SHORE STEWARDS NEWS

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Welcome to Adria Banks, new Skagit County Shore Stewards Coordinator!

Welcome to new Skagit County Shore Stewards Coordinator, Adria Banks! Adria joined WSU Extension on January 2, 2008 and will now be sharing responsibility in preparing *Shore Stewards News* and providing information to Shore Stewards in Skagit County. Chrys Bertolotto will continue as the Snohomish County Coordinator. Given Adria's expertise in marine mammal research, her presence will be a great asset to the program. Look for more frequent *Shore Stewards News* as a result! Also stay tuned for shoreline resident workshops this fall in a community near you, thanks to a grant from the Washington Department of Ecology.

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Tides in Puget Sound: In Brief

To all who live along Puget Sound, the rhythmic rise and fall of the tide is a backdrop to your every day happenings. To many of us, they are a mystery. This newsletter will explain why tides occur, what factors affect them, some common tidal terminology and how they are predicted.

Tides occur in response to the attraction of the sea by the moon and, to a lesser degree, by the sun. Puget Sound tides are solitary waves, or currents, that have a period of about 12 hours, 25 minutes and a length of about half the circumference of the earth (12,600 miles). Waves seen on the surface of the water, caused largely by wind, are not the same as tides. The tide wave moves into Puget Sound mostly through the Strait of Juan de Fuca, and to a much lesser degree, the Strait of Georgia from the north. Over 100 factors affect the height of tides at the shoreline, making tidal height a very difficult thing to predict.

Earth, Moon, Sun and Bulges

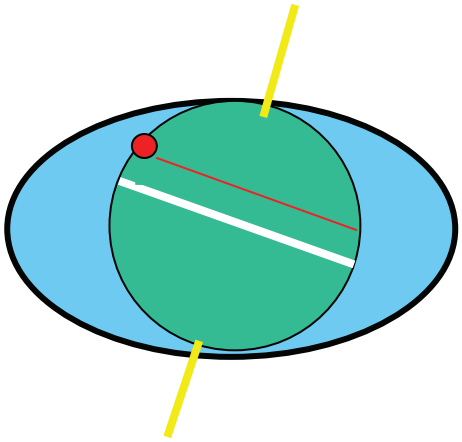
Tides are caused by two forces: gravitational force and centrifugal force. Gravitational force is the force of the attraction between two masses or bodies which has a tendency to pull the two bodies towards each other. A great example of this is an apple falling from a tree to the earth. Centrifugal force is a force outward, exerted by a mass moving in a curved path. Centrifugal force is what keeps people inside of roller coaster cars at the top of a loop instead of each person falling out of the car.

The earth rotates around the sun in a circular orbit because the inward pull between the two bodies (gravitational force) is exactly equal to the outward push (centrifugal force) on earth.

The same two forces affect the earth's surface waters, the land and the atmosphere. Because water is a fluid, it sloshes around a bit in the process, causing tides. The results to the land and atmosphere cannot be observed by the unaided eye.

The moon exerts gravitational force on the earth as well. Although the sun has 27 million times the mass of the moon, it is 390 times farther from the earth, resulting in the moon's pull on earth being 2.2 times greater than the sun's. That is why the tides are mainly affected by the pull and relative location of the moon rather than the sun.

The gravitational attraction between the earth and moon are strongest on the side of the earth that is facing the moon. The moon's gravity pulls the water nearest the moon slightly away from the solid part of the earth. At the same time the moon pulls the earthly slightly away from the water on the opposite side of the earth. In this way, the moon's gravity produces two ocean bulges. The bulge is always greatest on the side of the earth that faces the moon, since that is where gravitational force is greatest. The two bulges will stay roughly aligned with the moon as the earth rotates. Because the earth takes 24 hours, 50 minutes to rotate relative to the moon, one place on earth will experience two tidal highs and two tidal lows in that time frame. Our most extreme tides happen when the earth, sun and moon are all in a line.



Lastly, consider that the earth rotates on its axis. If we follow one point on earth around the globe as it passes through high and low tide scenarios, unless you are at the equator, the two high tides will be unequal, and the two low tides will be unequal. Go ahead, put your finger on the red dot on the graphic to the right and follow the red line. Do you see the different sizes of the bulges that spot will experience as the earth rotates?

With all these permutations, and many more, it takes the moon 18.5 – 19 years to pass through all possible bulge creating positions.

Commonly Used Tide Terminology

We have something called a mixed semidiurnal (semi-daily) tide in Puget Sound. It means we have two unequal high tides and two unequal low tides every day. This goes back to the fact that the earth is tilted in its rotation and does not move through both of the ocean bulges in the same location each day. Related terms are high high (the highest daily tide), low low (lowest daily tide), high low (secondary low tide) and low high (secondary high tide).

Spring tides are the most extreme tides of the month and neap tides have the least tidal range. Spring tides are when the earth, moon and sun are all in a line, creating the largest tidal bulges.

Incoming rising tides are flood tides. Outgoing falling tides are ebb tides. The lull between the ebb and flood tides are slack tides.

Mean Lower Low Water is the term that regulators refer to when considering permit applications for bulkheads, piers and other fixed structures. The Mean Lower Low Water level is the average of all the lower low waters over time. Mean Higher High Water is the average of all the higher high waters over time.

Other Factors Affecting Tides

There are over 100 factors that can affect what tidal height we see on a beach. They can be largely captured in the headings of topography (shape of the land), bathymetry (shape of the water bodies' bottom) and weather.

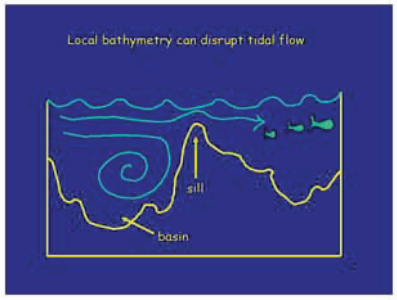
Topography. As water moves from wider areas into more restricted areas, the speed of the water movement is increased. At Deception Pass, a very narrow channel, the maximum speed has been recorded at 8 knots. The inverse is true as well – water moving into wider areas will slow down.

The shapes of bays and inlets can also affect tidal circulation. It may look like a tide is ebbing in an embayment even

as it is flooding. This is because an incoming tide will move laterally along a shoreline in some areas rather than straight in and out. Port Gardner is an example.

The location of a shoreline, too, can affect the observed tidal height and the delay in tidal change. As high water tides run out of places to go, they tend to pile up on land causing more extreme tidal heights. Therefore beaches that are at the "end of the line" tend to have greater tidal ranges than other areas. That is why we see the highest tidal variations in South Puget Sound. In addition, those areas have to wait longest for the tidal changes to be felt. In the South Sound, tidal changes occur approximately four hours after they are initiated at the mouth of the Strait of Juan de Fuca.

Lastly, the shape of a beach can have a very large impact on how dramatic a tidal change is observed. The difference isn't in the tide; it is in how much beach is exposed with each change. A shallow beach will expose much more beach at a low tide of the same height as a steep beach.



Local bathymetry. The bottom of Puget Sound is not flat. There are deep areas and shallow areas. There are also sills, or ridges in a few different places in the sound. The most famous sill in Puget Sound is at the mouth of Hood Canal. Due to the high sill, tidal circulation is restricted, as shown on the picture.

Weather. Pressure systems can also affect tides. When there is a high pressure system off shore, it acts like a weight on the water, pushing it up higher around the edges (shorelines, in this case). In addition, winds can affect the tidal height. An off shore wind (blowing from land to sea) will blow the tidal currents away from the beach, making the observed tidal height less than predicted. High tides coupled with an onshore wind and winter storms can create extreme tidal heights that have been known to cause major property damage.

Predicting Tides

By using astronomical data, it is possible to predict the tides with considerable accuracy. However, the height and time of the tide at any place not on the open coast are primarily a function of the local landscape, distance to the ocean and weather.

There are several places you can find your local tidal predictions. There are tide charts available for just a few dollars at any bait shop, although they are all mostly showing Seattle area tides. Tides are still provided in standard telephone books and in the weather section of daily newspapers. Today, most people use websites where you can choose a certain location and a set series of dates and see the predicted tides for that area. Two frequently used sites are:

www.saltwatertides.com www.mobilegeographics.com/pugetsoundtides.html

References / Resources

This newsletter was prepared by Chrys Bertolotto, WSU Extension / Snohomish County drawing heavily on a draft tides article by retired WSU Extension / Snohomish County Natural Resources faculty John Munn as well as using the following resources:

- Washington Tides, Williams, Robert E and Alyn C. Duxbury, Washington Sea Grant, 1975.
- The World Book Encyclopedia, Volume 18, Pages 218-220, 1967.
- Salish Sea Tides PowerPoint presentation prepared by Jan Holmes, WSU Beach Watcher / Island County, 2005.

Graphics provided by Jan Holmes, Salish Sea Tides PowerPoint presentation.