The Canoe Is the People

Indigenous Navigation in the Pacific

NAVIGATING

United Nations
Educational, Scientific and
Cultural Organization

LiNKS
Local and Indigenous
Knowledge Systems

Navigating

Before setting out, a navigator and his community have to prepare well for a journey. Once at sea, the navigator has to bring together all his knowledge about the stars, sea, sun, and wind to keep the canoe on course and safely find land. At all times, he must know his canoe's position in relation to his home and destination and adjust his course if necessary. To do this, he must stay awake for long periods – sometimes all day and night. Otherwise, he might miss important information, like a star sighting or wind change.

But navigating isn't just practical – it's spiritual as well. It is said that you can tell a navigator because of his red eyes – a sign that he's spiritually blessed, not so much that he's had no sleep! In the Caroline Islands, a navigator carries a *charm*[*] made of wood and stingray spines to protect the voyage. In the Louisiade Archipelago, he places plants like coconut leaves on the canoe to show his authority and keep spirits away. In Kiribati (Gilbert, Phoenix, and Line Islands), he might perform a *chant* to keep away dangers like bad weather.

Ruberubei-te-nang, nkoe!
Me na baka, me na maototo i maiaki-ni wa-u ni boborau ikai!

Tremble-the-cloud, you!
So it falls, so it breaks to the south of my voyaging canoe!

Adapted from Grimble, A. (1972).

Video 1 - Cook Islands navigator Tua Pittman

A lot of things that we do on the canoe are things that we're not able to explain. There are things that are more spiritual than physical or mental, and they're a very big part of voyaging as well. You can be very physical, you can be the strongest guy on the canoe, but if you don't have that spiritual feeling as well, you don't have the whole package.

[*] NOTE: Definition of words in *italics* can be found in the Glossary in the CD-ROM Storehouse.

Video 2 - Satawalese navigator Mau Piailug

I use different things at different times. I use the wind and weather. I watch the shape and colour of the clouds. I look for yellow, red, or blue to know when it will storm or rain or blow.

From The Last Navigator © INCA 1989. Directed by Andre Singer.

Video 3 - Satawalese navigator Jerome Rakilur

The first time I returned from college, my uncle taught me "the key of sailing", what we call akurigiy. This means every aspect of sailing including all about the canoe, how it is built, how to handle it, the stars, winds, currents, and directions. Everything ... nothing is hidden. A navigator has to know where the wind is coming from, what is behind you when you leave the island, and he has to know to what destination he is travelling. When my uncle knew that I had learned everything that I needed to know, he then asked me to try sailing.

Video 4 - Maori master canoe builder, Hekenukumai Busby (New Zealand)

We went to the Marquesas. In Nuku Hiva we prepared for the BIG voyage, which was to be 2300 miles (3700 km). We had two trainee navigators who would get the canoe to Hawaii from Nuku Hiva. The University of Hawaii electronically recorded our course. Later, the data showed Te Aurere to be the closest canoe to the sail plan submitted before the voyage. I was proud of our trainee navigators.

1 Preparing and Starting Out

Throughout the Pacific, a canoe is thought of as the mother of the crew and the navigator as their father. Before leaving, the navigator must make sure that:
• the canoe is working well
• there is enough food and water
• the time to go is right.
Lots of people in the community help with these preparations.

The navigator knows many sea paths. In the days before a voyage, he goes over the one he will follow. He knows each star on the path, what weather he might find, and *alternative* routes to take if currents or winds push his canoe off course.

In many parts of the Pacific, like Satawal, the navigator has to follow *taboos* before trips, like avoiding sexual contact or only eating food made especially for him. He also performs certain *rituals* to protect the canoe from dangers. Some navigators are said to have spiritual powers to control natural forces like the weather.

Video 1 - Maori master canoe builder, Hekenukumai Busby (New Zealand)

While we were preparing for the 1995 Voyage of Rediscovery, Te Aurere was invited to sail to Raiatea to remove an ancient curse placed on a marae, centuries ago by one of our ancestors. Re-establishing connections is important and removing the curse of our ancestors would be a way forward leaving past deeds behind. Our elder Te Ao Peehi led the ceremony. I will never forget that day because it felt as if we were surrounded by all our ancestors.

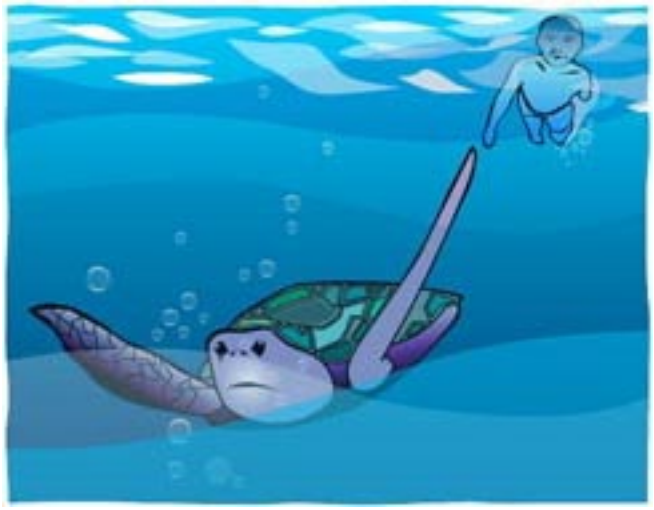
Video 2 - Satawalese navigator Mau Piailug prepares his crew and visits his father's grave before a voyage

I sit here because … What do you call this? Grave. Yeah, this grave is for my father. He taught me about navigation. That's why … when I sail from here to Saipan or anywhere. Because I learned from him.

From The Last Navigator © INCA 1989. Directed by Andre Singer.

Video 3 - A spiritual cleansing ceremony takes place in the Cook Islands

Story 1 - Turtle and Canoe: The Importance of Preparation (Palau, Micronesia)



Eledui from Ngerdemai wanted to be the best hunter of all. He wanted to catch the Great Turtle – the Old One. Then people would tell stories about his great strength! "The old men waste time waiting for a sign. Begin the hunt now, I say!"

On a night with no moon or stars, he started out. He forgot to look for storms or strong currents. But when a small tern cried out at him, he stopped paddling. He started to laugh, but then the bird disappeared. Did he just imagine it? Now he remembered – he had forgotten to greet the spirits, the providers of safety. These spirits often changed into birds with warnings. So Eledui gave thanks and asked to be forgiven for his hurry. He threw water on the front of the canoe and then paddled to the outer reef.

There, he saw the Old One! He threw his spear and hit him. Eledui dived in. He must stop the turtle from diving deeper. But he forgot to anchor his canoe. It was caught in a current and moving towards the ocean! He must swim now to save it … but he didn't want to lose the turtle. He decided to use the turtle to pull him to his canoe. Waves splashed, and Eledui's strength was nearly gone. The sea was red with the blood of both of them. Then the turtle dived down hard, and Eledui lost his hold. "No, no!" he screamed. But only the waves heard him.

1.1 Canoe

Before starting out, the canoe must be in good working order. It also needs extra equipment for emergencies – for example, wood (to replace broken masts), pandanus sails, ropes, and paddles, as well as breadfruit sap and burned lime to fill small leaks … not forgetting pandanus hats to protect from the sun and rain! Everything adds weight and slows the canoe down, so only necessary items are taken. The equipment is stored well to keep the canoe balanced. Extra parts are tied to the hull. If the canoe turns over in a storm, these parts won't be lost. Navigators and crew know how to fix the canoe with these parts when travelling.

Big canoes are needed for long voyages. On Satawalese outrigger canoes, there is an epep (lee platform) with a little aimweim (house) on top to keep passengers and things dry. In Hawaii and other Polynesian islands, double-hulled voyaging canoes have an even bigger platform between the hulls to carry people, animals, food, and extra parts.

Video 1 - Satawalese navigator Jerome Rakilur

After I learned about the stars, I also learned pwang – canoe repair at sea. This is important to know for when my canoe breaks. Then I can do the repairs and make it back to the island.

Video 2 - Satawalese navigator Lewis Repwanglug

He said they can work in the sea. Let's say the typhoon destroys their canoe, they have to go down and get the part if it's still there. They have to tie it. They take extra rope with them so they can use it … so they can swim around to fix the canoe. OK, this is the magic. He also mentioned that he can also do this magic or whatever to calm down the wind and the waves.

1.2 Food

Depending on what is found locally, food for a journey can include:

- breadfruit, taro, and pandanus (cooked, dried, grated, and so on)
- ripe coconuts for eating and young green ones for drinking
- fish (cooked or dried)
- sugar cane.

In the past, special foods were sometimes prepared as gifts for islands being visited – for example, coconut candy balls for the Yapese on the old sawei voyages (a traditional ceremonial voyage in Micronesia).

On Satawal, women keep the gardens and prepare all the food, not only for voyages but also other events, like canoe building and the pwo (initiation ceremony for navigators). They prepare taro year round. They cook in earth ovens or over open fires at home. They also prepare breadfruit when it's in season. Teenage boys climb the breadfruit trees owned by their relatives and throw the big fruits down. The women may preserve the breadfruit in the ground for use on later voyages. They wrap the food in leaves to keep it dry and clean.

At sea, the crew also collect rainwater and catch birds and fish. They sometimes cook on fires of coconut *husks* inside wooden bowls lined with sand and small stones.

Video 1 - Cook Islander Dorice Reid
They learned how to preserve breadfruit – how to put it into the ground so it was like being refrigerated underground, that when they were ready to voyage, they could take it. It was called mahi in those days, and the breadfruit would also be preserved and last such a long time.

Video 2 - Satawalese women collect and replant taro and prepare breadfruit in an earth oven.

Video 3 - Satawalese girls cook fish over a fire.

Video 4 - Young Satawalese boys collect fish for the women to cook.

1.3 When to Go

The navigator needs to choose the right season, weather, and time of day to depart. The success of a voyage often depends on these things. All Pacific societies had complex calendars based not only on astronomical observations, but also things like weather patterns and seasonal variations in the local flora.

In Woleai and other Carolinian Islands, the departure time may also be affected by bwe - knot *divination*. To tell the fortune of a canoe voyage, a trained diviner ties knots *randomly* in coconut frond leaves and then counts them. Different knot combinations represent the different spirits who ride the canoe of destiny. Readings tell things like whether the canoe and voyagers will travel safely and whether the community will be happy with their return. If the readings are bad, the voyage may be delayed [See figure 1].

Figure 1

Season

There are good and bad seasons for sailing. For example, in the Carolines and Kiribati, the voyaging skies are from March to September. Navigators know the seasons from the phases of the moon and the way certain stars rise and set at dawn and dusk. Stars rise and set at different times during the year, and sometimes they can't be seen at night. This means that the star path to an island changes with the seasons.

Weather

Navigators know the weather conditions of the sailing seasons in their region. In the South Pacific, trade winds blow from the south-east most of the year. But from December to March, distant storms sometimes make the wind blow from the west. Navigators use this wind to travel east. They know that the trade winds will soon return to blow them home [See figure 2].

A navigator might wait weeks for the right winds. He studies the natural signs carefully. The shape and colour of clouds can give clues about wind strength or direction, and animal behaviour can indicate bad weather. For example, when frigate birds suddenly return to the shores of Rarotonga, bad weather is on the way. If lots of ants come out in Kiribati, good weather is coming. Sometimes, the navigator or a weather expert performs *rituals* to bring good weather.

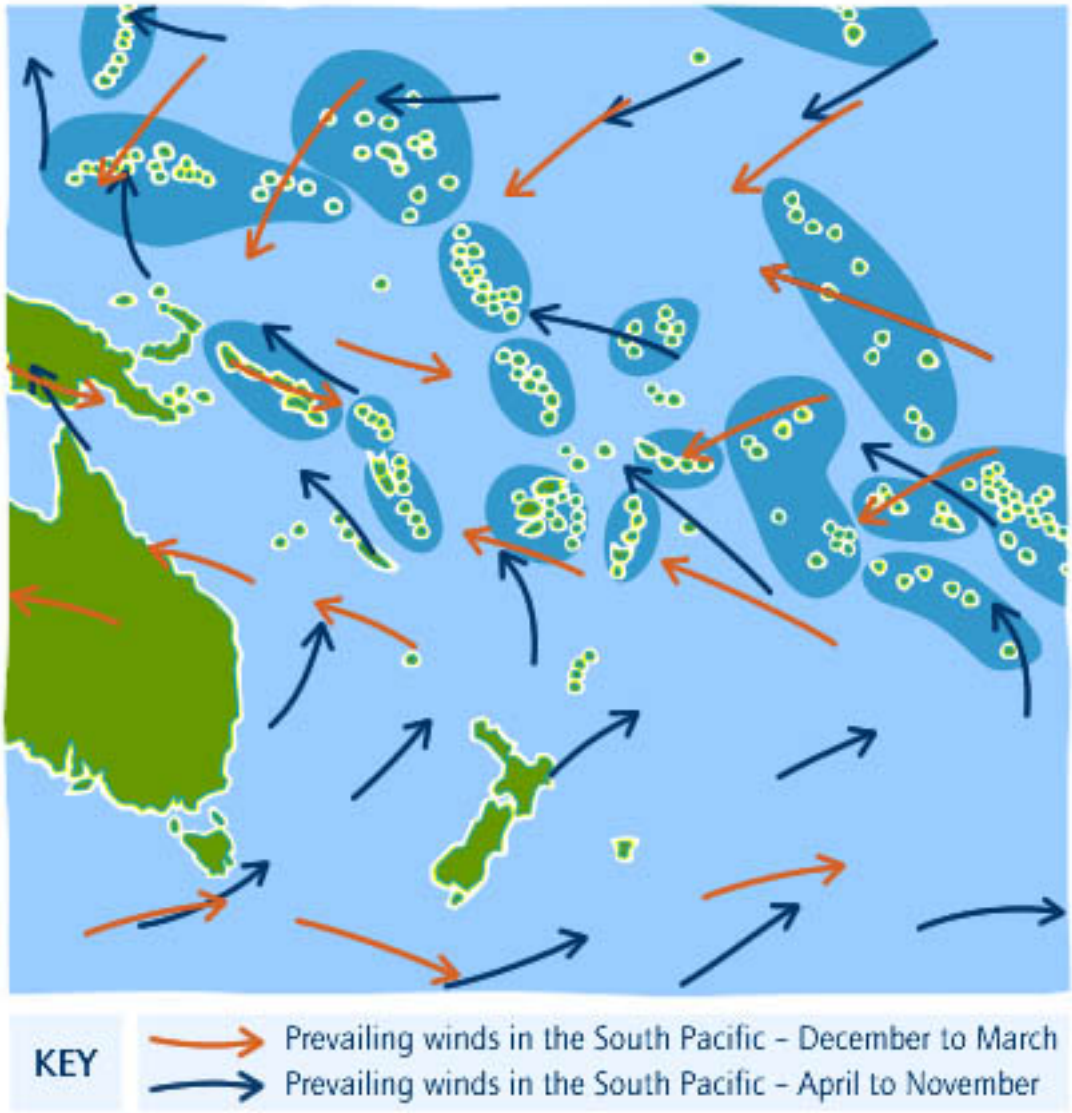


Figure 2

Time of Day

The time of day to leave depends on the journey:

• Voyages might be timed to arrive at an island at dawn or dusk. This is when birds fly to or from their homes. The birds are good signs of land.

• To allow for farewells and food preparation, long voyages don't depart too early.

• Leaving in the late afternoon allows navigators to take their position from stars as the land fades from view. At noon, the sun is high, which isn't good for navigating.

Video 1 - Piailug interprets the shape and colour of the clouds

We spend two days here [in West Fayu]. Piailug interprets the shape and colour of the clouds at sunrise and sunset to forecast the weather. The wind is blowing north-east – a bad direction for us. It will make for wet, rough sailing [to Saipan].

From The Last Navigator © INCA 1989. Directed by Andre Singer.

Video 2 - Satawalese navigator Lewis Repwanglug performs a weather chant

Calling spirits Uturenga, Rapwi, come down to drink all the rain water on Satawal so it will dry up. The rain stops. The land is totally dry.

1.4 Setting Out

For most important paths to other islands, there is a particular place to leave from. The navigator knows how his island should look as he starts out from this place. He lines up points on his canoe with points on the land, like mountains, rocks, or trees. If he starts out at night, fires are lit on land to guide him. Keeping the points in line sets the canoe on the right course. In English, this practice is called taking back sightings. It is especially useful if the stars or sun can't be seen. If the canoe moves sideways in relation to the points on land, the navigator knows that a *current* is affecting his canoe's position. He can then adjust his course.

When launching a canoe, navigators perform special *rituals* and *chants*, like the one below from the Tuamotu Islands. These are often about protecting the canoe on the voyage.

Ringiringi te horo o tena vaka!
Ko nei au hiri ka.
Ko tena ko te piu …

Bursting in spray sped that canoe!
I sat there amazed.
The sea swelled around me …

From Emory, K. P. (1969).

Video 1 - Satawalese navigator Mau Piailug and his crew celebrate before voyaging.

From The Last Navigator © INCA 1989. Directed by Andre Singer.

Video 2 - A Satawalese man chants before a voyage

I sit and I sit on the beach near my village. And I will set sail. We will sail down west. We will hold that course, and we will finish our voyage as men.

From The Last Navigator © INCA 1989. Directed by Andre Singer.

Video 3 - Canoe launch

A canoe is launched for a voyage from Satawal to Saipan, and Mau Piailug performs a chant.

From The Last Navigator © INCA 1989. Directed by Andre Singer.

2 Steering by the Stars

Nga tangata i wheturangitia … our ancestors, the people who have become stars.

Maori saying

The stars are usually a navigator's main guide. With learning and experience, he comes to know the night sky so well that he can steer accurately when only one or two stars can be seen. A navigator knows the exact positions and times that particular stars rise and set around the *horizon*. Westerners talk about the star compass to describe how navigators in different islands visualise star positions in this way. In Satawal, the rising and setting stars are called ururun mor.

A navigator also knows the star paths – the ururun mor to follow from one island to another. In Satawal, this knowledge is called ofanuw and is repeated in long *chants*. He also knows the zenith stars, which pass directly above particular islands.

Video 1 - Satawalese navigator Jerome Rakilur

The first thing I learned from my uncle was the names of the stars, paafu. The same person also taught me areuum and amaas. Amaas is knowing the star in front of the canoe and the star behind it. Areuum is knowing the stars in front and behind the tam (outrigger). Ofanuw is the knowledge about stars associated with an island destination. Then I started learning ururun mor – when each star rises and sets. If I just know how to sail but I don't know when each star will rise, I will die in the ocean.

2.1 Star Compass

Hawaiian navigator Keahi Omai (taught by Nainoa Thompson): “We use Papa Tom’s [Sir Tom Davis’] houses. Houses are divided into 32 portions in the sky where the stars live. I think of them as stars living in a house, just like people living in a house.”

From Bader, H. and McCurdy, P., eds (1999).

Stars move across the sky from east to west. Each night, they rise and set a few minutes earlier than the night before. Near the equator, each star rises from the same point on the *horizon* in the east and sets at the same point in the west.

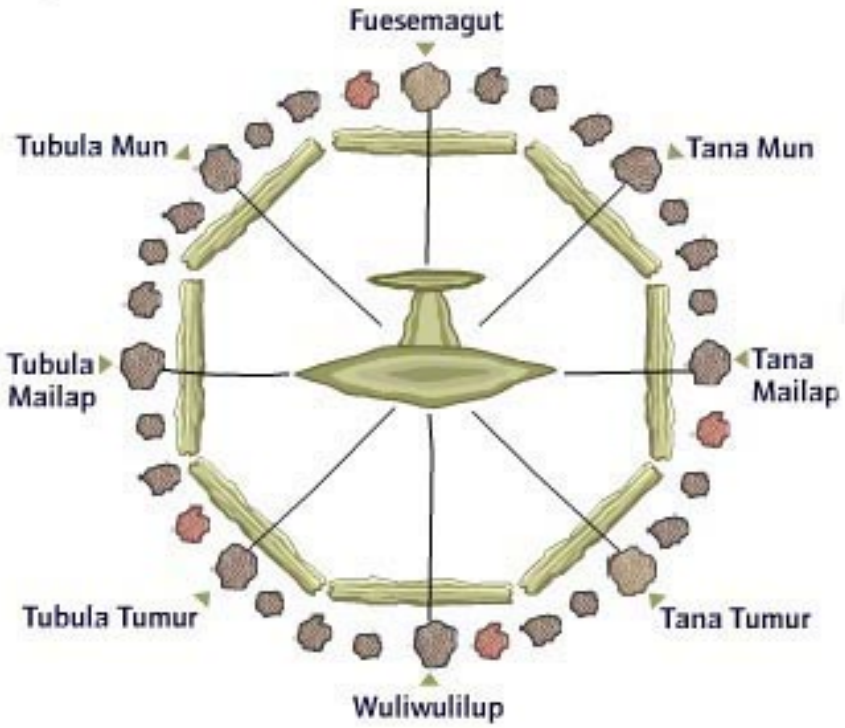
The Carolinians divide the horizon into 32 points where specific stars rise and set. The Polynesian Te Ngapore o te Ao (Directions Around the World) also has 32 points. People from other places, like Indonesia, use similar models. Each star point, or paafu in Satawalese, has a name. It also has a pair. For example, the star x rising is paired with the star x setting. A navigator learns each pair as well as the pair of stars that rise and set at right angles to it. This way, he can steer by lining up rising and setting stars with the front, side, or back of his canoe.

When no stars are visible (in the day or on a cloudy night), a navigator can still use the star compass to steer because he knows the direction of the *swell* and the wind in relation to it.

Figure 1. Diagram based on the diagram which appears in "Cartography in the Traditional African, American, Arctic, Australian and Pacific Societies." Edited by David Woodward and G. Malcolm Lewis, 1998, pg 462.

Carolinian Star Compass

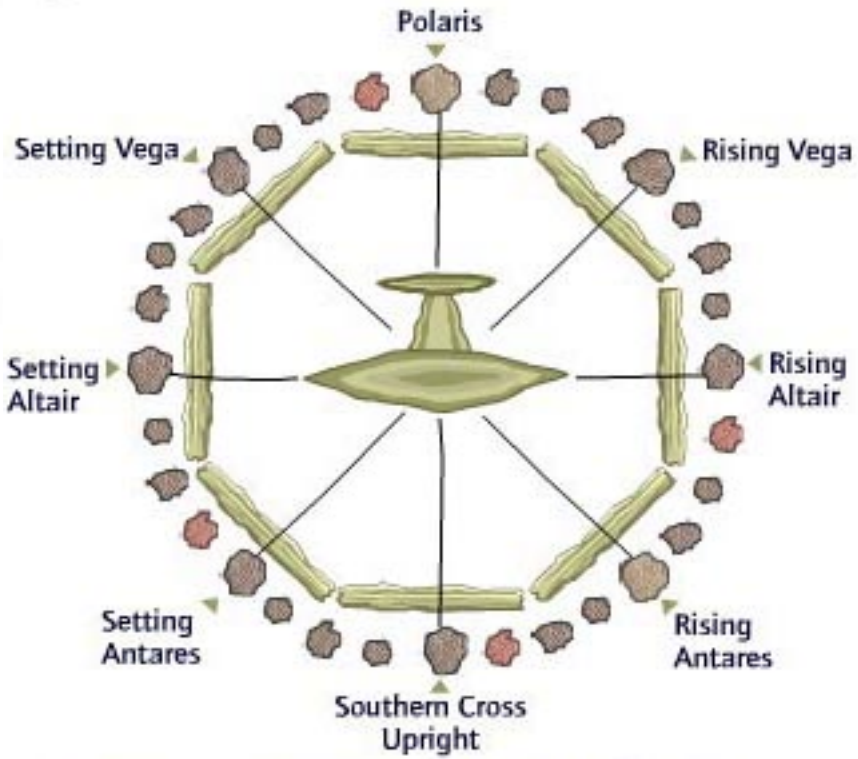
Figure 1 Carolinian



The Carolinian navigators used pieces of coral to represent the 32 compass points, and bundles of coconut leaves to represent the 8 swell directions.

Carolinian Star Compass

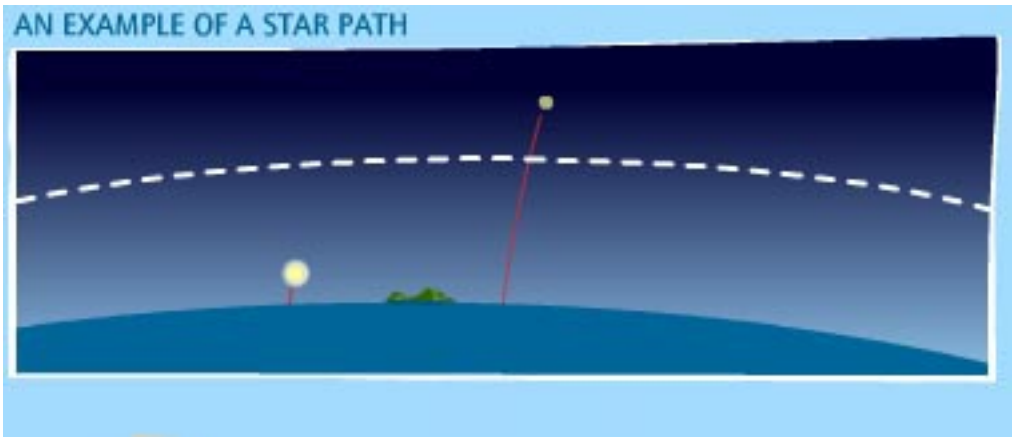
Figure 1 English



The Carolinian navigators used pieces of coral to represent the 32 compass points, and bundles of coconut leaves to represent the 8 swell directions.

2.2 Star Path

A star that is just rising or setting is a very good guide. A navigator steers towards the star that rises or sets in the direction of the destination island. A rising star, however, doesn't go straight up from the *horizon* (unless you are at the equator). It moves to the side of the island and soon is no longer a good guide. A navigator then uses the next star that rises in the same direction, and so on. There might be up to 10 stars in a star path for one night's sailing, but only one might have a name.



Often, songs or stories are used to remember the star paths. A journey between two islands can have more than one star path. Any star path can only be used in a particular season. Six months later, the same stars are only above the horizon in the day and so can't be seen. Different star paths are also used when there are strong currents or winds.

"When we sailed from Puluwat to Saipan [one of the Northern Mariana Islands] … with Hipour's sailing directions … there were three courses: … the direction in which the [island] lay, … the direction to allow for the west-going current, and the third … to allow for strong winds …"

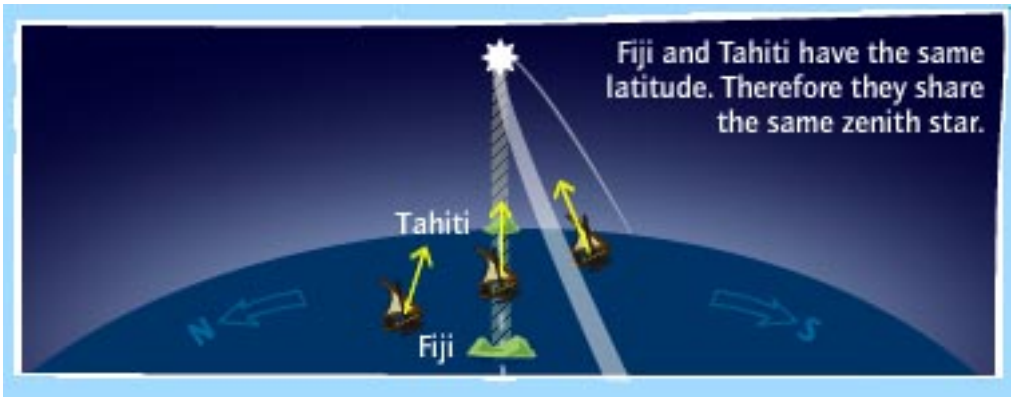
From David Lewis in Bader, H. and McCurdy, P., eds (1999).

Story 1 - Gaiuli and Gaisina (Samoa, Polynesia)

A story tells of the journey of Gaiuli and Gaisina from Tutuila in what is now American Samoa to Manua Islands. First, they headed towards the star Matatula. Then Tapuitea (the evening star) rose, and then Faipa and Tulalupe in the east. Then Toloa (the Southern Cross), Sumu, and Luatagata rose – all close together. Then Taelo rose, and they headed towards it. Then Tiotala, and they headed towards that. When morning approached, Amoga (Orion's Belt) and Lii (Pleiades) rose. They went towards Amoga. When it grew light, they faced Manua exactly.

2.3 Zenith Star

Stars cross the sky from east to west. They are at their zenith when they appear to reach their highest point. Certain stars are known to pass directly above specific islands when they are at their zenith. These stars are called zenith stars. Hokulea (Arcturus) is a zenith star for Hawaii Island. Aa (Sirius) is a zenith star for Tahiti and Fiji. When a navigator sights up his mast and sees Sirius directly overhead, he knows that he is at the same latitude as Fiji and Tahiti. The zenith star cannot tell him, however, how far he may be to the east or west of these islands.



Some people believe that in the past navigators memorised the zenith stars of different islands as well as the time distances between them. For example, on a voyage from Tahiti to Hawaii, a navigator knew that he was level with Nuku Hiva (Te Henua Enana (Marquesas Islands)) in the east when he was under the star Mataatau (Rigel).

Zenith stars can be useful for finding land. On north-south journeys, a navigator can sail upwind of the destination island until its zenith star is right above him. (That is, if the wind is coming from the east, he sails to the east side of the island.) He then turns *downwind*, keeping the zenith star above him. He sails along this east-west path until he finds land. Sometimes he *zigzags* to increase his finding range.

Anthropologist Ben Finney: “On the first voyage of Hokulea to Tahiti in 1976, David Lewis and I used Spica (the zenith star for Te Henua Enana (Marquesas Islands)) to tell when we were opposite that archipelago (group of islands). We sighted up the after mast until Spica was framed by the masthead. We couldn’t use Aa (Sirius), the zenith star for Tahiti, because it wasn’t visible at the time.”

3 Steering by the Sea, Sun, and Wind

When sailing, a navigator notices every clue in the environment and doesn't take chances. When the stars can't be seen (in the day or on cloudy nights), he uses other signs to guide him – the sea *swells*, sea marks, the sun, and the wind. He visualises these signs in relation to the star positions.

He uses all of his knowledge in an *integrated* way. This is the great art of navigation.

Story 1 - Tuita's Finger (Tonga, Polynesia)

Once, the old Tongan navigator Tuita (from the Haa Fokololo oe Hau navigator tribe) was voyaging in his kalia (double hull) with the King's fleet (group of canoes). When the fleet got lost, the King wanted to know where they were. Tuita was old and blind, so he asked his son to tell him what he couldn't see. Then he put his finger in the sea and tasted the water. He told the King that the water tasted of Fiji … and soon after, the fleet arrived there! The matapule (talking chiefs) of the Tuita tribe are named after this story – fafa ki taha: to touch the sea.

3.1 Swells

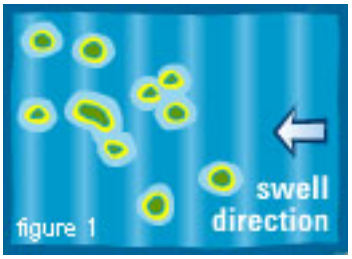
"I have heard from several sources that the most sensitive balance [to feel the swells] was a man's *testicles*…"

From Captain Ward in Lewis, D. (1972).

Unlike stars, which sometimes can't be seen, *swells* are always there and keep their direction for many days. This makes them very useful for navigation. A navigator relates their direction to the star positions. To learn about swells his teacher lies him on his back in the sea so he can feel them. He can't depend on sight at night or when visibility is bad.

The navigator knows how his canoe should move on the swell if it's heading in the right direction. For example, if its course is straight into a swell, the hull goes up when the swell meets it and down when the swell passes under it. If the canoe goes off course, it starts to roll. The point where the swell meets the hull changes too, and the navigator can see and feel this. He notices the shape of the swell to tell the direction and strength of the *current* underneath. Currents can affect his canoe's course and speed.

In the Marshall Islands, swells, currents, and winds are used more than stars for navigation. There, the two parallel chains of the Marshall Islands stretch across the face of the main swell, making it very reliable [See figure 1].



"With Tevake, in Santa Cruz … we had three wave patterns running … it started to rain, and the wind started to shift. Tevake stood … feeling this very faint lift of the swell coming … from the north-east, and he steered by that for 8 hours, standing sopping wet in his lavalava … So this is navigating by the swells, by feel …"

From David Lewis in Bader, H. and McCurdy, P., eds (1999).

What Causes Swells?

Swells are caused by big winds many kilometres away. They feel different from local waves, which are caused by local winds. Usually, local waves are shorter and *steeper*, and they break at the top. Swells are wider apart and have a rolling motion. Even when two or three swells are mixed with local waves, a navigator can separate them and use them to steer. He also knows which swells are most reliable.

Marshall Islands Navigation

Marshallese navigators have studied how waves *diffract* around and *reflect* off islands and then interfere with one another. They show how this happens in mattang stick charts, and they represent the wave patterns around specific islands in rebbellith and meddo stick charts. These charts are used for teaching. The Marshallese have many words to describe the currents too – for example, jukae (first area of currents – nearest an island), dibukae (second area of currents), and jejelatae (third area of currents – furthest from the island).

Interrupted swells are especially useful for finding land. Marshallese navigators have a highly developed system of knowledge about this.

Video 1 - Satawalese navigator Mau Piailug talks to his crew about the swells

Piailug first learned them as part of his grandfather's crew. The old man showed Mau how to read the swells. There are eight distinct swells. Each one is connected to a specific position of a star on the star compass. But swells tell more than what course you're on. If you can read their shapes, you can know the strength and direction of the current running beneath them. If you don't know what the current's doing, you can steer a perfect course and still become lost.

From The Last Navigator © INCA 1989. Directed by Andre Singer.

Video 2 - Satawalese Lourdes Lepanemai

The first time I sailed on a canoe, I was very sick – mumus. I didn't want to eat anything. I almost died of vomiting! I was sick every day!

3.2 Sea Marks

A navigator also relies on sea marks located in specific places to find his way. He might not take the shortest path to an island if this means that he can check his course from such sea marks. He learns the marks through experience as well as through stories and songs about them.

Reefs may act as sea marks, even those up to 50 m below the surface. The water above a reef has a different colour (light green) from the sea around it (blue). Short, steep waves sometimes form above a reef too. They are caused by a current meeting the reef. If the sea is flat, a navigator can see these waves from some kilometres away. At night, he can feel the canoe move differently over them [See figure 1].

Sea life (like sharks, whales, and dolphins) also act as sea marks for a navigator. Extraordinary animals are often found at the same place along a path, even over centuries. Some are well known to navigators and have been given their own names. They can be as helpful as reefs in guiding the navigator. Some sea life can also be helpful to find land.

Knowledge about sea marks is closely protected. Student navigators *chant* lists of marks that they can look for between an island and each star point. A navigator's wife may sing or tell a story about these sea marks while he is at sea.

Video 1 - Cook Islands navigation student Kaiki Tarangi (Karl)

You say, "Whoever you are, and I know you – that's the other thing, I know you, I trust you – can you hold me in the palm of your hand until I get back from this voyage and help us to get there safely?" And you'd be amazed, mate. So many navigators talk about when they're lost and they're getting nervous, and they just look down to the water and there's a shark, a white shark just swimming right in front, and they go, "That's the direction!"

Video 2 - Cook Islander Dorice Reid, crew member of Te Au o Tonga

Cook Islander Dorice Reid, crew member of Te Au o Tonga on the voyage to Taputapuatea Marae in 1995: We saw the birds, and we saw a whale. And we saw her go down and put her tail up, and she waved her tail just enough to allow us to know that she was there. And I say she because I'm sure the whale was a she. She waved her tail and disappeared. When we got to the mouth of the sacred harbour, the dolphins were there at the entrance. That meant we had permission to sail through that harbour. The priest of the marae said, "If you see the dolphins, that is your permission to go through the harbour." Well, they were there.

Video 3 - Satawalese Lourdes Lepanemai sings the song of Tutu ne Naipa (Shower of Naipa)

Satawalese Lourdes Lepanemai sings the song of Tutu ne Naipa (Shower of Naipa), which names a lot of sea life: The lady called Naipa goes to shower in Powrow on the reef. A wind comes down to her from the south. The men are shouting that a canoe is coming. It is Gamomumonu, who is getting away from his father. He is sailing to the south, under the stars. He sees the shark in its place. The leaf of the nat tree floats out from the beach. Now you are going to drink your nuu (coconut). The asaf (frigate bird) called Tinimwar – one of his hands in the west by Eurpiik and his neck and head by Metau Sarik (the ocean path between Satawal and Pik) … You are going to Pik to get the suum (giant clam) on the reef … for Naosow because she is thirsty and hungry.

3.3 Sun

Steering by day is less accurate than steering by night, when exact points of light can guide the navigator. Also, unlike stars, the sun rises and sets in different places during the year. The sun is really only useful for navigation when it is low in the sky – in the early morning and late afternoon.

Each dawn, a navigator lines up the sun's position with the star positions. During the day, he might also note the sun's angle over parts of the canoe to work out his course. Before the sun sets, he notes where it is. He knows his chosen star path in relation to this position.

3.4 Wind

A navigator can know the wind direction by how it feels on his face. On the canoe, he sits where the wind hits his face directly and where he can see the ocean and *horizon* ahead. Sometimes, he also watches the movement of feathers or pieces of *bark* attached to the sail or ropes. He can sense a change in wind direction by how the boat feels on the waves.

The navigator relates the wind direction to the star positions. However, because the wind often changes, it is not as accurate as the stars. Europeans talk about this technique as the wind compass. In 1876, missionary William Wyatt Gill described the Cook Islands wind compass, which divided the horizon into 32 points. The winds were taught by using a gourd with holes in it.

"At the edge of the horizon are a series of holes, some large and some small, through which Raka, the god of winds, and his children love to blow …"

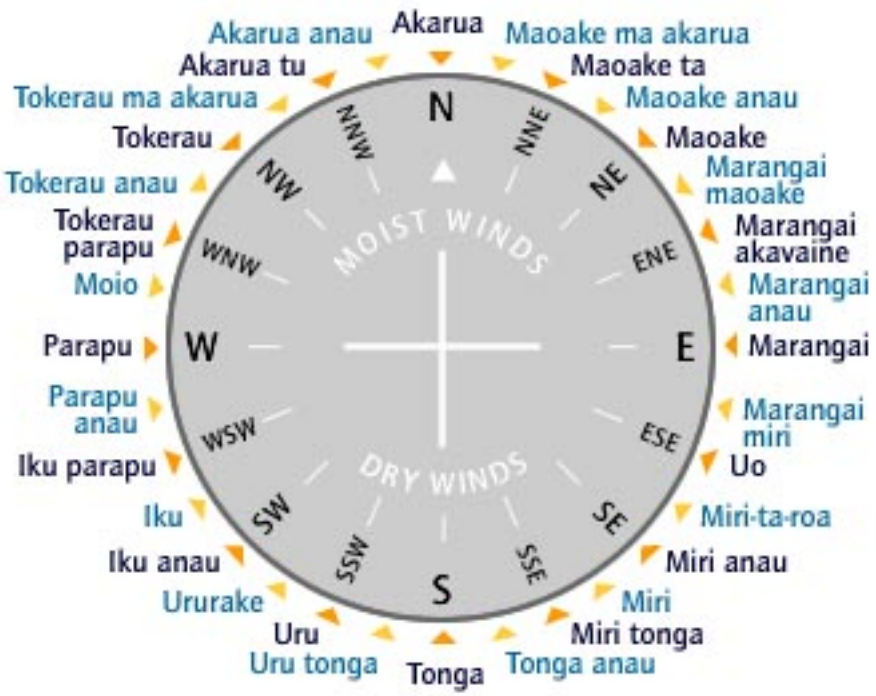
From Lewis, D. (1994).

There are also descriptions of wind compasses (divided into different numbers of points) from other islands, like the Carolines, Fiji, Tonga, Tokelau, and Tahiti. The great navigator and chief Kruso Kaveia once described one from the Santa Cruz (eastern Solomon Islands) outer islands.

"… for two hours, he stood there … and he named each wind. He pointed the direction … whether it was a cold wind, warm wind … and when he would expect them at different times of the year."

From David Lewis in Bader, H. and McCurdy, P., eds (1999).

Wind Compass



Based on the diagram which appears in We, the Navigators: The Ancient Art of Landfinding in the Pacific by D. Lewis, 1994, pg 113.

4 Knowing and Adjusting Position

Over many kilometres of ocean, a navigator needs to keep track of his canoe's position in relation to his home and destination so that he can change his course if necessary. To do this, he needs to carefully observe his *heading* and speed. He also needs to know how the *leeway* and *currents* can push him off course and affect his speed.

He puts all this information together to *estimate* his position at any time. There are different ways of doing this.

- Before modern equipment like the *GPS*, western navigators used a way called dead reckoning.
- Pacific navigators use dead reckoning, but they have also developed a very different way to track their position. The best known way is the etak system used in Satawal and other Carolinian islands.

The real test is when a storm blows a navigator's canoe off course for days. When this happens, he must use *intuition* as much as skill and experience to keep track of his position. For emergencies like bad weather, a navigator must always know where other islands are and the paths to them.

Story 1 - The Voyage of Moala Lahi (Tonga, Polynesia)

This story tells how a navigator had to change his path because of bad winds. Akauola was the head navigator from the Haa Fokololo oe Hau tribe in Tonga. Once, one of his kau moala (team of navigators and sailors) called Moala Lahi was sailing home to Vavau from Fiji with a group of kalia (double hulls). The journey was in a north-east direction. The winds became bad, and the canoes were separated, so Moala Lahi turned for Samoa in a north north-east direction. But the winds changed again, so he turned to Uvea (Wallis and Futuna) in a north-west direction, and he arrived there. The Uvean people helped him with his canoe. In return, he gave them what he was carrying. When the winds improved, he sailed back to Fiji for more supplies. Finally, he went on and arrived safely in Vavau.

4.1 Estimating Position

Judging Speed

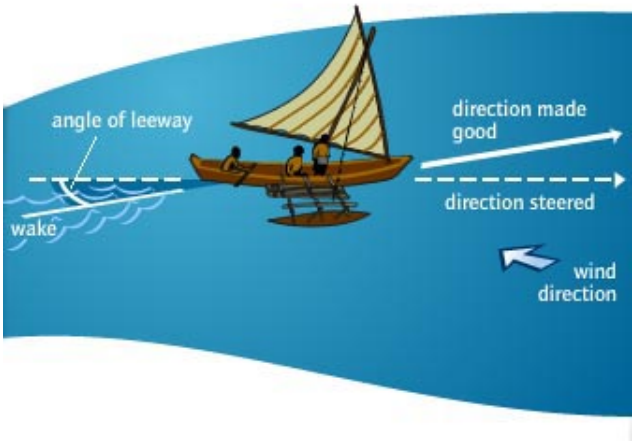
The wind's speed changes all the time, so the canoe's speed changes too. To judge speed, a Pacific navigator watches the spray from the water on the canoe's sides. He also feels the wind on his face and watches how it affects the sails or things hanging from them.

Hawaiian navigator Keahi Omai: "… We measure the bubbles from our front iako [bow] to our rear iako [stern] … if the bubbles travel between the two points within 5 seconds, we are going about 5 knots."

From Bader, H. and McCurdy, P., eds (1999). Note: The way that Keahi talks of knots and seconds shows that this method of measuring speed is influenced by the European system. Today, a lot of practices combine western with traditional ways.

Judging Leeway

When a canoe sails into the wind, the wind pushes it sideways, not just forwards. This is leeway. Because of leeway, there is a difference between the course that the navigator steers and the *course made good*. To judge leeway, Pacific navigators study the angle between the centre of the canoe and the *wake*.



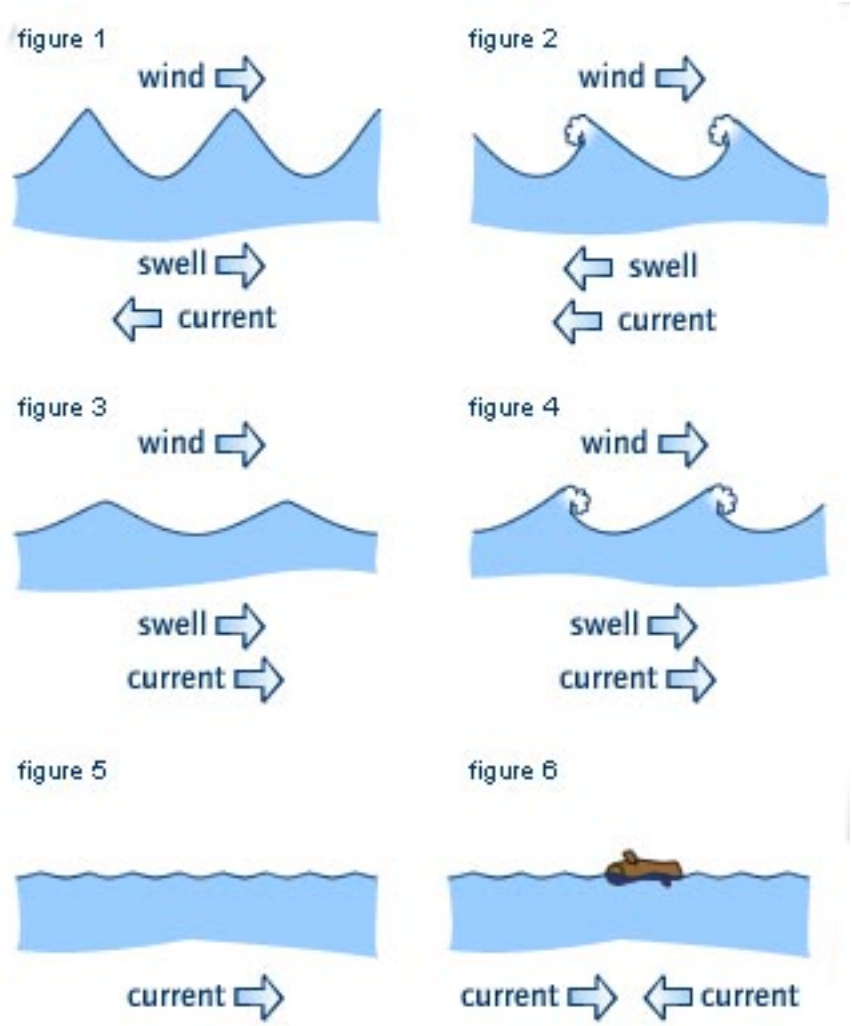
Reading Currents

Currents out at sea can push a canoe off course and affect its speed. If a canoe is sailing against the current, its speed is lower. If it's sailing with the current, its speed is higher. A navigator needs to know how to read the currents and adjust his course if necessary. A destination island can have different star paths for currents of different directions and strengths.

When he starts out, a navigator watches to see if his canoe moves sideways in relation to points on the land. Away from land, he looks for other clues about currents. For

example, he can read the direction and strength of a current by noting how the water moves in relation to the wind direction.

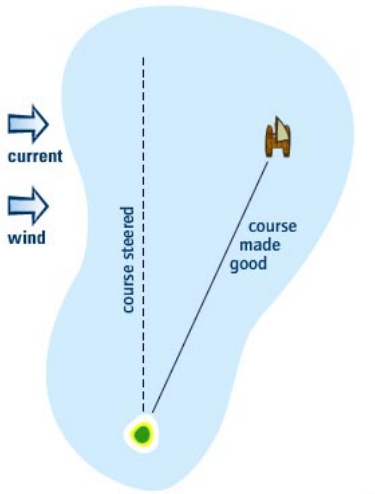
• If the waves stand up more than usual when they are moving with the wind, the current is moving against them [See figure 1].
• If white caps fall backwards into the wind, the current is moving against the wind [See figure 2].
• If the waves are smaller and flatter than usual, they are moving with the wind and the current [See figure 3].
• If white caps fall smoothly and their foam moves in a long line with the wind, the current is moving with the wind [See figure 4].
• When the sea is calm, *ripples* on the water's surface can show the direction and strength of a current [See figure 5].
• Lines of drifting wood and other objects can sometimes form where two currents meet [See figure 6].



4.2 Dead Reckoning

This way of tracking a boat's position is quite different from the etak system that Carolinian navigators use.

1. In the past, western navigators used to keep track of their *heading* with a magnetic compass. They worked out the distance they had sailed by throwing an object overboard and measuring how far and how fast it was left behind.
2. They estimated how the *leeway* and *currents* were affecting their heading and speed.
3. With this information, they *reckoned* how far and in what direction their boat had sailed over a certain time period – for example, 200 km at 90 degrees (straight east) over the last 24 hours.
4. They then marked the boat's position on a navigation chart and made any necessary course changes.



Today, the Global Positioning System (GPS) makes life even easier! A GPS is a hand-held computer that automatically tells sailors their position by communicating with *satellites*.

4.3 Etak System

As in dead reckoning, a Carolinian navigator keeps track of his canoe's *heading* and speed and the effects on his position of *leeway* and *currents*. But he doesn't use any instruments and he doesn't write anything down! Also, he doesn't talk of his position in terms of compass points (north, south, west, east), kilometres, or hours and minutes.

Instead, he imagines his canoe and the stars as unmoving. The sea and the land move backwards – like a mat pulled out from under the canoe. As the home island moves away, the destination island moves closer on this mat of sea. To both sides of the canoe, unseen islands beyond the horizon also move back.

1. He chooses the star compass point that is closest to the destination island. In his mind, he draws a course line to it.

2. He also chooses an unseen island to one side of the course line as a reference (positioning) island. He draws imaginary direction lines between it and each star compass point back to the course line.

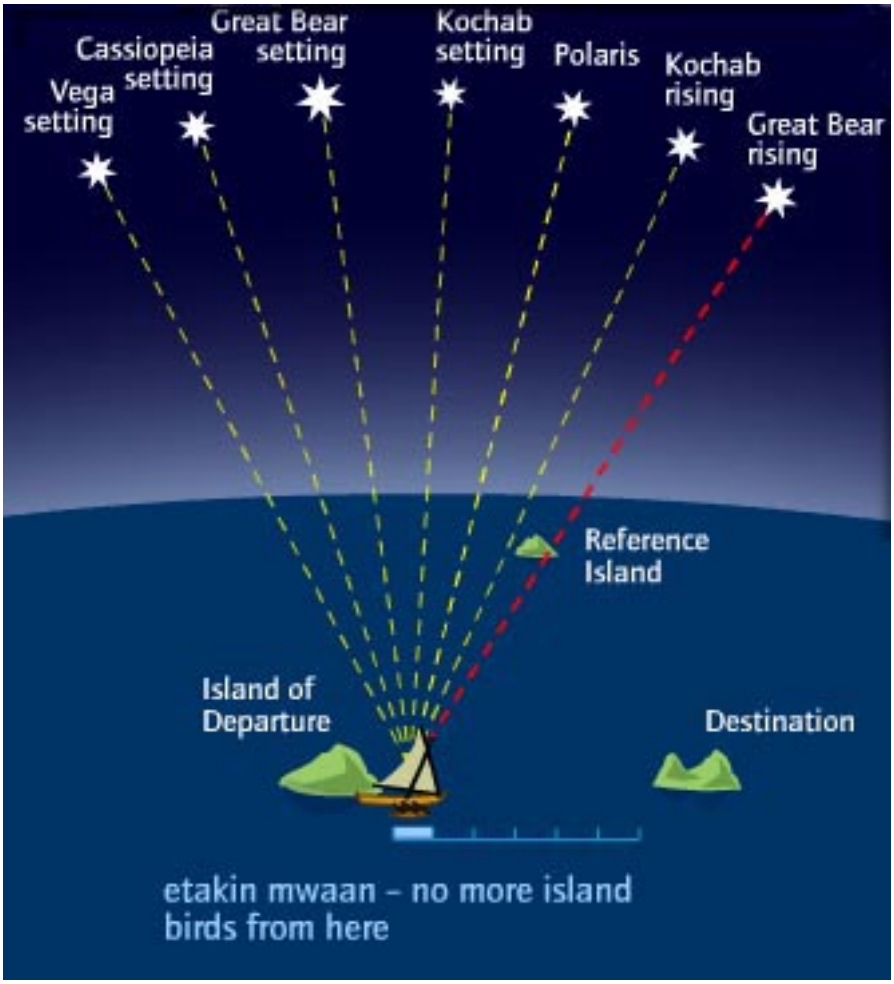
3. When he is sailing, the reference island moves from under one star point to under another. (Remember, the stars are unmoving in this system, like the canoe.) In this way, he cuts the course line into etaks (stages). He understands his canoe's position in terms of sailing from one etak to another. One etak is the movement of the reference island back by one star point as the canoe sails towards its destination.

Satawal Etaks

Journeys of all distances from Satawal to other islands are broken into six etaks:

- etakin mwaan – no more island birds from here
- palsapou – we're far away from it
- alugaan metaw – middle of the sea
- sapalongon alugaan ponsapilong – we're getting closer to the island
- etakin mwaan – the birds of the destination island can be seen
- etakin kena – looking for the island, it's about to be seen.

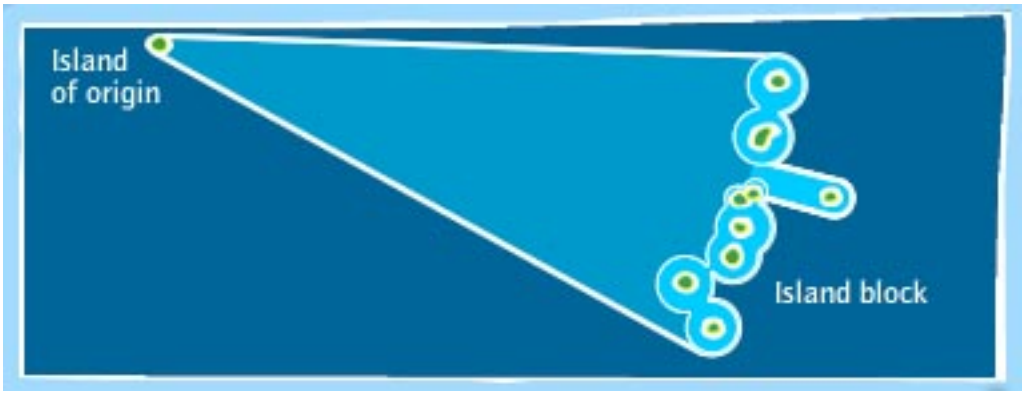
The two last etaks are the etaks of birds – the range of the flight of homing birds from land (about 30 km).



5 Finding Land

On a clear day, low islands can be seen from about 15 km away and high islands from even further away. Signs of land can normally be seen or felt from 30 km away or more. The signs include sea life, interrupted *swells*, clouds, and deep phosphorescence.

A navigator uses these signs to increase the size of his destination island. He can head for an area about 60 km in *diameter* instead of just the small island. He can then read the signs to find land. The enlarged islands join together to form island blocks, which can be hundreds of kilometres wide.



For each island, the signs differ, and the navigator reads them differently. At night, if the navigator doesn't know the area well, he may drop the sail and wait till morning before heading for land. When landing he may often have to sail into the wind and the current.

After a long voyage or fishing trip, there is usually a big welcome to celebrate a canoe's safe return as well as the supplies and food that it may bring.

Video 1 - Cook Islands canoe builder and navigator Sir Tom Davis (Papa Tom)

The great aspect of this ancient navigation is that the Polynesians were able to find very small atolls, isolated in the middle of the sea, with nothing around except perhaps the birds to help you, and of course always, during the hot day, in the day time and in the morning especially, there is the cloud that always sits, the thermal cloud that sits over every island in the Pacific and the world.

Video 2 - Cook Islander Dorice Reid, crew member of Te Au o Tonga

Cook Islander Dorice Reid, crew member of Te Au o Tonga on the voyage to Nuku Hiva, Te Henua Enana (Marquesas Islands) in 1995: The sky was full of birds. They were flying up and down as if they were celebrating. And at the same time as we sailed into this harbour, the water of the harbour was absolutely awash with fish. Hundreds of dolphins were swimming and leaping in the harbour entrance. So, here we had three phases of living things celebrating. We had man on the beach with drums and dancing, and we had birds in the sky flying up and down in huge celebration, and we had the fish. We had the fish in the harbour.

Video 3 - Local people in Saipan welcome Mau Piailug and his crew from Satawal.

From The Last Navigator © INCA 1989. Directed by Andre Singer.

5.1 Sea Life

Sea life – like fish, birds, and seaweed – is more common near land and can help to guide navigators in. For example, lines of seaweed can reach up to 200 km east of Aotearoa (New Zealand).

Homing birds are especially useful for finding land. These are birds that feed at sea during the day and return to land in the evening – for example, boobies, terns, and noddies. They fly in a direct line of up to 30 km to and from land. A large group of birds shows that land is 15 to 30 km away. To find out the direction of land, the navigator waits till evening when the birds fly home. Boobies may even circle a canoe before going home.

It is possible that *migrating* animals gave early navigators clues about where other islands were – for example, the kuaka (godwit) and the koekoea (long-tailed cuckoo), which fly across the Pacific and arrive in Aotearoa in spring each year. Whales also migrate to and from the Pacific, often using the same route from year to year.

Story 1 - How Pisiiras Was Found (Chuuk, Micronesia)

This story about land finding involves a shark and a bird. Five brothers lived on Moen Island. Their father told them about a lost island near Moen. When he died, the brothers sailed to find it. In four days, they found nothing. Only the youngest brother still believed in his father's story and kept looking. Soon, he saw a huge shark. It was guiding his canoe. The boy thought it must be the ghost of his father. The shark swam with the canoe until they reached the area of the lost island.

The boy dived down and found the island! The next day, he took his brothers there. The oldest tied a rope to it and pulled. The other brothers tried too, but they all failed. When the youngest tried, it came up! At that moment, a black bird flew by and told them to call the island Pisiiras.

Moen is now spelled Weno.

Story 2 - Paikea and the Whale (Aotearoa, Polynesia)

The Ngaati Porou iwi (tribe) of Aotearoa talks of how Kahutia Te Rangi (or Paikea) came to this land on a whale. Paikea lived in the homeland of Hawaiki. His father was Uenuku, and his older brother was Ruatapu. One day, Ruatapu climbed on the roof of Uenuku's house. This was a great insult to his father. Uenuku was very angry. He reminded Ruatapu that he was illegitimate (born of parents not married to each other) and that the younger Paikea was really the leading son.

So Ruatapu decided to kill all the leading sons of the chiefs of Hawaiki. He took them out on a waka (canoe) and drowned them by letting water into it. But Paikea escaped. A whale rescued him and brought him to Aotearoa. He arrived at Whangara on the East Coast of the North Island.

Ko wai te tekoteko kei runga?
Ko Paikea! Ko Paikea!
Whakakau Paikea hei!
Whakakau he tipua hei!
Whakakau he taniwha hei!
Ka u Paikea ki Ahuahu ...

Who is the carved figure on the roof?
It's Paikea! It's Paikea!
Paikea is swimming!
Paikea with his magical powers is swimming!
Paikea the great is swimming!
Paikea lands at Ahuahu ...

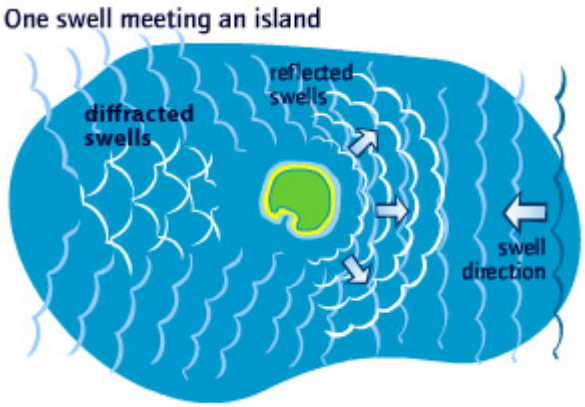
Adapted from the website of John Archer (www.folksong.org.nz/pataka.html).

5.2 Interrupted Swells

As well as using *swells* to set his course, a navigator uses *interrupted* swells to find land. He knows that they mean land within 50 km. Marshallese navigators have very *sophisticated* knowledge about the behaviour of swells and currents, which can be their main guide. They use stick charts to represent and memorise the interrupted swells and currents for many important islands. Here are two examples of the knowledge that a stick chart might show.

1. One swell meeting an island

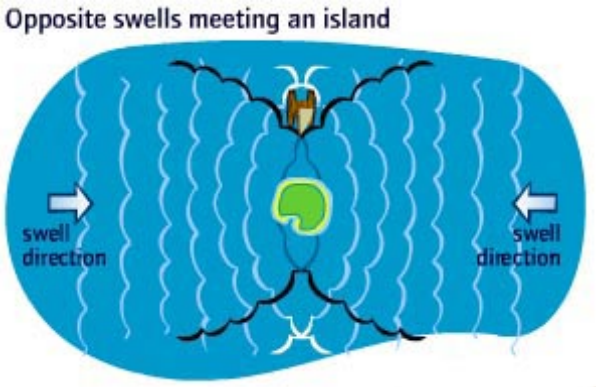
When a swell meets an island, some swell *reflects* off it, and the rest *diffracts* around it and joins on the other side. Where the two parts join, the sea is limaajnono (choppy, broken up, rough). Closer to the island, there is a calm area where the swell doesn't reach.

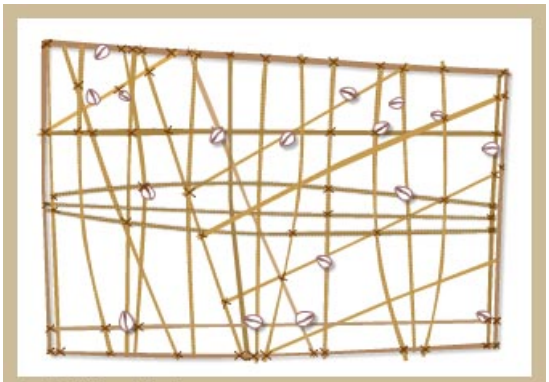


• If a navigator is sailing against the swell, he feels the pattern change when he meets the choppy water. When he reaches the calm water, he stays in it to find land.
• If he is sailing with the swell, he can feel his canoe pause slightly when it meets the reflected swell. The reflected swell is shorter than the main swell and at a different angle. The navigator can steer directly into it to find land.

2. Opposite swells meeting an island

Two swells coming from east and west (that is, from opposite directions) will curve around an island and meet north and south of it. The meeting swells create an okar (line of swell peaks) that points to the island. When a navigator meets an okar, he knows that he is to one side of an island, even when he can't see it. He can then sail down the okar to find land.

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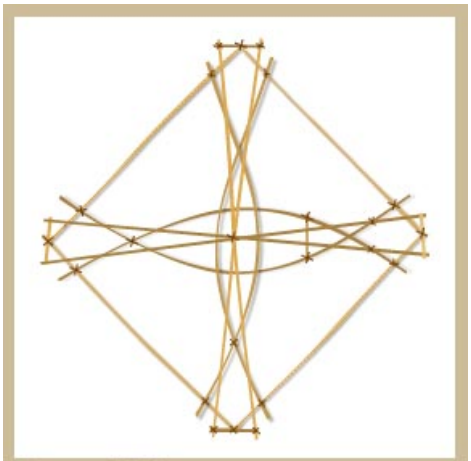

Mattang stick chart

5.3 Clouds

Aotearoa, the Maori name for New Zealand, means long white cloud … for a very good reason. Some Maori traditions tell how, on the voyage of discovery to Aotearoa, the navigator Kupe's wife said, "He ao, he ao, he ao tea, he ao tea roa!" … "A cloud, a cloud, a white cloud, a long white cloud!"

Clouds give many clues about land beyond the *horizon*. Navigators study their formation, shape, and colour for hours.

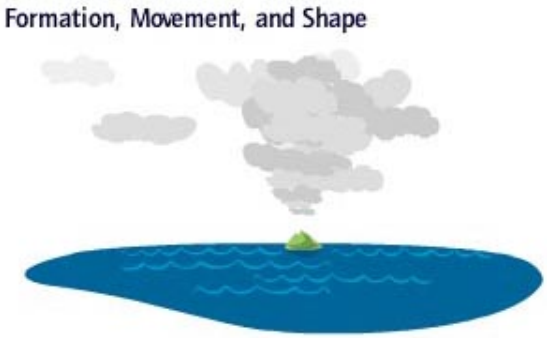
Formation and Movement

Clouds that keep forming in one place indicate land below.

• In cloudy, calm weather, the clouds tend to be thicker over land.

• In cloudy, windy weather, one cloud might sit above an island while others move fast.

• Clouds often move freely as they move towards an island. They slow as they near it, then break up and speed off on the other side.



Shape

V-shaped clouds often form over islands, especially in calm weather when few clouds are in the sky. The centre of the unmoving cloud stays above the land.

Colour

Clouds over land can reflect the land's colour – white for coral reefs and sand, pink for exposed coral reefs, and dark for plants.

Even a cloudless sky shows signs of land. White sand and lagoons reflect the sun as a pale, shining beam over an island. A lagoon reflects the stars more than the ocean does.

5.4 Deep Phosphorescence

"To the east of Whangaroa, there is … Te Au-kanapana, or flashing current … it is here that Kupe is said to have made land on his voyage from Hawaiki."

From Evans, J. (1998).

Navigators use flashes of light occurring in the deep ocean to know the distance and direction of land. This light is known as te lapa in the Santa Cruz Islands (eastern Solomon Islands), te mata in Western Kiribati, and ulo aetahi in Tonga. The flashes occur as far out to sea as 150 km, darting to and fro in the direction of the land. The closer land is, the shorter and quicker the flashes are. Once land is close enough to be seen, the flashes disappear.

This 'underwater lightning' as the navigator Tevake described it to David Lewis, appears a metre or more below the surface. Navigators often use it to steer by on dark and cloudy nights. It is different from phosphorescence, or more correctly, *bioluminescence*, which is commonly seen on the surface, in the wake of boats, and close to reefs and land. The exact nature of deep phosphorescence remains a mystery.


Hawaiian Islands
North Pacific Ocean
MICRONESIA
POLYNESIA
MELANESIA
Northern Mariana Islands
Guam
Federated States of Micronesia
Yap
Palau
Marshall Islands
Bismarck Archipelago
Papua New Guinea
Nauru
Solomon Islands
Louisiade Archipelago
Reef and Santa Cruz Islands
Vanuatu
New Caledonia
Gilbert Islands
Kiribati
Phoenix Islands
Tuvalu
Wallis and Futuna
Tokelau
Samoa
Line Islands
Society Islands
Cook Islands
American Samoa
Niue
Tonga
Fiji
Rarotonga
Tahiti
French Polynesia
Marquesas Islands
Tuamotu Archipelago
Gambier Archipelago
Austral Archipelago
Pitcairn Islands
Easter Island
Kermadec Islands
Norfolk Island
Australia
New Zealand
Chatham Islands
South Pacific Ocean