Marine Traditional Navigation Wayfinding Activity

INSTRUCTIONS: For a completed activity, you need complete only the first 5 sections of this assignment: Packing for the Journey, Which Way is Home?, How Far?, Seamarks, and Using Winds and Currents. The rest is optional. After this assignment is done, you will review key and can work with fellow students to answer the last part: Where Am I?

Text below is from [www.exploratorium.edu:](www.exploratorium.edu)

For thousands of years, group of explorers from a variety of indigenous cultures have set out on canoes for points unknown, possibly never to return, leaving behind loved ones and the safety of terra firma. What made them do it? No written record preserves much of this history, but speculations abound. They may have been driven by population pressures, a famine caused by a period of drought, or a lost battle. Or they may have been led by an ambitious chief, bent on glory or expansion. Some voyages may not have been driven by necessity at all, but instead by curiosity and a spirit of adventure.

This much is certain: Traditions of seafaring ran deep in the peoples of Pacific Coastal and Island nations, and often those who voyaged left their homes with no intention of returning, bringing with them the plants and animals they would need to start their lives afresh in a new land.

Today, with the rebirth of traditional voyaging in Hawai'i and elsewhere, we can ask the same question: Why set out for a weeks-long journey on a pitching canoe, risking the dangers of the open sea, and leaving behind loved ones and the comforts of home?

When the navigation renaissance began in the early 1970s, native peoples voyaged to prove a point, to refute the claim being advanced by some that their land was settled accidentally by the hapless drifting of rafts or by fishing boats blown off course. Now, with the tradition of traditional canoe navigation revived and thriving, the voyages allow new generations to connect with their native histories..

Of course, traveling thousands of miles by canoe without navigation aids has appeal in modern times, especially to people who love challenges as much as they love the ocean. But those voyagers who have mastered observation-based navigation techniques agree that it isn't really about the sailing, nor is it about the mental feat of getting from one tiny speck in the vast Pacific to another. These canoe voyages are really about preserving and celebrating culture—knowledge, traditions, and values that were very nearly lost.

Good video:

- finding land: http://www.exploratorium.edu/neverlost/#/navigation/basics/find
- North star: http://www.exploratorium.edu/neverlost/#/navigation/basics/hold
- Losing your bearings: http://www.exploratorium.edu/neverlost/#/navigation/basics/set
- Star compass: http://www.exploratorium.edu/neverlost/#/navigation/basics/set

Website: Mau Piailug -- wayfinding and ocean voyaging (Samoa) http://en.wikipedia.org/wiki/Mau_Piailug

Hokule'a Sailing 2009 (Honolulu, Hawaii) – Image by Kohuroa CC BY 2.0.

PACKING FOR THE JOURNEY

"Packing for a modern canoe voyage is a weighty matter, and the packing list looks much the same as for a long backpacking trip into the wilderness: water, nonperishable meals (think pasta and canned beans), a sleeping bag, a select and sturdy set of clothing, first aid and medications, a light source, and any of the things you can't imagine going a few weeks without—books, music, a journal, and yes, fishing gear. (Fresh sashimi is one of the delights of ocean travel.)

Water is the heaviest burden—a gallon of water per day per person. It must be stored and used in a carefully balanced arrangement, lest it disturb the steering and tracking of the canoe. When it rains, the crew uses tarps to catch the rainwater and refill empty bottles. Meals are also packed systematically, in bins marked "Day 1" and "Day 2," etc., for easy access" and to ensure there's enough food to last the voyage.

In a broader sense, preparing for a voyage has to do with not only what you bring, but also what you leave behind. Navigators counsel their crew members to make whatever arrangements are necessary to take care of responsibilities at home so that they can set out to sea untroubled." -- Exploratorium's *Never Lost*

Identify key things that will help you if lost at sea and needing to navigate on your own.

1. What would YOU bring or most like to have with you if out in the middle of the Pacific Ocean? (Pick your top 5.)
2. What would be the biggest challenges you'd face?

WHICH WAY IS HOME?

"If there is a golden rule among marine navigators, it is this: **Keep track of where you've been, and you will never be lost.** Traditional marine navigation is home-centered, meaning that the navigator keeps a mental and even a written log of every step of the voyage, starting from the moment the canoe is launched. What was the bearing? How far did the canoe travel? How did the wind and currents affect the canoe's path? By tracking direction and distance throughout the journey, the navigator maintains a mental roadmap of the canoe's path that establishes the location of both the destination and the home island. The payoff for such careful observation is that at any given moment during the voyage, you should always be able to point both to the destination and back to home. Even if the winds or currents put the canoe off track, even if the destination island never appears, returning home is still just a matter of retracing the journey, relying on the same clues that brought you. In this sense, you are never lost, because you always know the way home." -- Exploratorium's *Never Lost*

To make the above possible, there has to be a constant knowledge of how the boat is situated relative to north, south, east, and west. Use the rising sun in the east and the setting sun in the west to get your bearings first, then be sure you never lose them. Always know which direction your bow is facing at any particular time.

3. How would you keep track of where you've been and where you're going?
4. How do you orient yourself relative to north, south, east, west and keep your orientation (know the direction you're moving or facing?

HOW FAR?

"A voyaging canoe lacks two things that most people have come to expect in a moving vehicle: a speedometer and a trip odometer. So how do you know how far you've gone?

A straightforward way of measuring speed is by what's called dead reckoning. If you time the progress of bubbles and froth as they pass along the length of the canoe, it's possible to get a rough calculation of speed using simple algebra. To calculate canoe speed by dead reckoning, you can use a very simple formula: speed = distance / time.

So, for example, if it takes a bubble 4 seconds to travel 20 feet along the canoe, you know you are traveling at 5 feet per second. Divide by 6,077 feet per nautical mile, and multiply it by 3,600 seconds per hour, and you'll have your answer in nautical miles per hour, or knots—in this case, 3 knots.

Sometimes navigators prefer to simply estimate the distance traveled using "canoe days," the average distance a particular canoe covers over the course of a full day. For example, a voyaging canoe might average 120 miles (193 km) per day when sailing in tropical latitudes. So after sailing three days, you can assume you've traveled roughly 360 miles (579 km), although variations in winds and currents can alter this number dramatically." -- Exploratorium's *Never Lost*

5. If you paddle at the same rate every day, what are some reasons you would actually cover more ground (be moving faster) on a particular day? Moving slower on a particular day?
6. How fast are you travelling if your boat is 10 feet long, and you paddle past a floating log in 10 seconds? How far could you travel paddling at this speed for 8 hours?

SEAMARKS

"Seamarks can help track progress and indicate location. Seamarks are natural mid-ocean signposts that tend to appear at certain specific places along the way, including sea life, flocks of birds, free-floating seaweed or driftwood, or other natural phenomena. A particular zone might always host a swarm of jellies, say, or a school of porpoises. Seamarks reassure the navigator that he or she is on track.

Locating a small island in the middle of the Pacific might seem a nearly impossible feat, but navigators get help from a variety of sources. First, most islands occur in groups. This makes the navigator's target more of a zone than a dot. Find any island in the group, and you can use it to find the one you're looking for." -- Exploratorium's *Never Lost*

7. What are some reasons that areas would regularly have floating material?
8. What are some reasons that areas would regularly have high sea life?
9. How are the island chains and areas of active sea life related (especially areas with no visible islands)?

10. Refer to map below. In the areas around Hawaii, what direction has the highest amount of seamounts?

11. If you connected these island chains and seamounts with lines, what directions would they run? (Example: a line parallel to the equator would be east-west. A line parallel to a meridian would be north-south. What are the geometries of the lines of seamounts? (If you follow them in your boat, what two directions might you be traveling

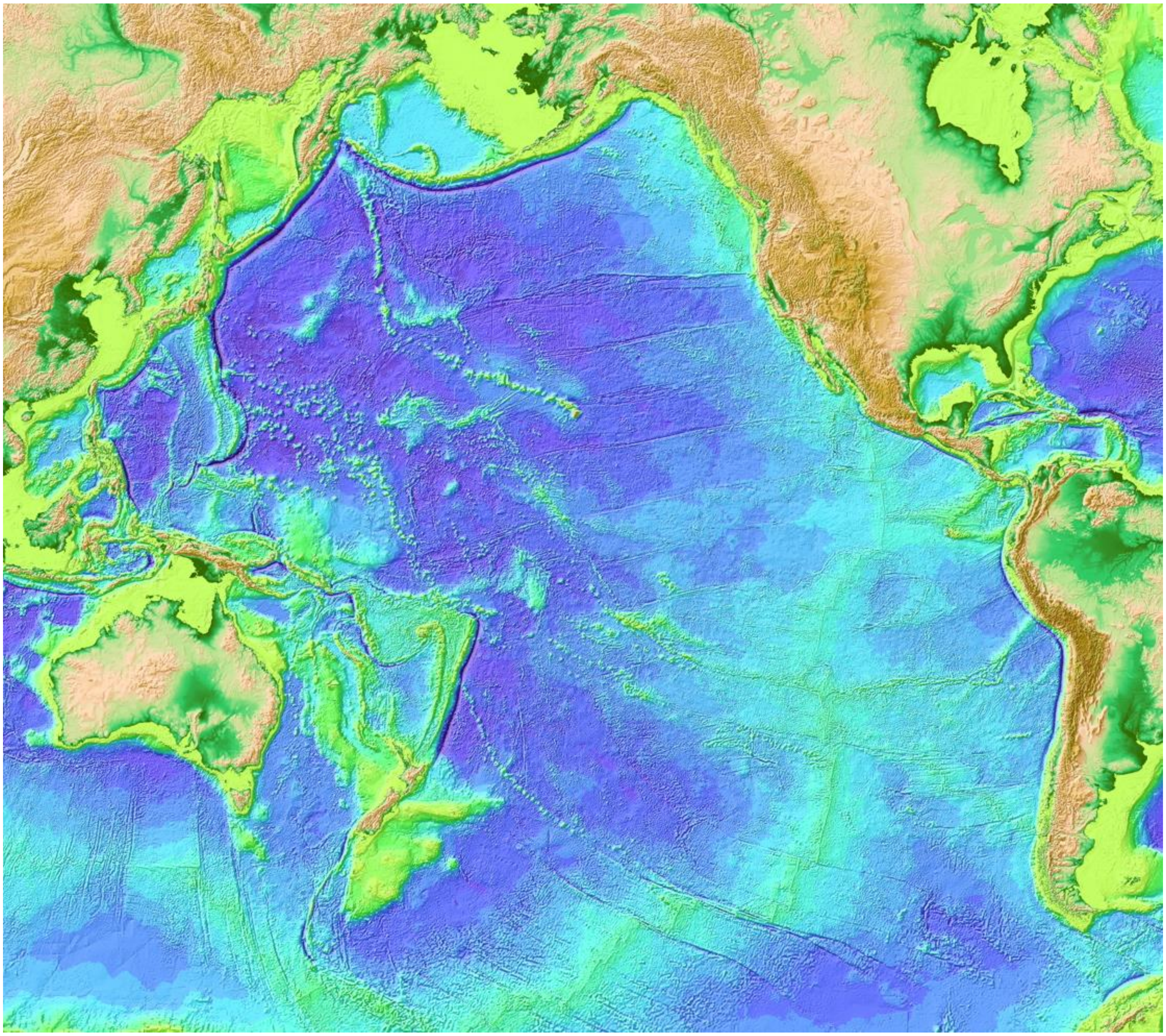


Image: NOAA

USING WINDS AND CURRENTS

“Most navigators plan their routes using a technique known as downwind sailing. The strategy is to set a course to a point at a given latitude upwind of the target island. Then, when you reach the correct latitude, you turn and let the wind carry you to your destination.

Downwind sailing helps simplify the challenge of locating the target island. If you sail directly toward your target and somehow miss it, you may not know which way to turn. Was it to the left or right? But if you deliberately sail to a point to one side (that is, east or west) and upwind of your target, you can then turn downwind and trust that the island is in front of you. Fortunately, many islands are part of a group of islands, presenting a larger target that is easier to locate than a single, lone island.

Another advantage to downwind sailing: It guarantees that the final leg of the journey will be relatively easy, giving the crew a break when they are likely to need it most.

Any successful sailing voyage requires intimate knowledge of wind patterns and currents. A strong current can be friend or foe, helping to carry you where you want to go or rapidly carrying you off course. Winds and currents vary widely from place to place and from season to season, and storms frequently disrupt the typical patterns. A good navigator takes careful consideration of the winds and currents likely to be in play at the time of a voyage.

Clouds can be a sign of land. Clouds accumulate over islands, and an isolated pile of clouds on the horizon often signals the presence of land. Reflected light on clouds can be another clue. When sunlight (or moonlight) shines on white sand and shallow bays, the light can reflect upward, illuminating the base of low clouds with a silver or greenish glow.” -- Exploratorium’s *Never Lost*

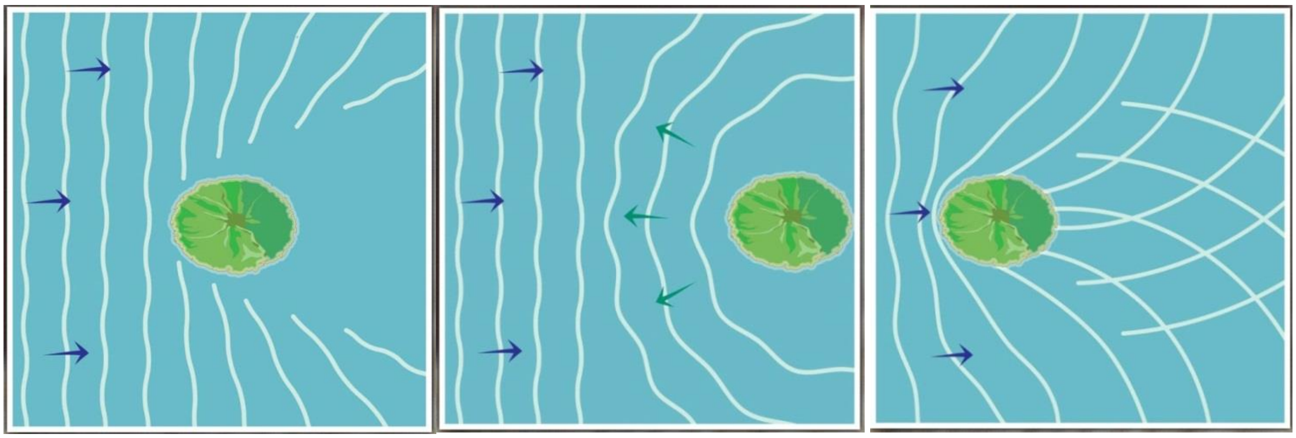
12. On the map on the previous page, draw in the typical currents found in the Northern and Equatorial Pacific. Label them with speeds (fast, slow) and temperature (cold, warm).
13. On the map on the previous page, in another color, draw arrows indicating the dominant wind directions (and names).
14. Circle on the map on the previous page, the largest islands that would be good targets for navigation (based on wind and current directions and not wanting to miss the island…)
15. How could you decide which current you were in if you found yourself in a current? Give example.
16. Where would you be if you noticed NO current? Put a big 0 mark there in the map on the previous page and indicate no current.
17. What happens to the location of currents and winds with the seasons?

SWELL

"Night and day, ocean swells can fill in as a rough guide to direction. Ocean swells are waves that have traveled far from the winds or storms that generated them. With practice, you can feel their subtle roll as they pass under the canoe and sense the direction the swells are coming from. If you note the direction from which the swells are coming at a time when the stars or other celestial guides are available, those same swells can guide you when the celestial guides disappear.

Unlike other guides to direction, swells are almost always present, which makes them especially important during the day, when other clues are absent. But swell patterns can and do shift, so a navigator can't rely on them indefinitely. When all else fails, and there's no way to keep a correct bearing, a good navigator "heaves to"; that is, takes down the sail and waits until he or she can set the course again.

Wave patterns, too, can be altered by the presence of land. Islands block, reflect, and refract ocean swells, creating distinct wave patterns that can help steer a seasoned navigator to land—especially helpful at night or when visibility is low. Bits of land vegetation such as seed pods or driftwood floating on the waves are yet another sign of land nearby." -- Exploratorium's *Never Lost*



Wave refraction around islands. Images reproduced with permission from the Exploratorium

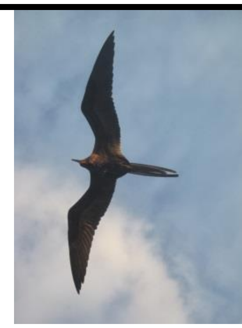
18. Where do swell originate? (And can that help you find your location at sea?)
19. How can you use swell direction to keep your direction/bearing constant during the day?
20. What do you do if you have lost your direction and no longer trust the swell direction?
21. If you are traveling in the opposite direction of the swell (against the swell) and notice an area of interference (where waves suddenly seem to be coming from multiple directions, what might that represent? (Put an X in the pictures above that mark that location.)

BIRDS

Birds can be helpful to a navigator in search of an island. Certain land-nesting birds fly out to hunt for fish in the morning and return to their nests in the evening, supplying a useful pointer to land. Not all birds make this daily commute between land and sea, however, so it's important to know one species from another.

A typical Pacific island can be sighted on a clear day from about 10 miles (16 km) away. Birds can significantly extend this detection zone. Some birds range only 30 miles (50 km) from land, while others, such as frigate birds can range much farther, up to 100 miles (160 km) from land. But don't trust every bird you see. Behaviors are general and many juveniles can be unpredictable.

Frigatebirds are found over tropical oceans and ride warm updrafts. Therefore, they can often be spotted riding weather fronts and can signal changing weather patterns. These birds do not swim and cannot walk well, and cannot take off from a flat surface. Having the largest wingspan to body weight ratio of any bird, they are essentially aerial, able to stay aloft for more than a week, landing only to roost or breed on trees or cliffs. Because they cannot swim or take off from a flat surface, they will never set down in the water. They mostly steal their food from other birds mid-flight.



The **Arctic Tern** travels the farthest of any bird, crossing the equator in order to spend the Austral summer in Antarctica. They thus travel from pole to pole, maximizing their food sources – summer in the Arctic and then summer in Antarctica, and back again.

Image: Malene Thyssen, Wikimedia Commons

Albatrosses usually spend 80 to 90 percent of their time at sea flying, day and night. They return to islands once a year to breed. If you can recognize the species and know its breeding time, you should be able to determine whether it's heading to land or open sea.

Image: Laysan Albatross, Kauai, Hawaii by Dick Daniels (Wikimedia Commons)

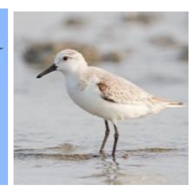
Shorebirds or land birds are those that must stay close to land and/or rely on freshwater. These include penguins, cormorants, coots (a few migrating species migrate only at night), eagles, herons, osprey, ducks, sanderlings, oyster catchers, ruddy turnstones, plovers, red- and blue-footed boobies, and more.

Coot

Cormorant

Penguin

Osprey



Sanderlings

Snowy Plover

(images from Wikipedia Commons)

22. Which birds provide no indication of the proximity of land?

23. Which birds indicate land is nearby?

24. Which birds can be used to indicate time of year? How?

CALCULATING YOUR LATITUDE

“The North Star, known as Polaris or Hōkūpa'a (Hawaiian), is an especially useful star. Situated at the north celestial pole, it is fixed in the sky and reliably marks due north. In the Southern Hemisphere, where the North Star can't be seen, there is no fixed pole star. But there is a constellation in the southern sky—called the Southern Cross, or Hānaiakamalama in Hawaiian—that points to the south. Draw a line from the top of the cross through the bottom, and this line points toward due south on the horizon.

Of course, stars aren't visible all the time. That's when the sun and moon can help. At dawn, as the stars are fading, you can note the position of the rising sun relative to the canoe and use the sun as a guide while it's low in the sky. At night, if clouds or fog pass in front of your guiding stars, the moon may still be visible and a good bearing marker when it is near the horizon.

Stars can also give clues about location. The height of a star as it passes through its highest point in the sky depends directly on the latitude of the observer. So you can measure the height of stars above the horizon to figure out your latitude.

The North Star, or Hōkūpa'a, is a useful latitude marker when you're in the northern hemisphere. The angular height of the North Star above the horizon, in degrees, is equal to your latitude. For example, in Hawai'i, the North Star is 20° above the horizon. That tells you that your latitude in Hawai'i is 20°.

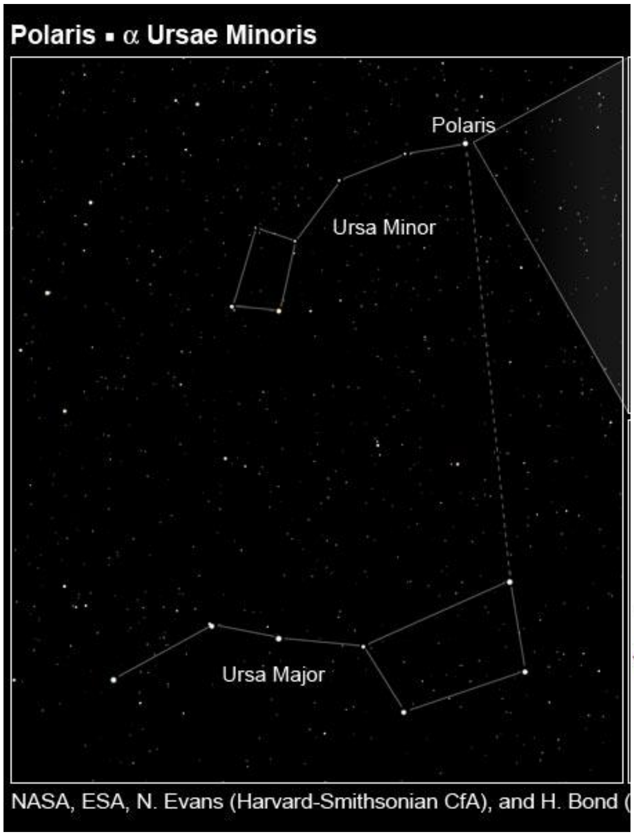
Measuring the angular height of a star in degrees may sound complicated, but it's something you can do easily, using your own body as a measuring tool. Stretch your hand out in front of you, as far as it will go. The width of your pinky is about 1°. Make a fist, and the width of your fist is about 10°. For greater accuracy, you'll want to "calibrate" your own hand as a measuring tool.

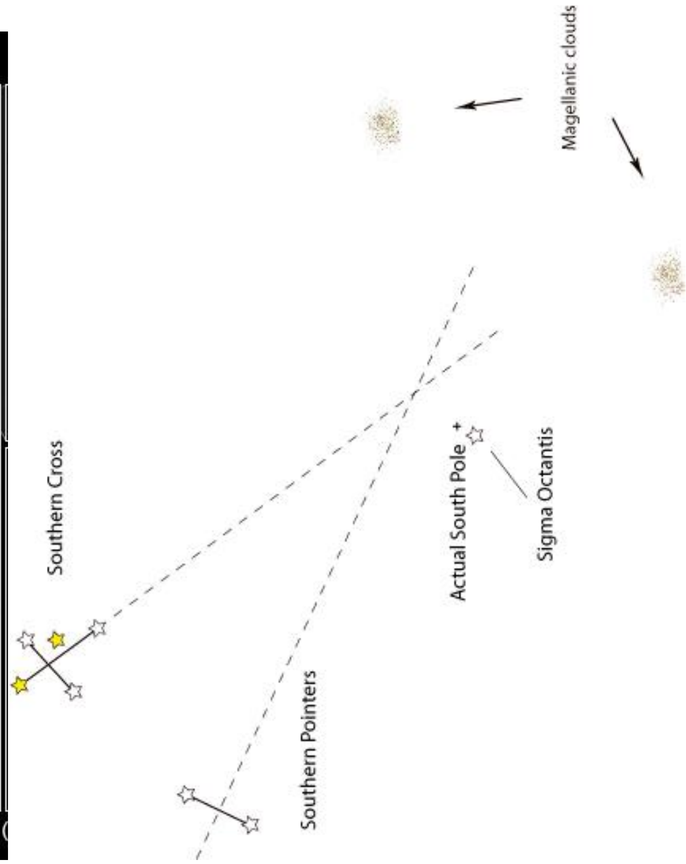
The Southern Cross, or Hānaiakamalama, is another useful constellation for finding your latitude, especially near Hawai'i. When the Southern Cross is upright above the horizon, and the distance between the top star and the bottom star is equal to the distance between the bottom star and the horizon, then you know you are at 20° north, the latitude of Hawai'i. Travel south from Hawai'i and the Southern Cross rises higher in the sky, to 30° above the horizon (about three fists) at the equator.” -- Exploratorium’s *Never Lost*

Hold your hand in front of you, as far as you can. Line up your outstretched hand with distant objects to measure their angular width or height. Various parts of your hand span different angles. These "rules of thumb" work for most people, but if you want to make your "handy" measuring tool even more personal and precise, try calibrating your hand.

- Find a wall that you can stand back from at least 2 meters.
- Get your meter stick and put a bright sticker or piece of tape at the following positions: 3.5 cm (1°), 17.5 cm (5°), 35.3 cm (10°), and 72.8 cm (20°). Write the degree measurement on top of each sticker.
- Use the clear tape to attach the meter stick to the wall. Orient the meter stick vertically and put the center of the meter stick roughly at eye level.
- Put your measuring tape on the floor and measure a distance of 2 meters from the wall. Use colored tape or a sticker to mark the spot on the floor.
- Stand on the spot and look toward the meter stick. Use the markings on the meter stick to figure out exactly what positions your hand must take to span the distance to each sticker. Memorize these and you'll have a handy measurement tool to take with you wherever you go!”

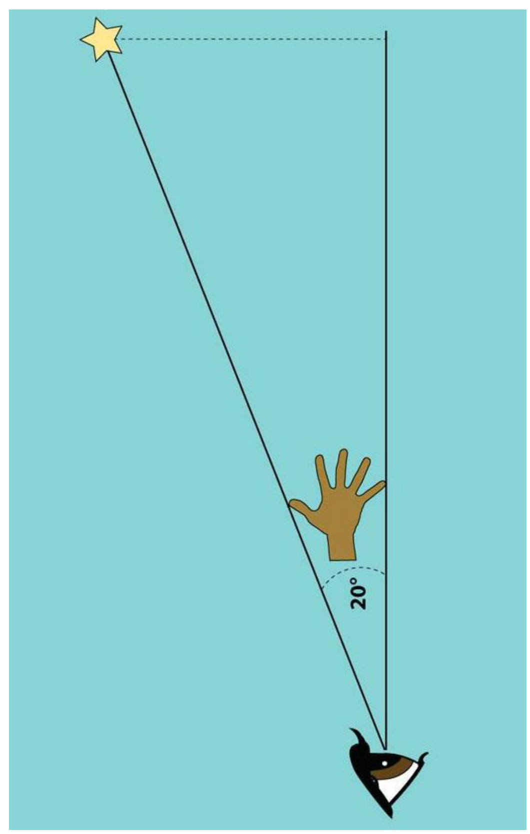
25. If you see Polaris at night and measure its angle above the horizon to be 15°, what portion of your hand does that represent? What is your latitude?
26. If you cannot see Polaris at night, what does that means about your location? What constellation would you use to locate south? How?
27. Go outside when the moon is out. Its full with is 0.5. What part of your hand does that represent?





Polaris Image from NASA | Southern Cross Image by Michael Millthorn (Creative Commons Share Alike 3.0)

Part of Hand to Compare	Angular Degrees (approximate)
Outstretched Thumb & Pinkie	20°
Thumb to Fingertip	15°
Clenched Fist	10°
Thumb	2°
Pinkie	1°



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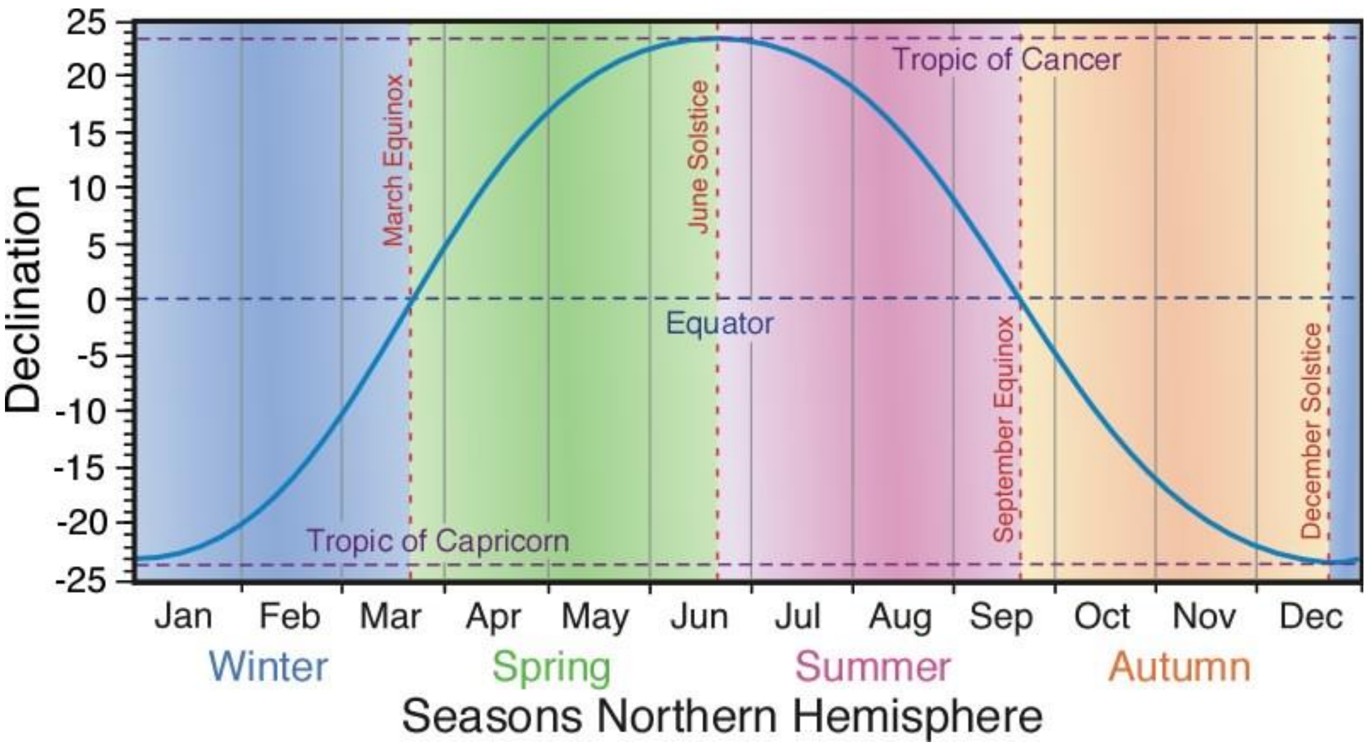
Finding latitude during the day:

Go outside at solar noon and measure the angle between the horizon and the sun. What is **solar noon**? Solar noon is the moment at which the sun is at its maximum height above the horizon. If you are at the Tropic of Cancer on the June Solstice in the Northern Hemisphere, the sun would be DIRECTLY over your head. If you are at a latitude further north from 23N (the tropic), the sun will always make its transit south of you, and you will have to look south to find it. North of 23N (and south of 23S), the sun will never be DIRECTLY overhead.

The rest of this section is based on information and uses images produced by Dr. Michael Pidwirny, University of British Columbia Okanagan. http://www.physicalgeography.net



June solstice D=23.5 º, December solstice D=23.5 º, March equinox D=0 º, and September equinox D=0 º.
Declination = the latitudinal angle at which the sun is directly overhead (depends on season).

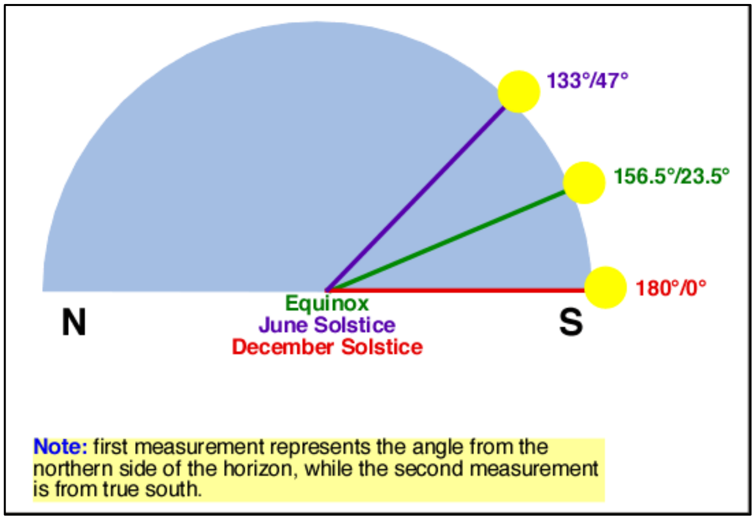
Maximum Sun altitudes for selected latitudes during the two solstices and equinoxes.

Location's Latitude	March Equinox March 20/21	June Solstice June 21/22	September Equinox September 22/23	December Solstice December 21/22
90 N	0 degrees	23.5 degrees	0 degrees	- 23.5 degrees
70 N	20 degrees	43.5 degrees	20 degrees	-3.5 degrees
66.5 N	23.5 degrees	47 degrees	23.5 degrees	0 degrees
60 N	30 degrees	53.5 degrees	30 degrees	6.5 degrees
50 N	40 degrees	63.5 degrees	40 degrees	16.5 degrees
23.5 N	66.5 degrees	90 degrees	66.5 degrees	43 degrees
0 degrees	90 degrees	66.5 degrees	90 degrees	66.5 degrees
23.5 S	66.5 degrees	43 degrees	66.5 degrees	90 degrees
50 S	40 degrees	16.5 degrees	40 degrees	63.5 degrees
60 S	30 degrees	6.5 degrees	30 degrees	53.5 degrees
66.5 S	23.5 degrees	0 degrees	23.5 degrees	47 degrees
70 S	20 degrees	-3.5 degrees	20 degrees	43.5 degrees
90 S	0 degrees	- 23.5 degrees	0 degrees	23.5 degrees

(winter in a hemisphere)
Latitude = 90 – sun altitude – sun declination
(L = 90º – (A – D))

(summer in a hemisphere)
Latitude = 90 – sun altitude + sun eclination
(L = 90º – (A + D))

In this equation, latitude (L) is in degrees as is declination (D). Sun altitudes (A) are measured relative to True North for southern latitudes and True South for northern latitudes. When using the above equation in tropical latitudes, Sun altitude values greater than 90º may occur for some calculations. When this occurs, the noonday Sun is actually behind you when looking towards the equator. Under these circumstances, Sun altitude should be recalculated as follows:



Solar noon Sun angles for 66.5° N.

$A_{new} = 180º - A_{original}$

EXAMPLES FOR NORTHERN HEMISPHERE:

What's your latitude if you measure the sun's altitude at solar noon to be 63.5º, and it is June 22?	
On June 21 or 22 (solstice) D=23.5 º.	
FROM TABLE	From the table above, on June Solstice, a 63.5º altitude means I'm at 50ºN latitude!
EQUATION	Latitude = 90 º – (63.5 º-23.5) = 50ºN

What's your latitude if you measure the sun's altitude at solar noon to be 20º, and it is September 23?	
On September 21 or 22 is equinox, D=0 º.	
FROM TABLE	From the table above, on September Solstice, a 20 º altitude means I'm at 70ºN latitude!
EQUATION	Latitude = 90 º – (20 º) = 70ºN

What's your latitude if you measure the sun's altitude at solar noon to be 50º, and it is March 1st?	
What is D? March 1st sits between D=0 º (at March 20/21) and D=23.5 º (December 21/22). From the above graph, I get that D on that day is ~10º. **(An estimate…if you needed to be really accurate, you would use this equation where δ = declination angle (rads); n = the day number, such that n = 1 on the 1st January.** $\delta = 23.45\frac{\pi}{180}\sin\left[2\pi\left(\frac{284+n}{36.25}\right)\right]$	
EQUATION	Latitude = 90 º – (50 º + 10 º) = 30ºN **(This answer is only as good as D was measured)**

YOUR TURN FOR SOUTHERN HEMISPHERE:

28. What's your latitude if you measure the sun's altitude at solar noon to be 53.5º, and it is Dec 21st?

29. What's your latitude if you measure the sun's altitude at solar noon to be 20º, and it is March 22?

30. What's your latitude if you measure the sun's altitude at solar noon to be 5º, and it is July 1st?

MAKING A SEXTANT.

MATERIALS: Protractor, jumbo paper clip, 20 cm string, clear plastic straw, tape, scissors, metric ruler.

1. Tape the straw to the protractor so that the straw goes through 90 degrees and the center hole.
2. Tie the string to the paper clip. Making sure that the string hangs freely, tape it to the center mark. (Note: the string should go through the O degree mark if the straw is held parallel to the ground.)
3. Pick an object high on the ceiling or outdoors above ground. Sight this object through the straw. Press the string against the protractor when it stops swinging and read the scale on the protractor. (Read the scale that ranges between O to 90 degrees.) This is the angle of the object above ground.

CALCULATING LONGITUDE *(nontraditional, but useful!)*

Although traditional ocean voyagers didn't have a pocket watch, modern mariners do. We can use these clock to help us determine longitude by seting it to keep track of what time it is at the Prime Meridian (Greenwich, England). On the day you want to know your latitude, go outside at solar noon with your watch.

EXAMPLE:

When it is solar noon in your location, your Greenwich clock says its 3:53 pm. What is your longitude?	
How many hours and what direction away from Greenwich are you?	We are 3 hrs and 53 minutes west of Greenwich
Convert 53minutes to hours	53 ~~minutes~~ x 1 hr = 0.883 hr TOTAL=3.883 hr 1 60 ~~minutes~~
Convert hours to º of longitude	3.883 ~~hr~~ x 15º of longitude = 58.25º of longitude W of PM 1 1 ~~hr~~

When it is solar noon in your location, your Greenwich clock says its 6:26 am. What is your longitude?	
How many hours and what direction away from Greenwich are you?	12:00 – 6:26 = 5:34 We are 5 hrs and 34 minutes East of Greenwich
Convert minutes to hours	34 ~~minutes~~ x 1 hr = 0.566 hr TOTAL=5.566 hr 1 60 ~~minutes~~
Convert hours to º of longitude	5.566 ~~hr~~ x 15º of longitude = 83.5º of longitude E of PM ~~0~~ 1 ~~hr~~

31. When it is solar noon in your location, your Greenwich clock says its 9:51 pm. What is your longitude?	
How many hours and what direction away from Greenwich are you?	
Convert minutes to hours	
Convert hours to º of longitude	

32. When it is solar noon in your location, your Greenwich clock says its 11:55 am. What is your longitude?	
How many hours and what direction away from Greenwich are you?	
Convert minutes to hours	
Convert hours to º of longitude	

33. When it is solar noon in San Francisco, your clock reads 12:15 pm. You then travel to Hilo, Hawaii and do not change your clock. The longitude of Hilo Hawaii is 155°W. The longitude in San Francisco is 122°W. What time should your clock read when it's solar noon in Hilo?	
How many degrees of longitude and what direction away from San Francisco are you?	
Convert longitude to hours and minutes.	
Add or subtract the time as necessary	

PIECING IT ALL TOGETHER—WHERE AM I?

Review and share what you've just learned to solve the following problem:

34. You are left in adrift in a dinghy after a fishing excursion gone awry somewhere near Hawaii over spring break. How can you use your knowledge to find your location and to make your way back to land? Use the following clues to identify the **your location on the following map** (mark with an X), and the **direction you would paddle to find land** (mark the location you would travel to with another X and draw an arrow between the two). Clues: ➢ Sun rises at **stern** (back) of your vessel and sets at **bow** (front) and you are keeping your vessel oriented this way throughout the day. ➢ Currents are moving towards the sunset (direction your bow is facing). ➢ Water temperatures are on the warm side. ➢ Frigate birds are flying from the sunrise direction in morning and the sunset direction in evening; ➢ Albatross and Arctic Tern are flying from **starboard** (right side when facing bow) to **port** (left side of vessel when facing bow). ➢ At night, Polaris is on starboard side of boat and appears at angle of 10 degrees from horizon. ➢ Winds are from starboard **stern**. ➢ Swell is approaching from multiple directions but no local storm and no clouds in sky. ➢ When on dry land in Hawaii, your noticed your clock read 12 noon at close to solar noon. Now it reads 1 pm at solar noon.
35. How would you ensure you were maintaining direction as you travel during the day?

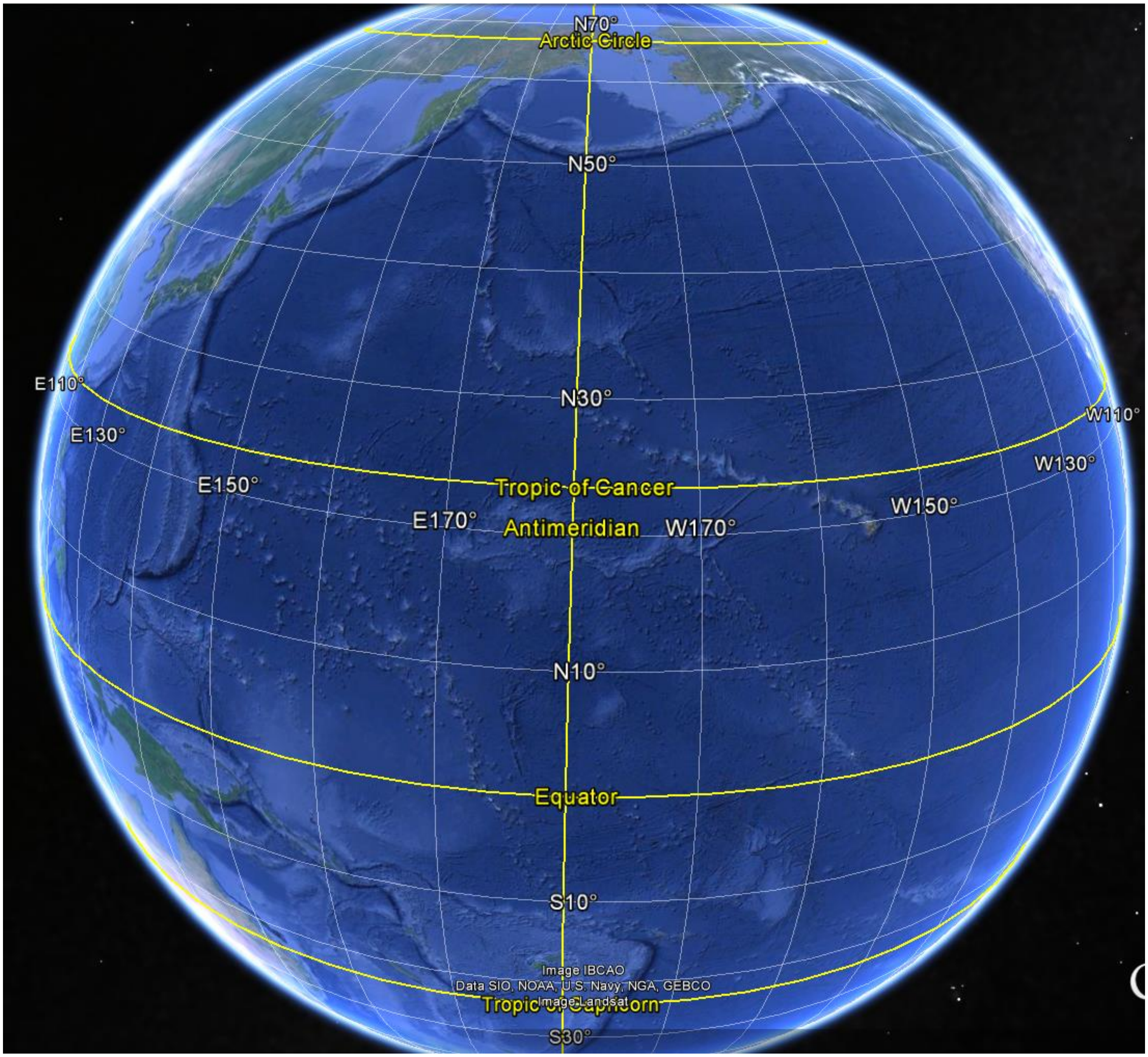


Image: Google Earth