

PISCO Training Program

An Introduction

- 1. The PISCO annual survey**
- 2. Benthic data collection methods overview**
- 3. Safety considerations**



Annual Survey

Purposes

- 1. To assess the annual and spatial variability of community structure across CA's MPA Network**
- 1. To provide a high quality, publicly accessible, rocky reef time series dataset for use by resource managers, stakeholders, and researchers**
- 1. To establish how spatio-temporal variability might be driven by oceanographic conditions (e.g., El Nino), and altered by anthropogenic actions (e.g., marine reserves)**



Annual Surveys

When

- June-November
- 1999-Present

Where

1. Different oceanographic regimes

- a) North of Point Conception (UCSC, HSU)
- b) Point Conception to Malibu & N. Channel Islands (UCSB)
- c) South of Malibu & S Channel Islands (Vantuna Research Group, Occidental College)

2. Marine protected areas (MPAs) and paired controls

- a) Anacapa, Scorpion, Gull Isle, Painted Cave, Harris Pt., South Point, Point Conception, Campus Point, etc.



Marine Protected Areas (MPAs)

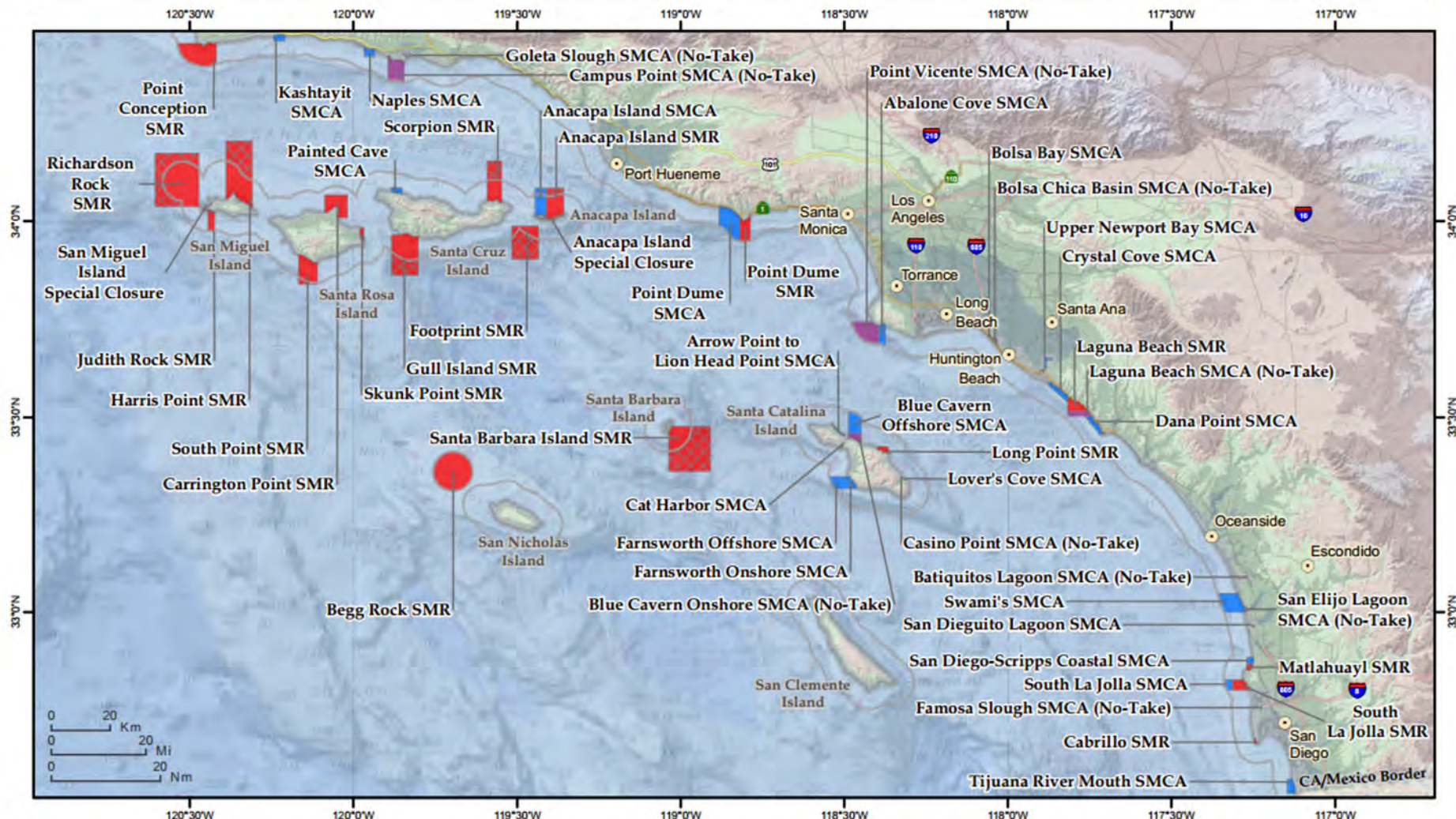
MPAs are designated areas of the ocean designed to protect ecosystems from extractive human activities, such as fishing.

Types of MPAs in California:

- SMR** - State Marine Reserve: all fishing and resource extraction is prohibited
- SMCA** - State Marine Conservation Area: some recreational and commercial activities permitted
- SMP** - State Marine Park: certain recreational fishing is allowed



California South Coast MPAs



DECADAL MANAGEMENT REVIEW



2022

- How has biomass of targeted fish species changed after protection?
- South Coast & Northern Channel Islands = significant increase in biomass for targeted species inside MPAs

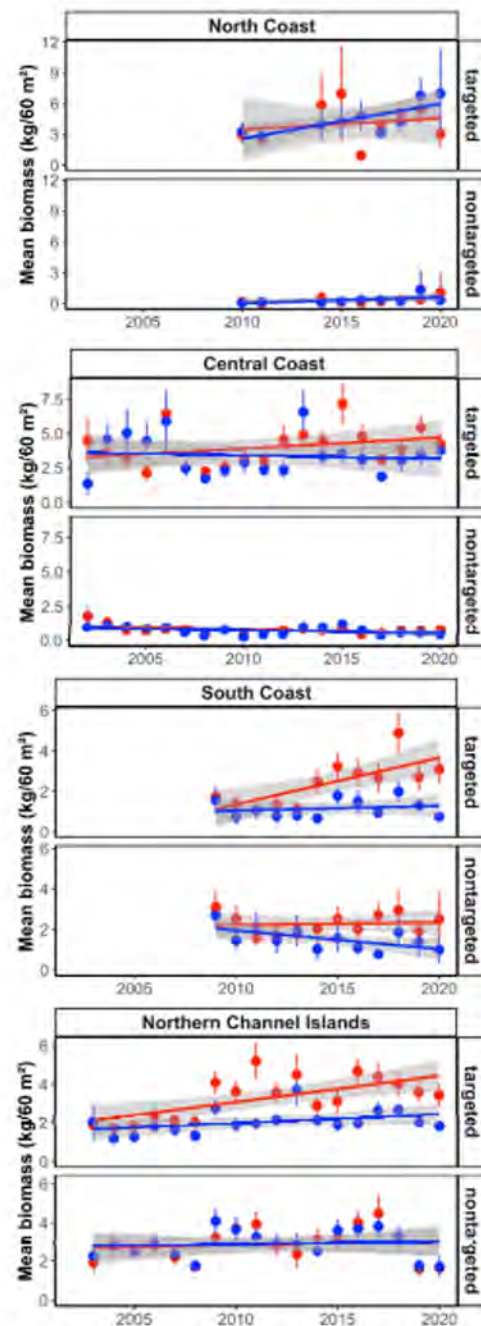
Biomass of targeted vs. non-targeted fish species by region

Baseline years:
2010-2011 / 2014-2015,
MPAs established:
2010 / 2012

Baseline years:
2007-2008
MPAs established:
2007

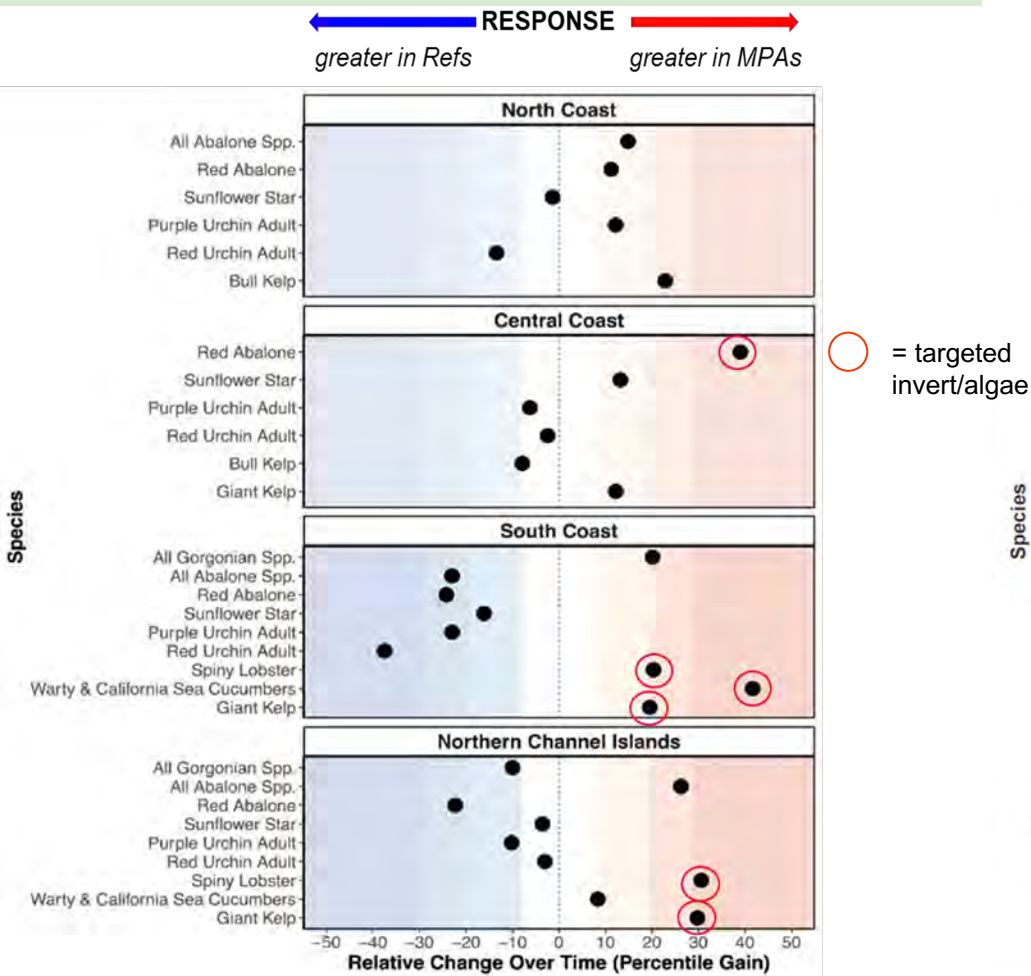
Baseline years:
2011-2012
MPAs established:
2012

Baseline years:
2005-2006
MPAs established:
2003



MPA
REF

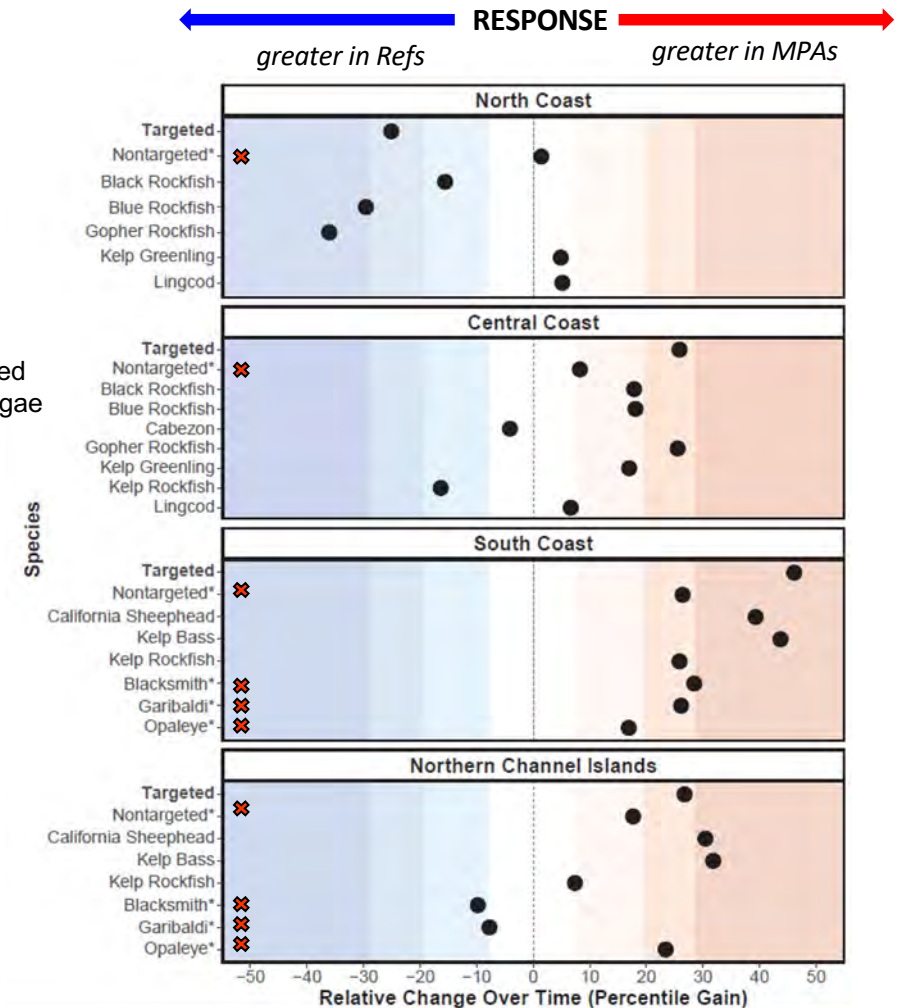
Relative change in invert & algae density over time



- Response to MPAs differ among species and fished status

- Targeted vs Non-targeted ✕

Relative change in fish biomass over time

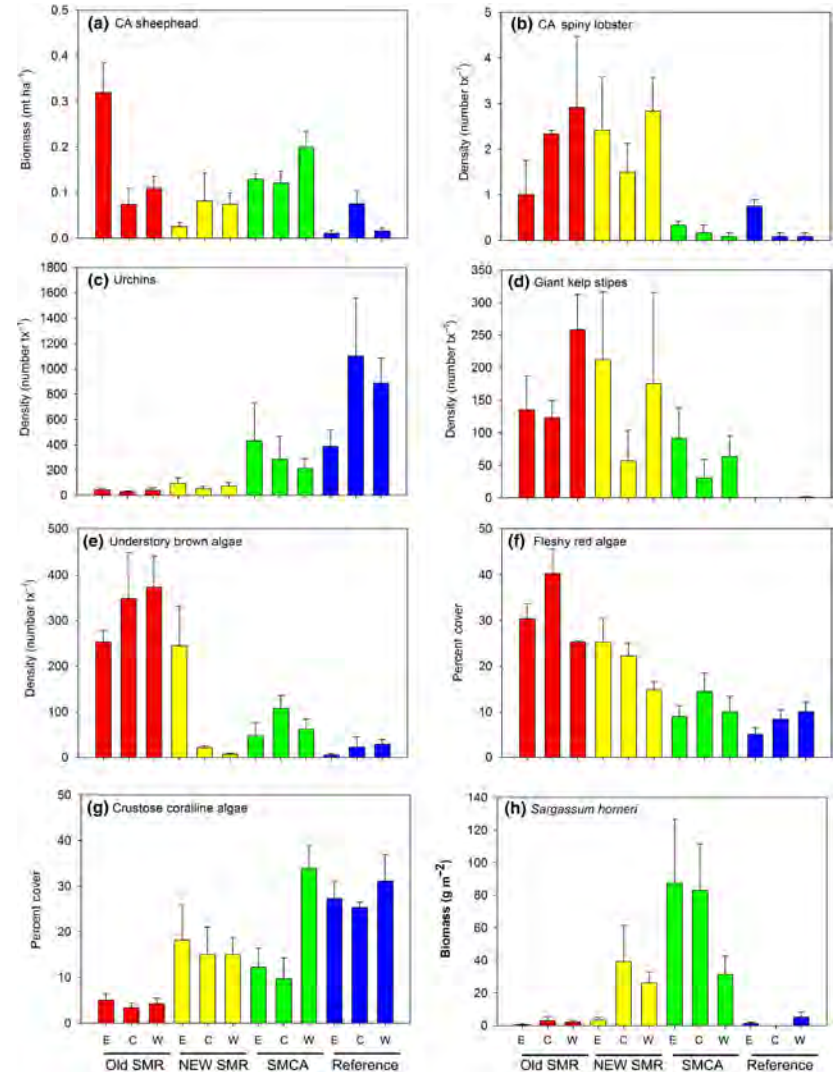
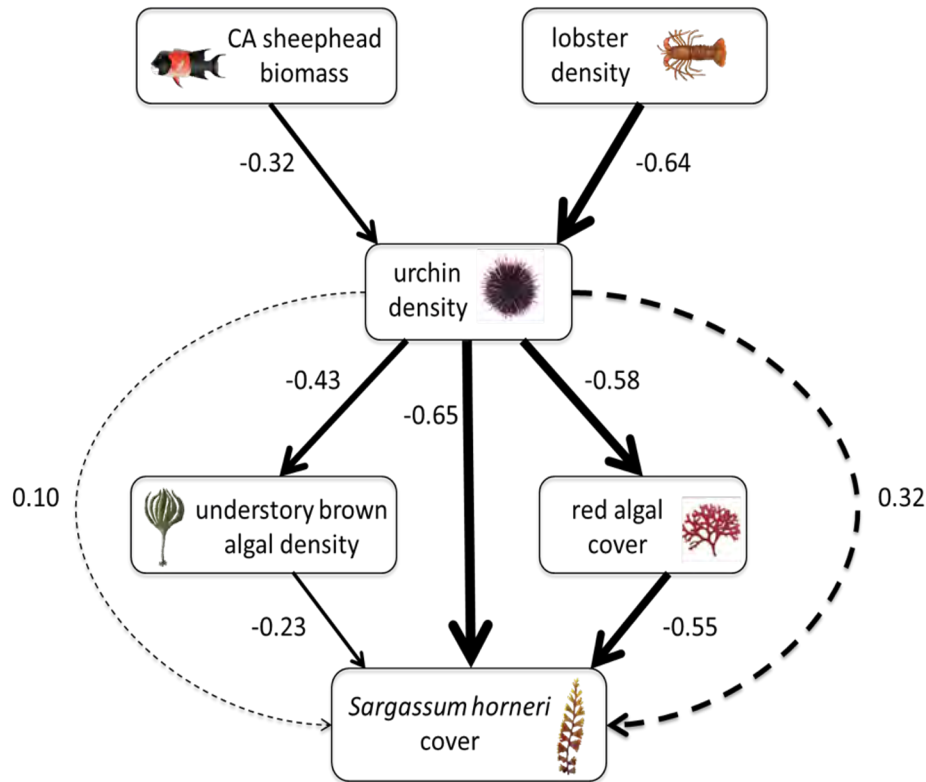


- Responses to MPAs differ among regions of the coast
- Species with the greatest responses are often heavily targeted, in mostly heavily fished regions where MPAs have been established longest

Other effects (beyond more and bigger fish)

Can MPAs help to buffer help forest communities against disturbances such as:

Invasive species?



Other effects (beyond more and bigger fish)

Can MPAs help to buffer kelp forest communities against disturbances such as:

Disease?

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



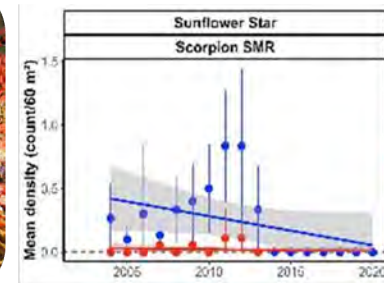
increase in density of 2 urchin predators
(**CA spiny lobster and CA Sheephead**)



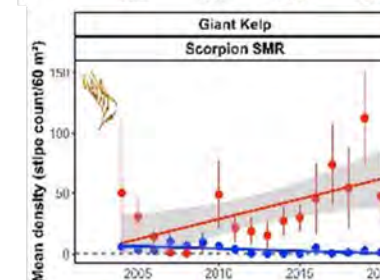
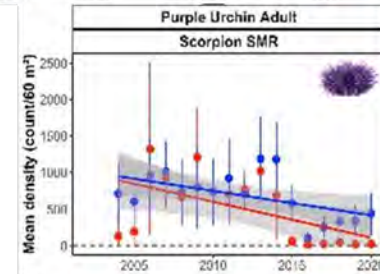
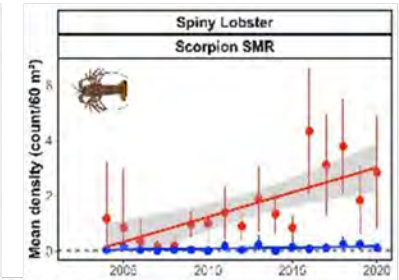
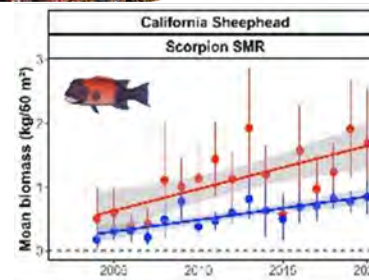
decline in density of **purple urchins**



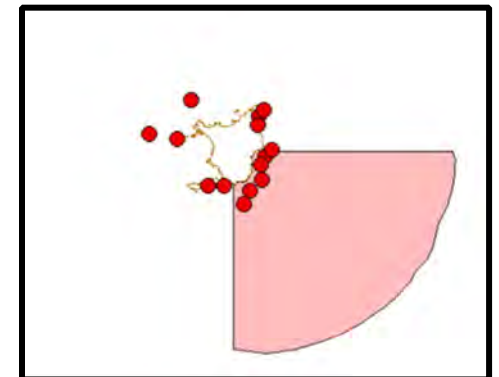
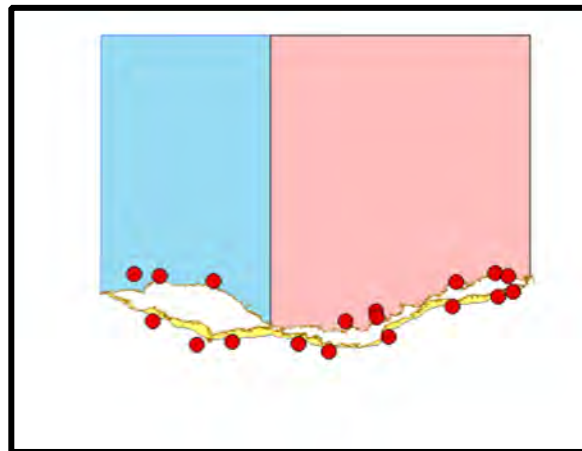
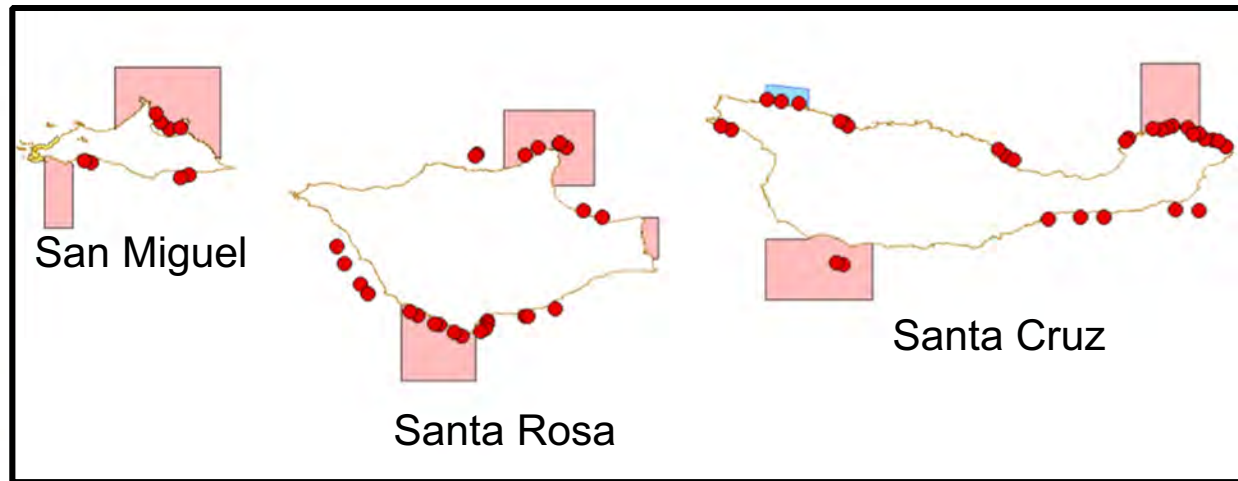
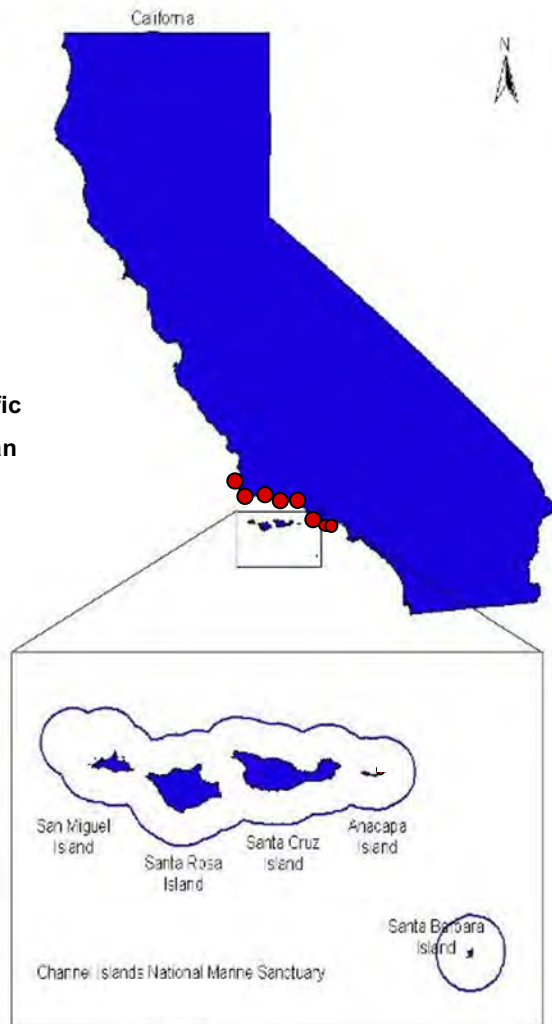
increase in density of **giant kelp**



Inside MPA
Outside MPA



UCSB Historical Sampling Sites



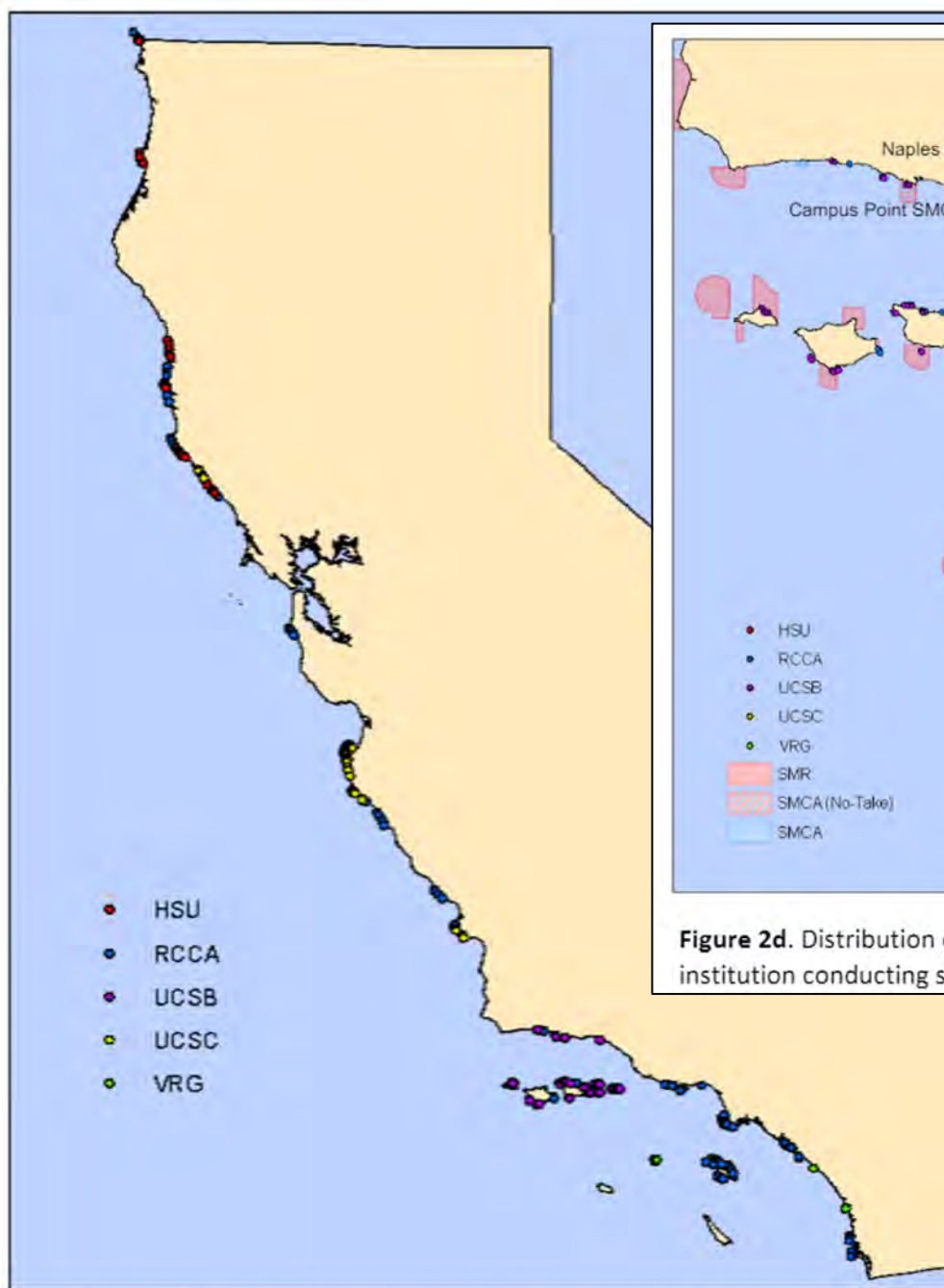


Figure 2a. Distribution of survey sites across the California coastline. Colors indicate the institution conducting surveys at each site.

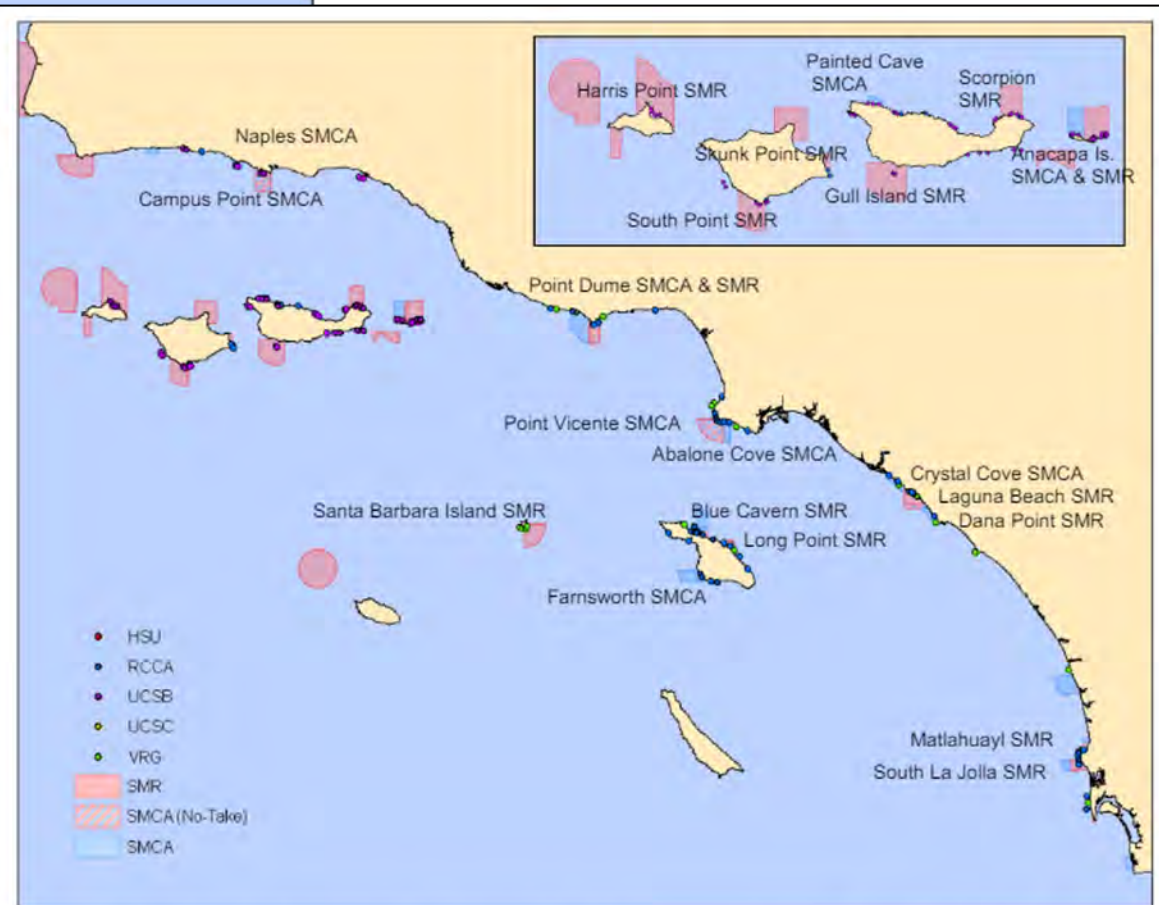


Figure 2d. Distribution of survey sites across the California coastline. Colors indicate the institution conducting surveys at each site.

Sampling sites and research partners

- CalPoly Humboldt
- Reef Check CA
- UC Santa Cruz
- Vantuna Research Group (Occidental)



Annual Surveys

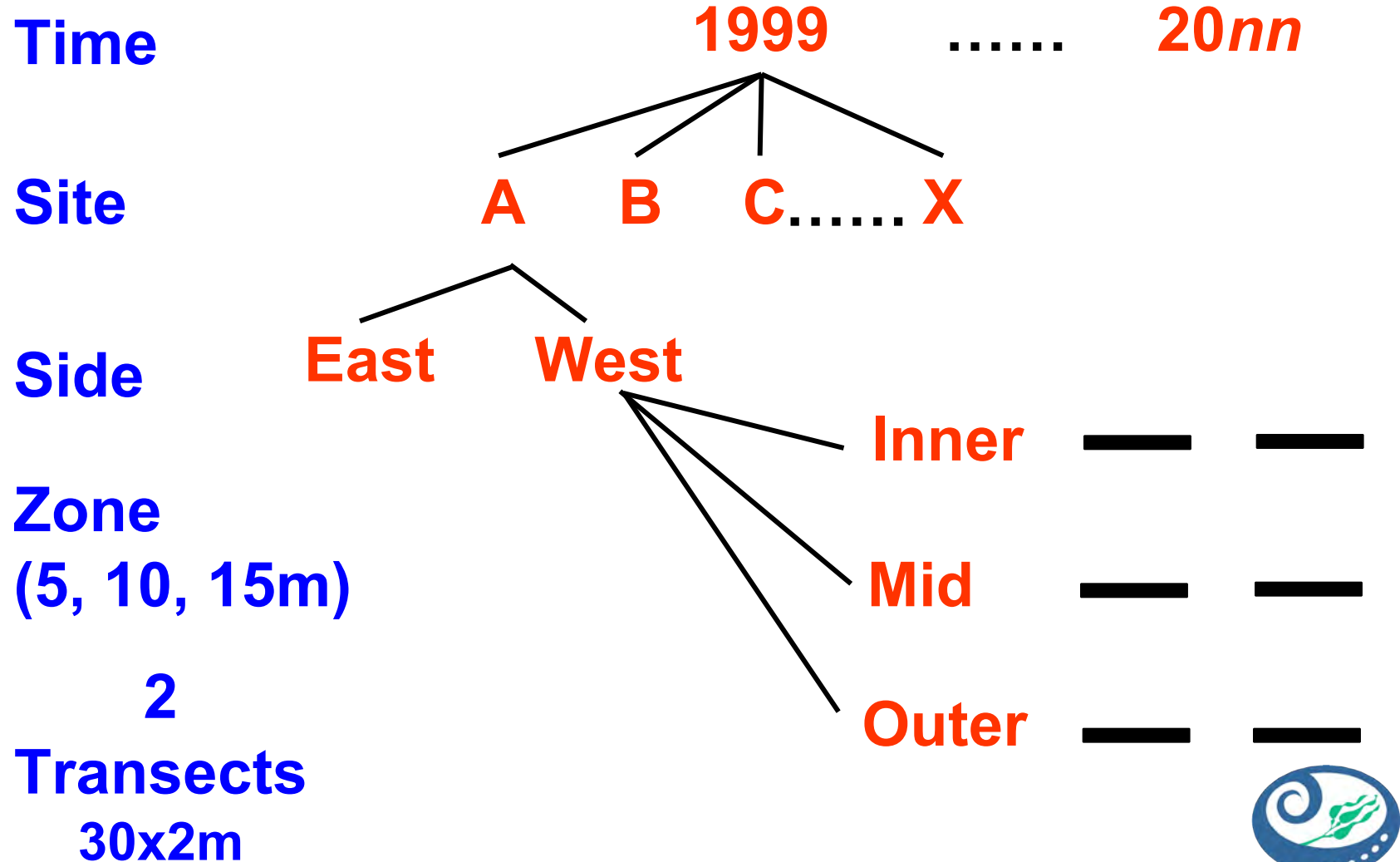
Transect Replication

- A “site” is comprised of 12 benthic transects and 24 fish transects
- A “side” is half or one third of a “site” (4 or 6 benthic, 8 or 12 fish)

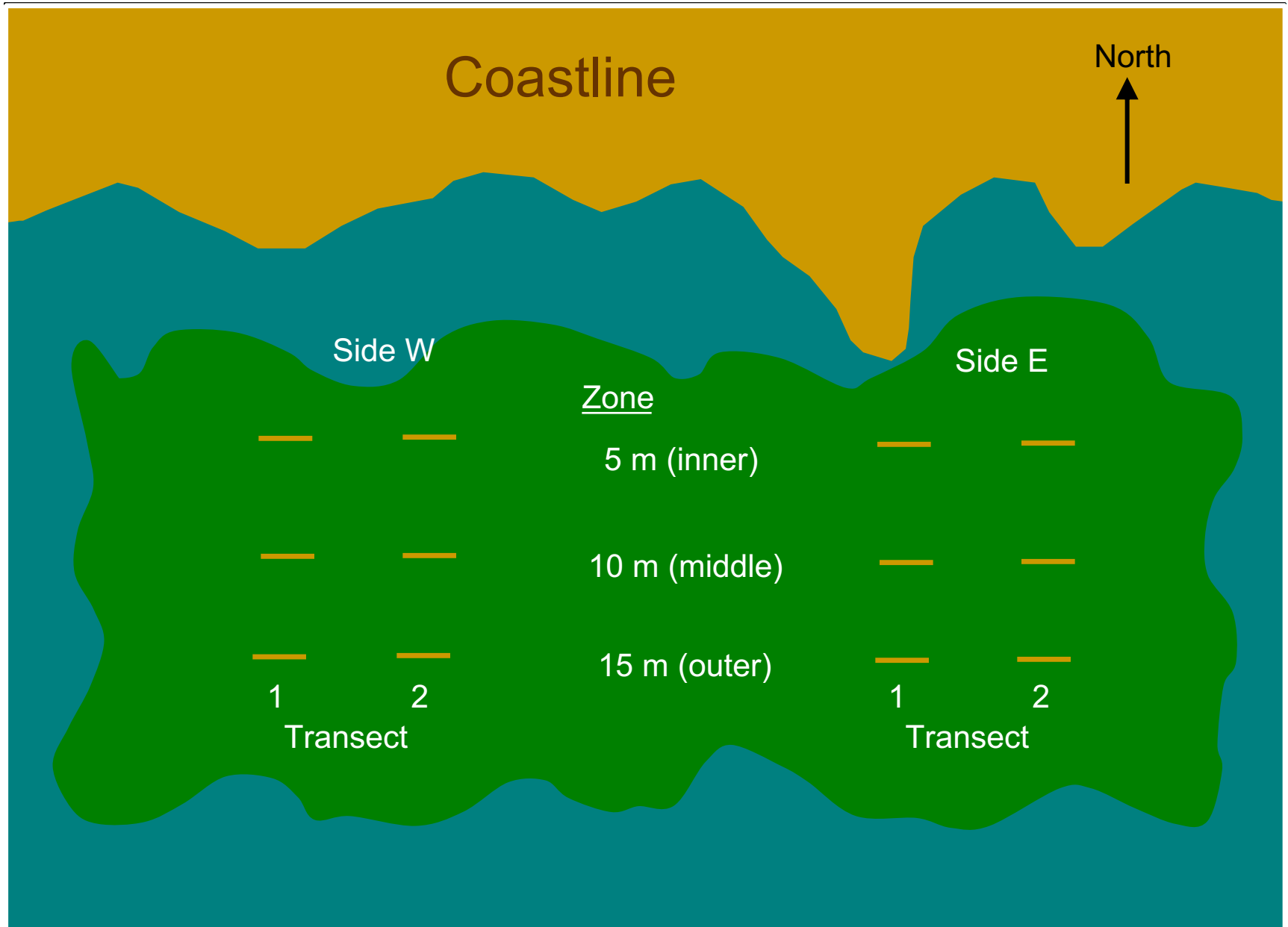


BENTHIC

Sample Design: Two-Sided Site

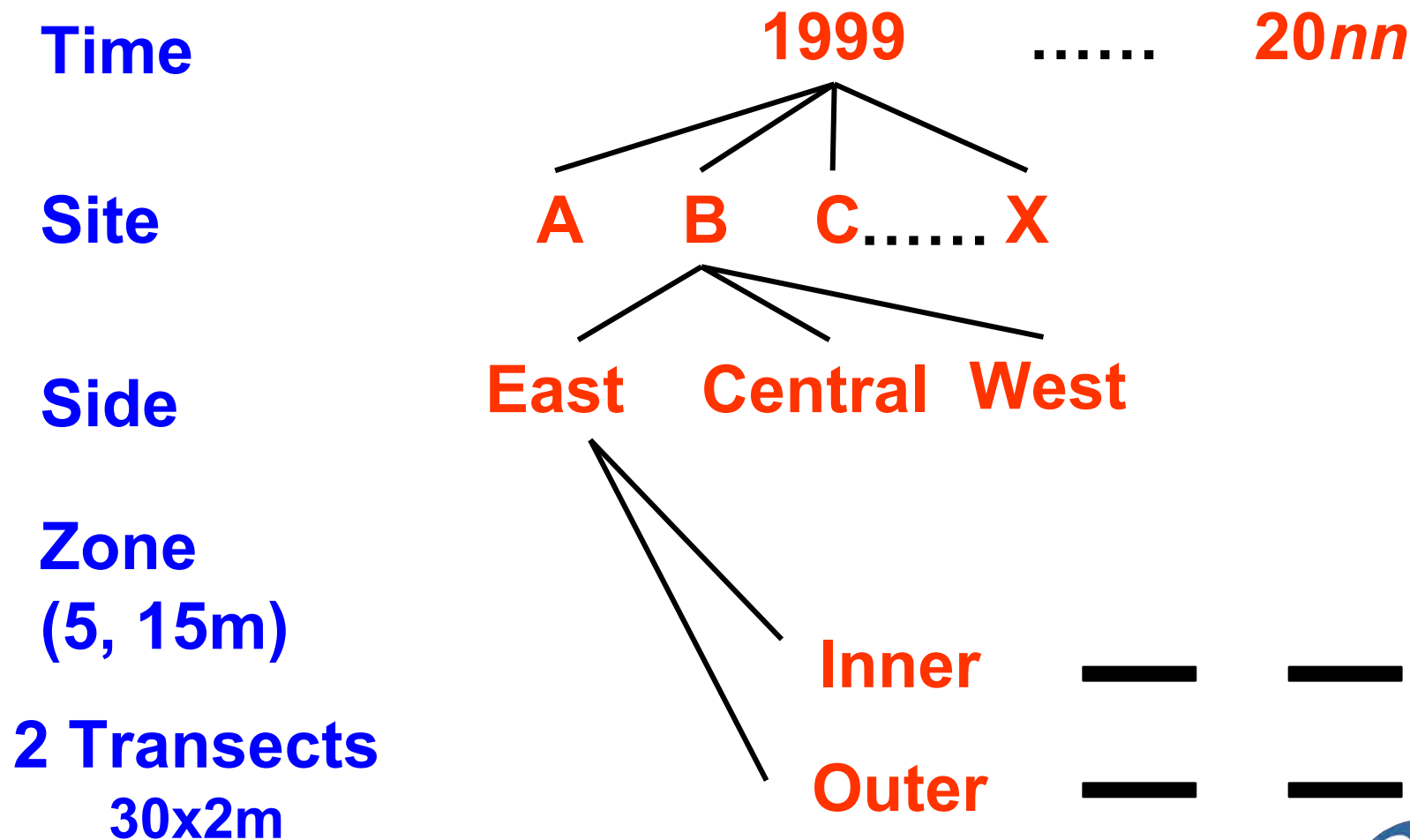


Site layout: Benthic transects. Two-side arrangement

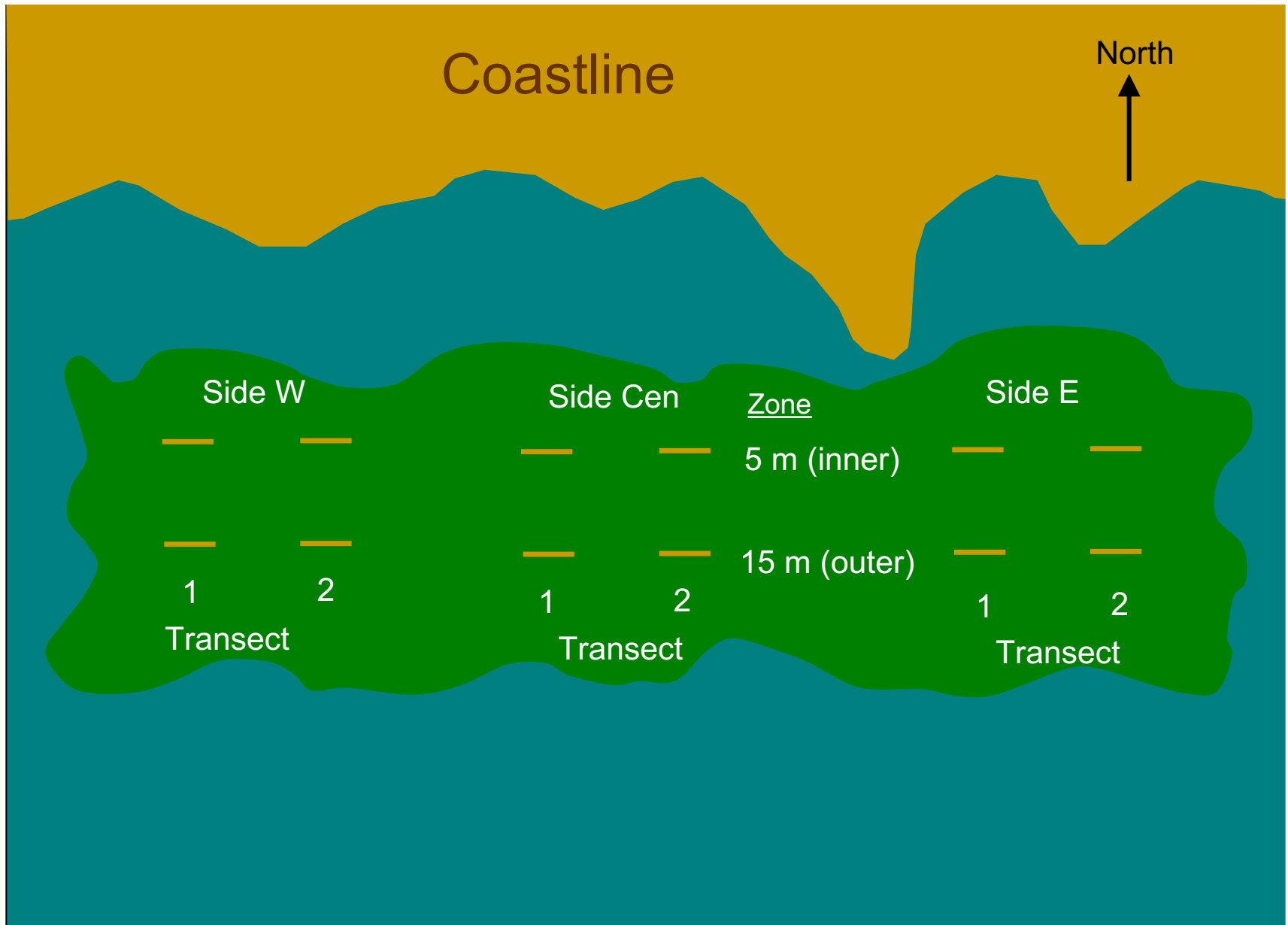


BENTHIC

Sample Design: Three-Sided Site



Site layout: Benthic transects. Three-side arrangement

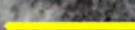


Pelican Bay Monitoring Sites

Not to be used for Navigation



Pelican Bay

-  NPS Fixed Transect
-  PISCO Subtidal Transect Areas

0 0.125 0.25 0.5 Kilometers



Annual Surveys

Benthic Surveys

Benthic surveys are comprised of three components:

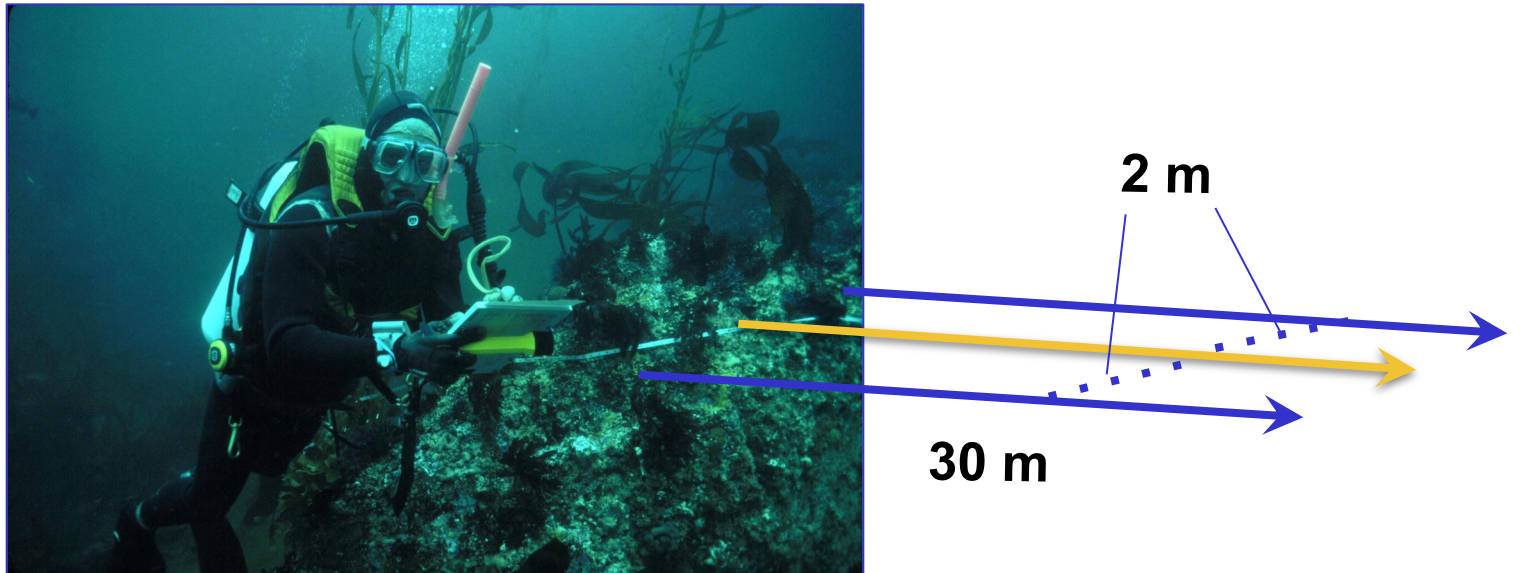
1. **Uniform point contact (UPC)** estimates of benthic cover and substrate characteristics
1. **Swath** transects to estimate the density of kelps and macroinvertebrates
1. **Size frequencies** of select organisms



Swath Sampling

Density

- kelps
- macroinverts



Transect Placement Guidelines

Priorities: rock > depth > compass 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. Keep the transect within 1m of the edge of the reef.

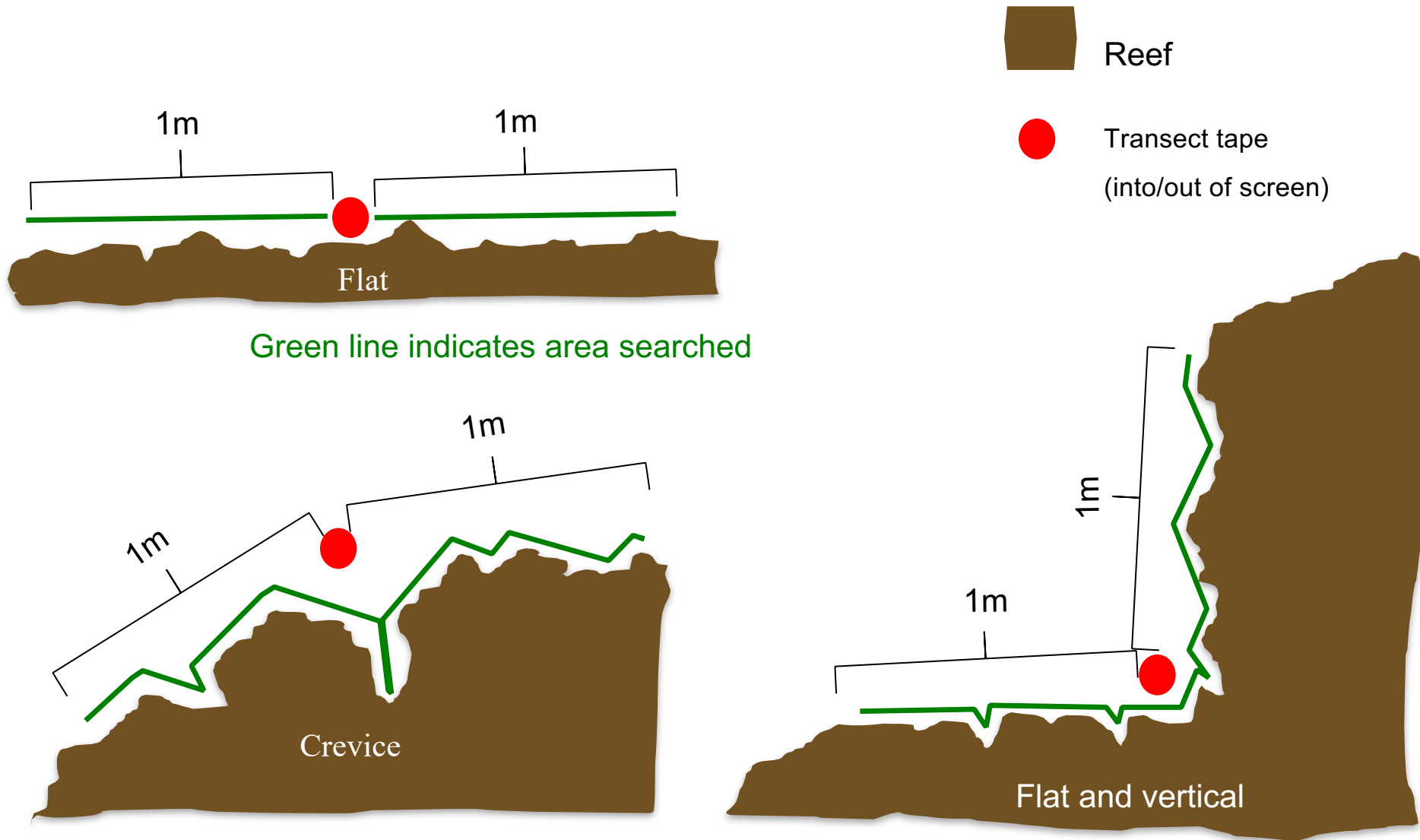
-Maintain constant depth (**continuously watching depth gauge**) by contouring around large rocks and avoid stringing the transect tape over very large crevices.

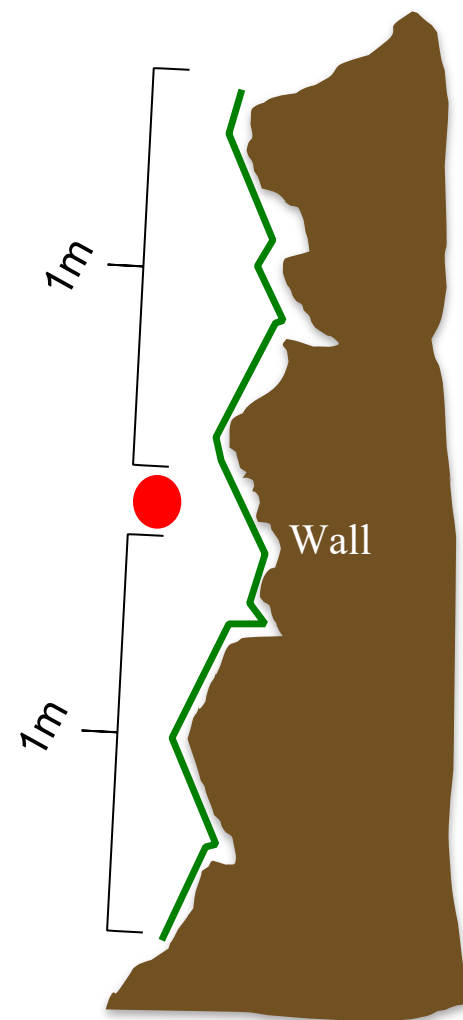
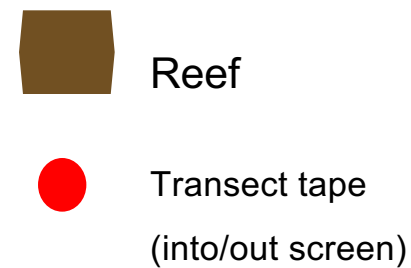
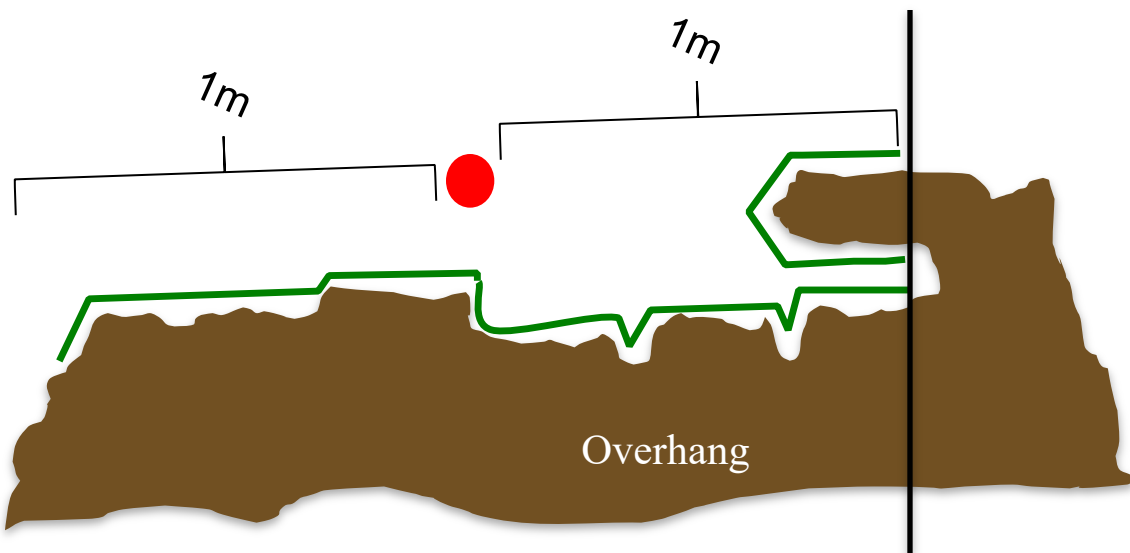
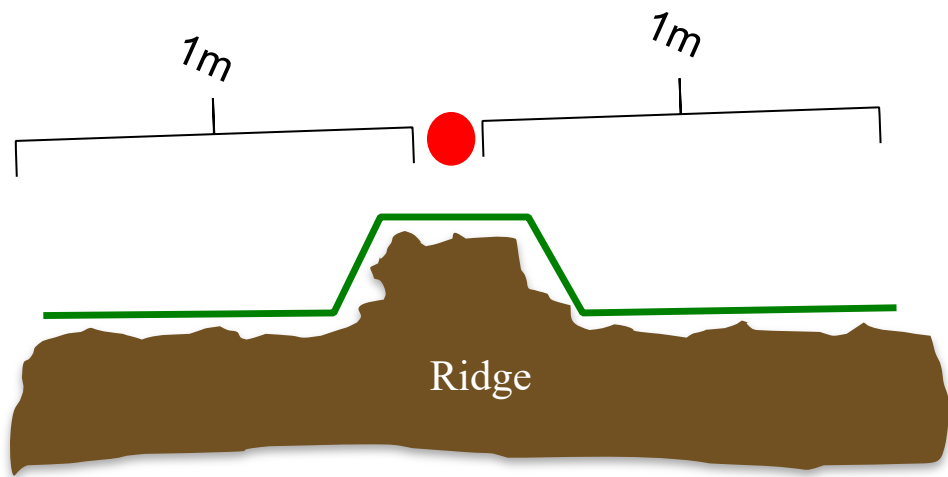
-Use kelp, gorgonians, rocks, etc. to anchor the transect tape along the bottom.

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



Swath Surveys: search area





Swath Sampling

- A diver slowly swims along the transect counting targeted invertebrates and macroalgae.
- Cracks and crevices are searched and understory algae are pushed aside.
- No organisms are removed.
- Any organism with more than half of its body outside the swath is not counted.
- Transects are divided into three, ten meter segments.
- Target species (giant kelp, lobsters, abalone, select seastars) are measured to obtain size frequency information.



Swath Sampling

Size cut-offs

- Most species have size cutoffs, designed to exclude recruits from density estimates.
- Kelps/macroalgae: Size cutoffs vary by species (covered in organism slides).
- Inverts: General rule is that organisms are included if they are 2.5cm or larger in their longest dimension (exceptions covered in organism slides).
- All size cutoffs are listed at the bottom of the swath datasheet.



Swath Sampling

Sub-Sampling

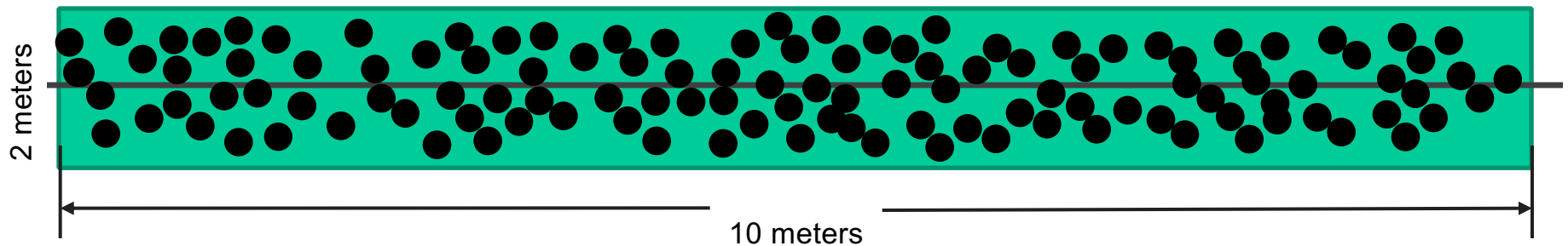
(For very high densities of macroinvertebrates and macroalgae)

- A diver's decision to sub-sample will be based on a threshold abundance level within each of 10 m intervals (0-10, 10-20, 20-30) along a transect.
- Within each 10 m increment, divers will enumerate organisms until the species threshold abundance (**30**) or the end of the 10m segment is reached.
- Once **at least 30** organisms are counted, the diver records the distance covered **within that segment** and stops counting that species until the next 10 m segment. Record to the nearest 0.1m of the transect line (e.g. **30 @1.4 m**).
- **Giant kelp, abalone and lobsters are NOT sub-sampled**



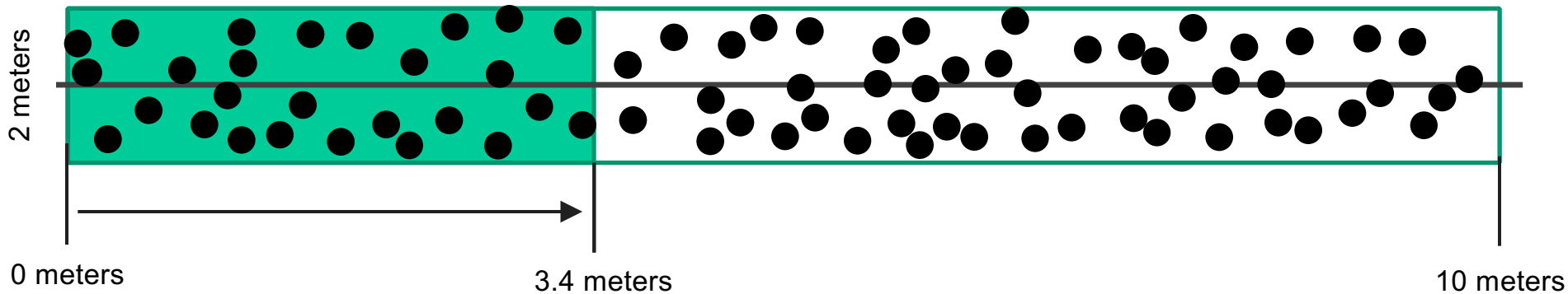
Subsampling

Counting smaller areas for very abundant organisms



Subsampling

Counting smaller areas for very abundant organisms



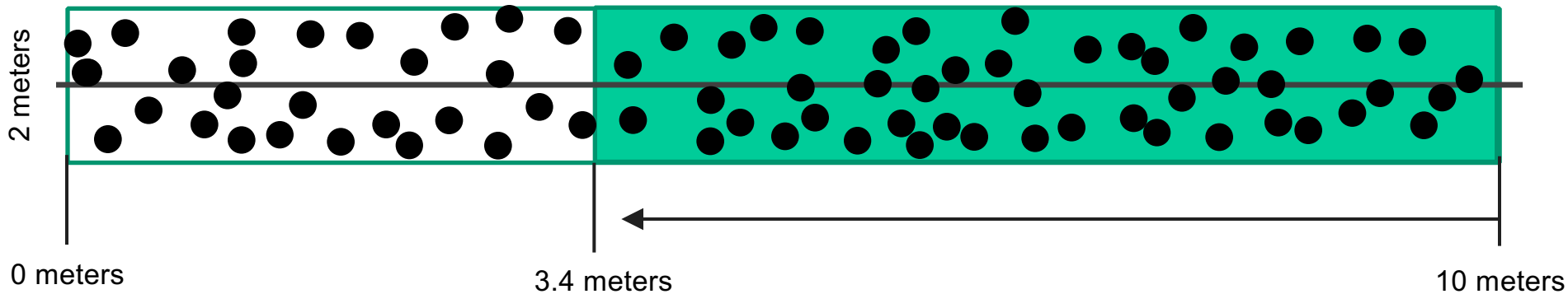
Record the number counted and the distance traveled within the segment:

“30 @ 3.4 m”



Subsampling

Counting smaller areas for very abundant organisms



If traveling backwards along the transect subtract the meter reached from 10

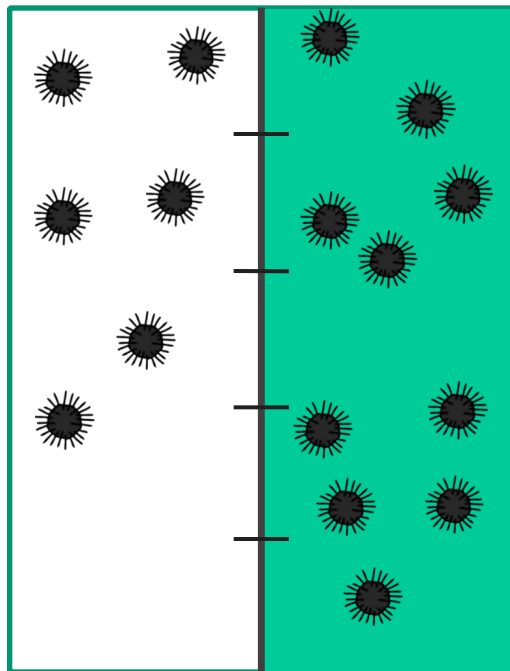
“30 @ 6.6 m”



Subsampling Protocols

30 @ 4.0 m

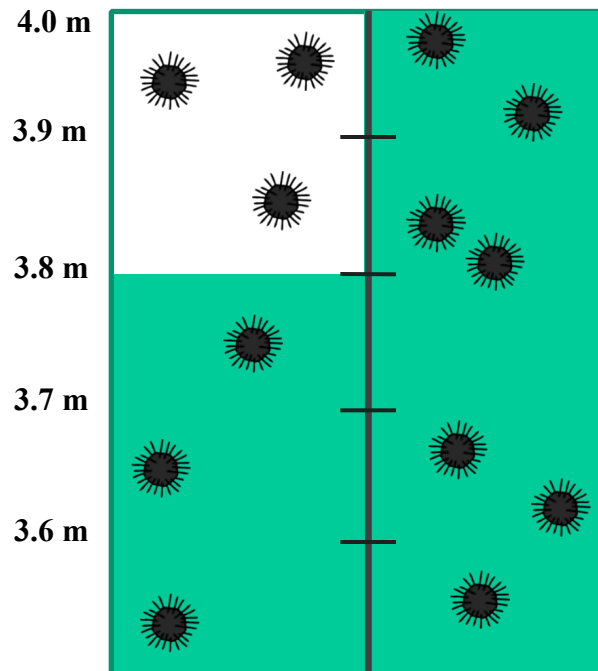
Incorrect!



20 Urchins

30 @ 4.0 m

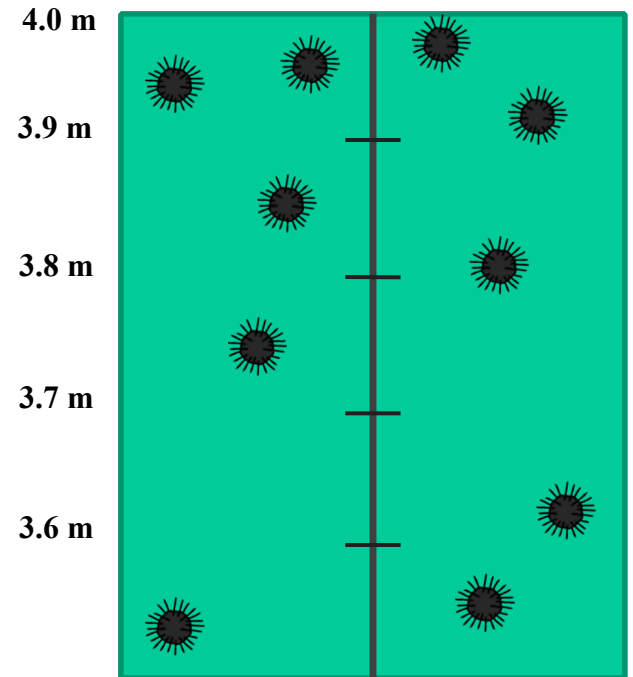
Incorrect!



20 Urchins

30 @ 4.0 m

Correct!



20 Urchins



Swath Sampling

Shark eggs

- Swell shark and horn sharks eggs will be counted on SWATH in the same way as targeted invertebrate species



Swath datasheet

- fill in all metadata fields in the header
- circle the total for each segment
- put boxes around sizes
- underline double digits, especially the number 11
- know the species list
- make your datasheet legible immediately after the dive

SWATH / PISCO subtidal sampling / UCSB / rev. 2022

SITE GULL ISLAND Date 7/4/20 Observer Chris H Buddy Conner J.
 Side: N 5 E 1 W CEN Zone: I M 0 Transect: 1 2 Heading: 30°

SEGMENT DEPTH:	56	57	60
SPECIES	20-30 m	10-20 m	0-10 m
MACPYR (alipes)	5, 7, 15	4, 2	6
STRPUR	VII (7)	XXI (21)	III (4)
MESFRA	VV (10)	VI (6)	II (2)
CENCOR	II (2)	I (1)	III (3)
MEGUND	VI (6)	II (2)	III (3)
KELKEL	I (1)	34 @ 5.6	II (2)
PANINT	14, 10, 8	11, 9	13, 12
HALFUL	14, 13, 16		11
CRAGIG	XII (12)	VI (6)	III (4)
NEOSPA	I (1)	II (1)	
LINCOL	I (1)	I (1)	I (1)
APLICAL	I (1)		
OCTO			I (1)
EISARB	XII (12)	XXI (21)	VIII (8)
EISARB 730	VII (7)	II (2)	III (3)
LAMSET	VI (6)	III (3)	II (2)
LAMSET 730	II (2)	I (1)	II (2)

Algae
 MACPYR (>1m)
 PTECALUS (>20cm total)
 PTECAL (>20cm total)
 EISARBUS (>20cm total)
 EISARB (>20cm total)
 LAMSETUS (>20cm total)
 LAMSET (>20cm total)
 LAMFAM (>15cm width)
 AGAFIM (>15cm width)
 STOBIM (>15cm across)
 UNOPIM (all sizes)
 MERLUE (>1m along)
 COSCOS (>15cm width)
 ALABAR (all sizes)

Echinodermata
 STRPUR (>2.5cm total)
 MESFRA (>2.5cm total)
 PATRIM (>2.5cm)
 DEIRIM (>2.5cm)
 ORTHOD (>2.5cm)
 AGSTER (>2.5cm)
 PISBRE (>2.5cm, MEASURE)
 PISOD (>2.5cm, MEASURE)
 PISODI (>2.5cm, MEASURE)
 PISCHL (>2.5cm, MEASURE)
 MEDAEG (>2.5cm)
 STYFUR (>2.5cm)
 LUPOL (>2.5cm)
 ASTARM (>2.5cm)
 LINCOL (>2.5cm)
 HENLEV (>2.5cm)
 LEPHEX (>2.5cm)

Cnidaria
 CENCOR (>2.5cm)
 ANSTRE (>2.5cm)
 LYTRIC (ALL SIZES)
 APOCAL (>2.5cm)
 APOPAR (>2.5cm)

Ctenophora
 ANTKAN (>2.5cm)
 ANTKOL (>2.5cm)
 CRALUB (>2.5cm)
 URTCOR (>2.5cm)
 URTCOL (>2.5cm)
 URTPEB (>2.5cm)
 URTCRA (>2.5cm)
 METSPP (>2.5cm)
 PACFIM (>2.5cm)

Ctenophora
 CANSPF (>2.5cm)
 PUSPOL (>2.5cm)
 PUSPRO (>2.5cm)
 PUSBAC (>2.5cm)
 LOXDRA (>2.5cm)
 LOXDRA (>2.5cm)
 PANINT (all sizes, MEASURE)
 TALHUT (>2.5cm)
 BALHUB (>2.5cm)
 CRYTIT (>2.5cm)

Mollusca
 MEGUND (>2.5cm)
 POMOR (>2.5cm)
 CRAGIG (>2.5cm)
 KELKEL (>2.5cm)
 MEGSPA (>2.5cm)
 CRYSTE (>2.5cm)
 MEGCRE (>2.5cm)
 APLCAL (>2.5cm)
 APLVAC (>2.5cm)
 HALOTIS SPP (ALL SIZES, MEASURE)
 TEGUND (>2.5cm)
 OCTOPUS (>2.5cm)
 PTESTE (>2.5cm)

Other Invertebrates
 TETCAL (>2.5cm)
 STYMON (>2.5cm)

*Indicate segments with disease with 'd' **All invertebrates 2.5cm in the longest dimension unless otherwise indicated

Entered on _____ by _____

Checked on _____ by _____



UPC Sampling

Data are taken at 30 points distributed uniformly (at every meter from 1 to 30) along the 30 meter transect line:

Data taken at each point:

- 1. Superlayer (only when applicable)**
- 2. Cover (10 points/segment)**
- 3. Substrate type (10 points/segment)**
- 4. Physical relief (10 points/segment)**



UPC Sampling

UPC measures percent cover:

- At each 1m point on the transect line, the line is pushed down to the substrate and cover is recorded.
- Epiphytes, epizoids, and mobile organisms are not included (only primary space holders)
- The diver's finger is projected to the substrate if the line does not touch



UPC Sampling

Superlayer

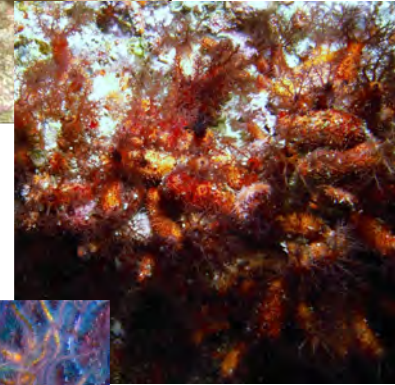
UNDLAMFAR

- If blades of *Laminaria farlowii* overlay the UPC point, then the blade is pushed aside and the species or substratum beneath it is recorded. Superlayer is recorded at UNDLAMFAR.



UNDPACRUB, UNDBRITTLE

- If dense mats of *Pachythone rubra* or brittle stars overlay the UPC point, then these organisms are pushed aside and the species or substratum beneath it is recorded. Superlayer is recorded as UNDPACRUB or UNDBRITTLE. Note that if you hit a PACRUB it has to be superlayer and cannot be CUCSPP.



UNDDRIFT

- If mats of drift algae overlay the UPC point, then the drift algae is pushed aside and the species or substratum beneath it is recorded. Superlayer is recorded as UNDDRIFT



UPC Sampling

Cover options not covered in organism slides:

- **BARROC** – When a point lands on a spot of bedrock, boulder, or cobble with no organisms growing on it.
- **BARSAN** – When a point lands on a patch of sand that is substantial enough that it cannot be dispersed with the wave of a hand (equivalent to a swell coming through). If the sand can be easily waved away, record cover beneath the sand layer.
- **SHELL** – When a point lands on a shell, or piece of shell that is not inhabited by a living organism.
- **MUD** – When a point lands in an area of inorganic sediment that is too fine to be called sand. Usually, if you stick your gloved finger into it, mud sticks to your glove.
- **SCUM** – When a point lands on a patch of unidentified organic matter, like a diatomaceous film.
- **DEADHOLD** – remaining holdfast from a dead Laminariales (including giant kelp)

UPC Sampling

Substrate type

- Bedrock (≥ 1 m diameter)
- Boulder (10cm – 1m diameter) – must be able to verify that all dimensions are less than 1m
- Cobble (< 10 cm diameter)
- Sand



UPC Sampling

Substrate = Sand vs. Cover = BARSAN

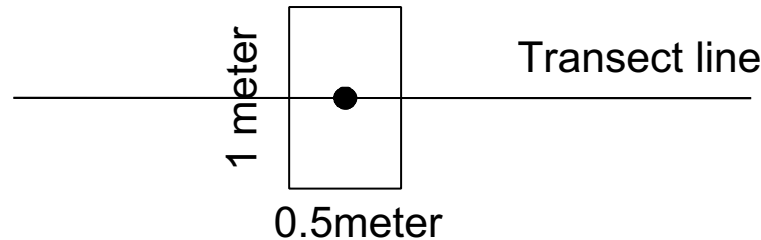
- It is possible to have sand as cover and bedrock as substrate.
- If you have a point that lands on a pocket of sand that cannot be waved away with the brush of a hand, but you can poke your finger into the sand up to your second knuckle and touch the rock under it, then **Substrate = Bedrock, Cover = BARSAN**.
- BUT if the pocket of sand is deep enough that you cannot touch the rock under it up to your second knuckle, then **Substrate = Sand, Cover = BARSAN** (even if you can see that it is just a small pocket of sand sitting on top of bedrock. It's all a matter of scale, at some point all sand has rock under it. The idea of this UPC survey is to record what is present at a particular point).



UPC Sampling

Physical relief

Top view of transect



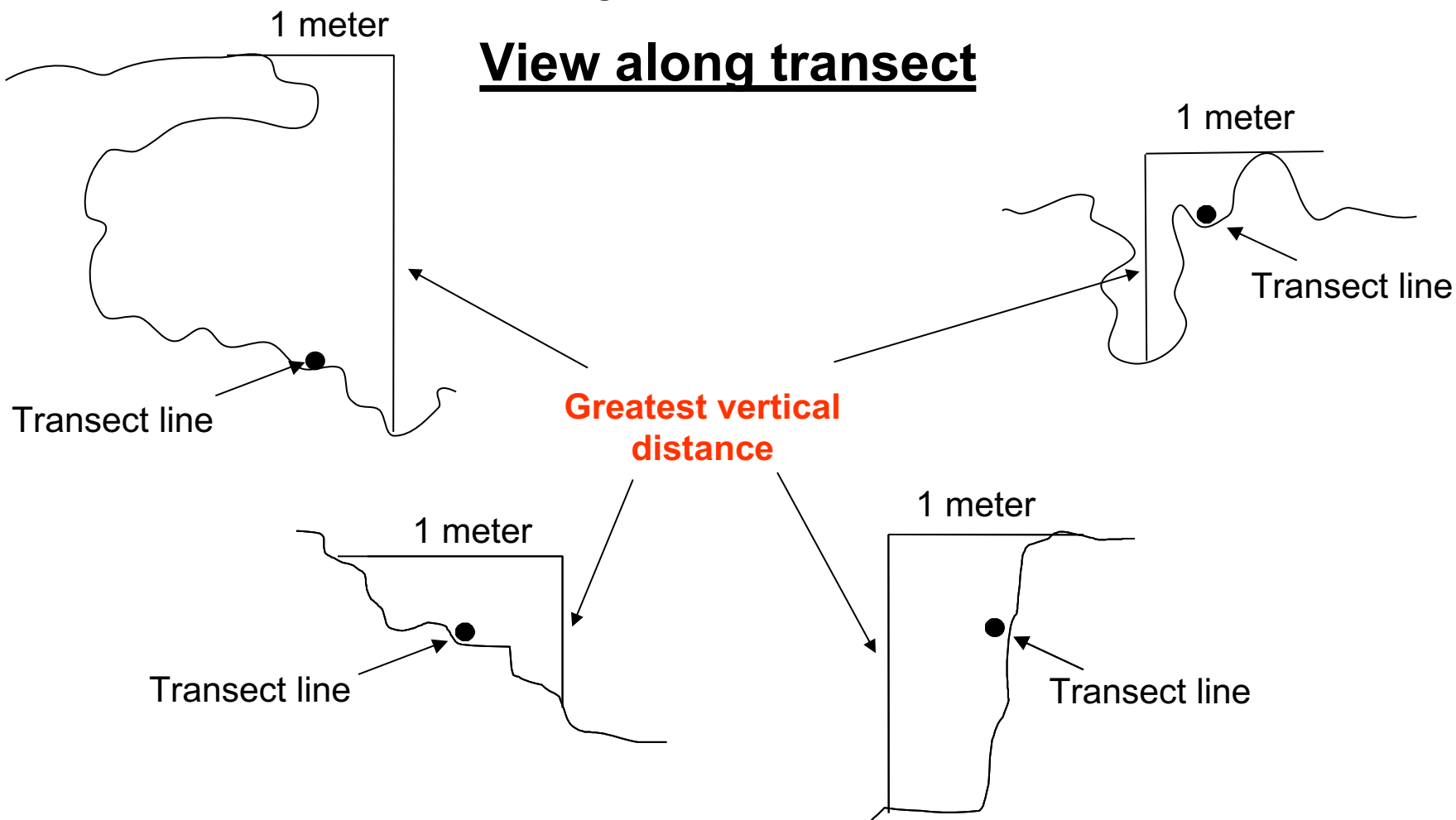
- Physical relief is measured as the greatest vertical relief that exists within a 1-meter wide section across the tape and a 0.5-meter section along that tape that is centered over the point



UPC Sampling

Physical relief

View along transect



UPC datasheet

- fill in all metadata fields in the header
- circle the total for each segment
- check underwater that you have 10 points on each segment (except for superlayer)
- know the species list
- Transfer any kelp stipe counts to the swath datasheet ASAP
- make your datasheet legible immediately after the dive

SITE GULL ISLAND Date 7/4/2020 Observer CJ Buddy CH
 Side: N S E W CEN Zone: I M O Transect: 1 2 Heading: 30°

SEGMENT:	20-30 m	10-20 m	0-10 m
SEGMENT DEPTH (m):	<u>56</u>	<u>58</u>	<u>60</u>

SUPERLAYER

UNDER LAMINARIA (Tallies)	<u>11</u>	<u>2</u>	
UNDER BRITTLE		<u>1</u>	
UNDER PACKUS			<u>1</u>
UNDER DRIFT ALGAE			

COVER

CRUCOR	<u>1111</u>	<u>4</u>	<u>111</u>	<u>3</u>	<u>111</u>	<u>5</u>
MACHOLD	<u>11</u>	<u>2</u>	<u>111</u>	<u>3</u>	<u>1</u>	
BARROC	<u>111</u>	<u>3</u>	<u>1</u>		<u>1</u>	
SOLTUN	<u>1</u>					
ANEM			<u>1</u>			
BRYO			<u>1</u>		<u>1</u>	
BARSAN			<u>1</u>		<u>1</u>	
GORG					<u>1</u>	

SUBSTRATE

sand		<u>1</u>		<u>1</u>
cobble (< 10 cm)		<u>1</u>		<u>2</u>
boulder (10 cm - 1 m)	<u>1111</u>	<u>4</u>	<u>111</u>	<u>3</u>
bedrock (> 1 m)	<u>1111</u>	<u>6</u>	<u>111</u>	<u>5</u>

RELIEF

0 - 10 cm	<u>1</u>	<u>1111</u>	<u>7</u>	<u>11</u>	<u>2</u>	<u>11</u>	<u>6</u>	<u>2</u>
10 cm - 1 m		<u>1111</u>	<u>7</u>	<u>11</u>	<u>2</u>	<u>1111</u>	<u>6</u>	<u>2</u>
1 m - 2 m		<u>11</u>	<u>2</u>			<u>11</u>		
> 2 m								

Species	Macropores 0-10m	Macropores 10-20m	Macropores 20-30m
Other	<u>5, 7, 15</u>	<u>4, 2</u>	<u>6</u>

Species List:

BARROC	BARROC	WORMS
BARSAN	SARMUT	DICHA
SHELL	PHICAL	SALTRI
MUD	BROWN	DOCFW
SCUM	GREEN	TUBEMAT
Algae	PHYSP	TUBEWORM
BRANCH	CRUCOR	Other Inverte
LEAFY	ERECOR	BRYO
BUSHY	CRUCOR	DIACAL
LACY	ANEM	KETPAC
ENCRD	CUP	WATSUB
TURF	AGLSTR	COMTUN
DICTALES	HYDROD	SOLTUN
EGRMEN	STYCAL	SPONGE
STEOSM	STYPAP	Echinodermata
MACHOLD	GORG	CUCSPP
OTHERLAM	CLAVSPP	Gastropoda
DEADHOLD	BARSAN	THYSQU
DESSPP	BORCLAM	PETMON
DICRET	SCALLOP	Coelocera
DICCAL	MUSSEL	BARN



PISCO Training Program

An Introduction

Part 2



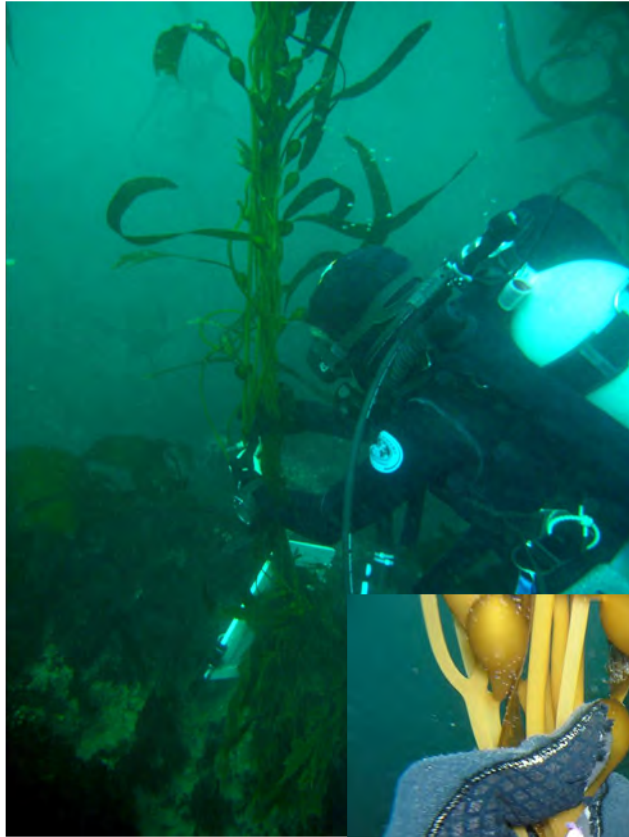
Size Frequency

- Giant kelp (Swath)
- Lobsters (Swath)
- Abalone (Swath)
- Select seastars (Swath)
- Emerging Fisheries Spp (Roving Diver)



Size Frequency

Macrocystis - Swath



- Part of Swath survey, often assisted by the UPC diver
- Count the total number of stipes of each individual “plant” at 1m height
- List each count separately so that each number represents the stipe count of one individual
- At least half of the holdfast must be within transect area
- Record data on Swath data sheet (if need be, transfer over from other diver’s slate immediately upon boarding the boat)
- **NO sub-sampling**



Size Frequency

Abalone - Swath



- Recorded on Swath survey
- Identify and measure each individual observed
- List each measurement separately so that each number written represents the length of one individual
- Measure length of shell at the widest point to the nearest cm
- Use tick-marks on slate to assist in measurement
- **NO sub-sampling**

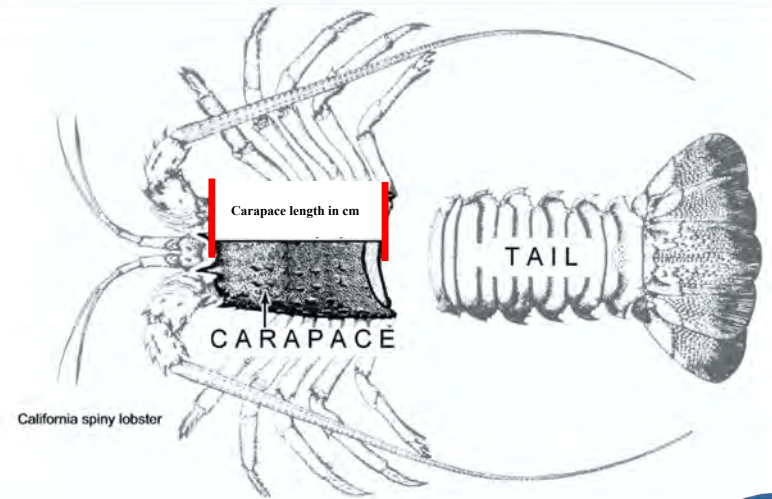


Size Frequency

Lobster - Swath



- For every lobster counted on a swath transect, visually estimate carapace length to the nearest centimeter and record.
- No sub-sampling



Size Frequency

Seastars - Swath



- Size individuals of all *Pisaster* species (PISGIG, PISOCH, PISBRE) and *Pycnopodia helianthoides* (PYCHEL) within the transect area on Swath datasheet.
- Size measurement is from the center of the oral disc to the tip of the longest arm (nearest cm).
- If you encounter a *Pycnopodia* off-transect, note the location and size in the natural history notes.



Seastar wasting syndrome



- Look for and record any signs of Sea Star Wasting Syndrome on *Pisaster* spp. by adding “S” after the size
- Other species are counted as normal, but note SSWD prevalence in the natural history log

Pycnopodia helianthoides

Noted Anywhere Anytime!

Stuart Halewood

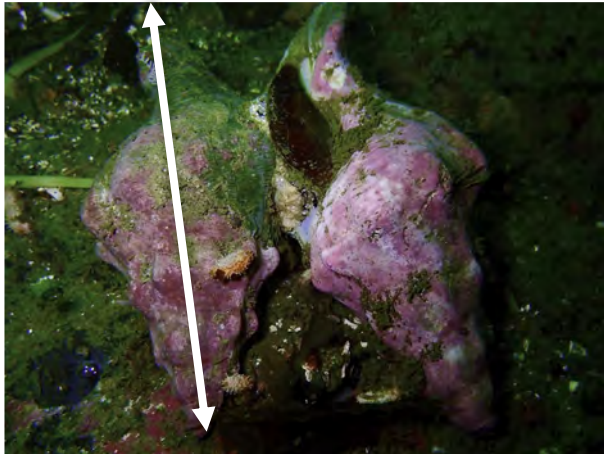


- Locally extinct as of 2013
- Endangered species
- If you encounter a *Pycnopodia* off-transect, note the location and size in the natural history notes.
- Size individuals of any *Pycnopodia* within the transect area on Swath datasheet.
- Size measurement is from the center of the oral disc to the tip of the longest arm (nearest cm).



Size Frequency

Emerging fisheries species - Roving diver

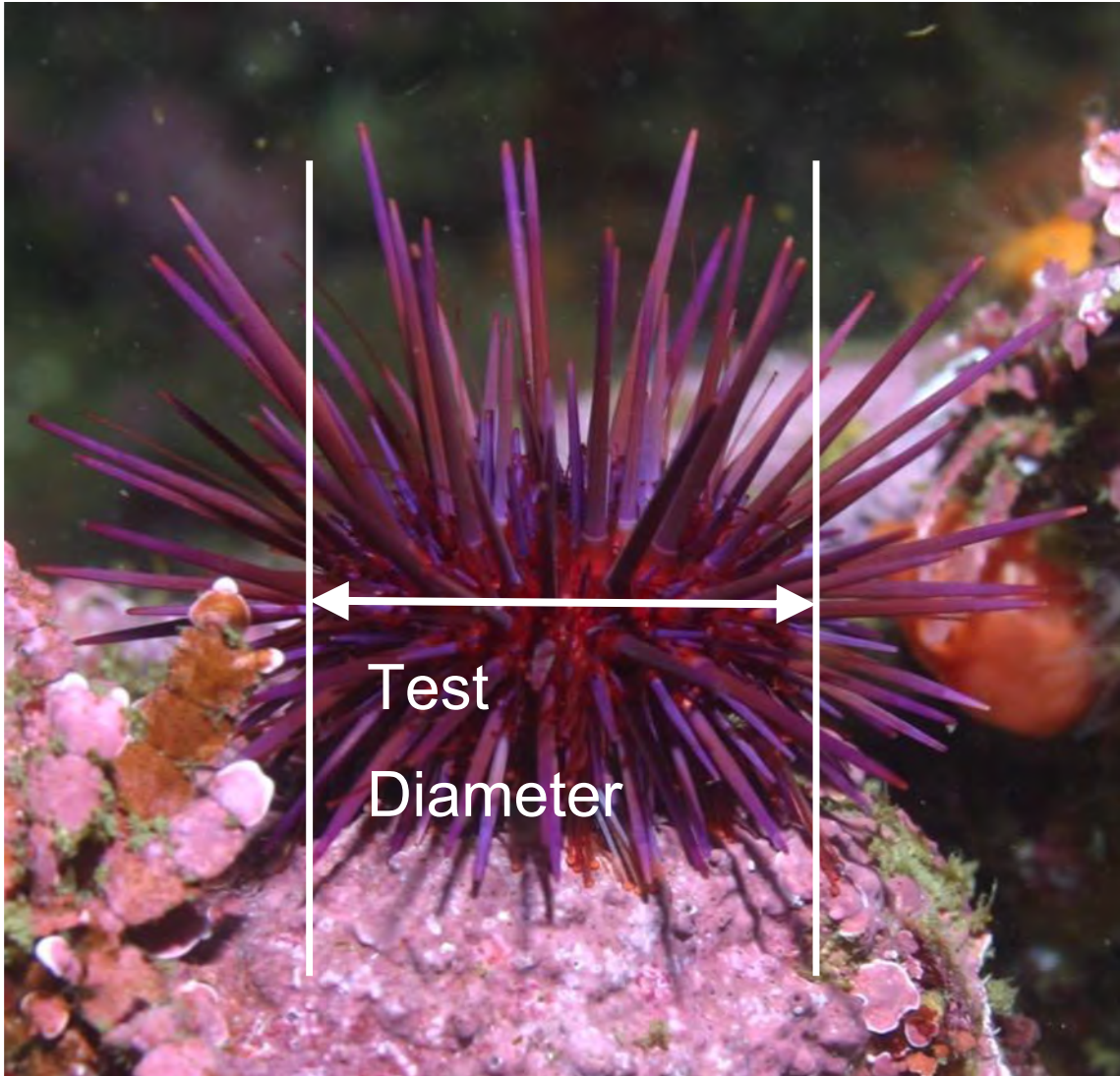


- Size individuals of *Kelletia kelletii*, *Megastrea undosa*, and *Megathura crenulata* on and off of transects, up to 100 per site.
- Measure the length of the shell for *Kelletia*, the maximum width at the base of the shell for *Megastrea*, and the top of *Megathura* where you can feel the shell under the mantle. Measure to the nearest mm.
- Carefully search so that all size classes are found and measured, and be sure not to remove individuals from transects that are still being surveyed.



Size Frequency

Purple and red urchins



- 150 red and purple urchins are sampled from each site
- Make sure to clear whole patches making sure that all size classes present are collected.
- Measure the test diameter to the nearest mm using calipers on the oral surface.



Size Frequency: Urchin Concealment

New for 2026!!!!!!



- Quantifying covered vs. exposed urchins
- Categorize all sized urchins



Disease classification protocols

Urchins (red and purple): disease type and prevalence recorded with size frequency (recorded in separate columns on size frequency datasheet)



Sea stars: disease prevalence recorded on swath survey. On sized species indicate disease with 's' next to the size. Other species use 's' instead of tick mark.



Urchin Disease Guide

Wasting disease

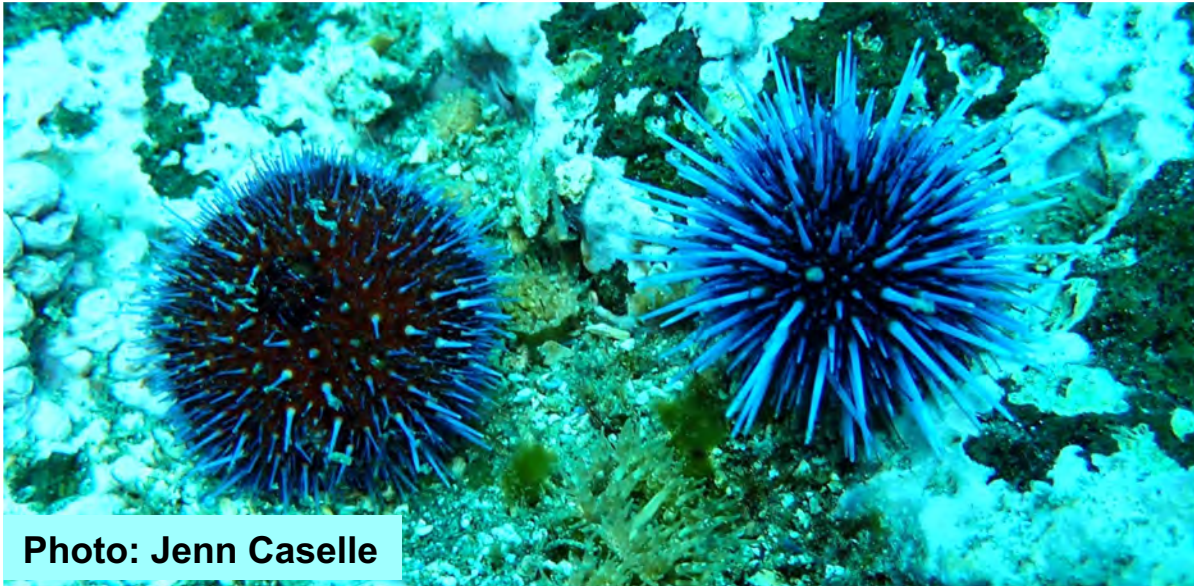


Photo: Jenn Caselle

Black spot



Safety Considerations

Dive profiles

- Approved by DSO
- All divers use a personal dive computer
- Well within no-decompression limits
- General maximum depth 60' (few exceptions)
- 3-5 min safety stops mandatory on dives below 30'
- NITROX used on UCSB boats (record O2 for each dive)
- Surface intervals (30 minutes for dives > 30', 1 hour for dives > 60')

Buddy system

- Make frequent visual contact with buddies and don't leave the transect line without making contact with all members of the dive team



Safety Considerations

Site considerations

- Diving will only be conducted in safe conditions

Live boating

- Some surveys may be live boated. The decision to live boat will be based on various factors (Currents, proximity to shore, team members onboard, etc.)

Other Vessels

- Recreational traffic
- Fishing traffic
- Dive flags
- Safe Ascents- using anchor line, look & listen



Safety Considerations

Insurance



- **Volunteer work not covered by UC workers compensation**
- **Please be aware of insurance coverage in the event of an accident, and consider DAN insurance**
- **Covers any type of diving (Spectre, beach dives, vacations, etc.)**
- **For 2025: DAN lowest level membership and insurance costs ~\$80**



Other Considerations

Data quality

Order of importance:

Safety > Data quality > Personal comfort

Transects can always be re-done. Speak up if you ever feel there are any issues with data quality.

Communication

**IMPORTANT! Check in after each transect. If anything is wrong feel free to communicate to team leaders.
Slow and steady wins the race.**

Flexibility

Scheduling, team dynamics, task assignment



Good Housekeeping

Communal Equipment

- Please be gentle with your slates, crates, and other loaner gear, and return them at the end of the dive season.
- Tools should be cleaned and put away immediately after use.
- If something gets salty, please rinse and dry it before putting it away.

Personal Equipment

- The ocean wants your stuff and will steal it if given the opportunity. Guard your gear and don't leave it in precarious places.

Teamwork

- There are always tasks to be done. If everyone lends a hand we can get more work done and all get home a little sooner.
- Being late is disrespectful to your teammates.



Other lab projects

- **Deep water drop cameras (BRUVs)**
- **Intertidal work (MARINe)**
- **California Collaborative Fisheries Research Program (CCFRP)**
- **Tropical reef ecology (Palmyra)**



Questions?

An underwater photograph showing a large school of fish, likely rockfish, swimming in clear blue water. In the background, a dense kelp forest is visible, with sunlight filtering through the water from the upper right. The fish are of various sizes and are swimming in different directions.

Caselle Lab Fish Community Survey Training



Annual Survey Design

When

June-October (early = invertebrate and algae; later = fish)

Where

1. Different oceanographic regimes

- a) North and south of Monterey Bay
- b) Carmel Bay
- c) Big Sur coast - Cayucos
- d) Santa Barbara Channel

2. Marine protected areas and “paired” comparison sites

- a) Existing MPAs: Hopkins, Pt Lobos, Big Creek
- b) Anticipated MLPA MPAs in Central and So. CA
- c) Channel Islands Marine Reserves

Annual surveys

Sample design-Fish

Time

1999

.....

200*n*

Site

1

2

3

.....

25

Area

1

2

a
Zone

I

IM

OM

O

(5, 10, 15, 20m)

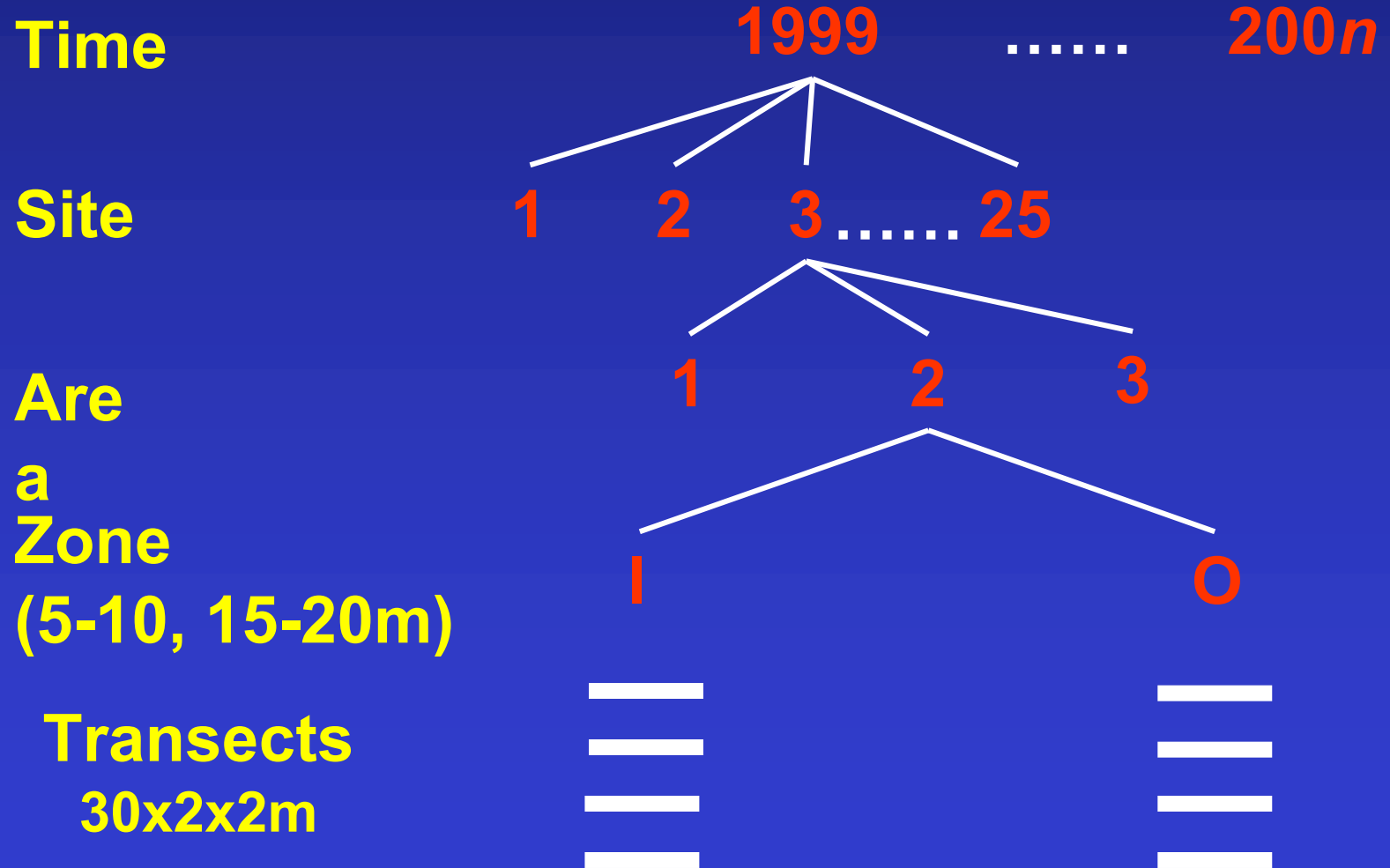
Transects

30x2x2m

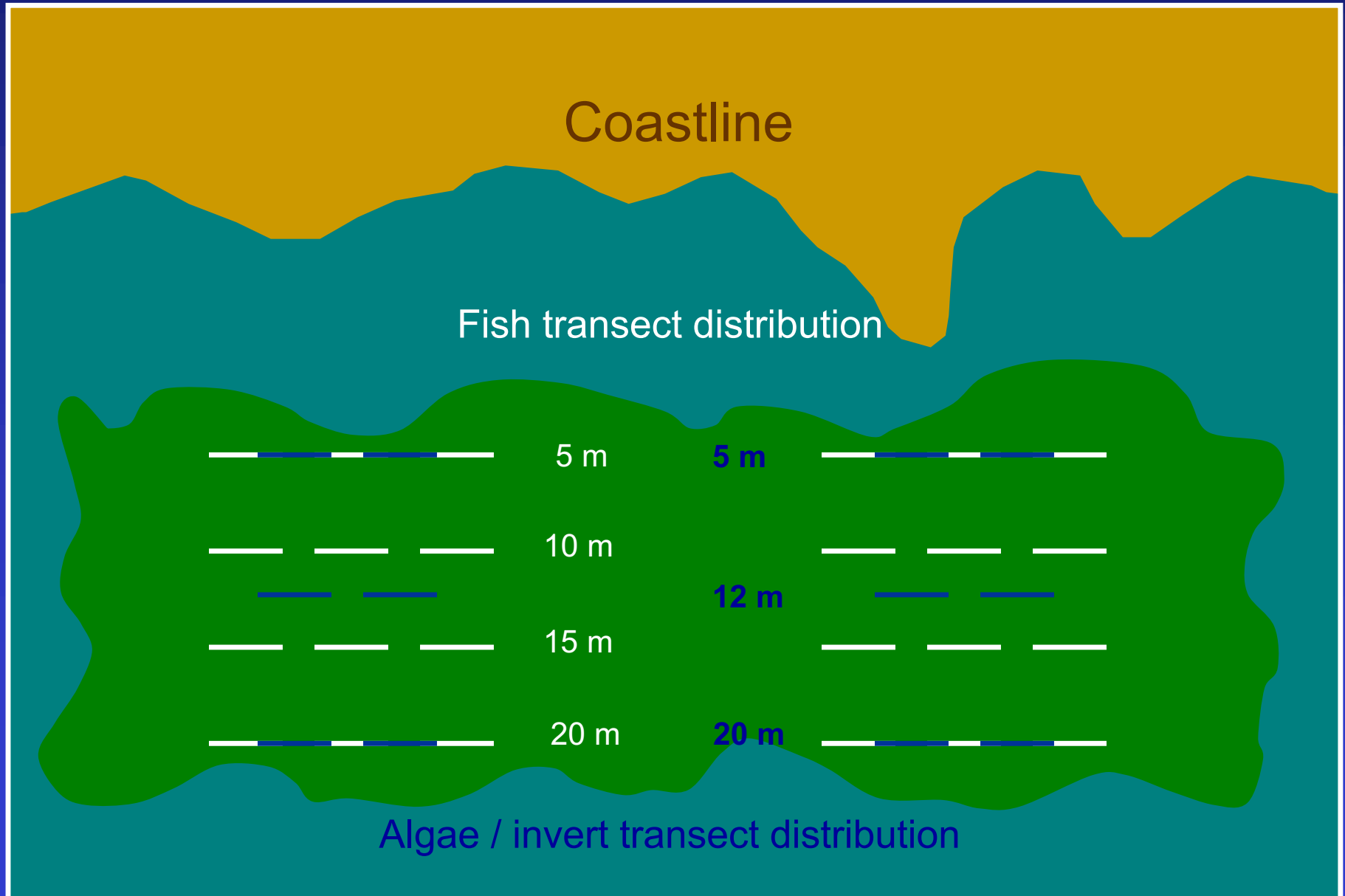


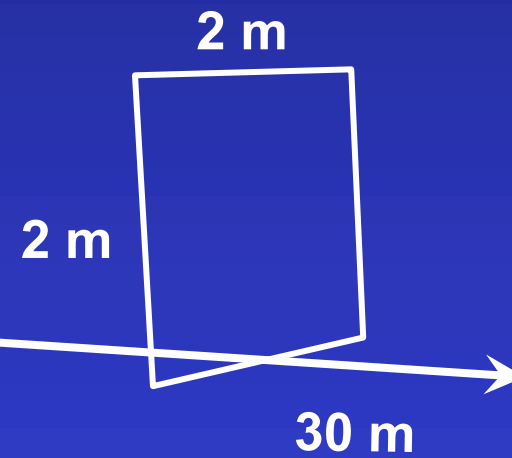
Annual surveys

Sample design - Fish Channel Islands Modification



Approach: Within-site Sampling Design





Fish

- density
- sizes

Annual Surveys

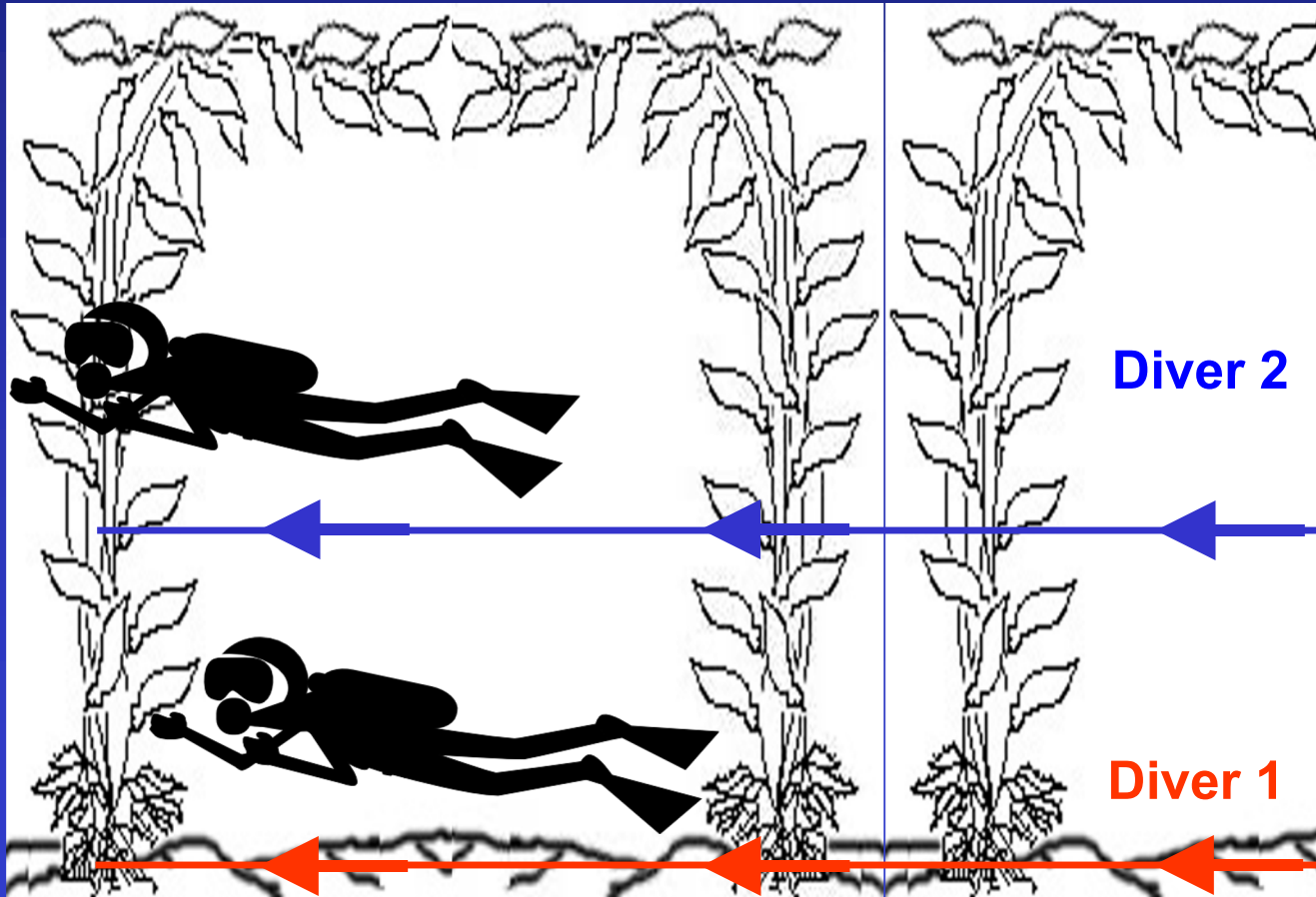
What

- 1. All identifiable non-cryptic fishes**
 - e.g., rockfishes, surfperches, greenlings
- 2. Estimate sizes**
 - total length to nearest centimeter
- 3. Three levels in water column**
 - bottom
 - midwater
 - surface canopy (when kelp reaches surface)

Visual transect overview

Fish Surveys

Phase 1 – mid-water, bottom



Diver 2

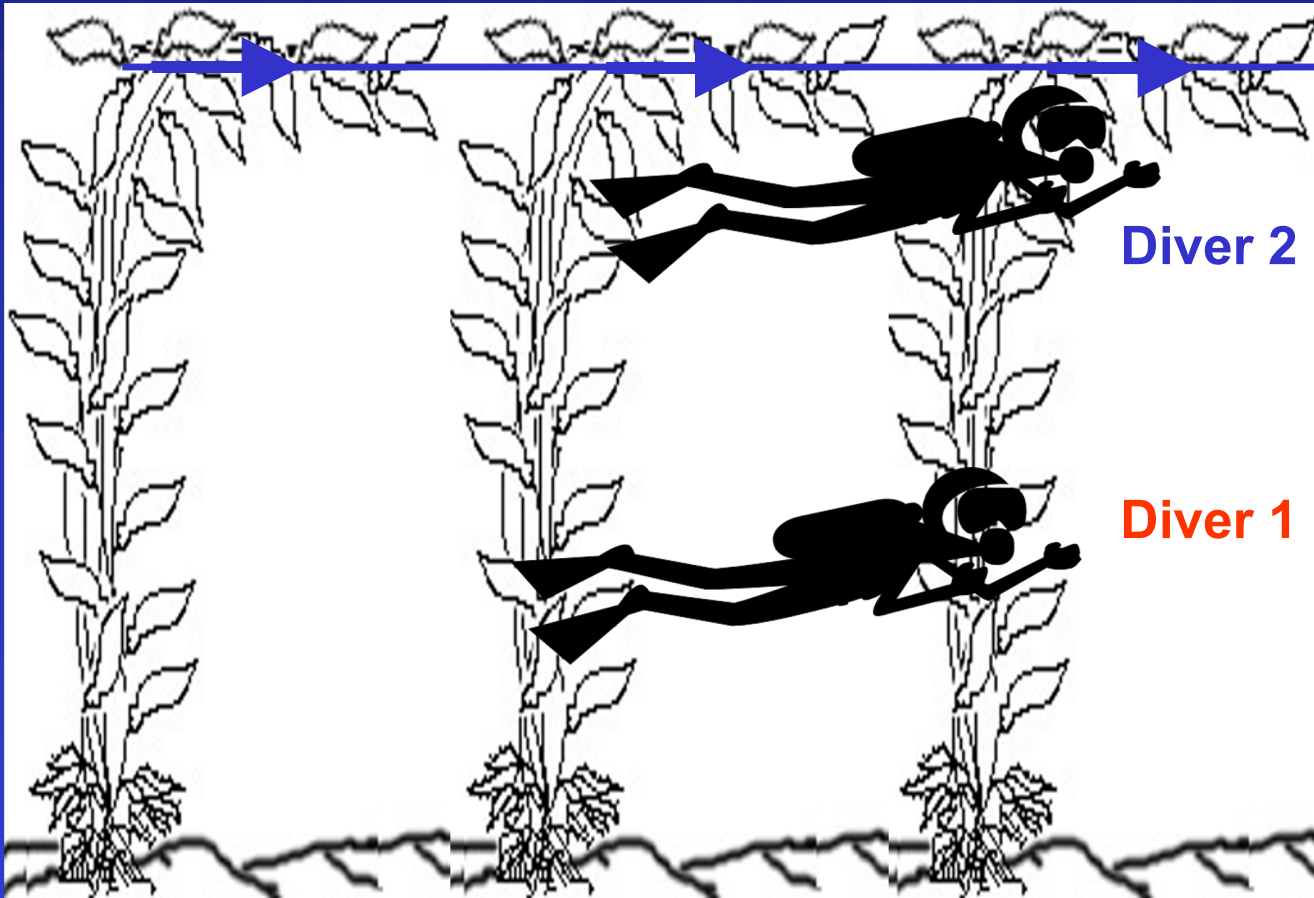
- counts midwater fish
- stays just ahead of bottom diver
- checks for canopy

Diver 1

- lays tape
- counts bottom fish and lobster

Fish Surveys

Phase 2 – canopy



Diver 2

- Lays tape
- Count canopy fish

Diver 1

- Safety stop
- buddy for canopy diver

Entire transect duration:
<20min

Survey Methods and Counting Rules

1. Transect location: **Rock > Depth > Heading**
2. Drop to bottom (together) at predetermined depth
 - Before beginning the dive, include a note on your datasheet specifying the depth range where the transects should be run
3. Identify start and heading
4. Secure transect tape to kelp plant or rock and record starting depth
 - Indicate depth to the midwater diver and wave slate to show you are starting the survey

Survey Methods and Counting Rules

5. Midwater diver begins, stays ahead, and maintains visual contact with bottom diver (constrained by depth)
6. Except for shallowest depth zone, midwater diver stays at least 3-5 m above bottom (> 1 m above bottom diver's window)
7. When surveying a wall, the midwater diver wants to be >3 m away from the wall. The midwater diver counts fish in the midwater, not on benthos

Survey Methods and Counting Rules

8. Bottom diver begins, running the transect in the direction where (1) hard bottom substrate is present, the (2) depth is within the predetermined zone and the survey is run using the appropriate (3) heading.
9. First: count large mobile exposed fishes -- SNAPSHOT
10. Second: search and count unexposed fishes and lobster
11. Only count ahead, never look back to count behind you
12. Maintain reasonable speed (speed can bias counts)

Survey Methods and Counting Rules

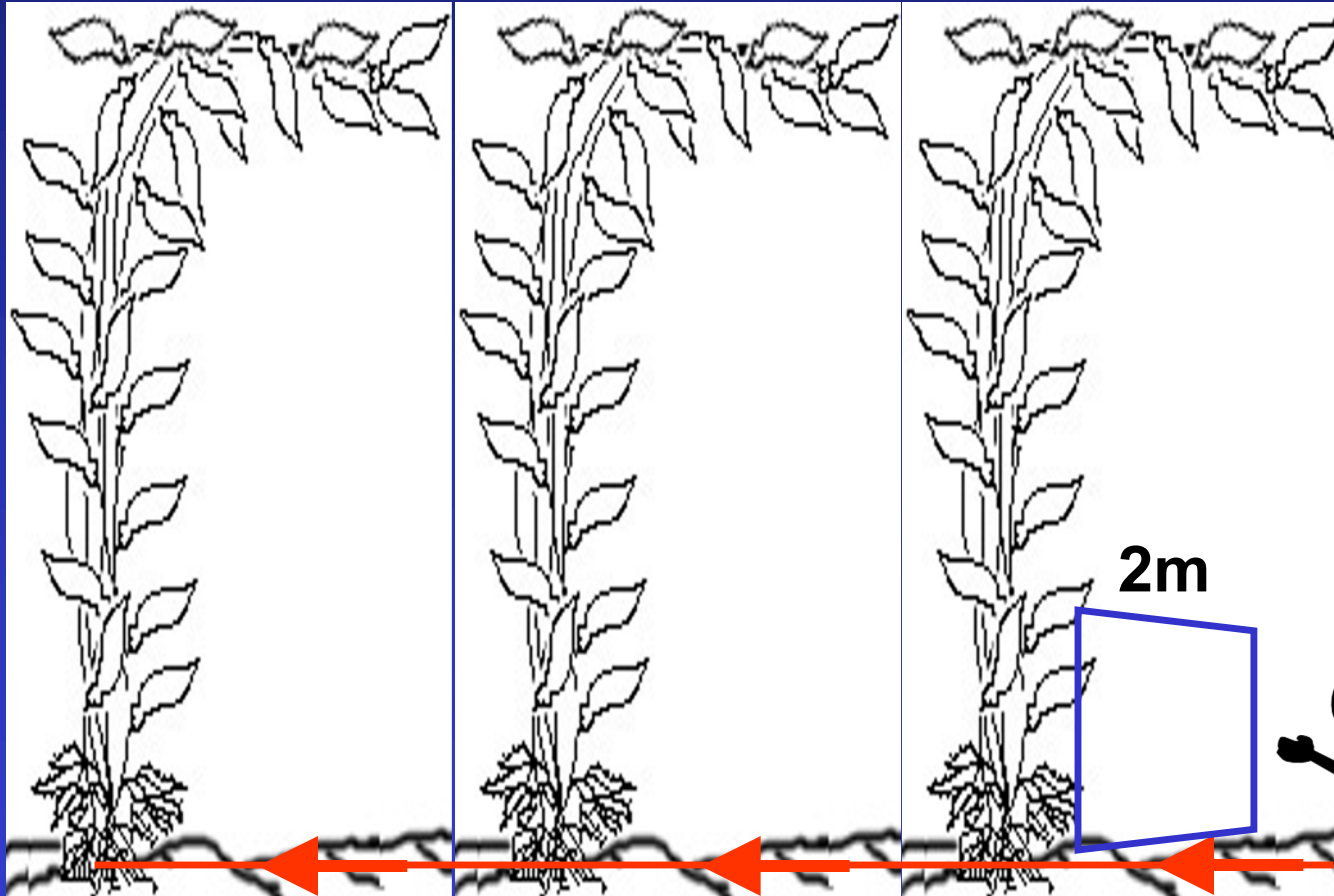
13. Sequential windows of 2-3 m (use habitat markers)
14. Repeat next window
15. End of transect: “pop” and rewind transect tape, regroup, random number of kicks to start of next transect
16. High relief -- contour rock and maintain depth
17. Sand -- if headed off reef > 4 m, redirect transect

Visual transects - Part 1

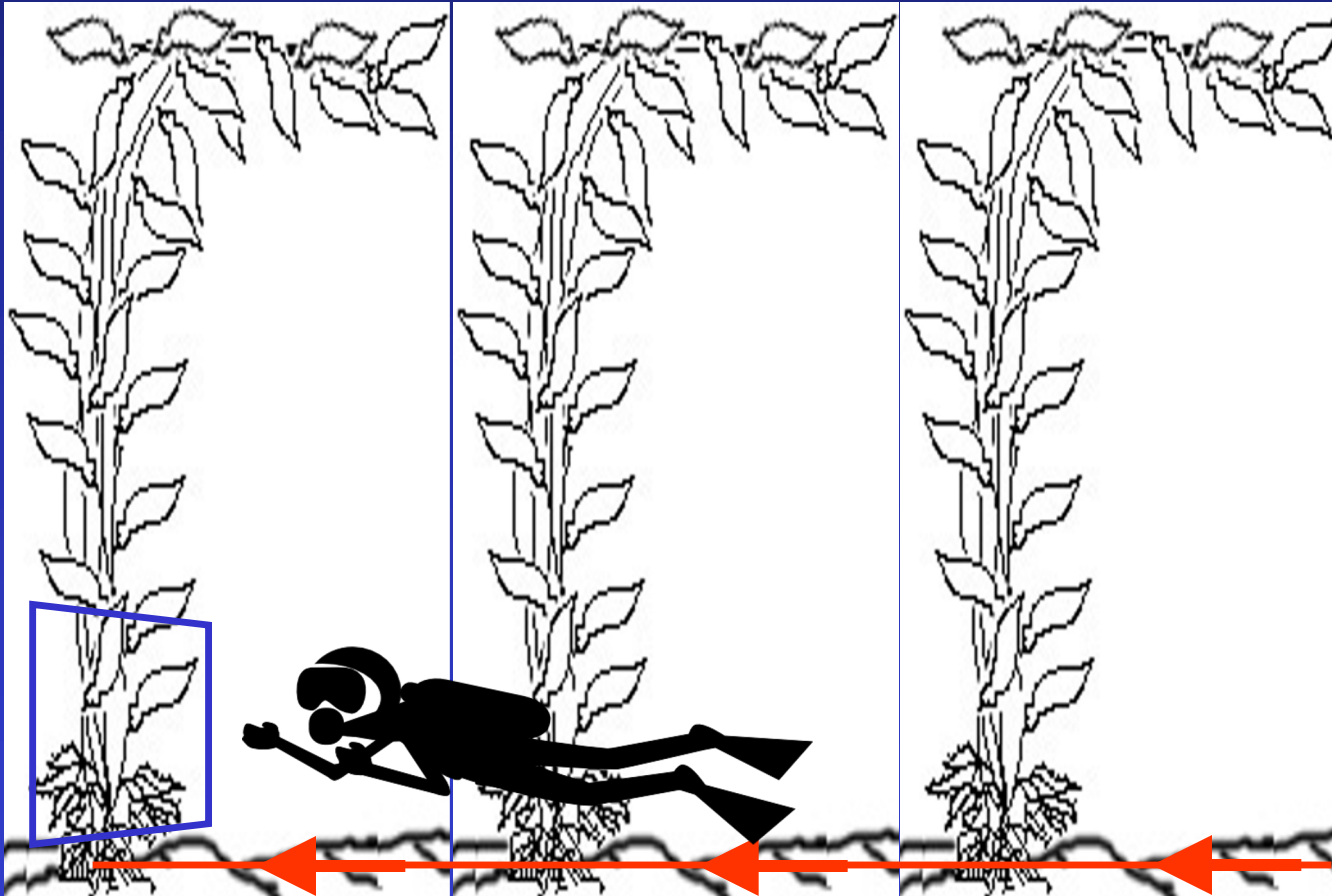
Technique

1. Dimension: 30x2x2m
2. Moving windows
3. Moving in bounds
4. The Stop, Scan, Search approach
5. When to write?
6. On what do I write, when I need to write?

Moving Windows

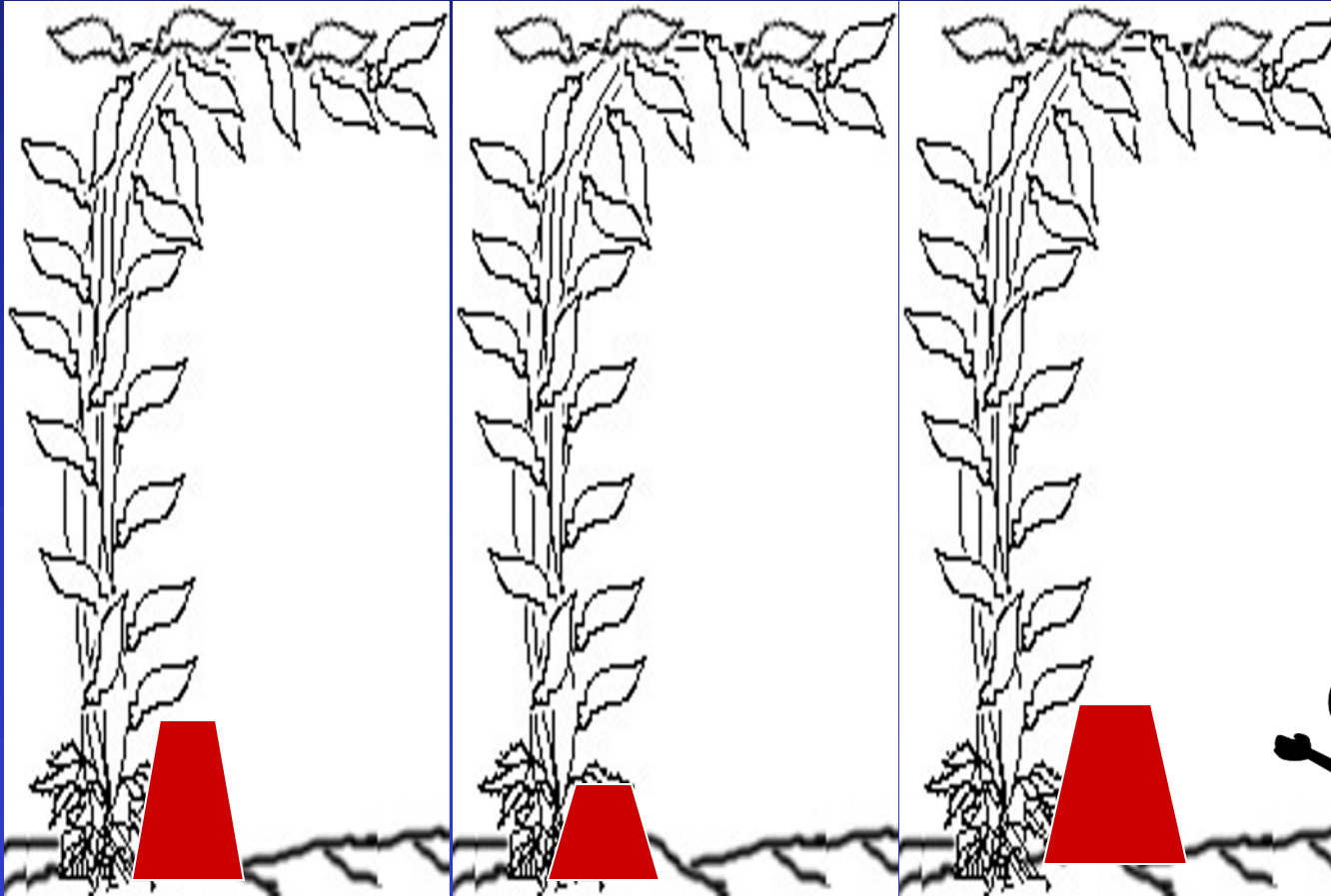


Moving Windows

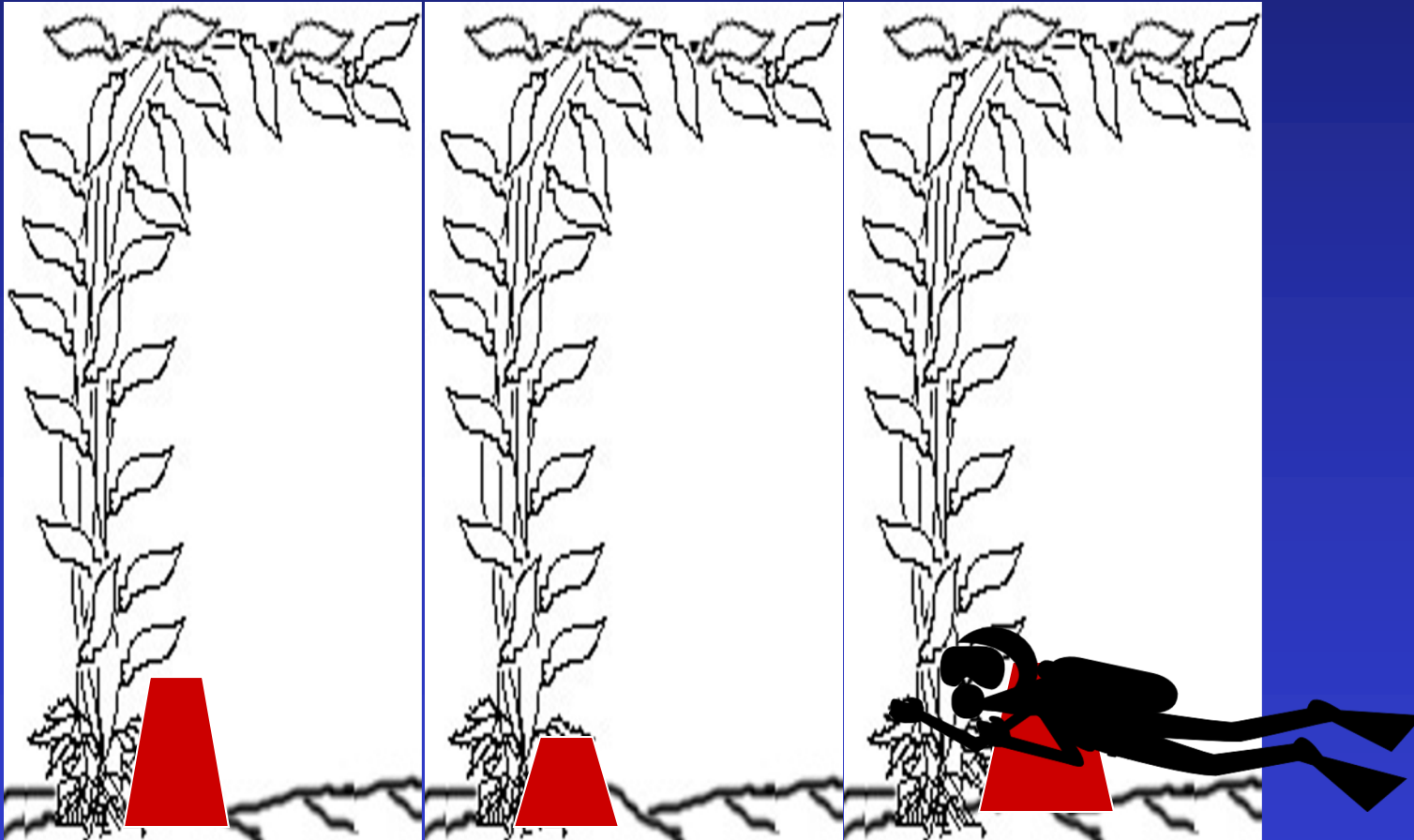


Look ahead, but not too far ahead

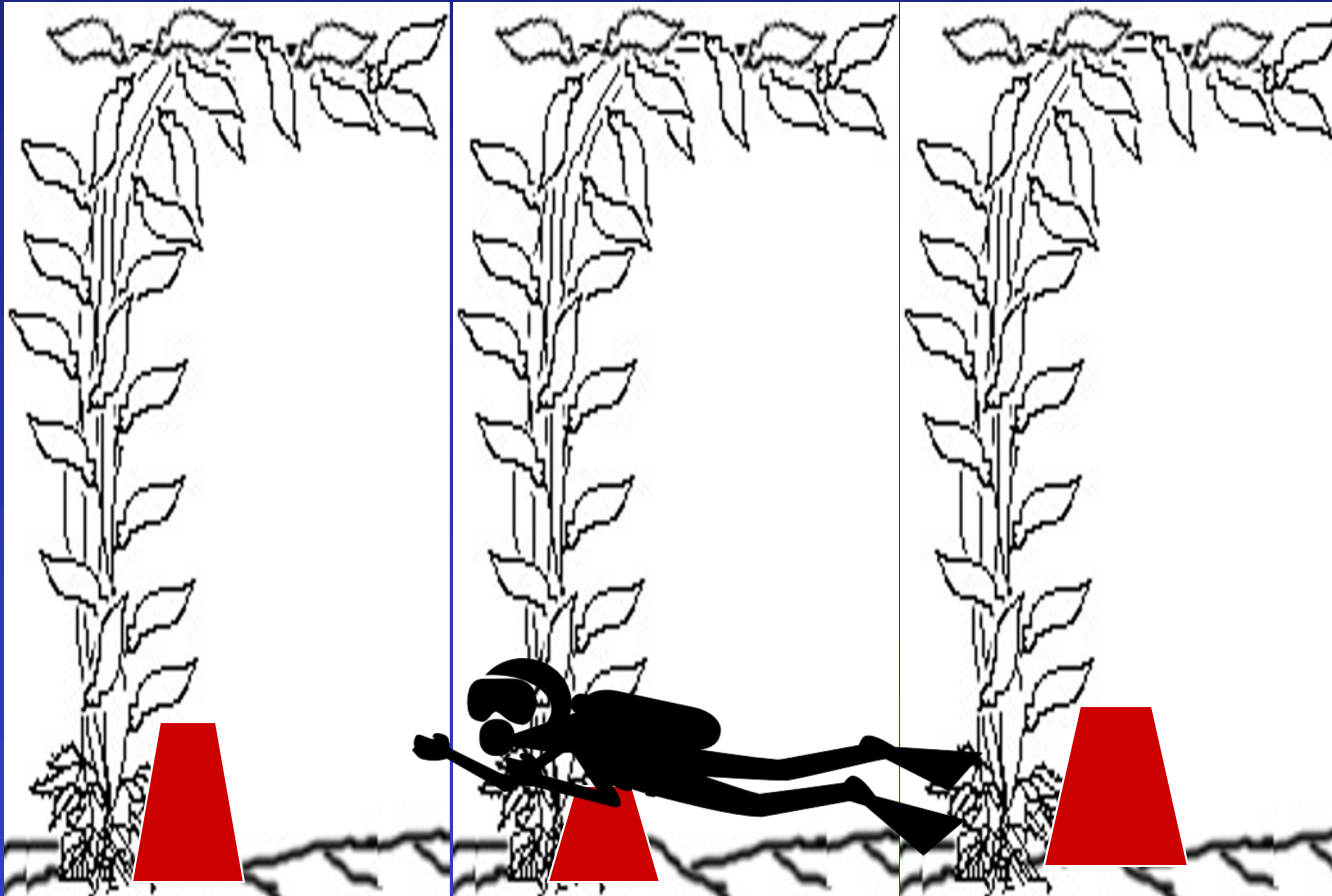
Moving In Bounds



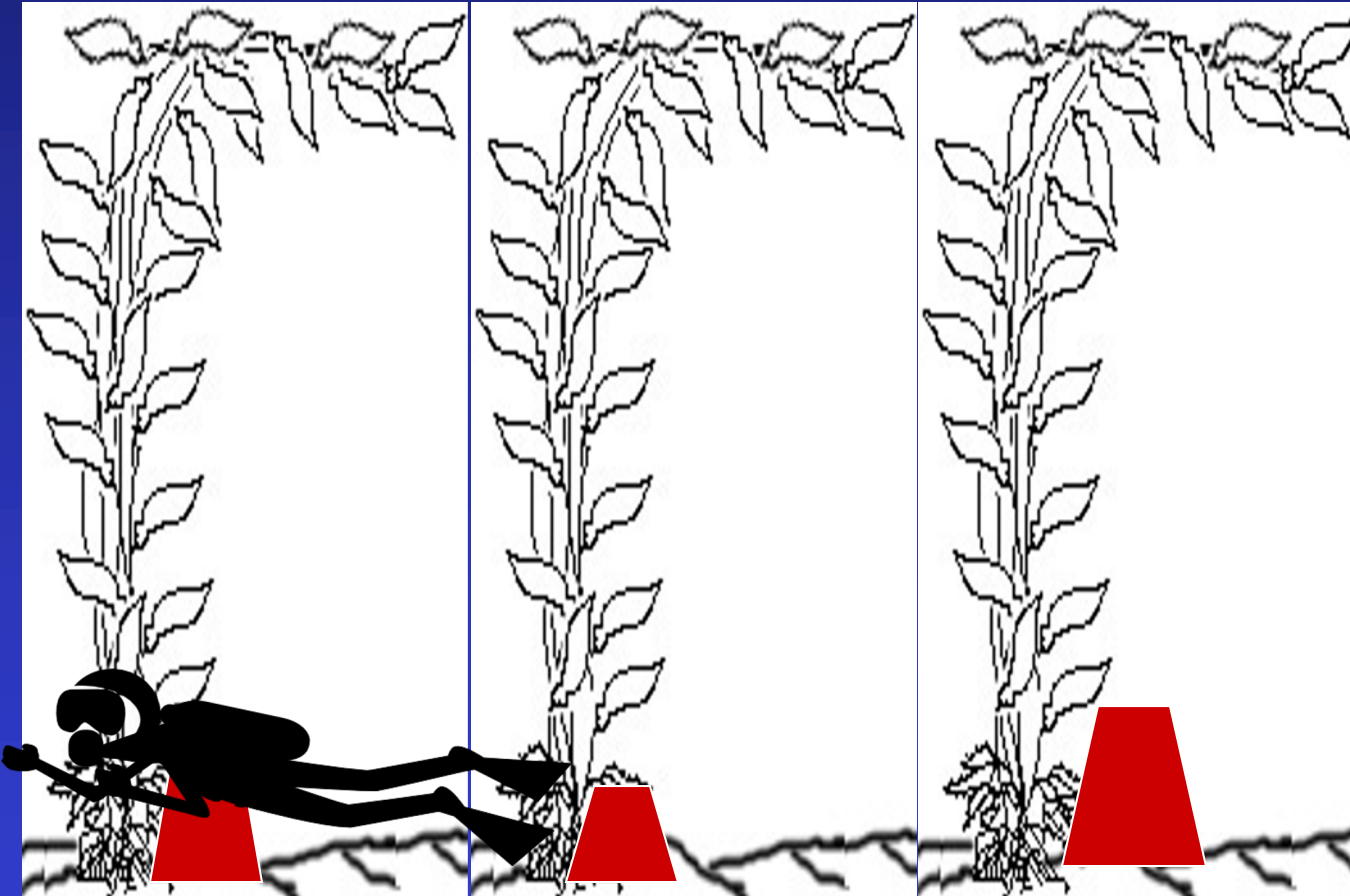
Moving In Bounds



Moving In Bounds

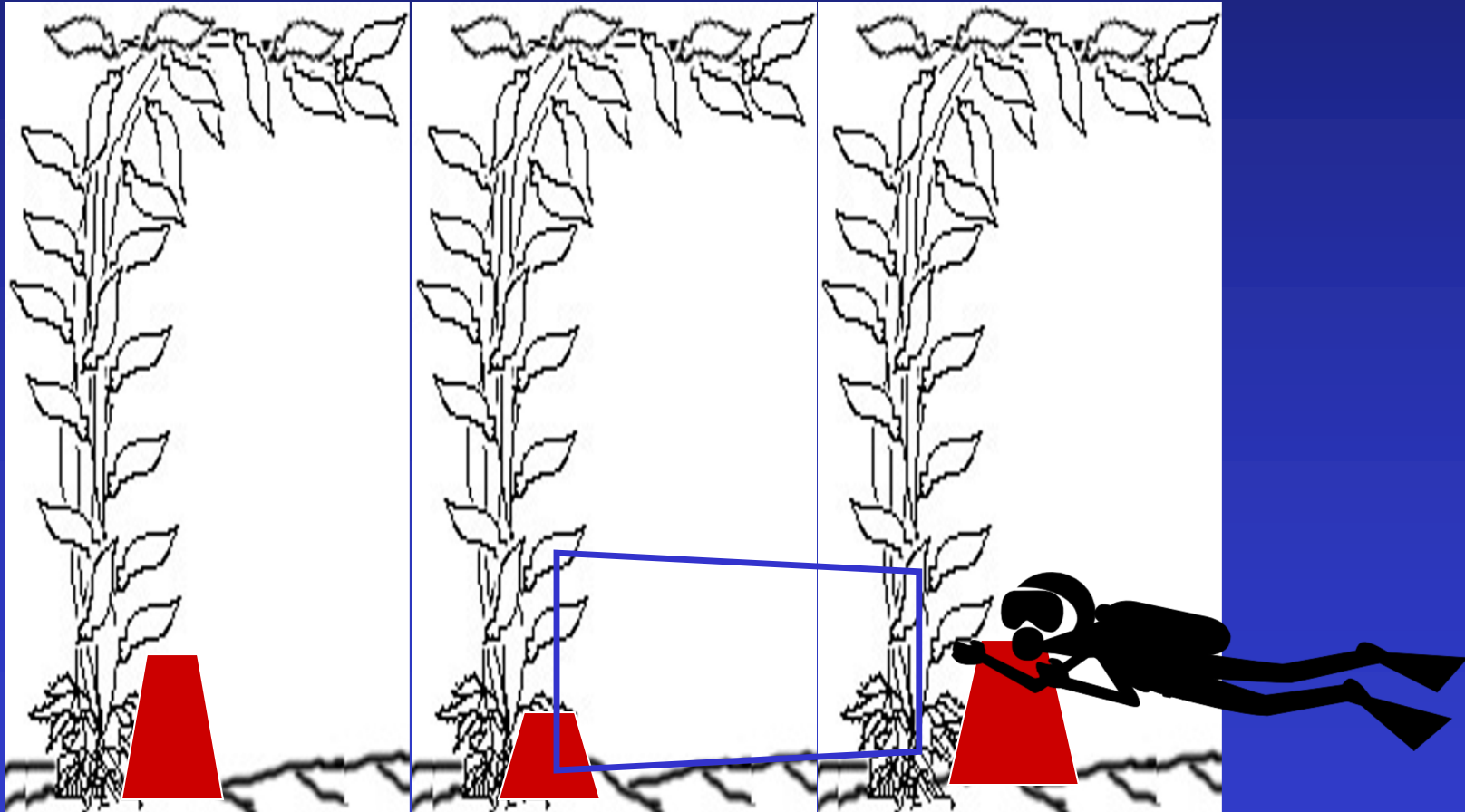


Moving In Bounds



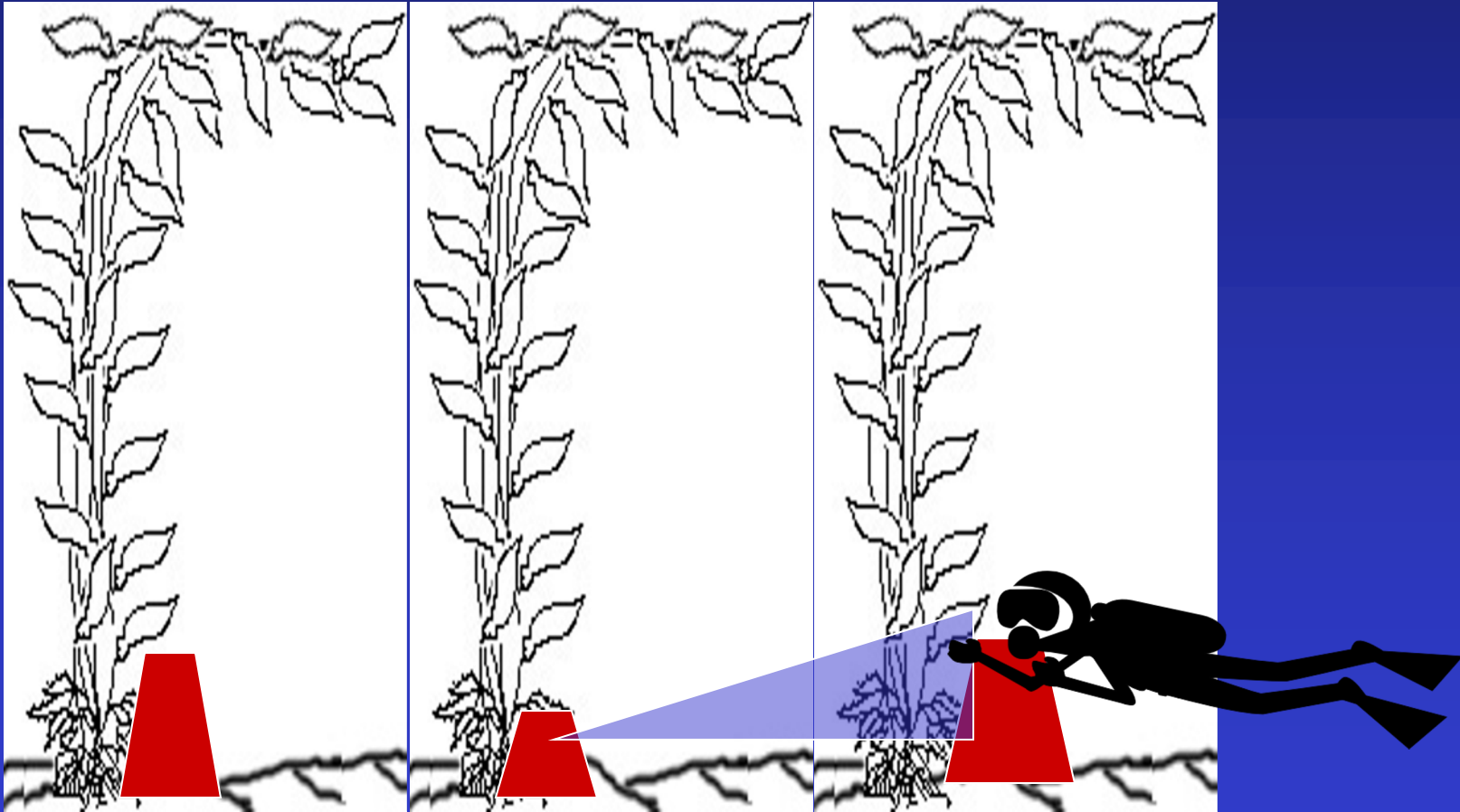
Use landmarks to help divide the transect

Stop, Scan, Search



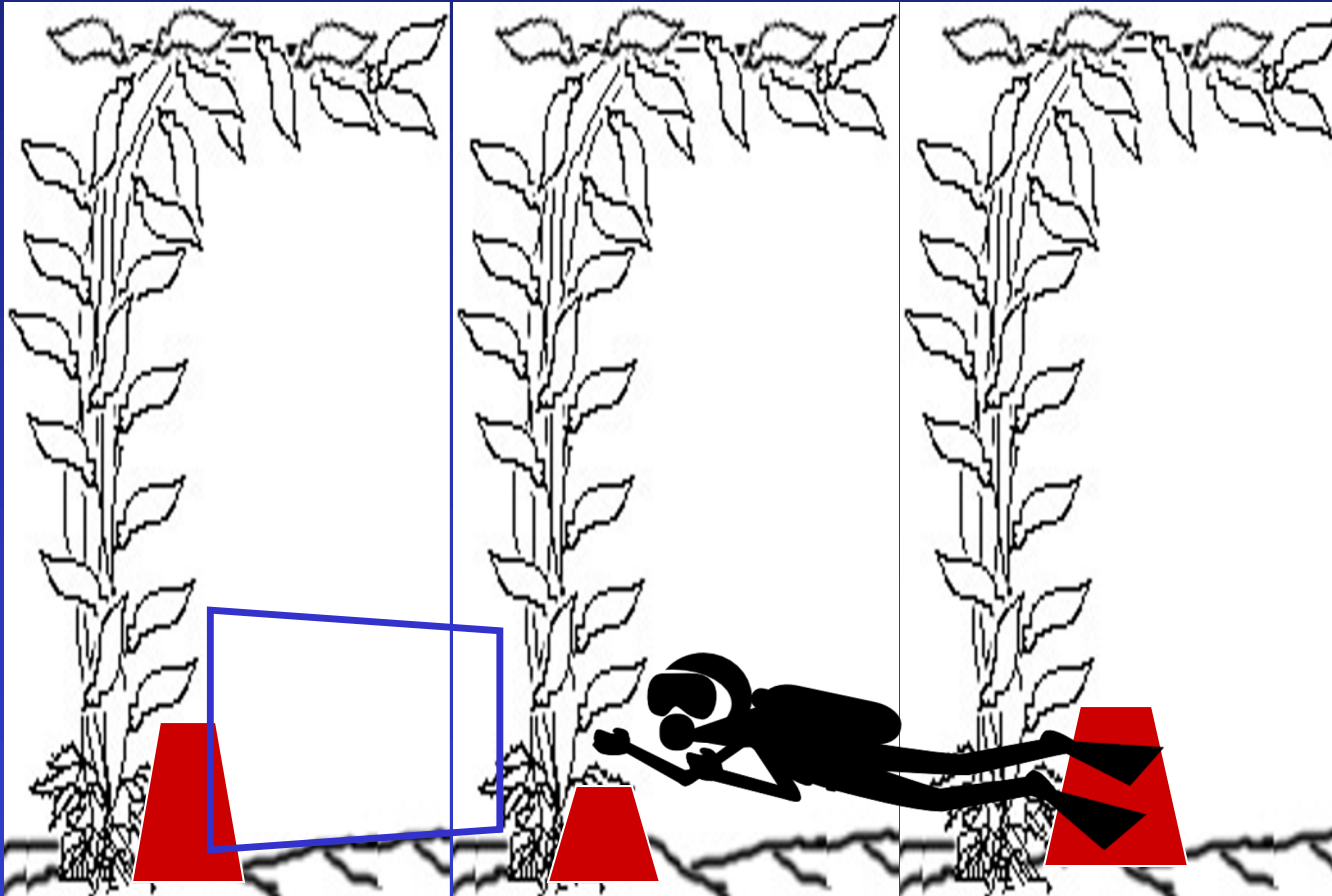
Mobile, shoaling species

Stop, Scan, Search

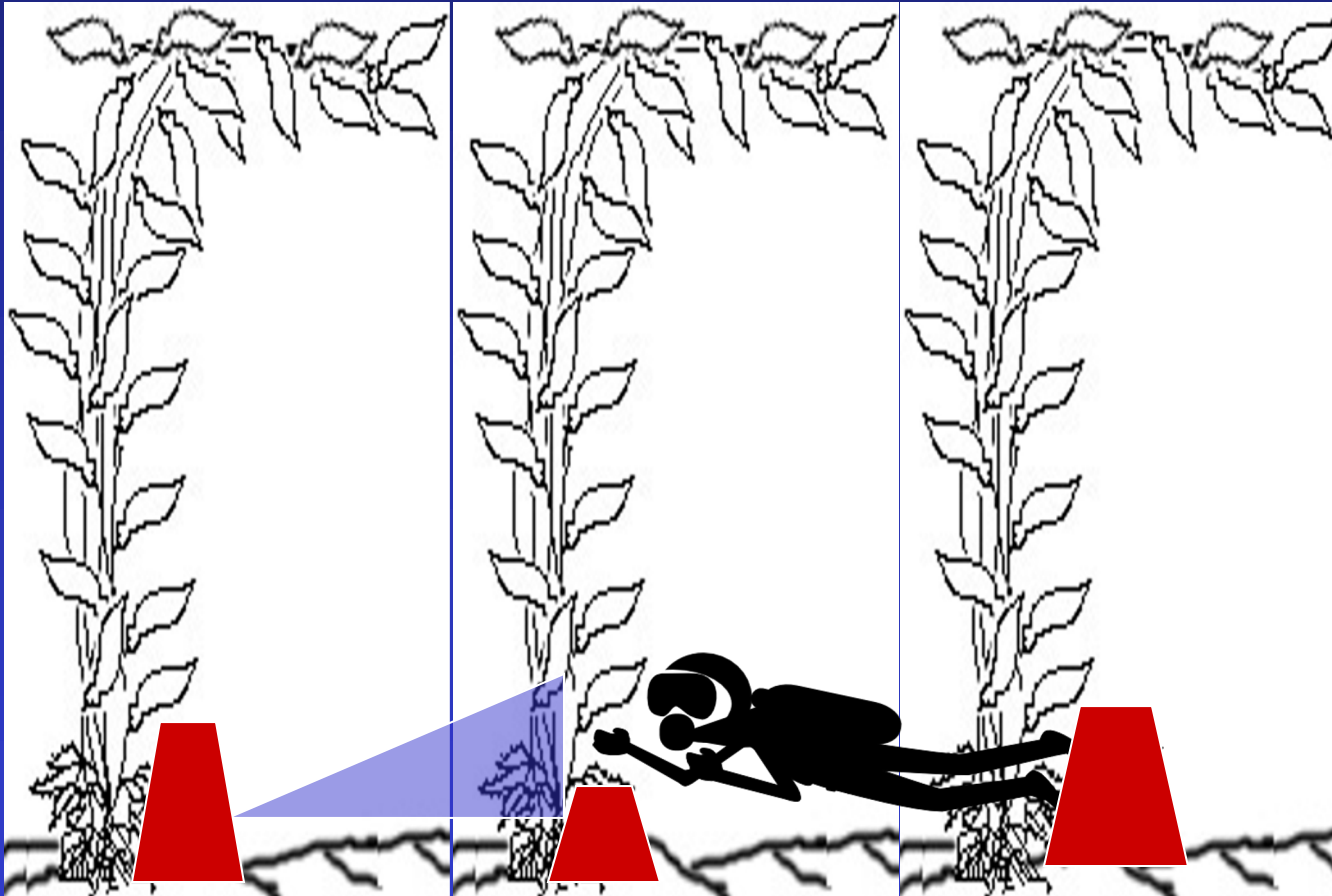


Sedentary, solitary, cryptic species

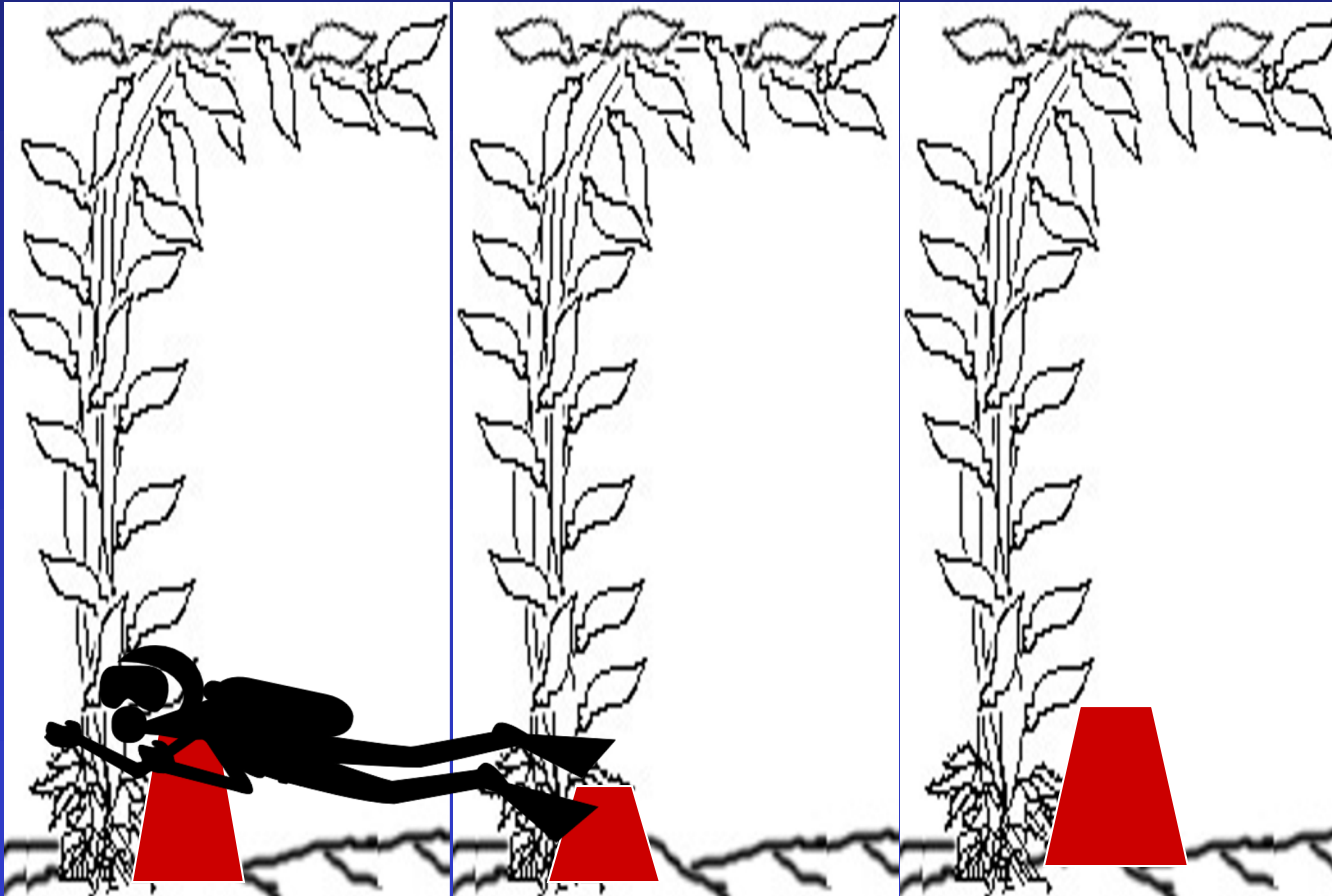
Stop, Scan, Search



Stop, Scan, Search



Stop, Scan, Search



Structure your counts, develop routine

Lobster Counted on Fish Survey

- Protocol added in 2022 for UCSB
- Count during search for cryptic/ unexposed fish
- Size lobster as you would for swath:
 - length = carapace length in cm



Visual transects - Part 2

What if...

1. My transect line isn't straight?
 - topography (contouring)
 - systematic navigation deviations
 - why bother with bearings anyway? (bias)
2. I seem to be in the wrong place?
 - 'structural zeroes' e.g., sand
 - OOZE - 'Out of Zone Experience' or 'How I learned to love the 30 m zone'
3. That sheephead looks awfully familiar?
4. There's a big rock in my way?

The canopy transect

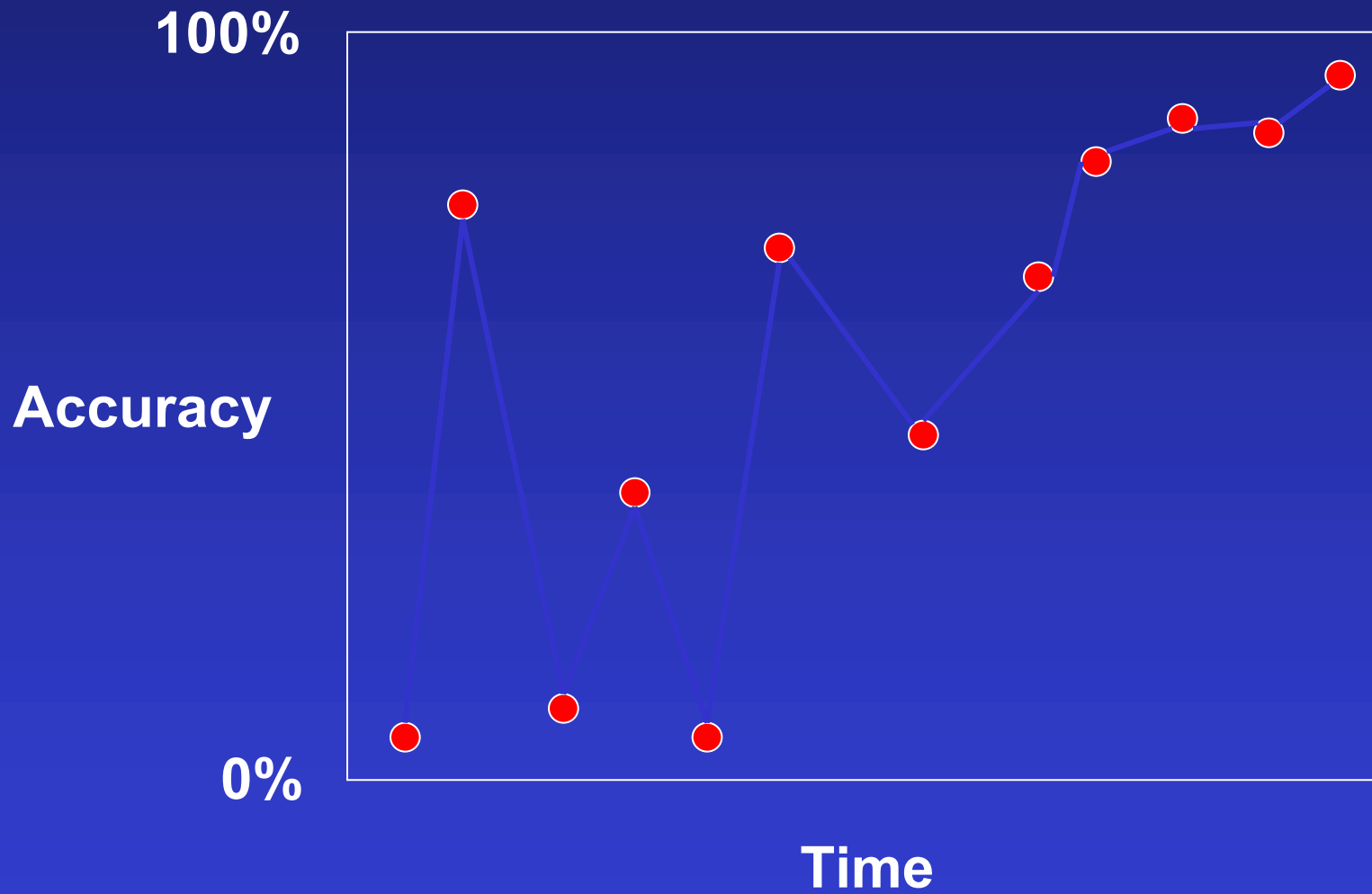
- 1. Diver: 6ft (2m) below surface**
- 2. Fasten tape -- follow bearing the whole time**
- 3. Look up, keep slate up**
- 4. Look through, not at the canopy**
- 5. Maintain bounds**
- 6. Percent canopy is the total percentage of kelp on the surface**

*** Once a canopy transect starts, it must be run the whole 30m even if kelp canopy stops***

Recap: Visual transect technique

1. Dimension: 30x2x2m
2. Moving windows
3. Moving in bounds
4. The Stop, Scan, Search approach
5. When to write?
6. On what do I write, when I need to write?

The progress function



There is hope!

Questions?

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: Never lower your slate!

On what do I write all this stuff down?

DATE:

OBSERVER:

TIME IN:

SITE:

SIDE: N S E W Cen

BUDDY:

TIME OUT:

TX #											
ZONE	CAN %										
LEVEL	T (°F)										
B M C											
HEADING	VIS (m)										
DEPTH (ft)	SURGE										
	H M L										
TX #											
ZONE	CAN %										
LEVEL	T (°F)										
B M C											
HEADING	VIS (m)										
DEPTH (ft)	SURGE										
	H M L										
TX #											
ZONE	CAN %										
LEVEL	T (°F)										
B M C											
HEADING	VIS (m)										
DEPTH (ft)	SURGE										
	H M L										

Entered on _____ by _____

Checked on _____ by _____

DATE: 8-20-2024

SITE: Naples

SIDE: N S E (W) Cen

OBSERVER: Jenn

BUDDY: Avrey

TIME IN: 0905

TIME OUT: 0940

TX #	1	SMYS	ELAT						
ZONE	CAN %								
outer	4	2(8)	1(12)III	(4)					
LEVEL	T (°F)								
(B) M C	61	14(25)	2(15)II	(4)					
HEADING	VIS (m)								
90	3	1(15)	3(7)II	(14)					
DEPTH (ft)	SURGE								
45	H M L		4(9)4,5	(13)					
TX #									
ZONE	CAN %								
LEVEL	T (°F)								
B M C									
HEADING	VIS (m)								
DEPTH (ft)	SURGE								
	H M L								
TX #									
ZONE	CAN %								
LEVEL	T (°F)								
B M C									
HEADING	VIS (m)								
DEPTH (ft)	SURGE								
	H M L								

- TL in parentheses
- Count outside of parentheses
- Underline double digit counts to differentiate from hash marks
 - II = 2, vs. II = 11
- Add up and circle totals for each size

Entered on _____ by _____

Checked on _____ by _____

DATE: 8-20-2024

OBSERVER: Jenn

TIME IN: 0905

SITE: Naples

SIDE: N S E (W) Cen

BUDDY: Avrey

TIME OUT: 0940

TX # 1		SMYS	ELAT							
ZONE	CAN %									
outer	4	2(8)	1(12) III (4)							
LEVEL	T (°F)	14(25)	2(15) II (4)							
(B) M C	61									
HEADING	VIS (m)	1(15)	3(7) II (14)							
90	3									
DEPTH (ft)	SURGE		4(9) 4,5 (13)							
45	H M (L)									
TX # 2		HCAR		HSEM	PCLA		BFRE	PVAC		
ZONE	CAN %									
0	10	24(12-15)		2(25) F	2(30) I (3)		1(6) III (7)	1(20)		
LEVEL	T (°F)									
(B) M C	61	2(5) 3,2 (7)		1(27) M	3(28) 2,1 (9) +3			31(12-13)		
HEADING	VIS (m)									
90	4	1(9)			2(34) 2 (4)			15(10-11), (20) +4		
DEPTH (ft)	SURGE									
43	H M (L)									
TX # 3		OCAL		SPUL(F)		SATR	SPUL(M)	EJAC		
ZONE	CAN %									
0	Ø	5(18)		1(26)		1(17)	1(42)	11(5)		
LEVEL	T (°F)									
(B) M C	61	2(19)		1(33)				3(6) I (4)		
HEADING	VIS (m)									
90	4	3(21) II (10) +5		2(29) I (3)				2(12) 3 (5)		
DEPTH (ft)	SURGE									
44	H M (L)			1(34)				19(6-7)		

Entered on _____ by _____

Checked on _____ by _____

Actual sample datasheet

FISH COUNTS / PISCO subtidal sampling / central Calif. / rev. 08-99

SITE Sand Hill - EAST DATE 9-17-99

NAME CARR TIME IN 1520 OUT 1520

TEAM A TRANSECT 6 S M D SURGE 0 1 2 3

PERCENT CANOPY COVER 50% BIX RF

		DEPTH		VIS		TEMP	
		CANOPY	MIDWATER	BOTTOM			
				<u>15-18</u>			

	FISH	Blue RF	Olive RF	Gryllus	Gryllus	Painted	Kelp greenling	Striped perch	Pile perch	Rainbow
B O T	0-10		<u>15(8)</u>	<u>40(8)</u> <u>50</u>	<u>25, 2(18)</u>		<u>20</u> <u>rock - 10, 15</u> <u>kelp perch - 12</u>	<u>2(10)</u> <u>12, 14</u>	<u>10</u>	
	10-20			<u>12(8)</u>			<u>5 triper</u> <u>rock - 12</u>	<u>12, 20</u> <u>4</u>		
	20-30	<u>4(8)</u>	<u>30(8)</u>	<u>20(8)</u>		<u>Bryccacio</u> <u>rock - 15</u>	<u>4(12)</u>		<u>10</u>	
M I D	0-10	<u>4(8)</u> <u>15</u>			<u>20</u>	<u>2(8)</u>			<u>12, 12</u> <u>10(10)</u>	
	10-20				<u>2(15)</u>				<u>12, 10</u> <u>12, 10</u>	
	20-30									
C A N	0-10			<u>1(8)</u>					<u>1(10)</u>	
	10-20				<u>1(10)</u>					
	20-30								<u>1(8)</u> <u>2(10)</u> <u>4(12)</u>	

Data Recording Protocols

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

Size of fish should be in centimeters in parentheses

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

(12) 9, 15, 11

OR

1(12) IIIII, 10, IIII

Data Recording Protocols

Size Ranges will be acceptable when the diver feels that they are unable to reasonably estimate the actual size of each individual fish (i.e. large schools of batfishes, aggregations of YOY's).

Ranges **must be kept within a 5 cm** bin (for example 25-30 or 30-35), but if possible, smaller bins should be made.

Try to only use size ranges for **5 or more individuals**. **DO NOT BIN** a size range for any less than 5 fish.

Data Recording Protocols

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

All small, cryptic sculpins/gobies 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 figured out back on the boat.

- If you encounter a fish that you do not recognize, hit the books right away!
- Draw pictures, note shape, markings, or behavior and describe it to the other divers as soon as you get back on the boat.)

DATE:

OBSERVER:

TIME IN:

SITE:

SIDE: N S E W Cen

BUDDY:

TIME OUT:

TX #										
ZONE	CAN %									
LEVEL	T (°F)									
B M C										
HEADING	VIS (m)									
DEPTH (ft)	SURGE									
	H M L									

- **SIDE:** A division of the site into two or three areas, referred to as sides, depending on their relative position along the coast.
- **TRANSECT:** A number representing one of the three/four transects sampled within the same zone. With the heading and zone, this describes the location of each transect relative to all others.
 - Transects are numbered sequentially from left to right while facing the coastline.
- **ZONE (I, IM, OM, O):** A division of the side into 4 categories representing onshore (5m) - offshore (20m) stratification or targeted bottom depths (m) for transects.
- **LEVEL (B , M , C):** Letter code for the position of the transect in the water column (Bottom, Midwater or Canopy)

DATE:

OBSERVER:

TIME IN:

SITE:

SIDE: N S E W Cen

BUDDY:

TIME OUT:

TX #										
ZONE	CAN %									
LEVEL	T (°F)									
B M C										
HEADING	VIS (m)									
DEPTH (ft)	SURGE									
	H M L									

- **DEPTH:** Average actual depth(ft) of the transect estimated by the diver. Add a note for yourself on the depth range each transect should be at before the start of the dive.
- **HEADING:** Compass direction of transect along isobath
- **TEMP:** The temperature (°F) on each transect measured by the divers computers.
- **VISIBILITY:** The diver estimation of horizontal visibility (in METERS) on each transect. Measured by reeling in the tape and noting the distance at which the end of the tape can first be seen.
- **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

DATE:

OBSERVER:

TIME IN:

SITE:

SIDE: N S E W Cen

BUDDY:

TIME OUT:

TX #										
ZONE	CAN %									
LEVEL	T (°F)									
B M C										
HEADING	VIS (m)									
DEPTH (ft)	SURGE									
	H M L									

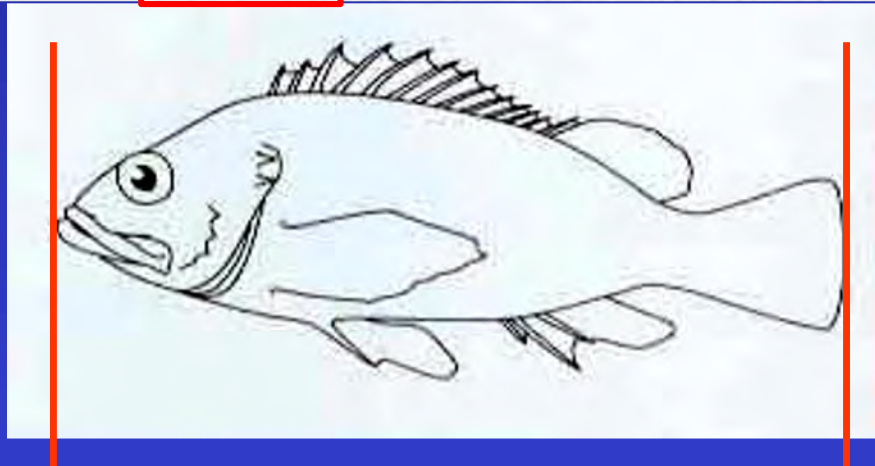
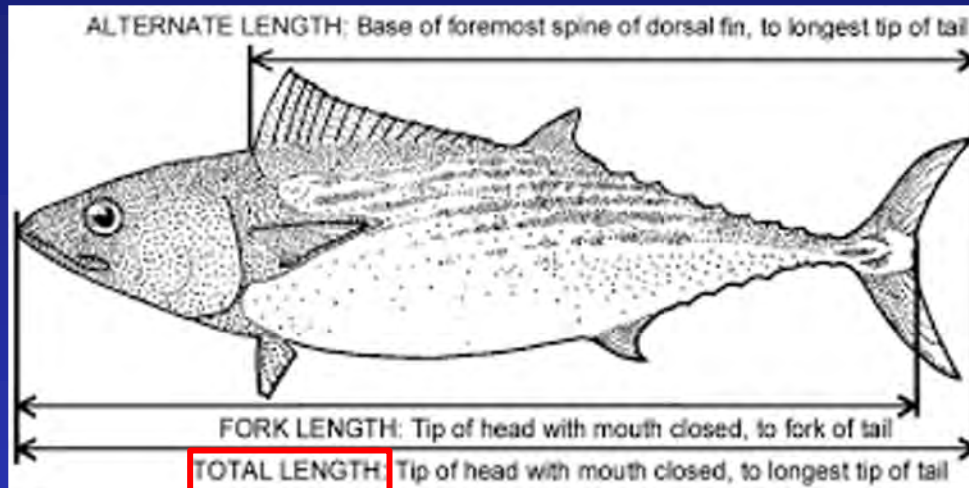
- **Canopy %:** An estimate of the amount of kelp cover per transect.
 - Bottom and midwater fish divers record percentage of kelp on transect (NOT what is above you)
 - Remember 2m x 2m x 30m transect
 - Midwater checks above for % of surface kelp canopy to determine if canopy transects are needed
 - <5% canopy cover = No canopy survey needed
 - If canopy is not to surface add a note saying “Kelp NTS” or “Kelp Not to Surface”
 - Note which transects have enough canopy to survey
 - Canopy diver records % of kelp canopy on the surface
 - If you run out of canopy, continue to run transect in a straight line based on compass heading

Sizing

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%

**Exception: Batrays
measure wingspan

2. Aids to sizing fish

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

3. Factors that contribute to under and overestimation of size

Underestimation

- 1. Low light**
- 2. Dull body color**
- 3. Poor visibility**
- 4. Objects in foreground**
- 5. Deep-bodied fish**

Overestimation

- 1. Bright light**
- 2. Bright body color**
- 3. Good visibility**
- 4. Objects in background**
- 5. Elongate fish**

Fish sizing exercises

1. Sizing inanimate objects/fish models
 - Check accuracy by measuring object after size estimate is written down
2. Sizing live fish
 - Work in pairs
 - Identify and size a wide variety of fish encountered (and anything else that gets in your way)
 - Practice with individual fish as well as schools with a range of sizes
 - Compare notes

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 (500 psi minimum)

3. Buddy system

- members of a dive team are always in visual contact

4. Sea conditions

- diving will only be conducted in safe conditions

5. Live boating

- fish teams are sometimes live-boated

Questions?