white, giant plumose anemone (nee *M. farcimen*)

Lytechinus pictus = white urchin, has brown patches

Aplysia californica = red sea hare

Aplysia vaccaria = black sea hare

Megastrea undosa = wavy turban snail (Southern CA species)

Loxorhynchus grandis = sheep crab, greenish, spines, few epibionts

Neobernaya spadicea = chestnut cowry

Swath Surveys: recording observations

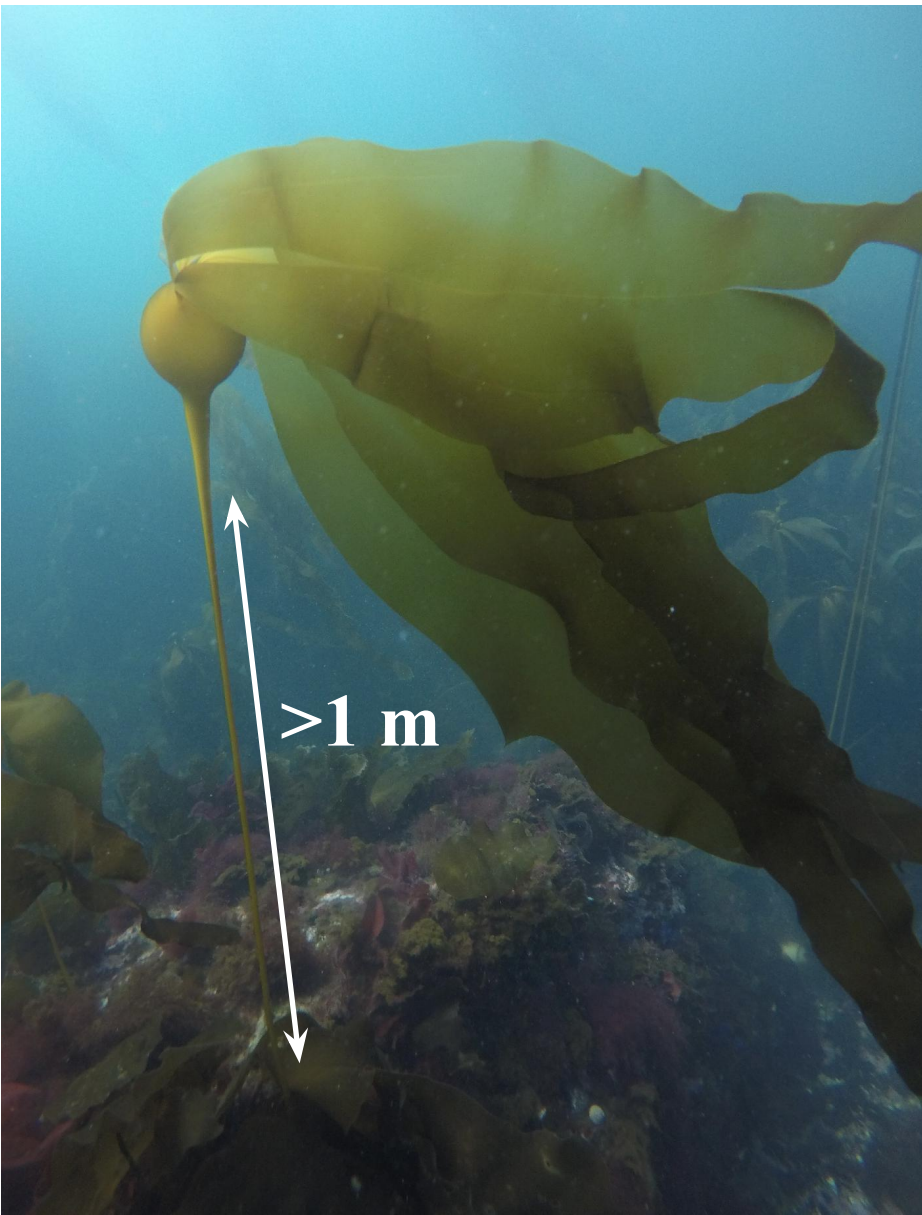
Anemones	Urticina lofotensis white spots in distinct columns			
	Urticina piscivora solid red column, smooth	III		
	Anthopleura sola radial bands on oral disc			
Cucumbers	Cucumaria miniata bright orange tentacles	IIIIII		
	Apostichopus californicus large, triangular papillae; 'thorn-like'			
	Apostichopus parvimensis black stubble, small papillae			
Crustaceans	"Cancer" spp. classic crab shape			
	Pugettia producta smooth carapace; red, brown, or golden	III		
	Pugettia richii/gracilis spiked carapace, striped red-white legs			
	L. crispatus/ Scyra acutifrons cryptic decorator, tan or gray coloring			
	Pugettia foliata (was Mimulus) broad rectangular carapace, various colors			
	Balanus nubilus giant acorn barnacle	III, 7, 22		
Mollusks	Cryptochiton stelleri Gumboot chiton	I		
	Crassadoma gigantea Giant Pacific rock scallop			
	Megathura crenulata Giant keyhole limpet			
	Pomaulax gibberosus Red turban snail			
	Kelletia kelletii Kellet's whelk	I		
	Ceratostoma foliatum Leafy hornmouth			
Other	Tethya californiana Orange puffball			
	Styela montereyensis Stalked tunicate	I, 4, IIIII, E		
	Stylaster californicus California hydrocoral			

If you ever want to write the number eleven, do not write II, instead use E. There is no eleven other than E. Anything else is "2".

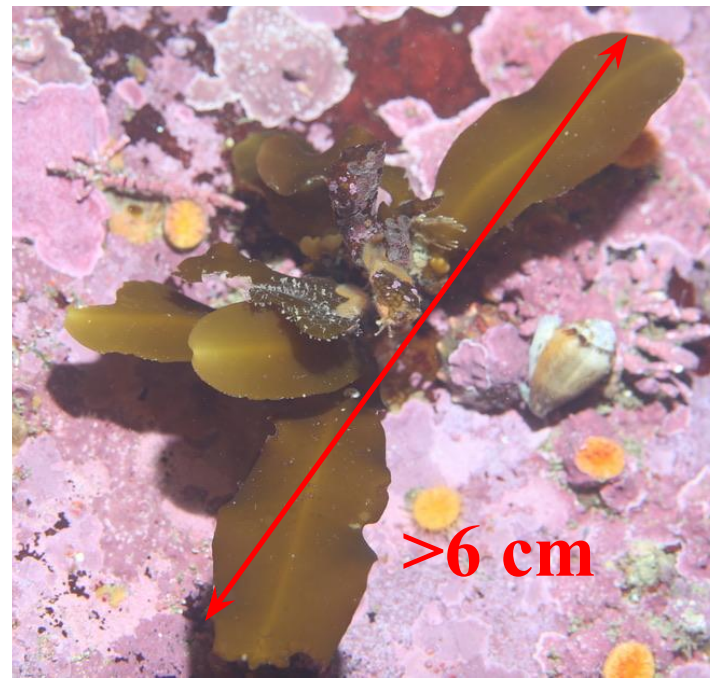
Swath Surveys: recording observations

Anemones	Urticina lofotensis white spots in distinct columns			
	Urticina piscivora solid red column, smooth			
	Anthopleura sola radial bands on oral disc			
Cucumbers	Cucumaria miniata bright orange tentacles			
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	Ceratostoma foliatum Leafy hornmouth			
Other	Tethya californiana Orange puffball			
	Styela montereyensis Stalked tunicate	I, 4, , E		
	Stylaster californicus California hydrocoral			

Swath Surveys: adult algae sizing rules



<i>Macrocystis</i>	stipe(s) >1 m
<i>Nereocystis</i>	stipe >1 m
<i>Pterygophora</i>	stipe >30 cm
<i>Laminaria setchellii</i>	stipe >30 cm
<i>Pleurophyucus</i>	stipe >30 cm
<i>Eisenia</i>	stipe >30 cm
<i>Stephanocystis</i>	>6 cm diameter
<i>Laminaria farlowii</i>	>10 cm width
<i>Costaria</i>	>10 cm width
<i>Alaria</i>	no restrictions



Swath Surveys: recording data

SITE: Fuller's		DATE: 7-17-26		HEADING OUT: 330		OBSERVER: Lonhart	
UPCOAST DOWNCOST		TRANSECT #: 1 2		ACT. DEPTH: 38'-30'		BUDDY: Carr	
		TARG. DEPTH: S M D					
		0-10 m		10-20 m			
(>1 m stipe length. Count stipes at 1 m.)	Macrocystis pyrifera	1, 3, 37, 15, 8, 5, 2, 45					
	Nereocystis (circle super bundles)	III, 4, 2, III III I		III, 9, 9, E 32 @ 4.3 m			
>30 cm stipe length	Pterygophora						
	Eisenia arborea						
	Pleurophycus sp.						
	Laminaria setchellii	6, 6, 2, 14, 5, 2 35 @ 6.3 m					
	Stephanocystis (>6 cm dia)			III, E, 3, 2			
Count any	Laminaria farlowii (>10 cm width)						
	Costaria costata (> 10 cm width)						
	Alaria marginata						
	Undaria pinnatifida						

- Record # of stipes for each individual *Macrocystis*, separate with commas
- Record number of *Nereocystis*
- Count stipes of *Pterygophora*, *Eisenia*, *L. setchellii*, & *Pleurophycus*
- Sum all non-*Macrocystis* counts upon surfacing
- Circle super-bundles of *Nereo* (i.e. multiple entwined adult stipes)



Swath algae data and ending the dive

Once the **swath** diver is done collecting invert data, then that diver is now at the 30 m end. The **swath** diver can then collect swath algae data from 30 m towards 0 m.

If the UPC diver reels out the tape, and is done with UPC (i.e. is now at 0 m), then begin surveying back towards the 30 m end counting **swath** algae. When UPC and **swath** algae meet, they ensure that the area between them is counted. Then both swim towards the **KelpUR** diver (towards the 30 m end of tape).

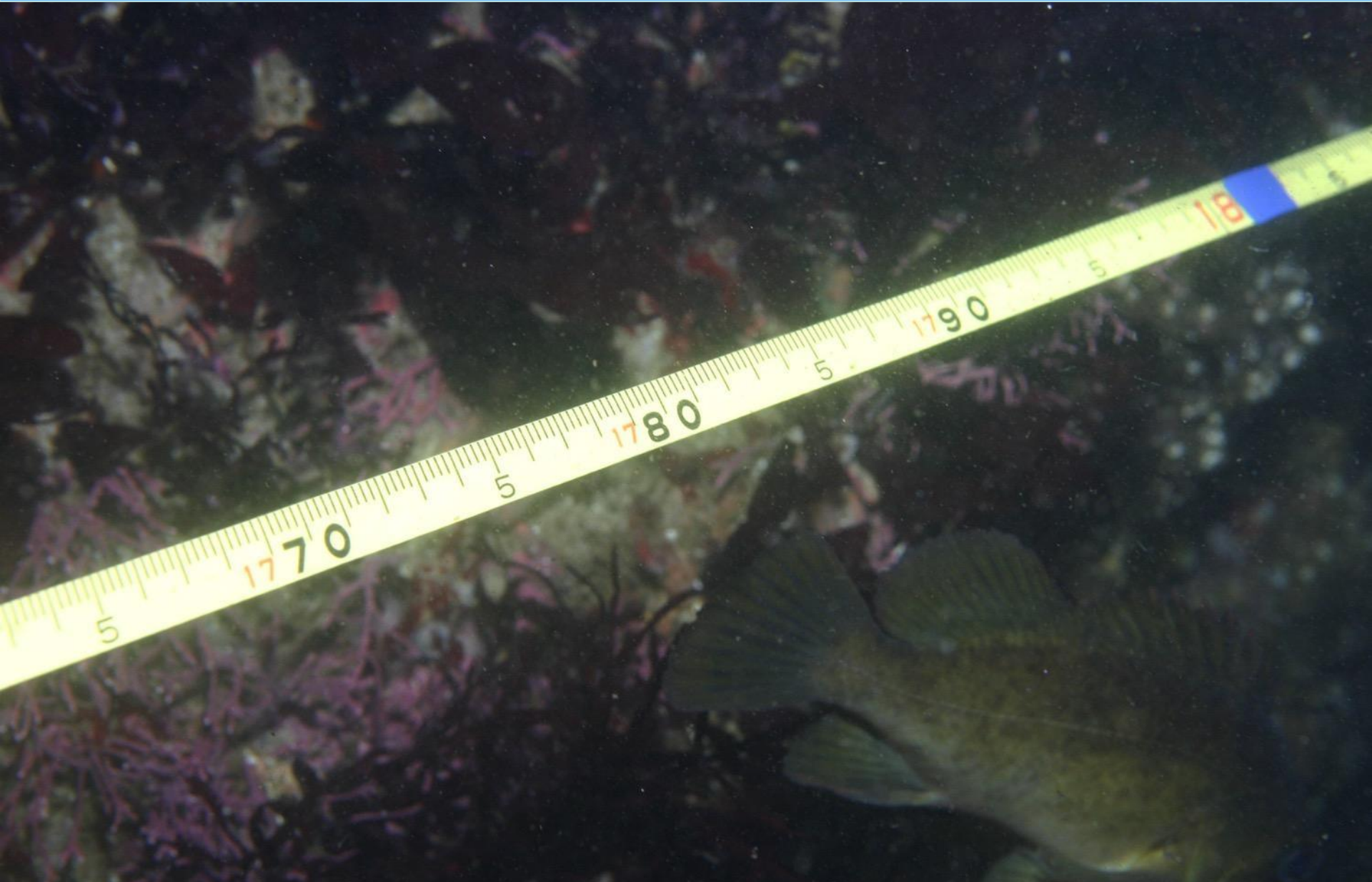
Upon reaching 30 m end, the **KelpUR** diver reels in the tape, since they are typically slower than the **swath** diver.

Sub-sampling reminders!

1. Within each 10 m segment, if you reach 30 or more individuals of a single species, note how many were counted followed by the distance covered (e.g., 32 @ 2.7 m). Adult *M. pyrifera* excluded.
2. You re-start all counts in the next 10 m segment.
3. Be sure to finish the entire 'rectangle' so we capture an accurate density estimate. Sample both sides of the tape equally.

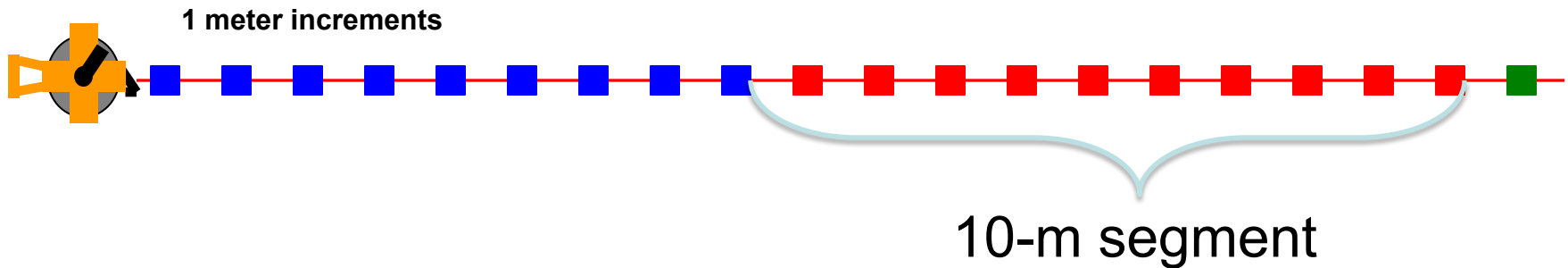


UPC Surveys: tape meter marks



UPC Surveys: tape meter marks

Data collected every 1 m on a 30 m transect tape



Transect tapes are marked at 1 m increments. Every 10 m segment has a single color of tape at each 1-m mark.

Be sure to count 10 points per segment. For example, if you start at 30 m mark you stop at 21 m mark, and 20 is your next segment's starting point, thus you finally end at 1 m mark and not 0 m (30 to 1). If you start at 29 m, you end at 20 m, and at end of tape, end at 0 m mark (29 to 0).

0-9 is ten digits, but 0-10 is eleven digits. Think about it....

UPC Surveys: 30+ counts per 10 m

SITE: Hopkins

DATE: 7-23-2026

HEADING OUT: 300

OBSERVER: Lonhart

UPCOAST | DOWNCOAST

TRANSECT #: 1 | 2
TARG. DEPTH: S | M | D

ACT. DEPTH: 16'-18'

BUDDY: Malone

Substrate:	0-10M	10-20M	20-30M
Substrate			
Bedrock (> 1 m)			
Boulder (10 cm - 1 m)			
Cobble (< 10 cm)			
Sand			
Relief			
0 - 10 cm			
10 cm - 1 m			
1 m - 2 m			
> 2 m			
Superlayer			
Drift Algae:			
Juvenile Laminariales			
Inanimate			
Bare rock			
Bare sand			
Shell Debris			
Sediment/mud			
Dead Kelp Holdfast (any)			
Red Algae			
BRANCH-flat branching			
LEAF- blade, unbranched			
BUSHY-cylindrical branches			
LACY-filamentous/dense			
ENCRUSTING RED			
TURF - red turf - < 2 cm			
Coralline			
Crustose coralline algae			
Articulated coralline algae			
Brown Algae			
Stephanocystis osmundacea			
Dictyoneurum spp.			
Egregia menziesii			
Desmarestia spp.			
Macrocystis holdfast (Live)			
Laminariales Holdfast (Live)			
Dictyotales (Dictyota Dictyopteris)			
Tube Worms			
Tubeworm - Other Solitary			
Diopatra ornata / Chaetopterus			
Phragmatopoma			

Substrate

Relief

Superlayer

Point
(cover)
i.e. the "thing"

UPC Surveys: substrate



Barlotti

Substrate	Bedrock (≥ 1 m)			
	Boulder (10 cm - 1 m)			
	Cobble (≤ 10 cm)			
	Sand			

UPC Surveys: sand vs. bare sand

Sand can be substrate (Sand) and a point (Bare sand category)

What happens when bedrock has a pocket of sand?

If you wave your hand above the sand and it goes away, then the substrate is bedrock.

If the point lands on a pocket of sand that cannot be waved away with the brush of a hand, but you can poke your finger into the sand and easily touch the rock under it, then

Substrate = Bedrock and Point = Bare sand

If the pocket of sand is deep enough (>2 knuckles) such that you cannot touch the rock under it, it is potential habitat, so then

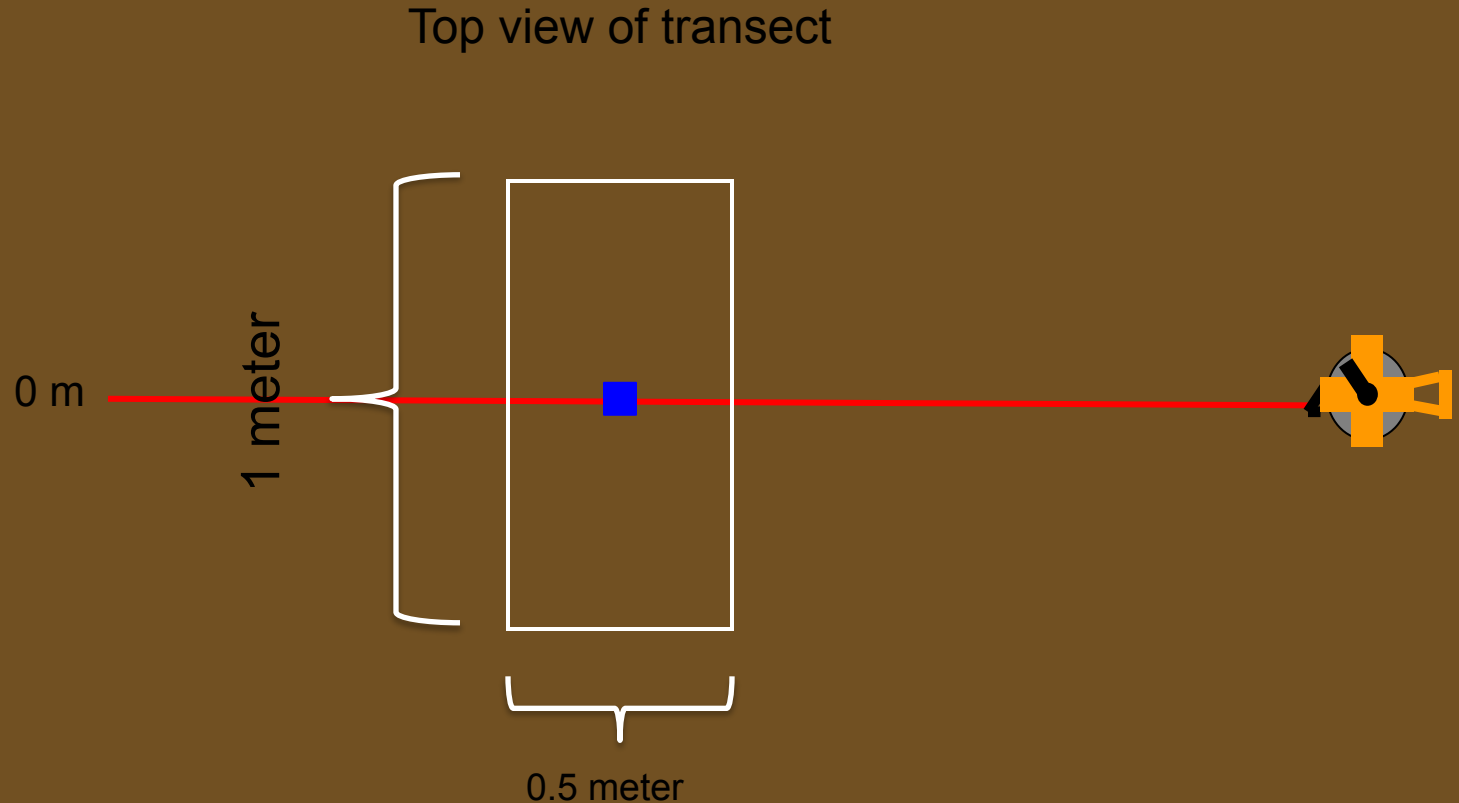
Substrate = Sand and Point = Bare sand

If you are on bedrock and come across a sand-filled crevice full of *Diopatra*, and your point hits the *Diopatra*, then

Substrate = Sand and Point = *Diopatra*

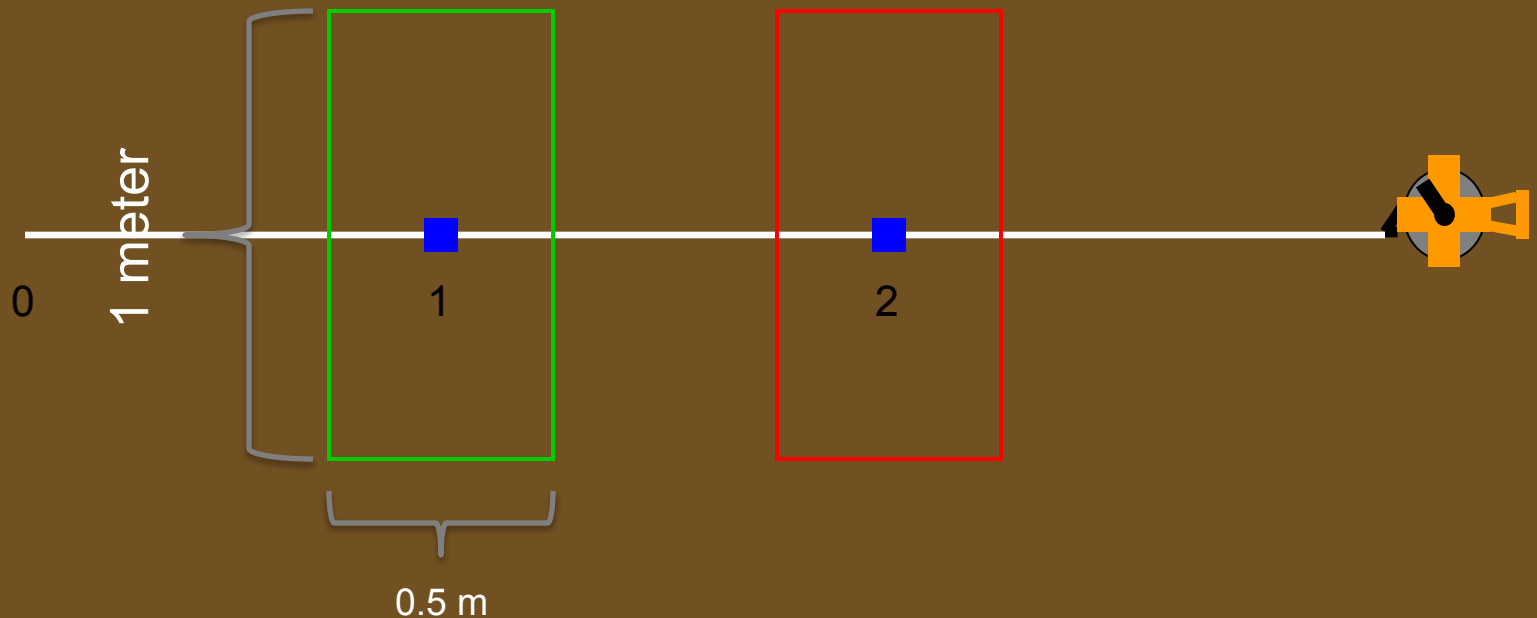
UPC Surveys: determining relief

Relief is the absolute difference in elevation between the highest and lowest point within a 1 m by 0.5 m rectangle



UPC Surveys: determining relief

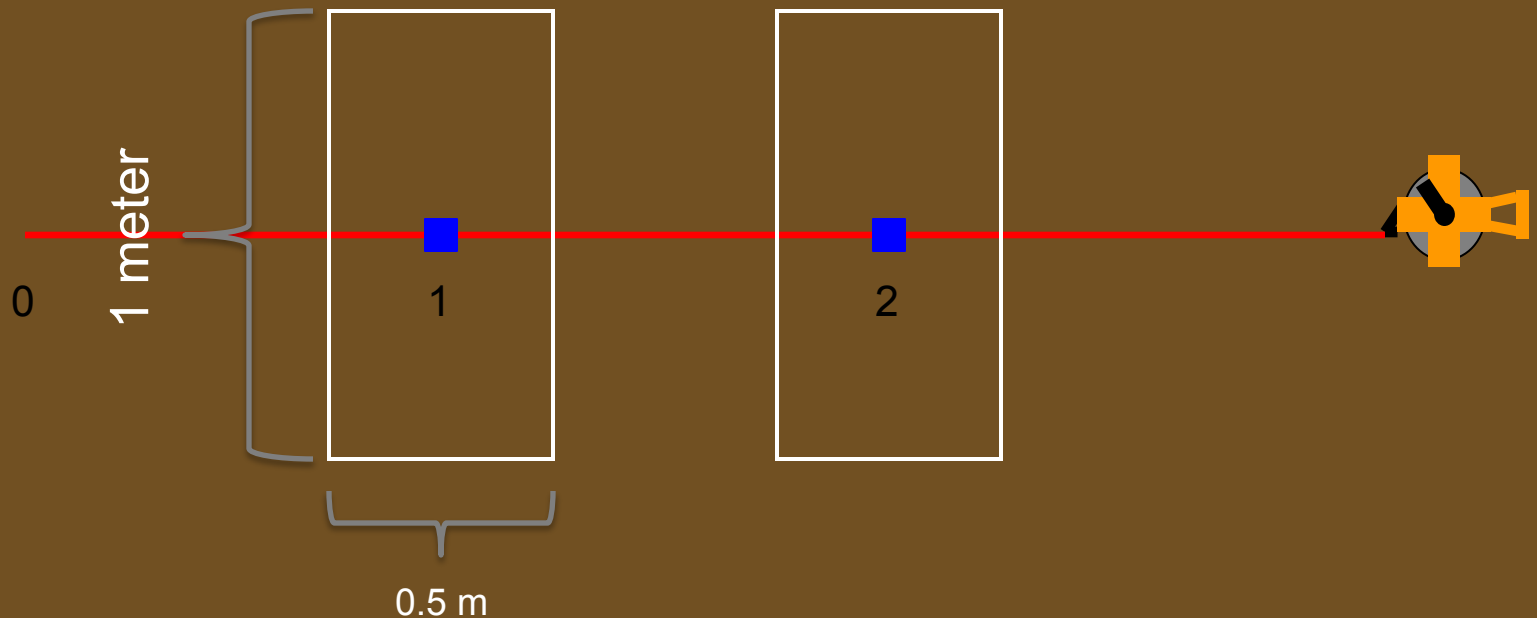
Relief is determined within non-overlapping rectangles (1 m by 0.5 m) as depicted below



The rectangle is centered on the UPC point. Each rectangle extends 0.5 m on both sides of the tape, and 0.25 m in front of and behind the point along the tape.

UPC Surveys: determining relief

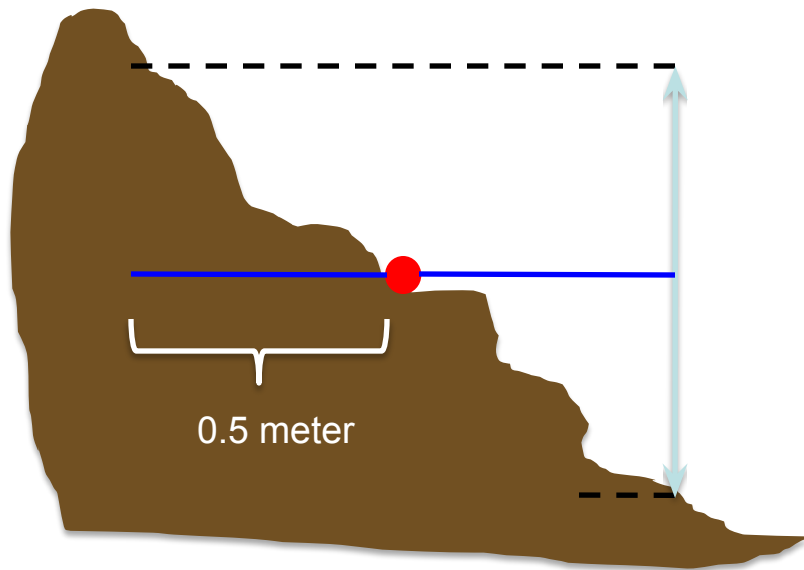
Imagine the rectangle is suspended above the bottom, as if it had been lowered from the surface and was perfectly level.



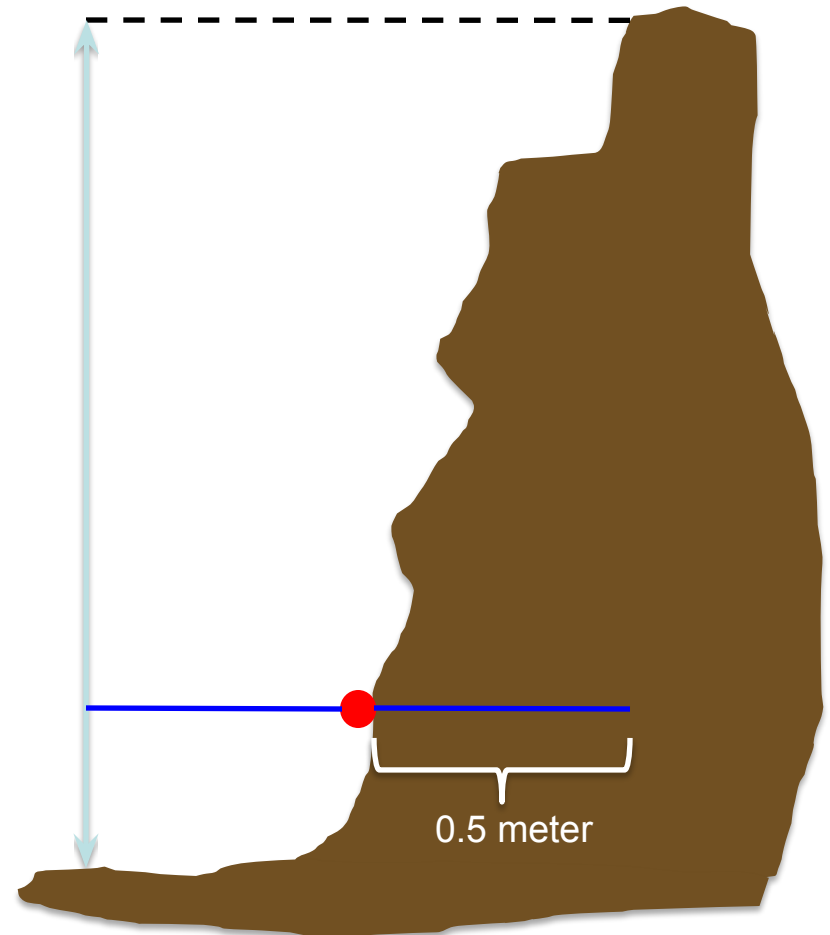
Within each rectangle find the highest and lowest points, then determine the vertical distance between the two.

UPC Surveys: high and low points

Find the high and low points in each rectangle. Remember it is 0.5 m to either side of the meter mark, and 0.25 m in front and behind it.



End-on view of transects



UPC Surveys: relief categories

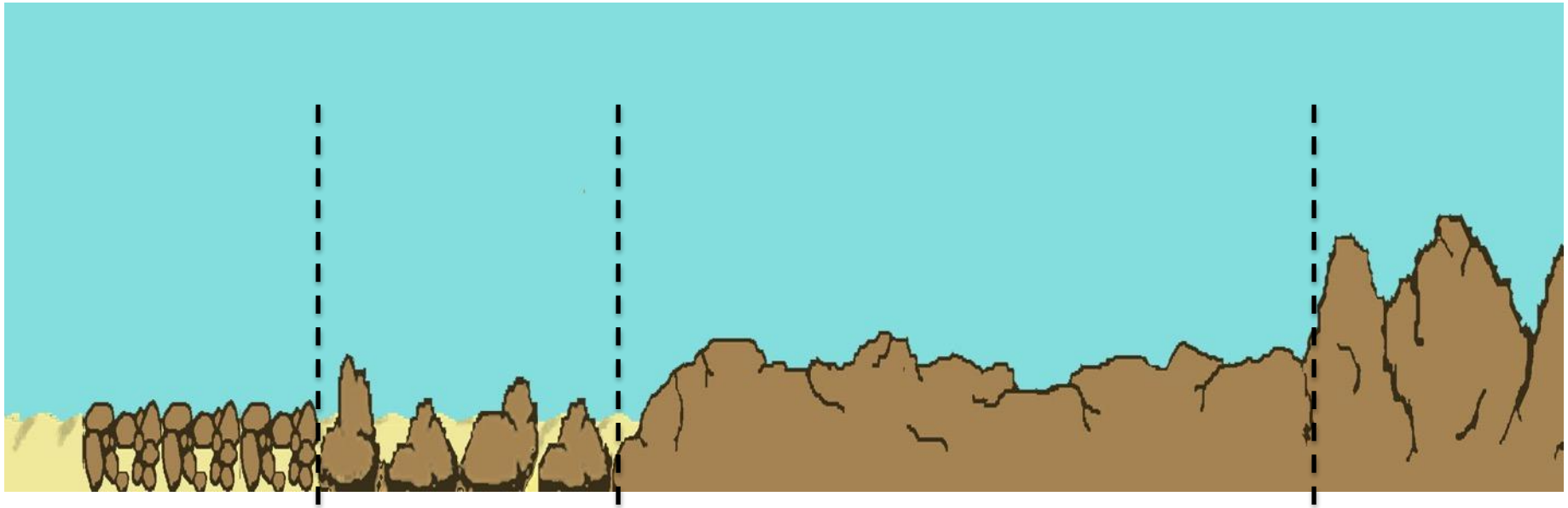
Relief is binned into four categories. Basically they are: flat, knees to head, standing, and wall.

0-0.1 m

0.1-1 m

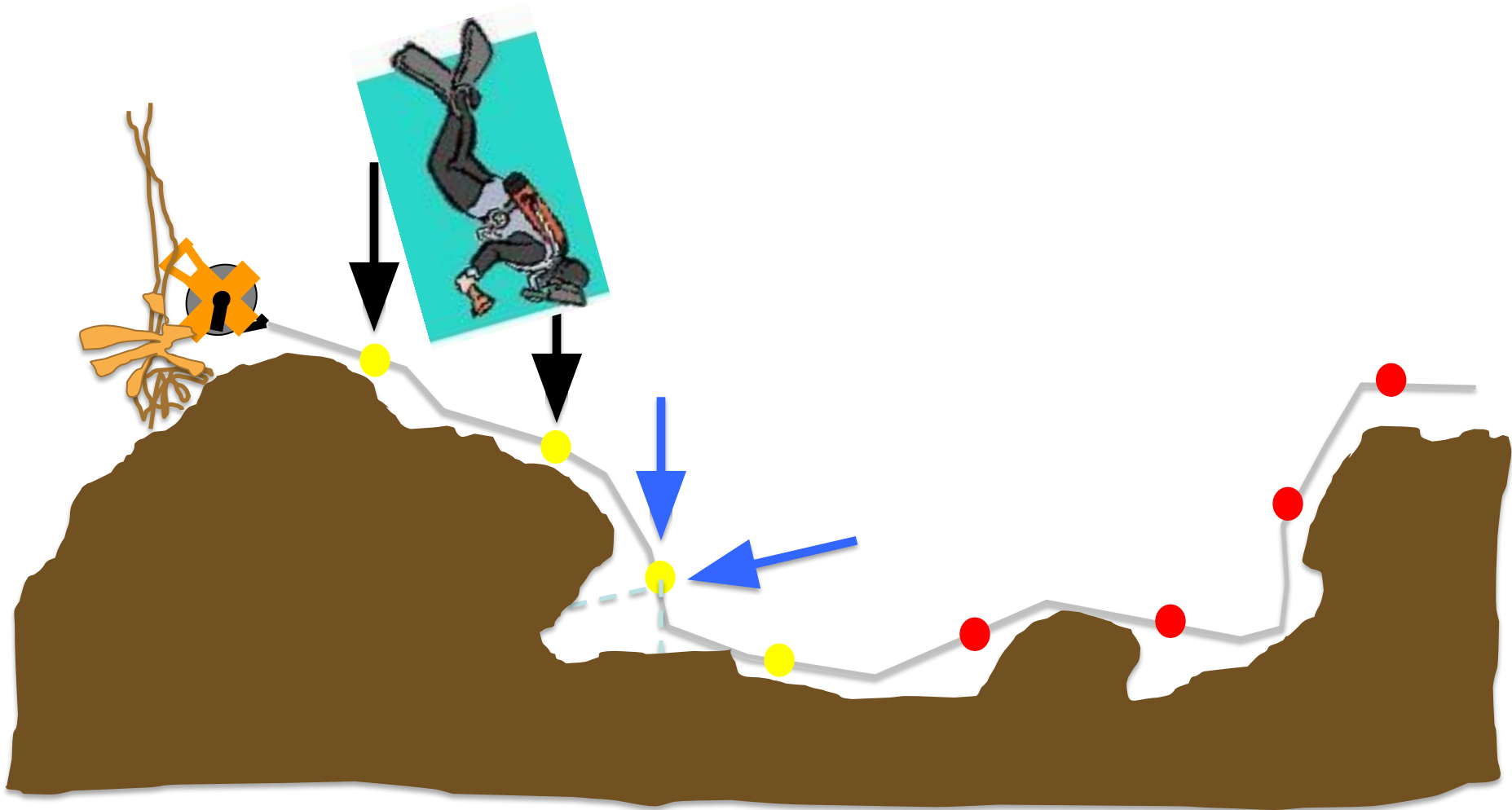
1-2 m

>2 m



UPC Surveys: tape to bottom

**Remember not to bias your data!
Look once and pick the point, do not “look around.”**



UPC Survey “rules” for layers

1. Identify and record the first thing you see “at” the point on the tape—this is the point (or the “thing”), except:
 - a. Ignore attached, adult kelp blades/stipes above (or below) the point—they are canopy or subcanopy.
 - b. Record drift algae as such, and record thing underneath drift.
 - c. Record juvenile Laminariales, and record thing underneath.
 - d. You can have a maximum of one drift layer and one juvenile Laminariales per point.
 - e. Ignore epibionts.
 - f. Ignore mobile invertebrates and all fishes.
2. The algal piece that covers/is below the point can be attached to primary substrate somewhere other than under the point. Just be sure the algal piece is neither drift nor an epibiont.

UPC Surveys: ignore epibionts

Colonial
tunicate
on a solitary
tunicate

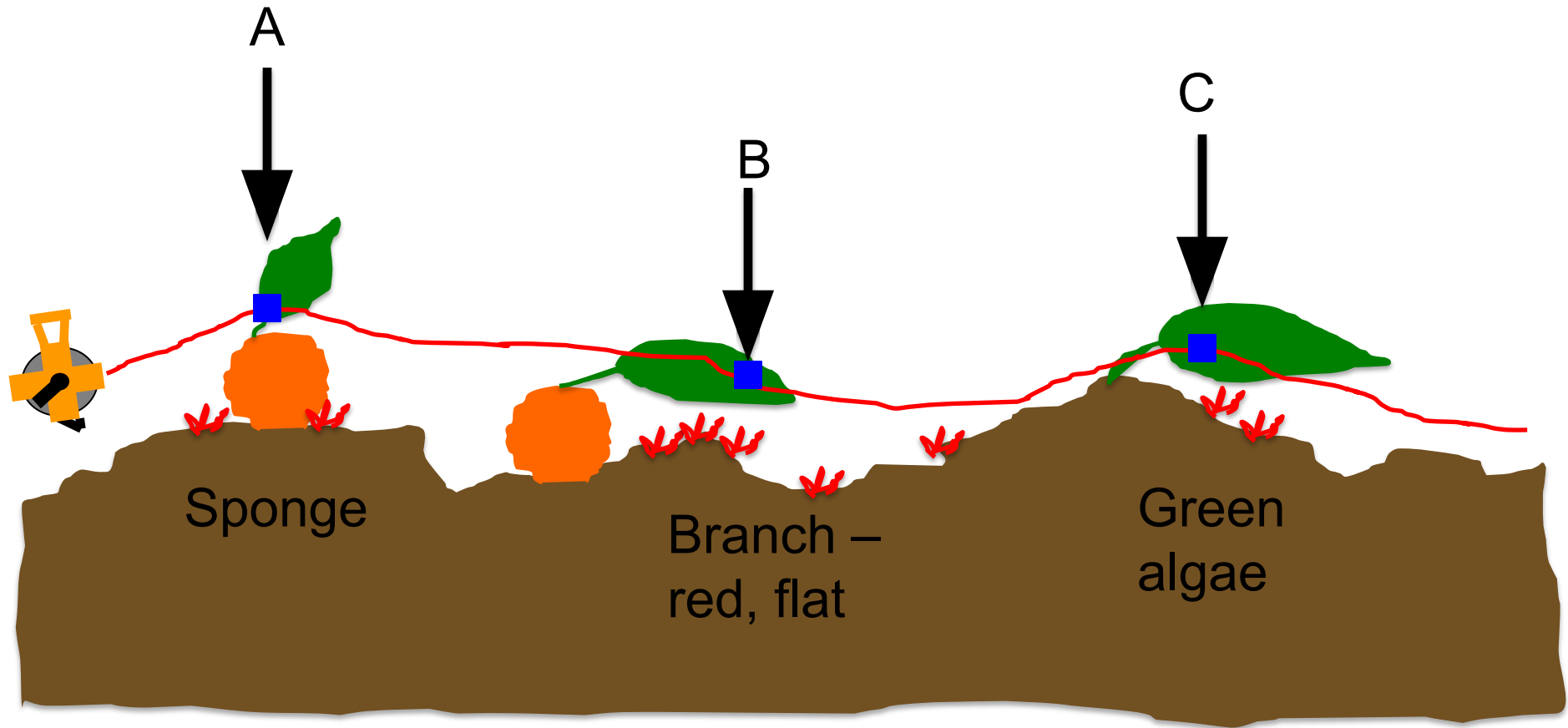


Lonhart/MBNMS

If your point falls on a mobile invertebrate or epibiont, ignore it and make sure you are recording the organism underneath it that is somehow *attached to the substrate!*

(Note, it need not be attached under the point, elsewhere is ok)

UPC Surveys: ignore epibionts



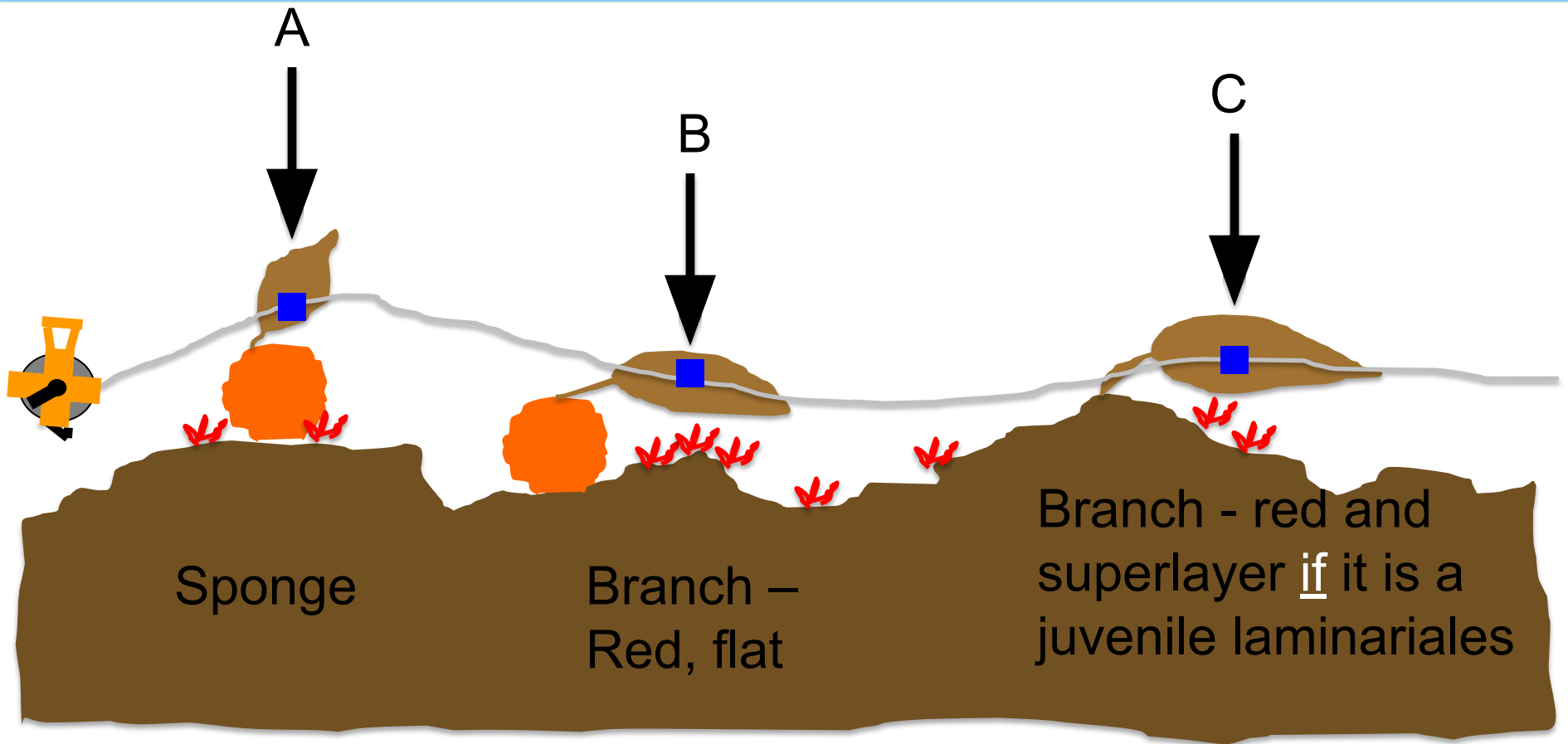
UPC Surveys: superlayer

Drift algae and juvenile laminariales (e.g., <30 cm stipe *Laminaria*, *Eisenia*, *Macrocystis*, *Pterygophora*) can be the first thing you encounter at your point. Record the superlayer, move it aside and then record the primary substrate holder.

Superlayer	Drift Algae:		
	Juvenile Laminariales		



UPC Surveys: epibionts & superlayer



If it is not a juvenile laminariales then the data point is either *Stephanocystis*, Dictyotales, *Dictyoneurum* spp., *Eggregia*, *Desmarestia* spp., *Sargassum* spp. or Other Brown (i.e. NOT red branch)

UPC Surveys: superlayer species or not?

Laminariales genera
in central California:

Laminaria

Costaria

Pleurophycus

*Egregia**

Eisenia

Alaria

Pterygophora

Macrocystis

Nereocystis

*Dictyoneurum**

**Dictyoneurum* spp. and *Egregia* are on the
UPC sheet, so they cannot be a superlayer.

Non-laminariales genera
that are brown and
in central California:

Stephanocystis

Dictyotales

Desmarestia spp.

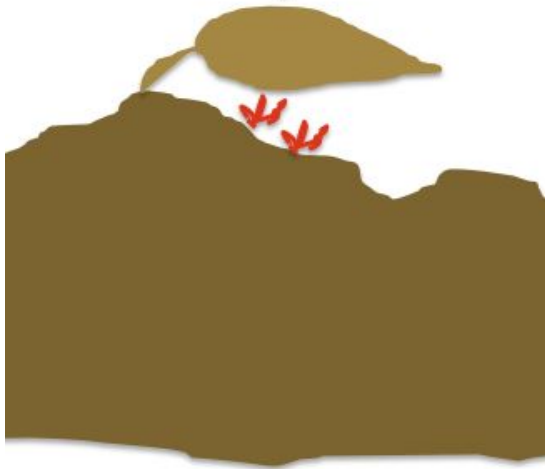
Sargassum spp.

Other Brown

None of these can be superlayers, since
they are NOT in the Order Laminariales and
they are all on the UPC sheet already as
an option.

UPC Surveys: ID superlayer spp.

Key is to determine what this is!



Juvenile *Nereocystis* above, and juvenile *Macrocystis* below.
Both <1 m tall, thus juvenile laminariales.



UPC Surveys: ID superlayer spp.

Key is to determine
what this is!

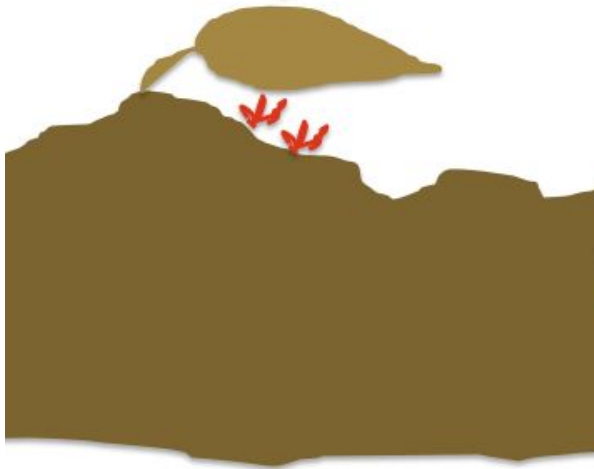


Juvenile *Eisenia arborea*. <30 cm.



UPC Surveys: ID superlayer spp.

Key is to determine
what this is!



Juvenile *Pterygophora californica*. <30 cm.

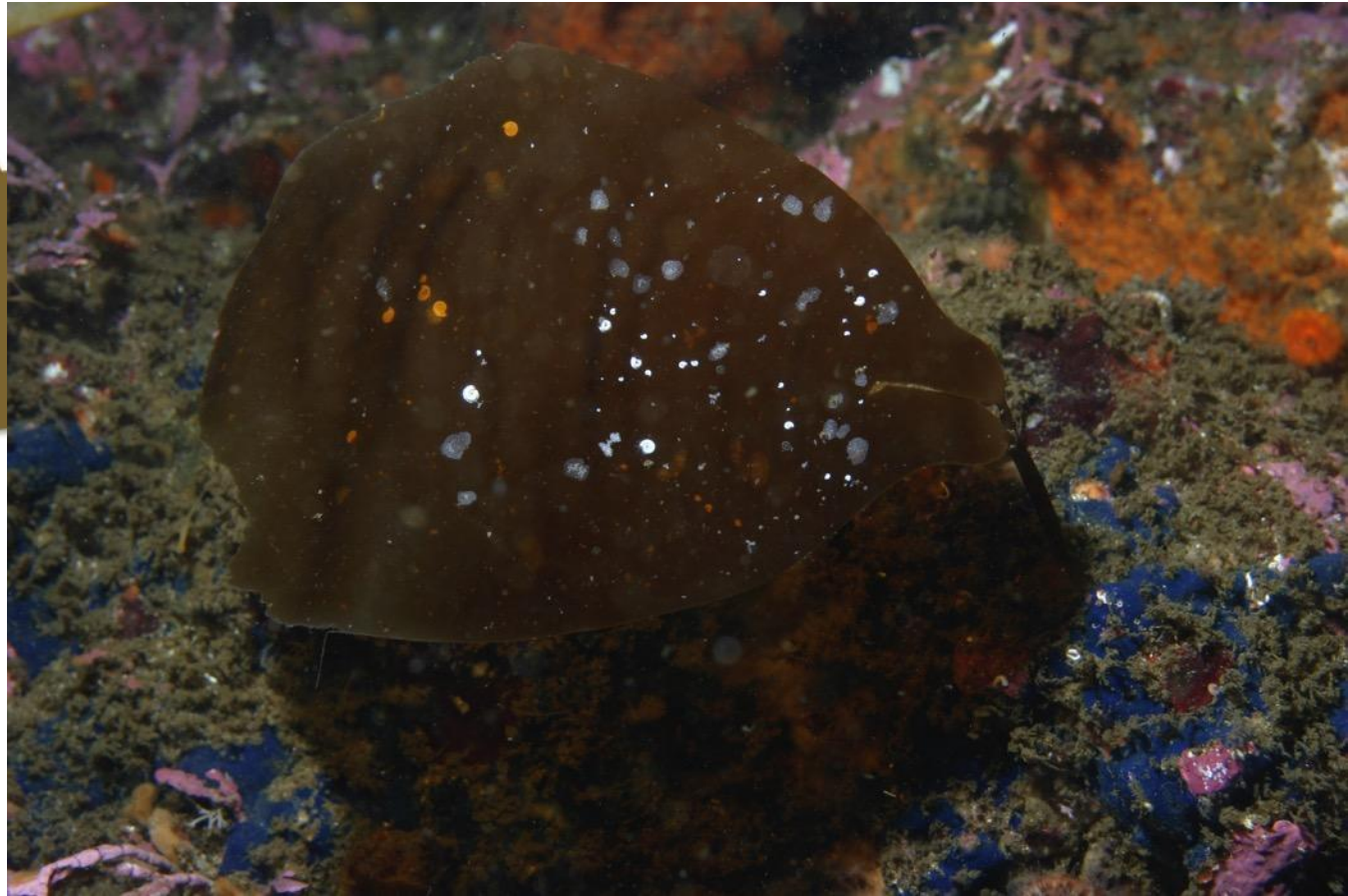


UPC Surveys: ID superlayer spp.

Key is to determine
what this is!

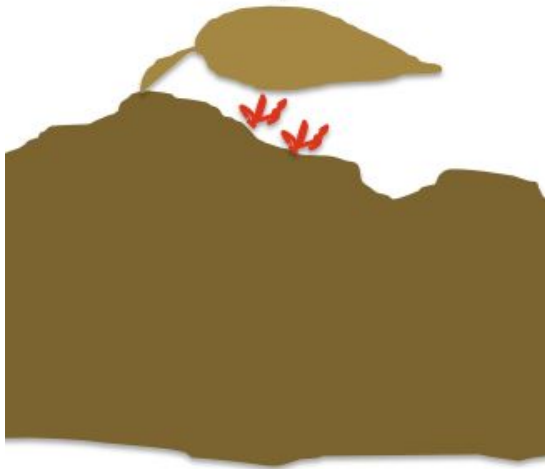


Juvenile *Macrocystis pyrifera*. <1 m.

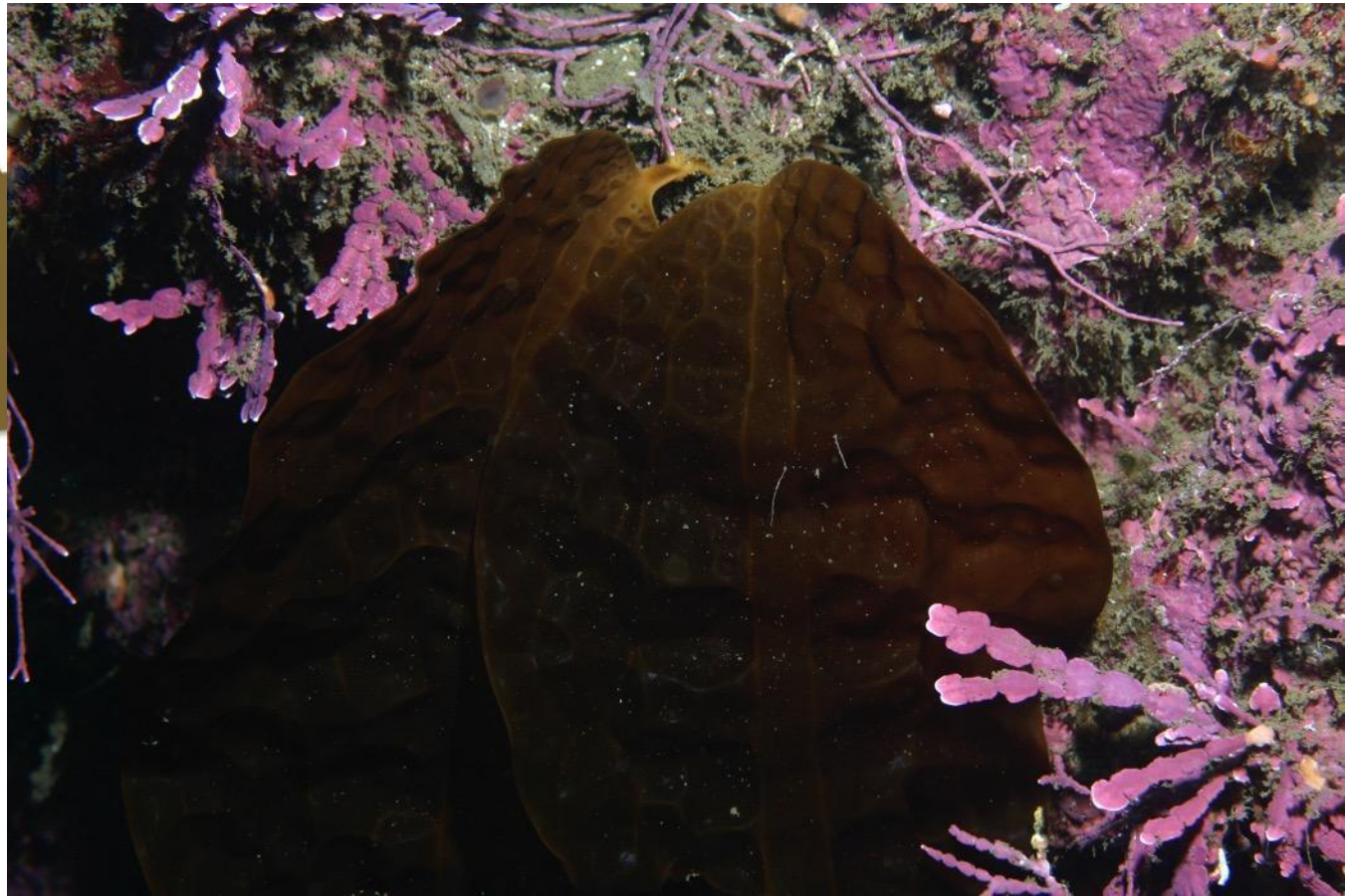


UPC Surveys: ID superlayer spp.

Key is to determine
what this is!

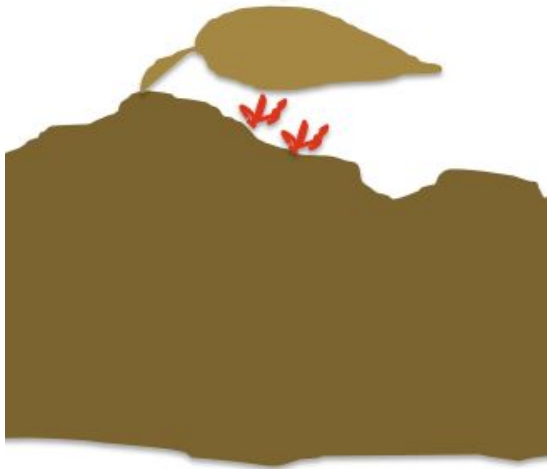


Dictyoneurum is NOT a superlayer. It is a
UPC category.



UPC Surveys: ID superlayer spp.

Key is to determine
what this is!



Desmarestia spp., is not a Laminariales,
therefore NOT a superlayer. It is already
a UPC point on the sheet.

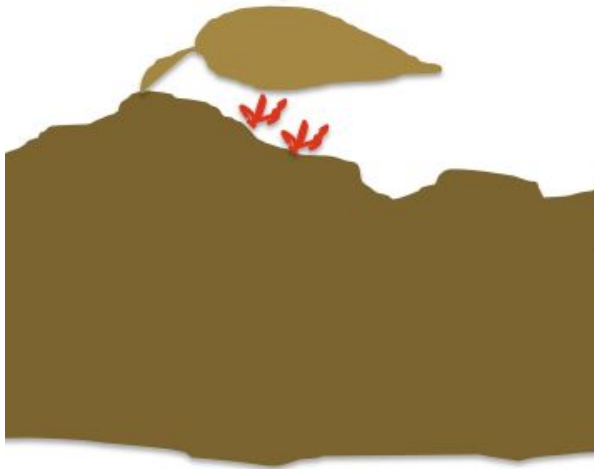


UPC Surveys: ID superlayer spp.

Key is to determine
what this is!

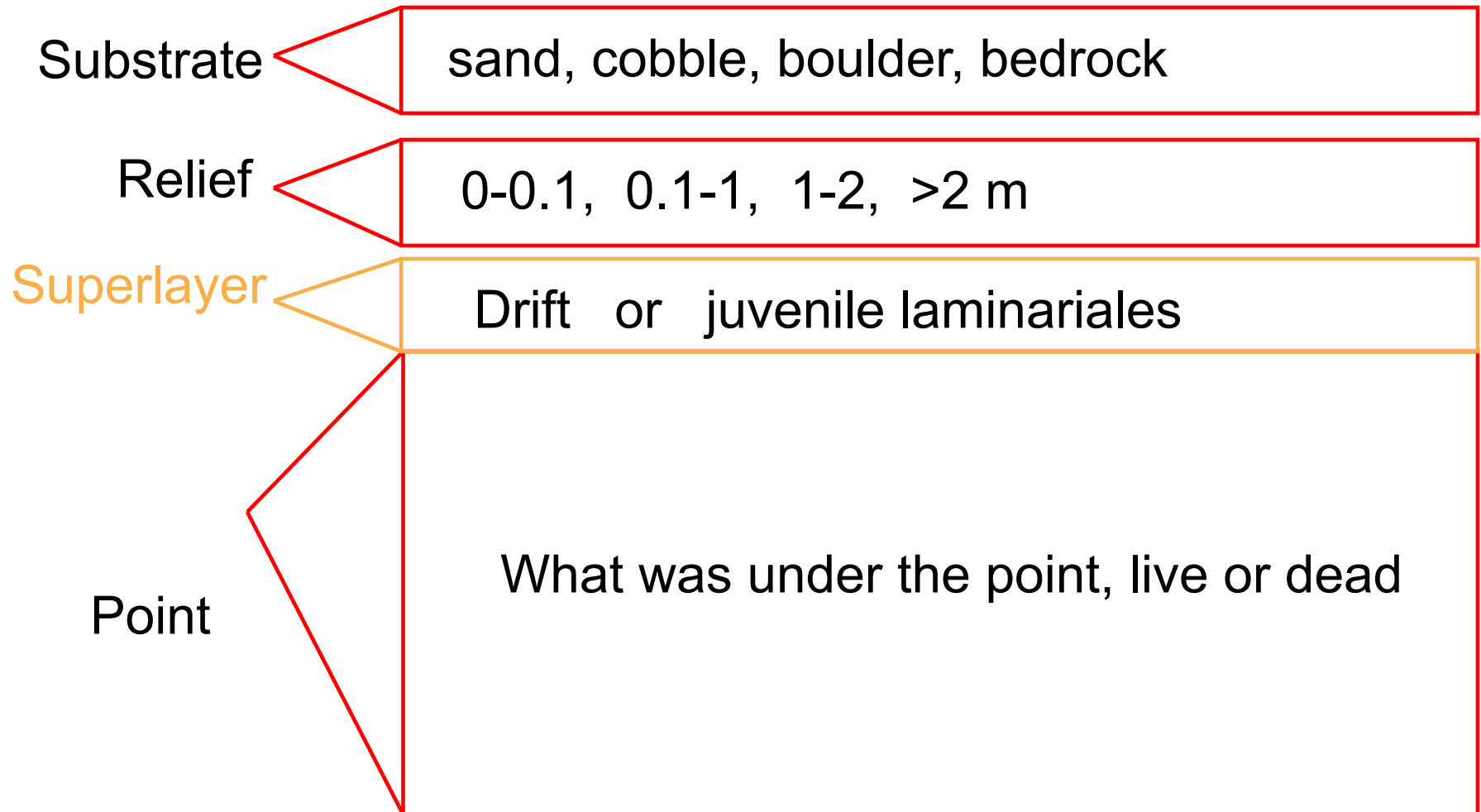


Order Dictyotales is not Order
Laminariales and therefore it is NOT a
superlayer.



UPC Surveys: review

At the end of the 30 m you should have 30 points in 3 categories (i.e. substrate, relief, and point—90 total) and possibly some superlayer data.



UPC Surveys: recording data

SITE: Hopkins		DATE: 7-23-26		HEADING OUT: 330		OBSERVER: Lonhart	
TRANSECT #: 1 2		TARG. DEPTH: S M D		ACT. DEPTH: 16'-14'		BUDDY: Fett	
UPCOAST DOWNCOAST							
Substrate:		0-10M		10-20M		20-30M	
Substrate	Bedrock (≥ 1 m)						
	Boulder (10 cm - 1 m)						
	Cobble (≤ 10 cm)						
	Sand						
Relief: 1/2 m to either side of transect line & 1/4 m ahead of and behind point							
Relief	0 - 10 cm						
	10 cm - 1 m	2 2 4		1			
	1 m - 2 m	2		4 2 3		2 4 2 2	
	> 2 m						
Superlayer	Drift Algae:						
	Juvenile Laminariales						
Inanimate	Bare rock						
	Bare sand						
	Shell Debris			2			
	Sediment/mud						
	Dead Kelp Holdfast (any)					2	
Red Algae	BRANCH-flat branching						
	LEAF- blade, unbranched						
	BUSHY-cylindrical branches						
	LACY-filamentous/dense						
	ENCrustING RED						

Did you find the error?

UPC Surveys: recording data

SITE: Hopkins		DATE: 7-23-26		HEADING OUT: 330		OBSERVER: Lonhart	
TRANSECT #: 1 2		TARG. DEPTH: S M D		ACT. DEPTH: 16'-14'		BUDDY: Fett	
UPCOAST DOWNCOAST							
Substrate:		0-10M		10-20M		20-30M	
Substrate	Bedrock (≥ 1 m)						
	Boulder (10 cm - 1 m)						
	Cobble (≤ 10 cm)						
	Sand						
Relief: 1/2 m to either side of transect line & 1/4 m ahead of and behind point							
Relief	0 - 10 cm						
	10 cm - 1 m	2 2 4		1			
	1 m - 2 m	2		4 2 3		2 4 2 2	
	> 2 m						
Superlayer	Drift Algae:						
	Juvenile Laminariales						
Inanimate	Bare rock						
	Bare sand			2			
	Shell Debris						
	Sediment/mud						
	Dead Kelp Holdfast (any)					2	
Red Algae	BRANCH-flat branching						
	LEAF-blade, unbranched						
	BUSHY-cylindrical branches						
	LACY-filamentous/dense						
	ENCrustING RED						

Did you find the error?

UPC Surveys: summing rows

SITE: Hopkins		DATE: 7-23-26	HEADING OUT: 330	OBSERVER: Lonhart
TRANSECT #: 1 2				
TARG. DEPTH: S M D		ACT. DEPTH: 16'-14'	BUDDY: Fett	
UPCOAST DOWNCOAST				
Substrate:		0-10M	10-20M	20-30M
Substrate	Bedrock (≥ 1 m)			
	Boulder (10 cm - 1 m)			
	Cobble (≤ 10 cm)			
	Sand			
Relief: 1/2 m to either side of transect line & 1/4 m ahead of and behind point				
Relief	0 - 10 cm			
	10 cm - 1 m	2 4 1	2 2	
	1 m - 2 m	4 1 2 2 2 2 2 4		
	> 2 m			
Superlayer	Drift Algae:			
	Juvenile Laminariales			
Inanimate	Bare rock			
	Bare sand			
	Shell Debris	2		
	Sediment/mud			
	Dead Kelp Holdfast (any)			2
Red Algae	BRANCH-flat branching			
	LEAF-blade, unbranched			
	BUSHY-cylindrical branches			
	LACY-filamentous/dense			
	ENCrustING RED			

Between dives, ensure all data are legible.

Safety Considerations

- 1. Dive profiles**
 - approved by DSO**
 - well within no-decompression limits**
 - maximum depth 20 m**
 - 3-5 min safety stops mandatory on dives >10 m**
- 2. Air consumption**
 - safety over data collection (500 psi @ surface)**
- 3. Buddy system**
 - members of a dive team are always in contact via the transect line**
- 4. Sea conditions**
 - diving will only be conducted in good conditions**

Dive Safety Brief

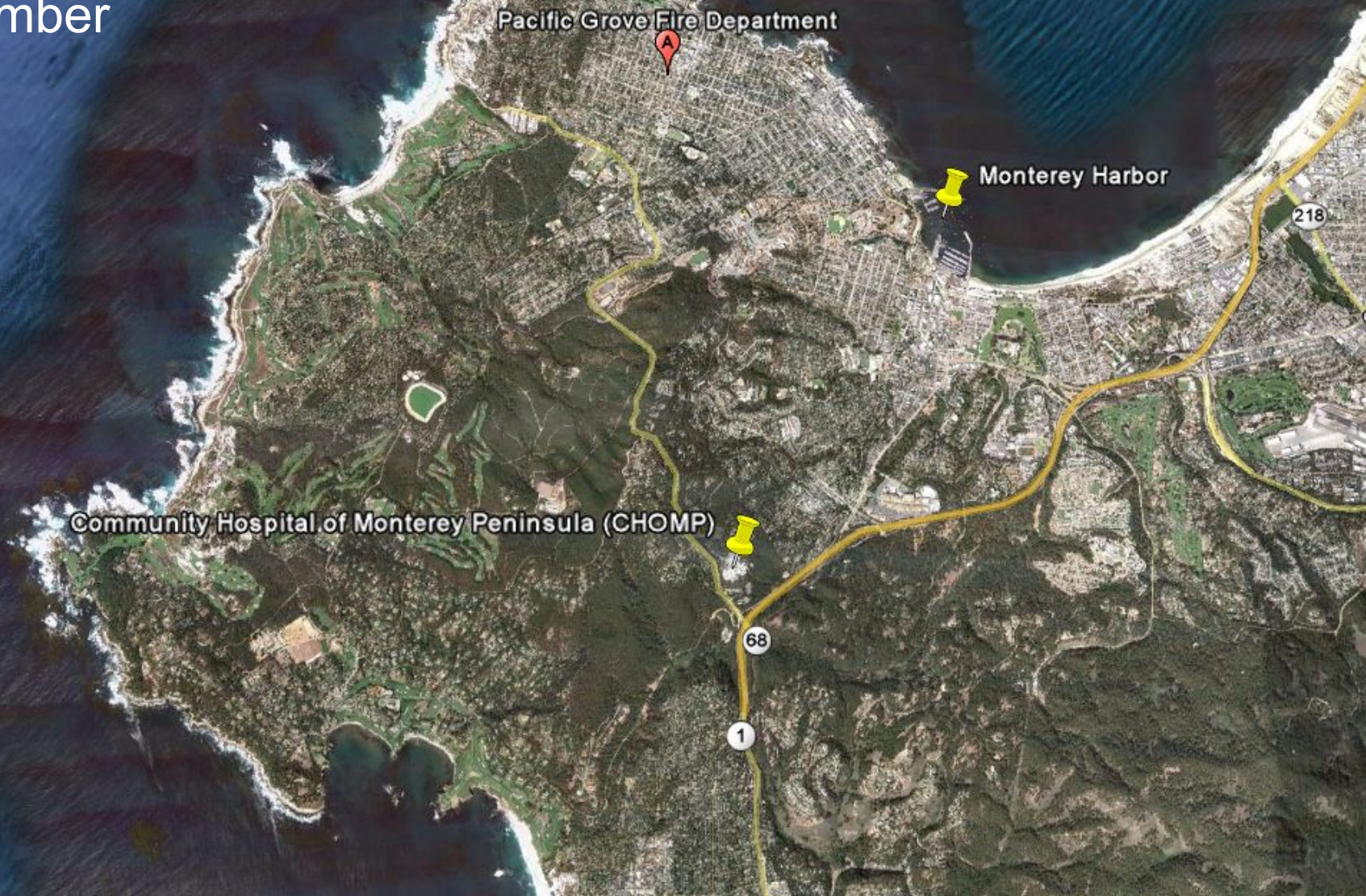
- 1. Dive log - sign out and in**
- 2. Dive procedures**
 - ascent rate 1 ft per 2 sec**
 - deep-shallow**
 - maintain dive team**

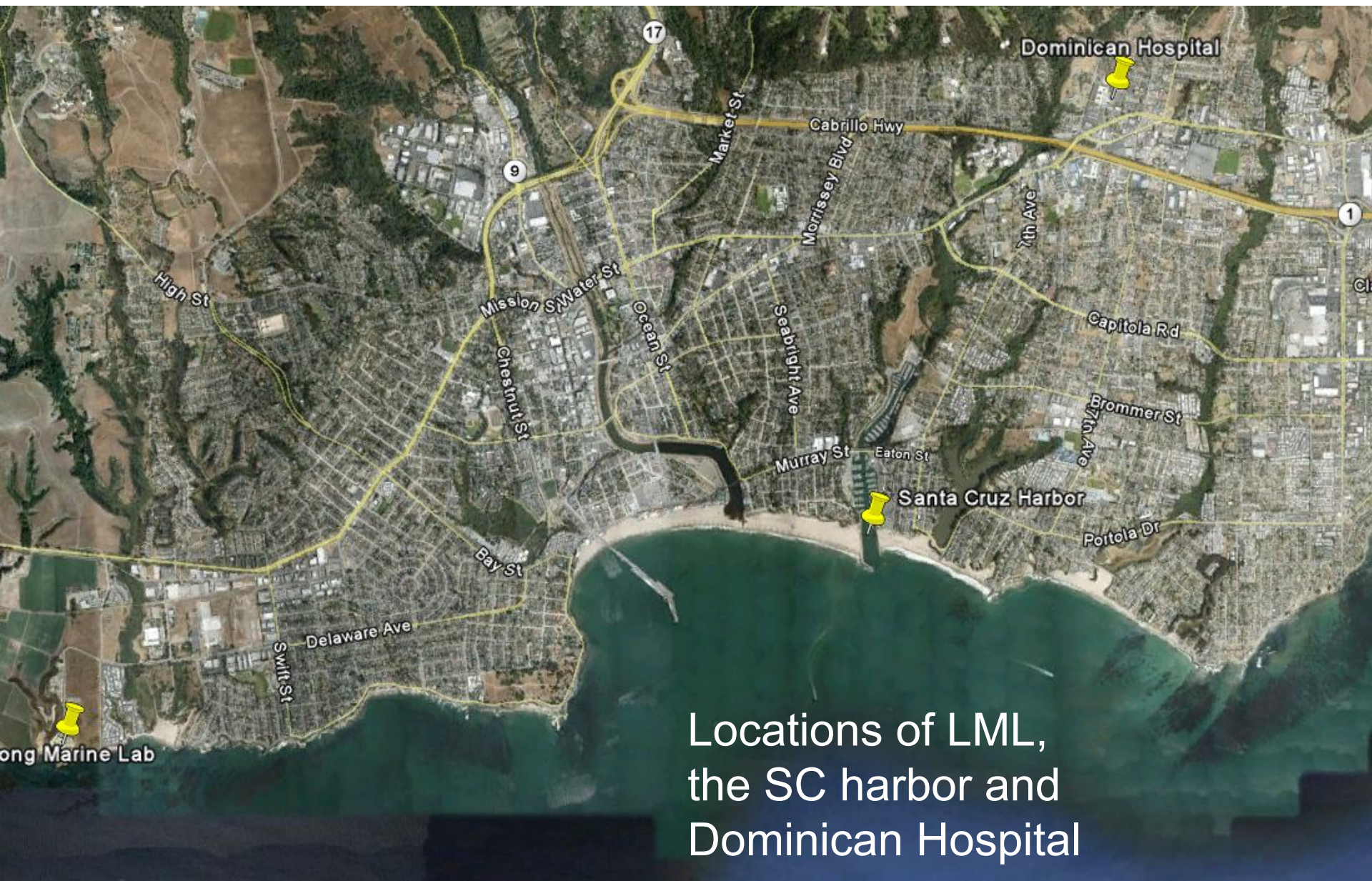
[illegible]

3. On board communications: cell phone, VHF Ch 16 (small boat), & SPOT system
4. First Aid & Oxygen - Shore and vessel
5. Evacuation plan: this is developed for each site and must be covered prior to the dive



Locations of CHOMP and PG chamber

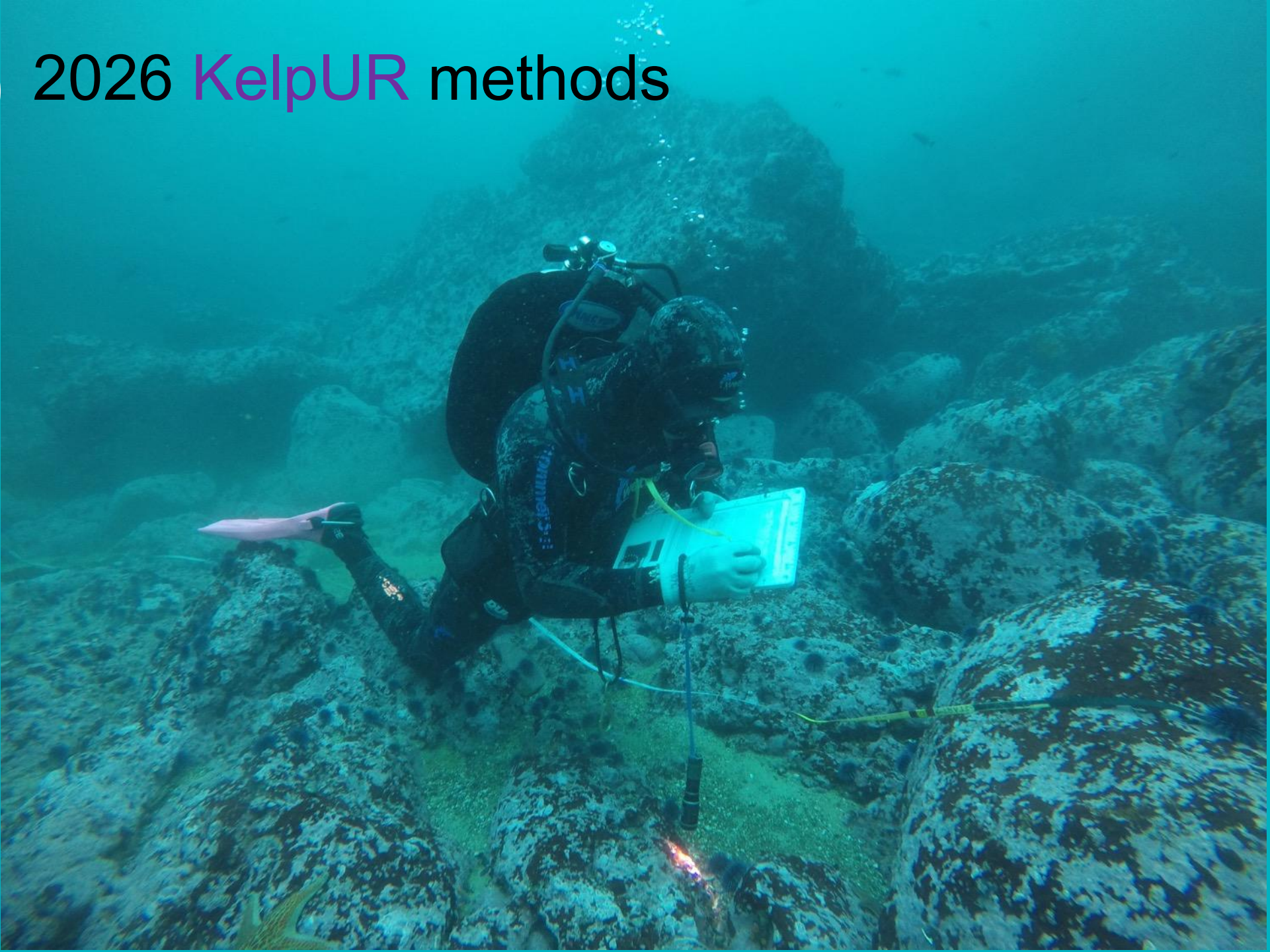




Locations of LML,
the SC harbor and
Dominican Hospital



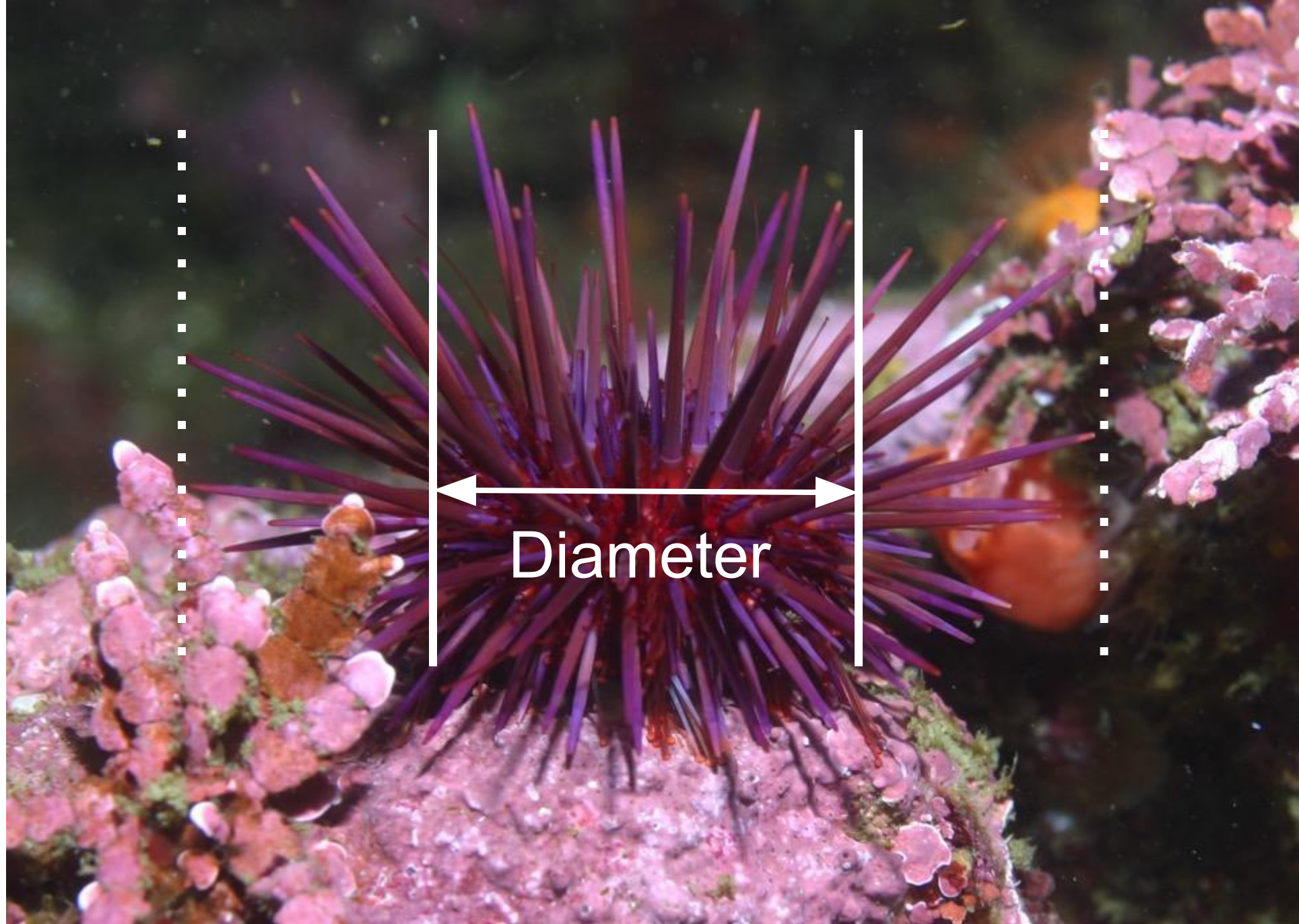
2026 KelpUR methods





KelpUR survey

- Count **kelp** recruits and **purple** & **red** urchins on the swath transect (30 m x 2 m) in three 10-m segments.
- Flashlight mandatory! Look carefully for small (1 & 2 cm) urchins, search cracks & crevices.
- Size the first 10 **purple** urchins, recording if [C]oncealed or [E]xposed.
- Size the first 10 **red** urchins.
- Size to nearest cm based on urchin test diameter (i.e. shell), excluding spines.
- Count an additional 20+ urchins per 10-m segment for each species & note distance traveled.
- Note diseased urchins with an asterisk.





Urchin disease

Disease protocols

- Diseased (*) vs. healthy (default)
- If diseased, ID wasting vs. black spot if possible
- Complete dead tests (shell) counted
- Share info with dive team immediately, inform Dan Malone

Wasting Disease



Black Spot





Urchin “wasting disease”

Strongylocentrotus purpuratus unless noted

Wasting Disease - Shortened spines/generally uniform loss of spines. Sometimes shortening of spines is not uniform; see bottom two photos.



Photo: Channel Islands National Park



Photo: Channel Islands National Park
Kelp Forest Monitoring Program



Photo: Channel Islands National Park
Kelp Forest Monitoring Program



Photo: Channel Islands National Park
Kelp Forest Monitoring Program



Urchin “black spot disease”

Black spot disease symptoms - Appearance of fairly characteristic lesions that can cause localized spines loss, test stains, and holes through the test. Also note that some dislodged urchins that are tossed around (striking rocks) can have abraded patches of spine loss, but these are not lesions (from Engle)



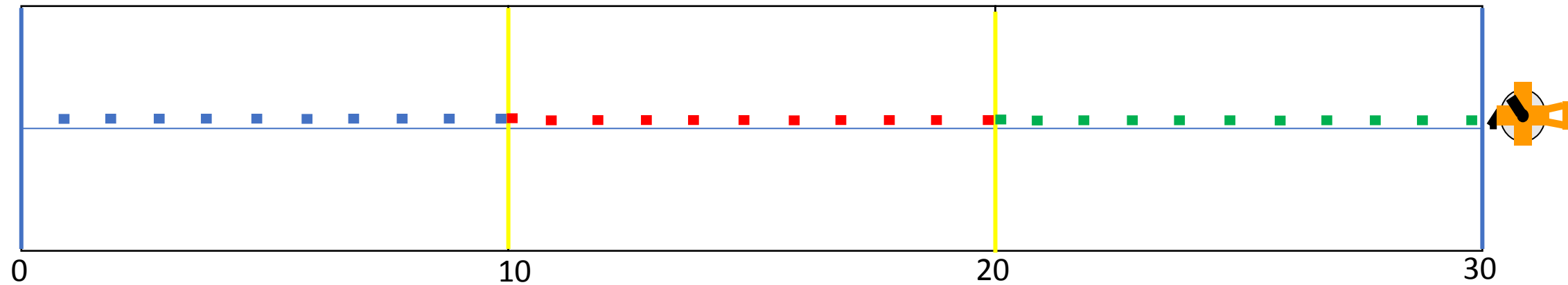
Orange County, CA



Orange County, CA



KelpUR Diver: **UPC** or **swath** diver lays the tape, other follows, and **KelpUR** is last, heading from 0 m to 30 m



Kelp/URchin diver (**KelpUR**)

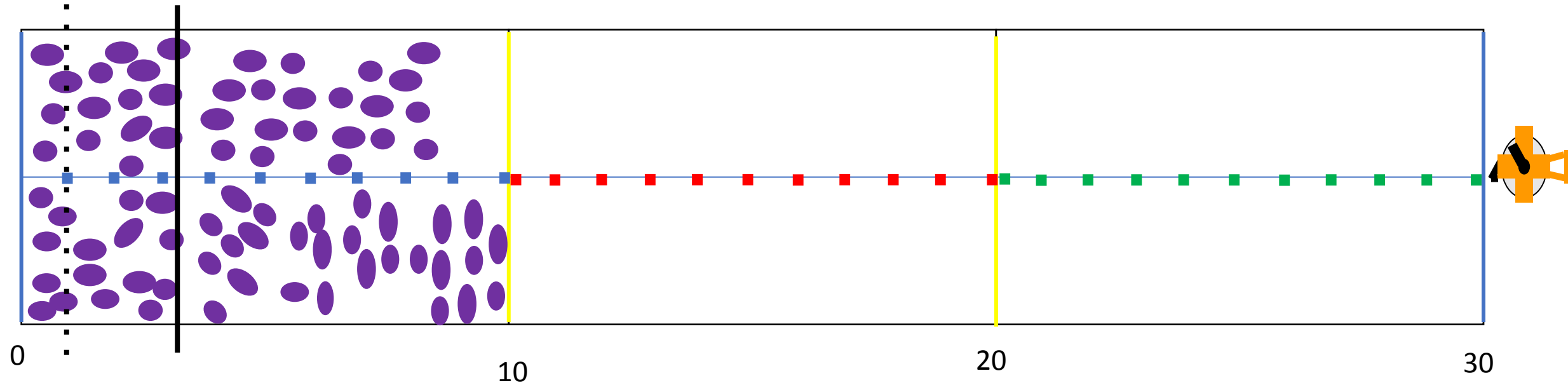
- Size 10 **purple** and **red** urchins (1 cm increments) and record 10 **purple** sizes in [C]oncealed or [E]xposed column.
- Count additional ≥ 20 **purple** and **red** urchins within 10 m segment as necessary, noting distance covered (e.g., @2.2 m)
- Record number kelp recruits to the end of each 10 m segment OR a total of 30 are recorded (in each kelp recruit category).
- 8 kelp recruit & juvenile categories:
 - LAMREC = Recruit in the Order Laminariales you cannot ID to species **AND** not juvenile Laminariales listed below.
 - MACREC = *Macrocystis pyrifera* recruit single, ruffled blade, “split” absent
 - MACJ = *Macrocystis pyrifera* juvenile <1 m stipe length (blades excluded); “split” present
 - Ptery juv. = *Pterygophora californica* juvenile <30 cm stipe length
 - **NERJ** = *Nereocystis luetkeana* juvenile <1 m stipe length
 - **LSETJ** = *Laminaria setchellii* juvenile <30 cm stipe length
 - **EISJ** = *Eisenia arborea* juvenile <30 cm stipe length
 - **COSJ** = *Costaria costata* juvenile <10 cm blade width

SITE: McAbee		UP - DN	CEN	DATE: 8-17-26	OBSERVER: Lonhart	BUDDY: Murrell
Transect:	1 2	Zone: S M D		Actual Depth: 46'-50'	Heading: 270	
	0-10m		10-20m		20-30m	
PURPLE URCHIN	2 (				2 (	
size 10 per segment separate (E)xposed vs. (C)oncealed	3 (				3 (	
	4 (				4 (	
	5 (				5 (	
	6 (				6 (	
		E	C		C	E
additional urchins subsample 20+@m						
complete tests						
RED URCHIN	3 (				3 (	
size 10 per segment	4 (			4 (		4 (
	5 (			5 (		5 (
	6 (			6 (		6 (
	7 (			7 (		7 (
additional urchins, subsample 20+@m						
Macrocystis recruit						
Laminariales recruit						
Macro. juv (<1m)						
Ptery. juv (<1m)						
Other Kelp Juvs write in: NERJ (<1m), LSETJ, EISJ (<30cm), COSJ (<10cm width)						

Record concealed
vs exposed purple
urchins, first 10
encountered

Denote disease
with asterisk *

KelpUR Diver tasks: First 10-m segment



- From 0 m to dashed vertical line $n=10$ purple urchins sized to nearest cm, [C]oncealed or [E]xposed.
- From dashed line to solid line an additional $n=21$ purple urchins counted, sub-sampled @3.2 m.

Within each 10-m segment, the KelpUR diver:

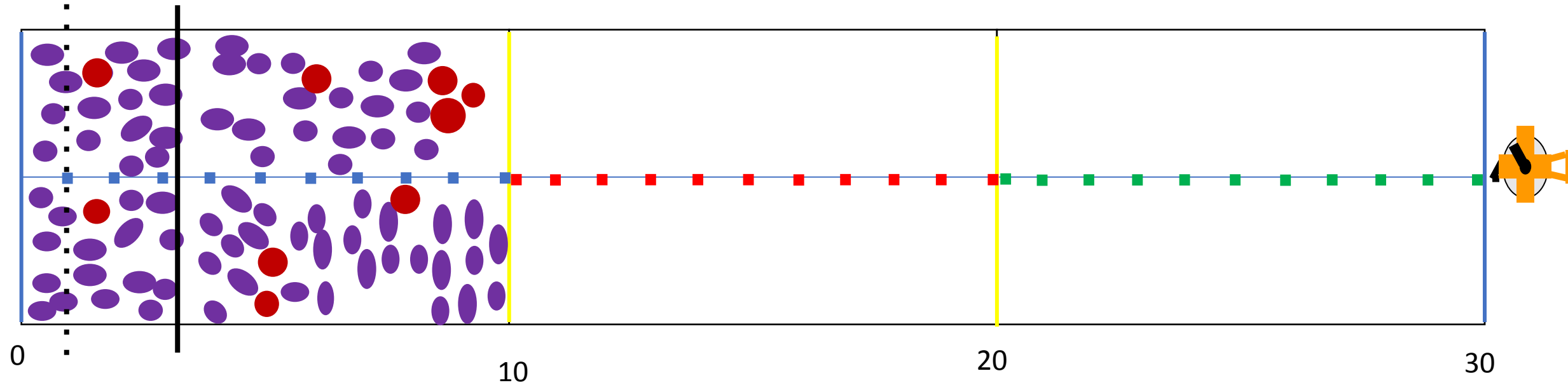
- ➔
1. Sizes the first 10 purple urchins AND notes if they are [C]oncealed or [E]xposed, then counts an additional 20+ purple urchins (uncommon to count exactly 30, in total) and notes distance sub-sampled to nearest 0.1 m.
 2. Sizes the first 10 red urchins and counts an additional 20+ red urchins (uncommon to count exactly 30, in total) and notes distance sub-sampled to nearest 0.1 m. We do not record if red urchins were exposed or concealed.
 3. Counts the first 30+ non-adult *M. pyrifera* and notes distance sub-sampled to nearest 0.1 m for both recruits (MACREC) and juveniles (MACJ) separately.

SITE: McAbee		UP - DN	CEN	DATE: 8-17-26	OBSERVER: Lonhart	BUDDY: Murrell
Transect: 1 2		Zone: S M D		Actual Depth: 46'-50'	Heading: 270	
	0-10m		10-20m		20-30m	
PURPLE URCHIN	2 (				2 (	
size 10 per segment separate (E)xposed vs. (C)oncealed	3 (2	I			3 (	
	4 (4, I*				4 (	
	5 (	II			5 (	
	6 (				6 (	
		E	C		C	E
additional urchins subsample 20+@m	21 @ 3.2 m *(2)					
complete tests	7					
RED URCHIN	3 (				3 (	
size 10 per segment	4 (			4 (	4 (	
	5 (			5 (	5 (	
	6 (			6 (	6 (	
	7 (			7 (	7 (	
additional urchins, subsample 20+@m						
Macrocystis recruit						
Laminariales recruit						
Macro. juv (<1m)						
Ptery. juv (<1m)						
Other Kelp Juvs write in: NERJ (<1m), LSETJ, EISJ (<30cm), COSJ (<10cm width)						

Record concealed
vs exposed purple
urchins, first 10
encountered

Denote disease
with asterisk *

KelpUR Diver tasks: First 10-m segment



- From 0 m to dashed vertical line $n=10$ purple urchins sized to nearest cm, [C]oncealed or [E]xposed.
- From dashed line to solid line an additional $n=21$ purple urchins counted, sub-sampled @3.2 m.

Within each 10-m segment, the KelpUR diver:

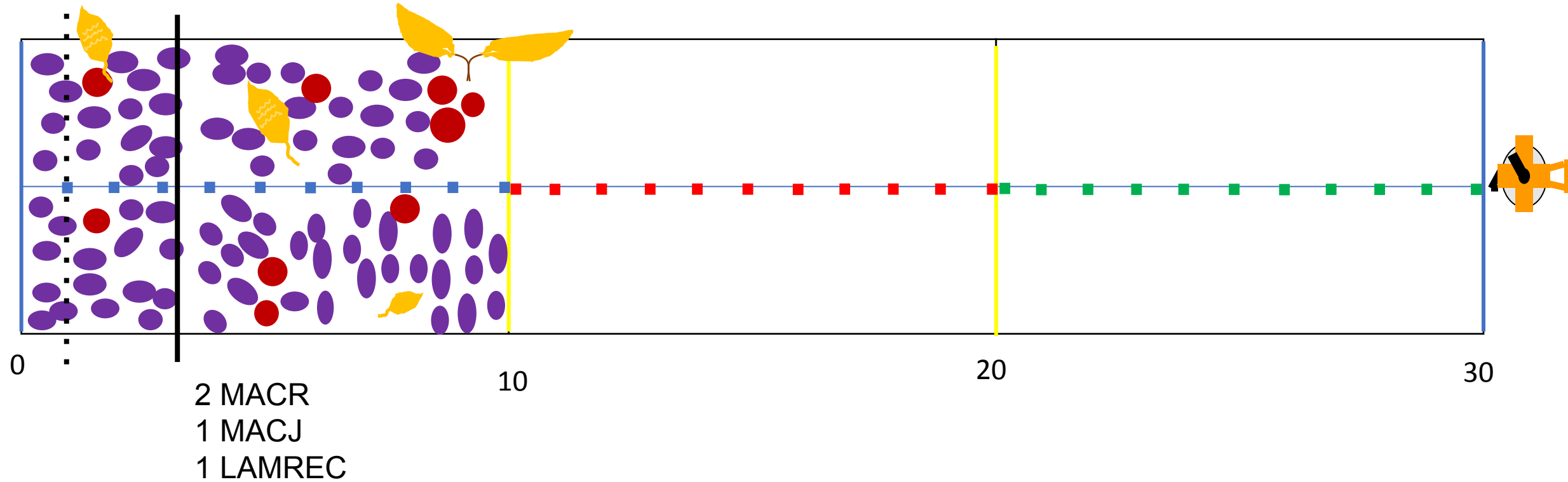
1. Sizes the first 10 purple urchins AND notes if they are [C]oncealed or [E]xposed, then counts an additional 20+ purple urchins (uncommon to count exactly 30, in total) and notes distance sub-sampled to nearest 0.1 m.
- ➔ 2. Sizes the first 10 red urchins and counts an additional 20+ red urchins (uncommon to count exactly 30, in total) and notes distance sub-sampled to nearest 0.1 m. We do not record if red urchins were exposed or concealed.
3. Counts the first 30+ non-adult *M. pyrifera* and notes distance sub-sampled to nearest 0.1 m for both recruits (MACREC) and juveniles (MACJ) separately.

SITE: McAbee		UP - DN	CEN	DATE: 8-17-26	OBSERVER: Lonhart	BUDDY: Murrell
Transect: 1 2		Zone: S M D		Actual Depth: 46'-50'	Heading: 270	
	0-10m		10-20m		20-30m	
PURPLE URCHIN	2 (				2 (	
size 10 per segment separate (E)xposed vs. (C)oncealed	3 (2	I			3 (	
	4 (4, I*				4 (	
	5 (	II			5 (	
	6 (				6 (	
		E	C		C	E
additional urchins subsample 20+@m	21 @ 3.2 m *(2)					
complete tests	7					
RED URCHIN	3 (				3 (	
size 10 per segment	4 (3, 2, I			4 (	4 (	
	5 (			5 (	5 (	
	6 (I			6 (	6 (	
	7 (	9) 2		7 (	7 (	
additional urchins, subsample 20+@m						
Macrocystis recruit						
Laminariales recruit						
Macro. juv (<1m)						
Ptery. juv (<1m)						
Other Kelp Juvs write in: NERJ (<1m), LSETJ, EISJ (<30cm), COSJ (<10cm width)						

Record concealed
vs exposed purple
urchins, first 10
encountered

Denote disease
with asterisk *

KelpUR Diver tasks: First 10-m segment



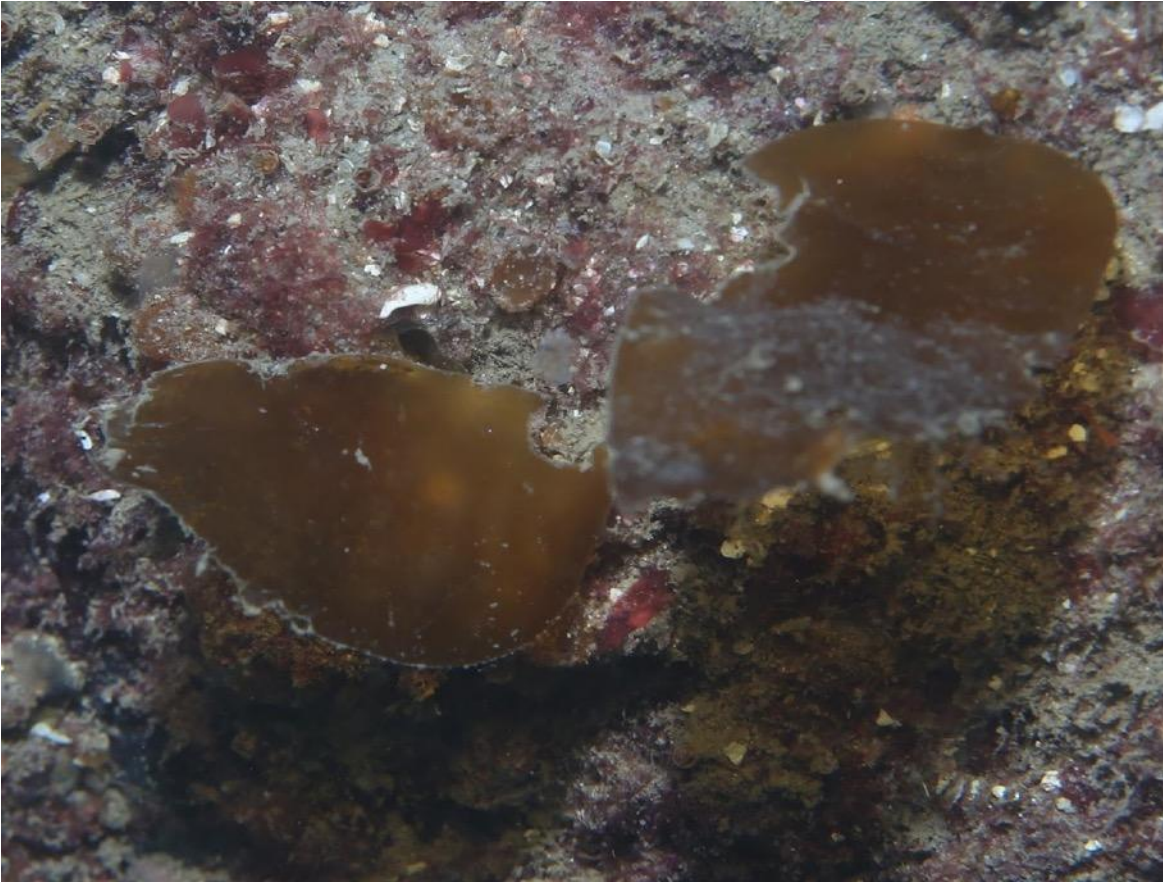
Within each 10-m segment, the KelpUR diver:

1. Sizes the first 10 purple urchins AND notes if they are [C]oncealed or [E]xposed, then counts an additional 20+ purple urchins (uncommon to count exactly 30, in total) and notes distance sub-sampled to nearest 0.1 m.
2. Sizes the first 10 red urchins and counts an additional 20+ red urchins (uncommon to count exactly 30, in total) and notes distance sub-sampled to nearest 0.1 m. We do not record if red urchins were exposed or concealed.
- ➔ 3. Counts the first 30+ non-adult *M. pyrifera* and notes distance sub-sampled to nearest 0.1 m for both recruits (MACREC) and juveniles (MACJ) separately.

SITE: McAbee		UP - DN	CEN	DATE: 8-17-26	OBSERVER: Lonhart	BUDDY: Malone
Transect: 1 2		Zone: S M D		Actual Depth: 46'-50'	Heading: 270	
	0-10m		10-20m		20-30m	
PURPLE URCHIN	2 (		2 (		2 (	
size 10 per segment separate (E)xposed vs. (C)oncealed	3 (2	I	3 (		3 (	
	4 (4, I*	II	4 (		4 (	
	5 (		5 (		5 (	
	6 (		6 (		6 (	
	E	C	E	C	E	C
additional urchins subsample 20+@m	21 @ 3.2 m *(2)					
complete tests	7					
RED URCHIN	3 (		3 (		3 (	
size 10 per segment	4 (3, 2, I		4 (		4 (	
	5 (		5 (		5 (	
	6 (I	9) 2	6 (		6 (	
	7 (		7 (		7 (	
additional urchins, subsample 20+@m						
Macrocystis recruit	2					
Laminariales recruit	I					
Macro. juv (<1m)	I					
Ptery. juv (<1m)						
Other Kelp Juvs write in: NERJ (<1m), LSETJ, EISJ (<30cm), COSJ (<10cm width)						

- 8 kelp recruit & juvenile categories:

- 
 LAMREC = Recruit in the Order Laminariales you cannot ID to species **AND** juvenile Laminariales not listed below.
 - MACREC = *Macrocystis pyrifera* recruit single, ruffled blade, “split” absent
 - MACJ = *Macrocystis pyrifera* juvenile <1 m stipe length (blades excluded); “split” present
 - Ptery juv. = *Pterygophora californica* juvenile <30 cm stipe length
 - NERJ = *Nereocystis luetkeana* juvenile <1 m stipe length
 - LSETJ = *Laminaria setchellii* juvenile <30 cm stipe length
 - EISJ = *Eisenia arborea* juvenile <30 cm stipe length
 - COSJ = *Costaria costata* juvenile <10 cm blade width



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- NERJ = *Nereocystis luetkeana* juvenile <1 m stipe length
- LSETJ = *Laminaria setchellii* juvenile <30 cm stipe length
- EISJ = *Eisenia arborea* juvenile <30 cm stipe length
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- MACJ = *Macrocystis pyrifera* juvenile <1 m stipe length (blades excluded); “split” present
- Ptery juv. = *Pterygophora californica* juvenile <30 cm stipe length; stipe “shadow” extends into blade
- NERJ = *Nereocystis luetkeana* juvenile <1 m stipe length
- LSETJ = *Laminaria setchellii* juvenile <30 cm stipe length
- EISJ = *Eisenia arborea* juvenile <30 cm stipe length
- COSJ = *Costaria costata* juvenile <10 cm blade width



Pterygophora californica



Pterygophora californica



Laminaria setchellii

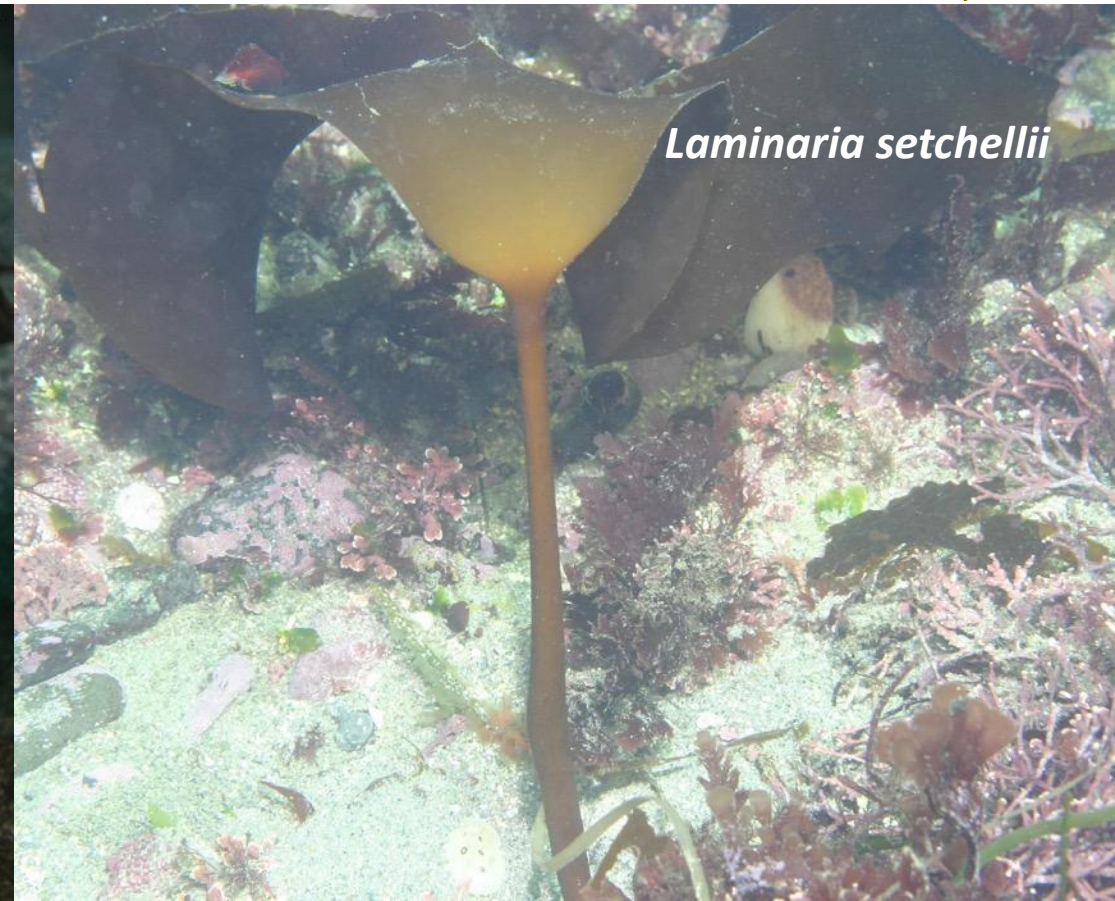
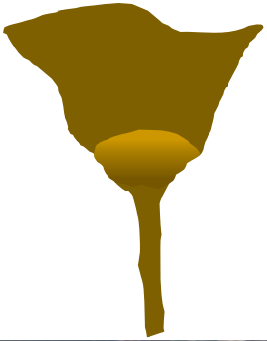
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- 8 kelp recruit & juvenile categories:

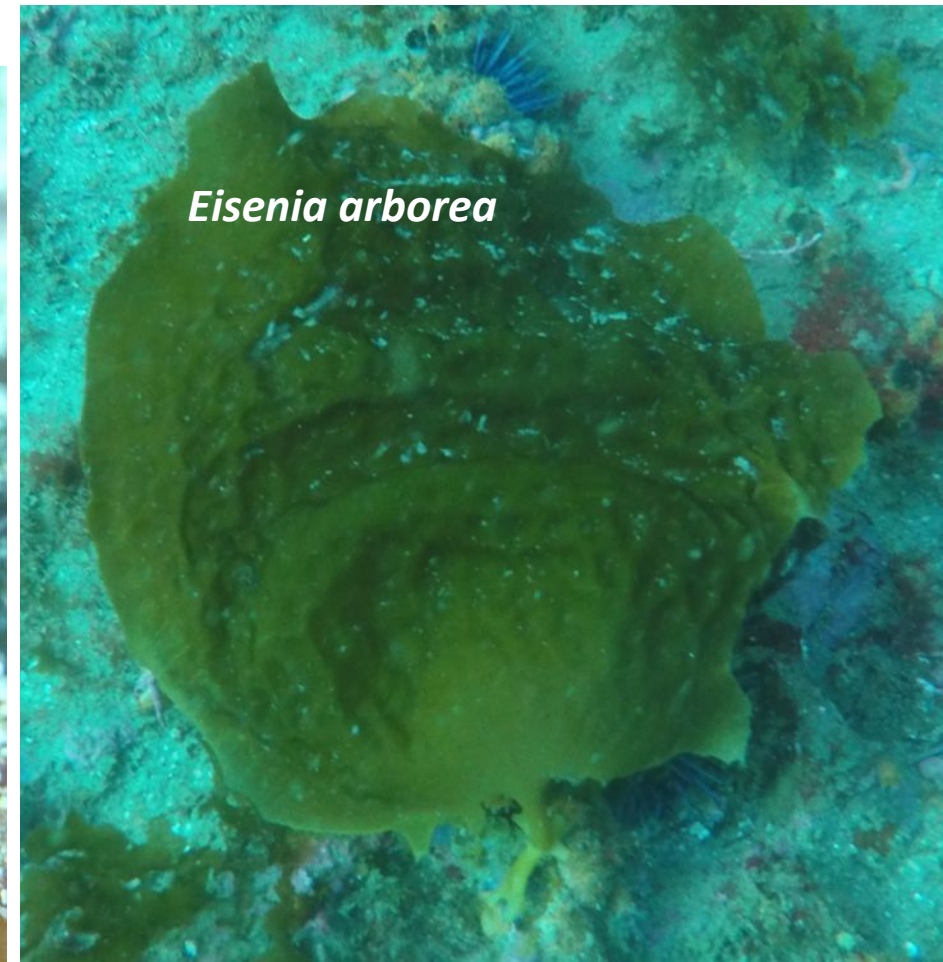
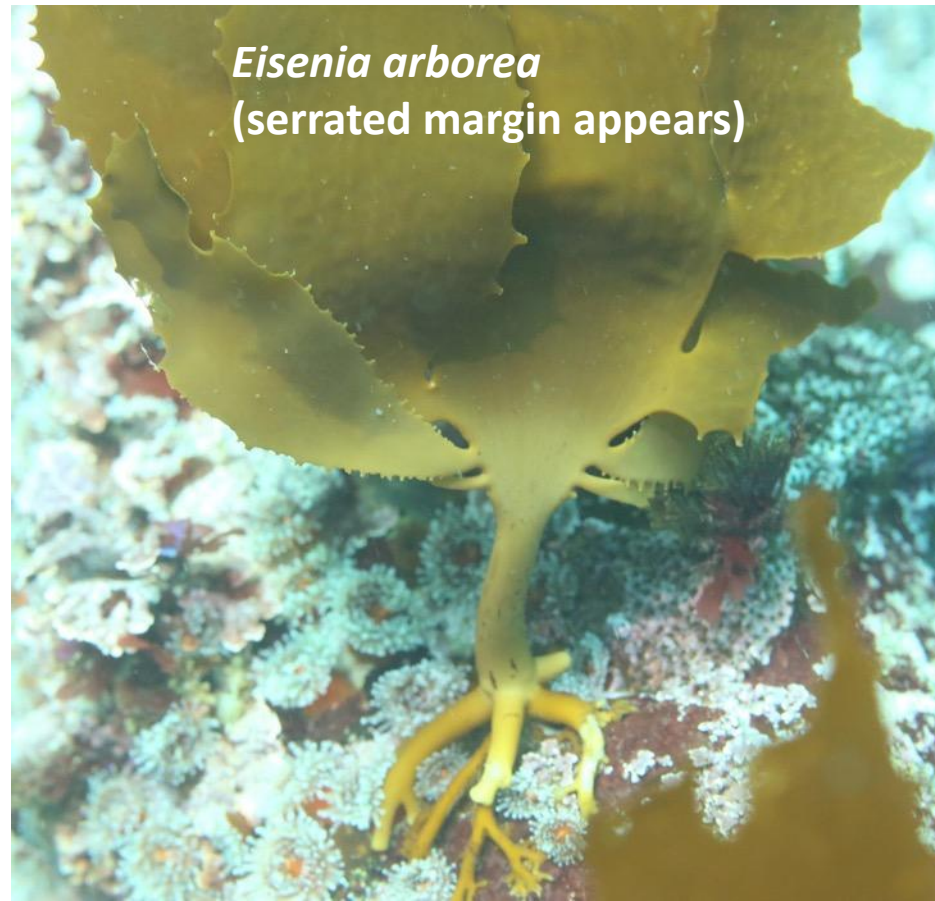
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- NERJ = *Nereocystis luetkeana* juvenile <1 m stipe length
- **LSETJ = *Laminaria setchellii*** juvenile <30 cm stipe length
- EISJ = *Eisenia arborea* juvenile <30 cm stipe length
- COSJ = *Costaria costata* juvenile <10 cm blade width



Laminaria setchellii

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- NERJ = *Nereocystis luetkeana* juvenile <1 m stipe length
- LSETJ = *Laminaria setchellii* juvenile <30 cm stipe length
- EISJ = *Eisenia arborea* juvenile <30 cm stipe length
- COSJ = *Costaria costata* juvenile <10 cm blade width



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