



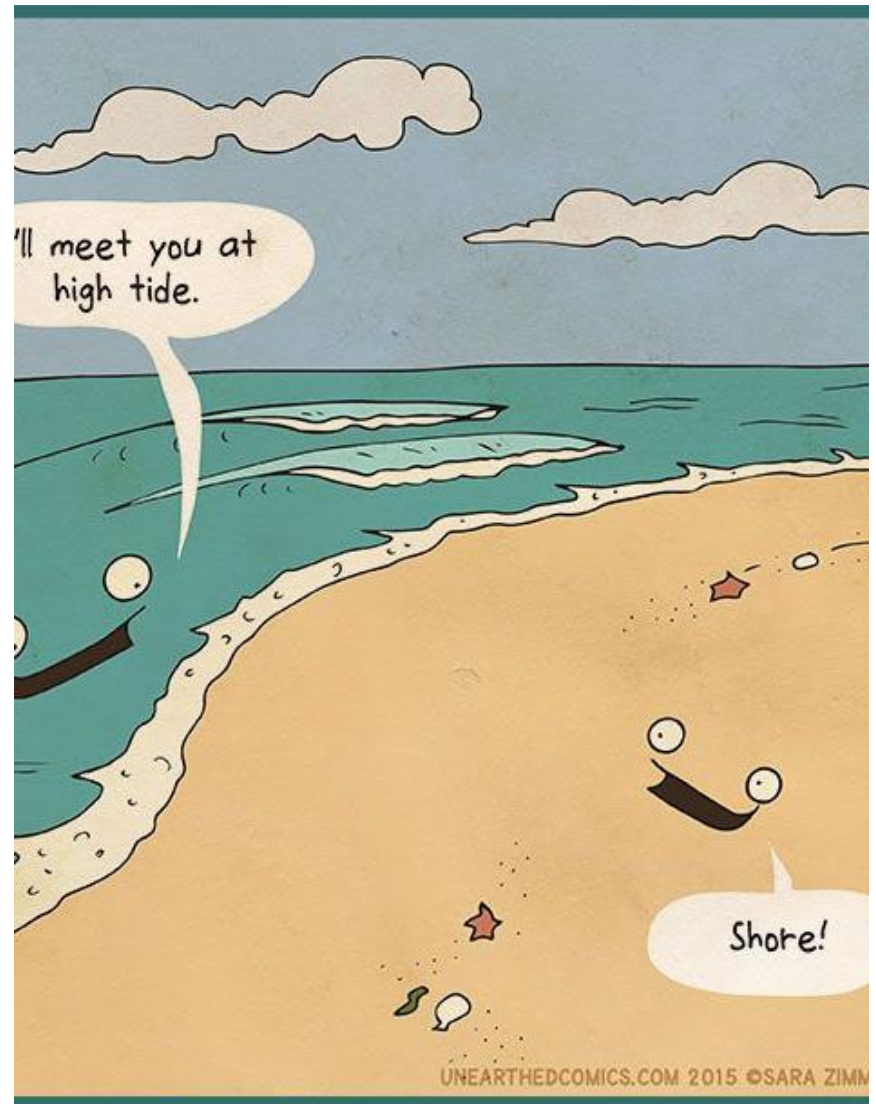
# SERC Tides and Currents

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# Tides and Currents Contents

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# Tide Overview

**Objective:** to understand the tides and currents in San Francisco Bay and to make sense of all those "eyes glazing over" numbers in the tide book.

- Tides go up and down; currents move left and right.
- Tides are driven by the gravitational force of the moon and sun. Tides are characterized by water moving up and down over a long period of time.
- The current describes the motion of the water. Oceanic currents are driven by several factors. One is the rise and fall of the tides. Tides create a current in the oceans, near the shore, and in bays and estuaries along the coast. These are called "tidal currents." Tidal currents are the only type of currents that change in a very regular pattern and can be predicted for future dates.
- A second factor that drives ocean currents is wind. Winds drive currents that are at or near the ocean's surface. These currents are generally measured in meters per second or in knots (1 knot = 1.85 kilometers per hour or 1.15 miles per hour). Winds drive currents near coastal areas on a localized scale and in the open ocean on a global scale.
- A third factor that drives currents is thermohaline circulation - a process driven by density differences in water due to temperature (thermo) and salinity (haline) in different parts of the ocean. Currents driven by thermohaline circulation occur at both deep and shallow ocean levels and move much slower than tidal or surface currents.



# Tide Overview

- The current ebbs (empties) and floods (fills up).
- Currents are measured in knots. 1 knot = 1.15 miles.
- Ebbs generally range from 2 to 6 knots.
- Floods generally range from 1 to 4 knots.
- Gravitational pull of the sun and the moon causes the variation in speed. (High and low pressures systems, rain run-off and snow melt also influence.)
- The full ebb / flood cycle lasts approximately 12.5 hours with the ebb portion lasting 7-8 hours and the flood 4-6 hours.
- Water level can vary up to 8 feet creating powerful currents.

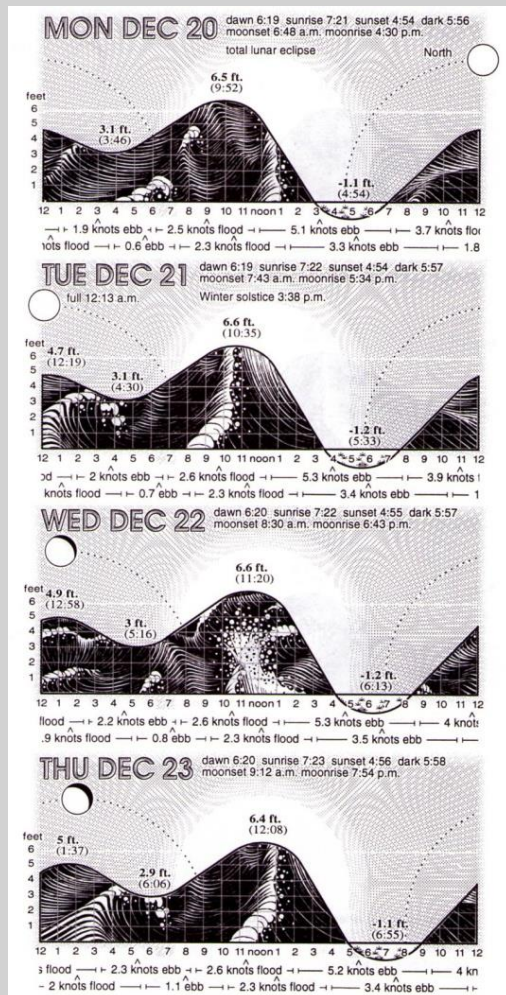
*TAKEAWAY - we swim in a river.*



# Two Types of Tide Tables

## Sinusoidal Tide Table

## Tabular Tide Table



**DECEMBER**  
**TIDES AT GOLDEN GATE, CALIFORNIA - 2010**  
Heights in feet Pacific Standard Time

Day	Time	Low	High	Low	High
1 Wed	0035	1.5	0726 6.3	1404 0.1	2040 4.3
2 Thr	0130	1.9	0808 6.6	1454 -0.6	2148 4.5
3 Fri	0223	2.3	0850 6.8	1541 -1.0	2248 4.7
4 Sat	0314	2.6	0933 6.8	1626 -1.3	2341 4.9
5 Sun	0404	2.8	1015 6.8	1709 -1.4	
6 Mon	0031	4.9	0452 2.9	1057 6.6	1752 -1.3
7 Tue	0117	4.9	0541 3.0	1140 6.3	1833 -1.1
8 Wed	0202	4.9	0632 3.1	1223 6.0	1915 -0.7
9 Thr	0246	4.9	0726 3.1	1307 5.6	1957 -0.3
10 Fri	0328	4.9	0826 3.0	1355 5.1	2040 0.1
11 Sat	0409	4.9	0932 2.9	1448 4.6	2123 0.6
12 Sun	0447	5.0	1043 2.6	1552 4.1	2209 1.1
13 Mon	0524	5.1	1150 2.2	1710 3.7	2258 1.6
14 Tue	0600	5.3	1249 1.7	1840 3.6	2348 2.0
15 Wed	0636	5.5	1339 1.1	2006 3.6	
16 Thr	0040	2.4	0713 5.7	1422 0.6	2115 3.9
17 Fri	0130	2.7	0751 5.9	1502 0.1	2211 4.1
18 Sat	0217	2.9	0830 6.1	1539 -0.4	2257 4.4
19 Sun	0302	3.0	0911 6.4	1616 -0.8	2339 4.6
20 Mon	0346	3.1	0952 6.5	1654 -1.1	
21 Tue	0019	4.7	0430 3.1	1035 6.6	1733 -1.2
22 Wed	0058	4.9	0516 3.0	1120 6.6	1813 -1.2
23 Thr	0137	5.0	0606 2.9	1208 6.4	1855 -1.1
24 Fri	0217	5.2	0701 2.7	1259 6.1	1939 -0.8
25 Sat	0258	5.4	0804 2.5	1355 5.5	2024 -0.3
26 Sun	0341	5.6	0914 2.2	1501 4.9	2112 0.4
27 Mon	0425	5.8	1029 1.7	1619 4.3	2204 1.0
28 Tue	0511	6.1	1144 1.1	1753 4.0	2301 1.7
29 Wed	0559	6.3	1252 0.4	1930 3.9	
30 Thr	0004	2.2	0649 6.5	1353 -0.2	2052 4.2
31 Fri	0107	2.6	0740 6.6	1446 -0.6	2157 4.5

**LUNAR DATA**  
 ● = NEW MOON    ○ = LAST QUARTER    N = FARTEST NORTH OF EQUATOR  
 ● = FIRST QUARTER    A = IN APOGEE    E = ON EQUATOR  
 ○ = FULL MOON    P = IN PERIGEE    S = FARTEST SOUTH OF EQUATOR

**DECEMBER**  
**CURRENTS AT GOLDEN GATE ENTRANCE 2010**  
SOUTH OF PT. DIABLO Pacific Standard Time

Day	Slack	MAX Current	MAX Current	MAX Current	MAX Current	Slack
1 Wed	0259	0600 3.2F	0902 1209 4.4E	1608 1906 3.4F	2213	
2 Thr		0036 2.5E	0353 0651 3.1F	0946 1301 4.9E	1701 2005 3.8F	2317
3 Fri		0135 2.4E	0445 0740 3.1F	1031 1351 5.3E	1752 2059 4.1F	
4 Sat	0015	0230 2.3E	0536 0828 3.0F	1117 1440 5.4E	1841 2149 4.2F	
5 Sun	0109	0321 2.2E	0625 0916 2.9F	1202 1526 5.4E	1928 2237 4.2F	
6 Mon	0159	0408 2.1E	0714 1002 2.7F	1248 1612 5.3E	2015 2323 4.0F	
7 Tue	0246	0454 2.0E	0802 1048 2.6F	1333 1657 5.0E	2101	
8 Wed		0008 3.8F	0332 0539 2.0E	0852 1136 2.3F	1419 1742 4.7E	2146
9 Thr		0052 3.6F	0417 0625 2.0E	0946 1225 2.1F	1507 1827 4.2E	2230
10 Fri		0136 3.3F	0501 0712 2.0E	1044 1317 1.8F	1559 1914 3.7E	2315
11 Sat		0220 3.0F	0544 0801 2.1E	1146 1414 1.7F	1657 2003 3.2E	
12 Sun	0000	0305 2.8F	0625 0852 2.3E	1250 1516 1.6F	1802 2054 2.8E	
13 Mon	0045	0349 2.6F	0706 0943 2.5E	1351 1623 1.7F	1912 2149 2.3E	
14 Tue	0132	0435 2.4F	0745 1034 2.9E	1448 1730 1.9F	2023 2245 2.0E	
15 Wed	0220	0520 2.3F	0824 1124 3.2E	1539 1831 2.2F	2129 2341 1.8E	
16 Thr	0307	0605 2.3F	0904 1212 3.7E	1626 1925 2.5F	2230	
17 Fri		0036 1.7E	0354 0649 2.3F	0943 1259 4.1E	1710 2012 2.9F	2325
18 Sat		0128 1.7E	0438 0733 2.3F	1023 1344 4.5E	1753 2055 3.2F	
19 Sun	0015	0216 1.8E	0521 0816 2.4F	1103 1429 4.8E	1834 2137 3.5F	
20 Mon	0102	0303 1.9E	0603 0900 2.5F	1144 1513 5.1E	1915 2218 3.7F	
21 Tue	0147	0349 2.0E	0646 0944 2.6F	1226 1558 5.3E	1957 2300 3.9F	
22 Wed	0231	0436 2.2E	0732 1030 2.6F	1312 1644 5.3E	2039 2342 4.0F	
23 Thr	0314	0523 2.3E	0824 1119 2.6F	1401 1731 5.2E	2122	
24 Fri		0026 4.0F	0357 0612 2.6E	0921 1212 2.6F	1455 1820 4.9E	2207
25 Sat		0111 3.9F	0440 0703 2.8E	1025 1310 2.5F	1556 1912 4.3E	2253
26 Sun		0159 3.7F	0523 0756 3.1E	1133 1414 2.4F	1706 2007 3.7E	2343
27 Mon		0248 3.4F	0606 0852 3.5E	1244 1524 2.5F	1824 2106 3.1E	
28 Tue	0035	0341 3.2F	0652 0949 3.8E	1352 1639 2.7F	1943 2209 2.5E	
29 Wed	0132	0436 2.9F	0740 1049 4.2E	1456 1754 3.0F	2100 2315 2.1E	
30 Thr	0232	0533 2.8F	0830 1147 4.5E	1556 1902 3.3F	2211	
31 Fri		0023 1.9E	0332 0629 2.7F	0921 1244 4.8E	1651 2001 3.7F	2313

# Tides and Currents

## **Tides** (using Tabular Tide Table)

Data is listed for the Golden Gate Bridge. At Aquatic Park, high and low tides roughly 10-15 minutes later. Number following the time is the height, in feet, of the water above the average low tide.

## **Currents** (using Tabular Tide Table)

Max = the fastest velocity in the current's cycle.

Slack = the transition in direction of the current.

Currents generally begin along the shore and widen out into the Bay. Data is listed for the Golden Gate Bridge. Very general rule of thumb is slack at the Opening is one hour earlier than listed in the tide book.

# Calculating Actual Current

Currents listed for the Golden Gate Bridge are not the same throughout the Bay. Two data points are used to calculate the speed at any given location. The first comes from the **Factor Chart**. Select a “factor” based on the maximum speed of the current. Example: the “factor” for a maximum 4.9 ebb is **1.1**.

From the current tables the speed of the current at 17°21' (time of maximum current used as reference) is found to be 2.7 knots. For a predicted maximum flood speed of 2.7 knots the table gives a factor of 0.8 to be applied to the speeds on the chart. The approximate speed of the current in the channel off Point San Pablo is then found to be  $1.2 \times 0.8 = 1.0$  knot.

## FACTORS FOR CORRECTING SPEEDS

MAXIMUM FLOOD		MAXIMUM EBB	
Predicted speed (knots)	Factor	Predicted speed (knots)	Factor
0.5-0.8, multiply by.....	0.2	0.7-1.1, multiply by.....	0.2
0.9-1.1, multiply by.....	0.3	1.2-1.5, multiply by.....	0.3
1.2-1.4, multiply by.....	0.4	1.6-2.0, multiply by.....	0.4
1.5-1.8, multiply by.....	0.5	2.1-2.4, multiply by.....	0.5
1.9-2.1, multiply by.....	0.6	2.5-2.9, multiply by.....	0.6
2.2-2.4, multiply by.....	0.7	3.0-3.3, multiply by.....	0.7
2.5-2.8, multiply by.....	0.8	3.4-3.8, multiply by.....	0.8
2.9-3.1, multiply by.....	0.9	3.9-4.2, multiply by.....	0.9
3.2-3.4, multiply by.....	1.0	4.3-4.7, multiply by.....	1.0
3.5-3.7, multiply by.....	1.1	4.8-5.1, multiply by.....	1.1
3.8-4.1, multiply by.....	1.2	5.2-5.6, multiply by.....	1.2
4.2-4.4, multiply by.....	1.3	5.7-6.0, multiply by.....	1.3
4.5-4.7, multiply by.....	1.4	6.1-6.5, multiply by.....	1.4
4.8-5.1, multiply by.....	1.5	6.6-6.9, multiply by.....	1.5



# Calculating Actual Current

The second datum is the number obtained from the ***Tidal Current Charts***. Example: the “number” (highlighted in yellow) at Pier 7 one hour before max ebb is **2.7**.





# Exercise and Resources

## **Exercise**

To calculate estimated speed, multiple the "factor" x the "number."

Using the "factor" and "number" from the two previous slides, calculate the estimated speed at Pier 7 one hour before maximum ebb. (hint:  $1.1 \times 2.7 = ?$ )

## **RESOURCES**

Tides and Current Book available at SERC or any Harbor Master office.

## **URLS**

### Tides

<https://tidesandcurrents.noaa.gov/noaatideannual.html?id=9414290>

(click "download")

### Currents

[https://tidesandcurrents.noaa.gov/noaacurrents/Annual?id=SFB1201\\_26](https://tidesandcurrents.noaa.gov/noaacurrents/Annual?id=SFB1201_26)

(click "create")

## **APP**

AyeTides - select "San Francisco Bay Entrance (Outside), California Currents"