Aquatic Consulting Services
356 Sumner Ave. • P.O. Box 1418 • Avalon • California • 90704
Santa Catalina Island • (619) 602-4435 • alison@alisonosinski.com

Boating Tip #56: Waves

Ocean waves are wind generated, with the exception of tsunami which are a result of seismic activity such as earthquakes, and volcanic eruptions. The effect that wind will have on wave formation depends on the wind speed, the duration or amount of time the wind blows over an area, and its fetch. The fetch is the unobstructed distance over which the wind blows. When waves travel beyond the fetch, the wavelength, period and direction of travel become more uniform, and the seas are then referred to as swell. Waves exist as energy as the swell moves through the water. Water doesn't move in open oceans and lakes, although the opposite is true in rivers.

Capillary waves or ripples form first. As the size of a wave increases, it becomes narrower and steeper, developing the trochoid form unique to ocean waves.

Wave height (the vertical distance from the trough to the crest) is equal to $1/20^{th}$ of the wave length (the horizontal distance from crest to crest). Wave motion is circular, with the circles getting progressively smaller as you go deeper in the water.

The pattern changes as the wave approaches shore. The ocean bottom crowds the energy upward, motion becomes oval shaped or elliptical rather than circular, and actually flat on the ocean bottom, surging forward and back.

When water depth equals one half of the wave length, the bottom friction begins to slow the advancing wave. The back of the wave crowds the front of the wave and water piles up. The bottom of the wave is moving slower than the top of the wave, so the top begins to curl. A wave will break, creating surf, when the angle at the crest falls below 120°, or when the height of the wave is $1/7^{th}$ the length of the wave, or when wave height reaches 3/4 of the water depth.

The speed at which a wave travels in open water depends on its wavelength, and can be calculated using the formulas:

Speed (in knots) equals 3 times the interval period (in seconds)
____ $C = 3 \times T$

or

Speed (in knots) equals 1.34 times the square root of the wavelength (in feet)
____ $C = 1.34 \sqrt{\lambda}$

T (Period)	Λ (Wavelength)	C (Speed)
6 seconds	182 feet	18 knots
7 seconds	242 feet	21 knots
8 seconds	322 feet	24 knots
9 seconds	408 feet	27 knots
10 seconds	502 feet	30 knots
11 seconds	610 feet	33 knots
12 seconds	725 feet	36 knots
13 seconds	850 feet	39 knots
14 seconds	985 feet	42 knots
15 seconds	1,128 feet	45 knots
16 seconds	1,284 feet	48 knots

When waves move toward shallower water, wave speed decreases, the wave length becomes shorter and height increases. Wave speed in shallow water is more dependant on the depth of the water, and can be calculated using the formula:

Speed (in knots) equals 3.4 times the square root of the water depth (in feet)
____C = 3.4 \/ h

C (Speed)	
1 foot	3.4 knots
2 feet	4.8 knots
3 feet	5.9 knots
4 feet	6.8 knots
5 feet	7.6 knots
6 feet	8.3 knots
7 feet	9.0 knots
8 feet	9.6 knots
9 feet	10.2 knots
10 feet	10.7 knots
11 feet	11.2 knots
12 feet	11.7 knots
13 feet	12.2 knots
14 feet	12.7 knots
15 feet	13.1 knots
16 feet	13.6 knots
17 feet	14.0 knots
18 feet	14.4 knots