Context:
Gabriola, oceanography

Citations:
Doe, Nick, Winter tides, *SHALE* 10, pp.33–36, January 2005.

Errors and omissions:

References:

Doe, Nick, Summer tides, *SHALE* 5, pp.45–7, December 2002.

Doe, Nick, Two tides a day? *SHALE* 6, pp.25–31, April 2003.

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November 26, 2012.

Notes

This section of *SHALE* provides an opportunity for contributors to present the partial results of ongoing research, publish less-than-normal-length articles, and provide "interesting facts".

Winter tides—*by Nick Doe*

In *SHALE* 6 we looked at the question of why there are two tides a day and not one; and in *SHALE* 5, we went some way to answering the question as to why the tide on Gabriola is so often low when if you looked at the position of the moon and sun you'd expect it to be high. The reason is that, although the tide in the day in summer really should be high, particular if it's a new or full moon, it isn't because it takes several hours for changes in the level of the open Pacific to filter through to the Strait of Georgia. The expected day-time high, which does occur on the open west coast of Vancouver Island, doesn't get to Gabriola until later on in the evening.

For reasons we'll get to shortly, the sun has a strong influence on our local tides, so time-of-day is more important for us than it is in many other places in the world.

All of those readers who got to the end of the piece on "summer tides" without getting more than mildly confused can give themselves five points—I don't really think I'm worth more than four myself—however, you must deduct two of those points if the following question didn't occur to you. Here it is:

> Forget for a moment the tidal delay in the straits and just accept that the tide in the summer tends to be low during the day when the sun is highest in the sky. Then why isn't the tide also low in the winter around mid-day? After all, the sun may not be as high in the sky at noon on a mid-winter's day as it is in summer, it is none-the-less higher at noon than at any other time of the day or night.

Hmm… The background to this question is of course that everyone who lives on Gabriola knows that in the winter, low tide occurs at night, and the tide is often high just about when you want to go get some oysters for brunch.

Well…don't panic—the answer's fairly simple. The tide actually *does* tend to be low at mid-day in the winter, too. It's just not *very* low that's all.

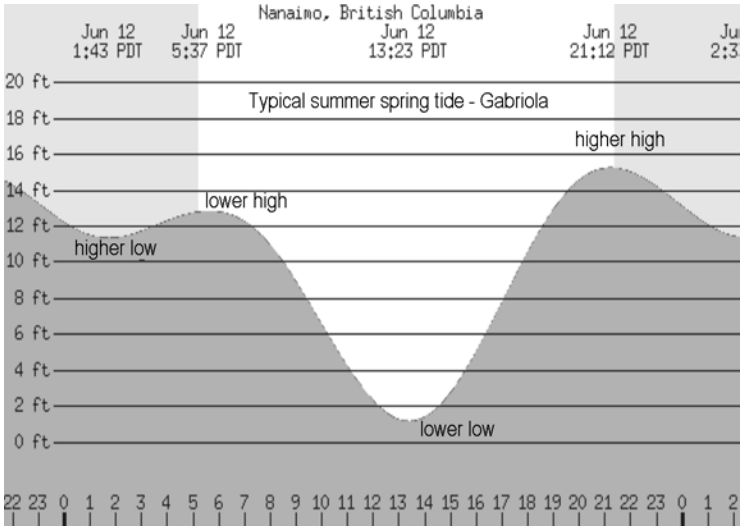
Take a look at the diagrams on the next page. They show typical spring tides[1] in summer and winter on Gabriola, and on the west coast of Vancouver Island. When you look at the tides associated with a particular age of the moon, winter tides are just the same as summer tides except that they occur twelve hours (half a solar day) apart. We notice this change on Gabriola because here, around the time of the solar solstices, the two daily low tides are very unequal in height. On the west coast, the difference is not so great.

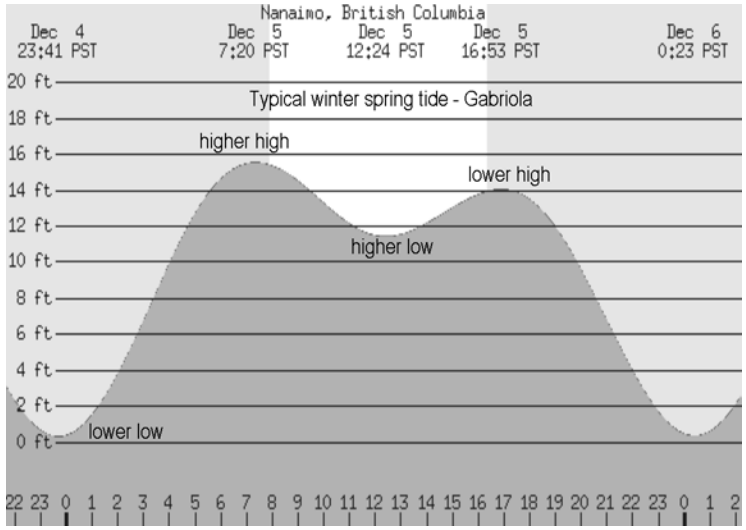
[1] I wish there were another name for these. How many times have you read that there's no connection between "spring", the season, and "spring", the tide? A spring tide is a tide that occurs whenever the moon, earth, and sun are roughly aligned—from a few days before until a few days after new moon, and again at full moon. Spring tides are larger than average because on "spring-tide days" the solar and lunar tides are going up and down together instead of at different times of the day and night.

Notes

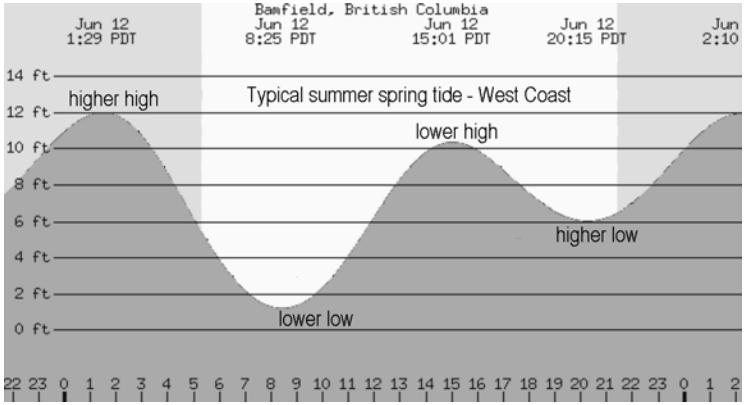
On Gabriola in the summer (left), the low low-tide tends to occur during the day, while the high low-tide tends to occur during the night.

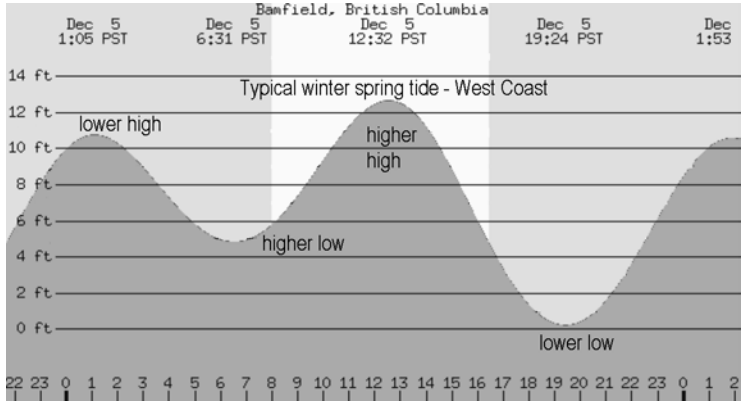
In winter (right), it's the reverse.



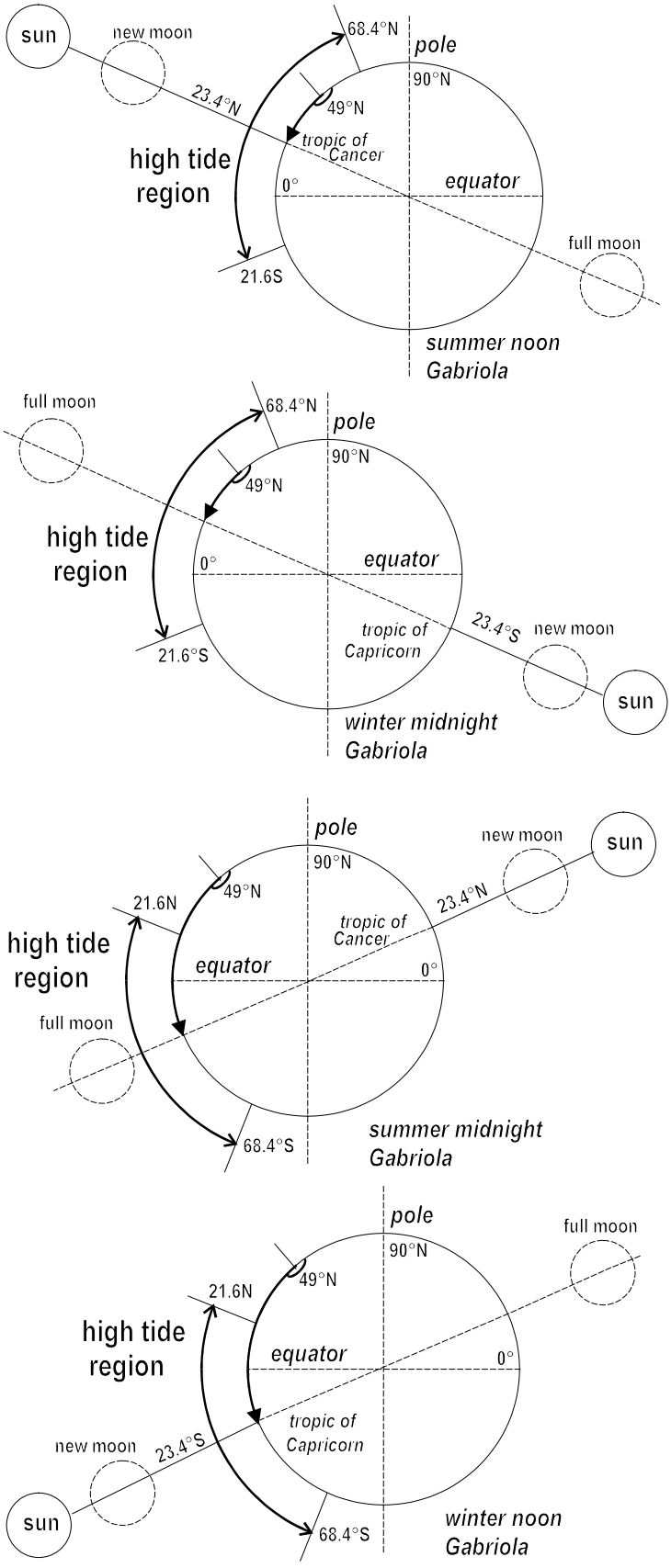


Out on the west coast of Vancouver Island, there's the same seasonal change between lower and higher tides; however, the change is less noticeable because the two daily tides in the open Pacific are more nearly equal.





David Flater & Jeff Dairiki http://www.dairiki.org/tides



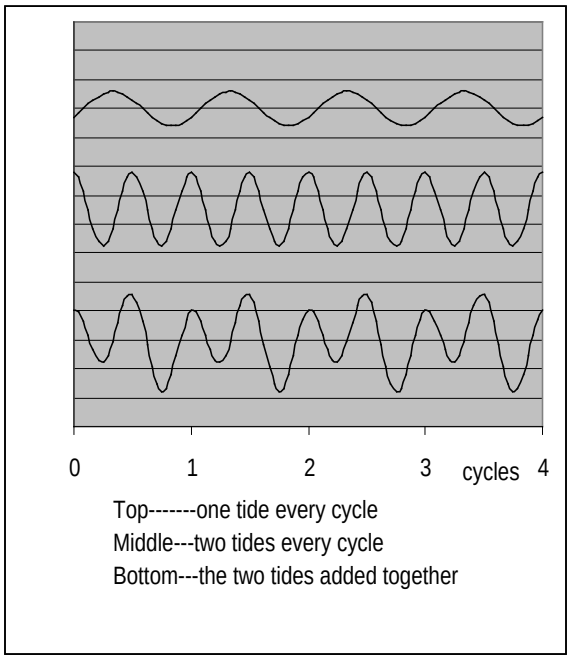
The similarity between summer noon and winter midnight tides, for the same age of moon, is a result of geometry.

In summer (*top diagram*), the noon sun is directly overhead off the coast of Mexico at the tropic of Cancer (23.4°N), about fifteen hundred nautical miles south of Gabriola. This is close enough to result in high spring tides off the BC coast. These correspond to low low-tides on Gabriola.

In winter (*second diagram*), the midnight sun is directly overhead in the southwest Indian Ocean off of Madagascar at the tropic of Capricorn (23.4°S) on the other side of the earth. This spot is on a direct line through the centre of the earth to the Pacific, and so, because both the moon and sun create equal tides on both sides of the world, the tides are almost exactly the same as in the first diagram.

In summer (*third diagram*), the midnight sun is directly overhead somewhere in the Gulf of Oman. This spot is on a direct line through the centre of the earth to the remote south Pacific, not far from Pitcairn Island—a long way from the BC coast—so the high springs are not very high. These correspond to high low-tide (springs) on Gabriola.

In winter (*bottom diagram*), the noon sun is directly overhead in the remote south Pacific, so again, the high off the BC coast is not very high, and the tides are practically the same as they are in the third diagram.



The movement of the sun's position either side of the equator every solar year, and the equivalent movement of the moon's position every "lunar year", or month as we call it, means in effect that we have, not two equal highs and two equal lows a day, but two unequal highs and two unequal lows a day. Only at the time of the equinoxes, when the sun is above the equator, do the two solar highs and the two solar lows become the same; and only at the time of the lunar equinoxes (which occur twice a month) do the two lunar highs and the two lunar lows become the same.

Another way to look at this is to consider there to be not two tidal cycles—a lunar cycle every 12 hour 50 minutes, and a solar cycle every 12 hours—but four cycles. The four cycles being the two semi-diurnal cycles just mentioned plus a lunar diurnal cycle every 25 hours 40 minutes, and a solar diurnal cycle every 24 hours. The graph *above* illustrates the principle that if you add two components, one (the stronger) with twice the frequency of the other, you create a waveform with two unequal peaks and two unequal troughs per cycle.[2]

So now, given that the two daily high, and the two daily low tides, are unequal, why are they more unequal in the Strait of Georgia than they are on the open coast? The answer is surprisingly simple, and is as follows:

Whenever the water-level in the open Pacific differs from what it is in the strait, water flows into or out of the strait through the narrow passageways of the Gulf and San Juan Islands in the south, and the islands of Discovery Passage and Desolation Sound in the north. The rise or fall in the water-level in the strait is thus dependent on two things: the difference in height between the water in the open ocean and in the strait (this determines the velocity of the flow through the tidal channels); and the duration of flow.

This last point is the crucial one. If, for example, you *double* the time that you allow water to flow into the strait, you effectively *double* the water-level rise. And because the diurnal tides last twice as long as the semi-diurnal ones before they change direction, the ratio of the diurnal to semi-diurnal tides in the strait is *double* what it is in the open ocean. Out at Tofino, the ratio of the diurnal to semi-diurnal tides is about 0.47, but in the strait, and here on Gabriola, it is about 1.06. Our diurnal tides are as strong, if not stronger, than our semi-diurnal tides, which is why the solar diurnal tide is so noticeable. And that's (almost) all there is to it. ◊

[2] If you think having four tides is complicated, now isn't the time to tell you that oceanographers consider there to be 46 tidal cycles in the Strait of Georgia, and 64 in Nanaimo Harbour. These additional cycles allow for the irregular movements of the sun and moon in the sky, and the non-constant strengths of their gravitational pulls (because the earth and moon's orbits are not circular). In Nanaimo Harbour, they also allow for the fact that tidal components are not additive in shallow water.